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ESTONIAN MIRES: INVENTORY OF HABITATS

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PUBLICATION OF THE PROJECT "ESTONIAN MIRES INVENTORY COMPLETION FOR MAINTAINING BIODIVERSITY"

Compiled by Jaanus Paal and Eerik Leibak

Tartu, 2011

The project was financially supported by the EEA and Norway Grants, Estonian Environmental Investment Centre and Ahti Heinla.

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FOREWORD

The aim of the project "Estonian Mires Inventory completion for maintaining biodiversity" was to complete the inventory of all mires in Estonia and, on the basis of the inventory results, to develop recommendations (including reference to required restrictions) concerning the potential use of these wetlands. There has been an inevitable necessity to complete such an inventory – without this it is neither possible to assess objectively the conservation status of those habitats, nor to estimate the sufficiency and circumstances of sites currently included in the Natura 2000 network. These data are also of value for other countries in the boreal biogeographic region, especially for monitoring of mires of international importance and for responsibility habitats identifying.

This project was built upon the results and experience of the project "Estonian Wetlands Conservation and Management Strategy", implemented using co-financing of the World Bank Norwegian Trust Fund in 1997. During the wetland inventory in 1997, 1,560 wetlands were studied using the same methodology as in the present project. The results from that project allowed to make several proposals to protect wetlands with high conservation value which was especially important for the implementation of the EU Habitats Directive in Estonia.

In the course of the current project 13,901 areas were studied of which 8,676 were determined as mires and 603 sites including mires as marginal habitats. This means that for the first time we have the total overview about all areas in Estonia covered by mire vegetation, and their conservation value. The findings also specify our knowledge regarding the coverage of Estonian territory by mires. Until now 22.3% or 1,009,101 ha have been defined as peatlands and this figure has often been transferred to mires. According to the present inventory the surface of mires is 233,000 ha or 5.2% of Estonia's territory. Unfortunately, the inventory once again brings us to a conclusion that the total surface of Estonian mires has decreased by nearly 2.8 times as compared to the data from the 1950s.

The mission of the Estonian Fund for Nature is to preserve the rich natural diversity in Estonia and in the world. The inventory made it possible to work in this direction and we appreciate the continuous support by Norway through EEA and Norway Grants. Our gratitude also belongs to the Estonian Environmental Investment Centre (SA Keskkonnainvesteeringute Keskus) and private funder Ahti Heinla for their financial support to the project. We also thank the Estonian Environmental Board for its contribution.

The two-year project has been difficult for the executive team of the project, the 152 experts and assistants who carried out the field works, and for the contributors of this publication – thank you all for your contribution.

Jüri-Ott Salm
Managing Director
Estonian Fund for Nature

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INTRODUCTION AND TERMS

The importance of wetlands, *incl.* mires¸ is nowadays widely recognized and in many countries numerous efforts have been implemented to protect or restore them. These ecosystems encompass a large variety of wildlife habitats supporting landscape and biological diversity; species at risk, freshwater quality, hydrological integrity, carbon storage and sequestration, but also geochemical and palaeo archives. In addition, they are inextricably linked to social, economic and cultural values important to human communities worldwide (Joosten & Clark, 2002). Peatlands and their related environmental and social values are specific at national, regional and local levels and, therefore, any actions to use these values either by protecting or managing should be adapted to the specific socio-economic, cultural and ecological conditions (Clarke & Rieley, 2010).

From one aspect peat has a substantial importance in several countries as a fuel and international demand of peat for horticulture is also not decreasing; from the other aspect peatlands store very large amounts of carbon that can be released to the atmosphere by exploiting this resource, contributing to the anthropogenic greenhouse effect. Managing such conflicting values is not easy and becomes a political and economic debate as much as a scientific issue (Charman, 2002).

In the Strategy for Responsible Peatland Management (Clarke & Rieley, 2010) it has been stressed that peatland management activities influencing habitats, species or genetic diversity of peatland ecosystems should:

1. maintain, through government legislation and conservation designations and actions, the biodiversity and natural resource functions of representative examples of important mire types and semi-natural peatland ecosystems;
2. recognize the importance of all peatlands as important reservoirs of biodiversity, and ecosystem services at the landscape level and integrate them within land use planning and management procedures;
3. include actions to safeguard peatland ecosystem functions when planning and implementing management interventions for specific sites;
4. include biodiversity protection and enhancement in after-use plans for peatlands used for peat extraction, forestry, agriculture and other uses;
5. take actions to maintain and/or enhance biodiversity on drained, cut-over and degraded peatlands through appropriate planned management during and after use;
6. maintain as much peatland biodiversity as possible in areas adjacent to those where peatlands may be lost forever (e.g. flooding for generation of hydro-electricity or removal of the peat for sub-surface mineral extraction).

In Estonia, forestry and agriculture are the dominant types of land-use, carried out on 21,974 km^2 (50,3%) and 13,805 km^2 (31.6%) of the total territory, respectively (Pärt et al., 2010). At the same time, wetlands (open mires, peatland forests, floodplains, etc.) are widespread landscapes, covering 25–30% of the country's territory, including a substantial fraction of agricultural and forest land. The management of wetlands is, accordingly, an important component of agricultural and forestry land-use. Moreover, peat excavation takes place on many bogs, agricultural practice and urban development are influencing the coastal wetlands and floodplains. Those facts indicate at the strenuous need for a strategy for their wise usage and management.

In the course of the "Estonian Wetlands Conservation and Management Strategy" project (Paal et al., 1998) implemented in 1997, the criteria for evaluating wetlands nature protection value, based on the Estonian Environmental Strategy were elaborated. An inventory of 1,376 wetlands was carried out using unified criteria and a database connected with geographical information system was created. Recommendations for future management and/or conservation of the examined wetlands were presented. Considering the specific task of the project, principles for selecting drainage systems for rehabilitation, recommendations for evaluating the state of wetlands in the course of drainage planning, as well as various measures for reducing conflict among different interests were discussed.

The current project is principially a continuation of the work accomplished in 1997. The general aim of the project is to complete the inventory of all mires in Estonia, and on the basis of these results to develop a national strategy for management of mires.

In 2005 the State Audit Office audited the activities of the state in planning the use of peat resources and managing their extraction[1]. On that ground it was suggested to the Ministry of the Environment that they stop issuing of new permissions for mining regarding mires or parts of mires which are not mined yet. This was done in order to sustain the use of peat and conserve valuable sites. The current project will support the implementation of that suggestion and provide reliable data needed for decision makers and interest groups regarding possible mining in new sites. At the same time, the project results will be of use for local municipalities and different governmental departments in the process of issuing relevant permissions, approvals or other documents concerning the use of natural resources within wetlands and their surroundings. In that way the results of the project enable wise and sustainable use of peat as a natural resource by producing objective baseline data for planning of peat-use on both regional and time level. The results are of value for providing local people living in the surroundings of mires with an overview concerning the future of those wetlands and thus enabling people to have some perspective views and confidence in the future of their home (milieu) and community.

According to the title, the "Estonian Mires: Inventory of Habitats" project is focused on mires leaving the other types of wetlands aside. Though the terminology concerning mires, peatlands, wetlands etc. has been rather well fixed during the last decades in scientific literature we still repeat below, for the sake of clarity, an explanation of some basic terms used in the following text.

Wetlands. The broadest definition of wetlands has been fixed in the Ramsar Convention on Wetlands[2]:

In the USA Clean Water Act[3], the term 'wetlands' has a notably limited scope; in this document wetlands are considered as "… areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas". In this book the term 'wetlands' is mostly used in the same scope if not marked otherwise.

Peat. In order to define 'peatland' we must first define 'peat'. Peat is sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material (Joosten & Clark, 2002).

Peatland is an area with or without vegetation with a naturally accumulated peat layer at the surface (Joosten & Clark, 2002).

Paludifying grassland is an open or treed area where peat layer depth is less than 30 cm.

Paludifying forest is an area where peat layer depth is less than 30 cm, with tree layer having an

1 Access at: http://www.riigikontroll.ee/tabid/206/Audit/1850/Area/15/ language/et-EE/Default.aspx#results (03.04.2011).

2 Access at: http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on-20708/main/ramsar/1-31-38%5E20708_4000_0_. Convention on Wetlands of International Importance Especially as Waterfowl Habitat Final Text adopted by the International Conference on the Wetlands and Waterfowl at Ramsar, Iran, 2 February 197 I. (02.04.2011).

3 Access at: http://cfr.vlex.com/vid/230-3-definitions-19816974. 40 CFR 230.3 - Definitions. (02.04.2011).

average height of trees more than 4 m and layer density more than 0.3 (projective cover more than 30%).

Mire is a peatland with peat layer at least 30 cm depth which is continuously forming and accumulating; in mire the average height of tree layer does not exceed 4 m and tree layer density is less than 0.3 (projective cover less than 30%).

Fen is a groundwater-fed (minerotrophic) mire.

Bog (raised bog, ombrotrophic mire) is a mire usually raising due to the thick peat layer above the surrounding landscape and where plants are fed only by precipitation.

Transitional (mixotrophic) mire is characterized both by minerotrophy and ombrotrophy: on higher microforms (hummocks) plants get their nutrients from precipitation only, while in depressions their roots reach the level of groundwater and get some additional nutrients from that.

Treed mire (Jeglum et al., 1974) is a mire with scattered tree layer having an average height of trees less than 4 m and tree layer density less than 0.3 (projective cover less than 30%).

Peatland forest is a peatland with tree layer having an average height of trees more than 4 m and layer density more than 0.3 (projective cover more than 30%).

Mire site is a complex of microsites and can be described on the basis of its components (microsites, microforms, features); in bogs these include hummocks, hollows, lawns, hollowpools, funnels and pools (Sjörs, 1948; Masing, 1982, 1984). A mire site can be composed by a single, very large feature (e.g. hummocks or lawns), or by two or more kinds of features (e.g. hummocks and hollows; hummocks, hollows and pools) which are repeated in indefinite numbers and alternate more or less in the same way all over the site (Sjörs 1948). Mire site /…/ is a combination of those mire features which, at any particular location, are under influence of fairly homogeneous hydrological conditions (Moen, 2002).

Mire massif (Galkina, 1946) or synsite (Moen & Singsaas, 1994) is the combination of mire sites that are usually found together. This is often the level/unit that is used when classifying and mapping mires (Rydin & Jeglum, 2006)

Mire complex consists of several mire massifs; it is bounded by dry mineral areas (Moen & Singsaas, 1994).

Mire system embraces several mire complexes what are separated by mineral ridges/areas but located in one landscape region.

Mire area is an inventoried mire contour on map. It can include one or several mire massifs.

Natura site (Natura 2000 site, Habitat Directive site) means an area/habitat that belongs to the Natura 2000 network and represents one or several habitat types of EU importance indicated in Habitat Directive Annex I (Habitat Directive, 1992).

Natura 2000 network is an ecological network of special protection areas hosting the natural habitats of types listed in Habitat Directive Annex I and habitats of the species listed in Annex II. The network shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range (Habitat Directive, 1992).

Site of Community Importance (SCI) means a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type indicated in Habitat Directive Annex I (Habitat Directive, 1992).

In the chapters 2 and 4 issues of wetlands *sensu lato* are discussed, whereas in chapters 5–8 only mires are dealt with.

THE INSTITUTIONAL BASIS FOR THE PROTECTION AND USE OF WETLANDS

2

2.1 Legal and political framework

2.1.1 International conventions

Estonia has acceded to several international conventions, under which the obligations have been taken to protect areas and objects, valuable for biological diversity or environment. According to section 123 of Estonian Constitution, in case of contradiction, the ratified international convention and other international legal acts are superior to domestic legal acts.[4]

The most relevant international conventions are following:

Ramsar (1971) Convention on Wetlands of International Importance especially as Waterfowl Habitat. The convention was ratified by Estonia on October 20, 1993 and it entered into force for Estonia on July 29, 1994.[5] Its main objective is the protection of wetlands and waterfowl. Wetlands in this context would cover mires and shallow fresh and marine water areas down to a depth of 6 m. Each state that has acceded to the convention, must determine at least one wetland as a so-called Ramsar Site. In Estonia, the wetlands of international importance are currently Soomaa, Vilsandi and Matsalu national parks, Emajõe Suursoo, Puhtu–Laelatu, Laidevahe, Alam-Pedja, Endla, Muraka, Nigula, Sookuninga ja Nehatu nature reserves, also Hiiumaa Islets and Käina Bay.[6]

Bern (1979) Convention on the Conservation of European Wildlife and Natural Habitats.[7] Estonia acceded to the convention on January 17, 1992 and it entered into force for Estonia on December 1, 1992. The purpose of the Bern Convention is conservation of European wild flora and fauna and their natural habitats and promoting international co-operation of the protection of wildlife, paying particular attention to the protection of endangered species, including endangered migratory species. For the achievement of these objectives, the convention foresees protection of all species of wild flora and fauna and their habitats and special protection of some species of flora and fauna. The species, belonging under the special protection are listed in Annex I (strictly protected plant species), in Annex II (strictly protected animal species) and in Annex III (protected animal species). In Annex IV, prohibited means and ways of capture and killing of animals are listed.[8] Several of these species are found in Estonian wetlands and mires.

4 Access at: (in Estonian): https://www.riigiteataja.ee/akt/12846827&leiaKehtiv (10.02.2011).
5 Access at: (in Estonian): https://www.riigiteataja.ee/akt/13058000&leiaKehtiv (10.02.2011).
6 Access at: http://ramsar.wetlands.org/Database/Searchforsites/tabid/765/language/en-US/Default.aspx (09.02.2011).
7 OJ Estonian special edition 2004, Chapter 11, Vol 14, p 282 (in Estonian).
8 Access at: (in Estonian): http://www.envir.ee/1091398 (09.02.2011).

The Rio de Janeiro (1992) Convention on Biological Diversity[9]. The convention was ratified on May 11, 1994 and entered into force for Estonia on October 25, 1994.[10] The objectives of this convention are: to protect biological diversity, to ensure sustainable use of its components and equitable distribution of the benefits arising from the exploitation of genetic resources.

The Helsinki Convention (1974/1992) on the Protection of the Marine Environment of the Baltic Sea Area. The convention was ratified on April 9, 1995 and entered into force for Estonia on May 9, 1995.[11] In addition to environmental problems of the Baltic Sea, the convention also pays attention to the conservation of natural habitats and biological diversity and to the protection of ecological processes throughout the Baltic Sea catchment area.

Of other relevant conventions that are currently in force in Estonia, the following are worth mentioning:

- the Helsinki (1992) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (signed by Estonia in 1992);
- the Washington (1973) Convention on International Trade in Endangered Species of Wild Fauna and Flora (ratified in Estonia on October 21, 1993).

2.1.2 The directives and the policy of the European Union

2.1.2.1 The directives of European Union

On the 1, May the 2004 Estonia acceded to European Union and consequently since this date, the legal acts of European Union must be applied in Estonia. The directives of the European Union must be transposed to Estonian domestic law, but the EU regulations are directly applicable.

For the protection of wetlands, the most important legal acts of the European Union are the Habitat Directive (1992) and the Bird Directive (2009). The habitat types and habitats of the species, including the list of types of wetlands, which need to be protected, are presented in annexes of these directives. A coherent European ecological network of special areas of conservation shall be set up under the title "Natura 2000" for the habitats listed in the annexes of the directives (Section 3 subsection 1 of the Habitats Directive). The member states fulfil the obligations provided in the directives by transposing them into their legal acts and practice.

The Water Framework Directive (2000) regulates the protection of wetlands as well. Its objective among other things is to prevent the deterioration of the condition of wetlands and to protect and improve their condition (section 1). The Annex VI part B of the directive provides creation or restoration of wetlands as an additional measure for the achievement of good ecological status of a water body. The Water Framework Directive and the Groundwater Directive (2006) protect indirectly terrestrial ecosystems, which are connected to water ecosystem, including wetlands. The Groundwater Directive also determines wetlands as an object of protection (section 3 subsection 1 b).

9 Access at: http://www.cbd.int/convention/text/ (22.04.2011).

10 Access at: (in Estonian): https://www.riigiteataja.ee/akt/12918700&leiaKehtiv (09.02.2011).

11 Access at: (in Estonian): https://www.riigiteataja.ee/akt/12918700&leiaKehtiv (09.02.2011).

Taking into account the general circulation of water and the fact that the Water Framework Directive also protects wetlands, following directives are worth mentioning as indirect means of the protection of wetlands:

- Commission Directive 2009/90/EC of 31 July 2009 laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status (OJ L 201, 1.8.2009, p. 36–38)
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council (OJ L 348, 24.12.2008, p. 84–97)
- Directive 2006/11/EC of the European Parliament and of the Council of 15 February 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. (Codified version) (OJ L 64, 4.3.2006, p. 52–59)
- Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. (OJ L 375, 31.12.1991, p. 1–8;…L 311, 21.11.2008, p 1)
- Council Directive of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC) (ELT L 020, 26.1.1980, lk 43–48;… L 377, 31.12.1991, p 48)

2.1.2.2 Commission communication on wetlands

On May 29, 1995 the European Commission published a communication on the wise use and conservation of wetlands.[12] In this document, the problems connected with wetlands and their value, the avoidance of deterioration, including drying out, restoration, appropriate use and management of wetlands, education and raising of awareness in connection with wetlands, also the integration of the protection and regulation into other sectors are described.

Communications of the European Commission create obligations neither for the states nor the persons, these are only policy guidelines.

2.1.2.3 Mining on Natura sites

On October 4, 2010, the European Commission published the communication about the mining opportunities of mineral resources (excl. the energy carriers) on Natura sites.[13] The purpose of the document is to increase clarity on the opportunity and conditions of the mining activity, in case the mineral resource is on the Natura site.

The guidelines say that mining on sensitive areas, including wetlands has a bigger influence than on significantly altered environment and that mining also has influence outside the mining area, possibly causing the drying out of wetlands. It is found in the document, that mining activity and the protection of habitats and species do not necessarily exclude each other, but that the permission for mining must be considered separately in every single case, deriving from the protection objective of the Natura site.

For reconciliation of the contradictory interests, strategic planning is seen as an important tool, making

12 Access at: http://aei.pitt.edu/4792/01/003327_1.pdf (10.02.2011).

13 Access at: http://ec.europa.eu/environment/nature/natura2000/management/docs/neei_n2000_guidance.pdf (02.02.2011).

it possible to find the solution for the conflict in the earliest possible stage. The Commission has pointed out, that the choice of the location of mining should be made in the stage of strategic planning, where it is possible to involve wider public and a big amount of interest groups. This is also useful for miners, for whom a more stable and predictable framework of activity is created in this way.

The guidelines of the Commission are not legally binding and it does not add new principal legal consequences. The permission of activities on Natura sites has to take into account assessment of the circumstances of the certain case currently as well.

2.1.3 Estonian policy documents and legal acts

2.1.3.1 The state environmental policy

On September 14, 2005 the Estonian Parliament approved **Environmental Strategy of Estonian sustainable development – Sustainable Estonia 21**[14] (hereinafter *Sustainable Estonia 21*). The Sustainable Estonia 21 sets as its purpose ecological balance, the basic component of which is the conservation of biological diversity and natural sites.

On February 14, 2007 Estonian Parliament approved the **Estonian Environmental Strategy until 2030** (hereinafter *Environmental Strategy*). Environmental Strategy is the development strategy of the environmental field, which is guided by the principles of Sustainable Estonia 21. It is the roof strategy for all development plans in the field of environment, which have to be guided by the principles of Environmental Strategy when drawn up or amended. The aim of Environmental Strategy is to determine long-term development directions for the conservation of good conditions of the natural environment, being guided at the same time by the connections of the environmental field with economical and social fields and their impact on the surrounding natural environment and human beings.[15] A separate chapter in the Environmental Strategy is dedicated to landscapes and biological diversity; the purpose to preserve the favourable conservation status of mires and other similar landscapes. The indicator for this purpose is to preserve 22% from the Estonian land territory as a territory of peatlands.[16]

For the application of Environmental Strategy, the **Estonian Environmental Action Plan for 2007-2013** (hereafter *EAP*) has been drawn up and approved by the Government on February 22, 2007.[17] In EAP the indicator of the conservation of the favourable status of peatlands is to keep 22% of the whole land territory for peatlands.

The reports of the annual activities of EAP are to be submitted to the Government. In 2010, profound monitoring about the application of EAP was carried out[18] and in 2013 another one will follow. The results of monitoring will be used for the renovation of EAP and Environmental Strategy.[19] The 2010 report finds that a most important activity in achieving the aim of the landscape diversity conservation, set in Environmental Strategy, has been the financial support for the maintenance and restoration of semi-natural communities on Natura sites.[20]

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14 Access at: https://www.riigiteataja.ee/akt/940717&leiaKehtiv (10.02.2011).
15 Access at: http://www.envir.ee/2959 (01.02.2011).
16 Access at: https://www.riigiteataja.ee/aktilisa/0000/1279/3848/12793882.pdf (01.02.2011).
17 Access at: https://www.riigiteataja.ee/akt/12796956&leiaKehtiv (01.02.2011).
18 Access at: http://www.envir.ee/orb.aw/class=file/action=preview/id=1131709/KTK+aruanne+2007-2009+v5+8.06.2010.pdf (01.02.2011).
19 Access at: http://www.envir.ee/2851 (01.02.2011).
20 The Report on EAP 2007-2009. P 17.

The Government approved on December 11, 2008 the drawing up of **The Development Plan of the Protection of Nature until 2020** (hereafter *DPN 20*) and the Ministry of the Environment is currently working on it.[21] DPN 20 is based on the draft of **The Development Plan of the Protection of Nature until 2035**[22] (hereafter *DPN 35*), which was drawn up between 2004-2006, and replaces it, so DPN 35 most likely will not be adopted.

DPN 20 sets as its purpose to use the natural resources of marshes sustainably and to conserve marshes with high environmental value. For the achievement of these purposes the draft of DPN 20 foresees the obligation to restore the exhausted and spoilt peat marshes as wetlands.

The Ministry of the Environment has prepared and published "**The Basis of the Use and Protection of the Earth's Crust**" (draft as July 21, 2010)[23] (hereafter *the Basis*), which is basis for the new draft on Earth's Crust Act.

According to this document the basis of the use of Earth's crust is the priority of conservation of natural environment, and environmental requirements need additional analysis (page 5). In addition to several new principles the document disserts in detail the impact on mining of mineral resources on environment and the alleviation of it, the avoidance of environmental damage and the necessity for quick restoration of mined areas.

According to the Basis, the requirement of approval by the Ministry of the Environment must be stipulated in case a local protected area is in the process of establishment, if the registered mineral reserves (deposit or deposits) are within the protected area (page 15). In the Basis the buffer zone is expected to be provided in law, which will have two purposes: 1) to protect registered infrastructure of mineral resources from the impact of facility and 2) to protect the surroundings of deposit from the possible impact from mining activities.

In the Ministry of Environment "**The Basis of the Protection as the Sustainable Use of Estonian Peatlands**" has been prepared (draft as October 5, 2010)[24] (hereafter *the Peat Concept*). The purpose of the Peat Concept is to form and to word on the consensual basis the principles and the activities of different interest groups (environmentalists, users of mineral resources, foresters, etc), which would guarantee the protection and the sustainable use of Estonian peatlands in the next twenty years. The Peat Concept should become the basic document, on the ground of which the proposal to draw out the development plan together with the implementation plan on the protection and sustainable use of peatlands to the Government of the Republic can be made. In the Peat Concept necessary means and planned research works are foreseen, in order to guarantee the protection and the sustainable use of the peat areas.

2.1.3.2 Environmental legal acts

The Constitution

Section 5 of Estonian Constitution provides: The natural wealth and resources of Estonia are national riches which shall be used economically.[25] According to the commented edition of the Constitution,

21 Access at: http://www.envir.ee/orb.aw/class=file/action=preview/id=1153447/LAK_eelno.pdf (01.02.2011).

22 Access at: http://www.envir.ee/orb.aw/class=file/action=preview/id=181566/Looduskaitse_arengukava100506.pdf (01.02.2011).

23 Available online: http://www.envir.ee/orb.aw/class=file/action=preview/id=1127881/ALUSED_21072010.pdf (28.03.2011)

24 Available online: http://www.envir.ee/orb.aw/class=file/action=preview/id=1083186/Turbakontseptsioon_kodulehele_T%C4IENDATUD.pdf (29.03.2011)

25 Access at: https://www.riigiteataja.ee/akt/12846827&leiaKehtiv (11.02.2011).

the term "national riches" is not the same as national property of natural resources, but it entitles and obliges the state to acquire natural resources according to Section 32, subsection 3 of the Constitution, when it is necessary for the sake of their general national and sustainable use.[26]

According to Section 53 of the Constitution, everyone has a duty to preserve the human and natural environment and to compensate for damage caused to the environment by him or her. The same provision also stipulates that the procedure for compensation shall be provided by law. The comments of the Constitution say that the purpose of the sustainable use of living and natural environment is to ensure satisfied living environment to the people and necessary natural resources. According to the comments it is possible to restrict constitutional rights (e.g right of entrepreneurship and ownership) arising from this constitutional obligation.[27]

The non-monetary remedying of damage caused to the environment is regulated by the Environmental Liability Act[28], but in some cases the damage must be compensated financially, according to environmental legal acts. The Supreme Court has declared that natural resources have an objective value, additionally to commercial and fiscal value, which does not depend on the owner and must be compensated as well.[29]

Act on Sustainable Development

Act on Sustainable Development was adopted on February 22, 1995 and entered into force on April 1, 1995[30] as a consequence of UN Conference on Environment and Development (Rio de Janeiro, 1992). The Act provides that the conservation of the biological diversity will be ensured by the national program and action plan adopted by the Government. According to the Act, the different types of ecosystems and landscapes must be conserved, and for balancing and compensating urbanization and economic activity the network of natural and semi-natural biotic communities must be created.

Nature Conservation Act

The present Nature Conservation Act (NCA) was adopted on April 21, 2004 and entered into force on May 10, 2004.

NCA stipulates the prerequisites for placing a natural object under protection and the relevant procedure. To the protected natural objects belong protected areas, limited conservation areas and species protection sites (Section 4 subsection 1 clauses 1, 2 and 4). The prerequisites for placing natural objects under protection are the following: a natural object is under risk, is rare or typical, has scientific, historic, cultural or aesthetical value or is subject to protection under an international agreement (section 7). The area is placed under protection as a protected area or limited conservation area by the decision of Government of the Republic (Section 10 subsection 2). NCA transposes the requirements of EU Habitats and Bird's Directives; on the basis of NCA the network of Natura sites is placed under protection.

The protected areas are divided to national parks, nature reserves and landscape protection areas (Section 4 subsection 2), which have different protection purposes. Protected areas have different

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26 Eesti Vabariigi põhiseadus. Kommenteeritud väljaanne. Toim: E.-J. Truuväli jt. Juura, Õigusteabe AS. Tallinn 2002. p 69.
27 Eesti Vabariigi põhiseadus. Kommenteeritud väljaanne. Toim: E.-J. Truuväli jt. Juura, Õigusteabe AS. Tallinn 2002. p 334.
28 Access at: https://www.riigiteataja.ee/akt/13316047&leiaKehtiv (11.02.2011).
29 Decision of the Penal Chamber of the National Court 16.12.1997, 3-1-1-109-97. Referred: Eesti Vabariigi põhiseadus. Kommenteeritud väljaanne. 2002. p 335.
30 Access at: https://www.riigiteataja.ee/akt/13148461&leiaKehtiv (09.02.2011).

zones, where different restrictions for activities are applied: strict nature reserve, conservation zone and limited management zone. Landscape protection areas do not have strict nature reserves. A more specific protection order is determined in the protection rules, where the extent of the protection zones is determined and different restrictions are determined according to different zones.

NCA regulates also the protection of shores and banks and nature protection on the municipal (local) level. The purpose of protecting banks and shores is among other things the conservation of natural biotic communities which are situated on the banks and shores and the restriction of negative impact deriving from human activities (Section 34). Restrictions on use of shores and banks are set by the limited management zone, the building exclusion zone and the water protection zone (Section 35 subsection 1). The extent and the restrictions of water protection zone are stipulated in Water Act.

The purpose of nature protection on the municipal (local) level is the particularity of the nature, the culture, the settlement and the land use in the area or protection of their single elements and determination of the terms of use by the local government (section 43). In the area of local protection the restrictions of conservation zone are applied, which can be relieved by the protection rules and planning (Section 44 subsection 1).

Earth’s Crust Act

Earth’s Crust Act (ECA) was adopted on November 23, 2004 and entered into force on April 1, 2005.[31] ECA provides the principles and rules for investigation, protection and use of the Earth’s crust in order to ensure its economically feasible and environmentally sustainable use. The Act regulates geological investigation, geological exploration and the procedure for granting permits for these activities. ECA also provides requirements for the use of Earth’s crust which is not connected with mining.

From the point of view of wetlands, mining is an important activity, permission of which is also regulated by ECA. ECA provides an obligation to apply technologies of mining, in order to have minimum damaging effect on the environment and human beings (Section 24 subsection 1). The issue of an extraction permit shall be refused if mining would damage a protected natural object or a natural object, proceedings for the placing of which under protection are conducted, or if mining is prohibited by the rules of protection (Section 34 subsection 1 clauses 2 and 3). The issue of extraction permit shall also be refused if the disturbed land cannot be restored to be usable with reasonable expenses and environmental impact assessment report shows that mining has significant environmental impact and it cannot be avoided or minimized (Section 34 subsection 1 clauses 13 and 19).

The holder of an extraction permit is required to restore land disturbed by extraction of mineral resources on the basis of a restoration project (Section 48 subsection 1). The holder of an extraction permit is required to submit, once a year, information on the land disturbed by extraction of mineral resources and restoration of the disturbed land to the issuer of permits (Section 48 subsection 3).

Upon restoration of land disturbed by extraction of mineral resources, it shall be ensured that:

1. the ground-water regime of the mining area corresponds to the specific purpose of land use;
2. the restored area fits into the surrounding landscape;
3. the relief of the restored area is as nature-identical as possible;
4. the restored area does not pose a danger arising from its special character to the persons in the area (Section 48 subsection 4).

31 Access at: https://www.riigiteataja.ee/akt/13342547&leiaKehtiv (10.02.2011).

Section 49 of Earth's Crust Act provides the mechanism of guaranteeing the restoration of the disturbed land, which is the precept by the issue of extraction permit and the implementation of compulsory measures (penalty payment and substitutive enforcement) according to the Substitutive Enforcement and Penalty Payment Act. The issuer of extraction permit shall declare the obligation to restore disturbed land to be performed, taking account of the proposal of the commission (Section 50 subsection 1). If mistakes have been made during the restoration work, in the result of which environmental damage occurs, then this damage must be eliminated. For fulfilment of this obligation the compulsory mechanism (substitutive enforcement) is foreseen according to the Substitutive Enforcement and Penalty Payment Act (Section 51).

Land Improvement Act

Land Improvement Act (LIA) was adopted on January 22, 2003 and entered into force on July 1, 2003, partially on July 1, 2004.[32] LIA provides requirements for the design, construction and management of land improvement system. For the construction of land improvement system, design criteria and a building permit are necessary. Agricultural Board shall refuse to issue a project design of land improvement system if the planned land improvement system is dangerous to environment (Section 8 subsection 3 clause 2) and to issue a building permit if environmental impact has not been assessed, but was required (Section 15 clause 7).

The owner or the possessor of the land improvement system must perform the necessary management works of land improvement system including the area close to it, in order to guarantee that the system meets the requirements provided in law. The possessor must not impede water flow in land improvement system when he carries out the management works, or cause damage to other land possessors by other activities (Section 45 subsections 2 and 3).

Whereas land improvement in the sense of LIA is among others drainage of land, irrigation and mutual regulation of the land water regime (Section 2), then it is possible to establish or restore the wetland on the basis of this act, if the wetland is established using existing land improvement system. It is decided case by case on the basis of the project and other data and sometimes the conduction of EIA is necessary.

Water Act

Water Act has been adopted on May 11, 1994 and entered into force on June 16, 1994.[33] The Water Act regulates the use and protection of water, taking into account the requirements of the EU directives. Water Act differentiates between the public use and special use of water. The special use of water might have significant impact on environment (e.g abstracting more than 30 m^3 of surface water and more than 5 m^3 of ground water, effluent or other water pollutants are discharged to environment or water is discharged to environment as a result of mining activity) and requires a permit (Sections 8 and 9).

For sewage water and rain water the emission limit values of pollutants are provided under Section 24 subsection 2 of Water Act, but no emission limit values of the pollutants are stipulated for mining water. Also the requirements are not provided for drainage water of land improvement activities. According to Section 2 clause 2 of Water Act, sewage water emitted to environment is determined as water which has been used, i.e. that water must have been used directly by human being (e.g industrially). Mining water and drainage water is not sewage water according to this interpretation, because it has not been

32 Access at: https://www.riigiteataja.ee/akt/13316787&leiaKehtiv (10.02.2011).

33 Access at: https://www.riigiteataja.ee/akt/123122010041&leiaKehtiv (10.02.2011).

directly used. Such interpretation is also referred to in section 8 subsection 2 clause 13, which stipulates that mining water is just water not sewage water. In practice the requirements for mining water and drainage water are provided in the water permit, taking partially into account the emission limit values of pollutants, which are stipulated for sewage water. It cannot be considered as transparent administrative practice and also it gives too wide discretion to administrative body (see suggestions in Chapter 8.5.1).

By December 15, 2015, good status of surface and ground water must be obtained (Section 3^5 subsection 2). In order to achieve this objective, the restrictions to discharge of pollutants, including dangerous substances, and requirements to agriculture are provided.

The status of wetlands is taken into account in determination of the limit values of the concentration of pollution and dangerous substances to groundwater (Section 26^6 subsection 2).

Environmental Impact Assessment and Environmental Management System Act

Environmental Impact Assessment and Environmental Management System Act (EIA Act) was adopted on February 22, 2005 and entered into force on April 3, 2005.[34] EIA Act regulates environmental impact assessment (EIA) of the development projects, which have significant environmental impact and strategic impact assessment (SEA), which is carried out to strategic planning documents (development plans and spatial plans). The Act provides the rules of procedure of EIA and SEA and the requirements of the content of the reports if EIA and SEA.

Environmental impact shall be assessed in the following cases:

1. upon application for or application for amendment of a development consent if the proposed activity which is the basis for application for or amendment of the development consent potentially results in significant environmental impact;
2. if activities are proposed which alone or in conjunction with other activities may potentially significantly affect a Natura 2000 site (Section 3).

It is presumed that environmental impact is significant, *inter alia*, in the following cases (Section 6 subsection 2 clauses 18, 28, 29 and 31):

- at least 10 million m^3 of ground water is abstracted in a year;
- mineral resources are extracted in open mining on bigger territory than 25 ha;
- mineral resources are extracted underground or peat is extracted mechanically;
- the extraction of mineral resources in previous cases and extent is finished;
- the wetland is drained on larger territory than 100 ha.

EIA may be conducted also in other cases if during the consideration of issuing a permit it will be determined that there is significant environmental impact (Section 6 subsections 3-5).

In result of EIA and SEA the alternatives of activities or locations will be offered and also the measures of prevention or reduction of significant environmental impact or environmental requirements.

34 Access at: https://www.riigiteataja.ee/akt/116112010013&leiaKehtiv (10.02.2011).

The Act of General Part of the Environmental Code

On February 16, 2011 the Estonian Parliament adopted the Act of General Part of the Environmental Code (GPEC).[35] GPEC provides the general terms of Estonian environmental law, the principles of environmental protection, general duties and the duties of operators, environmental rights and a new integrated environmental permit issuing procedure. All these establish the general part of environmental law in narrow sense. During elaboration of GPEC, the objective was not only the systematization of the current law and the collection of general regulation to general part but also critical revision of the current law, solving the contradictions and filling the gaps.[36]

GPEC will not enter into force before the Special Part of the Environmental Code Act (SPEC, see the next) enters into force, for the GPEC and SPEC establish a coherent entity.

The Special Part of the Environmental Code Act

Composing of the draft of the Act of Special Part of the Environmental Code (hereafter draft SPEC) is also currently in process.[37]

The codification of the special part of Estonian environmental law is ambitious. In addition to organizing the current law, the objective is also to offer significant amendments. The draft SPEC includes provisions in the fields of atmosphere air, water, waste, integrated pollution prevention and control, nature protection, genetically modified organisms, forestry and hunting and fisheries (later the provisions for marine protection and earth's crust may be added). The purposes of codification have been, among other, to harmonize the current fragmentary law and reduction of over-regulation.[38]

Other relevant Acts

- Waste Act (provides the prohibition of bringing the waste into the environment, including the wetland)
- Forest Act (provides cutting volumes and other rules of cutting trees, also in wetlands)
- Environmental Supervision Act (provides environmental supervision measures, also for prevention of violation of law on wetlands)
- The Act on Maintenance of Law and Order (it is important for the application of Environmental Supervision Act)
- Environmental Liability Act (provides the duties of prevention and remedy of environmental damage, also restoration of wetland if it is spoilt)
- Building Act (provides rules for issuing permits for building of roads, ditches, utility works and networks)
- Penal Code (provides criminal sanctions for significant violations of environmental law).

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35 Access at: http://www.riigikogu.ee/?page=eelnou&op=ems&emshelp=true&eid=1147282&u=20110216112744 (16.02.2011).
36 Access at: http://www.riigikogu.ee/?page=eelnou&op=ems&emshelp=true&eid=1147282&u=20110211114542 (11.02.2011).
37 Access at: http://www.just.ee/41314 (11.02.2011).
38 Access at: http://www.just.ee/41314 (11.02.2011).

2.2 Regional policy and planning

2.2.1 Planning of land use

Spatial planning (hereinafter *planning*) is regulated by the Planning Act (PA), which was adopted on November 13, 2002 and entered into force on January 1, 2003.[39]
According to PA the types of plans are:

1. national spatial plan;
2. district plan;
3. comprehensive plan;
4. detailed plan.

Plans are hierarchically related: every plan on a higher level serves as the basis for the plan on lower level. Nevertheless, during drawing up the district plan, the comprehensive plans must also be taken into consideration, or it has to be agreed with the local government to propose to amend the comprehensive plan. A comprehensive plan may contain proposals of amendment of district plan, if necessary.

The national spatial plan is enacted by the Government of the Republic (PA Section 24 subsection 1), the district plan is enacted by the district governor, and comprehensive and detailed plan are enacted by the local government (PA Section 24 subsections 2 and 3).

The national organizing and supervising body in the field of spatial planning is the Ministry of Internal Affairs. The same activities in a district are within the competence of the district government and the rural municipality; or town in the competence of the local government (PA Section 4 subsections 1 and 2).

The national spatial plan is drawn up for the whole territory of the state. It determines the principles and directions of sustainable and balanced spatial development and establishes the functions of the district plans (Section 6 subsection 2). The national spatial plan designs the system of natural and semi-natural biotic communities, which balances the urbanization and economic impacts and ensures the conservation of different types of ecosystems and landscapes or green network (Section 6 subsection 2 clause 5).

District plan is drawn up for the whole territory or part of a district. Among other functions, it handles the principles of sustainable development, conservation of natural resources, valuable agricultural lands, landscapes, green network and natural biotic community, terms of use of land and water areas, including mining areas and areas affected by mining (Section 7 subsection 3).

Comprehensive plan is drawn up for the whole territory of a rural municipality or city or a part of them. Its functions include taking into account the principles of sustainable management, determination of general terms of the use of land and water areas, including the intended purpose of land use; determination of valuable agricultural fields, parks, green areas, landscapes, single parts of landscape and natural biotic communities, also the determination of their terms of protection and use; establishing the conditions that ensure the function of green network; making proposals to place land areas under protection if necessary; making proposals to specify, amend or finish the protection regime in areas placed under protection if necessary (Section 8 subsection 3).

Detailed plan is the basis of land use and building activity in the near future and it is drawn up for a part of rural municipality or city. Among other things the functions of a detailed plan are to make proposals to specify, amend or finish the protection regime in the protected areas (if necessary); also to make

39 Access at: https://www.riigiteataja.ee/akt/13328539 (10.02.2011).

proposals to place land areas under protection if necessary (Section 9 subsection 2). A detailed plan also determines the intended use of land (Section 9 subsection 4 clause 1).

Protected areas are not established on the basis of spatial plans, but on the basis of Nature Conservation Act, relying on the criteria of nature protection.

2.2.2 The economic and planning measures of nature protection

2.2.2.1 Management plans

For the purpose of managing the limited conservation areas and protected areas, management plans shall be prepared for each area which shall bring out (NCA Section 25 subsection 1)[40]:

1. the natural values in the area and indicators for measuring them;
2. the significant environmental factors and their impact to the natural object;
3. the objectives of protection, work necessary to reach the objectives, and the priority, schedule and volume of work;
4. a budget for accomplishing the plan.

Management plan shall be drawn up for 3-10 years. Information regarding approval of the management plan shall be published on the website of the Environmental Board (NCA Section 25 subsection 2).

2.2.2.2 Necessary activities within protected natural objects

According to Section 17 subsection 1 of the Nature Conservation Act, the activities necessary within the area of a protected natural object hosting semi-natural biotic communities are activities which promote the natural aspect and species composition thereof, such as mowing, grazing, and designing, thinning or deforestation of tree and shrub layers, the extent of which shall be determined, in the case of a limited conservation area, by a management plan and in the case of other protected natural objects, by protection rules. Semi-natural community occurrence areas are areas hosting communities of natural biota, such as wooded meadows, alvars, paludifying meadows, fen meadows, coastal meadows, floodplain meadows, grasslands on mineral soils, wooded pastures which have developed in the course of long-term human activity, such as grazing or mowing (NCA Section 17 subsection 2). The necessary activity within a protected natural object may be conducted by the possessor of the land but when the possessor refuses to perform it, it can be carried out by the state (NCA section 17 subsections 6-9).

Nature conservation subsidy is paid to the possessor of land for performance of work specified by the protection rules or management plan, necessary for preservation of semi-natural biotic communities of protected areas, limited conservation areas or species protection sites (NCA Section 18 subsections 1 and 2).

Environmental Board has compiled the inventory plan of semi-natural biotic communities until 2013 and it was delivered to Estonian Agricultural Registers and Information Board for implementation. During

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40 Access at: https://www.riigiteataja.ee/akt/13228916&leiaKehtiv (10.02.2011).

2007-2009, the subsidy for management of semi-natural biotic community was paid to legal and natural persons in sum of more than 151 million Estonian crowns (9,65 million euros). [41]

2.2.2.3 Acquisition of immovable containing protected natural objects

An immovable, which contains a protected natural monument or is located, as a whole or partially, within the territory of a protected area, limited conservation area or species protection site and use of which for its intended purposes is significantly hindered by the protection regime, may be acquired by the state upon agreement with the owner of the immovable for payment corresponding to the value of the immovable (NCA Section 20 subsection 1 and 1^2).

Acquisition of an immovable may be initiated by the owner of an immovable, the administrative authority of a protected natural object or the Minister of the Environment. The Minister of the Environment shall decide on acquisition of immovables. The costs related to the acquisition of immovables shall be borne by the state and acquisition shall be financed within the limits of an amount specified in the state budget for each budgetary year (NCA Section 20 subsection 2).

2.2.2.4 Taxfree land

On May 6, 1993, the Land Tax Act (LTA) was adopted, entering into force on July 1, 1993.[42] LTA provides incentives for future land owners to place semi-natural biotic communities, including wetlands under protection. Costal and flooded meadows and other relatively rare biotopes have often low fertility or are situated in places difficult to access. Thus, agricultural activity is inexpedient and these areas are left out of use. Traditional uses for conservation of such biotic communities (mowing, herding) are not considered as economic activity according to Section 17 subsection 10 of NCA.

Land tax is not imposed on:

- land where economic activities are prohibited by law or pursuant to the procedure provided by law;
- land of strict nature reserve or conservation zone, also land of conservation zone of species protection site (LTA Section 4 subsection 1 and 1^1).

From limited management zone and limited conservation areas only 50% of land tax shall be paid.

2.2.3 Land reform

On October 7, 1991, the Land Reform Act (LRA) was adopted and it entered into force on November 1, 1991.[43] Based on the continuity of rights of former owners and the interests of current land users that are protected by law, and to establish preconditions for a more effective use of land, the objective of land reform is to transform relations based on state ownership of land into relations primarily based on private ownership of land (LRA section 2). In land reform, unlawfully expropriated land is returned to its former

41 The Report on EAP 2007-2009. p 16.
42 Access at: https://www.riigiteataja.ee/akt/13316772&leiaKehtiv (10.02.2011).
43 Access at: https://www.riigiteataja.ee/akt/13338097&leiaKehtiv (10.02.2011).

owners or their legal successors or compensated, therefore, land is transferred for or without charge into the ownership of persons in private law, legal persons in public law or local governments, and land to be retained in state ownership is determined (LRA section 3 subsection 1).

By beginning of 2011, the land reform has not ended yet; according to information from Land Board, 86,6% of Estonian surface is registered in Land Register. However, there is no clear prognosis of the end term of the reform.

2.3 Environmental authorities

The institutional system of environmental protection involves a legislative organ – the Parliament and the representatives of executive power – the Government of the Republic, Ministry of the Environment and Environmental Board. The state supervision authority is Environmental Inspectorate.

2.3.1 Ministry of the Environment

The main authority, responsible for the elaboration and implementation of the policy on wetlands, is the Ministry of the Environment. In the area of government of the Ministry of the Environment are among other things: the administration of environmental and nature protection, administration of use, protection, reproduction and registering of natural resources, environmental supervision, administration of nature research, geological investigation and geological exploration, and elaboration of corresponding drafts of legal acts (Act on the Government of the Republic Section 61 subsection 1). In the area of government of the Ministry of the Environment are Land Board, Environmental Board, Environmental Inspectorate (Act on the Government of the Republic Section 61 subsection 2) and Environmental Information Center.[44]

2.3.2 Environmental Board

Environmental Board is a government agency in the area of government of the Ministry of the Environment, which exercises executive power, and State supervision of state coercion on the basis and to the extent provided by law. The area of activity of the Board is the use of environment and nature conservation and the implementation of action plans, policies and programs of radiation safety.

The Board shall carry out the following tasks among other things:

- issues environmental permits and the permits on the use of natural resources in the cases and the extent provided in law;
- gives opinion on plans and designs in the cases and the extent provided in law;
- participates in the procedure of EIA and SIA in the cases and ways provided in law;
- administers the prevention and remediation of environmental damage in the cases and the extent provided in law, deriving from the polluter pays principle;
- administers protected natural objects determined by the Government and the Minister of the Environment;

44 Access at: https://www.riigiteataja.ee/akt/13288527&leiaKehtiv (15.02.2011).

- administers elaboration of protection rules of protected natural objects and the decisions of placing the object under the protection;
- compiles the action plans and protection rules of the protected natural objects and administers their implementation;
- gives assessment to the performance of the protection of protected natural objects and the purposefulness of the protection order;
- organises and implements the scientific and investigation work of natural objects and monitoring.[45]

2.3.3 Environmental Inspectorate

Environmental Inspectorate is the governmental authority in the area of government of Ministry of the Environment. Environmental Inspectorate co-ordinates and supervises the use of natural environment and resources, implementing administrative coercive measures, stipulated in law.

Environmental Inspectorate is a body, conducting extra-judicial proceedings in the case of violations of environmental law. Environmental Inspectorate performs primary investigative activities in criminal cases.

Environmental Inspectorate supervises and conducts proceedings of violations in all fields of environmental protection, according to the Environmental Supervision Act.[46]

Environmental Inspectorate has a right:

- to implement measures stipulated in law in order to combat unlawful activity and apply obligatory environmental protection measures;
- to suspend activities which are in conflict with the requirements for environmental protection and the use of environment and also lawful activities if such activities endanger the life, health or property of persons;
- organise the storage, sale, return to the lawful owner or destruction of natural products of undetermined ownership and of equipment and instruments used for procurement thereof;
- organise, in the cases prescribed by law, the liquidation of unauthorized construction works.

According to recent amendments in Criminal Proceedings Code,[47] since September 1, 2011 the Environmental Inspectorate will have powers to carry out criminal proceedings in full extent as an independent investigator.

2.3.4 Other appropriate authorities

- Land Board (carries out the land reform and proceeds transfers of use of state land).
- Environmental Investment Centre (issues environmental refunds).
- Environmental Information Centre (collects, processes, analyses and distributes information about the nature in Estonia, the state of the environment, including the state of wetlands and the factors that have impact on them, also keeps appropriate registers).
- State Forest Management Centre (40% of Estonian forests, including on wetlands belong to state; these forests are kept, managed and raised by the State Forest Management Centre. In addition to the activities connected with the forest, the activities of the State Forest Management Centre include conservation of landscape, cultural heritage and protected

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45 Access at: https://www.riigiteataja.ee/akt/13359693&leiaKehtiv (16.02.2011).
46 Access at: https://www.riigiteataja.ee/akt/13315879 (24.02.11).
47 Access at: https://www.riigiteataja.ee/akt/123022011001 (24.02.11).

natural objects, as well as organization of practical nature protection management on the state land).

- Agricultural Board (draws out together with the Ministry of Agriculture land improvement management plan, issues design criteria and land improvement building permits, exercises state supervision in the field of land improvement).
- District Governor (proceeds and enacts district plans).
- Local Government (draws up, proceeds and enacts comprehensive and detailed plans, issues building permits, approves applications of mining permits).

2.4 Academic and non-governmental institutions involved in nature protection and wetland management

2.4.1 Academic institutions

The organization and structure of Estonian academic institutions have been undergoing crucial changes after the re-establishing of independence. At present, no institution narrowly specializes on the study of peatlands. Nevertheless, several institutes have high competence and a good potential for wetland research, and are able to provide well-based recommendations about the policy and management of wetland protection.

The following institutes are more closely involved in research on conservation and management of different wetlands:

- Institute of Ecology of the Tallinn University;
- Institute of Ecology and Earth Sciences of the University of Tartu:
- Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences;
- Institute of Geology of the Tallinn University of Technology.

2.4.2 Non-governmental organizations

Cooperation between governmental institutions and non-governmental organizations (NGOs) in the field of nature conservation in Estonia is quite extensive.

The non-governmental organizations (NGOs) which are known to be involved in biodiversity conservation activities can be divided into three groups – professional, academic (scientific) and membership-based NGOs.

Professional NGOs:

- Estonian Fund for Nature;
- Estonian Wetland Society;
- Estonian Peat Association;
- Estonian Semi-natural Communities Conservation Association.

Professional NGOs are active in questions of nature conservation issues at the national level, dealing partly with the technical and legal aspects of new legislation. For example, they have contributed to the drafting of the Act on Protected Natural Objects (approved in 1994), and of the statutes and protection rules for the new national parks and protected areas, but also implementing inventories.

Academic NGOs:

- Estonian Naturalists' Society;
- Estonian Ornithological Society;
- Estonian Geological Society;
- Estonian Geographical Society;
- Nature Conservation Commission of the Academy of Sciences;
- Discussion Club of Scientific Societies on Sustainable Development.

Scientific NGOs are involved in providing detailed information and expertise in their particular fields (the Ornithological Society concerning bird species and areas needing protection, the Geographical Society concerning *inter alia* landscape protection, the Naturalists' Society concerning lists of insect species, etc.). The Nature Conservation Commission of the Academy of Sciences has been involved in preparation of the Red Data Book for Estonia (Lilleleht 1998).

Membership based NGOs:

- Estonian Council of Environmental NGOs (EKO); nine non-governmental environmental organisations belong to the council;
- Estonian Society for Nature Conservation.

Membership-based NGOs have been involved in several projects surrounding the Baltic Sea, in promotion of public awareness concerning environmental problems, sustainable consumption and environmental education. Common positions have been formed in partnership with other NGOs. For example, EKO compiled political suggestions for political parties for parliamentary elections in 2011, which included a chapter for conservation and usage of peatlands. One of the proposed issues was that peat should be determined as non-renewable resource in Estonian legislation.

ESTONIAN NATURE 3

3.1 Geographical setting

3.1.1 Location and area

The Republic of Estonia is situated between 57°30'34" and 59°49'12" N, and 21°45'49" and 28°12'44" E (Fig. 1). The total area (not including an area in SE Estonia surrounding Petseri and areas east of the Narva River) is calculated to be 45,227.1 km², of which 4,132.7 km² ha (9.2%) is made up of the more than 1,500 islands and islets (Varep & Saar, 1995).

FIGURE 1. Estonia and the neighbouring countries.

3.1.2 Geology

Estonia is located on the southern slope of the Fennoscandian Shield, in the northwestern part of the East-European Platform (Raukas, 1997). Here three vertical complexes are presented: crystalline basement, Paleozoic sedimentary underground cover, and uppermost, loose Quaternary deposits (Raukas, 1978).

The crystalline basement lies at a depth of 110–600 m below the sea level; it has no influence on recent landforms and does not directly participate in pedogenesis. The underground in northern, western and central Estonia consists mainly of Ordovician and Silurian carbonate limestone, marls and dolomites. In the north, a limestone plateau faces the Baltic Sea and forms the North-Estonian Klint. To the south of the Pärnu–Navesti–Puurmani–Mustvee line there is a region of noncalcareous Devonian sandstone ("Old Red"), but locally Devonian calcareous rocks crop out in the Haanja Upland. Moraines attain a more significant thickness (up to 200 m) in South Estonia (Aaloe et al., 1960; Rõõmusoks, 1983).

The surface relief of the bedrock is generally flat, with slight elevations and depressions. Quaternary deposits are unevenly distributed; they are almost lacking on the northern coast but can reach a 100–200 m thickness in southern Estonia.

3.1.3 Landforms and soils

The topography of Estonia has developed its contemporary form as a result of the erasing and accumulating action of the continental ice sheet and the subsequent postglacial transgressions of the Baltic Sea. Estonia was freed from the glacier 13,500–11,000 years ago (Raukas, 1986). Orographically, Estonia is a section of the East European Plain, being situated only 0 to 318 meters above sea level. The territory can be divided into two parts – Lower Estonia and Upper Estonia. Lower Estonia consists of the western part of the country having an altitude of less than 50 m above sea level, including numerous islands and bays, and big lake depressions in the eastern part of the country (Fig. 2). After the retreat of ice, Lower Estonia was inundated by the Baltic Glacial Lake and local ice lakes for a considerably longer time than Upper Estonia (Varep, 1968).

Upper Estonia consists of the Haanja, Otepää, Karula, Sakala, Pandivere and Vooremaa Uplands, and Central, North and South-East Estonian Plains, and the landscapes here are more diverse. The till deposits are thick and the soils are more fertile compared with that of Lower Estonia. In southern Estonia the uplands are intersected by a number of river valleys with outcrops of Devonian red sandstone on high river banks.

The density of rivers and streams on the territory of Estonia is 0.72 km/km (Hang & Loopmann, 1995) and the number of lakes with an area of over 0.1 ha is more than 1,500 (Mäemets & Saarse, 1995).

In southern Estonia, podzols, peaty podzols and peat soils on tills and sands are widespread. The most fertile sandy clayey soils, related to brown soils, occur on yellowish-gray calcareous moraines. In northern, central and western Estonia calcareous (rendzina) and peat soils are predominant (Reintam, 1995).

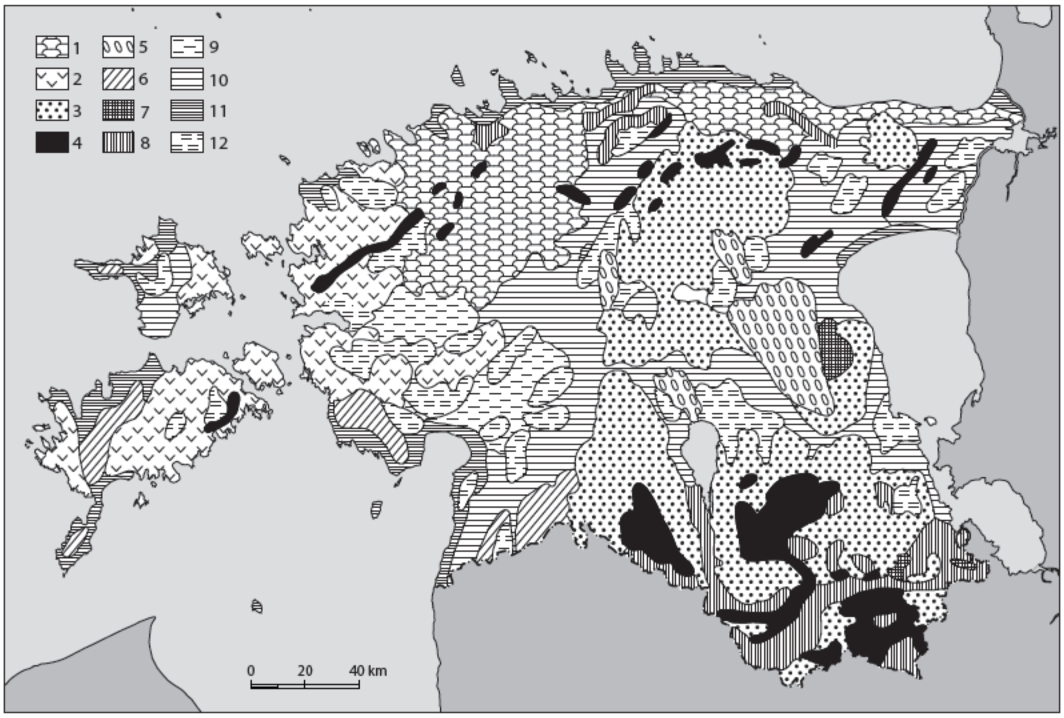

FIGURE 2. The landscape types of Estonia (from Varep, 1978): 1 – limestone plateaus, 2 – limestone and abraded till plains, 3 – till plains, 4 – hilly moraine landscapes, 5 – drumlin landscapes, 6 – abraded elevations, 7 – kame landscapes, 8 – glaciofluvial delta areas, 9 – plains of varved clays, 10 – plains of periglacial lakes, 11 – coastal plains of marine sands and dunes, 12 – peatland landscapes.

3.1.4 Climate

Estonia is situated in the temperate zone. The North-Atlantic cyclone belt, locally modified by the Baltic Sea, dominates the climate. It is characterized by rather warm summers and moderately mild winters. However, regional differences – with the predominant coastal influence in the west and the continental character in the southeastern part of the country – can be noticed.

The average annual temperature is 4–6 °C. The difference in the temperature of the air between the coastal and inland regions is the greatest in winter, being in January 4.9 °C on the average. The vegetation period with mean diurnal air temperatures above +5 °C lasts 170–185 days; the period with an average air temperature above +10°C lasts 120–130 days (ENE, 1970).

The climate is humid, especially in the coastal regions. The average annual precipitation is 550–650 mm. During the vegetation period (from April to October) it is 330–480 mm. The mean annual amount of precipitation is highest in South Estonia and in the area of the Pandivere Upland (up to 700 mm per year), and lowest on the large islands of the Baltic Sea (about 550 mm) (Eesti NSV kliimaatlas, 1969). Since the annual precipitation exceeds evaporation roughly twofold, the climate is excessively moist.

The amount of solar radiation varies widely throughout the year. The length of a summer day exceeds, in northern Estonia, three times that of a winter day. The height of the sun attains 55° at summer solstice and only 8° at winter solstice. The prevailing winds are from the SW, S and W (ENE, 1970).

3.1.5 Vegetation

The vegetation of Estonia is rather diverse. Forests, mires and grasslands alternate with cultivated land. Forests make up 47.2% of the territory, moreover, 1.7% is covered by bushes (Pärt et al., 2010); grasslands add up to 20% (Peterson, 1994). Peatlands with peat deposits thicker than 30 cm cover approximately 9,150 km^2. If water-logged areas with peat deposits less than 30 cm thick are included, 1,010,000 ha or 22.3% of the Estonian territory could be considered to be covered by peat (Orru et al., 1992).

The zonal or climax vegetation type for Estonia's climatic and edaphic conditions is boreo-nemoral coniferous forest dominated by Norway spruce *Picea abies*, together with elements of silver birch *Betula pendula*, aspen *Populus tremula* and Scots pine *Pinus sylvestris*. To a lesser extent also lime *Tilia cordata*, ash *Fraxinus excelsior*, mountain elm *Ulmus glabra* and pedunculate oak *Quercus robur* are found in the tree layer. Such forests grow on fertile soils and are the most productive, as to biomass, of our forest types. As a result of agricultural development, only a small proportion of broad-leaved forests have been preserved (Laasimer, 1965, 1975). Today, the majority of Estonian forests grow on soils, which are of little or no use for agriculture. Most of the forest ecosystems have been influenced by fire, logging or drainage (Lõhmus, 1995).

Swamp forests are dominated by black alder *Alnus glutinosa* and downy birch *Betula pubescens* and sometimes by spruce or ash. *Crepis paludosa*, *Thelypteris palustris*, *Calla palustris*, *Cirsium oleraceum*, *Filipendula ulmaria*, etc. are typical species in the herb layer.

Aspen, grey alder *Alnus incana* and most of the silver birch forests are in the secondary succession stages in Estonia, replacing other types of forests after clear-cutting or covering abandoned fields and grasslands.

Most of the grasslands have developed as a result of deforestation or drainage of mires, and subsequent continuous mowing or pasturing of these areas. Paludifying grasslands (with a peat layer thickness less than 30 cm) on calcium-poor tills have evolved, as a rule, from paludifying birch forests. Wet meadows, particularly rich in plant species, are found on calcareous tills or bedrock. They are closely related to rich fens. Floodplain meadows, like floodplain fens, are spread in river valleys and lake basins. On seashore areas, mainly in western Estonia, saline flooded meadows are presented.

Geobotanically, Estonia belongs to the hemiboreal (boreo-nemoral) vegetation zone (Ahti et al., 1968; Moen, 1999) as does Latvia, the northern part of Lithuania, the adjacent part of European Russia, the southernmost part of Finland, a broad belt across Sweden (south of *Limes norrlandicus*, e.g. Sjörs, 1967) and the southern part of Norway (Fig. 3).

The western part of Estonia together with Denmark, the Oslofjord area in Norway, a larger part of southern Sweden, the southernmost part of Finland, the western part of Latvia and Lithuania and the northernmost part of Poland belong to the slightly oceanic section (O1, Fig. 4; Moen, 1999). The eastern part is more continental. It is included in the indifferent oceanic-continental section (OC), as are the larger areas of Poland, Lithuania, Latvia and the western parts of Russia. The same section also covers the extensive parts of Finland, central and northern parts of Sweden and the eastern part of southern Norway.

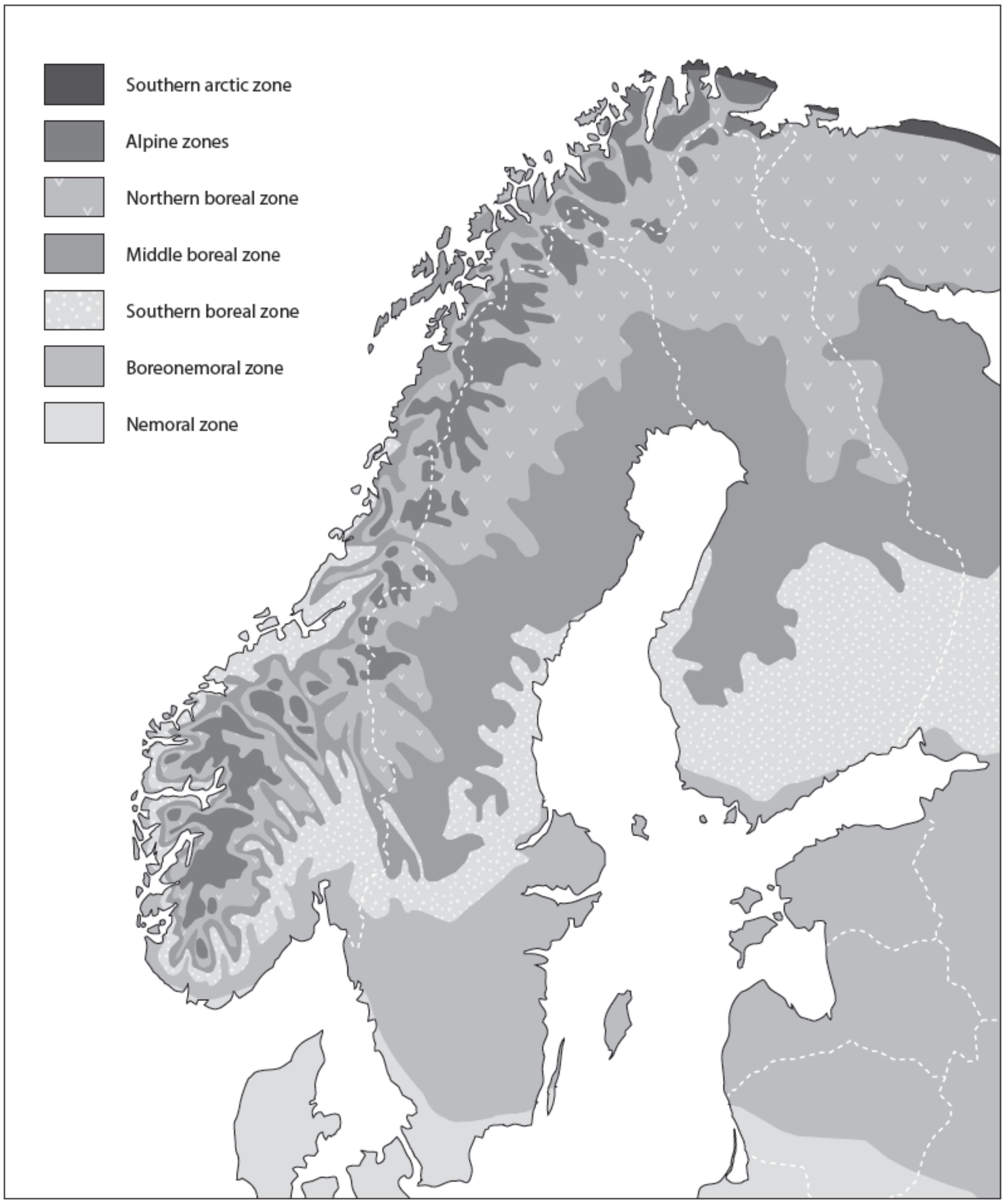

FIGURE 3. Vegetation zones of northern Europe (from Moen, 1999). 1 – southern arctic zone, 2 – alpine zone, 3 – northern boreal zone, 4 – middle boreal zone, 5 – southern boreal zone, 6 – boreo-nemoral zone, 7 – nemoral zone.

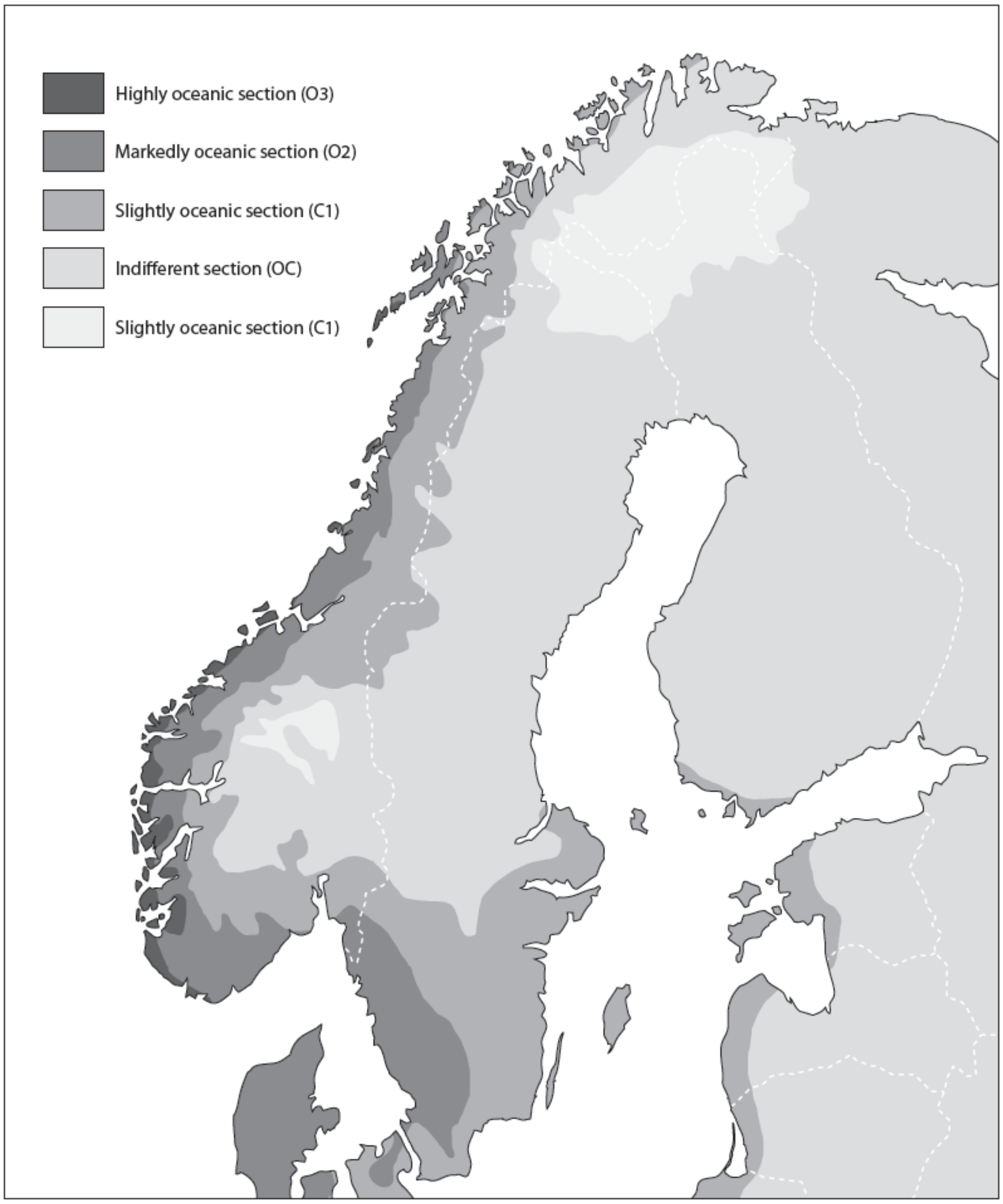

FIGURE 4. Vegetation sections of northern Europe (from Moen, 1999). O2, O3 – oceanic sections, O1 – slightly oceanic section, OC – oceanic-continental section, C1 – continental section.

Elsewhere in the world, the same zone-sections as in Estonia are mainly found in the eastern part of North America, in a zone from Nova Scotia and Maine westwards to the large lakes at the border between US and Canada (Fig. 5).

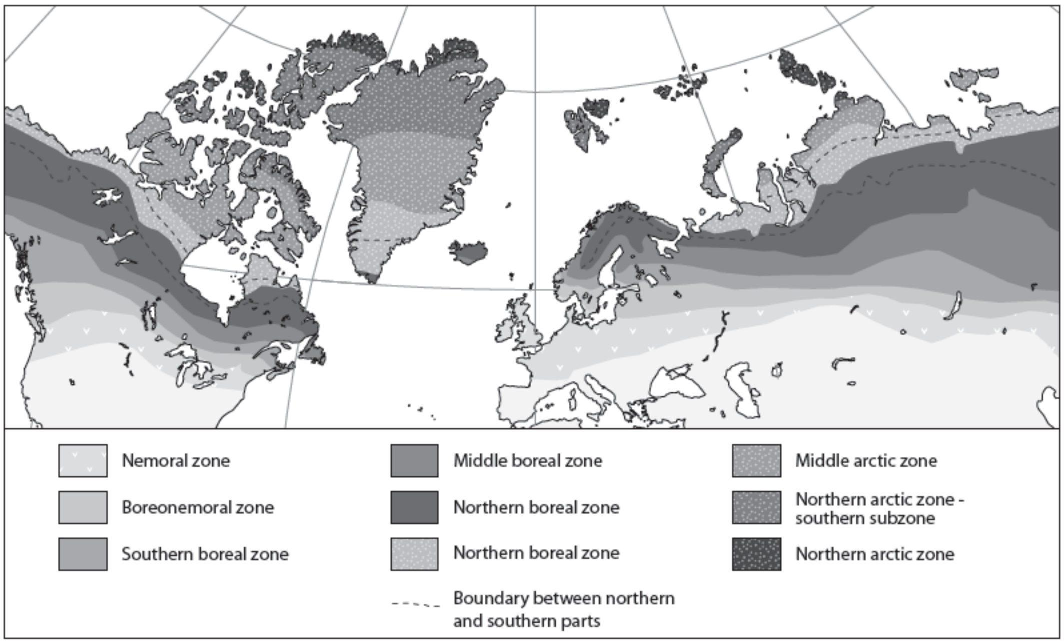

FIGURE 5. Vegetation zones of northwestern Eurasia and eastern North America (from Moen, 1999). Vegetation zones from south to north: 1 – nemoral, 2 – boreo-nemoral, 3 – southern boreal, 4 – middle boreal, 5 – northern boreal, 6 – southern arctic, 7 – middle arctic, 8 – northern arctic.

ESTONIAN WETLANDS **4**

4.1 Peatlands

4.1.1 Peatlands development in Holocene

The landscape and the climate in Estonia have favoured the formation of peatlands, which constitute a dominating element of the landscape. In the second half the Boreal period (8,500 – 8,000 years ago) the comparatively warm and moist climate initiated a large-scale terrestrialization and paludification of shallow waterbodies (Thomson, 1936; Raukas, 1988). Fens with predominating bryophytes, calcifilous sedges and other *Cyperaceae*, where the bush layer was formed by *Betula pubescens*, occupied wide areas step by step. In the last stages of the period floodplain forests were developed on river levees, including black and gray alder and elms (*Ulmus laevis, U. glabra*).

During the Atlantic period (8,000 – 5,000 years ago) climate was much warmer and more humid than nowadays. Then large fen areas began to turn to mixotrophic (transitional) mires and thereafter to raised bogs (Raukas, 1988). In river valleys dense floodplain forests grew, on sites with high groundwater level black alder and swamp birch *Betula pubescens* swamp forest developed (Sarv & Ilves, 1971; Ilves et al., 1974).

In the Late Holocene (Sub-Atlantic climatic period) that began about 2,500 years ago and is still lasting (Raukas et al., 1995b), humid and rather cool climate prevails. Water level in lakes rose and the area of fens increased. Climate favored the increment of peat forming plants and accelerated peat deposition. Raised bogs enlarged their areas as well and numerous new bogs were born. Large floodplains were mostly occupied with grasslands and willow thickets while fens were covered mainly by birch forests (Laasimer, 1965).

4.1.2 Distribution of peatlands

Peatlands are distributed over the whole territory of Estonia (Fig. 6). The largest peatland systems (including the peat extraction areas) are Puhatu with 468 km^2, Epu–Kakerdi with 417 km^2, Lihula–Lavassaare with 383 km^2 and Sangla with 342 km^2 (Orru, 1995).

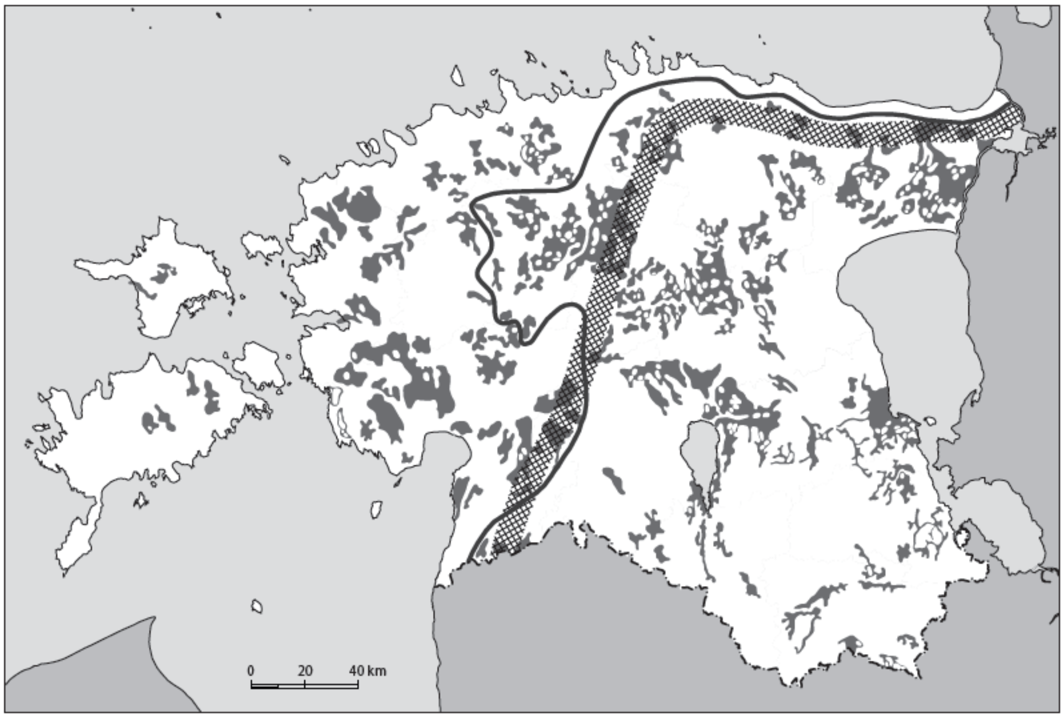

FIGURE 6. Distribution pattern of peatlands larger than 1,000 ha in Estonia (after Allikvee & Ilomets, 1995, with complements). Solid line indicates the maximum ditribution limit of the Baltic Ice Lake B, and divides Estonia's territory into Lower and Upper Estonia. The cross-striped belt follows the approximate boundary between the East- and West-Estonian geobotanical provinces (after Laasimer, 1965) and corresponds well with the distribution pattern of the West-Estonian type of plateau bogs and the East-Estonian type of convex bogs.

If up to the 1960s minerotrophic fens were the most widespread, then after extensive amelioration carried out in the 1970s, their area decreased more than 10 times, and the area of mixotrophic peatlands more than five times (Table 1). Still, according to the data published by Orru (1997), in the mid-1990s 1,626 peatlands with an area over 10 ha and peat layer more than 0.9 m thick were left in Estonia altogether. In the distribution of these numerous mires, certain regularities can be observed, first of all in regard to the features of landscape topography.

TABLE 1. Decreasing of peatland area (ha) in Estonia during 40 years.

Peatland type	Data, year	
	Truu et al., 1964	Ilomets & Pajula, 2004
Minerotrophic	515,000	45,000
Mixotrophic (transitional)	114,000	20,000
Ombrotrophic	278,000	250,000

The undamaged minerotrophic peatlands are nowadays occupying not more than about 45,000 ha, undamaged mixotrophic peatlands some 20,000 ha and ombrotrophic ones 250,000 ha (Ilomets & Pajula, 2004). Extensive minerotrophic peatlands have primarily survived in the western and central parts of the Estonian mainland.

4.1.3 Mires

4.1.3.1 Mire zones and provinces including Estonia

Botch & Masing (1983) summarized the data from the former Soviet Union, including a map of mire zones and sections (Fig. 7). Estonia and a large area to the east belong to the "Mire zone of raised string bogs." On a more detailed scale, Estonia is separated in the "Baltic coast bog province" and the "East Baltic bog province." The first-mentioned province is characterized by raised treeless plateau bogs while convex, concentric raised bogs are typical of the eastern province.

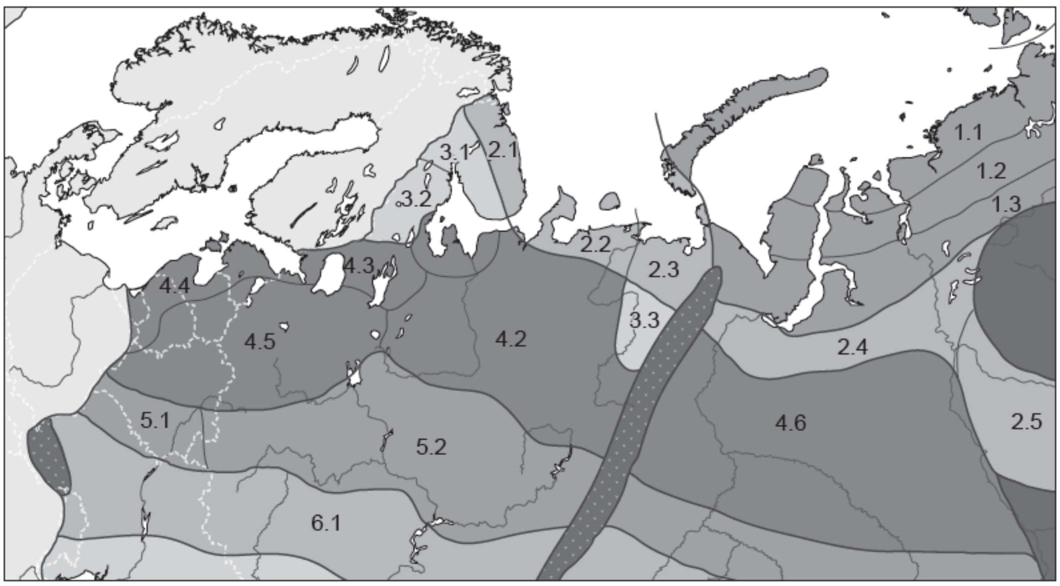

FIGURE 7. Mire zones and provinces in the western part of the former U.S.S.R. (from Botch & Masing, 1983). 1 – zone of polygon mires, 2 – zone of palsa mires, 3 – zone of aapa mires, 4 – zone of raised string bogs: 4.1 – White Sea coast bog province, 4.2 – Northeast European bog province, 4.3 – South Karelian bog province, 4.4 – Baltic coast bog province, 4.5 – East Baltic bog province, 4.6 – West Siberian bog province, 5 – zone of pine bogs and fens, 6 – zone of reed and sedge fens.

Succow & Jeschke (1990) describe the mire zones and provinces of Europe and western Siberia (Fig. 8). Zone IV – the raised bog zone – includes Estonia and the other Baltic states, and a broad area further to the east and north-east. Ireland and the larger part of Great Britain, the southern part of Fennoscandia, the whole of Denmark and the Netherlands, and smaller parts of northern Germany and northernmost Poland belong to the raised bog zone as well. In addition, some smaller areas at higher elevation in Central Europe (e.g. southern Germany, Austria, Switzerland) belong to this zone. Saaremaa, Hiiumaa, Gotland and the southernmost part of Sweden are included in the minerotrophic mire zone. Estonia is further separated between the "East Baltic sea" and the "Northeast European lowland" mire provinces.

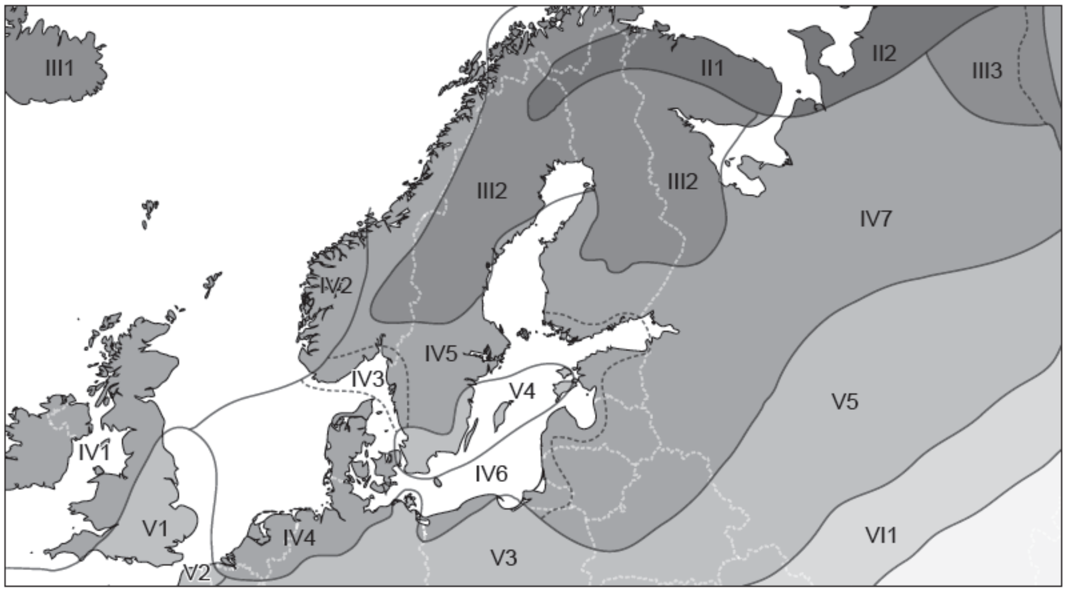

FIGURE 8. Mire zones and provinces in northern Europe (from Succow & Jeschke, 1990). II – zone of palsa mires, III – zone of aapa mires and sloping fens, IV – zone of raised bogs: IV 3 – southern Norway and western Sweden, IV 4 – north-western Central Europe, IV 5 – Scandinavia, IV 6 – eastern Baltic area, IV 7 – north-eastern European lowland, V – zone of minerotrophic forested and open mires: V 3 – central Europe, V 4 – south-eastern Sweden, V 5 – central East Europe, VI – zone of reed and sedge fens.

4.1.3.2 Estonian mire site types

As complex phenomena, mires can be classified on the basis of different criteria or features, depending on the purpose of classification. The widely used division of mires into three main categories, according to Weber (1902, 1908), is based on their developmental stage and trophic conditions:

1. Eutrophic mires, rich in nutrients, low-lying in depressions (*Niedermoore, Niedurungsmoore* in German),
2. Mesotrophic or transitional mires (*Übergangsmoore*),
3. Oligotrophic mires, poor in nutrients and mostly situated "high" in watershed areas (*Hochmoore*), named also bogs.

This division was adapted to Estonian conditions using additional characteristics of vegetation (Table 2).

TABLE 2. Differences in mires due to trophic conditions (after Laasimer & Masing, 1995).

Characters	Eutrophic	Mesotrophic	Oligotrophic
Water sypply and trophic states	precipitation, ground, surface and flood water	precipitation, little influence of ground water	precipitation water only
Landform of the mire as a whole	flat or concave	flat	convex or flat
Microtopography	even or with grass(sedge) tussocks	cotton-grass tussocks and moss hummocks	a mosaic of moss hummocks and depressions
Tree layer	*Betula pubescens, Alnus glutinosa,* sparse *Picea abies,* seldom *Pinus sylvestris*	*Betula pubescens* and *Pinus sylvestris* only	*Pinus sylvestris* only, and/or sparse *Betula pubescens*
Shrub layer	*Betula fruticosa*, *Myrica gale*, *Salix* ssp.	*Myrica gale*, sparse *Salix* ssp.	absent
Dwarf shrub layer	absent	*Calluna vulgaris*, *Ledum palustre*, *Andromeda polifolia, Chamaedaphne calyculata*, *Vaccinium uliginosum* on hummocks	
Grass and herb layer (field layer)	various grasses, herbs and forbs, especially *Carex* ssp.	in depressions eutrophic plants, often *Potentilla palustris, Menyanthes trifoliata Trichophorum alpinum, Carex lasiocarpa*	*Eriophorum vaginatum, Trichophorum cespitosum, Rhynchospora alba, Rubus chamaemorus* and *Drosera* ssp.
Moss layer	mainly *Bryales*	mainly *Sphagnales*, often *Polytrichum strictum*, *Aulacomnium palustre*	
Peat	mainly sedge or woody peat suitable for fuel and fertilizing	mainly sedge peat suitable for fuel and litter	only sphagnum peat suitable for litter and gardening

Considering hydrochemical conditions and water sources as main principles for mire classification, the following system can be used (Masing, 1975, 1988):

1. minerotrophic mires, supplied by precipitation as well as by telluric water, derived from the ground:

1.1. soligenous mires, supplied by springs,

1.2. topogenous mires, supplied by ground water,

1.3. limnogenous mires, supplied by floods or forming through terrestrialization of waterbodies;

2. ombrotrophic mires, supplied exclusively by precipitation.

Mixotrophic (transitional) mires represent an intermediate stage in mire development and they are often surrounding ombrotrophic (raised) bogs.

Every landscape can be treated as a complex of developing bio- and geosystems which form parts of higher systems and at the same time can be divided into smaller sub-systems (Masing, 1982, 1984). Therefore, a site (especially a mire site) is a complex of microsites and can be described on the basis of its components (features); in mires, these include tussocks, hummocks and the depressions between them (hollows, hollowpools, funnels). Following this structural approach, the principles of Estonian bog sites classification can be represented according to Table 3.

TABLE 3. Components of Estonian raised bogs connected with particular 'bog features' (*sensu* Sjörs, 1948; synonyms: nanotopes, microforms) forming 'bog sites' (*sensu* Sjörs, 1948) and/or 'bog massifs' (*sensu* Masing, 1984; synonym: bog complexes). Modified after Masing ,1982, 1984.

<table>
<tr><td colspan="5">Components:</td></tr>
<tr><td>Bog forest</td><td>Treed community</td><td>Hummock (ridge) community</td><td>Hollow (lawn and/or carpet) community</td><td>Bog lake/pool community</td></tr>
<tr><td>↓</td><td>↓</td><td>↓</td><td>↓</td><td>↓</td></tr>
<tr><td colspan="5">Sites/massifs consisting of predominantly one component:</td></tr>
<tr><td>Bog forest site or massif</td><td>Treed site</td><td>Hummock site</td><td>Hollow site</td><td>Bog lake/ pool site</td></tr>
<tr><td colspan="5">Sites/massifs consisting of two components:</td></tr>
<tr><td></td><td>Treed-hummock site or massif</td><td>Hummock-hollow site</td><td>Hollow-pool site</td><td></td></tr>
<tr><td></td><td></td><td>Hummock-pool site</td><td></td><td></td></tr>
<tr><td colspan="5">Sites/massifs consisting of three components:</td></tr>
<tr><td></td><td colspan="3">Treed-ridge(hummock)-hollow site or massif</td><td></td></tr>
<tr><td></td><td colspan="3">Treed-ridge-pool site or massif</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Ridge-hollow-pool site</td></tr>
<tr><td colspan="5">Sites/massifs consisting of four components:</td></tr>
<tr><td></td><td colspan="4">Treed-ridge(hummock)-hollow-pool site or massif</td></tr>
</table>

The main plant communities in the upper part of tussocks are *Calluno–Cladinetum* and *Calluno–Sphagnetum fusci*. In the lower part of tussocks and between them, *Eriophoro–Sphagnetum fusci* and *Calluno–Sphangnetum magellanici* are common. In hollows, *Rhynchosporo–Sphagnetum cuspidatum* and *Scheuchzerio–Sphagnetum cuspidatum* are typical.

According to Paal (1997) in Estonian mires 10 mire site types have been established (Annex 2). Though in the amended version[48] the respective classification system comprises five site types and 11 subtypes, we will refer to the first cited version, as that has been published and was used as basis for estimation of habitat types in the current study. The evaluation of species richness of site types in Table 4 is derived mostly indirectly from published data, since they have been collected for other purposes and do not deal specially with problems of diversity.

48 Access at: http://www.botany.ut.ee/ jaanus.paal/etk.klassifikatsioon.pdf. Classification of the Estonian vegetation site types; an amended version after Paal (1997) (23.04.2011).

TABLE 4. Typological diversity and species richness of Estonian mires. Species richness intervals (number of vascular plant species, *Bryales* and *Sphagnales* in 4 m^2): * < 15, ** 15–30, *** > 30. Human impact classes: W – without direct human impact, F – former human impact (e.g. drainage, fire), P – permanent human impact (e.g. hay making, grazing), S – strong human impact (e.g. intensive drainage, forest plantation). In parenthesis a synonymous name is presented, in brackets is a possible attribute of the name.

Type group	Site type	Main communities	Species richness	Human impact
Minerotrophic fens	Rich fen	*Primulo–Seslerietum* *Caricetum davallianae* *Schoeno–Drepanocladetum* *Caricetum appropinquatae–cespitosae* *Carici paniceae–Seslerietum* *Molinietum caeruleae* *Cladietum marisci* *Caricetum hostianae* *Caricetum buxbaumii* *Schoenetum nigricantis*	** (***)	W (F, P)
	Poor fen	*Geranio palustris–Filipenduletum* *Caricetum appropinquatae–cespitosae* *Caricetum vesicariae–rostratae* *Caricetum acutiformis* *Caricetum elatae* *Eriophoretum angustifolii* *Caricetum paniceae–nigrae* *Drepanoclado–Caricetum lasiocarpae* *Calamagrostetum canescentis*	* (**)	W, F
	Minerotrophic quagmire	*Scorpidio–Schoenetum* *Phragmitetum australis* *Equisetetum fluviatilis*	* (**)	W
Mixotrophic (transitional) grass mires	[Treed] mesotrophic bog	*Sphagno–Trichophoretum alpini* *Sphagno–Caricetum lasiocarpae* *Sphagno–Caricetum rostratae* *Sphagno–Eriophoretum vaginati* *Sphagno–Trichophoretum cespitosae* *Sphagno–Caricetum limosae*	*(**)	W
	Mixotrophic quagmire	*Scorpidio–Caricetum lasiocarpae* *Caricetum diandrae* *Cariceto limosae–Menyanthetum*	* (**)	W
Spring fens	Spring fen	*Carici lasiocarpae–Eriophoretum* *Caricetum davallianae* *Caricetum diandrae* *Scorpidio–Schoenetum*	* (**)	W
Heath moors	Heath moor	*Calluno–[Sphagno]–Pinetum* *Ledo–[Sphagno]–Pinetum*	*	F, P, S
Treeless and treed ombrotrophic raised bogs	Treed/treeless hummock bog	*Calluno–Cladinetum* *Calluno–Sphagnetum fusci* *Eriophoro–Sphagnetum fusci* *Trichophoro–Sphagnetum fusci* *Calluno–Sphagnetum magellanici*	*	W, F, P
	Treed/treeless hollow-ridge bog	*Rhynchosporo–Sphagnetum cuspidatum* *Rhynchosporo–Spagnetum baltici* *Scheuchzerio–Sphagnetum cuspidatum* *Sphagno baltici–rubelluetum* *Sphagnetum majus*	*	W
	Treed/treeless pool-ridge bog	*Nupharo–Nympahaetum* *Sphagnetum cuspidatum*	*	W

Although in Paal (1997), floodplain fens are treated under the site type 2.2.1.2 (wet floodplain grassland site type) among floodplain meadows, this site type has been distinguished in earlier reviews (e.g. Laasimer, 1965, Krall & Pork, 1980) and as a subtype in further modifications of the habitat classification system elaborated by J. Paal[49]. As floodplain fens were often distinguished during the inventory, we did not omit this site type from the analysis and from Annex III. In floodplain fens on 4 m^2, depending on ecological conditions, usually 15–30 vascular plant species, *Bryales* and *Sphagnales* can be recorded, but sometimes the number of species may be considerably lower. Communities of the following types can be distinguished:

- *Calamagrostietum strictae;*
- *Caricetum distichae;*
- *Polygono–Cirsietum;*
- *Caricetum acutae;*
- *Caricetum vesicario-rostratae;*
- *Carici paniceae–Seslerietum;*
- *Caricetum diandro–nigrae;*
- *Caricetum appropinquato–cespitosae;*
- *Caricetum elatae;*
- *Drepanoclado–Caricetum lasiocarpae;*
- *Phragmitetum australis;*
- *Phragmiteo–Schoenoplectetum.*

Species-rich fens are mainly found on the calcareous sub-surface on Saaremaa Island and in the western coastal part of the mainland. The *Primulo–Seslerietum* communities are typical in the areas with thin peat deposits (up to 1 m). In communities of this type, the number of vascular plants may exceed 130. The communities with rather restricted distribution, such as *Caricetum hostianae*, *Caricetum buxbaumii* and *Schoenetum nigricantis* are also found in the same regions, but the species richness may be less (not more than 100 species of vasculars). The *Drepanoclado–Schoenetum ferruginei* communities with *Salix rosmarinifolia* and *Myrica gale* in the bush layer are mostly found in western Estonia, but occur also in central Estonia. The *Cladietum marisci* communities may grow on calcareous seashores as well as in fens in the western part of Saaremaa Island; they occur also on the western coast of the mainland. These communities form usually only small patches, but in some cases – as in the Nehatu fen – they can cover tens of hectares.

Spring fens are distributed rather sparsely over the country; they are mostly located on the marginal slopes of the Pandivere and Sakala Upland and on Saaremaa Island. The water of the rare soligenous or spring fens is usually calcium-rich and supports communities such as *Schoenetum nigricantis*, *Scorpidio–Schoenetum*, *Juncetum subnodulosae*, etc. (on Saaremaa Island).

Floodplain (limnogenous) fens are most widely represented in the lowermost part of the western and southwestern Estonian river valleys as well as in the eastern and southeastern Estonia.

Poor fens are more common in the eastern part of the country. Communities dominated by sedges such as *Carex elata*, *C. lasiocarpa*, *C. appropinquata*, *C. vesicaria, C. rostrata*, *C. nigra*, *C. panicea, etc.* are very characteristic here (see Chapter 8.1.1.1).

Transitional (mixotrophic) fen/bog communities with *Carex lasiocarpa*, *C. rostrata*, *C. limosa* are found in western, central and northeastern Estonia. They are rather scattered, except around lakes, where they are common. On the other hand, the *Sphagno–Eriophoretum vaginati* communities of the treed transitional bogs often form a belt around large ombrotrophic bogs, especially in northern Estonia.

49 Access at: http://www.botany.ut.ee/ jaanus.paal/etk.klassifikatsioon.pdf. Classification of the Estonian vegetation site types; an amended version after Paal (1997) (23.04.2011).

Heath moors occur in depressions between sandy dunes on the western coast and on the Hiiumaa Island, but also between old dunes located far from the recent coastline (Paal, 1997).

The larger **ombrotrophic bogs** are located in the western, central and northeastern parts of the Estonian mainland. Two regional types of ombrotrophic bog complexes are distinguished in Estonia – a "western" type and an "eastern" type (Thomson, 1924; Masing, 1982). The marginal slopes of the western type have a steep rise. The bog expanse is even and relatively flat, with an irregular pattern of compound microsites. The bogs of the eastern type are convex, with a well-developed concentric pattern of microsites and no distinct steep slope. Eastern bogs have favourable conditions for *Chamaedaphne calyculata*, which does not grow in western bogs. On the other hand, *Trichophorum caespitosum* and *Drosera intermedia* grow mainly in the bogs of the western type and occur in the eastern part of the country very seldom. Certain differences can also be found in the distribution of *Sphagnum* species: *S. fuscum* is characteristic for the eastern type raised bogs while *S. rubellum*, *S. imbricatum* and *S. magellanicum* are more common in the west Estonian bogs.

According to the distribution pattern of mires and their general features, Estonia can be divided into eight mire districts (Kurm, 1960; Allikvee & Masing, 1988; Fig. 9).

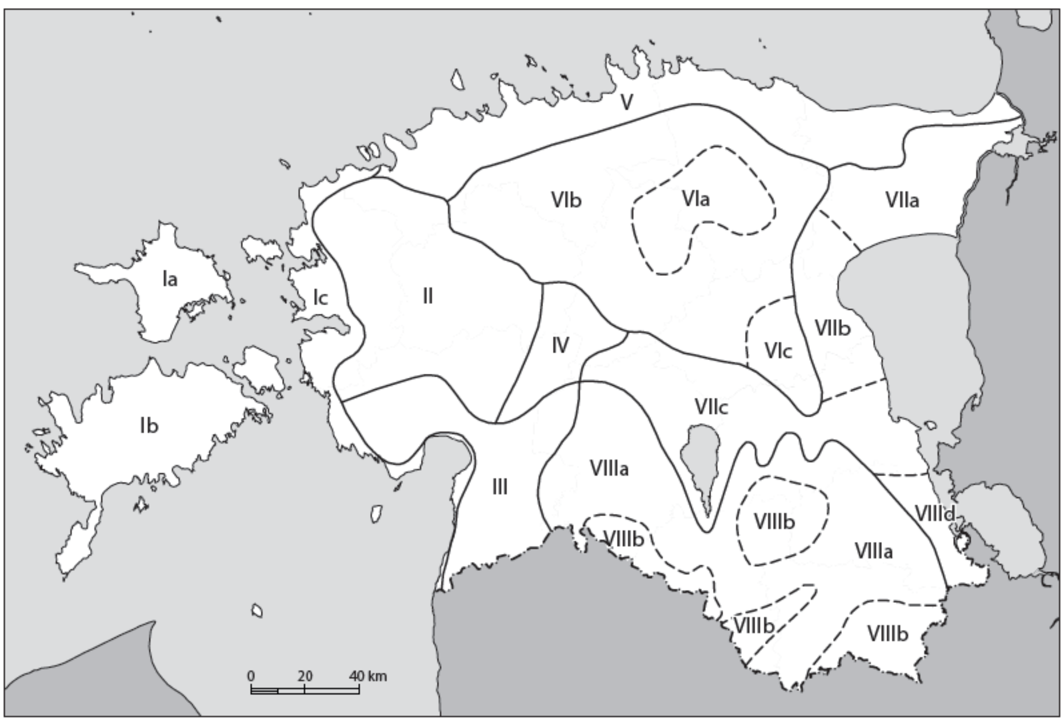

FIGURE 9. Estonian mire districts by their area and peat layer characteristics (after Allikvee & Ilomets, 1995). I – District of West Estonian small and middle size fens; subdistricts: a) Hiiumaa, b) Saaremaa, c) western coast; II – District of West Estonian middle size and large mires; III – District of South-West Estonian large bogs; IV – District of Central Estonian small bogs; V – District of North Estonian Plain small and middle size mires; VI – District of upper North Estonian large mosaic mires; subdistricts: a) central part (Pandivere Upland), b) marginal part, c) Vooremaa; VII – District of Central and East Estonian large mires; subdistricts: a) northern part of Peipsi Lake depression, b) north-western part of Peipsi lake depression, c) depression of Võrtsjärv Lake and Emajõgi River delta, d) southern part of Peipsi Lake depression; VIII – District of South Estonian small mires; subdistricts: a) valleys of uplands, b) moraine hill areas (Otepää, Karula, Haanja).

4.1.4 Paludifying forests

Paludifying forests occur on depressions and plains where due to paludification up to a 30 cm thick peat layer has developed and peat accumulation is continuing. According to Paal (1997), the rich (meso-eutrophic, eutrophic) paludifying forest habitats present three site types: *Dryopteris*, *Filipendula* and *Molinia*, whereas among the poor (oligotrophic) paludifying forests *Polytrichum* and *Vaccinium uliginosum* site types are distinguished.

4.1.4.1 Rich paludifying forests

Dryopteris site type forests occur in alluvial and synclinal valleys with rivers flowing into and out of them, on Eutric and Histic Gleysols, Histosols, as well as on Gleyic and Histic Fluvisols. The O + AT horizons have a total depth of 10–30 cm, and the soil pH_{KCl} is 5.0–7.0. One characteristic is mobile groundwater with its changeable level: reaching often the surface in spring, while dropping somewhat deeper in summer. This promotes an intensive decomposition of organic substances.

The majority of trees in the stands consist of birches, grey and black alders; spruce forests can be found in the less swampy or better drained parts. Ash, lime, elm and maple are other associate species. Both the undergrowth and the ground vegetation are rich in species. The characteristic plants in the undergrowth are *Padus avium*, *Ribes nigrum*, *R. alpinum*, *Frangula alnus*, *Lonicera xylosteum* and *Viburnum opulus*. For ground vegetation the abundance of ferns is characteristic, typical species are: *Athyrium filix-femina*, *Matteuccia struthiopteris*, *Dryopteris expansa*, *D. carthusiana*, *Phegopteris connectilis*, *Filipendula ulmaria*, *Cirsium oleraceum*, *Angelica sylvestris*, *Crepis paludosa*, *Chrysosplenium alternifolium*, *Urtica dioica* and *Geum rivale*. Bryophytes grow on microhummocks: *Rhytidiadelphus triquetrus*, *Eurhynchium angustirete*, *Climacium dendroides*, *Plagiomnium undulatum*, *Rhodobryum roseum*, etc.

Filipendula site type forests are common on various Gleysols both on tills and aqueous deposits with the texture from fine sand to varved clay. Gley horizon of tilly origin contains yellowish crumble pieces of calcareous pebble. Reaction of the O and AT horizons is slightly acidic to neutral, deeper usually being neutral. Groundwater level is rather changeable. In spring and autumn water can be on surface, but may drop deeper than 1 m in a dry summer.

Birch is the predominant species (2/3 of the total area), with spruce (1/5) and black alder (1/20) being less frequent. Mixed forests are quite common. The undergrowth is rich in species: *Frangula alnus*, *Sorbus aucuparia*, *Padus avium*, *Ribes alpinum*, *R. nigrum*, *Daphne mezereum* and *Lonicera xylosteum*. The species characteristic of the ground vegetation are *Filipendula ulmaria*, *Crepis paludosa*, *Cirsium oleraceum*, *Geum rivale*, *Calamagrostis canescens*, *Ranunculus repens*, *Stellaria holostea*, *Equisetum sylvaticum*, *Carex cespitosa*, *C. digitata*, *C. vaginata* and *Galium palustre*. The mosses grow usually scattered; more common species in moss layer are *Climacium dendroides*, *Plagiomnium* spp., *Rhodobryum roseum*, *Plagiochila asplenioides* and *Calliergonella cuspidata*.

Molinia forest site type stands are presented mostly in the western part of Estonia, on the low plain areas of the Baltic Sea transgressions, plains alongside of mires, sometimes depressions between dunes. The groundwater level is high, on poorly drained areas it is on the surface in spring and autumn. The soil parent material is fine-grained fluvial sand of various thicknesses. In western Estonia being under the influence of hard groundwater, Eutric Gleysols and Eutri-Histic Gleysols have developed, while in eastern Estonia Dystric Gleysols and Dystri-Histic Gleysols are characteristic.

The bush layer includes *Frangula alnus*, *Juniperus communis*, *Viburnum opulus*, *Salix cinerea*, *S. phylicifolia,* etc. The ground vegetation species differ depending on the tree layer. Under sparse pine and birch stand *Molinia caerulea*, *Calamagrostis canescens*, *C. epigeios*, *Deschampsia cespitosa*, *C. vaginata* and *C. nigra* prevail. *Filipendula ulmaria*, *Peucedanum palustris*, *Potentilla erecta*, *Lysimachia thyrsiflora* and *L. vulgaris* are also common. The moss layer is discontinuous. On hummocks around the tree bases *Pleurozium schreberi* and *Hylocomium splendens* grow, while between hummocks *Aulacomnium palustre*, *Calliergonella cuspidata* and *Sphagnum* spp. are more common.

4.1.4.2 Poor paludifying forests

Forests growing on overmoistened soils with rather thick litter of the moor type belong to this site type group. Recent soils often have compact humus-illuvial spodic horizon at the boundary of the capillary fringe.

***Polytrichum* site type forests** grow all over Estonia on sands where Gleyic, Carbic and Histic Podzols occur. The total thickness of ground litter and peat layers is 10–30 cm, and according to the decomposition rate it can be divided into 2–3 subhorizons.

The leading tree species is pine (60%); birch (21%) and spruce (17%) occur less often. The undergrowth is sparse or absent. There can grow *Frangula alnus*, *Salix cinerea*, *S. rosmarinifolia* and *Sorbus aucuparia*. Ground vegetation consists of a few species only and *Vaccinium myrtillus* dominates. The coverage of *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum palustre* and *Calluna vulgaris* is smaller. Other typical species are: *Carex globularis*, *Molinia caerulea*, *Equisetum sylvaticum*, *E. palustre*, *E. fluviatile*, *Calamagrostis canescens*, *Carex nigra*, *C. lasiocarpa*, *C. echinata*, *Dryopteris carthusiana,* etc. The moss layer is vigorous, with abundant quantities of ordinary *Polytrichum commune*, *Sphagnum* spp., *Pleurozium schreberi*, *Dicranum polysetum*, *D. scoparium* and *Aulacomnium palustre*.

***Vaccinium uliginosum* site type forests** are characterized by well-developed dwarf shrub and moss layer, which contains considerable amount of sphagna and hair moss. These habitats are widespread everywhere in Estonia inducing podzolisation, often with a humus illuviation in the condition of ground-gleying on sands that are poor in most chemicals. Carbic, Gleyic and Histic Podzols are typical. Total thickness of ground litter and peat is 10–30 cm, and according to the decomposition rate it can be divided into 2–3 subhorizons.

The scarce tree layer is formed by pines alone, but in regrowth some spruce or birch can grow as well. The bush layer is almost lacking or represented by sparse junipers, *Frangula alnus* and/or willows (*Salix cinerea*, *S. myrtilloides*, *S. rosmarinifolia*, *S. lapponum*, *S. aurita*). Dwarf shrubs such as *Vaccinium uliginosum*, *V. myrtillus*, *V. vitis-idaea*, *Calluna vulgaris*, *Ledum palustre*, *Empetrum nigrum* and *Andromeda polifolia* dominate in the ground vegetation. Some grasses or herbs grow also there, such as *Molinia caerulea*, *Eriophorum vaginatum*, *Rubus chamaemorus* and *Melampyrum pratense*. The moss layer is continuous and *Sphagnum* spp. form the majority of the cover.

4.1.5 Peatland forests

Though peatland forests *sensu lato* include paludifying forests as well, in the present publication the term 'peatland forest' is only used for forests which peat horizon thickness is at least 30 cm. According to the development stage, as well as the botanical, nutrient and water content of peat, peatland forests are divided as minerotrophic, mixotrophic and ombrotrophic ones.

4.1.5.1 Minerotrophic swamp forests

Minerotrophic swamp forests grow on areas with medium or well-decomposed peat, which are comparatively rich in nutrients. A characteristic feature is high water table, water is often on surface. These forests occur all over Estonia but more frequently in western, northwestern, northeastern and central parts.

Mobile water swamp (*Calla*) site type forests are situated on plains, slanting slopes and depressions where Eutric Histosols of various thickness as well as Histic Fluvisols and Gleysols occur. Peat is well decomposed, with high content of mineral substances (loss on ignition is >10%) and nitrogen; its pH_{KCl} varies from 5.0 to 6.5. In *Calla* swamp forests paludification takes place mainly due to the movable mineral-rich groundwater; its level reaches the surface almost during the whole vegetation period and drops down for 20–30 cm only in dry periods.

For habitats with thicker peat layer swamp birch is typical, while in areas with shallower peat black alder is predominant. In the latter sites black alder can also be intermixed with spruce. Windfalls are frequent and cause a heterogeneous microtopography due to the numerous pits and mounds. The bush layer is rich in species and in places rather dense. It is formed by *Padus avium*, *Viburnum opulus*, *Ribes nigrum*, *R. alpinum*, *Sorbus aucuparia*, *Frangula alnus*, *Salix* spp. Sedges as well as hydrophilous forbs are characteristic in the ground vegetation. There grow *Calla palustris*, *Caltha palustris*, *Carex loliacea*, *C. elongata*, *C. cespitosa*, *Lysimachia thyrsiflora*, *L. vulgaris*, *Iris pseudacorus*, *Calamagrostis canescens*, *Thelypteris palustris*, *Scirpus sylvaticus*, *Potentilla palustris*, *Menyanthes trifoliata*, *Filipendula ulmaria*, *Cirsium oleraceum*, on tussocks *Paris quadrifolia*, *Galeobdolon luteum*, *Rubus saxatilis*, *Mercurialis perennis*, etc. The moss layer is discontinuous. In hollows *Climacium dendroides*, *Plagiomnium* spp., *Calliergonella cuspidata*, *Calliergon cordifolium*, *Sphagnum squarrosum, Plagiochila asplenioides* are typical, on tussocks grow *Hylocomium splendens*, *Pleurozium schreberi*, *Dicranum scoparium*, *Eurhynchium angustirete*, etc.

Stagnant water swamp site type forests are represented in low depressions and plains where the stagnation of groundwater is characteristic and Eutri-Dystric Histosols of various thicknesses and stage of decomposition are spread.

The predominant part of the stands is formed by swamp birch, with pine forests following. The bush layer is usually sparse, consisting mainly of willows *Salix* spp., *Frangula alnus*, *Betula humilis* (sporadically) and *Myrica gale* in the western part of Estonia. The ground vegetation is rather species-poor. Dominating are sedges: *Carex lasiocarpa*, *C. elongata*, *C. rostrata*, *C. diandra*, *C. appropinquata*, frequent are also such species as *Calamagrostis canescens*, *Galium palustre*, *Menyanthes trifoliata*, *Potentilla palustris*, *Lysimachia thyrsiflora*, *Equisetum palustre*, *E. fluviatile* and *Phragmites australis*. In the rather modest moss layer *Aulacomnium palustre*, *Calliergonella cuspidata* and *Sphagnum* spp. are typical.

Floodplain forests. A separate group of swamp forests are bounded with floodplains along the rivers but also on the low banks of some lakes. Floodplain forests as riparian ecosystems represent transitional habitats between terrestrial and aquatic ecosystems, and have very specific ecological conditions in the temperate zone (Klimo, 2001; Hager & Schume, 2001). The distinct characteristics of these habitats are regularly occurring floodings and enrichment of soils with alluvial sediments brought by floodwater. The amount of alluvial sediments depends on several circumstances: (i) geological features of the river upper course, (ii) agricultural practices in the river upper course and surrounding areas, (iii) floodplain topography, (iv) velocity and depth of floodwater, and (IV) longevity of the flood period. Sediment deepness can be 1 m and even more, whereby layers rich in organic substances change with poorer ones. Structure of floodplain swamp forests, their species content and ecological conditions depend very much on the location of the stand in floodplain. According to a general scheme, the coarsest particles will be deposited close to the riverbed, while finer particles are carried further from the riverbed and deposited there. Parallel to the riverbank a low wall of sedimentary material will develop where deciduous hardwood forests will grow. These forests are more similar to the deciduous boreo-nemoral stands and are not discussed here. Behind riverbank walls (levees) topography is lower, floodwater will stay much longer there and in those anoxial conditions backswamp forests are characteristic.

These stands comprise black alder communities. In field layer often *Filipendula ulmaria* dominates but on veins of groundwater it can be largely replaced by *Phragmites australis.* The characteristic species are, in addition, *Carex elongata*, *C. acutiformis*, *C. vesicaria*, *Chrysosplenium alternifolium*, *Cardamine amara*, *Thalictrum flavum*, *Ranunculus repens*, *Thelypteris palustris, Iris pseudacorus* and *Caltha palustris*, from mosses – *Calliergonella cuspidata*. Typical are Molli-Histic and Histic Fluvisols (Paal et al., 2007).

4.1.5.2 Mixotrophic (transitional) bog forests

Mixotrophic bog forests are more frequent in northeastern, central and western Estonia. They often surround ombrotrophic raised bog areas or are located between raised bogs and mineroptrophic fens on Dystric Histosols. The characteristic feature of these soils is the presence of a layer of bog peat not very well decomposed, at least in the upper part of the solum. Loss on ignition is 5–10%, pH_{KCl} 3.5-5.0. Soils are always saturated with water; its table will drop to the depth not more than 10–30 cm in the summer period.

Pine stands dominate among these communities, the share of birch forests is smaller. In the bush layer such species as willows *Salix* spp., *Frangula alnus* and *Betula humilis* grow. The ground vegetation may be very varied, the proportions between the plants of the grassy swamp and those of the bog depend on the position in the succession sequence "fen → transition bog → bog" and the intensity of drainage. A characteristic feature is that species of ombrotrophic bogs grow on tussocks – e.g. *Eriophorum angustifolium*, *Ledum palustre*, *Vaccinium uliginosum*, *Andromeda polifolia*, while hollows are occupied by fen species – *Carex lasiocarpa*, *C. chordorrhiza*, *C. nigra*, *C. rostrata*, *Phragmites australis*, *Calamagrostis canescens*, *C. stricta*, *Molinia caerulea*, *Potentilla palustris*, *Menyanthes trifoliata*, *Oxycoccus palustris*, etc. In moss layer the *Sphagnum* spp. cover more than 10%.

4.1.5.3 Ombrotrophic bog forests

Bog forests occur all over Estonia on deep Dystri-Fibric Histosols. They are mostly rather sparse pine stands where undergrowth is almost lacking or may be represented only by few willows. A typical feature of the ground vegetation is the well-developed dwarf shrub layer formed by *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris*, *Empetrum nigrum*, *Andromeda polifolia*, *Chamaedaphne calyculata* (in eastern Estonia), *Vaccinium vitis-idaea*, *Oxycoccus palustris*, *Betula nana* (locally). In herb layer *Eriophorum vaginatum*, *Rubus chamaemorus*, *Drosera rotundifolia*, *Carex limosa* are represented. In the moss layer *Sphagnum* spp. dominate, intermixed with *Polytrichum strictum*, *Aulacomnium palustre*, on tussocks grow *Pleurozium schreberi*, *Hylocomium splendens* and *Dicranum* spp.

4.1.5.4 Drained peatland forests

Specific features of these forests are the intensively drained bog soils with horizons of forest litter and of well-decomposed peat decay as well as the ground vegetation characteristic of forests on mineral soils. Soils are Dystric Histosols of various thicknesses. The first tree generation constitutes usually pines and birches, which as stunted trees were growing there already before drainage; in the next tree generations spruce can prevail. Ground of drained peatland forests is usually poor in species; depending on water conditions can remind that of oligo-mesotrophic or mesotrophic boreal forests, or eutrophic boreo-nemoral forests but in some habitats flush field layer is formed by ferns (*Dryopteris expansa*, *D. carthusiana*).

4.2 Other wetlands

As it was mentioned in Introduction, according to the Ramsar Convention[50], the term 'wetland' is considered very widely. In addition to peatlands, different habitats without peat layer are included among them: floodplain and coastal grasslands, springs, rivers, a larger part of lakes as well as sublittoral.

Floodplain habitats on Histic Fluvisols with peat thickness less than 30 cm belong to the floodplain grasslands. Like floodplain forests, they are situated in areas along river and lake sides, which are more or less regularly inundated (flooded) by water which supplies plants with additional nutrients in the form of alluvial sediments. The lower-lying areas along the rivers may be flooded every year, while areas at a slightly higher elevation are flooded not so frequently.

On larger floodplains plant communities usually form several belts parallel to the river banks. Close to the banks, on the wettest sites where the flood is deeper and long-lasting, reed communities usually grow. They constitute mainly of *Phragmites australis*, *Phalaris arundinacea*, *Schoenoplectus lacustris,* etc. Communities of high sedges: *Carex acuta*, *C. elata*, *C. appropinquata*, *C. acutiformis*, *C. disticha*, etc. follow to them. Farther from waterbodies, in dryer habitats, plant communities richer in species and lower sedges (*Carex nigra*, *C. panicea*, *and C. cespitosa*) are dominating. Several other species are accompanying: *Calamagrostis canescens*, *Potentilla palustris*, *Thelypteris palustris*, *Lysimachia vulgaris*, *L. thyrsiflora*, *Lythrum salicaria*, *Filipendula ulmaria*, *Geranium palustre*, *Deschampsia caespitosa* etc.

Coastal grasslands on seashore are characterized by (**i**) periodical flooding or temporal inundation by seawater, producing a specific moisture regime in soils and (**ii**) high and variable salinity of the subsurface water and soils, favouring the growth of halophilous vegetation in distinct zones (Ratas et al., 1988). Coastal grasslands are located as narrow belts on lowshore, following the shoreline; only in a few places their width exceeds 100 m onshore.

Still, not all communities along seashores are wetlands, and not all are grasslands. The saline coastal grasslands in the eulittoral belt comprise habitats on more or less saline soils with a glei horizon (AsG). The vegetation can be further divided into hydrolittoral and geolittoral habitats. In a saline site type the most common plant communities are: *Junco–Glaucetum*, *Elytrigietum repentis*, *Salicornietum europaeae*, *Spergularietum marinae* and *Eleocharetum uniglumis*. The suprasaline (less saline) coastal grasslands, in higher parts of the geolittoral or epilittoral belt, are less or infrequently inundated, with AsG or Ast soils. In the suprasaline habitat site type the plant communities are comparatively species-rich and diverse. Communities such as *Festucetum rubrae*, *Festucetum arundinaceae*, *Arrhenatheretum elatii*, *Tetragonolobo–Molinietum* and *Caricetum nigrae-paniceae* are most widespread. In places where organic debris (mainly drift litter) has been carried in, the extensive nitrophilous plant communities dominated by *Atriplex* spp., *Cakile maritima*, *Elymus repens*, *Alopecurus ventriculosus* etc. occur.

Springs, rivers, lakes and sublittoral are treated as waterbodies, thus, we will not specify them in the present publication.

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50 Access at: http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on-20708/main/ramsar/1-31-38%5E20708_4000_0_. Convention on Wetlands of International Importance Especially as Waterfowl Habitat Final Text adopted by the International Conference on the Wetlands and Waterfowl at Ramsar, Iran, 2 February 197 I. (02.04.2011).

4.3 Estonian mire habitats in the international context

In last decades several all-European habitat classification systems have been compiled. Their first versions were hardly real classification systems but mostly just simple lists of habitat units distinguished by greatly different criteria. The latest versions, instead, have been quite converged, the criteria for delimiting the habitats are fairly conformed and the results, therefore, largely overlapping.

4.3.1 CORINE habitat classification

Initially the CORINE (COoRdinated INformation on the Environment of Europe) Land Cover Programme applied a method for land cover data collection based on a hardcopy inventory from satellite image printouts. This proved to be the most feasible approach in the mid-1980s, the starting period of the programme (Bossard et al., 2000). Thereafter the European Commission and the Council of Europe started to work out plans for protection of habitat types of priority importance and/or being endangered in the European scale; the habitat classification of CORINE was used for that as a basis. The CORINE classification has been repeatedly amended, in the last version (Devillers et al., 2005) the following types are presented at least partly corresponding to the Estonian mire habitat types:

- 51 Raised bogs
  - 51.1 Near-natural raised bogs
    - 51.11 Bog hummocks, ridges and lawns
      - 51.111 Colourful sphagnum hummocks (bulten)
      - 51.112 Green sphagnum hummocks bases and lawns
      - 51.113 Dwarf shrub hummocks
    - 51.12 Bog hollows (schlenken)
      - 51.121 Deep schlenken (*Caricetum limosae* p.)
      - 51.122 Shallow schlenken (*Rhynchosporetum albae*)
    - 51.13 Bog pools
    - 51.131 Bog eye (kolk)
    - 51.14 Bog seeps and soaks
    - 51.15 Laggs
    - 51.16 Bog pre-woods
- 54 Fens, transition mires and springs
    - 54.23 Davall sedge fens (*Caricetum davallianae*)
    - 54.21 Tall herb fens
  - 54.4 Acidic fens
  - 54.5 Transition mires
    - 54.51 Slender-sedge swards (*Caricetum lasiocarpae*)
    - 54.52 *Carex diandra* quaking mires (*Caricetum diandrae*)
    - 54.53 Bottle sedge quaking mires
    - 54.54 Mud sedge swards (*Caricetum limosae* p.)
    - 54.55 String sedge swards (*Drepanoclado-Caricetum chordorrhizae*)
    - 54.57 Beak-sedge quaking bogs (*Sphagno-Rhynchosporetum albae*)
    - 54.58 Sphagnum and cottongrass rafts
    - 54.59 Bog bean and marsh cinquefoil rafts
    - 54.5C Harestail cottongrass quaking bogs
  - 54.6 White beak-sedge communities (*Rhynchosporion albae*)

53 Water-fringe communities

- 53.11 Common reed beds (*Phragmitetum*)
- 53.13 Reedmace beds (*Typhetum angustifoliae*, *Typhetum latifoliae*)
- 53.14 Medium-tall watrerside communities
- 53.15 Reed sweetgrass beds (*Glycerietum maximae*)
- 53.16 Reed canary-grass beds (*Phalaridetum arundinaceae*)
- 53.21 Large *Carex* beds
- 53.31 Fen *Cladium* beds.

4.3.2 EUNIS habitat classification

The European Nature Information System (EUNIS) habitat classification[51] is also a pan-European system, which was developed between 1996 and 2001 by the European Environment Agency (EEA) (EUNIS 2002). The starting point was the Palaearctic Habitat classification, extended from the CORINE habitat classification which was developed for use by the European Community in the pilot CORINE biotopes programme by the EU Commission 1986–1991 (Davies & Moss, 2002). A novel feature of that hierarchical classification was the development of criteria in order to make a key for identification of habitats, analogous to keys for identification of species.

Mires are included in unit D – 'Mire, bog and fen habitats'. The following subunits correspond rather well to the Estonian mire habitat types:

D1.1 Raised bogs

- D1.1/P-51.1 Active, relatively undamaged raised bogs
- D1.12 Damaged, inactive bogs

D2.2 Poor fens

- D2.2/P-54.42 [*Carex nigra*], [*Carex canescens*], [*Carex echinata*] fens

D2.3 Transition mires and quaking bogs

- D2.3/P-54.51 [*Carex lasiocarpa*] swards
- D2.3/P-54.52 [*Carex diandra*] quaking mires
- D2.3/P-54.53 [*Carex rostrata*] quaking mires
- D2.3/P-54.54 [*Carex limosa*] swards
- D2.3/P-54.55 [*Carex chordorrhiza*] swards
- D2.3/P-54.57 [*Rhynchospora alba*] quaking bogs
- D2.3/P-54.58 [*Sphagnum*] and [*Eriophorum*] rafts
- D2.3/P-54.59 [*Menyanthes trifoliata*] and [*Potentilla palustris*] rafts
- D2.3/P-54.5C [*Eriophorum vaginatum*] quaking bogs

D4 Base-rich fens

- D4.1/P-54.22 [*Schoenus ferrugineus*] fens
- D4.1/P-54.23 Subcontinental [*Carex davalliana*] fens
- D4.1/P-54.21 Tall herb fens
- D4.1/P-54.2K [*Sesleria caerulea*] fens
- D4.1/P-44.93(p) [*Myrica gale*] scrub on rich fens
- D4.1/P-54.12 Hard water spring mires

D5 Sedge and reedbeds, normally without free-standing water

- D5.1/P-53.112 [*Phragmites australis*] beds normally without free-standing water
- D5.1/P-53.12(p) [*Scirpus lacustris*] beds normally without free-standing water
- D5.1/P-53.13(p) [*Typha*] beds normally without free-standing water

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51 Access at: http://lv-twk.oekosys.tu-berlin.de/project/twinning/documents/htmls/EUNIS%20-20Draft%20Habitat%20 Classification_information_copied.htm (10.03.2011).

D5.1/P-53.21 Beds of large [*Carex*] spp.
D5.2/P-53.112 [*Phragmites australis*] beds normally without free-standing water
D5.2/P-53.31 Fen [*Cladium mariscus*] beds.

4.3.3 Map of the Natural Vegetation of Europe

On the Map of the Natural Vegetation of Europe at the scale of 1: 2.5 million, compiled and produced by an international team of geobotanists from 31 European countries over the period 1979–2003 (Bohn & Neuhäusl, 2003; Bohn et al., 2007), altogether 22 types of bogs and fens are distinguished. Other types of peatlands, such as alder, birch or spruce carrs (swamp forests), salt marshes, littoral reed and tall-grass swamps are incorporated in the other vegetation formations, although they can often accumulate peat (Rybnicek & Yurkovskaya, 1995). In Estonia, five types of bogs and fens are recognized (K. Rybnicek, pers. comm.):

Ombrotrophic bogs:

- S–2 Eastern Finnish – western Russian *Sphagnum fuscum* raised bogs (in the eastern part of Estonia);
- S–7 Baltic *Sphagnum magellanicum* raised bogs (in Saaremaa and western mainland);

Minerotrophic mires:

- S–17 Eastern European wooded transitional fens (in the mainland);
- S–19 Boreal tall-sedge fens (in the eastern mainland);
- S–21 Low-sedge brown-moss rich fens (on the islands and the mainland).

4.3.4 Habitat Directive

The Habitat Directive of the European Union (Habitat Directive, 1992) on the conservation of natural habitats aims to ensure the preservation of wild fauna and flora species by protecting their habitats as well as preserving the endangered habitats themselves. For that purpose a network of protected areas, called Natura 2000, has been established. The list of habitat types having an all-European importance is presented in the Annex I of the directive. Since ratification by member states, the Habitat Directive has become a leading legislative document in the contemporary nature protection policy and pratice. Still, whereas the legislative acts cannot be flexibly amended or changed, the habitat types listed here have the similar shortcomings with the initial versions of CORINE. The most serious deficiency is connected with the intermixing of different discrimination criteria on the same hierarchy level of the habitats. Moreover, the ecological amplitude (volume) of different habitat types is extremely variable. Therefore, in every country different limits for the interpretation of considered habitat types should be established in accordance with the peculiarities of local nature. Nevertheless, in several cases the ecological conditions of the Habitat Directive types and respective Estonian vegetation habitat types are largely overlapping, and then it is easy to establish what types correspond to each other; often, however, the concurrence is only partial and dovetailing of habitat types is rather complicated (Table 5 and 6).

TABLE 5. Habitat Directive mire habitat types presented in Estonia and their cross-references in the Estonian vegetation habitats classification (Paal, 1997). Notations: HD – Habitat Directive, EVH – Estonian vegetation habitat, STC – site type class, STG – site type group, ST – site type, subT – subtype.

HD code	HD type	EVH code	EVH type
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	2.2.1.2	Wet floodplain grassland ST
		2.4.1.2	Rich paludifying grassland ST
		3.1.1.2	Rich fen ST
7110	Active raised bogs	3.2.2	Treeless and treed ombrotrophic raised bogs TG
7120	Degraded raised bogs still capable of natural regeneration	3.2.2	Treeless and treed ombrotrophic raised bogs TG
7140	Transition mires and quaking bogs	3.1.1.3	Minerotrophic quagmire ST
		3.1.2.1	Mixotrophic grass mire ST
		3.1.2.2	Mixotrophic quagmire ST
7150	Depressions on peat substrates of the *Rhynchosporion*	3.2.2.2	Treeless/treed hollow-ridge bog ST
		3.2.1.1	Heath moor ST
7160	Fennoscandian mineral-rich springs and springfens	3.1.3.1	Spring fen ST
		6.1.2.1	Watercourse ST
7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	2.4.1.2	Rich paludifying grassland ST
		3.1.1.2	Rich fen ST
7220	Petrifying springs with tufa formations (*Cratoneurion*)	3.1.3.1	Spring fen ST
7230	Alkaline fens	2.4.1.1	Poor paludifying grassland ST
		2.4.1.2	Rich paludifying grassland ST
		3.1.1.1	Poor fen ST
		3.1.1.2	Rich fen ST

TABLE 6. Estonian mire vegetation habitat types (Paal, 1997) and the respective types in terms of the Habitat Directive. Notations as in Table 5.

EVH code	EVH type	HD code	HD type
2.4.1.1	Paludifying grasslands TC Poor paludifying grassland ST	6410	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caerulea*)
		6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
		6530	Fennoscandian wooded meadows
		7230	Alkaline fens
		9070	Fennoscandian wooded pastures
2.4.1.2	Paludifying grasslands TC Rich paludifying grassland ST	6530	Fennoscandian wooded meadows
		7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
		7230	Alkaline fens
		9070	Fennoscandian wooded pastures
3.1.1	Minerotrophic fens TG	2190	Humid dune slacks
3.1.1.1	Minerotrophic fens TG Poor fen ST	6410	*Molinia* meadows on calcareous peaty or clayey-silt-laden soils (*Molinion caerulea*)
		7230	Alkaline fens
3.1.1.2	Minerotrophic fens TG Rich fen ST	6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
		7160	Fennoscandian mineral-rich springs and springfens
		7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
		7220	Petrifying springs with tufa formations
		7230	Alkaline fens
3.1.2.1	Mixotrophic (transitional) mires TG Mixotrophic (transitional) grass mire ST	7140	Transition mires and quaking bogs
3.1.2.2	Mixotrophic (transitional) mires TG Mixotrophic quagmire ST	7140	Transition mires and quaking bogs
3.1.3.1	Spring fens TG Spring fen ST	7160	Fennoscandian mineral-rich springs and springfens
		7220	Petrifying springs with tufa formations (*Cratoneurion*)
3.2.1.1	Heath moors TG Heath moor ST	7150	Depressions on peat substrates of the *Rhynchosporion*
3.2.2	Treeless and treed ombro-trophic raised bogs TG	7110	Active raised bogs
		7120	Degraded raised bogs still capable of natural regeneration
3.2.2.2	Treeless/treed hollow-ridge bog ST	7150	Depressions on peat substrates of the *Rhynchosporion*

MIRES EXPLOITATION, EMERGING CONFLICTS

5

Mires support a number of different human interests and activities. Some of them are not an immediate threat to the ecosystems (e.g. research, eco-tourism, modest hunting, collecting berries, etc.). Other activities are based on the extensive use of the mires (drainage, extraction of peat or mud) and cause principal changes in the soil structure and in hydrological conditions.

5.1 Agriculture

Exploitation of mires for peat extraction and agriculture started in the 17th century. At the beginning of the l9th century, drainage and burning of peatlands was commonly practiced for agricultural purposes (Valk, 1998). In 1839 the Estonian Agricultural Society was founded. One of its aims was to introduce and enlarge the drainage of peatlands. The first drainage system, where pipes made of burnt clay were used, was constructed as early as in the 1850s. By the end of the century the cultivation of peatlands was expanding fast.

In 1908, the Baltic Peatland Improvement Society was founded in Tartu, with the purpose of promoting and facilitating peatland cultivation. In 1910, the Tooma Experimental Bog Station was opened, which specialized in the development of peatland cultivation and the study of mire hydrometeorology (Juske, 1996).

According to Ratt (1985) from 1918 to 1940, more than 350,000 ha of lands were ameliorated, predominantly for agricultural purposes, whereas afforestation accounted for perhaps less than 5% of the whole drained area. Unfortunately, no more detailed data about the drained peatland areas is available.

After 1947, there was a significant increase in peatland drainage, as powerful machinery became available. Data on drainage specified according to soil types (peat, peaty, mineral) are missing. In the 1950s almost all undrained peatlands were bordered by ditches. This means that the hydrological regime of the marginal parts of mires, mostly of minerotrophic ones, was damaged. In 1960–1970, open drainage was constructed in numerous fens with thin peat layer (about 1 m thick); this was frequently made by excavating one or a few ditches across the mire. Constructions of this kind were not regarded as a drainage system and therefore were not included in the official statistics. The marginal part of fens, accounting for some 20–25% of the total fen area, where the thickness of peat layer was less than 40 cm, was classified as peaty soil and not considered by statistics as a "real" peatland.

At the beginning of the 1970s the area of peatlands which belonged to collective and state farms equaled 379,800 ha (Kokk & Rooma, 1974). During six years (1970–1975), on drained Histosols 31,600–47,000 ha grasslands, 10,700–11,600 ha pastures, 1,900–42,800 ha arable lands were established

(Hommik, 1982). Therefore, perhaps some 250,000–300,000 ha of peatlands (mostly minerotrophic habitats) had been drained by the end of 1980s and brought into agricultural production as cultivated grassland, pasture and arable land.

According to Ratt (1985), by 1980 about 1,006,300 ha of lands were ameliorated, including 338,400 ha of forests and 584,400 ha of agricultural lands.

Comparison of the distribution area of different peatlands in the 1950s and in the 1990s (Table 7) proves that nearly natural conditions (in at least 2/3 part of a peatland) were still preserved in some 200 larger peatlands covering a total area of about 320,000 ha (Ilomets, 1993, 1994b; Ilomets & Kallas, 1995). Based on the data and the speculations presented above, it has been concluded (Ilomets et al., 1995, Ilomets & Kallas, 1995) that about 70% of Estonian peatlands are drained or influenced by drainage to an extent, which presumably does not allow peat accumulation any more. The most endangered mire types are the minerotrophic mires, especially spring fens and species-rich calcareous fens. Of these, less than 10% are still in a more or less natural state from the hydrological point of view. The state of ombrotrophic bogs is somewhat better, mainly due to nature conservation efforts in the 1970's; 60–65% of raised bog sites may hitherto be in an untouched or natural state (Ilomets, 1994b). Loopmann (1994) has disputed these estimations: according to his calculations, the area of drained peatlands has not changed very much during the period of 1975–1995 and the proportion of mires in natural state can constitute 71%. Loopmann's calculations were based on the official data of the Statistical Department and the marginal parts of peatlands where the peat layer thickness is less than 0.3 m in drained grasslands and 0.5 m in drained forests were not taken into consideration.

TABLE 7. Distribution of different types of Estonian peatlands in 1950s and 1990s (after Ilomets et al., 1995, with complements) and the main factors causing their decline.

Mire type	Approximate area		Impact factor
	in 1950s	in 1990s	
1. Minerotrophic habitats	650,000	58,000	
1.1. Soligenous peatlands	1,500	400	surrounding areas drained
1.2. Topogenous peatlands	334,200	40,000	
1.2.1. Rich fens	74,900	7,000	mostly drainage for agriculture
1.2.2. Poor fens	152,300	30,000	drainage for forestry and agriculture
1.2.3. Wooded swamps	10,700	3,000	drainage for forestry
1.3. Limnogenous peatlands	84,300	2,500	
1.3.1. Quagmires	1,300	1,300	
1.3.2. Floodplain fens	83,000	1,000	mostly drainage for agriculture
1.3.3. Wooded swamps on mobile groundwater habitats	500	50	drainage for forestry
1.4. Topo-ombrogenous and limno-ombrogenous transitional peatlands	230,000	18,000	
1.4.1. Transitional mires	76,200	10,000	partly drainage for agriculture
1.4.2. Wooded transitional peatlands	151,800	8,000	mostly drainage for forestry
2. Ombrotrophic habitats	383,000	250,000	
2.1. Heath moors	3,000	1,500	mostly drainage for forestry
2.2. Raised bogs	380,000	250,000	
2.2.1. Bog margins	80,000	60,000	drainage for forestry, industry
2.2.2. Bog centres	170,000	125,000	industry
2.2.3. Bog forests	130,000	65,000	drainage for forestry
Total	1,033,800	310,000	

If a mire is drained, peat accumulation stops and extensive denudation of the peat layer takes place in the process of peat thickening. According to Tomberg (1970, 1992) who has monitored this process on drained fen sites for several decades, the rate of peat surface setting is about 1 to 3 mm per year. The annual loss of organic matter due to mineralization is 15–20 tons $ha^{-1}yr^{-1}$ during the first decade after drainage and does not depend on the manner of exploitation (pasture, cropfield, grassland). Later, the rate of loss stabilizes at about 10–15 ton $ha^{-1}yr^{-1}$ on cropland and 5–10 ton $ha^{-1}yr^{-1}$ on grasslands. The leaching of nitrogen may amount to 150–250 kg N $ha^{-1}yr^{-1}$ and 100–200 kg N $ha^{-1}yr^{-1}$, respectively. Due to the mineralization on grasslands the drained peat layer subsidence will be 1 meter for the first 20 years and during a century about 2 meters

Loopmann (1994) has calculated that peat increment has ceased in Estonia at least on 383,000 ha drained agricultural land where potentially 4.0 million m^3 of raw peat had been produced. By Ilomets (2001, 2003) the peat loss on this area constitutes ca 2.56 million tons per year due to mineralization. Even if the peat loss in drained forests is not taken into account, this figure is roughly five times bigger than peat increment.

Assuming that the mean annual value of organic matter mineralization is about 5–10 t $ha^{-1}yr^{-1}$ and the average carbon content in peat constitutes 53%, the annual emission of CO_2-C only from ameliorated fen areas may reach the quantity 0.8–1.6 million tons of CO_2-C. Comparing this emission range with the possible total annual carbon storing by peat accumulation (0.25–0.32 million t CO_2-C), it follows that the emission from drained fen sites alone is on the average four times higher than its total annual carbon accumulation. Adding the drained areas for forestry and industry purposes, we may reckon with up to 8–10 times higher emissions (Ilomets et al., 1995). In any case, the total CO_2-C emission from our peatlands may be about 9.6 million t yr^{-1} with corresponding ca 4.0 million t CH_4-C emission only (Punning et al., 1995). Therefore it is not surprising that drained peatlands are considered to be as the second important carbon source after industry in Estonia.

5.2 Forestry

Draining of mires for improved forest production or afforestation started in the beginning of the 19th century. This work was begun more systematically in 1830–1840 remaining on a rather low scale until 1950. During 1918–1940, for example, 170–220 km of new ditches were dug every year and about 400 km of old ones were restored (Valk, 1998).

Most of the development has taken place during the last 40 years, though since the end of the 1960s, it has been recognized that the afforestation of ombrotrophic bogs is clearly uneconomical and the drainage activity of such areas has therefore been excluded from state subsidies and grant funding. Nevertheless, drainage of forests adjacent to bogs or even the digging of only border ditches around bogs have caused a serious impact, not so much on the ombrotrophic mires themselves, but on the communities of mixotrophic (transitional) mires often forming a lagg belt around the ombrotrophic bogs.

In the 1970s, the annual drainage of wetlands for forestry purposes reached 15,000–20,000 ha; up to 1981 158,000 ha of mires and 202,000 ha of overmoist areas on mineral soils were drained (Kollist, 1988). By 1987, about 180,000 ha of land on Histosols (i.e. mires) and 238,000 ha of land on paludifying mineral soils had been drained for forestry purposes (Valk, 1998), in the mid-1990s the area of drained forests was all in all approximately 560,000 ha (Pikk, 1997).

5.3 Peat extraction

Peat is one of the most important natural resources for Estonia. The total peat resources amount to 1.64 billion tons, of which active resources make up 1.12 billion tons (Soosaar, 2005). In Table 8 there are presented the exploitable peat resources in deposits; exploitation of active deposits is economically and ecologically feasible, in passive deposits exploitation is not expedient.

TABLE 8. Exploitable peat deposits as of January 1, 2004 (million t). SD – slightly decomposed peat, WD – well decomposed peat.

Deposits	Active	Passive
SD peat	60.3	11.1
WD peat	241.1	60.4
Total	301.4	71.5

According to the Estonian Land Board data (08.01.2007), the Cadastral Register includes 279 peat deposits with total area 358,923 ha; from those 90 deposits (44,874 ha) are active. In 2004 mining was permitted in 77 peat fields (20,549 ha) (Fig. 10).

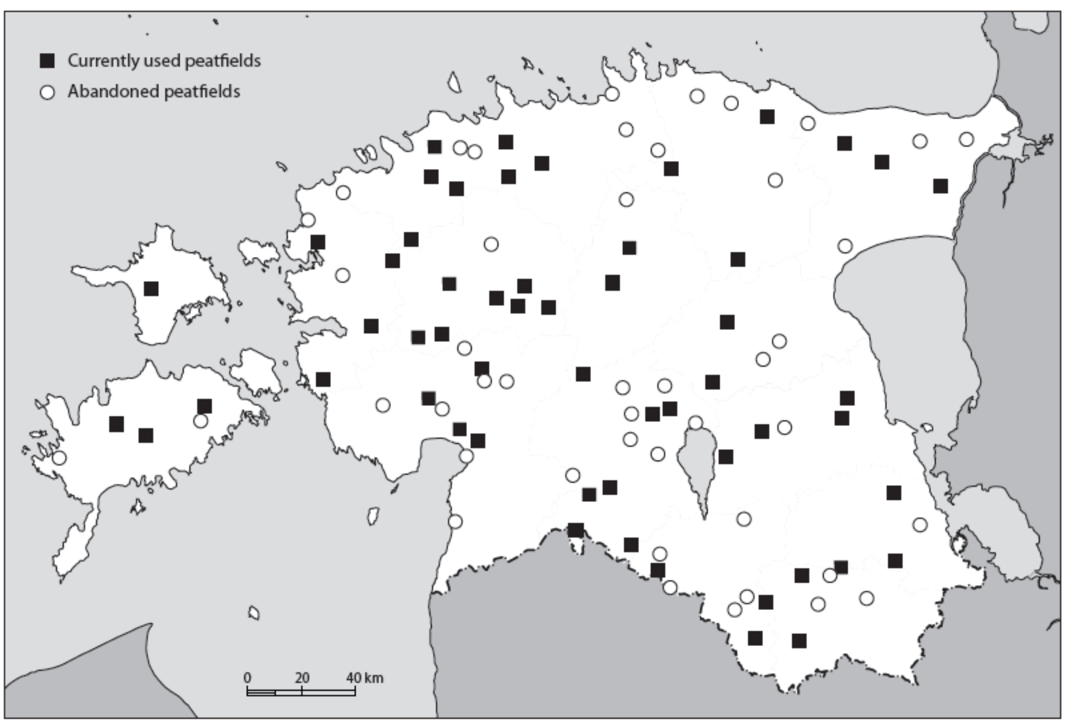

FIGURE 10. Excavated and abandoned peatfields (compiled by M. Orru).

Estonia has a long experience of using peat for heating purposes. Peat is here the third important indigenous fuel, after oil shale and wood. Coordination of investigation and economical usage of peat in the Baltic countries was already one of the purposes of the Livonian Nonprofit Economical Society (*Livländische Gemeinnützige und Ökonomische Sozietät*), founded in 1792 in Riga (Latvia), which was settled in Tartu (Estonia) in 1813. The excavation of peat began on a larger scale at the end of the 18th century and it was used as a fuel mainly in distilleries and peasant households, and also as litter for cattle. In the middle of the 19th century more than 300 pits of hand-cut peat were registered. These were located mostly on the lands of former estates (Animägi, 1995).

Since 1860, machine-cut peat has been used as fuel for the Sindi Cloth Factory, where two Schilickeysen peat presses with tractor engines operated. At the beginning of the 20th century, the use of peat as fuel and as a means of producing electricity increased remarkably. In the 1920s peat served as the main fuel for power stations; in 1926 it provided 10% of the total amount of industrial fuel (Ilomets et al., 1995). In 1922, in order to organize and coordinate peat excavation, the State Peat Industry enterprise was founded, uniting the Lavassaare, Aruküla and Ellamaa peat industries, later also the Pööravere Briquette Industry (presently Tootsi). Smaller peat excavation companies joined into local societies, the total number of them being 916 in 1939 (Juske, 1995).

Due to the increasing role of timber in the total fuel balance, the importance of peat decreased in 1925–1935. In order to stop the expanding cutting of forests, the Government initiated a fuel reform, which foresaw the growth in the share of peat in the fuel balance up to 27.6%. In reality, an increase up to 11.8% was achieved. The production of peat briquettes was started in Tootsi in 1939, which yielded 50,000 tons of peat briquettes a year (Juske, 1995).

In several local industries the use of peat as fuel increased remarkably after World War II. Peat excavation units associated to factories, amounting to 20 in number, were put into operation. In 1959, a new complex of the briquette factory was completed in Tootsi, with an annual output of about 110,000 tons. Later, two other factories were built – in 1964 the Oru peat briquette factory with the annual production of 200,000 tons, and in 1975 the Sangla factory with a yearly output of 50,000 tons (Juske, 1995).

From 1962 onwards, several small peat excavation units were closed due to the increase in use of liquid fuels. One reason for the decrease of sod peat excavation may have been the lack of machinery for small-scale exploitation. The machines available were designed for large-scale enterprises with an output of 20,000 tons per year. Since 1957, peat excavation in Estonia has been completely mechanized. In 1982, cutting of sod peat was terminated, but in 1987/88 the extraction of thin sod peat began again (Paal et al., 1998). In 1990, extraction of block peat was started for horticultural needs, and formed some 4% of the total annual peat output (Animägi, 1995).

Milled peat extraction was initiated in Estonia in 1938 (Luberg, 1995). The output of milled peat started to increase rapidly in 1950–1960 on the basis of new products, horticultural and litter peat (Table 9). In 1975, milled peat made up to 98.6% of the total amount of peat extracted annually. The production of litter peat increased in the 1960s, when local agricultural associations were established in districts and excavation of peat became to be financed from the state budget. In 1975, there were 96 fields from which as much as 1,264,000 tons (40% humidity) of litter peat were excavated. That kind of peat exploitation has presently decreased remarkably (in 1994 only 345,300 tons) and the peat-fields are only partly used.

In Estonia, preconditions have been created for briquette production with a full capacity of 420,000 tons. The maximum output of 340,000 tons was achieved in 1976, and since the beginning of 1990s the factories have been working at reduced capacity.

As the domestic use of milled peat is declining, exctraction for export (to the Netherlands, Germany, U.K., Sweden, Finland) has increased from 116,000 tons in 1993 to 400,000 tons in 1996 (Table 10). This increasing trend is likely to continue as the high quality horticultural *Sphagnum* peat resources are very limited in western Europe (Hammer, 1998). In the recent years as much as 90% of the horticultural peat production and 65% of the fuel peat has been exported (Orru, 2003). Estonia is the 3rd or 4th largest exporter of horticultural peat in the world[52].

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52 Access at: http://www.riigikontroll.ee/tabid/206/Audit/1850/Area/15/ language/et-EE/Default.aspx#results (assessed 03.04.2011).

TABLE 9. Peat extraction in Estonia in 1953–2010 (compiled by M. Orru and E. Niitlaan).

Year	Number of mining areas	Area (ha)	Production (thousand tons)		Total (thousand tons)
			slightly decomposed peat	well decomposed peat	
1953	18	8901	no data	475	475
1954-1960	no data	no data	1800	2400	4200
1961	12		151	404	555
1962	10	8500	104	133	237
1963	17	23205	138	761	899
1964	17	23205	165	828	993
1965	17	23205	174	831	1005
1966	17	23205	307	1086	1393
1967	36	20206	354	902	1256
1968	76	26582	642	1078	1720
1969	72	28059	710	1091	1801
1970	70	26570	899	735	1634
1971	69	25130	970	1248	2218
1972	69	16683	866	938	1804
1973	71	10745	1084	1320	2404
1974	81	11935	145	752	897
1975	74	11522	1210	1321	2531
1976	72	12360	1079	1109	2188
1977	70	12702	1239	1020	2259
1978	74	12612	909	1543	2452
1979	75	10466	1328	1120	2448
1980	78	15615	1325	544	1869
1981	74	11883	596	718	1314
1982	74	11320	1351	830	2181
1983	75	13540	1552	1190	2742
1984	75	13100	1394	768	2162
1985	73	12920	1042	969	2011
1986	75	11243	1497	1339	2836
1987	76	10285	1362	1243	2605
1988	74	10250	1100	1250	2350
1989	70	10300	640	850	1490
1990	68	12000	440	550	990
1991	46	15000	391	536	927
1992	66	15000	656	690	1346
1993	63	15000	197	335	531
1994	56	15000	616	629	1245
1995	47	15000	389	623	1012
1996	58	15000	437	687	1124
1997	59	15000	480	594	1074
1998	60	15000	145	188	334
1999	62	15000	834	566	1400
2000	63	20000	151	609	760

Year	Number of mining areas	Area (ha)	Production (thousand tons)		Total (thousand tons)
			slightly decomposed peat	well decomposed peat	
2001	62	20000	718	125	843
2002	62	20000	1174	334	1508
2003	62	20000	479	533	1012
2004	60	20000	400	362	762
2004	60	20000	400	362	762
2005	63	20549	415	659	1074
2006	60	no data	551	706	1256
2007	59	no data	385	516	901
2008	67	no data	350	352	702
2009	68	no data	380	462	842
2010	no data	no data	399	524	923

TABLE 10. Peat extraction for domestic use and export in Estonia (in thousands of tons) (compiled by M. Orru and E. Niitlaan).

Year	Domestic use	Export
1993	505	116
1994	816	237
1995	653	367
1996	724	400
1997	no data	no data
1998	no data	594
1999	no data	424
2000	no data	789
2001	no data	868
2002	no data	1,022
2003	no data	992
2004	no data	no data
2005	no data	583
2006	no data	620
2007	no data	879
2008	no data	1,004
2009	no data	739

As a result of peat mining, the area of exhausted and abandoned peatlands has also gradually expanded. Their total area constitutes now 9,371 ha (Ramst & Orru, 2009) and in the coming decades it will be more than double. Abandoned peatlands have a negative impact on the local hydrological conditions (Price et al., 2003), are sources of decomposition gases emission (Paavilainen & Päivanen, 1995; Laine & Minkkinen, 1996), cause high fire risk (Puhkan, 2004) and reduce landscape and biological diversity.

5.4 Industry and pollution

Significant areas of valuable mires have been destroyed through excavation of oil shale in open-cast mines in northeastern Estonia. In order to get to the oil shale layer, the surface has to be removed. Due to this, about 2,000 ha of peatlands have been destroyed. If the activity is allowed to continue, an additional area of 100 ha will be destroyed annually (Paal et al., 1998).

In northeastern Estonia the flue gases containing calcium-rich alkaline compounds from the power plants burning oil shale (kukersite) have a remarkable impact on mires. In the 1980s, when the air pollution loads were highest, up to 400,000 t yr^{-1} of oil shale fly ash was emitted. The gases contain, in addition to Ca, several heavy metals such as As, Zn, Th, Hf, V, which accumulate in plant tissues and peat (Punning et al., 1987). About 200,000 ha of land in a 30 km radius around the power plants have been affected. It has been estimated that 30,000 tons of Ca are deposited in dust falling on this area, resulting in the disappearance of the *Sphagnum* carpet, which in turn has halted the peat forming process and increased the decomposition of organic matter in the bogs within 10–15 km of the pollution source (Karofeld, 1994, 1996; Ilomets & Kallas, 1995). Due to the combination of high Ca input and increased pH (from an average 3,5-4,5 up to 6-6,5) in air-polluted bogs in northeastern Estonia, the total disappearance of *Sphagnum* mosses and the appearance of plant species typical of more nutrient rich and/or alkaline habitats were recorded (Karofeld, 1994, 1996; Liblik et al., 2003), as well as the increased radial growth of Scots pines (Pensa et al., 2004, 2007; Ots & Reisner, 2007; Kaasik et al., 2008).

The majority of these air-polluted bogs in northeastern Estonia belong to Estonia's largest protected mire complexes in the Puhatu and Agusalu protected areas. Therefore, concern about their poor state, and interest in the success of the restoration of their original natural state is justified. In recent decades, the emission of pollutants from power plants has been reduced dozens of times due to the decreased production of electricity and the installation of improved dust catching filters (Liiv & Kaasik, 2004; Liblik & Maalma, 2005). The first signs of the natural recovery of vegetation in these bogs have already been documented, namely the reappearance of *Sphagnum* mosses and the increase in their coverage (Karofeld, 1996; Karofeld et al., 2007, 2008). The reduction in the radial growth of Scots pines (Kaasik et al., 2008) and the decrease in the content of heavy metals in mosses (Liiv & Kaasik, 2004) have also been recorded. However, it is yet unclear whether the atmospheric input of pollutants into bogs has been reduced sufficiently for bog system recovering, and how much time such a self-restoration process would take. Geochemical variables, for example, indicate that bogs located close to power plants still exceed their threshold of environmental buffering capacity, and that these bogs are subject to an ongoing risk of large-scale changes in ecosystem quality and vegetation structure. In heavily polluted bogs, fewer bog-specific vascular plant and bryophyte species can be found, and the moss layer is still very fragmented – the ecosystem greatly reminds a of the transitional mire (Karofeld et al., 2007; Paal et al., 2009).

5.5 Urban development

The expansion of built up areas influencing the state of mires is the most actual around Tallinn. Several ombrotrophic bogs such as Pääsküla and Harku are totally drained, Tondi and Sõjamäe bogs do not exist any more. A part of the Pääsküla bog was used as a municipal garbage dump. Although the garbage dump is closed now, the habitat is lost. The same is threatening mires around some other Estonian cities (Tartu, Pärnu, etc.). In several places, holiday camps or residental areas are built on paludifying areas. Though this kind of impact on the mires is rather modest, the effect on other types of wetlands can be considerable.

5.6 Tourism and recreation

On numerous Estonian bogs (Nigula, Männikjärve, Viru, Kuresoo, Meenikunnu, Laeva, Loosalu, etc.) there are more than 50 wooden paths to ease crossing the bog landscape and ca 30 observation towers (Kimmel, 2009). Informational materials have been published for tourists visiting these bogs. Estonian tourist agencies have included some mire areas in their tourism packages. It can therefore be said that mire tourism is still in a developing stage, considering the perspectives of well-organized tourism and the large mire areas. On the other hand, decrease of breeding sites of waders in the vicinity of wooden paths has been proved (Leivits et al., 2009) and therefore building of new wooden paths has been limited within protected mires.

Estonian bogs possess quite important recreational significance and many local people visit bogs especially during their summer holiday. As bogs are distributed all over the country, there has not been any significant negative impact on the bog wildlife by such dispersed visits.

5.7 Gathering of berries and other natural products

At the beginning of the 1970s, the inventory of Estonian cranberry resources was made by the staff of the Nigula Nature Reserve. It was concluded that in Estonia there are not less than 70 mires covering about 25,750 ha in total with a cranberry yield of over 50 kg per ha (Ruus, 1973). The potential overall annual production may reach up to at least 5 million tons.

The mires with the best cranberry crops are located in eastern and northeastern Estonia, where approximately 70% of the potential resources can be found. Furthermore, two mire systems – Emajõe Suursoo (transitional) mires on ca 6,200 ha and Muraka mire complex on ca 5,000 ha – give about 50% of the annual yield of Estonian cranberries – 1.5 and 1.0 million tons respectively. In certain places, picking of cranberries is one of the extra income sources for local people. According to official data, the state purchases of cranberries during some years of the Soviet period in Estonia were 300–1,300 tons (Table 11).

TABLE 11. State purchases of cranberries during 1963-1975 in Estonia (from Cherkassov et al., 1981).

Year	Tons	Year	Tons
1963	315–417	1970	870
1964	1218	1971	1305
1965	315–417	1972	657
1966	315–417	1973	918
1967	315–417	1974	717
1968	570–576	1975	199
1969	570–576		

Much less is known about the distribution and yields of cloudberry (*Rubus chamaemorus*) resources. Perhaps some 30–40 sites are of commercial interest.

During the last decades, interest in sundew (*Drosera* spp.) has been aroused and representatives from western pharmaceutical companies have been appearing. Up to now, the amounts gathered are still small, but may increase in the future. The collecting of *Drosera* species, which have disappeared in the greater part of western Europe, therefore, must be regulated, otherwise the impact on many bogs will rise importantly.

Although there is economic potential and ongoing activities for collecting of berries and other natural products, no data about these activities neither possible risks from the last decades has been recorded.

5.8 Military bombing

Several mires were situated in former Soviet army military training areas and were used as the target areas for bombing practice. This left cell craters of various size thus changing the topography of bog surface and locally increasing the content of several chemicals in peat at bombing area (Karofeld, 1999).

5.9 Fires

On burned raised bogs the microforms are almost levelled, the uppermost peat layer becomes thicker, capillary raise of water is impeded, peat water-holding capacity as well as aeration will considerably decrease and the soil chemistry significantly changes – the ash contains quite a lot of mineral components that increase the soil pH and trophicity for a certain period. Still, these additional nutrients will be rather quickly carried away by water and peat becomes even poorer for plant growth than before the fire (Masing, 1960). Several non-mire species are characteristic to the vegetation of the first successional stages after fires, first of all *Epilobium angustifolium,* and due to the lack of competition also *Rubus chamaemorus* and *Rhynchospora alba* can grow abundantly in some localities.

After 4–5 years the whole burned area will be covered by vegetation: instead of former *Pinus sylvestris*, tree layer is now formed by *Betula* spp., in field layer *Ledum palustre*, *Calluna vulgaris*, *Andromeda polifolia*, in some cases also *Vaccinium uliginosum* will dominate. Development of the bottom layer starts often several years later; the commonest species being *Polytrichum strictum* associated with lichens such as *Cladonia squamosa*, *C. cenotea*, *C. cornuta*, *C. floerkeana*, *C. deformis*, *C. incrassata* etc. Rehabilitation of the *Sphagnum*-carpet begins usually with the growth of some patches of *S. acutifolium*, then also *S. magellanicum*, *S. fuscum*, etc. will appear (Masing, 1960, 1964; Masing & Valk, 1968). Then a long period of stabilization of vegetation structure follows. Into the field layer *Oxycoccus* spp., *Empetrum nigrum,* etc. return, in the bottom layer the pioneer species will be replaced by *Sphagnum* spp. and partly by forest mosses like *Pleurozium schreberi*, *Hylocomium splendens,* etc. A further development of plant cover depends largely on the formation of tree layer: if this remains scattered, the characteristic features of bog fires will be obvious for long years. The rehabilitation of burned bogs and recovery of pre-fire communities structure takes from 50 to 100 years (Masing, 1964).

If fire occurs in a transitional mire, the lower microhabitats (lawns, carpets) usually do not suffer very much and will recover comparatively quickly, but hummocks of sphagna together with dwarf shrubs may be destroyed seriously and their recovering can take several decades as in case of raised bogs.

During the last decades, fires have had noticable impact in Läänemaa Suursoo (western Estonia), Feodorisoo (northeastern Estonia), Varnja soo (eastern Estonia) and, to a lesser extent, in some other mires. Some of the burnt bogs have been objects of relevant monitoring.

5.10 Long-term effects

Some serious effects of the former extensive drainage will appear only decades later. That concerns especially successional changes of mire vegetation structure due to lowering of the water table in the surrounding areas: even in protected mires the characteristic communities will be replaced by others, having a simple structure. In that way communities of several types as well as numerous plant and animal species turn to be threatened and rare.

In western Estonia the fen flora and vegetation has been intensively studied in 1948–1955 and re-studied in 1991–1992. On this basis it is possible to characterize the main trends in the composition of flora during the last 35–40 years, mainly due to the amelioration in neighboring areas.

According to Trass (1994), four groups of species should be distinguished:

(i) species with unchanged frequency: *Juncus subnodulosus*, *Myrica gale*, *Rhinanthus rumelicus* subsp. *osilinensis*, *Cladium mariscus*, and several common obligate telmatophytes such as *Potentilla palustris*, *Peucedanum palustre*, *Carex lasiocarpa*, *C. elata,* etc.;

(ii) species with incresed frequency: *Molinia caerulea*, *Deschampsia cespitosa*, *Carex nigra*, *C. panicea*, *C. canescens*, *Epipactis palustris*;

(iii) species with slightly declined frequency: *Tofieldia calyculata*, *Carex buxbaumii*, *C. hostiana*, *C. davalliana*, *C. heleonastes*, *Eriophorum gracile*, *Schoenus ferrugineus*, *Liparis loeselii*, *Hammarbya paludosa*, *Drosera intermedia*, *Saussurea alpina* subsp. *esthonica, Pedicularis sceptrum-carolinum, Utricularia minor, Equisetum variegatum, Euphorbia palustris*;

(iv) species with frequency fallen to the critical limit: *Gymnadenia odoratissima*, *Selaginella selaginoides*, *Pinguicula alpina*, *Malaxis monophyllos*.

Notable changes had taken place also in fen vegetation. Trass (1994) has established five change-groups:

(i) communities met on approximately as large an area and with the same frequency as 35–40 years ago: *Phragmitetum australis, Drepanoclado–Caricetum lasiocarpae, Scorpidio–Caricetum lasiocarpae, Caricetum diandrae, Cladietum marisci, Primulo–Seslerietum, Caricetum cespitoso–appropinquatae, Caricetum flavae, Caricetum acutae, Juncetum subnodulosi, Equisetetum fluviatilis*;

(ii) communities the area of which has diminished to some extent (mostly only for some hecatares on certain fen): *Drepanoclado–Schoenetum, Caricetum hostianae, Caricetum dioicae, Caricetum elatae, Caricetum vesicariae, Schoenetum nigricantis, Eriophoretum polystachionis, Scorpidio–Schoenetum, Menyantheto–Caricetum limosae*;

(iii) communities the area of which has considerably decreased (for hundreds or even thousands hectares, or if the community type is rare, more than 50%): *Caricetum davallianae, Caricetum buxbaumii;*

(iv) communities the area of which has somewhat increased (on some fens for tens or hundreds of hectares): *Myrico–Schoenetum, Seslerio–Caricetum paniceae, Calamagrostietum canescentis, Caricetum paniceo–nigrae, Myrico–Betuletum pubescentis*;

(v) communites the area of which has remarkably increased (for hundreds or thousands of hectars): *Molinietum caerulea, Deschampsio–Caricetum paniceae, Caricoso–Betuletum pubescentis, Phragmitoso–Betuletum pubescentis*.

The reason for the decrease of areas of the 13 community types is in the secondary successions, which replaced natural communities after amelioration. The increase of *Molinia caerulea* dominance on calcareous fens and swamps after drainage has been recorded also by Roosaluste (1984).

MIRE CONSERVATION AND MONITORING

6

6.1 History

Ilomets (1994a) has distinguished four periods in Estonian mire conservation:

1. 1920–1940. Mire conservation was catalyzed by the need to protect birds; the idea of protecting mires for their intrinsic value was not a matter of discussion at all as a large number of mires was still intact. The need for nature protection in mires was first pointed by palynologist P.W. Thomson in his presentation in the Estonian Naturalists' Society in 1923. Still, the first mire area, Ratva bog (1,109 ha), was taken under protection only in 1938, mainly to protect the eyrie of the Golden Eagle (*Aquila chrysaetos*) there;
2. 1940–1955. A lethargic period with extensive mire drainage. The concept of "improving nature" became the official policy in the whole Soviet Union where the occupied Estonia belonged and from the end of the 1940s about 45,000 ha of peatlands were drained annualy for agriculture and 20,000 for forestry;
3. 1955–1968. A renaissance, with mire conservation driven by the need to protect both bird and plant species. The Nature Protection Act was passed in 1957 by the Estonian Supreme Soviet, among others Nigula bog and Viidumäe spring fens were declared state nature reserves; Muraka bog, Nehatu *Cladietum marisci* fen, and Nätsi bog were taken under protection as botanical-zoological reserves, etc.;
4. 1968–1992. An active, successful period of significant achievements. In 1968, the "Telma" project was initiated to specify more accurately the criteria for mire protection areas. An active discussion between scientists and ameliorators started in 1968 in the nature monthly "Eesti Loodus" and this resolved some of the mire protection issues. The mires more important from the water management aspect and the richest areas in berries were excluded from the land drainage programme. Thus 30 new mire reserves were created. Among others, the most important mires of the present-day Soomaa National Park and Endla Nature Reserve got their protected status. Hence the surface area of officially protected peatlands rose to 15% of the total peatland surface in Estonia (Ilomets, 1994b). In the 1960s–1970s, District Governments also established hundreds of protected areas of "local importance"; some of these contain peatlands. Mires are also represented in the Lahemaa National Park established in 1971, in some geological and landscape reserves, etc.

It seems rational to add the fifth period now, starting at the beginning of the 1990s, since Estonia had re-established its political independence. After that Estonia has joined a number of international conventions, whereby it has made commitments to protect areas, objects or functions of biodiversity and environmental quality value (see Chapter 2). In the 1990s two large protected areas rich in mires – Soomaa National Park (370 km^2) and Alam-Pedja Nature Reserve (260 km^2) – were founded. All previous "mire reserves" were re-declared either as nature reserves or, to a lesser extent, as landscape reserves, to achieve favourable conservation status of both mires themselves as well as the neighboring forest habitats. A number of new protected areas including mires have also been established.

Considering the drastic changes in land-use practice in connection with the collapse of the collective farm system and the re-privatization of land from one side, and requirement for establishing an effective nature management planning and protection system from the other side, several large scale nature inventory projects have been carried out between 1993 and 2000 (Paal, 2003). From the standpoint of promoting the mires protection the Estonian Biodiversity Country Study, 1996–1997 (Paal, 1997; Külvik & Tambets, 1998; Kull, 1999) and Estonian Wetlands Conservation and Management Strategy, 1997 (Paal et al., 1998) should be mentioned. Results of these inventories were largely used for Estonian Natura 2000 National Programme, approved by the Estonian Government for years 2000–2007 in 2000. The general aim of the program was to establish the Estonian Natura 2000 network in accordance with the Habitat Directive (1992) and Bird Directive (2009).

By March 2011, different types of protected areas, limited conservation areas and species protection sites together cover 7,804 km^2 (excluding marine areas), i.e. 17% of the Estonian territory. Coverage of protected mires is presented and discussed in Chapter 8.

6.2 Threatened and/or legally protected species

The first Estonian Red Data Book was compiled by the Nature Conservation Committee of the Estonian Academy of Sciences in 1979. It was typed in four copies and intended for official use only. 259 species were presented in this book.

The popular version of the Estonian Red Data Book was published in 1982 (Kumari, 1982). In 1988 the second list of species of Estonian Red Data Book was compiled taking into account the new proposals of specialists. All in all 315 species endorsed by the Red Data Book Committee were included.

In 1993 the Red Data Book of the Baltic Sea Region (Ingelög et al. 1993) was published. In this book the lists of threatened higher plant and vertebrate (excluding fishes) species were presented.

The third editon of the Estonian Red Data Book was published in 1998 (Lilleleht, 1998). This time it included already 1,318 taxa and the IUCN system of categories of endangered species has been used.

In the end of 2008 the new Estonian Red List of Threatened Species was compiled according to the rules of IUCN[53]. The new database is available on eBiodiversity website[54]. Mire species of the first five categories (EX – regionally extinct, CR – critically endangered, EN – endangered, VU – vulnerable and NT – near threatened) are presented in the next chapters. The species of other categories (least concern (LC), data deficient (DD) and not evaluated (NE)) are pointed only if they are among the national protected species in Estonia.

During the two last decades, lists of legally protected species have been established after adoption of the Act on Protected Nature Objects in 1994 and the Nature Conservation Act in 2004. Minor changes in the lists have been also done meanwhile.

53 Access at: http://www. iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria(18.03.2011).
54 Access at: http://elurikkus.ut.ee/prmt.php? lang=eng (18.03.2011).

6.2.1 Plants

The first attempts to analyse the total number of species characteristic to the Estonian mires were undertaken in the 1980s. It was estimated that 35 bryophyte species of *Marchantiopsida* and 118 species of *Bryopsida*, among them 35 *Sphagnum* spp., grow in peatlands (Kannukene & Kask, 1982). From vascular plants 18 species of *Pteridophyta*, three species of *Gymnospermae* and 355 species of *Angiospermae* are represented (Kask, 1982). Of animals, more than 300 species of *Aranei* (Vilbaste, 1980, 1981), more than 1600 species of *Insecta*, four species of *Amphibia*, three species of *Reptilia*, more than 200 species of *Aves*, 11 species of *Mammalia* are regarded to inhabit peatlands (Maavara, 1988)

Still, Trass (1994) has pointed out that these compendiums do not help very much in understanding mire flora because the authors did not define what a "true" mire plant is, and the typology of mire plants was lacking in cited publications. According to his analysis, the flora of vascular plants of Estonian natural mires includes 280 species; from these 230 occur in fens, 103 in transitional mires and 45 species in raised bogs, respectively. 52% of the 280 species are facultative, 36% obligate-facultative and only 12% obligate telmatophytes, which demonstrates the very low specific character of the mire flora.

6.2.1.1 Vascular plants

About 60 species on the Estonian Red List[55] are only or mainly growing in mires; some of them are found in certain types of mires (e.g. in rich fens only) or they are shared between several site types.

In 2004 the Estonian Gouvernment accepted a new list of protected species[56]. In addition to the endangered species pointed at in the Estonian Red List, several other mire species are among legally protected plants in Estonia. In the following text the protected species are marked with the number of the protection category (1, 2 or 3) after the slash. At the same time, not all red-list species are, yet, legally protected; they are denoted with a '–' after the slash. On the other hand, if a legally protected species is not included in the Red Data Book, '–' is given before the slash (e.g. all orchids are protected whether they are red-list species or not).

Some Estonian mire species such as *Betula humilis*, *Eriophorum gracile*, *Hammarbya paludosa*, *Liparis loeselii* and *Malaxis monophyllos* are included in the European List of Threatened Plants[57].

The list below comprises species, which predominantly or solely grow in different types of mires:

Angelica palustris	NT/3	coastal grasslands, fens, floodplains;
Betula humilis	VU/–	paludifying grasslands, fens;
Betula nana	NT/–	mixotrophic mires, bogs;
Carex davalliana	NT/–	rich fens and paludifying grasslands;
Carex dioica	VU/–	paludifying grasslands, mixotrophic mires, bogs;
Carex heleonastes	EN/2	mixotrophic mires, swamp forests, bog margins;
Carex irrigua	NT/2	mixotrophic mires, bogs;
Carex paniculata	NT/–	floodplain fens;
Carex pauciflora	NT/–	bogs;
Carex pulicaris	NT/–	paludifying grasslands;
Cladium mariscus	NT/3	rich fens, lake shores, temporary waterbodies;

55 Access at: http://www.zbi.ee/punane/english/index.html (04.03.2011).
56 Access at: https://www.riigiteataja.ee/akt/13360504 and https://www.riigiteataja.ee/akt/13360720 (25.04.2011).
57 Access at: http://www.archive.org/stream/listofrarethreat83iucn/listofrarethreat83iucn_djvu.txt (25.04.2011).

Corallorhiza trifida	EN/2	peatland forests, bog margins;
Dactylorhiza fuchsii	LC/3	paludifying grasslands and forests, fens;
Dactylorhiza incarnata	–/3	paludifying and wooded meadows, fens,
Dactylorhiza incarnata spp.*cruenta*	–/2	paludifying meadows, rich fens;
Dactylorhiza incarnata spp. *incarnata*	LC/–	paludifying and wooded meadows, fens, coastal grasslands;
Dactylorhiza incarnata spp. *ochroleuca*	NT/–	rich fens;
Dactylorhiza maculata	NT/3	peatland forests, mires;
Dactylorhiza russowii	VU/2	spring fens a.o. mires, rich paludifying grasslands;
Epipactis palustris	LC/3	fens, paludifying grasslands;
Erica tetralix	EX/–	mires;
Eriophorum gracile	VU/2	mixotrophic mires, quagmires, paludifying grasslands, ditches;
Gentiana pneumonanthe	VU/2	poor fens, mixotrophic mires, paludifying grasslands, floodplains;
Gymnadenia conopsea	LC/3	grasslands, forest edges, fens;
Gymnadenia odoratissima	VU/2	calcareous spring fens, rich fens, paludifying grasslands;
Hammarbya paludosa (*Malaxis paludosa*)	EN/2	mires, paludifying forests;
Herminium monorchis	NT/2	coastal and paludifying grasslands, spring fens;
Hydrocotyle vulgaris	EN/2	shores of waterbodies, fens, paludifying grasslands;
Iris sibirica	NT/3	paludifying grasslands, floodplains, fens;
Juncus inflexus	EX/1	fens, paludifying grasslands;
Juncus squarrosus	EN/1	bog margins, heath moors;
Juncus stygius	EN/–	bogs;
Juncus subnodulosus	VU/2	spring fens, rich fens;
Ligularia sibirica	VU/1	paludifying grasslands and shrubs, fens;
Liparis loeselii	VU/2	spring fens, rich fens, coastal grasslands;
Lycopodiella inundata	EN/2	heath moors, bog margins, mixotrophic bogs, riversides;
Malaxis monophyllos	VU/2	peatland forests, paludifying grasslands, fens;
Myrica gale	NT/3	rich fens, mixotrophic mires;
Ophrys insectifera	NT/2	paludifying grasslands, rich fens, spring fens, coastal grasslands;
Pedicularis palustris	NT/–	fens;
Pedicularis sceptrum-carolinum	EN/3	paludifying grasslands, fens;
Pinguicula alpina	NT/2	spring fens, rich fens;
Pinguicula vulgaris	VU/–	paludifying grasslands, spring and rich fens;
Primula farinosa	NT/–	rich fens, paludifying grasslands;
Rhinanthus rumelicus subsp. *osiliensis*	VU/2	spring fens, paludifying grasslands;
Rhynchospora fusca	EN/2	heath moors, fens, temporary pools;
Rubus arcticus	CR/2	paludifying grasslands and forests, fen margins;
Saussurea alpina ssp. *esthonica*	NT/3	rich fens, paludifying grasslands;
Saxifraga hirculus	EN/2	mixotrophic mires, paludifying grasslands, fens;
Salix lapponum	VU/–	floodplains, mixotrophic mires;
Salix myrtilloides	VU/–	mixotrophic mires, peatland forests;
Scheuchzeria palustris	NT/–	mixotrophic mires, bogs;
Schoenus nigricans	VU/2	rich fens, coastal grasslands, spring fens;
Selaginella selaginoides	EN/2	fens, paludifying grasslands;
Sparganium glomeratum	EN/–	rivers, fens;
Swertia perennis	VU/1	rich fens, floodplain and paludifying grasslands;
Tofieldia calyculata	NT/–	rich fens and paludifying grasslands;
Utricularia australis	VU/–	mires;

Viola uliginosa	NT/3	paludifying grasslands, floodplains, peatland forests.

Kull (2010) has proposed to strengthen protection category for *Lycopodiella inundata* from category 2 to 1, for *Pedicularis sceptrum-carolinum* from category 3 to 2 and to take under protection as category 2 species *Tofieldia calyculata* (NT). A supplementary study is needed to elucidate the situation with following species growing at least locally in peatlands: *Carex rhyncophysa* (–/2), *Eleocharis mamillata* (NT/–), *Equisetum scirpoides* (CR/–) and *Juncus stygius* (EN/–).

6.2.1.2 Bryophytes

The Estonian bryoflora includes 579 species (Vellak et al., 2009), a great part of which is more or less connected with wetlands. The list of bryophytes of Estonian peatlands (Kannukene & Kask 1982) contains 153 species, but as several peatland species had been left out from this list, the true number of wetland bryophytes is much higher.

Amblyodon dealbatus	EN/–	mires;
Amblystegium humile	EX/–	peatland forests, mires;
Aplodon wormiskioldii	VU/–	bogs;
Barbilophozia kunzeana	NT/–	quagmires, peatland forests;
Meesia longiseta	EX/–	mires;
Meesia triquetra	NT/–	minerotrophic quagmires, fen forests, spring fens;
Meesia uliginosa	EN/–	paludifying grasslands, mires;
Oncophorus wahlenbergii	EX/–	coastal grasslands, paludifying forests, mires;
Paludella squarrosa	NT/–	fens, peatland forests, floodplains, mixotrophic mires, paludifying grasslands, spring fens;
Philonotis caespitosa	NT/–	fens, springs;
Pohlia sphagnicola	LC/–	bogs;
Riccardia incurvata	VU/–	mires;
Sphagnum aongstroemii	EX/–	paludifying forests, mires;
Sphagnum auriculatum	DD/–	mixotrophic mires;
Sphagnum inundatum	VU/3	bog pools;
Sphagnum jensenii	DD/–	mires;
Sphagnum lindbergii	NT/2	paludifying forests, bogs;
Sphagnum molle	VU/–	bogs, bog forests;
Sphagnum quinquefarium	VU/–	peatland forests, mires;
Sphagnum subfulvum	EN/–	mires;
Splachnum sphaericum	EX/–	bogs;
Splachnum rubrum	EN/–	mires;
Splachnum vasculosum	EX/–	mires;
Warnstorfia tundrae	VU/–	mires, floodplains.

6.2.1.3 Algae

Chara strigosa	NT/–	mire lakes;
Cosmarium holmiense var. *holmiense*	NT–	floodplain and mire pools;
Cosmarium holmiense var. *integrum*	NT–	bog pools;
Cosmarium holmiense var. *granulatum*	NT–	bog pools;
Eurastrum crassum var. *michiganense*	NT/–	bog lakes.

6.2.2 Fungi incl. lichens

Here are pointed only species growing on ground or on plant remains:

Bovista paludosa	EN/2	rich fens;
Cladina portentosa	NT/–	bogs;
Hypholoma flavorhiza	VU/–	treed bogs;
Peltigera scabrosa	EN/–	bogs;
Ochrolechia frigida	VU/2	bogs.

6.2.3 Animals

The list includes both mire specialists as well as species, which occur in mires among other habitats:

Asio flammeus	EN/2	bogs, coastal and cultivated grasslands;
Aquila chrysaetos	VU/1	peatland forests, bogs;
Bubo bubo	VU/1	coniferous forests, treed bogs;
Calidris alpina schinzii	EN/1	coastal grasslands, hollow bogs;
Caprimulgus europaeus	LC/3	bog forests, treed bogs;
Circus cyaneus	NT/2	fens, floodplains, cultivated grasslands, shrubs;
Circus pygargus	NT/3	minerotrophic and mixotrophic mires, floodplains;
Coenonympha hero	DD/3	fens, moist forests, shrubs;
Erebia embla	DD/3	bogs;
Euphydryas aurinia	DD/3	fens, floodplain grasslands;
Falco columbarius	VU/1	bogs, pine stands;
Falco peregrinus	EX/1	bogs;
Falco vespertinus	NE/3	mixotrophic mires, forests,;
Gavia arctica	CR/2	dystrophic lakes, bog-pools;
Gallinago media	VU/2	floodplains, fens;
Grus grus	LC/3	mires;
Hirudo medicinalis	NT/2	eutrophic lakes, fens;
Lagopus lagopus	EN/1	bogs;
Lanius excubitor	NT/3	bogs;
Leucorrhinia albifrons	LC/3	bogs, dystrophic ponds;
Leucorrhinia pectoralis	DD/3	mires, dystrophic ponds;
Limosa limosa	NT/2	mires, coastal grasslands, floodplains;
Lycaena dispar	LC/3	floodplains, paludifying grasslands, fens;
Lymnocryptes minimus	VU/2	mixotrophic mires;
Numenius phaeopus	NT/3	bogs;
Numenius arquata	LC/3	mires, coastal, floodplain and cultivated grasslands;
Pluvialis apricaria	LC/3	bogs;
Podiceps auritus	NT/2	small lakes, bog-pools;
Porzana porzana	LC/3	floodplains, paludifying grasslands, fens;
Tetrao tetrix	NT/3	mires;
Tringa glareola	LC/3	bogs, mixotrophic mires;
Tringa nebularia	NT/3	mixotrophic mires, bogs.

6.3 Threatened and/or rare plant communities

The list of community types in Estonian mires was presented above in Chapter 4.1.3.2, but the Habitat Directive (1992) 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 largely with the criteria most emphasized in the assessment of the conservation value of biotopes (Margules, 1986): representativeness, diversity, rarity, naturalness, area and threat of interference. Proceeding from the biodiversity concept of plant communities protection, three components must be taken into account: rarity, level of threat and typicalness, each of which is a complex phenomenon (Jackel & Poschlod, 1996). Quite often in nature conservation 'rare' is used more or less as a synonym for 'threatened', the latter being the main criterion for compilation of Red Data Books of biotopes (e.g. Blab et al., 1993; Riecken & Ssymank, 1993). The problem of discordant use of 'rarity' and 'threatenedness' in categorization of species is thoroughly debated by Munton (1987) and Gaston (1994), usage of these concepts in assessment of Estonian plant communities is discussed by Paal (1998a,b,c).

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 type groups. This was the case, for example, with our wetlands in the period 1950–1979, when in the course of a campaign started by Soviet rulers huge areas were drained and several hitherto common mire vegetation types turned to be threatened.

In Estonia, following these ideas, rarity categories for plant community types are proposed without merging 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 search;
- 1 – Very rare. Communities that are known in 1–5 localities with a total area less than 10 ha;
- 2 – Rare. Communities that occur in 6–15 localities with a total area less than 50 ha for woodlands or less than 100 for grasslands and mires;
- 3 – Fairly rare. Communities that are represented in 16–40 localities with a total area less than 300 ha;
- 4 – Approaching rare. Communities
  - that are likely to move into the previous categories in 5–10 years if the casual factors continue to operate, or
  - that are growing in a restricted number of habitats but about which there is insufficient information to decide which of the categories are appropriate; the localities must, consequently, be checked.

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 a very great risk of total disappearance at least due to one of the following factors:
  - total area of communities has decreased 75% in the course of 10 last years;
  - communities are substituted due to the adverse causal factors, continuation of which will probably decrease the total area up to 75% in next 10 years;
  - due to the extremely fragmented occurrence, communities are obviously loosing the inherently characteristic features of structure (content of species, abundance proportions between species, layering, mosaicness etc.);
  - communities belong to the rarity category 1;
- 2 – Threatened. Community types that are at great risk of total disappearance at least due to one of the following factors:
  - total area of communities has decreased 50% in the course of 10 last years,
  - communities are substituted due to the adverse causal factors, which continuation

will probably decrease the total area up to 50% in next 10 years,
  - fragmentation of these communities has in 10 last years increased up to three times,
  - communities belong to the rarity category 2 or 3;

3 – Fairly threatened. Communities that are in considerable danger due to one of the following factors:
  - total area of communities has decreased 25% in the course of 10 last years,
  - communities are substituted due to the adverse causal factors, which continuation will probably decrease the total area up to 25% in next 10 years,
  - fragmentation of these communities has increased twofold in 10 last years,
  - to this category should be qualified also communities being rather frequent in Estonia and having here not a very restricted area, but which are rare or greatly endangered in neighbouring countries, i.e. responsibility communities.

Due to their species richness the most conspicuous mires in Estonia, on a North European scale, are calcareous fens and spring fens (Trass, 1975). Numerous 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* are growing here. Several fen types more widely distributed in western and central Europe reach the northern distribution limit in Estonia (Table 12).

Plant communities of bogs are relatively species-poor and widespread, and therefore are of no conservation priority on the community or site type level. Of mixotrophic mires, Laasimer (1975) names communities with *Myrica gale* as having become rare in western Estonia, but no communities are listed as in need of protection by Paal (1997, 1998a,b,c).

TABLE 12. Threatened communities of mires and rich paludifying grasslands. R – category of rarity, T – category of threatenedness (Paal 2005). Nomenclature of the site types and communities follows Paal (1997).

Site type	Community type	Distribution	R	T
Poor fens	*Caricetum flavae*	locally, mainly in E Estonia	4	3
Rich fens	*Caricetum davallianae*	mainly on western islands, in mainland scarcely; on northern limit of its areal	4	3
	Caricetum hostianae	in W and NW Estonia, seldom in other localitites; near the northeastern limit of its areal	4	2
	Caricetum buxbaumii	in W Estonia	3	2
	Cladietum marisci	mainly on western islands, locally on mainland; on northern limit of its areal	3	2
	Schoenetum nigricantis	in western part of Saaremaa Island and on Hiiumaa Island; on northern limit of its areal	2	2
	Rhynchosporetum fuscae	in NW Estonia	1	1
	Primulo-Seslerietum	mainly in W, N and NE Estonia, on western islands	4	3
Minerotrophic quagmires	*Scorpidio-Schoenetum ferruginei*	in W Estonia and on western islands	3	2
Spring fens	*Scorpidio-Schoenetum ferruginei*	in W Estonia and western islands	3	2
	Juncetum subnodulosae	in western part of Saaremaa Island; on northeastern limit of its areal	1	1
	Caricetum davallianae	mainly on western islands, locally on mainland; on northern limit of its areal	3	2
	Primulo-Seslerietum	mainly on western islands, in W, NW and N Estonia	4	3

Site type	Community type	Distribution	R	T
Rich paludifying grasslands	*Caricetum hostianae*	in W and NW Estonia, seldom in other localitites; near the northeastern limit of its areal	4	2
	Caricetum davallianae	mainly on western islands, in W ans N Estonia; on northern limit of its areal	4	3
	Primulo-Seslerietum	mainly on western islands, in W, NW and N Estonia	4	3

6.4 Protected areas

6.4.1 Natura 2000 network

For a long time, mire conservation policy in Estonia was essentially designed to protect large ombrotrophic mire systems and it was difficult to preserve fens due to their use as potential agricultural land, despite their high natural value and high level of vulnerability (Ilomets & Kallas, 1995; Paal et al., 1998).

Through Natura 2000 process a number of protected mires of several types have been added to the existing protected areas network. The total surface of mires within the Natuta 2000 network and trends were assessed by the Estonian Ministry of the Environment in 2007, within the process of assessment according to article 17 of the Habitat Directive[58] (Table 13).

TABLE 13. State of Natura 2000 mire habitas in Estonia by the Habitat Directive Article 17 Report (2001–2006). Range – the natural range describes roughly the spatial limits within which the habitat occurs, Area – area covered by habitat within the range in the biogeographic region concerned, Struc. & funct. – specific structures and functions (including typical species), Future prosp. – Future prospects (as regards range, area covered and specific structures and functions), Overall asses. – overall assessment; FV – favourable, U1 – unfavourable – inadequate, U2 – unfavourable – bad, XX – unknown; %GR – the percentage of range computed from the gridded spatial data, %GD – the percentage of the area of the distribution computed from the gridded spatial data.

Habitat type	Range (km^2)	%GR	Range trend	Area (km_2)	%GD	Area trend	Struc. & funct.	Future prosp.	Overall asses.
7110 Active raised bogs	38,350	6.4	=	1,580	5.5	-	FV	U1-	U1-
7120 Degraded raised bogs still capable of natural regeneration	34,960	15.3	=	565	14.7	+	U1	U1	U1
7140 Transition mires and quaking bogs	32,430	3.6	=	180	2.4	-	U1-	U1-	U1-
7150 Depressions on peat substrates of the *Rhynchosporion*	38,250	34.4	=	80	98.8	=	FV	U1-	U1-

58 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw%. (22.04.2011).

Habitat type	Range (km^2)	%GR	Range trend	Area (km_2)	%GD	Area trend	Struc. & funct.	Future prosp.	Overall asses.
7160 Fennoscandian mineral-rich springs and springfens	36,500	4.8	=	7.3	5.7	=	U1-	U1-	U1-
7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	6,665	6.5	=	36	24.3	=	U2-	U2-	U2-
7220 Petrifying springs with tufa formation (*Cratoneurion*)	8,753	4.2	=	0.7	13.8	X	XX	XX	XX
7230 Alkaline fens	39,740	6.3	=	239	16.7	-	U1-	U2	U2

In the referred report the main pressures and threats of the mire habitats included into Natura 2000 network are also pointed (Table 14).

TABLE 14. Main pressures and threats of Estonian mires by the Habitat Directive Article 17 Report (2001–2006).

Habitat type	Main pressures	Threats
7110 Active raised bogs	Peat extraction Drainage Modification of hydrographic functioning, general	Peat extraction Drainage Modification of hydrographic functioning, general
7120 Degraded raised bogs still capable of natural regeneration	Peat extraction Drainage Modification of hydrographic functioning, general	Peat extraction Drainage Modification of hydrographic functioning, general
7140 Transition mires and quaking bogs	Cultivation Forest planting Modification of hydrographic functioning, general Biocenotic evolution	Peat extraction Drainage Modification of hydrographic functioning, general Biocenotic evolution Invasion by a species
7150 Depressions on peat substrates of the *Rhynchosporion*	Peat extraction Drainage Modification of hydrographic functioning, general	Peat extraction Drainage Modification of hydrographic functioning, general
7160 Fennoscandian mineral-rich springs and springfens	Cultivation Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Biocenotic evolution	Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Biocenotic evolution Invasion by a species Other natural processes
7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	Cultivation Drainage Modification of hydrographic functioning, general Biocenotic evolution	Cultivation Peat extraction Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Biocenotic evolution Invasion by a species
7220 Petrifying springs with tufa formations (*Cratoneurion*)	Biocenotic evolution	Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Biocenotic evolution

Habitat type	Main pressures	Threats
7230 Alkaline fens	Cultivation Fertilisation Abandonment of pastoral systems Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Other human induced changes in hydraulic conditions Biocenotic evolution Eutrophication Invasion by a species	Abandonment of pastoral systems Forest planting Peat extraction Urbanised areas, human habitation Drainage Modification of hydrographic functioning, general Biocenotic evolution Eutrophication Invasion by a species

6.4.2 Ramsar areas

The Ramsar Convention[59] provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. One of the main goals of the Convention is to establish a global ecological network through the development of the List of Wetlands of International Importance (Ramsar sites). All of the parties to the Convention must implement measures for the protection of wetlands and pursuant to Article 2.4 of the Convention, submit at least one wetland for inclusion in the Ramsar List. Today (March 2011) 160 countries have joined the convention and the List of Wetlands of International Importance includes 1920 areas with a total area of 187,055,551 hectares[60]. Wetland sites for inclusion in the Ramsar List are selected by member states by reference to the Criteria for Identifying Wetlands of International Importance[61].

Estonia ratified the Ramsar Convention on April 21, 1993 and it came into force on July 29, 1994. In the same year, Matsalu Nature Reserve (first designated already in 1976 by the former USSR) was designated by Estonia as a Ramsar site and the Estonian Ramsar Committee was established by the Minister of the Environment. In March 1997, National Programme on the Implementation of the Ramsar Convention was adopted by a governmental decree No 48. The Programme named nine additional Ramsar sites (which were added to the Ramsar List in the same year) and 14 potential areas (the Shadow List).

Estonia presently has twelve sites included in the Ramsar List. Five additional sites have been designated as Ramsar sites and forwarded by the Minister of the Environment to the treaty secretariat. After the Secretariat ensures that the presented data and maps meet the standards set by the Conference of the Parties, the sites will be added to the Ramsar List.

Currently in Estonia only areas that have been protected under the terms of the Nature Conservation Act (2004) may be chosen as Ramsar sites. Consequently, all the territory of the Ramsar site has to be nationally protected as protected area or limited conservation area or combination of them. A special note that the area is a Ramsar site must be added to the protection rules or to the decree about the establishment of limited conservation areas.

59 Access at: http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on-20708/main/ramsar/1-31-38%5E20708_4000_0_. Convention on Wetlands of International Importance Especially as Waterfowl Habitat Final Text adopted by the International Conference on the Wetlands and Waterfowl at Ramsar, Iran, 2 February 197 I. (02.04.2011).

60 Access at: www.ramsar.org (02.04.2011).

61 Access at: http://www.ramsar.org/pdf/rec/key_rec_4.02e.pdf (23.04.2011).

The boundaries and area of most of the earlier nominated Ramsar sites have been revised and Ramsar Information Sheets (RIS) updated. As new protection rules for four areas designated in 1997 have still not been adopted, the information sheets are not updated and this causes problems in reflection of information in Ramsar Data Base and in Estonian Environmental Register.

1. Matsalu National Park. Ramsar site no. 104. Originally designated in 1976, second time designated by Estonia in 1994, area 48,610 ha. A shallow islet-rich Matsalu Bay surrounded by 3000 ha of coastal meadows, 3,000 ha of reedbeds and 4,000 ha of floodplain of the Kasari River delta which serve as an excellent roosting and feeding place for large number of species of water and coastal avifauna. The area is especially important as roosting place for waterfowl on East-Atlantic Fly-way.

2. Alam-Pedja Nature Reserve. Ramsar site no. 905. Designated in 1997, area 34,220 ha. A large, mostly flat wilderness area with a complex of mires separated by unregulated rivers and associated floodplain meadows and alluvial forests, surrounded by extensive forests, including alluvial and swamp forests. Very important spawning site for several fish species, an important stop-over point for numerous species of migrating waterfowl.

3. Emajõe Suursoo Mire and Piirissaar Island. Ramsar site no. 906. Designated in 1997, area 32,600 ha (will be updated after the revision of protection rules). A large wilderness area formed by the Emajõe Suursoo mire system, the waters of Lake Peipsi and the Piirissaar Island. The largest delta-mire complex in Estonia is represented by different types of mires, rivers and lakes. Being extremely important for the hydrology and water quality of Lake Peipsi, the site is also important as a moulting and staging area for waterbirds and as a spawning area for many fish species.

4. Endla Nature Reserve. Ramsar site no. 907. Designated in 1997, area 10,110 ha. A freshwater ecosystem of bogs, swamp forests, freshwater lakes, rivers and karst springs. Numerous species of vulnerable or endangered waterbirds use the area for breeding. The site is an important area for water supply, and scientific research.

5. Hiiumaa Islets and Käina Bay. Ramsar site no. 908. Designated in 1997, area 17,700 ha (will be updated after the revision of protection rules). Shallow watershelf sea with small islets, mudflats and bays. The site is important for breeding and migrating birds, valuable spawning ground for many fish species and regular resting ground for the Ringed Seals.

6. Muraka Nature Reserve. Ramsar site no. 909. Designated in 1997, area 13,980 ha. One of the few extensive wilderness areas surviving in northeastern Estonia, consisting of an integral complex of various bog massifs, mixotrophic mires and primeval forests. The species diversity of fauna is one of the highest for mires in Estonia.

7. Nigula Nature Reserve. Ramsar site no. 910. Designated in 1997, area 6,398 ha. Extensive bog complex of various mire types, fringed by deciduous forest. The site includes a relict lake, many pools and hollows. The site supports numerous species of summering waterbirds and acts as a stopover place for fall migrating birds. An important area of scientific research. Part of the North Livonian Transboundary Ramsar site.

8. Puhtu–Laelatu–Nehatu Wetland Complex. Ramsar site no. 911. Designated in 1997, area 4,640 ha (will be updated after the revision of protection rules). A wetland consisting of a chain of lagoons together with coastal meadows, alvars, an species-rich wooded meadow and broad-leaved forest, and of species-rich fen typical of western Estonia. The coastal area is a stopover for migrating waterfowl, the site is important also as a nesting biotope of mire birds and roosting place for waterfowl.

9. Soomaa National Park. Ramsar site no. 912. Designated in 1997, area 39,639 ha. A complex of five large bog complexes separated by unregulated rivers with floodplain meadows, alluvial forests and wooded meadows and surrounded by extensive forests, including swamp forests. Being the most representative and valuable part of the remaining large wilderness area in southwest Estonia, the wetland is important as a nesting biotope of mire birds and the stopover site for migrating birds.

10. Vilsandi National Park. Ramsar site no. 913. Designated in 1997, area 24,100 ha. A large wilderness area comprised of a varied coastal landscape. The largest part of the site is formed by the sea speckled with 161 small islands and reefs. It also includes shallow bays, dunes, coastal lakes, coastal meadows and reed beds. The wetland complex is important as a breeding area of seabirds and Grey Seals, and wintering area of globally threatened Steller´s Eider.

11. Laidevahe Nature Reserve. Ramsar site no. 1271. Designated in 2003, area 2,424 ha. A mosaic wetland complex with broad diversity of coastal and aquatic habitats including lagoons, shallow coastal lakes, more than 40 islets, coastal saltmarshes, and extensive reedbeds. The wetland has a specific significance for breeding and migrating birds and spawning fish.

12. Sookuninga Nature Reserve. Ramsar site no. 1748. Designated in 2006, area 5,869 ha. A complex of six different raised bog massifs supporting rare, vulnerable and endangered species of birds and plants, some of them occurring in great numbers or densities. Part of the North Livonian Transboundary Ramsar site with Latvia.

Areas recently submitted by Estonia, which have not yet been officially added to the Ramsar List:

1. Agusalu Nature Reserve. Area 11,000 ha. A part of an extensive wilderness area (Agusalu–Puhatu mire complex) in northeastern Estonia charcterized by different mire types – bogs, transition mires and fens.

2. Leidissoo Nature Reserve. Area 8,178 ha. A large and particularly mosaic wetland complex being a part of an extensive wilderness area in northwestern Estonia and supporting high variety of mire types and habitats. The most typical are species-rich minerotrophic open fens dominated by *Myrica gale*.

3. Lihula Landscape Reserve. Area 6,620 ha. A large intact mire complex with open plateau bog surrounded by open and wooded minerotrophic and mixotrophic fens.

4. Luitemaa Nature Reserve. Area 11,240 ha. A mosaic wetland complex with the diversity of coastal and inland habitats including shallow sea, the diverse coastline with small bays, capes and islands, coastal meadows, reed-beds. Remarkable ridges of dunes formed in various phases of the Baltic Sea, mires, dry and wet forest stands are characteristic.

5. Haapsalu–Noarootsi. Area 27,240 ha. The site includes the Silma Nature Reserve, Osmussaare Landscape Reserve and Nõva–Osmussaare Limited Conservation Area. A large mosaic marine/coastal wetland complex along the northwestern coast, consisting of coastal seascape, shallow inlets and bays, coastal lagoons, coastal meadows, reedbeds, flooded mud- and sandflats.

Pursuant to Article 5 of the Convention Estonia and Latvia have designated the North-Livonian Transboundary Ramsar site (consisting of Nigula and Sookuninga Ramsar sites in Estonia and Northern Bogs Ramsar site in Latvia). Contracting Parties can designate their Ramsar sites as Transboundary Ramsar sites when an ecologically coherent wetland extends across national borders and the Ramsar Site authorities have formally agreed to collaborate in its management and have notified the Secretariat of this intent.

Thus, eight of 12 designated Ramsar sites in Estonia consist mainly or partly of mires, mainly bogs. Of five additional sites, four occur to be mire complexes. Their nomination will improve representation of minerotrophic and mixotrophic mires within Estonian Ramsar sites remarkably.

6.4.3 Potential Ramsar sites

According to the assessment by WWF-Sweden (2008) as to what extent the existing network of Ramsar sites meets the objective of the representation of the diversity of wetlands in the Baltic Sea catchment area, the representation of wetland types is generally acceptable in Estonia, with some reservations for freshwater lakes, calcareous/alkaline fens and bog woodland.

Several suitable areas listed in the National Programme on the Implementation of the Ramsar Convention are still waiting the designation. It has been decided by the National Committee that in the first order the following areas will be proposed as Ramsar sites: Puhatu Nature Reserve, Väike Väin Limited Conservation Area and Struuga Landscape Reserve.

In the second order Avaste Nature Reserve, Nätsi–Võlla Nature Reserve, Paope Nature Reserve and Kõrgessaare–Mudaste Limited Conservation Area, Rahuste Nature Reserve and Kaugatoma–Lõu Limited Conservation Area will be proposed.

In the third order the most complicated areas concerning border delineation will be proposed: Mullutu–Loode Limited Conservation Area and Linnulaht, Tõstamaa coastal meadows, Hari kurk Strait. For example, there is currently no suitable protected area as a basis for proposing Tõstamaa coastal meadows as a Ramsar site.

Recently Lavassaare mire system has been added to the Ramsar shadow list by the Committee. Additional mire areas can be added there after the present inventory has been completed, concerning especially wetland types under-represented in Ramsar network and being the responsibility habitats for Estonia.

It has to be mentioned that there is still a considerable additional potential for establishing new Ramsar sites in Estonia. For example, in 2001 BirdLife International identified from the data of the European IBA programme the wetlands that appear to qualify for Ramsar site designation under the criteria based on bird species and ecological communities, and concluded that areas within 48 Estonian IBAs qualify as Ramsar Sites (BirdLife International, 2001). However, the Estonian Ramsar Committee has declared that designation of all suitable IBAs as Ramsar sites is not necessary and only the most valuable and representative areas will be included to the List.

6.4.4 Management and monitoring of Ramsar sites

One of the main responsibilities of the member country is to set up a monitoring system and to update the information on Ramsar sites. Parties are urged, as a matter of high priority, to put in place mechanisms in order to be informed at the earliest possible time, if the ecological character of any wetland in its territory included in the Ramsar List has changed, is changing or is likely to change, to report any such change without delay to the Ramsar Secretariat (so as to implement fully Article 3.2 of the Ramsar Convention), and to report on these matters in the National Reports prepared on the occasion of each meeting of the Conference of the Parties. Therefore it is reasonable to implement comprehensive and well-designed monitoring programmes for Ramsar sites. In Estonia the protection and monitoring of Ramsar sites is carried out according to the management plans of national protected areas. The Environmental Board is responsible for drafting and implementing of these plans.

Ramsar sites which are considered to have undergone, to be undergoing, or to be likely to undergo change in their ecological character brought about by human action may be placed on the Montreux Record and may benefit from the application of the Ramsar Advisory Mission and other forms of technical assistance. Currently Estonia has no sites placed on this Record.

6.5 Monitoring of mires

6.5.1 Hydrometeorological monitoring

In 1950 the Tooma Bog Station was founded as part of the State Hydrometeorological Network of the former Soviet Union. A stationary observation network was established in Männikjärve and Linnussaare bogs. The observation program of the Tooma Bog Station (now belonging to the Estonian Meteorological and Hydrological Institute as Tooma Mire Monitoring Department) has been quite stable and includes direct measurements of all components of bog water balance (precipitations, evapotranspiration, discharge, ground water level, bog water level, microclimate on bog and mineral ground). On the basis of data gathered at the station, several papers have been published including widely avowed monograph about mire hydrology "Water movements in mirelands" by K. Ivanov (1981). Long-term hydrometerological research activities and history of the Tooma Bog Station have been described in several papers (e.g. Kimmel, 1997, 1998; Järvet, 2010).

During the last decade, various local hydrological surveys have been carried out in some partly disturbed mires to optimize the restoration projects. A network of automatic divers for monitoring of water level has been installed (e.g. in Ruunasoo bog).

6.5.2 Monitoring of geochemical processes

In four minetrotrophic peatlands (Oidremaa, Rehemäe, Karja and Tooma), which were drained for agricultural proposes, peat losses and surface decomposition have been monitored for several decades (Tomberg, 1970, 1992; see Chapter 5.1).

Hydrochemical monitoring of bog waters was performed in three protected bogs (Nigula, Meenikunnu and Viru) during a decade from mid-1980s by the Institute of Geology (Kink, 1996). During the last decade several local hydrological surveys were carried out to collect information about mire water chemistry in frames of pre-studies for mire restoration projects.

Since 2008 emission of greenhouse gases (CO_2, CH_4, N_20) has been instrumentally measured in a selection of natural, drained and mined mire areas (Salm et al., 2010).

6.5.3 Plant communities monitoring

The regular monitoring of plant communities including mires as part of Estonian national monitoring program "Monitoring of Species and Habitats" was started in 1994 (Klein, 2000).

By subprogram "Monitoring of Rare and Endangered Plant Communities" during 1994–1997 monitoring stations (permanent transects including 20 1x1 m sample plots divided into 16 subplots; planned re-monitoring after 5 years) were established *inter alia* in 11 bogs and two fens. On sample plots along transects, coverage of all plant species (bryophytes, field, bush and tree layer species) has been recorded. To monitor influence of atmospheric pollution to bog plant communities, most bog monitoring stations are located in northeastern Estonia, both in heavily and minor polluted areas.

In 1998–2001 state monitoring of wetland plant communities has been carried out in eight bogs, in 2002–2004 in nine bogs and six fens. In 2005 methods for plant communities were modified. Though the previous method was powerful enough for detecting changes caused by the communities management regime, it was not suitable for collecting information concerning the conservation status of Natura 2000 habitats. For obtaining a more general overview on the status of Natura 2000 habitats, since 2005 a simplified monitoring method (without permanent plots) was implemented also for monitoring Natura 2000 peatland habitats.

Habitat status of 100 mire sites (50 bogs, 50 fens) has been monitored with the new methodology during 2006–2010 in frame of state monitoring program. During the last decade several local pre-restoration surveys of vegetation were carried out in several partly disturbed peatlands (e.g. lagg zone of Ruunasoo bog, drained part of Kuresoo mire complex, Paraspõllu fen) in connection with the planned restoration projects and methods for monitoring restoration effectiveness proposed.

Valuable baseline information for detection of long-term changes in wetland plant cover has been collected for bogs in Nigula (Ruus, 1975) and Endla mire complexes and for fens in Avaste mire (Kask, 1955).

6.5.4 Mire habitats and landscapes monitoring by remote sensing

The methodology of mapping land cover changes and monitoring the dynamics of Estonian mire landscapes by means of sequential aerial photographs has been developed in the late 1980s (Aaviksoo, 1986, 1993). Monitoring of landscape changes on the ground of satellite based remote sensing data was initiated in 1996 as an integrated part of the Estonian National Environmental Monitoring Program. By means of medium-scale satellite imagery (LANDSAT) the landscape changes have been studied in seven monitoring areas including protected Alam-Pedja, Endla and Soomaa wetland systems (Aaviksoo et al., 2000; Aaviksoo & Meiner, 2001). A comprehensive integrated methodology for medium-scale (1:50,000) land cover mapping and monitoring using satellite images and national GIS data has been developed within the framework of the Landscape Monitoring Program (Aaviksoo et al., 2000; Aaviksoo & Muru, 2008).

Later additional monitoring sites were established on three other protected areas (Nigula, Emajõe Suursoo, Kõnnumaa) containing different mire types (Aaviksoo & Muru, 2008). In 1986–1998 shrub and tree invasion to open wetlands (both in mires and grasslands) and overgrowing of seashores with reeds were the main development trends in wetland-dominated landscapes (Aaviksoo & Muru, 2008). Monitoring studies based on high-resolution satellite images (e.g. IKONOS, QuickBird), aerophotos, LiDAR data, and even kite aerial photographs offer a great potential for accurate monitoring of vegetation in general as well for monitoring of certain species' habitats, especially on open and semi-open peatlands (Aber et al., 2002; Burnett et al., 2003; Sepp & Kiis, 2007[62]; Leivits & Leivits, 2009). During the past decade, for example, some pilot studies based on different high-resolution data sources (including LiDAR) have been carried out in Nigula and Männikjärve bogs (Burnett et al., 2003; Leivits & Leivits, 2009). At present the Estonian Land Board is regularly producing high-resolution aerophotos and LiDAR data, which is a very promising basis for application of the remote sensing technique for mapping and monitoring of mires.

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62 Access at: http://eelis.ic.envir.ee:88/seireveeb/ – Sepp, E., Kiis, K. 2007. Matsalu rahvuspargi ja Nigula looduskaitseala satelliitseire 1986-2001. Riiklik keskkonnaseire programm, alamprogramm "Elusloodusе mitmekesisuse ja maastike seire", allprogramm "Maastike kaugseire". (10.03.2011).

6.5.5 Species monitoring

The results of bird surveys have considerably influenced the formation of wetland conservation network in Estonia as existing bird data have been quite frequently crucial for making political decisions for legal protection of wetlands. The surveillance of the breeding birds in the Estonian wetlands was started in the middle of the 20th century. The first countrywide survey of the breeding bird fauna of the mires (mostly bogs) was carried out during 1948–1957 (Kumari 1972, 1985). Annual censuses of breeding birds were started in Nigula bog in 1968 (Irdt & Vilbaste, 1975; Leivits et al., 2008) and since 1986 the censuses of mire birds have been expanded to several other mire complexes where baseline survey of breeding birds has been performed since the middle of the 20th century by a team headed by E. Kumari. Since 1994 the monitoring of breeding birds of mires has been part of the National Environmental Monitoring Programme. Some protected threatened species breeding in floodplain fens and grasslands (e.g. *Gallinago media*) or coastal grasslands and mires (e.g. *Calidris alpina schinzii*) have been monitored quite intensely during the recent decades. Many other protected and threatened species (especially species listed in the Habitat Directive Annexes II and IV) have been monitored within the framework of various projects of National Environmental Monitoring Programme[63].

63 Access at: http://eelis.ic.envir.ee:88/seireveeb/aruanded (20.02.2011).

MIRES INVENTORY 7

7.1 Study objectives

The overall objective of the project was the assessment of values and the favourable conservation status of all habitat types of Estonian mires.

The aim of the project was to complete the inventory of all mires in Estonia, and to develop recommendations and required restrictions concerning the use of these wetlands. The operational objectives were formulated as follows:

- to improve the classification and identification system for establishing the nature conservation value of mires in Estonia (considering the relevant conventions and other international legal instruments, e.g. the Convention on Biological Diversity, the EEC Habitat Directive, etc.) based on the criteria reflecting the principles of the Estonian Environmental Strategy;
- to characterize and evaluate Estonian mires according to the aims of their future management and/or conservation;
- to complete the database and the geographical information system on Estonian mires, the exchange of relevant data with the Natura 2000 database and with the Estonian Nature Information System;
- to assess the typological and areal representativeness of protected mires network in Estonia, including the Natura 2000 network;
- to develop guidelines and recommendations for the best management practices of mires taking into consideration the principles of management and conservation and the proportions and scope of different activities; provision of these guidelines and recommendations to the relevant national, regional and local authorities;
- to promote public awareness concerning the nature protection value of mires.

This study used experience gained during the project "Estonian Wetlands Conservation and Management Strategy", implemented using the co-financing of the World Bank Norwegian Trust Fund in 1997.

7.2 Existing data sources and studies

Between 1935 and 1955, extensive mapping of plant cover was carried out, the main results of which were published in "Vegetation of the Estonian S.S.R." by prof. L.-M. Laasimer in 1965. Among other results, a plant-cover classification system of Estonian mires and paludifying areas was elaborated, data concerning the distribution pattern and the area of different types of plant communities were presented.

The Peat Group of the Estonian Geological Survey made an inventory of Estonian peat resources between 1971 and 1987, taking into account all peat-covered areas of more than 1 ha. The peat resources of all peatlands with industrial resources on more than 10 ha (1,598 peatlands) were surveyed thoroughly (Orru et al., 1992). The results concerning part of the peatlands – 539 of them – were published (Orru, 1995), but the main fraction of the data by administrative districts can be found in the Reports of Peat Resources (in manuscripts). These reports also give certain information about the plant cover and the community types in the mires that were examined. As the survey differs by administrative districts, the data between them are not well comparable and are partly outdated. Therefore, the map compiled as the result of the study cannot be taken as the map of recent Estonian peatlands. It would be more exact to call this the map of Estonian peat deposit types.

During a five-year period (1992–1996), the Peat Group of the Estonian Geological Survey made an inventory of the residual peat resources of the Estonian peat fields under exploitation. The manuscripts contain valuable data about the state of several peatlands.

In 1972, a report was made to the Ministry of Nature Conservation and Forestry by E. Kask about the conservation needs of Estonian wetlands. In this manuscript, data concerning more than 100 mires are presented, and their typology is discussed.

In 1973, a report about cranberry resources in Estonian mires was made by specialists from the Nigula Nature Reserve. Productive cranberry sites on about 25,750 ha are documented in tables and maps.

Information about the distribution of forest drainage systems is found in maps and tables compiled by the Estonian Forestry Survey in 1976.

Rather comprehensive data about the distribution pattern of peat soils are recorded in the Estonian soil maps (1:10 000).

The state of Estonian peatlands is assessed in the report "Complementary list of peatlands for their protection" compiled by M. Ilomets in 1993. In the enclosed map, mire complexes still untouched and those affected by drainage are presented.

M. Ilomets and Ü. Kasemetsa have in 1997 also issued a report concerning the state of peatlands with industrial peat resources: "Ecological Inventarisation of Estonian Peatlands. I. Database formation. Peatlands with industrial peat resources". This report provides data about the state of 539 peatlands, based on the comprehensive analyses of existing data (mostly manuscripts) collected by different institutions during the preceding 40 years.

The Estonian Wetlands Conservation and Management Strategy project was carried out with the financial support of the World Bank Norwegian Trust Fund in 1997. Between June and November 1997, 1,376 different wetlands were visited and described. This inventory did not include most of the protected mires and concentrated only on larger mires. All districts were covered more or less equally; the main gaps (compared with the areas planned) were situated in SW Estonia. Together with earlier data, the publication of the project (Paal et al., 1998) includes data concerning 1,560 wetlands (mires, floodplain meadows, coastal pastures, peatland forests). Conclusions of the inventory include certain proposals of addition of wetlands with high conservation value to the protected areas network. Since 1997, a lot of those proposals have been realized by the Government of Estonia, largely in the course of implementation of the EU Habitats Directive in Estonia. On the basis of the results of the project, a preliminary list of mires with low conservation value was compiled. This list, later discussed and developed together with the Environment Management Department of the Estonian Ministry of the Environment, was thought to serve as a source of potential new peat fields, to avoid extraction of bogs with high conservation value. However, the Ministry did not find enough juridical founding to establish it as a ministerial regulation (a new version of Earth's Crust Act was not adopted yet) and it worked only on recommendation level.

Thus, by the spring of 2009, sufficient data concerning 1,425 mires on 92,721 hectares was available for the present project, the majority of these areas were not re-inspected during field work. These data have been collected by the following experts and their assistants: Erik Absalon, Arne Ader, Esko Aikio, Martin Aim, Loore Ehrlich, Marju Erit, Tõnu Feldmann, Anne-Ly Feršel, Eli Fremstad, Herdis Fridolin, Toomas Hirse, Bert Holm, Erik Holm, Priit Holtsmann, Mati Ilomets, Nele Ingerpuu, Sulev Ingerpuu, Anneli Jussila, Sanna-Kaisa Juvonen, Katrin Jürgens, Mart Jüssi, Aino Kalda, Kaili Kattai, Arne Kivistik, Kaupo Kohv, Marika Kose, Tanel Kosk, Toomas Kukk, Thea Kull, Andres Kuresoo, Rein Kuresoo, Andrus Kuus, Valdo Kuusemets, Kaidi Kübar, Mari Lahtmets, Säde Lahtmets, Malle Leht, Raivo Leht, Eerik Leibak, Mare Leis, Agu Leivits, Meelis Leivits, Leida Lepik, Aivo Lepp, Raili Lille, Sirje Lillemets, Madli Linder, Marje Loide, Kaja Lotman, Heikki Luhamaa, Leho Luigujõe, Lauri Lutsar, Ott Luuk, Asko Lõhmus, Piret Lõhmus, Lilian Maaring, Riina Martverk, Remek Meel, Elle Meier, Vivika Meltsov, Marja-Liisa Meriste, Olev Merivee, Meeli Mesipuu, Rita Miller, Asbjørn Moen, Matis Mägi, Maarika Männil, Tiina Ojala, Ivar Ojaste, Indrek Ots, Margus Ots, Erkki Otsman, Helina Otsnik, Merit Otsus, Pekka Paaer, Jaanus Paal, Taimi Paal, Uku Paal, Kärt Padari, Raimo Pajula, Anneli Palo, Hannes Pehlak, Hannu Ploompuu, Mats Ploompuu, Tõnu Ploompuu, Erki Püssa, Uku Püttsepp, Ülle Püttsepp, Aivi Raak, Uve Ramst, Gunnar Raun, Ülle Reier, Arbo Reino, Helina Reino, Margit Reintal, Mari Reitalu, Kalle Remm, Reelika Rohtla, Elle Roosaluste, Aivar Sakala, Silvia Sepp, Aigar Sirel, Alar Soppe, Jaak Sultson, Meelis Suurkask, Kadri Tali, Anneli Tamm, Illi Tarmu, Uudo Timm, Urmas Tokko, Pille Tomson, Helen Toom, Toomas Trapido, Kaia Treier, Tiina Troškin, Laimdota Truus, Erki Uustalu, Peter Veen, Ain Vellak, Kai Vellak, Eike Vunk and Jürgen Öövel.

7.3 The work plan

The project Estonian Mires Inventory Completion for Maintaining Biodiversity included the following activities:

- field inventory of all mires of different types, with the aim to obtain a complete overview of the nature conservation value of these habitats;
- completion of the mires database, exchange of relevant data with the Natura 2000 database (Estonian Ministry of the Environment) as well as the environmental register (EELIS – Estonian Nature Information System);
- development of recommendations (including required restrictions and their justification) concerning the potential use of mires; provision of those to the relevant national, regional and local authorities;
- publication of a printed overview of project results and a complete overview of the state of mires; publication of information leaflets for the local inhabitants and local authorities (concerning e.g. the requirement to perform environment impact assessment (EIA) prior to undertaking activities in Natura 2000 wetlands, etc.);
- organization of an international conference to primarily Nordic and Baltic participants concerning the value of mires and measures to preserve and protect those as biodiversity values and reservoirs for the future.

The activities of the current project did not include an inventory of semi-natural wetlands like coastal pastures and floodplain meadows. Inventory of those habitats was carried out in 1999–2001 by the Estonian Fund for Nature and the Estonian Semi-natural Communities Conservation Association; the respective database is held by the latter organization.

7.4 Project organization

The responsible organization for the project was the Estonian Fund for Nature in co-operation with the State Nature Conservation Centre (now Environmental Board).

The executing team was made up of the following specialists:

- Taime Puura (Estonian Fund for Nature), who performed as the Project Manager for the study;
- Eerik Leibak (Estonian Fund for Nature), who performed as the conservation expert;
- Lauri Lutsar (Estonian Fund for Nature), who performed as the database manager;
- Agu Leivits (Environmental Board), who performed as manager of the project partner, the Estonian Environmental Board;
- Jaanus Paal (University of Tartu), who performed as compiler and editor of the publication.

In addition, the following persons have contributed to the field activities and/or to the completion of the project publication:

- Eli Fremstad (Norwegian University of Science and Technology);
- Nele Ingerpuu (University of Tartu);
- Kai Kimmel (Estonian Environmental Board);
- Toomas Kukk (Estonian Seminatural Communities Conservation Association);
- Valdo Kuusemets (Estonian University of Life Sciences);
- Erki Niitlaan (Estonian Peat Association);
- Elina Saunanen (Estonian Environmental Law Centre);
- Kärt Vaarmari (Estonian Environmental Law Centre);
- Kai Vellak (University of Tartu).

The project benefited from the cooperation and information exchange with several institutions:

- Estonian Land Board which helped to complete the set of basic maps;
- Estonian Defence Forces which allowed to use the digital map supporting the use of the GPS software for the field works;
- Estonian Environment Information Centre which provided the map layer of Estonian protected areas;
- Chair of Geoinformatics and Cartography of the Department of Geography (Faculty of Science and Technology, University of Tartu) which provided with additional data of small mires of especially southern and northwestern Estonia;
- REGIO Ltd. which enabled to use some of their map layers and prepared the present publication for printing.

7.5. Field worksheet and maps

The principles of the data format were worked out by J. Paal who drafted the worksheet in 1997. In the beginning of the 2000s, fields coming from the Natura 2000 standard data form[64] were added or previous fields were changed so that data on those fields can directly be transferred to or compared with the Natura 2000 database, the National Environmental Register (EELIS) and other databases. The final form

64 Access at: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/standarddataforms/ notes_en.pdf (22.03.2011).

of the data format was fixed in 2008. Translation of the main (mire) worksheet is presented in Annex I.

For the inventory three field worksheets were used: one for (open) mires and others for grasslands and forests. In all worksheets the following characters were examined and respective assessments given:

- Estonian vegetation habitat site type (according to Paal 1997);
- Natura 2000 habitat type;
- state of shrub and tree layers, their main species;
- obvious changes in field layer;
- human impact (drainage, mowing, grazing, burning, other impacts);
- nature conservation values (plant community state, floristical and aesthetical value, other values – hydrological, faunistical, recreative, didactic, etc.);
- representativity of habitat;
- global assessment (importance for nature conservation).

According to grassland/forest worksheets supplementary data were recorded concerning details and history of management, characters of communities structure, etc.

On the other side of the worksheets the standard registration list of the Estonian flora was printed for recording plant species and their abundance values. If possible, composition of (ornitho)fauna was also minuted.

To determine the sites for field work, and for the later use in GIS, a convenient map was needed. Of several maps for Estonia that exist in different scales and with various levels of accuracy, the basic map was chosen for the study. It is in 1:20,000 scale and covers the whole of the Estonian territory. The basic map is made on the ground of orthophotos, has good accuracy and well defined borders of landscape units. The map also has a digital version and has been constantly renewed.

Orthophotos have been used through public Web Map Service (WMS) offered by the Estonian Land Board.

7.6 Field work 2009-2010

The initial target for field work was set to 8,000 mires. However, in the course of the project, the number of the inspected mires reached 13,901 as the number of small mires depicted on the new basic map turned out to be larger than identified on older maps. Of these, 4,175 areas were inspected in 2009 and 9,726 mires in 2010.

Field work was started in mid-June 2009 when vegetation was sufficiently developed for determination of species. Usually a team consisted of 1-2 experts including scholars or nature conservation specialists, and students. During the inventory all areas on the map marked with open or treed mire symbol were visited.

Field work periods were June–November 2009 and June–November 2010. In the beginning of both field work periods, an instruction day for field experts was arranged. In May 2010, a special training day concerning mire vegetation was carried out. However, to unify the results of inventories and to diminish the quality control, a longer period training would have been beneficial.

The following experts participated in the field work: Ardo Aamer, Maire Akkermann, Ants Animägi, Madis Avi, Sirje Azarov, Tarmo Evestus, Eli Fremstad, Tiit Hallikma, Katre Halliko, Raili Hansen, Reeli Hansen, Indrek Hiiesalu, Toomas Hirse, Talvi Jusilo, Meeli Jänes, Johanna-Iisebel Järvelill, Ülle Jõgar, Helle Kaasik, Marko Kaasik, Karin Kaja, Liis Keerberg, Maris Kelner, Eva-Stina Kerner, Karin Kikas, Kai Kimmel, Arne Kivistik, Maria Knüpffer, Kaupo Kohv, Kai Koppel, Marika Kose, Maarja Kukk, Toomas Kukk, Thea Kull, Liis Kuresoo, Rein Kuresoo, Martin Küttim, Robert Laanpere, Tõnu Laasi, Eerik Leibak, Agu Leivits, Meelis Leivits, Helen Liiva, Luule Linamäe, Teisi Lindvest, Kaja Lotman, Jaana Luik, Ott Luuk, Kertu Lõhmus, Merit Mandel, Raul Melsas, Vivika Meltsov, Reet Merenäkk, Meeli Mesipuu, Jaak-Albert Metsoja, Liis Multer, Kiira Mõisja, Katrin Möllits, Maireet Müür, Rein Nellis, Siim Nettan, Riinu Ots, Jaanus Paal, Anne Palm, Oliver Parrest, Silvia Pihu, Tõnu Ploompuu, Taime Puura, Mikk Puurmann, Egert Puusepp, Egle Puusepp, Kuldar Pärn, Aage Raud, Mari Reitalu, Liina Remm, Elle Roosaluste, Peedu Saar, Aat Sarv, Daniel Savka, Kairi Sepp, Meelis Sepp, Toivo Sepp, Sirje Sildever, Hannes Sirkel, Silver Sisask, Alar Soppe, Jaan Spiegel, Gerda Suurkivi, Kätrin Suurkivi, Kadri Tali, Uku-Laur Tali, Indrek Tammekänd, Jaak Tammekänd, Helena Tammik, Sille Tammik, Jaanus Tanilsoo, Eleriin Tekko, Triin Tekko, Mihkel Tiido, Helen Toom, Jane Toomla, Aleksander Tukk, Margit Turb, Mari Uudelt, Ene Valdmann, Vallo Valdmann, Reet Viira, Johannes Vind, Eike Vunk, Ülo Väli and Heidi Öövel.

In addition to them, the following persons helped to carry out field work: Aira Alasi, Allar Annusver, Alina Gorecky, Elo Hermann, Dagmar Hoder, Epp Hunt, Katrin Jürgens, Alo Kaasik, Laila Kaasik, Inga Kangur, Julia Koblitzek, Marten Kose, Tõnis Peeter Kull, Siim Kuresoo, Säde Lahtmets, Vilge Lahtmets, Aleksei Lotman, Martti Maasik, Eha Metsallik, Rita Miller, Laine Opp, Tiina Orason, Anneli Palo, Kristi Parro, Raul Pihu, Tiit Randla, Martti Rohusaar, Urmo Saar, Jüri-Ott Salm, Eke Jaan Sarv, Erlend Sarv, Aleksander Sprogis, Monika Suškevičs, Jaak Tamboom, Üllar Tammekänd, Ants Tekko, Sirje Tekko, Ülle Valgi, Enn Vilbaste, Mariliis Võsu, Sirje Zahkna and Mark Zirk.

In most cases, both sides of the worksheet were filled out for each mire site. In cases where the site turned out to be strongly influenced by human impact or was very similar to the neighbouring one, only the evaluation form was filled out.

7.7 Development of geographical information system

7.7.1 Database

In the course of database management some of the original 13,901 data sheets were united into one, some divided into two or three, some united with data sheets from the older period, and a few were left out of the database (those erroneously filled out not for the habitats marked on the map, but somewhere in the neighbourhood). All in all, 13,850 data sheets from 2009–2010 were added into the database.

All textual data were computerized using the special *Visual FoxPro 9.0* application designed and programmed by Lauri Lutsar. Data input was carried out by Berit Hänilane, Eerik Leibak, Talis Lepik, Taime Puura and Gerda Spuul. All data sheets were checked, missing data (e.g. the Natura 2000 habitat type) interpreted and added, and individual differences of different experts unified by Eerik Leibak.

Though only mires were intended to be checked in the field, the selected areas actually contained a large variety of different habitats. This was caused by the errata on the basic map, use of the same map symbols for different site types (e.g. for fens and paludifying grasslands), fulfilment of data sheets per neighbouring habitats if field experts were strayed from the proper area, etc. In the result, the mentioned 13,850 data sheets represented the following site type groups: mires – 8,676 sheets, paludifying grasslands – 2,049 sheets, peatland forests – 1,587 sheets, paludifying forests – 409 sheets, floodplain grasslands – 320 sheets, dry and fresh grasslands – 292 sheets, waterbodies – 138 sheets, drained (decomposed) peatlands – 102 sheets, floodplain forests and shrublands – 79 sheets, coastal grasslands – 75 sheets, dry and fresh forests – 64 sheets, ruderal or cultivated habitats – 59 sheets.

In addition to the 8,676 mire sites and 603 sites including mires as marginal habitats, inspected during the 2009–2010 field work, 1,425 data sheets from the period of 1990–2008 were used. Together with uninspected mires, the final number of all data sheets of mire habitats or at least including any of mire habitats reached 11,023. More important fields of these data sheets are presented in Annex III.

7.7.2 GIS Setup

The geographical information system (GIS) for this project was developed using the MapInfo Professional mapping software (versions 8.5 and 10) together with MapBasic development environment. The areas were digitized from the screen by the boundaries of land-use units by means of Estonian Basic Map raster images. If there were two or more data sheets for one land-use unit on the Basic Map, the mutual borders of those areas were digitized according to orthophotos. Orthophotos were also often used for specification of borders (e.g. between bogs and peatland forests). The MapInfo can directly open the database format of Visual FoxPro, which supports the use of tabular data in both systems. However, only FoxPro can store memo fields containing extensive verbal descriptions. Data examination and unification of assessments was carried out in FoxPro, from where selected information was exported to MapInfo. Thus, each record in MapInfo stores spatial information (site boundaries) and selected textual and numeric information. Digitalization was carried out by Berit Hänilane, Maarja Kirt, Eerik Leibak and Gerda Spuul. By the end of the project, the GIS of the Estonian Fund for Nature contains 23,246 data records.

PRELIMINARY RESULTS AND CONCLUSIONS OF THE INVENTORY

8

In total, we have data about 11,023 areas (on 254,911 hectares) where the site type or at least one of site types have been determined as of mire vegetation. All these areas have been listed in Annex III (added on CD) and depicted on maps. Those inspected areas which turned out to be paludifying or peatland forests, grasslands, waterbodies or ruderal habitats without mire communities, are left out of further statistics.

Of these 11,023 areas, 340 (on 9,584 hectares) have been inspected insufficiently or not inventoried at all, and their conservation status and/or global assessment cannot be estimated. These areas form 3.1% by their number or 3.8% by their surface of all mires in Estonia.

In the next chapters, the main results of the inventory are presented by the Estonian habitat site types (hereafter: site types) and, separately, by the Natura 2000 habitat types. However, there are 793 areas in the database which include mires as only marginal habitats. As the division of surface between mire and non-mire habitats has not always been fixed in such cases, the following statistical data of each Natura or Estonian habitat site type are based only on those data sheets where the habitat of respective type was prevailing by area and recorded in the first position on the data sheet. The total number of such data sheets is 10,230 and these areas form 239,720 hectares.

The analysis of conservation of each site type habitat is based on percentages within national protected areas (*kaitsealad*), limited conservation areas (*hoiualad*) and species protection sites (*püsielupaigad*). All other categories of Estonian protected nature objects were regarded irrelevant to the present analysis. Analogously, the analysis of conservation of Natura 2000 habitats is based on percentages within Sites of Community Importance in Estonia. All boundaries of the mentioned protected nature objects are taken into account as they were fixed on March 31, 2011.

In Chapter 8.2, some aspects like geographical distribution are not repeated; these overviews are to be found in Chapter 8.1 by the relevant Estonian site types.

Here it should be pointed out that if the analyses of each site type according to the Estonian habitats classification are based on the above-mentioned 10,230 data sheets, then statistics about Natura 2000 mire habitats are based on all those data sheets in the database of the Estonian Fund for Nature which have indicated the respective habitat type as the main one. Thus, they include all data gathered also during other inventories (of grasslands, etc.). The difference between the two samples is unimportant for most of the Natura habitat types except 7210 and 7230.

8.1 Assessment of the state of Estonian mires

8.1.1 Minerotrophic mires

8.1.1.1. Poor fens (site type 3.1.1.1)

Poor fens are situated in low-lying depressions or plains, on watershed areas. Groundwater level is high, reaching the surface level in certain periods or locally. Soils are Dystric or Eutri-Dystric Histosols with different thickness and decomposition rate. Peat layer is not too thick for plants to receive nutrients from groundwater by roots. Peat pH varies from 4.6 to 6.0, average CaO content is 4.0% (Kollist, 1988a). In tree layer scattered *Betula pubescens* grow; the bush layer is formed by several willows: *Salix cinerea*, *S. phylicifolia*, *S. rosmarinifolia*. In the herb layer various sedges dominate: *Carex cespitosa*, *C. appropinquata, C. rostrata, C. elata, C. diandra, C. nigra, C. vesicaria*, *C. acutiformis*, *C. acuta*, *C. diandra*, *C. panicea*, *C. lasiocarpa*; in addition to them the following species are characteristic: *Calamagrostis canescens*, *Deschampsia cespitosa*, *Lysimachia vulgaris*, *L. thyrsiflora*, *Potentilla palustre*, *Equisetum fluviatile*, *Galium palustre*, *Menyanthes trifoliata*, *Filipendula ulmaria*, *Parnassia palustris,* etc. For moss layer *Campylium stellatum*, *Drepanocladus cossonii*, *Calliergonella cuspidata*, *Fissidens adianthoides* etc. are typical.

Number and area. 4,347 mire areas on 19,719 hectares have been registered as poor fens. Of these areas, 3,517 (on 10,939 hectares) include exclusively poor fens, while others consist in their marginal parts also of other habitats (mainly rich fens, poor paludifying grasslands or mixotrophic grass fens). Additionally, 566 areas include poor fens as marginal habitats. There are some hundreds of poor fen areas in the database where the depth of peat has not been measured and which may actually be either poor fens (site type 3.1.1.1), poor paludifying grasslands (site type 2.4.1.1) or both. Until we have no exact data concerning these areas, and taking into account the relatively large amount of areas with different marginal habitats, the above figure for the total surface of poor fens should be taken as a maximum.

Thus, open and treed poor fens are presented in Estonia on ca 19,000 (20,000?) hectares. This area is 10% larger than estimated by Ilomets et al. (2010), according to which open species-poor fens cover ca 17,000 hectares (Table 6).

Distribution. Poor fens are distributed all over Estonia but not evenly (Fig. 11). Their number and density is the highest on south Estonian uplands (Otepää, Karula, Haanja, Sakala) although all fen areas are small there. In other regions, the density is somewhat higher on Saaremaa Island, northwestern part of the mainland, eastern Estonia (Jõgevamaa) and locally in mid-western and northern Estonia. Poor fens are rare in intermediate Estonia and in most of northeastern Estonia.

Poor fens are usually small: nearly half of all inspected areas do not exceed the size of one hectare. There are only 23 areas larger than 100 hectares each, and only two of them exceed 500 hectares (Emajõe Suursoo central poor fen, 1,202 ha, and the central fen of Läänemaa Suursoo mire system, 633 ha). Other larger fens are also situated in northwestern (especially Leidissoo and Läänemaa Suursoo mire systems) and eastern Estonia (Emajõe Suursoo and Keeri–Karijärve mire complexes, Piirissaar Island, at and near Lake Pskov, etc.), but also in southern Saaremaa (at relict lagoons) and elsewhere.

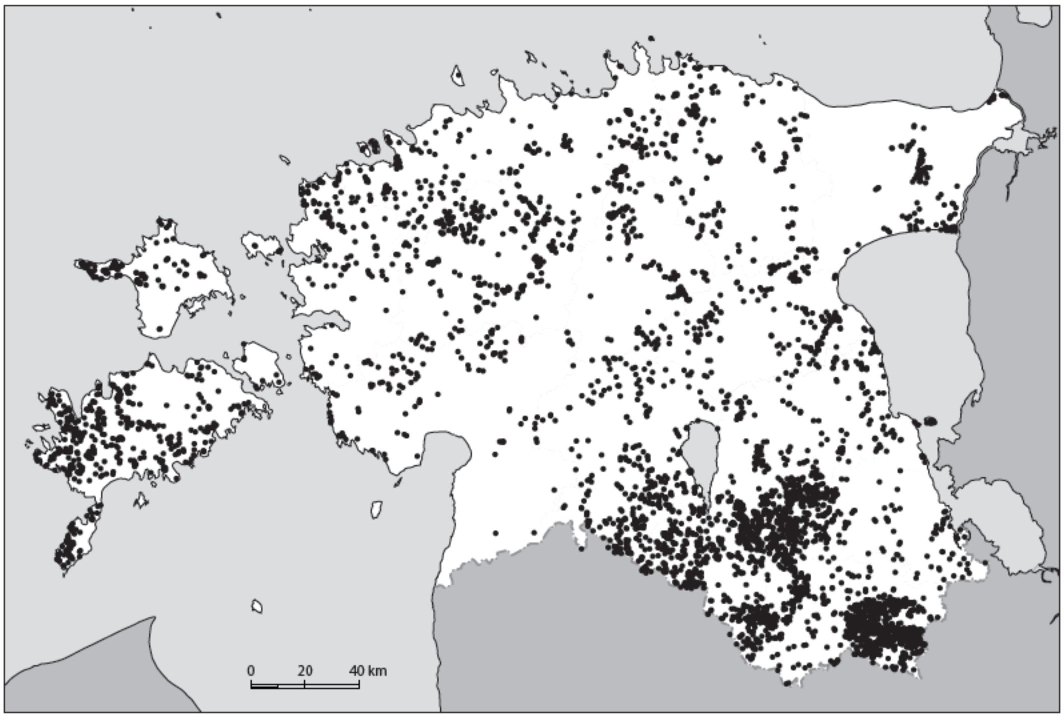

FIGURE 11. Distribution of poor fens in Estonia.

Division by Natura 2000 habitats. The majority of Estonian poor fens (1,035 areas on 16,309 hectares) correspond either to the Natura habitat type 7230 (alkaline fens; 1,358 areas on 10,849 ha) or to type 6430 (hydrophilous tall herb fringe communities; 2,184 areas on 6,592 hectares). 141 areas on 524 hectares have been classified as type 6410 (*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)), 27 areas on 116 hectares as type 9080 (Fennoscandian deciduous swamp woods) and 16 areas on 22 hectares as type 2190 (humid dune slacks). A few areas have been interpreted as representing other Natura habitat types (e.g. 6530, Fennoscandian wooded meadows) or do not correspond to the criteria of any Natura habitat type. The latter challenge (562 areas on 1,138 hectares) forms 6% of all areas, i.e. more than in the case of other mire site types.

As seen from the figures above, poor mires which correspond to the Natura 2000 habitat type 6430 are much smaller than those corresponding to the habitat type 7230 (3 ha *versus* 8 ha, on an average). This is caused by different ecological demands of certain plant communities, e.g. *Caricetum lasiocarpae* (which purely corresponds to type 7230) are bounded with large open areas and usually lack in narrow fringe areas which are covered, instead, by tall herb communities. However, in some regions habitat type 6430 may have been interpreted too widely (e.g. concerning larger communities, not only fringes, or some *Caricetum vesicariae-rostratae* communities) and therefore habitats of such areas should rather be qualified as Natura type 7230 (not 6430), or they should have been left without any Natura code at all.

Status and future perspectives. Assessment of conservation status (meaning habitat quality) of the inspected poor fens resulted as follows: excellent conservation (A) – 276 areas (3,418 ha), good (B) – 1,612 areas (9,701 ha), average or reduced (C) – 1,954 areas (5,389 ha), degraded (D) – 359 areas (707 ha), unknown – 146 (504 ha). Thus, 67% of all assessed poor fen habitats are of excellent or good quality. On the other hand, at least 271 areas on more than 700 hectares are classified as "drained fens" which merely correspond to the criteria of the respective site type and will turn into drained minerotrophic or drained peatland forests in the near future. The same can be expected concerning numerous other fens where the boundary between open/treed fen and minerotrophic woodland gradually moves towards the centre of the mire and the surface of the fen habitat decreases.

According to Laasimer (1965), open species-poor fens covered 152,300 hectares in the 1950s. This would mean that 87% of former poor fens have been destroyed by man and/or were substituted to rapid allogenic succession during the last 60 years. In the conditions of land deficit up to the mid-20th century the majority of poor fens were used for hay-making and grazing; after the end of agricultural activities, succession towards minerotrophic woodlands and forests is evident. This process is well expressed by the relatively low conservation value of the habitats of this site type (see above). Moreover, thousands of hectares of poor fens have been damaged or destroyed due to drainage or amelioration nearby, and instead a number of former fens, cultivated grasslands have been now established. Both succession and amelioration factors are foreseen to continue and, therefore, decrease of the number and surface of poor fen in Estonia will not be inhibited in the future.

Global assessment (conservation importance) of the inspected poor fens resulted as follows: excellent value (A) – 20 areas (1,515 ha), good value (B) – 485 areas (7,616 ha), significant value (C) – 1,771 areas (6,661 ha), low or lacking value (D) – 2,056 areas (3,912 ha), unknown value – 15 (14 ha). Thus, Estonian poor fens have a lower average conservation importance than habitats of any other mire site types: only 46% of all areas have high conservation importance.

Conservation. By surface, exactly half of the mentioned 4,346 areas are situated totally or partly within national protected areas (1,239 areas on 9,888 hectares).

All protected poor fens were evaluated during the field inventory as follows: excellent conservation value (A) – 17 areas (1,457 ha), good value (B) – 332 areas (5,711 ha), significant value (C) – 578 areas (2,180 ha), low or lacking value (D) – 305 areas (531 ha), unknown value – 7 (9 ha). Thus, the majority of our protected poor fens (72% by surface) are of high conservation value. The relatively higher percentage of protected poor fens with lower conservation value can be explained with their abundance within large protected areas with loose protection regime (e.g. Otepää and Haanja nature parks) and in many limited conservation areas where protection of poor fens is not among the main aims of those protected areas.

Additionally, there are 156 poor fens of excellent or good value totally or partly outside the protected areas, with the total surface of 1,963 hectares. Only five of these are larger than 50 hectares, and at least three of them – Mustakannu (Velna, Saarepää) fen (274 ha) in southeastern Estonia, Kivijärve fen (126 ha) in eastern Estonia and Venevere fen (111 ha) in central Estonia – should be added to the protected areas network together with their neighbouring wetlands. Smaller poor fens in this selection are located all over Estonia, and they need a detailed analysis of representativity and protection value.

8.1.1.2. Rich fens (site type 3.1.1.2)

Rich fens are situated in low-lying depressions or plains, on watershed areas or on floodplains. Groundwater level is high, reaching the surface level in certain periods or locally; it is movable to a different extent and comparatively rich in nutrients used by plants. Soils are Eutric Histosols with different thickness and decomposition rate. Peat layer is not too thick for plants to receive nutrients from groundwater by roots. Peat pH varies from 5.6 to 6.8, average CaO content is 4.5% (Kollist, 1988a).

Number and area. 1,439 mire areas on 19,337 hectares have been registered as rich fens. Of these areas, 1,096 (on 12,686 hectares) include only rich fens, while others consist in their marginal parts also of other habitats (mainly rich paludifying grasslands, poor fens and mixotrophic grass fens). Additionally, 399 areas include rich fens as marginal habitats.

Altogether, open and treed rich fens are presented in Estonia on almost 20,000 hectares. This area is nearly four times larger than estimated by Ilomets et al. (2010), according to whom open species-rich fens cover ca 5,000 hectares (Table 6). Evidently, the latter figure is an underestimate.

Distribution. Rich fens are distributed unevenly in Estonia (Fig. 12). The majority of respective areas are situated in western and northern Estonia where bedrock is formed by Ordovician and Silurian limestones and the soils are enriched with carbonaceous material. Southern Estonia (on Devon sandstone) includes only 51 areas on 181 hectares, and probably part of these may actually turn out to be (former) spring fens.

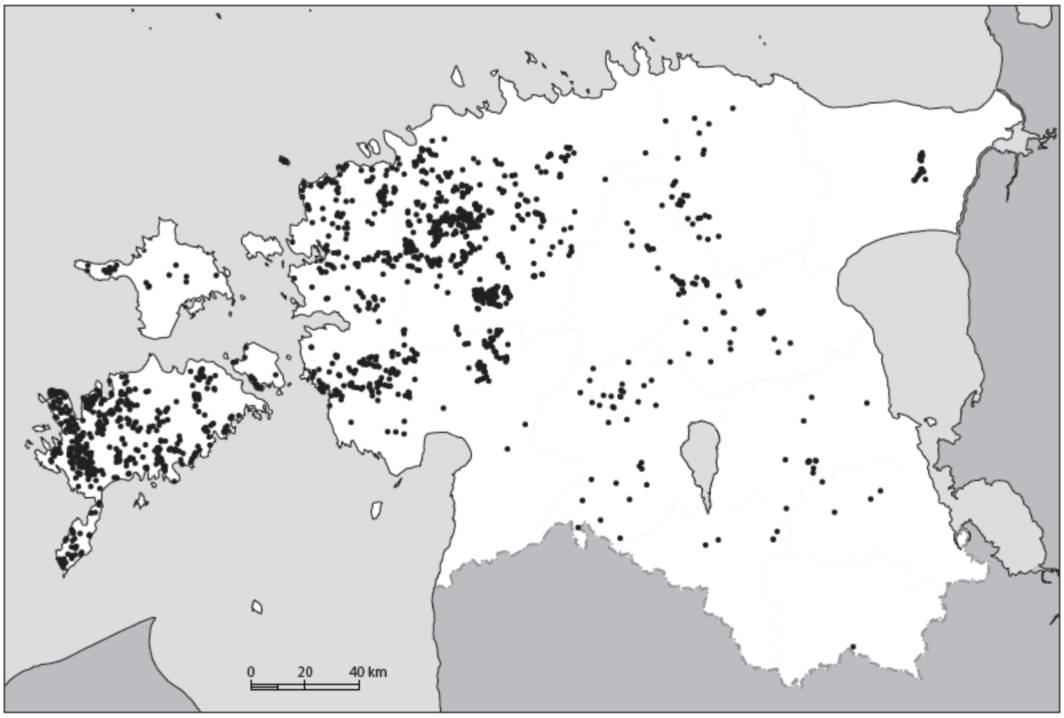

FIGURE 12. Distribution of rich fens in Estonia.

75% of all Estonian rich fens (753 areas on 14,467 hectares) are distributed in the northwestern and mid-western parts of the mainland, mainly within the district of West Estonian middle size and large mires (after Allikvee & Ilomets, 1995). This region comprises the largest Estonian rich fens (Avaste; 2,768 ha) and the most important rich fen complex (Leidissoo; larger massifs of 516, 364, 335 and 251 ha). The second remarkable rich fen complex is Tõrasoo (larger massifs of 249 and 199 ha together with 48 smaller ones). Other notable rich fens or rich fen complexes in this region are Suure-Aru and Leva in northern Estonia and Kiive, Nehatu and Paadrema in the western part of mainland.

19% of Estonian rich fens are located on Saaremaa Island (500 areas, 3,732 hectares). Though only three areas exceed 100 hectares there (Linnassoo fen, 148 ha; Järveküla fen, 138 ha; Karusoo fen, 127 ha) their density is often higher than in the western mainland. Impact of drainage seems to be lower than elsewhere, especially in western Saaremaa.

On Hiiumaa and Muhu islands the number and surface of rich fens is low, even on small Osmussaar Island their density is higher. On Muhu Island, the majority of fen areas have not reached 30 cm peat layer and are, therefore, classified as species-rich paludifying grasslands. Small areas of rich fens are sparsely located in central Estonia and rarely in the northeastern quarter of the mainland.

Division by Natura 2000 habitats. The majority of our rich fens (1,035 areas on 16,309 hectares) correspond to the Natura habitat type 7230 (alkaline fens). 257 areas on 1,563 hectares have been classified as type 6410 (*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion* *caeruleae*)) and 106 areas on 1,161 hectares as type 7210 (calcareous fens with *Cladium mariscus*). A few areas have been interpreted as representing other Natura habitat types (e.g. 6430, 9080) or do not correspond to the criteria of any Natura habitat type.

The relatively high percentage of the type 6410 habitats actually indicates that the hydrological conditions of areas may have been changed (damaged) by man. Drained species-rich fens are in Estonian conditions most often covered by *Molinietum caeruleae*, and the description of the relevant Natura 2000 habitat type seems to fit quite well with it. Still, some of more degraded rich fen communities might have been left without any Natura 2000 code at all, thus the above number of *Molinia* meadows (6410) may be overestimated. On the other hand, communities of *Molinietum caeruleae* cover also areas with unspoiled hydrology in western Estonia (mainly paludifying grasslands but also rich fens) and in such a way correspondence between the Natura 2000 type 6410 and the Estonian habitats classification site type 3.1.1.2 seems to be justified.

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected rich fens resulted as follows: excellent conservation (A) – 250 areas (7,417 ha), good (B) – 751 areas (9,278 ha), average or reduced (C) – 371 areas (2,208 ha), degraded (D) – 22 areas (105 ha), unknown – 45 (329 ha). Thus, 86% of all assessed rich fen habitats are of excellent or good quality.

According to Laasimer (1965), open species-rich fens covered 74,900 hectares in the 1950s. This would mean that 75% of former rich fens have been destroyed by man and/or were substituted to rapid allogenic succession during the last 60 years. Many rich fens have been damaged or destroyed due to drainage or amelioration nearby, especially in the mainland, and some (former) fen areas have even been afforested by pine and/or spruce plantations. In the conditions of land deficit up to the mid-20th century the majority of open rich fens were used for grazing and to a lesser extent for hay-making; after ceasing of agricultural activities succession towards minerotrophic forests is evident. These factors are foreseen to continue and, therefore, decrease of the number and surface of habitats of this site type will not be inhibited in the future.

Global assessment (conservation importance) of the inspected rich fens resulted as follows: excellent value (A) – 46 areas (5,314 ha), good value (B) – 474 areas (8,704 ha), significant value (C) – 688 areas (4,390 ha), low or lacking value (D) – 224 areas (908 ha), unknown value – 7 (22 ha). Thus, the majority of Estonian rich fens still have a relatively high conservation value.

Conservation. Of the mentioned 1,438 areas, 484 are situated totally or partly within national protected areas. The surface of protected rich fens reaches 12,360 hectares or 64% of their total area.

All protected rich fens were evaluated during the field inventory as follows: excellent conservation value (A) – 38 areas (5,108 ha), good value (B) – 271 areas (6,158 ha), significant value (C) – 151 areas (964 ha), low or lacking value (D) – 18 areas (117 ha), unknown value – 6 (12 ha). Thus, the majority of our protected rich fens (91% by surface) are of high conservation value.

There are 211 rich fens (2,752 ha) of excellent or good value outside the protected areas. Only nine of these are larger than 50 hectares, and at least four among them (Suure-Aru, Klooga, Pühatu on the mainland and Linnassoo on Saaremaa Island) should undoubtedly be added to the protected areas network. Smaller fens in this selection are located all over Estonia, and they need a basic analysis of representativity and protection value first. Taking into consideration the vulnerability of habitats of this site type against drainage, further additions to the existing protected areas network are inevitable.

8.1.1.3. Minerotrophic quagmires (site type 3.1.1.3)

Minerotrophic quagmires are formed in the course of terrestrialization (infilling – Rydin & Jeglum, 2006) of shallow lakes and ponds. Peat layer and roots of living plants have made a dense floating carpet holding men but under that carpet some water lens has persisted. Water level frequently reaches the surface. Soils are Eutric Histosols. The field layer is species-poor, often monodominant. Common vascular plant species are: *Carex nigra*, *C. rostrata*, *C. diandra*, *Eriophorum angustifolium*, *Phragmites australis*, *Equisetum fluviatile*, *Menyanthes trifoliata*, *Potentilla palustris*; in moss layer *Scorpidium scorpioides*, *Calliergonella cuspidata*, *Campylium stellatum*, *Drepanocladus cossoni*, etc. prevail.

Number and area. 284 areas on 1,634 hectares have been qualified as minerotrophic quagmires. Of these areas, 197 (on 1,061 hectares) include only habitats of this site type, while the remaining areas consist also of habitats of other types (mainly mixotrophic quagmires and/or poor fens) in their marginal parts. At the same time, additional 131 areas include minerotrophic quagmires as marginal habitats. The actual surface of habitats of this site type may be somewhat larger than the presented number since tens or even hundreds of lakes and pools have a very narrow strip of 3.1.1.3-type habitat on their banks, but these tiny areas were usually not among the objects of the inventory. Thus, the overall surface of mixotrophic quagmires in Estonia may be estimated at ca 1,800 hectares which exceeds the estimate by Ilomets et al. (2010) for all quagmires – ca 1,000 ha (Table 6) – nearly twofold.

Distribution. Minerotrophic quagmires are distributed unevenly in Estonia (Fig. 13). The number and density are the highest on southeastern uplands (Otepää, Karula, Haanja). On Sakala Upland their frequency does not differ from that of northern Viljandimaa. The number and density of minerotrophic quagmires are somewhat higher also in the northern part of intermediate Estonia (Lahemaa, Kõrvemaa), in the northwestern part of the mainland and locally on Hiiumaa Island. There are no minerotrophic quagmires in large areas of western, southwestern and northeastern Estonia.

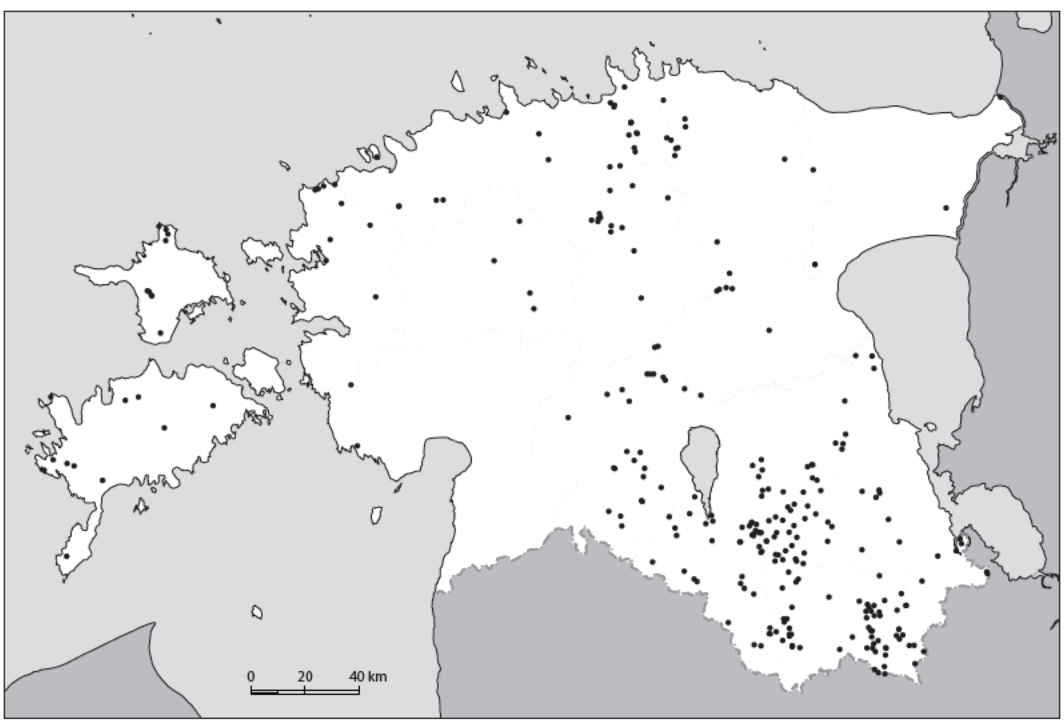

FIGURE 13. Distribution of minerotrophic quagmires in Estonia.

Minerotrophic quagmires are relatively small in area. Only one area – Karasoo in southeastern Estonia – exceeds 100 hectares (122 ha) and only the three next exceed 60 hectares. About one third of all areas hold less than 1 ha each. Thus, the majority of our minerotrophic fens are tiny to small.

Division by Natura 2000 habitats. The majority of our minerotrophic quagmires (264 areas on 1,497 hectares) correspond to the Natura habitat type 7140 (transition mires and quaking bogs). Seven sites on

65 hectares have been classified as type 7210 (calcareous fens with *Cladium mariscus*; in Saaremaa) and a few as other habitat types or not corresponding to any Natura habitat type.

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected minerotrophic quagmires resulted as follows: excellent conservation (A) – 71 areas (662 ha), good (B) – 129 areas (708 ha), average or reduced (C) – 65 areas (236 ha), degraded (D) – 3 areas (1 ha), unknown – 16 (26 ha). Thus, 84% of all assessed habitats are of excellent or good quality.

According to Laasimer (1965), minerotrophic quagmires covered 1,300 hectares in the 1950s. Thus, the surface of habitats of this site type has enlargened by nearly 40% which may be objective. During the last century, the total area of minerotrophic quagmires has increased due to terrestrialization/infilling of lakes and pools, especially if they have been influenced by nitrogen pollution or drainage. A lot of minerotrophic quagmires have appeared after the artificial lowering of water surface of lakes. Most probably, the recovering population of the beaver (*Castor fiber*) is also favouring the survival, restoration and maybe even formation of habitats of this site type.

The number and surface of minerotrophic quagmires is foreseen to increase also in the future, both due to natural processes (ageing of lakes) and the mentioned anthropogenic influence; even if those activities are not carried out any more, the once started processes will continue.

Global assessment (conservation importance) for the inspected minerotrophic quagmires was evaluated as follows: excellent value (A) – 15 areas (399 ha), good value (B) – 97 areas (770 ha), significant value (C) – 138 areas (348 ha), low or lacking value (D) – 31 areas (113 ha), unknown value – 3 (4 ha). Thus, the majority of Estonian mixotrophic quagmires by number have moderate conservation value but sites with high value dominate by surface.

Conservation. Of the 284 minerotrophic quagmire areas, 136 are totally or partly protected; they form 960 hectares or 59% of the total surface.

All protected minerotrophic quagmires were evaluated during the field inventory as follows: excellent protection value (A) – 15 areas (398 ha), good value (B) – 67 areas (441 ha), significant value (C) – 47 areas (116 ha), low or lacking value (D) – 5 areas (4 ha), unknown value – 2 (1 ha). Thus, the majority of protected mixotrophic quagmires (87% by surface) are of high conservation value, including all sites of excellent value.

There are 30 areas of good value on 331 hectares outside the protected areas, mainly in southeastern Estonia. Of these, the largest minerotrophic mire in Estonia – Karasoo – has been included in the shadow list of proposed new protected areas; it forms a complex with Sepasoo quagmire, other mires and wetlands. A further analysis is needed to decide which other unprotected minerotrophic quagmires should be added to the protected areas network. That depends mainly on the value of neighbouring habitats, but also on the floristic value of the area, etc.

8.1.1.4. Floodplain fens (site type 3.1.1.4)

Floodplain fens are situated on periodically flooded and poorly drained habitats where the vegetation is comparatively species-poor, but tall and productive. In soil cover Eutric Histosols prevail. Floodplain fens comprise the following types of plant communities: *Carici paniceae–Seslerietum, Caricetum paniceo–nigrae, Caricetum diandro–nigrae, Caricetum elatae, Drepanoclado–Caricetum lasiocarpae and Phragmitetum australis.* Minerotrophic communities on lake shores ("lake floodplains") are not interpreted under site type 3.1.1.4.

Number and area. 196 mire areas on 3,179 hectares have been registered as floodplain fens. Of these areas, 156 (on 1,861 hectares) include exclusively floodplain fens, while in marginal parts of the remaining areas habitats of other types persist (mainly mixotrophic grass fens, floodplain grasslands and shrublands). Moreover, 54 areas include floodplain fens as marginal habitats.

In addition to these areas, 55 areas of paludifying floodplain grasslands (on >450 hectares) have been marked in the nature conservation database of the Estonian Fund for Nature as representing the habitat site type 2.2.1.4 (lacking in Paal, 1997). Plant communities of these habitatas are largely the same as pointed above, but peat layer is thinner and in this way they have been formed on Eutric and Mollic Fluvisols or Histic Gleysols. Paludifying floodplain grasslands have not been included in Annex III, and a much more complete list of habitats of that site type is presented in the database of the Estonian Semi-natural Communities Association. As neither the depth of peat nor the soil type of floodplain communities were usually fixed during the inventories, it is often dubious whether the difference between habitat site types 2.2.1.2, 2.2.1.4 and 3.1.1.4 has been distinguished properly. Thus the actual number and surface of these habitat site types may differ from the above figures. For example, Ilomets et al. (2010) have estimated that floodplain fens cover ca 1,000 hectares in Estonia (Table 6), i.e. three times less than our estimate.

Distribution. Floodplain fens are distributed mainly in eastern Estonia (Fig. 14). They are typically located at rivers with slow flow. Seven areas are larger than 100 hectares (Keeveskisoo at the Soodla River, northern Estonia, is the largest – 248 ha). Three of those seven areas are situated in the Emajõe Suursoo mire system (at the lower course of the Emajõgi River, eastern Estonia). Other rivers with noticeable floodplain fens are Ärma, Kõpu, Õhne and Tänassilma in southern and Valgejõgi in northern Estonia. Presumable floodplain fens by the Halliste, (Koiva) Mustjõgi and Võhandu rivers have been mainly or totally registered as floodplain grasslands.

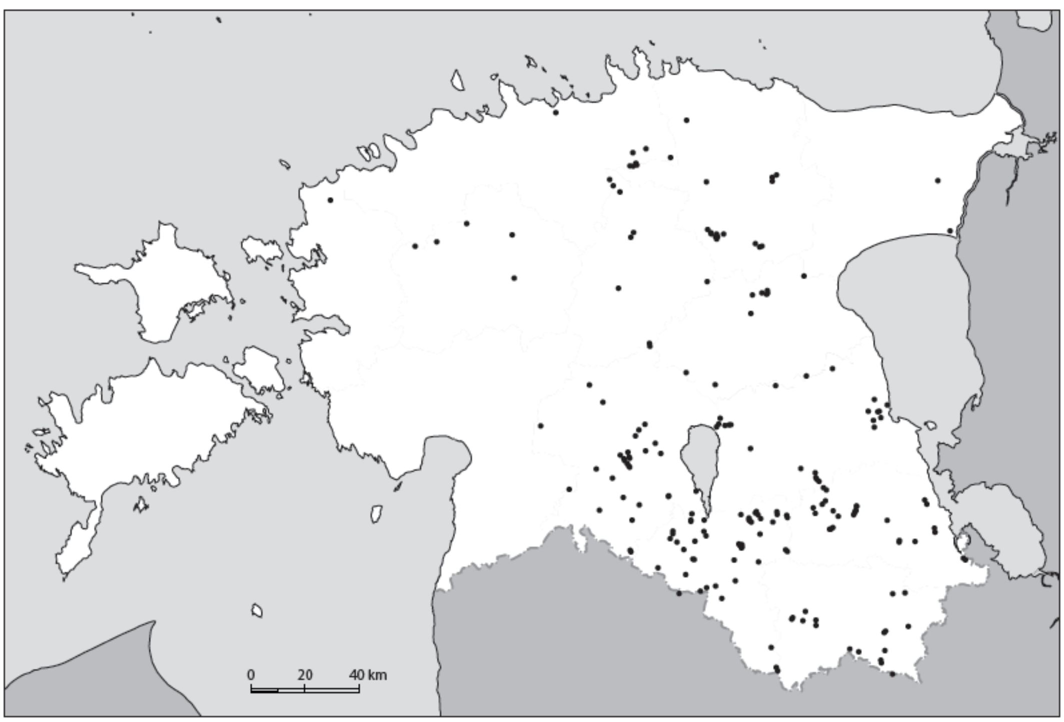

FIGURE 14. Distribution of floodplain fens in Estonia.

Floodplain fens in the western part of the mainland (lowland Estonia) are represented only by eight areas (on 88 hectares) in the database.

Division by Natura 2000 habitats. About half of the inspected floodplain fens (127 areas on 1,524 hectares) correspond to the Natura habitat type 6430 (hydrophilous tall herb fringe communities). 18

areas on 892 hectares have been classified as type 7230 (alkaline fens) and 36 areas on 604 hectares as type 6450 (northern boreal alluvial meadows). It should be mentioned that the Estonian habitat site type 2.2.1.4 corresponds mainly to the Natura 2000 habitat types 6450 and 6430.

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected floodplain fens resulted as follows: excellent conservation (A) – 12 areas (712 ha), good (B) – 79 areas (1,352 ha), average or reduced (C) – 82 areas (8,946 ha), degraded (D) – 9 areas (23 ha), unknown – 14 (199 ha). Thus, 84% of all assessed floodplain fen habitats are of excellent or good quality.

According to Laasimer (1965), floodplain fens covered 83,000 hectares in the 1950s. This means that less than 4% of the former floodplain fens have survived up to now. In the conditions of land deficit up to the middle of the 20th century the majority of the floodplain fens were used for hay-making; after ceasing of mowing, succession towards alluvial shrublands and forests started. In addition, parts of Estonian rivers have been straightened and hydrological regime of their (former) floodplains has often cardinally changed. Therefore, despite of possible differences in the content of figures marking the surface in the1950s and now, it is evident that a lot of floodplain fens have been drained and overgrown with bushes or forests and cannot be identified as the habitat site type 3.1.1.4 any more.

Global assessment (conservation importance) of the inspected floodplain fens resulted as follows: excellent value (A) – 3 areas (590 ha), good value (B) – 31 areas (949 ha), significant value (C) – 116 areas (1,294 ha), low or lacking value (D) – 42 areas (191 ha), unknown value – 4 (156 ha). Thus, only less than half (48%) of Estonian floodplain fens have high conservation value.

Conservation. Of the mentioned 196 areas, 86 are situated totally or partly within national protected areas. The surface of protected floodplain fens sums up to 1,656 hectares (52% of their total area).

All protected floodplain fens were evaluated during the field inventory as follows: excellent conservation value (A) – 3 areas (590 ha), good value (B) – 26 areas (611 ha), significant value (C) – 47 areas (304 ha), low or lacking value (D) – 8 areas (14 ha), unknown value – 2 (139 ha). Thus, the majority of our protected floodplain fens (72% by surface) are of high conservation value, including all registered sites of excellent value.

Additionally, there are five floodplain fens totally and six partly (338 ha together) of good value outside protected areas. A further analysis is needed whether these areas should be added to the protected areas network.

8.1.1.5 Spring fens (site type 3.1.3.1)

Spring fens are situated on slope foots but also on the coasts of waterbodies. Groundwater is often calcium-rich. Soils are well decomposed Eutric Histosols. The field layer is species-rich, several rare species can grow there. Typical species are: *Carex lasiocarpa*, *C. davalliana*, *C. hostiana*, *C. dioica*, *C. flacca*, *C. viridula*, *C. elata*, *Eriophorum angustifolium*, *E. latifolium*, *Equisetum fluviatile*, *Schoenus ferrugineus*, *Pinguicula vulgaris, P. alpina,* etc. In moss layer there are common *Drepanocladus* spp., *Scorpidium scorpioides*, *Plagiomnium elatum*, *Marchantia polymorpha,* etc.

Number and area. 230 mire areas on 784 hectares have been registered as spring fens. Of these areas, 180 (on 510 hectares) include only spring fens while others comprise other habitats in their marginal parts (mainly species-rich paludifying grasslands and/or rich fens). Additionally, 95 areas include spring fens as marginal habitats. The actual surface of spring fens may be somewhat larger than the presented number since it seems that few registrators had inadequate experience with that site type and, thus, some spring fens may have been listed under rich fens (3.1.1.2) or mixotrophic mires (3.1.2.1).

Open and treed spring fens are presented in Estonia on about 900 hectares. This area is twice as large as estimated by Ilomets et al. (2010), according to whom the total surface of spring fens equals ca 400 hectares (Table 6, row 1.1).

Distribution. Spring fens are distributed locally and unevenly in Estonia (Fig. 15).

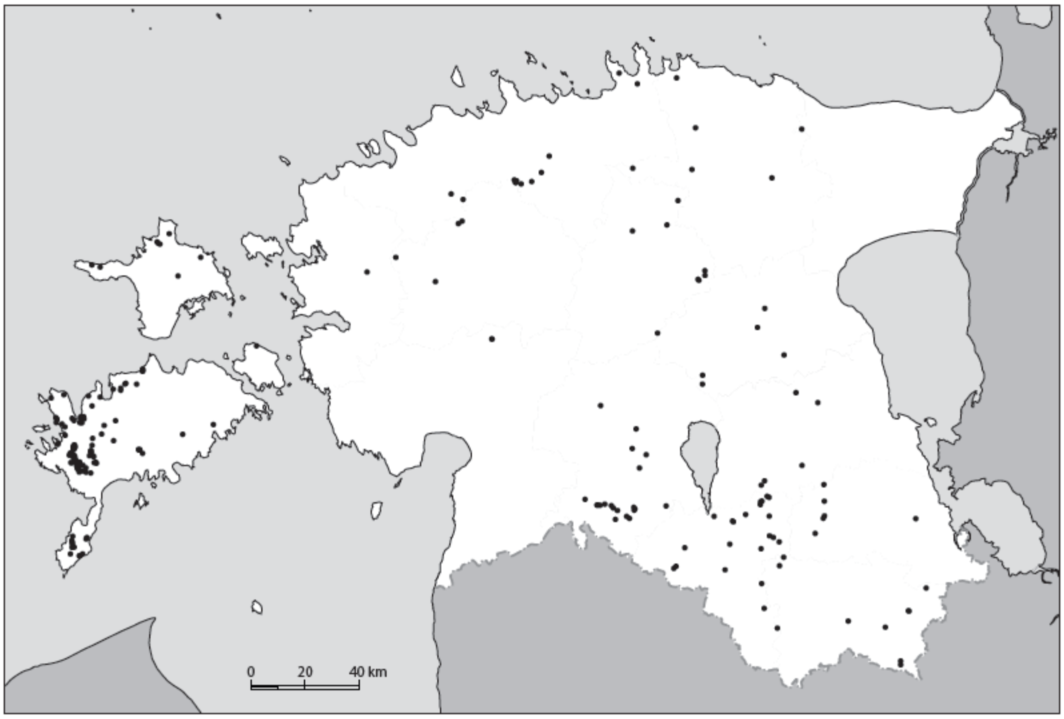

FIGURE 15. Distribution of spring fens in Estonia.

Their number and density are the highest in the western part of Saaremaa Island where half of the Estonian spring fens are situated (118 areas, 400 hectares). This is also the region where these habitats are floristically much more valuable than elsewhere. Some spring fen plant taxons (e.g. *Juncus subnodulosus*) are absent outside the region in Estonia or even in the World (*Rhinanthus rumelicus* subsp. *osiliensis*). The most important and well-known spring fens are situated within the Viidumäe Nature Reserve.

On the Estonian mainland, the density of spring fens is relatively high on the slopes of uplands. On Sakala Upland, the habitat can mainly be found in the southern part (especially in the upper basin of the Halliste River) and on Pandivere Upland – in its eastern part. On Otepää Upland spring fens are distributed more evenly. Some valuable spring fen habitats are situated sparsely outside uplands in southeastern Estonia (e.g. Õru, Pühaste, Tatra, Kassinurme).

Hiiumaa Island comprises Estonia's largest spring fen (Kukka soo, 58 ha) but generally the habitats of that type are quite rare there. On the lowlands of northern Estonia, the most important spring fens occur between Aruküla and Kohila (Paraspõllu, Kämbla, Tammiku).

Spring fens are lacking in those regions of Estonia which are rich in large raised bogs: Pärnumaa (southwestern Estonia), intermediate Estonia and Alutaguse.

Compared with other mire site types, spring fens are the smallest in surface. Only two areas (Kukkasoo in Hiiumaa and a spring fen near Ohtja in Saaremaa) exceed 50 hectares. The five next areas hold between 20 and 50 hectares and the next seven between 10 and 20 ha. All other 216 spring fen areas are less than 10 hectares each, and half of them even less than 1 ha.

Division by Natura 2000 habitats. The vast majority of our spring fens (223 areas on 768 hectares) correspond to the Natura habitat type 7160 (mineral-rich springs and springfens). Only some areas have been classified as type 7210 (calcareous fens with *Cladium mariscus*; in Saaremaa) or as type 7230 (species-rich fens). At Vanakubja (Saaremaa), spring fen habitat is interchanged with coastal grassland (Natura habitat types 1630 and 6410).

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected spring fens resulted as follows: excellent conservation (A) – 103 areas (471 ha), good (B) – 91 areas (231 ha), average or reduced (C) – 22 areas (65 ha), degraded (D) – 2 areas (6 ha), unknown – 12 (12 ha). Thus 90% of all assessed spring fen habitats are of excellent or good quality. It is also true, however, that (former) spring fen areas of lower value have lost their indicative features and do not correspond to this site type any more. Presumably, visited areas with spoiled hydrological regime and, therefore, lower conservation status were not classified as site type 3.1.3.1 but as rather "ordinary" fens (3.1.1), transition mires (3.1.2.1) or – in case of higher and denser tree layer – spring fen forests (1.4.1.1.A).

According to Laasimer (1965), open and treed spring fens covered 1,500 hectares in the 1950s. This means that more than a third of former spring fens have been destroyed by man and/or were substituted to rapid allogenic succession during the last 60 years. A lot of spring fens have been damaged or destroyed due to drainage or amelioration works nearby; however, on Saaremaa Island the situation is much better than in the mainland. Sometimes natural conditions, but most usually the impact of amelioration have caused intensification of tree-growth and succession towards spring fen forests or, in the case of strong drainage, towards drained peatland forests. These threats are probably going to persist, some protected spring fens are still endangered by planned mining activities in their nearest vicinity (Tammiku spring fens by Nabala pits, Kassinurme spring fen by a local pit, etc.). Therefore the number and surface of habitats of this site type may continue to decrease in the future, especially outside the protected areas.

Global assessment (conservation importance) for the inspected open and treed spring fens resulted as follows: excellent value (A) – 60 areas (453 ha), good value (B) – 103 areas (250 ha), significant value (C) – 53 areas (61 ha), low or lacking value (D) – 4 areas (11 ha), unknown value – 10 areas (9 ha). Thus, the majority of extant Estonian spring fens still have relatively high conservation value.

Conservation. Of the mentioned 230 areas, 106 are situated totally or partly within national protected areas. Protected spring fens form 432 hectares or 55% of their total surface.

All protected spring fens were evaluated during the field inventory as follows: excellent conservation value (A) – 48 areas (338 ha), good value (B) – 37 areas (65 ha), significant value (C) – 12 areas (23 ha), low or lacking value (D) – 1 area (1.5 ha), unknown value – 8 (5 ha). In that way, the vast majority of our protected spring fens (93% by surface) are of high conservation value.

On the other hand, there are 78 spring fens (300 ha) of excellent or good value outside the protected areas. Therefore, it is inevitable to implement additional and sufficient protection measures, especially on Saaremaa Island (Sõrve, Käesla, Pidula, Kodara, etc.) and southern Sakala Upland (Karksi, Abja, etc.). Spring fens near Viljandi and Tõrva, in western Põlvamaa and in other localities also need a future analysis whether they should be added to the protected areas network. The situation is better in the northwestern quarter of Estonia where the majority of the valuable spring fens are already protected, but additional attention should be paid to spring fens on the eastern slopes of Pandivere Upland.

8.1.2 Mixotrophic mires

8.1.2.1 Mixotrophic grass mires (site type 3.1.2.1)

Mixotrophic grass mires are situated on plains or slightly declining areas on the margins of raised bogs or in depressions with poor runoff. Part of the plants will still get necessary nutrients from groundwater, but several other plant species are forming hummocks and for their roots the groundwater is already inaccessible due to the thick peat layer: these plant get nutrients mainly from precipitation. In this way, mixotrophic grass mires represent an intermediate succession stage between minerotrophic and ombrotrophic mires. Soils are Eutri-Dystric Histosols. For the bush layer *Salix rosmarinifolia*, *S. lapponum*, *S. myrtilloides* and *Betula humilis* are typical. For the field layer beside the specific mesotrophic mire species (*Trichophorum alpinum*, *Carex chordorrhiza*, *C. irrigua*, *C. pauciflora*, *Dryopteris cristata*) species of both eutrophic and oligotrophic mires are characteristic. In the moss layer together with species of minerotrophic mires *Sphagnum* spp. have a considerable percentage (>10% coverage).

Number and area. 1,601 areas on 33,904 hectares have been registered as mixotrophic grass mires. Of these areas, 1,292 (on 24,087 hectares) include only habitats of this site type, while in the marginal parts of other areas habitats of other site types are also represented (mainly mixotrophic quagmires, poor fens and/or mixotrophic bog forests). Additionally, 356 areas include mixotrophic quagmires as marginal habitats.

The overall surface of open and treed mixotrophic quagmires in Estonia may be estimated to ca 35,000 hectares. This is three and a half times more than the estimate of Ilomets et al. (2010), according to which open mixotrophic grass mires equal to only ca 10,000 hectares (Table 6, row 1.4.1). Although in this table treed mixotrophic grass mires are included within wooded transitional mires on the row 1.4.2 (8,000 ha), it is clear that the respective estimate of the surface of mixotrophic grass fens (as well as mixotrophic forests) is underestimated to a great extent.

Distribution. Mixotrophic grass mires are distributed unevenly all over Estonia (Fig. 16). Larger and more important areas are concentrated in western Estonia (district of West Estonian middle size and large mires) and easternmost Estonia (subdistricts a and c of the district of Central and Eastern Estonian large mires; after Allikvee, 1995).

In western Estonia, large mixotrophic grass mires are found mainly in Läänemaa. In the southern part of this district, they are situated in Tuhu and Lihula mire complexes; the eastern part of Tuhu mire complex (Oidrema mire) is the largest representative of this site type (1,174 ha). In the northern part, large mixotrophic grass mires are situated in Läänemaa Suursoo and Orkjärve mire complexes, but also in Leidissoo and Marimetsa mires.

In eastern Estonia, vast and relatively intact mixotrophic grass mires are located in the Emajõe Suursoo mire complex. Varnja, Surnusoo, Jõmmsoo, Pedaspää a.o. mires (larger units comprise 382–924 ha) are separated by the Emajõgi River and its tributaries. Some of these areas are in the succession stage between minerotrophic and mixotrophic mires.

The most important mixotrophic grass mires in Alutaguse (northeastern Estonia) are found in Muraka, Valgesoo and Agusalu mire complexes. There they are somewhat smaller than in the two previous regions (the largest being Matkasoo, 547 ha), but their number and density are remarkable. Most areas of this habitat type in Puhatu mire complex have been degraded due to the neighbouring oil-shale quarries and alkaline air pollution from power stations (see Chapter 5.4), but some are still in good state. Totally degraded are mixotrophic grass mires of Kõrgesoo mire complex.

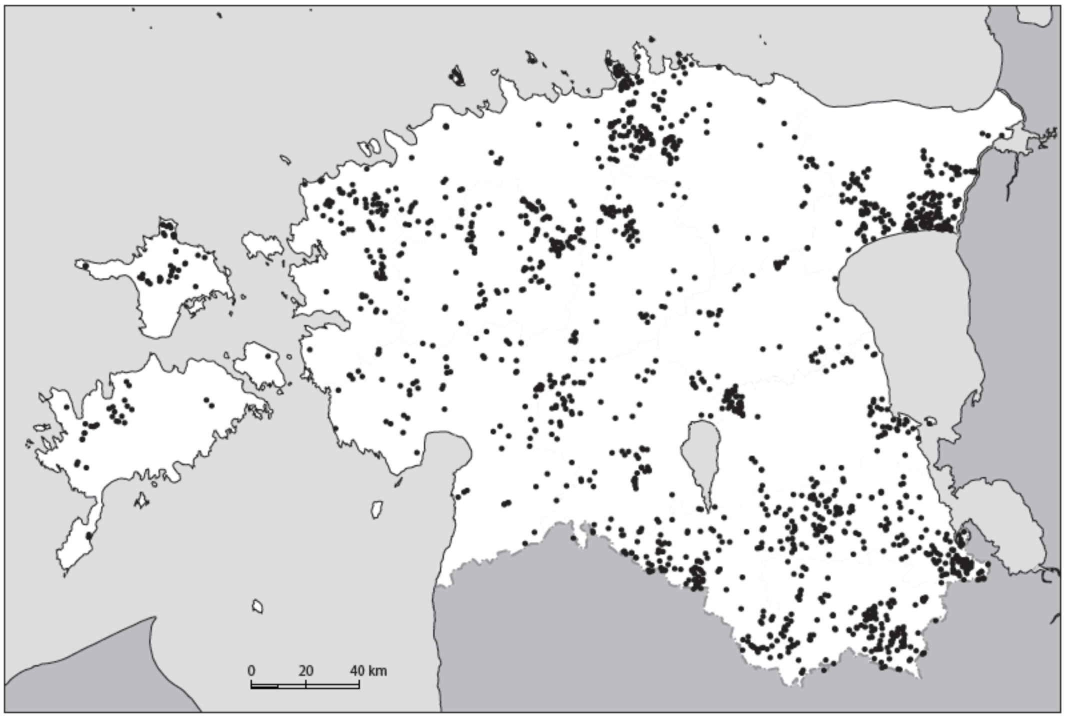

FIGURE 16. Distribution of mixotrophic grass mires in Estonia.

In Soomaa (southwestern Estonia), mixotrophic grass mires are mainly situated in Öördi and Valgeraba mire complexes as well as in the western part of Kuresoo mire complex. The western part of Öördi mire is the second largest habitat of this site type in Estonia (975 ha). Mixotrophic grass mires of the Alam-Pedja region (central Estonia) are smaller in size but numerous, relatively intact and forming part of an exceeding mire complex.

Parts of mid-western, central, northeastern and mid-eastern Estonia lack mixotrophic grass mires totally or contain only small ones. The number and density of that type of mires is low also in the western archipelago.

Division by Natura 2000 habitats. The vast majority of inspected mixotrophic grass mires (1,462 areas on 31,089 hectares) correspond to the Natura habitat type 7140 (transition mires and quaking bogs). 101 sites on 2,134 hectares classified as type 91D0 (bog woodlands), represent treed mixotrophic grass mires. Eight sites in coastal regions (13 ha) have been interpreted as belonging into habitat type 2190 (humid dune slacks). Only a few sites have been classified as type 7150 (depressions on peat substrates of the *Rhynchosporion*), type 7120 (degraded raised bogs) and others.

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected mixotrophic grass mires resulted as follows: excellent conservation (A) – 348 areas (13,493 ha), good (B) – 797 areas (14,421 ha), average or reduced (C) – 390 areas (4,903 ha), degraded (D) – 21 areas (408 ha), unknown – 45 (680 ha). Thus, 82% of all assessed mixotrophic grass mire habitats are of excellent or good quality.

According to Laasimer (1965), open mixotrophic grass mires covered 76,200 hectares in the 1950s, while treed mixotrophic grass mires and mixotrophic bog forests together formed 151,800 hectares. Even without the latter, and taking into consideration that at least part of the mixotrophic quagmires were also included within the mentioned 76,200 hectares, it is clear that the total surface of habitats of the considered site type has decreased more than twofold. Peat excavation has not been among the main reasons for this, as in the case of raised bogs. Habitat loss has largely been caused by overgrowing of these mires with pines and birches, i.e. replacement of open mixotrophic grass mires with mixotrophic bog forests (site type 1.4.2.1) or drained peatland forests (site type group 1.5.1). To some extent, this process has been caused by the present climate conditions in northern Europe, but mainly by the direct impact of drainage and/or nearby amelioration. Large-scale drainage took place especially between the 1950s and the 1980s, and only some regions (Emajõe Suursoo, Agusalu, western parts of Läänemaa Suursoo) escaped from that totally or at least largely. The majority of other mires are continuously suffering from ditches either bordering the habitat or crossing it. Therefore marginal parts of former mires have already become woodlands or forests, and often the boundary between open/treed mire and peatland forest gradually continues to move towards the centre of the mire. In that way, the absolute number of open and treed mixotrophic grass mires may also decrease in the future (succession towards site type 1.4.2.1).

Global assessment (conservation importance) of the inspected mixotrophic grass mires has been evaluated as follows: excellent value (A) – 66 areas (8,193 ha), good value (B) – 563 areas (18,829 ha), significant value (C) – 718 areas (5,050 ha), low or lacking value (D) – 249 areas (1,648 ha) and unknown value – 5 (184 ha). Thus, the majority of Estonian mixotrophic grass mires have high protection value.

Conservation. Of the mentioned 1,601 sites, 837 are situated totally or partly within national protected areas. Protected mixotrophic grass mires form 27,359 hectares (81% of the total surface).

All protected mixotrophic grass mires were evaluated during the field inventory as follows: excellent conservation value (A) – 61 areas (7,857 ha), good value (B) – 476 areas (17,114 ha), significant value (C) – 271 areas (2,050 ha), low or lacking value (D) – 26 areas (177 ha), unknown value – 3 (161 ha). In that way the majority of our protected mixotrophic grass mires (91% by surface) is of high conservation value.

There are 92 mixotrophic grass mires (2,052 ha) of excellent or good value outside the protected areas. Only three of them cover 125–170 hectares, the next five embrace 50–100 hectares whereas all others are smaller. The majority of those sites actually represent potential additions to the existing protected areas network (e.g. Läänemaa Suursoo) or form complexes with other valuable (mire) habitats (e.g. Kõrsa in southwestern Estonia). Only some separately located sites or site groups are proposed for protection. Most of these are situated in undrained or poorly drained parts of Alutaguse (northeastern Estonia), some in extreme southeastern Estonia and other sparsely elsewhere.

8.1.2.2 Mixotrophic quagmires (site type 3.1.2.2)

Mixotrophic quagmires like minerotrophic ones are formed as a result of terrestrialization of lakes and ponds but they occur also in the margins of bogs where bog water is infiltrating from bog slope. Groundwater is often on the surface or quite high below it. Soils are Eutri-Dystric Histosols. Field layer is species-poor, often monodominant. Common species are: *Carex lasiocarpa*, *C. diandra*, *C. limosa*, *Scheuchzeria palustris*, *Rhynchospora alba*, *Menyanthes trifoliata*. In moss layer *Sphagnum* spp. prevail, besides of them *Aulacomnium palustre* and *Scorpidium scorpidioides* are rather frequent.

Number and area. 349 areas on 3,657 hectares have been registered as mixotrophic quagmires. Of these areas, 274 (on 2,064 hectares) include only habitats of this site type, while others consist also of habitats of other site types (mainly mixotrophic grass mires and minerotrophic quagmires) in their marginal parts. Additionally, 145 areas include mixotrophic quagmires as marginal habitats.

The overall surface of mixotrophic quagmires in Estonia may be estimated to 3,500–4,000 hectares. This is remarkably more than the estimate of Ilomets et al. (2010), according to which all quagmires together equal to only ca 1,000 hectares (Table 6, row 1.3.1). Evidently, the latter figure is an underestimate.

Distribution. Mixotrophic quagmires are distributed unevenly in Estonia (Fig. 17), and they can be divided into three different subtypes:

(i) Larger quagmires at the edges of bog massifs and/or along mire streams. These quagmires have developed due to the paludification of former mineral land in certain hydrological conditions. They are distributed mainly in Alutaguse (northeastern Estonia) and intermediate Estonia, and are related to larger mire complexes like Puhatu, Muraka, Vonka Pususoo, Keava, Soosaare, Laeva Peenarsoo, Kuresoo, Öördi and Nigula. A few quagmires of that kind are situated elsewhere (e.g. Läänemaa Suursoo and Männiku mire in northwestern Estonia, Värska Kuresoo and Määsovitsa mire in southeastern Estonia).

(ii) Smaller quagmires at lake- and/or pool-sides, which have developed through succession from minerotrophic quagmires (former lakes and pools). Sites of this subtype are situated mainly in southeastern Estonia but also in Harjumaa (northwestern Estonia).

(iii) Secondary quagmires which have developed due to anthropogenic changes of hydrology. Such sites are situated in former pits of block-peat excavation, at some milled peat-fields, etc., and are of low or without conservation value.

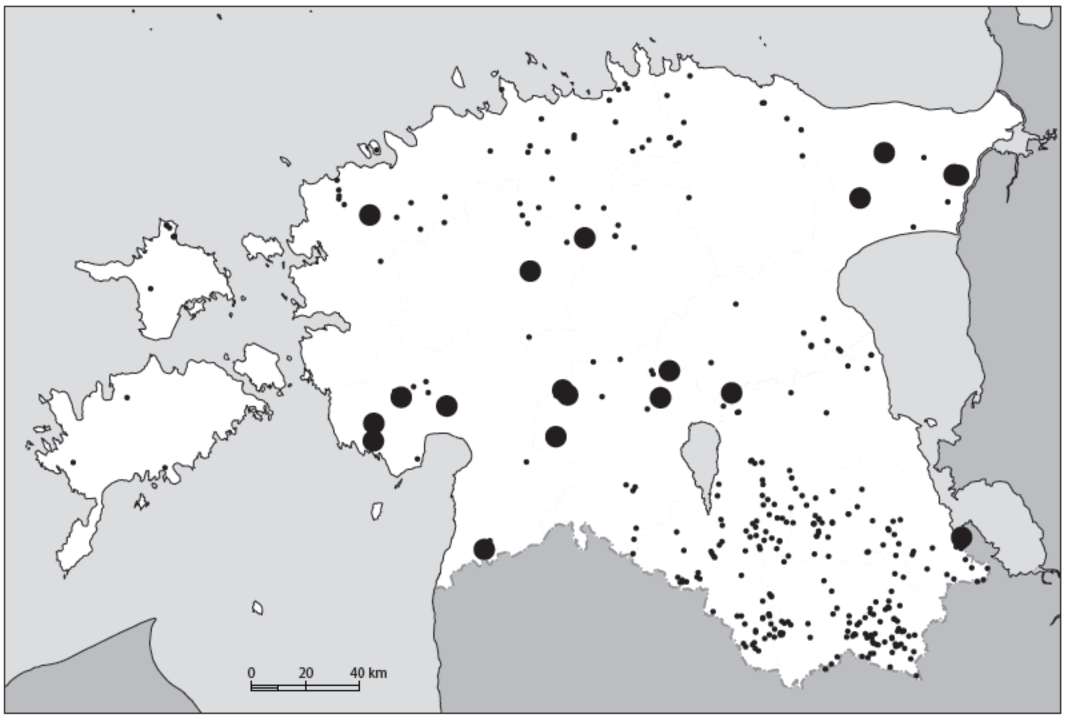

FIGURE 17. Distribution of mixotrophic quagmires in Estonia. Larger symbols mark areas over 50 hectares, smaller symbols areas less than 50 ha.

Mixotrophic quagmires are lacking in large areas of western, central and northeastern Estonia as well as on islands (except Saaremaa Island, where they are very rare).

Mixotrophic quagmires are quite different in surface. Most of the first subtype quagmires exceed 100 hectares, the largest is Vonka Pususoo (269 ha). Only some mires of this subtype hold between 15 and 100 hectares. Quagmires of the second subtype, on the contrary, are usually less than 10 hectares each (half of them even less than 1 ha), and a few of them between 10 and 100 hectares. Only two of the inspected mires of that subtype exceed 100 hectares – at Lake Parika (164 ha) and at Lake Ermistu (112 ha).

Division by Natura 2000 habitats. The vast majority of mixotrophic quagmires (342 areas on 3,624 hectares) correspond to the Natura habitat type 7140 (transition mires and quaking bogs). Only single areas have been classified as type 7150 (depressions on peat substrates of the *Rhynchosporion*), type 7210 (calcareous fens with *Cladium mariscus*; on Saaremaa Island) or type 91D0 (bog woodlands).

Status and future perspectives. Assessment of the conservation status (quality of habitat) of the inspected mixotrophic quagmires resulted as follows: excellent conservation (A) – 117 areas (2,637 ha), good (B) – 160 areas (689 ha), average or reduced (C) – 51 areas (291 ha), degraded (D) – 7 areas (2 ha), unknown – 14 (37 ha). Thus, 91% of all assessed mixotrophic quagmire habitats are of excellent or good quality.

According to Laasimer (1965), quagmires covered 1,300 hectares in the 1950s. The present surface of mixotrophic quagmires alone exceeds this number threefold. This contradiction can partly be explained with the fact that interpretation of mixotrophic/transition mires was developed in the 1940-1950s and therefore transition mires on up to 40% of the Estonian territory, mapped in the 1930s, were qualified under other site types. It is evident that L.-M. Laasimer considered mixotrophic quagmires of the first subgroup among mixotrophic grass mires (partly among hollow bogs) (Laasimer, 1965: 201). Additionally, part of the quagmires of the second subgroup might have been considered as floodplain fens (the surface of which is according to her surprisingly high, see Chapter 8.1.1.4). However, Laasimer (1965) clearly refers to differences in geomorphology and in character of floods between riverside and lakeside floodplains (and, *inter alia*, in the Natura-context we cannot speak about floodplains outside river valleys at all).

On the other hand, the total area of mixotrophic quagmires has increased due to infilling of lakes and pools, especially if they have been influenced by nitrogen pollution or drainage. Many areas of the second subtype owe their enlargened surface or even existence to the artificial lowering of lakes water level (e.g. Parika, Ermistu, Tõhela, Hindaste, Limu and numerous smaller areas).

Though agricultural pollution has noticeably decreased during the two last decades and the water level of lakes is rather restored than lowered, it is evident that the former anthropogenic influence has often caused irreversible changes in many habitats including quagmires. As succession from both natural and secondary minerotrophic quagmires towards bogs will continue, it is foreseen that the number and surface of mixotrophic quagmires will also increase in the future.

Global assessment for the inspected mixotrophic quagmires had been evaluated as follows: excellent value (A) – 35 areas (2,294 ha), good value (B) – 157 areas (928 ha), significant value (C) – 127 areas (309 ha), low or lacking value (D) – 27 areas (123 ha), unknown value – 3 (2 ha). In that way, the majority of Estonian mixotrophic quagmires still have high conservation value.

Conservation. Of the mentioned 349 areas, 168 are situated totally or partly within national protected areas. Protected mixotrophic quagmires form 2,792 hectares or 76% of the total surface.

All protected mixotrophic quagmires were evaluated during the field inventory as follows: excellent protection value (A) – 31 areas (2216 ha), good value (B) – 109 areas (553 ha), significant value (C) – 25 areas (22 ha), low or lacking value (D) – 1 area (0.5 ha), unknown value – 2 (1 ha). Thus, the vast majority of our protected mixotrophic quagmires (99% by surface) are of high conservation value, including all main large representatives of the first subtype.

There are 56 mixotrophic quagmires (453 ha) of excellent or good value outside the protected areas. Most of them are situated in southeastern Estonia, partly also in north-central Estonia and sparsely elsewhere. Part of these areas is of local importance, but some have clearly wider relevance (e.g. Värska Kuresoo and Määsovitsa mire together with other mires nearby in southeastern Estonia, southern part of Anija quagmire in northern Estonia, etc.). A further analysis is needed to decide which valuable unprotected mixotrophic quagmires should be added to the protected areas network. In many cases, it depends on thr abundance and quality of neighbouring habitats forming sometimes valuable habitat complexes.

8.1.3 Ombrotrophic mires

8.1.3.1 Heath moors (site type 3.2.1.1)

Heath moors are located on concave or flat sandy areas. They are formed as a consequence of repeated burning of heath forests causing perishing of trees, decrease of evaporation and forming a compact ortstein horizon inhibiting the water infiltration in soil (Masing, 1960; Valk, 1988b). In that way the development of heath moors has not started from the stage of minerotrophic fens but directly from bog-like communities (Valk, 1988a). The peat layer thickness is usually less than 0.5 m and it is laying on ortstein horizon. The tree layer is sparse and stunted, in bush layer some *Salix cinerea* or *S. starkeana* can grow. In field layer *Calluna vulgaris*, *Vaccinium uliginosum*, *Ledum palustre*, *Andromeda polifolia* and other dwarf-bushes dominate. In moss layer besides *Sphagnu*m spp., *Polytrichum commune* and/or *P. strictum* can grow rather abundantly.

Number and area. 85 areas on 1,165 hectares have been registered as heath moors. Of these, 76 areas (on 980 hectares) include only heath moors, while others also consist of habitats of other types in their marginal parts (mainly raised bogs and peatland forests). Additionally, 17 areas include heath moors as marginal habitats. The actual surface of heath moors may be somewhat larger than the presented figure, since it seems that some registrators did not recognize all heath moors and thus some localities of this site type may be listed under "common" hummock bogs (site type 3.2.2.1).

All in all, there are more than 1,200 hectares of open and treed heath moors in Estonia. This coincides sufficiently with the estimate of Ilomets et al. (2010), according to which heath moors and moor forests together equal to ca 1,500 hectares (Table 6).

Distribution. Heath moors are distributed locally and patchily in Estonia (Fig. 18). 62% of all registered habitats (52 areas, 719 ha) are situated either on Hiiumaa Island or in the northwestern part of the mainland. The number of heath moors on Saaremaa Island is notably low. Some small habitats of this site type can be found in central Estonia (between Tori and Jõgeva) and single sites randomly elsewhere. Large parts in western, southern and northeastern Estonia have no heath moors.

Compared with raised bogs, heath moors are small in area. Only two areas (Klooga in northern and Tapiku in central Estonia) exceed 100 hectares, the former being the largest (122 ha). The four next areas hold between 60 and 90 hectares and the next 19 between 10 and 50 ha. Thus, the majority of Estonian moors are tiny to small.

Division by Natura 2000 habitats. Most of our heath moors (49 areas on 715 hectares) correspond to the Natura habitat type 7110 (active raised bogs) and 33 areas (413 hectares) to the habitat type 91D0 (bog woodlands). This characterizes the proportion of relatively open heath moors and treed (wooded) moors.

Compared with raised bogs, heath moors are small in area. Only two areas (Klooga in northern and Tapiku in central Estonia) exceed 100 hectares, the former being the largest (122 ha). The four next areas hold between 60 and 90 hectares and the next 19 between 10 and 50 ha. Thus, the majority of Estonian moors are tiny to small.

Division by Natura 2000 habitats. Most of our heath moors (49 areas on 715 hectares) correspond to the Natura habitat type 7110 (active raised bogs) and 33 areas (413 hectares) to the habitat type 91D0 (bog woodlands). This characterizes the proportion of relatively open heath moors and treed (wooded) moors.

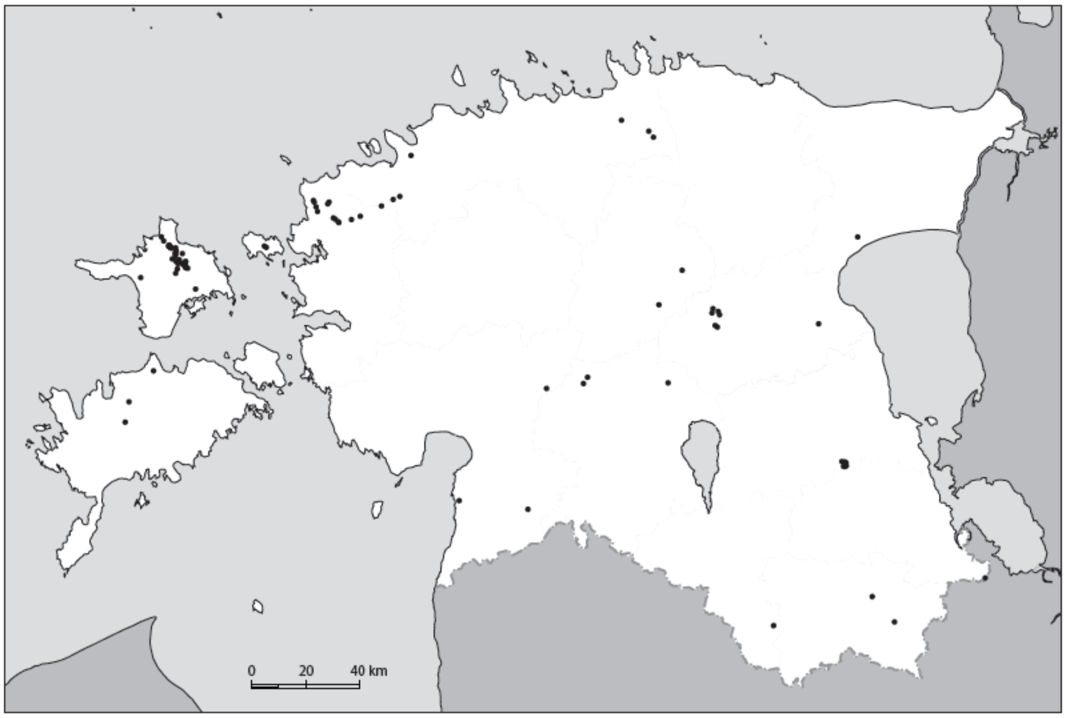

FIGURE 18. Distribution of heath moors in Estonia.

Status and future perspectives. Assessment of conservation status (quality of habitat) of the inspected heath moors resulted as follows: excellent conservation (A) – 14 areas (283 ha), good (B) – 60 areas (825 ha), average or reduced (C) – 8 areas (21 ha), degraded (D) – 2 areas (34 ha), unknown – 1 area (2 ha). In that way, 95% of all assessed heath moor habitats are of excellent or good quality. Presumably, visited sites with denser layer of young pines and, therefore, of lower quality were not classified as site type 3.2.1.1 at all but rather as peatland forests (1.4.3.1).

The largest Estonian heath moor at Klooga has survived without tree layer due to fires which now and then took place on the military training area where the habitat is situated. Now that further burning is not continuing there, the moor has rapidly been covered with young pines and birches and is losing the value of its habitat structure.

According to Laasimer (1965) open and treed heath moors covered 3,000 hectares in the 1950s. This means that at least 1,500 hectares of moors have been destroyed by man or followed rapid allogenic succession during the last 60 years. As this habitat is not attractive for economic use (peat layer is thin and vegetation is not suitable for grazing) we may suppose that the majority of the "lost" moors have been covered with dense tree layer, and correspond to peatland forests nowadays. Direct afforestation by man has been rather exceptional, but intensification of tree-growth has been mainly caused by direct or indirect drainage. Such impact will presumably continue and, therefore, the total number and surface of habitats of this site type may somewhat decrease in the future (succession towards the site type 1.4.3.1).

Global assessment (conservation importance) for the inventoried open and treed heath moors was evaluated as follows: excellent value (A) – 3 areas (234 ha), good value (B) – 215 areas (364 ha), significant value (C) – 56 areas (520 ha), low or lacking value (D) – 5 areas (47 ha). It means that the majority of existing Estonian heath moors still have relatively good protection value.

Conservation. Of the mentioned 85 areas, 29 are situated totally or partly within the national protected areas. Protected heath moors form 487 hectares or 42% of the total surface.

All protected moors were evaluated during the field inventory as follows: excellent protection value (A) – 2 areas (112 ha), good value (B) – 15 areas (340 ha), significant value (C) – 11 areas (35 ha), low or lacking value (D) – 1 area (0.3 ha). Thus, the majority of our protected bogs (93% by surface) are of high conservation value.

On the other hand, there are seven heath moors (146 ha) of excellent or good value outside the protected areas. The above-mentioned Klooga heath moor (Harjumaa; 122 ha) should be added to the protected areas network, the necessary protection regime does not contradict much with the needs and practice of the Ministry of Defence. Põhjaka heath moor (central Estonia, 10 ha) is also included in the Natura 2000 shadow list together with its neighbouring bogs and peatland forests. Unprotected valuable heath moors on Hiiumaa Island are situated in the vicinity of the similar protected ones, and may, therefore, be paid less attention on.

8.1.3.2 Treeless and treed ombrotrophic raised bogs (site type group 3.2.2)

Bogs represent the last development stage of mires. Here the peat layer is already so thick that the plant roots do not reach groundwater and they get all nutrients only from precipitation (ombrotrophy). Soils are Dystric Histosols. A well-developed dwarf-bush layer is typical. This constitutes species such as *Ledum palustre*, *Calluna vulgaris*, *Chamaedaphne calyculata*, *Oxycoccus palustris*, *Empetrum nigrum*, *Andromeda polifolia*; together with them grow *Trichophorum alpinum*, *Eriophorum vaginatum*, *Rubus chamaemorus*, *Drosera rotundifolia*; in bog hollows *Scheuchzeria palustris*, *Rhynchospora alba*, *Carex limosa*, *Drosera anglica*. In the moss layer *Sphagnum* spp. are predominant but typical are also *Polytrichum strictum*, *Aulacomnium palustre*, on hummocks *Pleurozium schreberi*, *Dicranum bergeri*, *Cladina stygia*, *C. rangiferina*, *Cladonia uncialis*, *C. crispata*.

Number and area. By the inventory, 1,364 mire massifs on 151,729 hectares have been registered as bogs. Of these mires, 1,107 (on 133,191 hectares) represent exclusively bogs, while on marginal parts of the remaining massifs habitats of other types are also presented (bog forests, laggs, etc.). At the same time, additional 237 areas include bogs as marginal habitats.

All in all, we can speak of at least 152,000 hectares of bogs in Estonia. This coincides pretty well with the estimate of Ilomets et al. (2010) according to which open and treed bogs equal to ca 158,000 hectares (Table 6, rows 2.2.1 and 2.2.2).

Distribution. Bogs are distributed all over Estonia but not evenly. Larger and more important bogs (Fig. 19) are concentrated in intermediate Estonia (districts of South-West Estonian large bogs, Central Estonian small bogs, upper North Estonian large mosaic mires) and easternmost Estonia (district of Central and Eastern Estonian large mires; see Fig. 9).

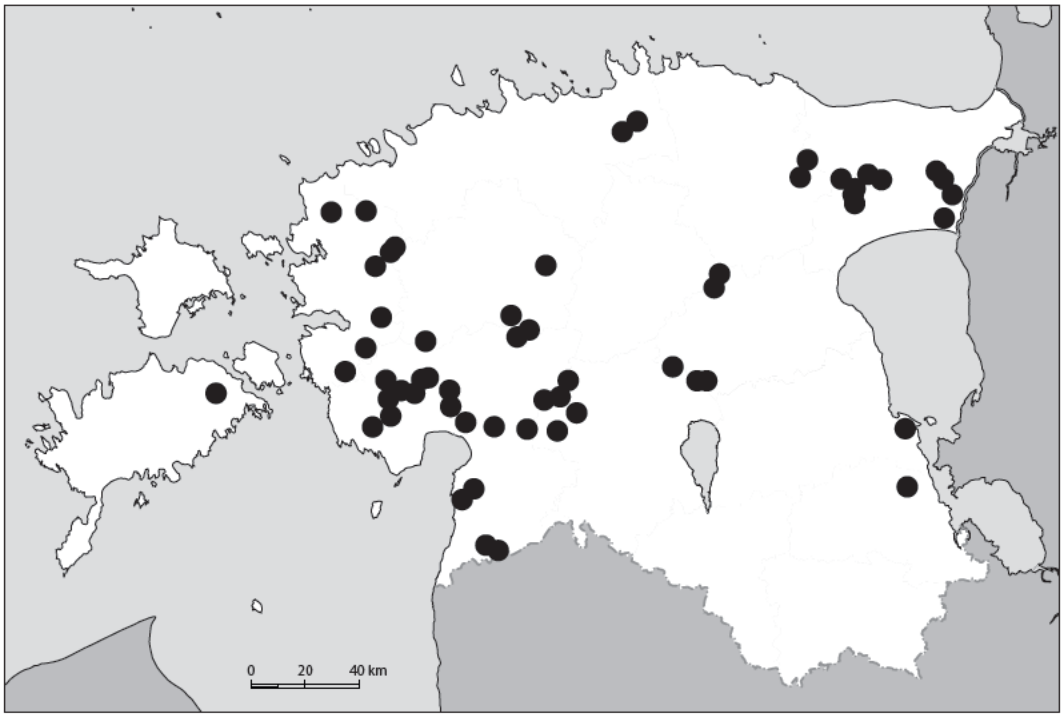

FIGURE 19. Distribution of large raised bogs in Estonia.

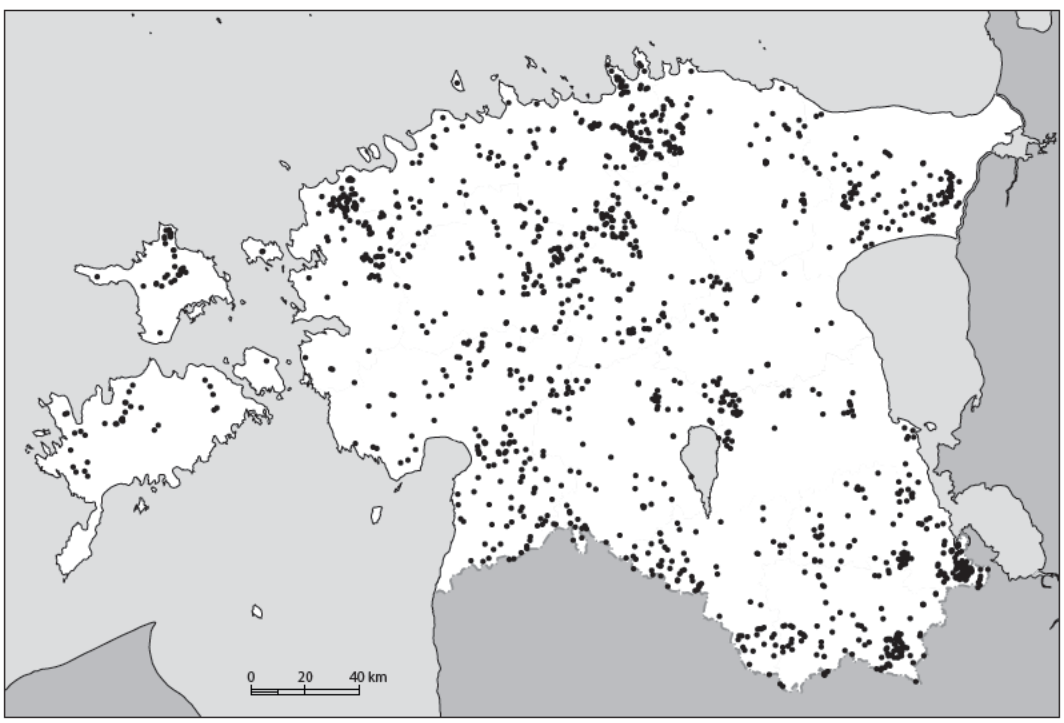

FIGURE 20. Distribution of small raised bogs in Estonia.

The usual knowledge in Estonia is that large bogs reach up to 8,000 or even 10,000 hectares. However, these numbers have been calculated on the basis of mire complexes (bogs together with transition mires, mire forests, etc.). The largest separate bog areas in the database are Võlla (5,610 ha), western and central part of Kuresoo mire complex (5,126 ha), Elbu/Nurme bog (4,544 ha), Kõima bog (3,710 ha) and Kikepera bog (3,351 ha), all situated in Pärnumaa, southwestern Estonia. Actually they are all bog complexes consisting of several massifs. All other bogs in Pärnumaa or elsewhere in Estonia comprise less than 3,000 hectares. In southwestern Estonia there are also situated Nigula bog (1,811 ha) which is perhaps internationally the best-known ombrotrophic mire in Estonia, as well as ornithologically very valuable Lihula (2,980 ha), Laisma (2,185 ha) and Kõrsa (1,485 ha) bogs, and many others.

Another well-known region of large bogs is Alutaguse (northeastern Estonia), but there bog massifs are densely intervened and separated by transition mires and, therefore, their areas are not comparable with bogs in Pärnumaa. The most important bogs *resp*. bog systems of Alutaguse are Muraka, Puhatu and Sirtsi.

A number of larger and medium-sized bogs can be seen in the northern part of intermediate Estonia. Bogs are typical of Lahemaa (e.g. Laukasoo, Hara, Aabla bogs), Kõrvemaa (e.g. Kõnnu Suursoo, Koitjärve, Kakerdaja, Roosna-Alliku) as well as Kõnnumaa (e.g. Loosalu, Keava, Taarikõnnu, Mõrdama) sub-regions.

Relatively large bogs are situated in northwestern Estonia. Marimetsa and Õmma (Tõlva) mire complexes consist mainly of bogs while mixotrophic and minerotrophic mires form an important part of Leidissoo and Läänemaa Suursoo mire complexes.

Parts of Central Estonia lack bogs totally, others contain small ones (Fig. 20). Larger bogs are concentrated in the Endla and Alam-Pedja mire systems. Quite similar is the situation in eastern and southern Estonia. Larger bogs are distributed there only in the easternmost part of the country (Määrästü, Meenikunnu and Tedremäe mire systems), at the Latvian border (Luhasoo) and in southeastern Mulgimaa (Rubina, Lagesoo). In the western archipelago larger bogs are found only in Saaremaa (Koigi, Pelisoo) and Hiiumaa (Pihla, Määvli) islands.

Subtypes and division by Natura 2000 habitats. It was not a task of the present inventory to calculate the exact surfaces of all bog subtypes (see Chapter 4.1.3.2). We can generalize that bogs of hollow-ridge subtype dominate in 148 areas (32,191 hectares) and bogs of pool-ridge subtype in 65 areas (26,120 hectares); other bogs belong exclusively or mainly to the hummock bog subtype. Moreover, there are tens of areas where pool-ridge or hollow-ridge subtypes dominate but large parts of those massifs are covered by hummock bog. On the other hand, bogs of both hollow-ridge and pool-ridge subtypes can be found as marginal habitats at many bog massifs where typical hummock bog subtype dominates. Therefore, the presented figures should not be taken as absolute numbers for hollow-ridge and pool-ridge bog subtypes, respectively.

The majority of Estonian bogs (1,017 areas on 137,772 hectares) correspond to the Natura habitat type 7110 (active raised bogs) and only 163 areas (7484 hectares) to the type 7120 (degraded raised bogs still capable of natural regeneration). This can be explained by the fact that damaged bogs or degraded parts of bogs are in Estonian conditions rapidly being covered by trees and are usually interpreted as degraded peatland forests (site type 91D0) or left without Natura habitat code at all. Therefore, part of 152 areas (4,357 ha) classified as Natura habitat type 91D0 (bog woodlands) may represent such transformed bogs, while others refer to the natural process of covering open bogs by pines. The most representative hollow areas (carpets, mudbottoms) with *Rhynchospora alba* are classified as type 7150 (depressions on peat substrates of the *Rhynchosporion*) (3 areas on 453 ha).

Status and future perspectives. Laasimer (1965) has estimated that in the 1950s open and treed bogs covered 250,000 hectares. According to that almost 100,000 hectares of bogs have been destroyed by man or followed rapid succession during the last 60 years. Indeed, ca 30,000 hectares of former bogs are under existing or abandoned industrial peat-fields (E. Niitlaan, pers. comm.; Ramst & Orru, 2009). Local excavation of block-peat took place all over Estonia and due to that, some thousands of hectares of former bogs may have been turned into drained peatland forests and other secondary habitats; however, this type of peat extraction took place mainly before the 1950s and only locally after that. Transformation of former open and/or treed bog habitats into peatland forests is evident, mainly due to amelioration in and/or near drained bogs, but it is dubious that block-peat excavation and amelioration together have caused disappearance of 60,000–70,000 hectares of bogs during half a century. It seems that part of the 250,000 hectares in the 1950s might actually have been peatland forests and/or other mire habitats (e.g. mixotrophic mires, see Chapter 8.1.2.2). Still, loss of some 50,000 hectares of Estonian bogs is indisputable.

Assessment of conservation status (quality of habitat) of the inspected raised bogs resulted as follows: excellent conservation (A) – 338 areas (79,994 ha), good (B) – 639 areas (45,466 ha), average or reduced (C) – 316 areas (19,008 ha), degraded (D) – 27 areas (994 ha), unknown – 44 areas (6,267 ha). Thus, 83% of the extant raised bog habitats are of excellent or good quality. However, 31 areas on ca 1,000 hectares were classified as "drained bogs" which merely correspond to the criteria of the raised bog site type and already represent or will turn into peatland forests or other habitat types in the near future. The same can be expected concerning the marginal parts of a number of large- or medium-sized bogs where boundary between open/treed bog and peatland forest gradually moves towards the centre of the peatland and the surface of the open bog decreases. On the other hand, central parts of many bogs are still untouched by direct drainage and not affected by indirect amelioration outside peatlands either. But all our bogs are subject to slow overgrowing with pines (Leivits & Leivits, 2009) – a result of complex impact of climate change, drainage, fires and increasing availability of nitrogen (Linderholm et al., 2002; Gunnarsson et al., 2002; Pellerin & Lavoie, 2003). In that way, the absolute number of habitats of this site type may somewhat decrease in the future due to succession towards the site type 1.4.3.1. – ombrotrophic bog forests.

In northeastern Estonia, some bogs (Mahu Murakasoo, Kõrgesoo, parts of Puhatu bog system) in the vicinity of large oil-shale based power stations and a cement factory have totally degraded and only minor parts of those can still be treated as bogs. Thanks to modern filters and cleaning facilities, pollution will not be an important factor of destroying bog habitats in the future, but bogs already degraded are recovering slowly and in some cases it is dubious whether they will ever be capable of natural regeneration into bogs (Karofeld, 1995, 1996; Karofeld et al., 2007, 2008; Paal et al., 2009).

The global assessment (conservation importance) for the 151,729 hectares of open and treed bogs has been evaluated during the field inventory as follows: excellent value (A) – 85 areas (42,987 ha), good value (B) – 475 areas (72,460 ha), significant value (C) – 581 areas (24,727 ha), low or lacking value (D) – 204 areas (6,592 ha), unknown value – 19 (4,963 ha). This means that the majority of extant Estonian bogs have still excellent or good protection value.

Conservation. Of the mentioned 1,364 areas, 702 are situated exclusively or mainly and 58 partly within national protected areas. Protected bogs and protected parts of bogs sum up to 115,453 hectares or 76% of the total surface.

All protected bogs were evaluated during the field inventory as follows: excellent protection value (A) – 82 areas (41,227 ha), good value (B) – 394 areas (62,630 ha), significant value (C) – 244 areas (6,637 ha), low or lacking value (D) – 31 areas (472 ha), unknown value – 9 (4,488 ha). Thus, the majority of our protected bogs (90% by surface) have high conservation value.

There are 84 bogs (11,590 ha) of excellent or good value outside the protected areas. The above-mentioned Kõrsa bog (Pärnumaa, 1,485 ha) and the northern part of Larvi bog (Harjumaa; 22 ha) are the best example of bogs, which should be added to the protected areas network as soon as possible. Other sites which should be protected are some small bogs in southern Pärnumaa, central Estonia (e.g. Jalametsa bog, 197 ha), southeastern Estonia and elsewhere. In some cases, central parts of bogs are within protected areas but their marginal parts are excluded. In that way, the number of bogs in need of protection as a whole is much lower than the above-mentioned 84.

8.2 Assessment of Natura 2000 mire habitats in Estonia

8.2.1 Active raised bogs (habitat type 7110)

The results of the inventory demonstrate that there are 1,070 bogs in Estonia, with the total surface of 138,731 ha, which correspond to the Natura 2000 habitat type 7110 (active raised bogs) (Fig. 21). In addition to these, 84 areas include active bogs as marginal habitats.

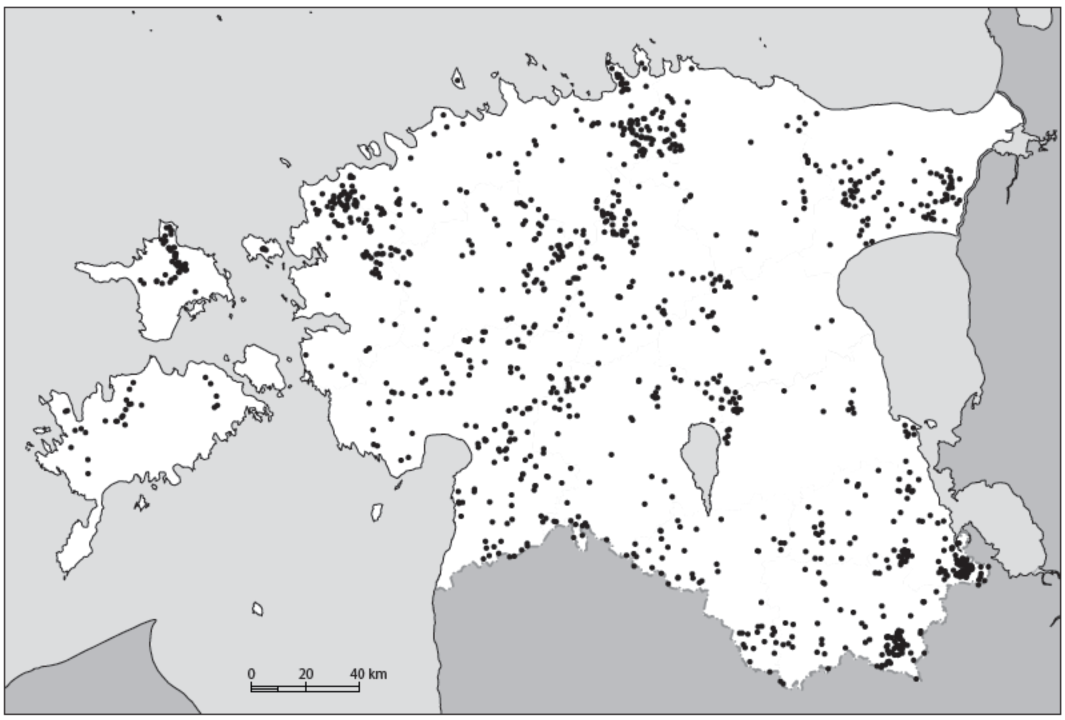

FIGURE 21. Distribution of active raised bogs in Estonia.

This calculation should be exhaustive since all areas with habitats of that Natura type are mires and, therefore, included in the inventory. The actual total surface of active raised bogs may even be smaller, since (i) if most of a bog massif was classified as belonging into habitat type 7110 and a minor part as, e.g. habitat type 7120, in data processing the whole area was considered as presenting type 7110, (ii) a lot of objects inventoried before 2007 were digitalized on the basis of boundaries on maps, without specifying them according to orthophotos, and, therefore, they may include marginal laggs, some peatland forests, etc. which actually should be excluded from the total area of habitats of type 7110.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of active raised bogs in Estonia at 158,000 hectares[65]. This figure correlates with the estimate for all open and treed bogs (habitat type group 3.2.2 according to

65 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

the Estonian habitats classification) but not all of them correspond to the Natura type 7110 (see Chapter 8.1.5). Both natural conditions during the last century and especially drainage have favoured succession of bog habitats from the type 7110 towards the type 91D0 (bog woodland) in Estonia, and peatlands on those 20,000 "lacking" hectares should be – at least partly – classified as type 91D0.

99.3% (1018 areas, 137,846 hectares) of active bogs (type 7110) correspond to the Estonian habitats classification site type group 3.2.2 (treeless and treed ombrotrophic raised bogs), the minority to the site type 3.2.1.1 (heath moors; 49 sites, 715 ha) and a few to other site types.

According to global assessments used in Natura 2000 data forms, the protection value of Estonian active bogs was estimated during the field inventory as follows: excellent value (A) – 85 areas (42,768 ha), good (B) – 461 areas (71,190 ha), significant (C) – 456 areas (19,599 ha), low or lacking (D) – 62 areas (1,475 ha), unknown – 6 (3,699 ha). The relatively low number of areas with low or lacking protection value is explained by the fact that bogs affected by direct drainage have soon been covered by trees and rather correspond to habitat types 7120 or 91D0 if to the criteria of any Natura habitat type at all.

568 active bogs were totally or partly situated within the Sites of Community Importance (SCI); the total surface of active bogs within SCIs is 108,144 hectares. Global assessment of all these protected bogs resulted as follows: excellent value (A) – 80 areas (40,865 ha), good value (B) – 350 areas (59,954 ha), significant value (C) – 130 areas (3,630 ha), low or lacking value (D) – 3 areas (86 ha) and unknown value – 5 (3,610 ha). Thus, the majority of active bogs within SCIs in Estonia (93% by surface) have high conservation value.

80% of Estonian active bogs (by surface) are included within SCIs, and their representation might be regarded sufficient. Nevertheless, of 116 active bogs (13,139 ha) of excellent or good value outside the SCIs, at least two are in an urgent need to be added to the Natura 2000 network: Kõrsa bog (Pärnumaa; 1,485 ha) and the northern part of Larvi bog (Harjumaa; 22 ha) (see Chapter 8.1.5).

8.2.2 Degraded raised bogs still capable of natural regeneration (habitat type 7120)

According to the results of the inventory there are 176 bogs in Estonia, with the total surface of 7,753 ha, which can be qualified as Natura habitat type 7120 (degraded raised bogs still capable of natural regeneration) (Fig. 22). Additionally, there are numerous degraded marginal parts of at least 66 unspoiled bogs, but in calculations and data processing they are considered as minority habitats under the type 7110 (active raised bogs). Still, the calculation of the total surface of the Natura habitat type 7120 should be more or less exhaustive since all areas of this habitat type are covered by mire vegetation and included, therefore, in the inventory. In practice, some totally degraded mire areas were not marked as subjects to visit if their low quality was evident already from orthophotos or from other sources; these areas might also include some habitats qualifying as type 7120. All in all, it could be estimated that the area of habitats of this type is some 10,000 hectares in Estonia.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of degraded bogs in Estonia at 56,500 hectares[66]. This seems to be highly overestimated. In the present Estonian conditions, degraded raised bogs tend to be covered by higher pines especially if *Sphagnum* layer becomes decomposed, and do not correspond to the type 7120 any more. They could rather be interpreted as type 91D0 of poor quality and many of them, after intensive decomposition of upper peat layer do not correspond to any Natura habitat type at all. The majority of abandoned peat-fields

66 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

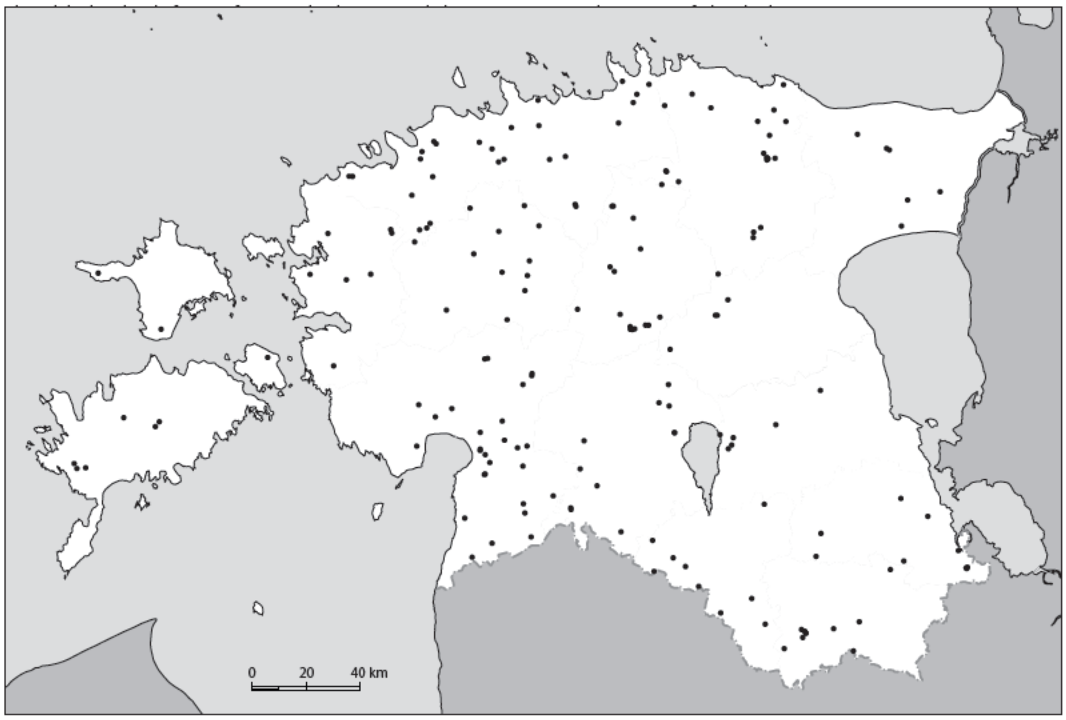

FIGURE 22. Distribution of degraded bogs in Estonia.

97% (164 areas, 7,517 hectares) of degraded bogs correspond to the Estonian classification site type group 3.2.2 (treeless and treed ombrotrophic raised bogs), the few others to drained and decomposed peatland forests (site type group 1.5.1), abandoned peat-fields, etc.

According to global assessments used in Natura 2000 data forms, the protection value of the Estonian degraded bogs was assessed during the field inventory as follows: excellent (A) – 0 areas, good (B) – 8 areas (230 ha), significant (C) – 67 areas (3,249 ha) and low or lacking value (D) – 101 areas (4,274 ha). The low number of areas with high protection value proceeds from the definition of this type. Higher protection value evidently indicates efficient recovery of natural bog plant communities on these areas.

40 degraded bogs were totally or partly situated within the Sites of Community Importance, with the total surface of 1,012 hectares. Global assessment of these bogs was evaluated during the field inventory as follows: excellent value (A) – 0 areas, good (B) – 6 areas (197 ha), significant (C) – 30 areas (800 ha) and low or lacking value (D) – 4 areas (14 ha). None of Estonian SCIs have been proposed for this habitat type but smaller areas covered by type 7120 habitats just happen to be found between valuable habitats for which a SCI has been proposed.

Two degraded bogs (total area 33 ha) of good conservation importance are situated outside the SCIs, and both of them may be left there also in the future. The Estonian priority has been and should be adequate preservation of active bogs of the habitat type 7110.

8.2.3 Transition mires and quaking bogs (habitat type 7140)

The results of the inventory prove that there are 2,109 areas in Estonia, with the total surface of 37,683 ha, which correspond to the Natura habitat type 7140 (transition mires and quaking bogs) (Fig. 23). In addition to these, 356 areas include transition mires or quaking bogs as marginal habitats.

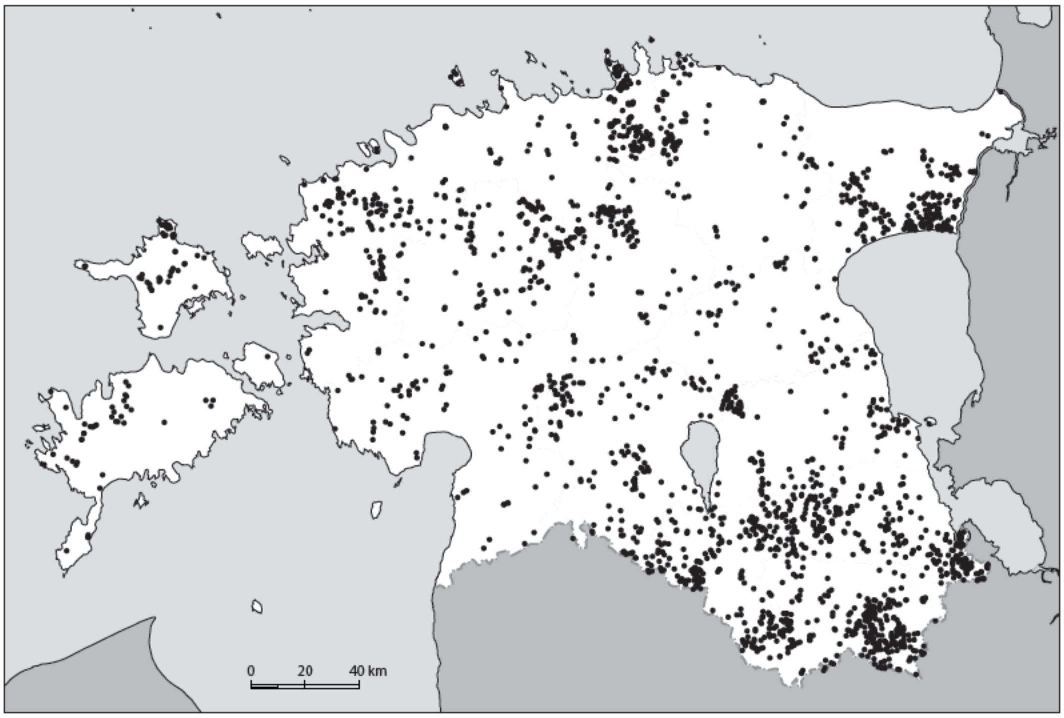

FIGURE 23. Distribution of transition mires and quaking bogs in Estonia.

This calculation should be exhaustive since all areas with habitats of that Natura type are mires and, therefore, included in the inventory. However, the actual total surface of transition mires may be slightly larger, since (i) if a larger part of an inspected mire was classified as belonging into habitat type 7110 (active raised bogs) and its narrow marginal lagg as habitat type 7140, in data processing all surface of that mire was considered as presenting only type 7110, i.e. the lagg were not summed up separately as type 7140, (ii) a lot of objects inspected before 2007 were digitalized on the basis of boundaries on maps, without specifying by orthophotos, and therefore areas classified as active raised bogs may include sections of transition mires which actually should be excluded from the total area of type 7110 and added to type 7140.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of transition mires and quaking bogs in Estonia at 18,000 hectares[67]. This figure correlates with the estimate of Ilomets et al. (2010) for all transition mires and mixotrophic forests (Estonian habitat classification type 1.4.2.1 and type group 3.1.2) which is an obvious underestimate (see Chapter 8.1.2.2). Evidently this mistake origins already from the mid-20th century: interpretation of mixotrophic/

67 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

transition mires was developed in the 1940–1950s and therefore transition mires on up to 40% of the Estonian territory, mapped in the 1930s, were qualified under other site types (Laasimer, 1965).

82.5% (1,462 areas, 31,089 hectares) of transition mires and quaking bogs correspond to the Estonian habitats classification site type 3.1.2.1 (mixotrophic grass mires), 9.6% (342 areas, 3,624 hectares) to the site type 3.1.2.2 (mixotrophic quagmires), 4.0% (264 areas, 1,497 hectares) to the site type 3.1.1.3 (minerotrophic quagmires) and the rest to other site types.

According to global assessments used in Natura 2000 data forms, the protection value of Estonian transition mires and quaking bogs was evaluated during the field inventory as follows: excellent (A) – 117 areas (11,802 ha), good (B) – 788 areas (19,432 ha), significant (C) – 929 areas (5,053 ha), low or lacking (D) – 254 areas (898 ha) and unknown value – 21 (497 ha). The relatively low number of areas with low or lacking protection value is explained by the fact that transition mires affected by direct drainage will soon be covered by trees and rather correspond to habitat type 91D0 or to any Natura habitat type at all.

981 transition mires and quaking bogs were totally or partly situated within the Sites of Community Importance, with the total surface within the SCIs 30,118 hectares. Global assessment value of all these protected mires was resulted as follows: excellent value (A) – 107 areas (11,327 ha), good value (B) – 590 areas (16,825 ha), significant value (C) – 249 areas (1,379 ha), low or lacking value (D) – 20 areas (158 ha) and unknown value – 15 (429 ha). Thus, the majority of transition mires and quaking bogs within SCIs in Estonia (93% by surface) have high conservation value.

According to these calculations, 80% of the Estonian transition mires and quaking bogs (by surface) are included within the SCIs, and their representation might be regarded as sufficient. Nevertheless, 208 transition mires and quaking bogs (3,082 ha) of excellent or good value are situated outside the SCIs. Part of these areas are of national or local importance, but few undrained or poorly drained areas especially in eastern Estonia have already been or will be included in the shadow list of potential SCIs. Additionally, boundaries of some existing sites should be corrected.

8.2.4 Depressions on peat substrates of the *Rhynchosporion* (habitat type 7150)

According to the results of the inventory there are only seven areas in Estonia, with the total surface of 473 ha, which correspond predominantly to the Natura habitat type 7150 (depressions on peat substrates of the *Rhynchosporion*) (Fig. 24).

This calculation is far from exhaustive since in the Estonian conditions *Rhynchosporion* communities form a natural part of active raised bogs (type 7110) and/or transition mires (type 7140), especially in western and northern Estonia (Kukk & Kull, 2005). In 36 of such mires, field experts recorded *Rhynchosporion* as only an additional habitat type after types 7110 or 7140, respectively, and these areas are not included in the data processing as representatives of habitat type 7150. Therefore, in the present study only those areas are listed where the habitat type 7150 was regarded as prevailing one: (i) in the most representative carpets or mud-bottoms dominated by *Rhynchospora alba* within large bog complexes, (ii) in areas with more abundant occurrence of *Rhynchospora fusca* in case they were in mires, not in paludifying forests as usual. As a result, the sample includes mainly areas in Muraka, Alam-Pedja, Kuresoo and Läänemaa Suursoo mire complexes.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of *Rhynchosporion* habitats in Estonia at 8,000 hectares[68]. The origin of this figure is unknown.

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68 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

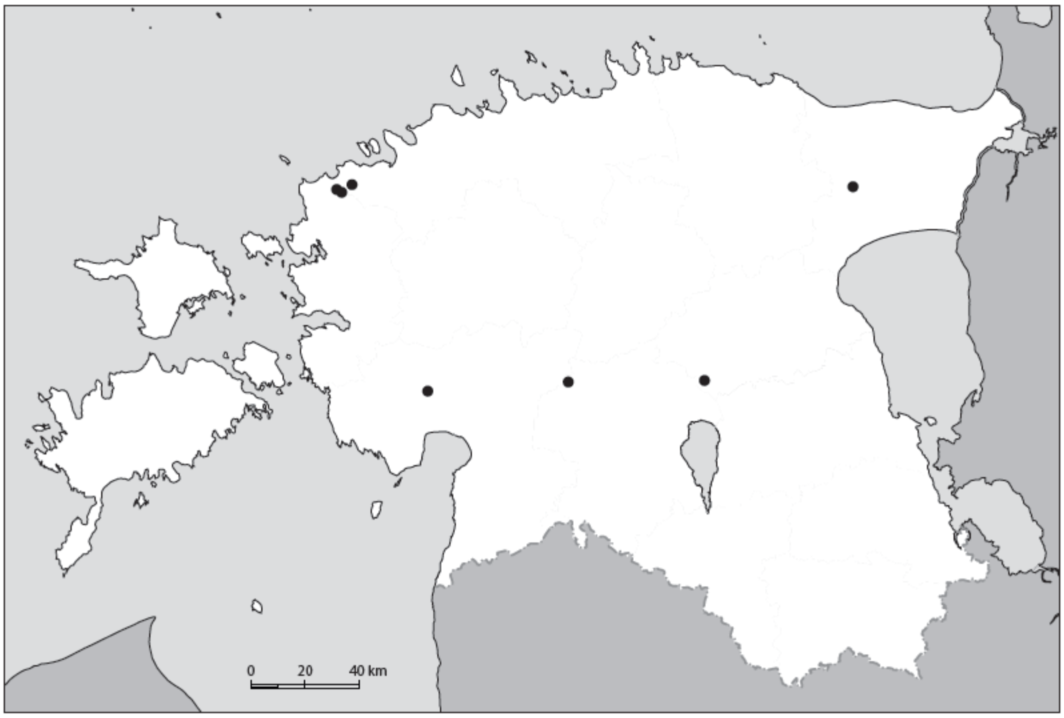

FIGURE 24. Distribution of depressions on peat substrates of the *Rhynchosporion* in Estonia.

By surface, 95.7% (three areas, 452 hectares) of the inspected *Rhynchosporion* (type 7150) correspond to the Estonian habitats classification site type 3.2.2.2 (treeless hollow-ridge bogs), the minority to the site types 3.1.2.2 (mixotrophic quagmires; two sites, 14 ha), 3.1.2.1 (mixotrophic grass fens, 5 ha) and 3.1.1.2 (species-rich fens, 1,5 ha).

According to global assessments used in Natura 2000 data forms, the conservation value of the Estonian depressions on peat substrates of the *Rhynchosporion* was estimated during the field inventory as follows: excellent (A) – 4 areas (467 ha), good (B) – 2 areas (3 ha) and unknown value – 1 area (3 ha).

Five areas covered by the habitats of type 7150 were totally or partly situated within the Sites of Community Importance; the total surface of these areas equals to 468 hectares. Their global assessment value was estimated during the field inventory as follows: excellent (A) – 4 areas (466 ha) and good (B) – 1 area (2 ha). Consequently, 99% of Estonian most representative *Rhynchosporion* areas (by surface) are included within the SCIs.

8.2.5 Fennoscandian mineral-rich springs and springfens (habitat type 7160)

There are data about 232 spring fens in the database of ELF, with the total surface of 856 ha, which correspond to the Natura habitat type 7160 (Fennoscandian mineral-rich springs and springfens) (Fig. 25). In addition to these, 66 areas include spring fens as marginal habitats.

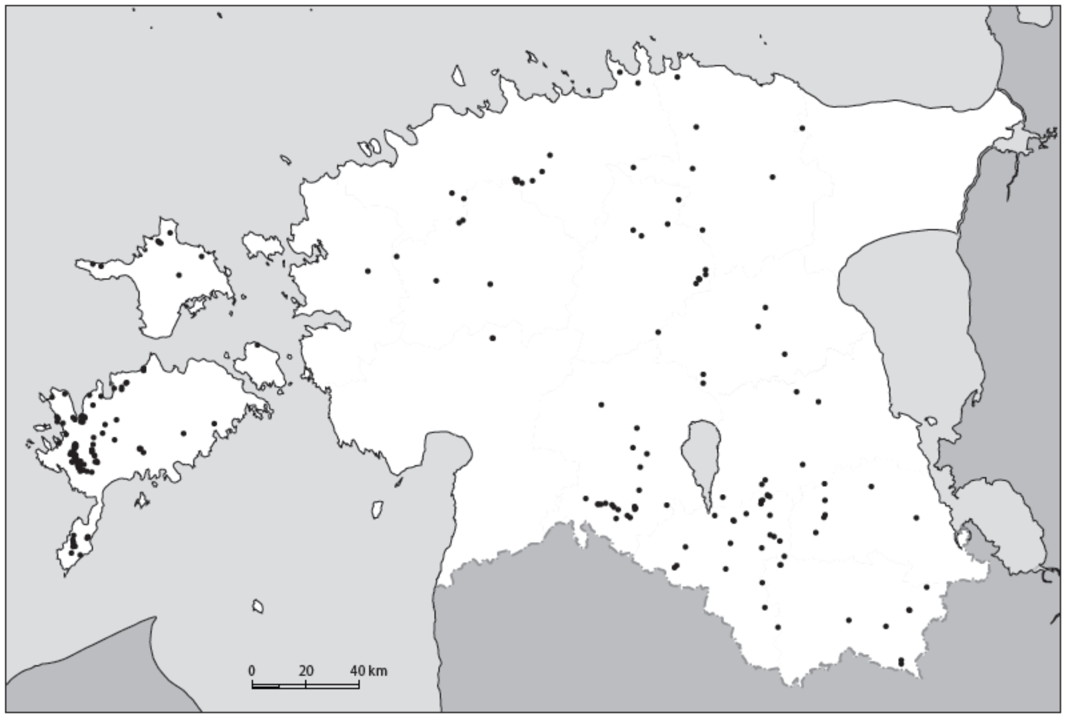

FIGURE 25. Distribution of springfens in Estonia.

This calculation is not exhaustive since our data include mainly open and sparsely treed spring fens. Densely treed spring fens rather correspond to the Estonian habitat site type 1.4.1.1A (spring fen forests); such areas appeared among the objects of the mire inventory only occasionally. Moreover, the habitat type 7160 includes also springs situated in other habitats/plant communities than mires (e.g. in meadows, forests, cultural vegetation). In Estonia, there are ca 3,000 springs (Timm & Järvekülg, 1975) altogether, but springs outside spring fen areas were not inventoried. These springs would not increase remarkably the total surface of the habitat type 7160 in our country, but the total number of areas that belong to the habitat type 7160 is actually much higher than stated above.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of springs and spring fens in Estonia at 730 hectares[69]. This is clearly less than the actual surface: open and treed spring fens alone form 900 hectares (see Chapter 8.1.3). Though springs outside spring fens would not increase the total surface remarkably, the total area of all 7160-type habitats is, nevertheless, rather 1,000 and not 730 hectares.

89.7% of the inspected spring fens (by surface) correspond to the Estonian habitat classification site type 3.1.3.1 (spring fens; 223 sites, 768 hectares), 9.8% to the site type 1.4.1.1A (spring fen forests; 2 sites, 84 ha) and a few to others.

According to global assessments used in Natura 2000 data forms, conservation value of Estonian spring fens was estimated during the field inventory as follows: excellent (A) – 60 areas (453 ha), good (B) – 103 areas (325 ha), significant vaue (C) – 55 areas (62 ha), low or lacking (D) – 2 areas (6 ha) and unknown value – 12 (11 ha).

69 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

102 spring fens were totally or partly situated within the Sites of Community Importance, the total surface of open and treed spring fens within the SCIs is 409 hectares. Global assessment of all these protected sites was resulted as follows: excellent value (A) – 47 areas (323 ha), good value (B) – 33 areas (60 ha), significant value (C) – 11 areas (17 ha), low or lacking value (D) – 1 areas (1.56 ha) and unknown value – 10 (7 ha). Thus, the majority of spring fens within SCIs in Estonia (94% by surface) have high protection value.

48% of Estonian spring fens (by surface) are included within the SCIs and their representation might seem sufficient. However, 83 areas (395 ha) of excellent or good value are outside the SCIs where their future cannot be guaranteed. It should be avoided to increase the percentage of spring fens within the Natura network just/purely due to habitat loss outside Natura sites, i.e. due to the decrease of the total area of these habitats in Estonia. Therefore, it is inevitable to establish additional SCIs at least on Saaremaa Island and in southern Viljandimaa (see more closely Chapter 8.1.3).

8.2.6 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* (habitat type 7210)

241 fens with *Cladium mariscus* which correspond to the Natura habitat type 7210 have been included in the database; their total surface is 1,688 ha (Fig. 26). According to the European standard interpretation, fens with species of the *Caricion davallianae* should also be included under this habitat type. However, to avoid confusion rising from the often mosaic pattern of Estonian species-rich fens, these plant communities are treated under the habitat type 7230 (alkaline fens), similarly to the interpretation used by the Estonian governmental authorities.

FIGURE 26. Distribution of calcareous fens with *Cladium mariscus* in Estonia.

This calculation should formally be exhaustive since all areas with habitats of that Natura 2000 type are covered by mire vegetation and, therefore, included in the inventory. Actually, only 84% of all inspected areas corresponding to the habitat type 7210, were actually mires (88 areas, 1,417 ha). Even the latter figure should be taken as a maximum whereas depth of the peat layer was not checked in all areas before 2009, and in that way part of these areas may formally turn out to be paludifying grasslands as surely are 15.5% of inspected *Cladium mariscus* habitats. Vegetation of fens and paludifying grasslands with *Cladium mariscus* is rather or extremely similar, only the depth of the peat layer is different. Quite similar plant communities additionally cover (former) coastal lagoons, but these habitats were not included in the inventory, and, therefore, the total surface of the 7210-type habitats in Estonia is somewhat larger. Taking also into consideration that habitats with *Cladium mariscus* were registered as a marginal habitat in 144 additional areas, we may estimate the total surface of the habitat type 7210 in Estonia to at least 2,000 hectares.

68.8% of inspected *Cladium mariscus* habitats (by surface) correspond to the Estonian habitat classification site type 3.1.1.2 (rich fens; 106 areas, 1,161 hectares), 33 areas (179 ha) to the site type 3.1.1.1 (poor fens), seven areas (65 ha) to the site type 3.1.1.3 (minerotrophic quagmires), three areas (10 ha) to the site type 3.1.3.1 (spring fens) and one area (3 ha) predominantly to the site type 3.1.2.2 (mixotrophic quagmires). 15.5% of inspected *Cladium mariscus* habitats (by surface) were registered as paludified grasslands (types 2.4.1.1 and 2.4.1.2; 88 areas, 270 ha), and 3 areas (9 ha) as different coastal and other habitats which inspection was not among the objectives of the inventory.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of *Cladium* fens in Estonia at 3,600 hectares[70]. This is twice as much as the total surface according to our inventory. As mentioned above, *Cladium mariscus* communities outside *Cladium* fens (paludifying grasslands, coastal lagoons) increase the total surface of the respective habitat type, but it is doubtful that those "other habitats" would comprise over 60% of all *Cladium mariscus* habitats in Estonia. Evidently, areas with only small patches of *Cladium mariscus* have been interpreted as *Cladium* fens entirely, and maybe surfaces of the same areas have even been calculated twice (both for types 7210 and 7230). It means that the figure 3,600 hectares should be regarded as an overestimate.

According to global assessments used in Natura 2000 data forms, the protection value of Estonian *Cladium* fens was estimated during the field inventory as follows: excellent (A) – 20 areas (485 ha), good (B) – 148 areas (993 ha), significant (C) – 68 areas (209 ha) and low or lacking (D) – 5 areas (2 ha). 74% of all inspected *Cladium* fens (1,254 ha by surface) are situated on Saaremaa Island, others on the western part of the mainland and on other islands. Two distribution patches are known from eastern Estonia. The plant communities dominated by *Cladium mariscus* are vital and expanding, and several new habitat patches are constantly added to the existing ones in coastal regions. To some extent that can also be explained with land uprising in western Estonia. Therefore the Estonian official estimate ("unfavourable – bad") for this habitat type in the last Natura 2000 assessment[71] is too dramatic. This estimate was given according to the presumable comparison with the data from the 1930–1940s (R. Pajula, pers. comm). However, the majority of small *Cladium* fens on Saaremaa Island were not properly inspected before the present inventory, and that is why the comparison was not objective. Estimates for structure and functions, future prospective and overall assessment for habitat type 7210 in Estonia should be "favourable" or, at the utmost, "unfavourable – inadequate".

133 *Cladium* fens were totally or partly situated within the Sites of Community Importance, with the total surface of 1,075 hectares. Global assessment of all these protected sites resulted as follows: excellent protection value (A) – 19 areas (468 ha), good (B) – 90 areas (549 ha), significant (C) – 24 areas (58 ha), low or lacking value (D) – 0 areas. In that way, the vast majority of *Cladium* fens within the SCIs in Estonia (95% by surface) have high conservation value.

70 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

71 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).

64% of the Estonian *Cladium* fens (by surface) are included within the SCIs and their representation seems sufficient. However, 59 areas (461 ha) of excellent or good value are left outside the SCIs. They need a future analysis of representativity and location towards other valuable habitats to decide whether they are worth of to be included in the shadow list of potential SCIs.

8.2.7 Alkaline fens (habitat type 7230)

According to the Nordic treatment, the Natura habitat type 7230 (alkaline fens) corresponds not only to alkaline habitats but also to slightly acidic fens which in the Estonian habitat classification are found as part of types 3.1.1.1 (poor fens) and 2.4.1.1 (poor paludifying grasslands). In the course of the present inventory, we have followed the same attitude. Still, not all plant communities of poor fens have been regarded to correspond to the habitat type 7230 but only those where small sedges were prevailing: *Caricetum paniceae–nigrae*, *Drepanoclado–Caricetum lasiocarpae* communities and partly, depending on accessory species, *Caricetum vesicariae–rostratae* and *Caricetum acutiformis* communities. It is possible that some more communities of species-poor minerotrophic habitats might have been interpreted as belonging to the habitat type 7230.

In that way, the database includes data about 2,767 areas in Estonia, with the total surface of 30,332 ha, which correspond to the Natura 2000 habitat type 7230 (alkaline fens) (Fig. 27). Of these areas, 1,035 (on 16,309 hectares) correspond to the Estonian habitats classification site type 3.1.1.2 (rich fens), 1,358 (on 10,849 hectares) to the site type 3.1.1.1 (poor fens), 194 (on 998 ha) to the site type 2.4.1.2 (rich paludifying grasslands), 18 (on 892 ha) to the site type 3.1.1.4 (floodplain fens), 121 (on 545 ha) to the site type 2.4.1.1 (poor paludifying grasslands), 26 (415 ha) to fens of undetermined type, and a few to other site types. In addition to these, 251 areas include alkaline fens as marginal habitats.

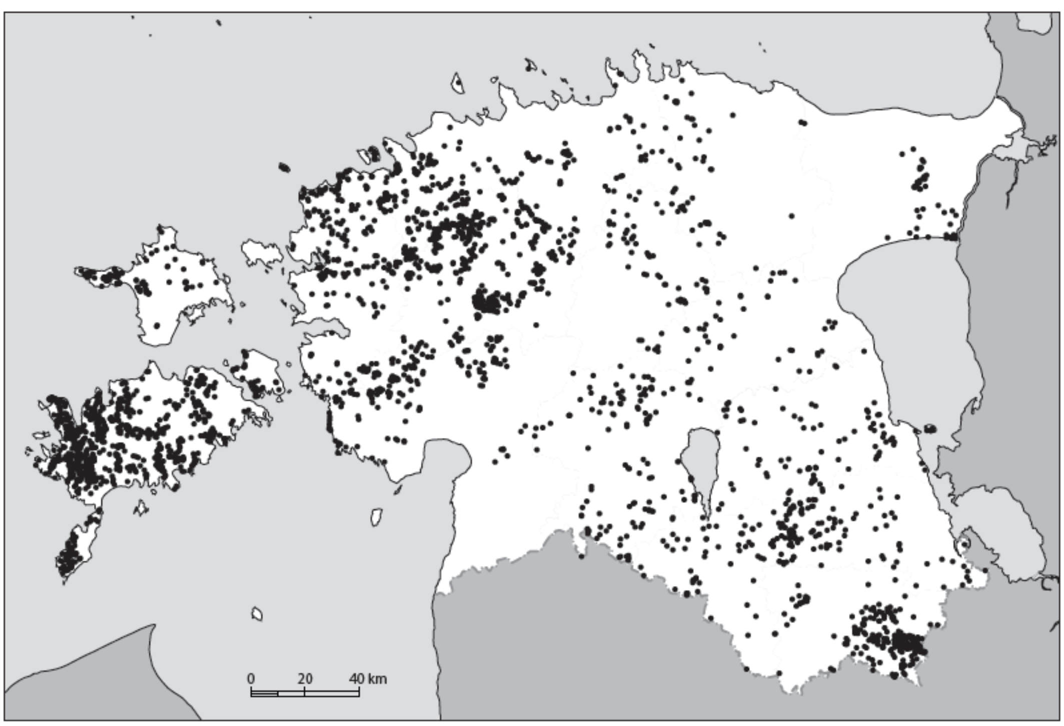

FIGURE 27. Distribution of alkaline fens in Estonia.

The above calculation of the total surface is not exhaustive since similar plant communities corresponding to the habitat type 7230 are in the Estonian habitat classification divided between two or three fen site types and two types of paludifying grasslands whereas all these site types correspond to type 7230 only partly. Habitats of the Estonian site types 3.1.1.1 and 3.1.1.2 should be included in our database more or less completely, but paludifying grasslands have been objects of different inventories of the Estonian Fund for Nature only to a lesser extent. A much more complete list of grasslands of this habitat type is recorded in the database of the Estonian Semi-natural Communities Association but even this does not include 100% of the paludifying grasslands. The total surface of paludifying grasslands in Estonia has been estimated up to 10,000–20,000 hectares (Kukk & Sammul, 2003) and probably habitats corresponding to the type 7230 are distributed on much larger area than the 1,547 hectares included in the our database. We presume that the overall surface of alkaline fens (type 7230) in Estonia (including areas with poor conservation status) might reach 35,000 hectares.

The Estonian official data for the Article 17 assessment, provided by the Estonian Ministry of the Environment, estimate the total surface of alkaline fens in Estonia at 23,900 hectares[72]. The origin of this figure is unknown and it should be taken as an underestimate.

According to global assessments used in Natura 2000 data forms, the conservation value of Estonian alkaline fens was estimated during the field inventory as follows: excellent (A) –56 areas (6,293 ha), good (B) – 784 areas (15,323 ha), significant (C) – 1,475 areas (7,447 ha), low or lacking (D) – 442 areas (1,250 ha) and unknown – 10 areas (19 ha).

811 alkaline fens were totally or partly situated within the Sites of Community Importance, with the total surface within the SCIs 19,626 hectares. Global assessment value of all these protected mires was the following: excellent (A) – 40 areas (6,009 ha), good (B) – 458 areas (11,532 ha), significant (C) – 278 areas (1,898 ha), low or lacking (D) – 27 areas (171 ha), unknown – 8 (16 ha). Thus, the majority of alkaline fens within the SCIs in Estonia (89% by surface) have high conservation value.

According to these calculations, 65% of the Estonian alkaline fens (by surface) are included within the SCIs, and their representation might be regarded as sufficient. Nevertheless, 342 areas (4,074 ha) of excellent or good value are situated outside the SCIs. Part of these unprotected fens are of national or local importance, but some have already been included in the shadow list of potential SCIs (examples in chapters 8.1.1.1 and 8.1.1.2). A further analysis is needed which additional alkaline fens should be added to the Natura 2000 network.

8.3 Assessment of threatened and/or protected species

8.3.1 Vascular plants

696 species of vascular plants have been found during the mire inventory, 43 of which belong to the Estonian Red Data Book[73], and 72 of which are protected by law[74]. However, the first figure does not

72 Access at: http://bd.eionet.europa.eu/article17/habitatsreport/?group =Z3Jhc3 NsYW5kcw% (20.03.2011).
73 Access at: http://www.zbi.ee/punane/english/index.html (04.03.2011).
74 Access at: https://www.riigiteataja.ee/akt/13360504 and https://www.riigiteataja.ee/akt/13360720 (25.04.2011).

correspond to mire species alone whereas many worksheets included data of peatland forest and grassland habitats. It should also be mentioned that searching for new sites of protected/threatened species was not the aim of the inventory.

It seems reasonable to make some comments here about species which are rare or threatened in neighbouring countries, but which are represented comparatively well in Estonia. These so-called responsibility species need, in addition to the protected Red Data Book species, special care. Among species growing in mires, the following could be qualified as responsibility species for Estonia: *Betula humilis*, *Carex davalliana*, *Cladium mariscus*, *Saussurea alpina* ssp. *esthonica* and *Schoenus ferrugineus* (Fig. 28).

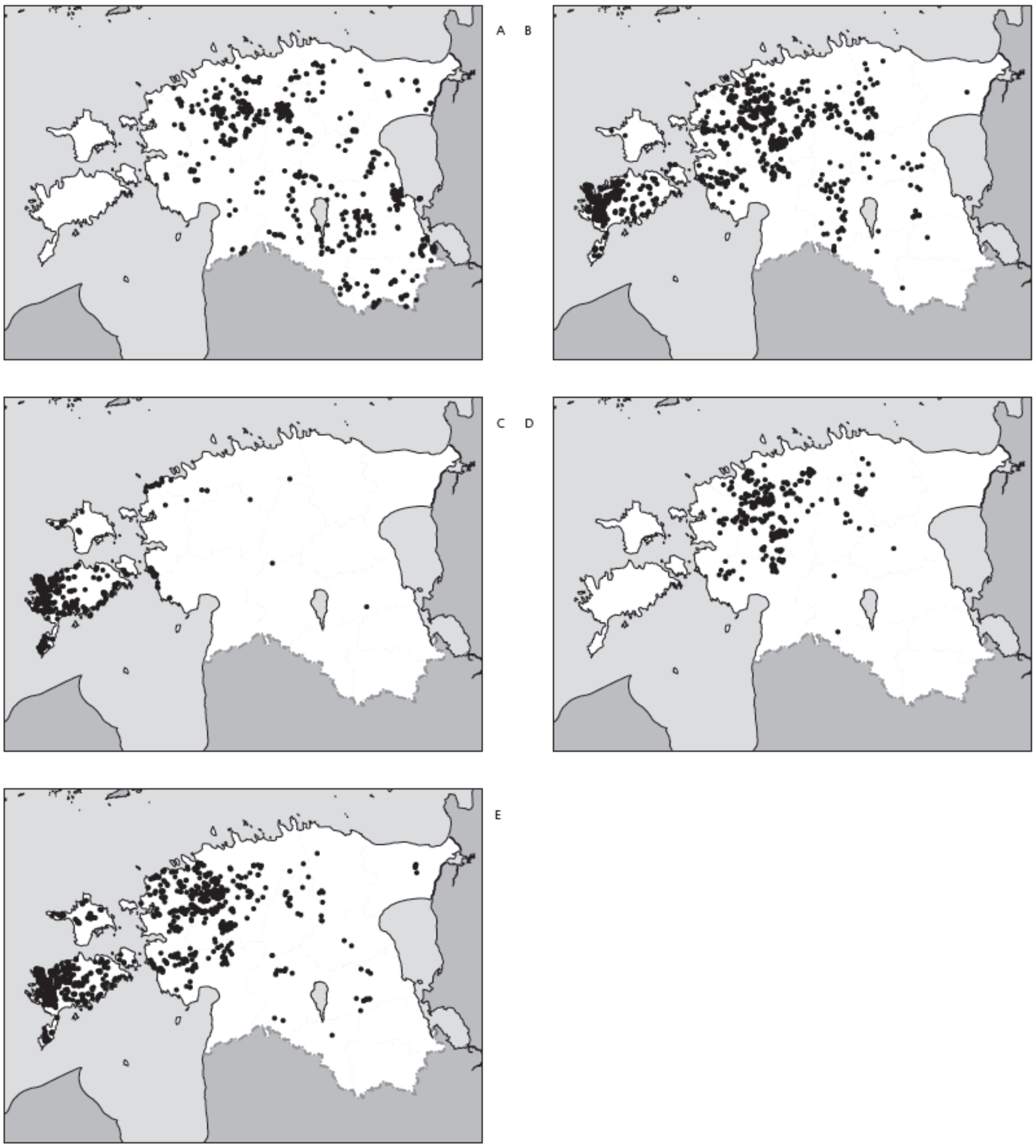

FIGURE 28. Distribution of the Estonian responsibility species in inventoried mires. A – *Betula humilis*, B – *Carex davalliana*, C – *Cladium mariscus*, D – *Saussurea alpina* subsp. *esthonica*, E – *Schoenus ferrugineus*.

The threatenedness categories below and the status of species in the countries around the Baltic Sea are given according to the Red Data Book of the Baltic Region (Ingelög et al., 1993); the status of species in Estonia is given according to the last edition of the Estonian Red Data Book[75].

Betula humilis is not the Red Data Book species in Estonia, Latvia or Lithuania, but in the Russian Leningrad region it is care demanding; in the Russian Kaliningrad region it is rare, in Poland vulnerable, and in the German states of Mecklenburg-Vorpommern and Schleswig-Holstein endangered. The species is absent on the western and northern side of the Baltic Sea. In Estonia, *Betula humilis* grows on the mainland paludifying grasslands, minerotrophic and mixotrofic fens, and swamp forests. Sometimes it is very abundant and forms a dense shrubbery together with willows.

Carex davalliana is also found only on the southern side of the Baltic Sea. In the Leningrad region and in Lithuania it belongs to the endangered species, in Poland it is vulnerable, in Latvia rare, and in Estonia care demanding. The status for this species seems to be the best in Estonia, which, consequently, has a special responsibility for this species among the Baltic states. According to Trass (1994), the frequency of *Carex davalliana* has decreased somewhat in western Estonia during the last 35–40 years. The species grows in calcareous wet grasslands and fens almost everywhere in Estonia except the southeastern part.

Cladium mariscus is endangered in Finland and in the Leningrad region of Russia, vulnerable in Lithuania and in the state of Schleswig-Holstein of Germany, rare in Latvia and Denmark, and absent in the Kaliningrad region of Russia. This species reaches almost its northern distribution limit in Estonia. It grows on shores of shallow waterbodies and in calcareous fens, often forming very dense populations. It is common on Saaremaa Island, in other parts of western Estonia the distribution is scattered. In the greater part of mainland Estonia it is lacking or extremely rare.

Saussurea alpina subsp. *esthonica*. This species is endangered in the Russian Leningrad region and Latvia, and lacking in other countries around the Baltic Sea. In Estonia it belongs to the care demanding species occurring in paludifying grasslands and fens mainly in central, northern and western parts.

Schoenus ferrugineus. This species is endangered in the Åland region of Finland and in the state of Mecklenburg-Vorpommern of Germany, vulnerable in the Leningrad region of Russia, Poland and Denmark, rare in Latvia and Lithuania, care demanding in Finland, and lacking in the Kaliningrad region of Russia and in the state of Schleswig-Holstein of Germany. In Estonia, it is common in the western and northwestern mainland and on Saaremaa Island; in central and southern Estonia the distribution is sporadic. It grows in calcareous fens, mixotrophic fens and spring fens.

As it appears, all the mentioned species are still in a rather good state in Estonia and have, therefore, a lower category in the Red Data Book than in many other neighbouring countries.

Among other (possible) responsibility species, the following could be mentioned: *Gymnadenia odoratissima*, *Liparis loeselii*, *Ophrys insectifera* and even *Primula farinosa* (decreasing everywhere but still abundant in Estonia) (Fig. 29).

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75 Access at: http://www.zbi.ee/punane/english/index.html (04.03.2011).

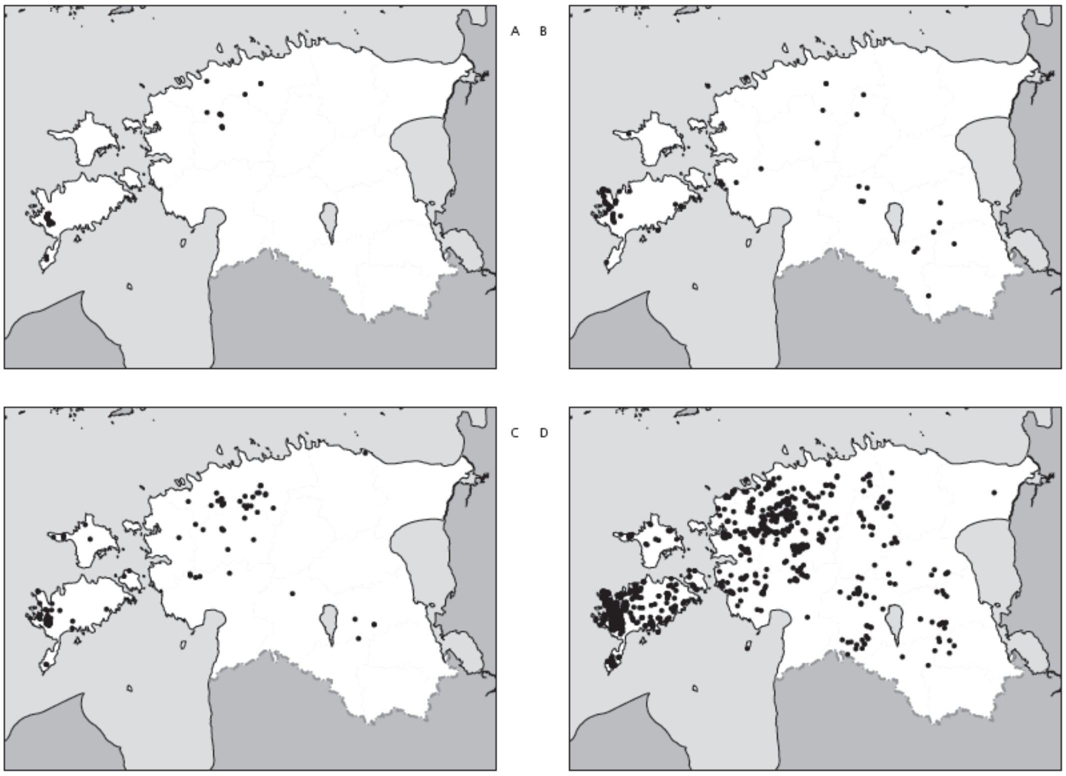

FIGURE 29. Distribution of possible responsibility species in inventoried mires. A – *Gymnadenia odoratissima*, B – *Liparis loeselii*, C – *Ophrys insectifera*, D – *Primula farinosa*.

8.3.2 Bryophytes

During the inventory in 2009–2010, 134 bryophyte species were recorded; among them 23 liverwort species and 21 peat mosses (G. *Sphagnum*). It was not possible to identify some specimens from the genera *Bryum* and *Philonotis* up to species, whereas two taxons were identified up to the variety (*Marchantia polymorpha* var. *aquatica* and *Racomitrium canescens* var. *ericoides*). The majority of identified species are most common and with wide ecological amplitude allowing them to grow in very different habitats. The most frequent species registered during field work was *Calliergonella cuspidata*. Half of all species were registered only once.

Together with the data of the first part of the inventory in 1997, five legally protected species were found in mires: *Hamatocaulis vernicosus*, *Leucobryum glaucum*. *Sphagnum inundatum*, *S. lindbergii* and *Warnstorfia tundrae*. The first one is also included in Annex II of the Berne Convention.

The Red Data List of the threatened species of Estonia[76] includes at least 13 species registered in mires during the inventories: *Barbilophozia kunzeana*, *Calliergon richardsonii*, *C. trifarium*, *Dicranum leioneuron*, *Hamatocaulis vernicosus*, *Lophozia rutheana*, *Meesia triquetra*, *Paludella squarrosa*, *Pohlia sphagnicola*, *Sphagnum inundatum*, *S. lindbergii*, *S. molle* and *S. wulfianum*.

76 Access at: http://elurikkus.ut.ee/prmt.php?lang=est&redgr_id=2 (23.04.2011).

8.4 Conclusions on assessment of habitats

8.4.1 Surface of mires

It has often been stated that mires cover more than 20% of the Estonian territory. Actually, all peatlands together cover 1,009,101 ha or 22.3% of Estonia (Orru, 1995) and this figure cannot be transferred to mires alone. This confusion has been caused by the fact that the Estonian word '*soo*' has been used both for 'mire' and 'peatland' in the past; the same problems occur in Finland concerning the interpretation of the Finnish word '*suo*' (T. Tahvanainen, pers. comm.).

According to the present inventory, mires form at least 233,000 ha or 5.2% of our territory. Adding numerous tiny (less than 0.5 ha) mires which were not inspected, and those mire habitats which occur as marginal patches within other habitats (and the surfaces of which are calculated among the surfaces of the latter ones), the total coverage of mires in Estonia may reach to ca 5.5% of the territory (240,000–245,000 ha). In any case, the remaining 17% are covered by paludifying grasslands and forests, peatland forests, degraded peatlands and other (former) peatlands.

As already mentioned in Chapter 8.1, the surface of the majority of mire site types in Estonia has decreased during the last 60 years. This tendency is illustrated by Table 20 according to which the total surface of mires has decreased 2.6–2.8 times: from 642,200 hectares to 232,900(–245,000) hectares. Statistics gathered in the course of the vegetation mapping in 1935–1955 (Laasimer, 1965) can be regarded detailed and objective, with the exception of mixotrophic mires (see Chapter 8.1.2.2). The quality of results of the present project is more uneven; however, further correcting of errata and misinterpretations of the field work results may rather decrease than enlargen the present surface of mires

TABLE 20. Comparison of mire habitat surface estimates in 1950s (Laasimer, 1965), in 1990s (Ilomets et al., 2010) and in 2010 (the present survey).

Habitat site type	Type code	Area (ha)		
		1950s	1990s	2010
Poor fens	3.1.1.1	152,300	17,000	19,000
Rich fens	3.1.1.2	74,900	5,000	20,000
Minerotrophic quagmires	3.1.1.3	1,300	300*	1,800
Floodplain fens	3.1.1.4	83,000	1,000	>3,000
Mixotrophic grass mires	3.1.2.1	76,200	10,000	35,000
Mixotrophic quagmires	3.1.2.2		700*	>3,500
Spring fens	3.1.3.1	1,500	400	900
Heath moors	3.2.1.1	3,000	1,500	1,200
Bogs	3.2.2	250,000	158,000	>152,000
Total		642,200	193,900	>232,900

* Ilomets et al. (2010) have estimated the total surface of minerotrophic and mixotrophic quagmires to 1,000 ha.

Estimates of Ilomets et al. (2010) are not based on overall inventory, and therefore they may be regarded as too pessimistic. For example, according to this assessment, the total area of rich fens decreased 15 times from 1950s to 1990s, but our results demonstrate the decrease of not more than 4 times; other major differences concern the total area of floodplain fens (83 *versus* 28 times), mixotrophic mires (7 *vs* 2 times) and spring fens (3.8 *vs* 1.7 times) (Table 20). Maybe the approach used by Ilomets et al. has been too strict – they have considered only mires in good natural state. Still, according to our position, the mire habitats, especially their plant communities often react rather inertly to modest human impact, keeping their character for a long period. It seems to be not legitimate to exclude destroyed but still surviving habitats from the calculations of the mire list; their conservation value is another question. Therefore the 3.3-fold decrease of the total surface of mires between 1950-1990 is probably exaggerated and the decrease of 2.8 times (by 2010) may be more realistic.

8.4.2 Conservation status

The current study proved that the percentage of mires with low conservation status (value of habitat) is remarkably small (Table 21): 67–95% of all inspected mires were assessed to be of excellent or high conservation status. This result proceeds from the fact that due to the direct or indirect impact of the human activities numerous mires have been covered by a dense tree layer (allogenic successions are taking place) and those habitats with low conservation status are often not qualified as mires any more but as peatland forests. Thus, the total number and surface of mires are decreasing but the conservation status of extant mire habitats remains relatively high.

8.4.3 Global assessment

The results concerning the estimates of global assessment (conservation importance) are quite similar to those of conservation status (Table 22). There are only two site types which habitats of high conservation importance form less than half of the total surface of the respective site type: poor fens (46%) and minerotrophic quagmires (48%). The percentage for heath moors (51%) is comparable with the latter ones. Habitats with high conservation importance of other site types form 72-90% of the total surface of each site type.

Habitat type (Paal, 1997)	Type code	Value A		Value B		Value C		Value D		Unclear value		Total	
		N	ha	N	ha	N	ha	N	ha	N	ha	N	ha
Fens	3.1	1194	29,879	3,644	36,674	2,957	14,090	427	1,262	442	3,653	8,664	85,558
Minerotrophic fens	3.1.1	617	12,322	2,592	21,326	2,491	8,818	396	846	231	1,506	6,327	44,817
Poor fens	3.1.1.1	276	3,418	1,612	9,701	1,954	5,389	359	707	146	504	4,347	19,719
Rich fens	3.1.1.2	250	7,417	751	9,278	371	2,208	22	105	45	329	1,439	19,337
Minerotrophic quagmires	3.1.1.3	71	662	129	708	65	236	3	1	16	26	284	1,634
Floodplain fens	3.1.1.4	12	712	79	1,352	82	894	9	23	14	199	196	3,179
Spring fens	3.1.3.1	103	471	91	231	22	65	2	6	12	12	230	784
Fens of unclear type	3.1.1 ?	8	113	21	287	19	91	3	10	10	448	61	948
Mixotrophic mires	3.1.2	474	17,087	961	15,118	444	5,207	29	411	66	1010	1,974	38,833
Mixotrophic grass mires	3.1.2.1	348	13,493	797	14,421	390	4,903	21	408	45	680	1,601	33,904
Mixotrophic quagmires	3.1.2.2	117	2,637	160	689	51	291	7	2	14	37	349	3,657
Mixotrophic mires of unclear type	3.1.2 ?	9	958	4	8	3	13	1	1	7	293	24	1,272
Minero- and mixotrophic mires of unclear type	3.1 ?	0	0	0	0	0	0	0	0	133	1,125	133	1,125
Ombrotrophic mires (bogs)	3.2	352	80,278	699	46,291	324	19,029	29	1,028	45	6,269	1,449	152,894
Heath moors	3.2.1.1	14	283	60	825	8	20	2	34	1	2	85	1,165
Bogs	3.2.2	338	79,994	639	45,466	316	19,008	27	994	44	6,267	1,364	151,729
Bogs of of unclear type	3.2 ?	0	0	0	0	0	0	0	0	0	0	0	0
Mires of unclear type	3 ?	1	1	0	0	2	10	1	13	113	1245	117	1,268
Total	3	1547	110,157	4,343	82,965	3,283	33,129	457	2,303	600	11,166	10,230	239,720

TABLE 21. Number (N) and area (ha) of mires of different conservation status (value of habitat). Notations: A – excellent value, B – good value, C – significant value, D – low or lacking value.

Habitat type (Paal, 1997)	Type code	Value A		Value B		Value C		Value D		Uunclear value		Total	
		N	ha	N	ha	N	ha	N	ha	N	ha	N	ha
Fens	3.1	251	19,712	1,923	38,400	3,645	18,224	2,648	6,967	197	2,255	8,664	85,558
Minerotrophic fens	3.1.1	84	7,818	1,097	18,389	2,741	12,786	2,366	5,181	39	642	6,327	44,817
Poor fens	3.1.1.1	20	1,515	485	7,616	1,771	6,661	2,056	3,912	15	14	4,347	19,719
Rich fens	3.1.1.2	46	5,314	474	8,704	688	4,390	224	908	7	22	1,439	19,337
Minerotrophic qugmires	3.1.1.3	15	399	97	770	138	348	31	113	3	4	284	1,634
Floodplain fens	3.1.1.4	3	590	31	949	116	1,294	42	191	4	156	196	3,179
Spring fens	3.1.3.1	60	453	103	250	53	61	4	11	10	9	230	784
Fens of unclear type	3.1.1 ?	0	0	10	350	28	93	13	58	10	447	61	948
Mixotrophic mires	3.1.2	107	11,441	723	19,762	851	5,376	278	1,775	15	479	1,974	38,833
Mixotrophic grass mires	3.1.2.1	66	8,193	563	18,829	718	5,050	249	1,648	5	184	1,601	33,904
Mixotrophic quagmires	3.1.2.2	35	2,294	157	928	127	309	27	123	3	2	349	3,657
Mixotrophic mires of unclear type	3.1.2 ?	6	953	3	5	6	17	2	4	7	293	24	1,272
Minero- and mixotrophic mires of unclear type	3.1 ?	0	0	0	0	0	0	0	0	133	1,125	133	1,125
Ombrotrophic mires (bogs)	3.2	88	43,221	496	72,824	637	25,247	209	6,639	19	4,963	1,449	152,894
Heath moors	3.2.1.1	3	234	21	364	56	520	5	47	0	0	85	1,165
Bogs	3.2.2	85	42,987	475	72,460	581	24,727	204	6,592	19	4,963	1,364	151,729

TABLE 22. Number (N) and area (ha) of mires of different global assessment (conservation importance). Notations: A – excellent value, B – good value, C – significant value, D – low or lacking value.

8.4.4 Sufficiency of the protected areas network

Table 23 demonstrates that in comparison with the total surface covered by habitats of different mire site types, the area of respective protected mires varies by site types from 42% to 81%. Thus, mire habitats are protected in Estonia much more sufficiently than habitats of some grasslands or forests. Here we are obliged to the efforts of the late Professor V. Masing, E. Kask and several other active fighters for mire protection. We can also admit the high global assessment values of the already protected mires, which means that the network of the Estonian protected areas has been established deliberately.

TABLE 23. Surface and percentage of protected and unprotected mire areas with high global assessment value.

Habitat site type	Type code	Total surface of areas within protected areas		Surface of protected areas with high conservation value		Surface of un-protected areas with high con-servation value
		ha	%	ha	% of all protected areas	ha
Poor fens	3.1.1.1	9,888	50	7,168	72	1,963
Rich fens	3.1.1.2	12,360	64	11,266	91	2,752
Minerotrophic quagmires	3.1.1.3	960	59	838	87	331
Floodplain fens	3.1.1.4	1,656	52	1,200	72	338
Mixotrophic grass mires	3.12.1	27,359	81	24,970	91	2,052
Mixotrophic quagmires	3.1.2.2	2,792	76	2,769	99	453
Spring Fens	3.1.3.1	432	55	403	93	300
Heath moors	3.2.1.1	487	42	452	93	146
Bogs	3.2.2	115,453	76	103,856	90	10,911
Total		1,711,387	–	152,922	–	19,246

Nevertheless, for every mire site type there were discovered some additional areas with high conservation value addition of which to the existing network of protected areas should be solved in the nearest future. Thorough assessment and case-by-case analysis of those areas was beyond the framework of the present project. In most cases, it depends on the representativity of each area, as well as on the abundance and quality of neighbouring habitats forming valuable habitat complexes. Moreover, some mires are protected only partially at present.

8.4.5 Sufficiency of the Natura 2000 network

Estimates of mire areas within the Sites of Community Importance have been previously assessed by the Estonian Ministry of the Environment (K. Möller, pers. comm.). For the majority of the habitat types, their estimates of the total surface differ noticeably from the results of the present survey but percentages of inclusion of areas into the SCIs coincide pretty well for the majority of the habitat types (Table 24). The only exceptions are types 7160 (Fennoscandian mineral-rich springs and springfens) and 7230 (alkaline fens) for which the earlier estimates of protectedness have been remarkably overestimated. (Habitat type 7150 is probably interpreted in different ways (see Chapter 8.2.4) and therefore the calculations cannot be compared; habitat type 7120 is of no importance in the Estonian conditions).

TABLE 24. Surface and percentage of mire areas the within Sites of Community Importance (SCIs) in Estonia according to the estimates of the Ministry of the Environment (K. Möller, pers. comm.) and specifications from the present inventory.

Habitat type	Total surface of areas within the SCIs				Surface of areas with high global assessment value outside SCIs
	K. Möller (pers. comm.)		present inventory		
	ha	%	ha	%	ha
7110	130,000	82	108,139	80	13,139
7120	2,000	4	1,011	13	197
7140	24,000	75	30,118	80	3,082
7150	6,000	75	468	99	1
7160	500	68	409	48	395
7210	1,900	53	1,075	64	461
7230	23,000	96	19,626	65	4,074
Total	ca 190,000	–	160,846	–	21,349

The occurrence of habitat types within the SCIs is mostly higher than 60% and, according to the traditions of the European Commission, they are considered as sufficiently represented. We may largely recognize such a conclusion and do not foresee large-scale establishment of additional sites for most of the mire habitat types in the future. Nevertheless, there are a few areas with a high global assessment value in nearly all habitat types inclusion of which into the existing Natura 2000 network was discussed in Chapter 8.2. The majority of unprotected areas with excellent or good global assessment value will need a thorough case-by-case analysis to decide which of them should be included in the list of potential SCIs.

However, there are two mire habitat types for which a number of additional sites are to be designated: Fennoscandian mineral-rich springs and springfens (type 7160) and alkaline fens (type 7230). The present occurrence of these habitat types within the SCIs – 48% and 65%, respectively – may formally seem sufficient, but habitats of these two types are the most threatened in Estonia (Table 12). From the hydrological point of view, only less than 25% of spring fens and less than 10% of species-rich alkaline fens were stated to be in a more or less natural conditions (Ilomets, 1994b) and their favourable conservation status cannot be guaranteed outside the Natura 2000 network.

8.4.6 Responsibility habitats

Estonia has a large number of mires of international importance: for example, some of the largest and most intact boreo-nemoral raised bogs and rich (calcareous) fens are valuable in all-European context. Though the Natura 2000 network has been established to protect different rare and/or threatened habitats on larger (European) scale than only within one state (as it is too often done), and though Estonian mire habitat types are mostly listed in Annex I of the Habitats Directive, it is clear that not all valuable sites are of equal importance. It has often happened that a lot of attention is paid and finances applied to keep a single representative of a certain habitat type in a country (region) not asking whether habitats of the same type could be common in other countries (regions). And, *vice versa*, a country (region) may be heedless of those habitat types which are very widespread and common within it but not in other countries. Therefore it should be recommended to widen the concept of responsibility species also to responsibility habitats.

It is evident that large open raised bogs (type 7110) are among the responsibility habitats for Estonia. By the total surface of all active raised bogs, Estonia holds the third place in Europe after Sweden and

Latvia, even in absolute numbers[77]. However, the number and surface of large bogs is much lower in Latvia (comparable to the situation in southeastern Estonia) and in southern Finland the pressure of amelioration and other kinds of human impact have been much more intensive than in Estonia. Therefore Estonia (probably together with Sweden) turns out to be the main responsible country for preserving these bogs within the European Union.

We can conclude that further analysis is needed to specify the total list of responsibility habitats for Estonia. Of mire habitats, habitat types 7160 and 7230 might also become candidates, at least in the scale of the Boreal bioregion, especially due to the rarity of intact calcareous habitats in most of the other countries of the region. Even Estonian *Cladium mariscus* fens almost lacking in 2/3 of the country, will occupy the 3rd place in Europe after France and Sweden by their total surface [78].

8.4.7 Habitat complexes

The mire as a landscape type is often a complex of different vegetation habitat site types. A common feature for mires is that the larger the area they cover, the more different are the site types presented in it. Therefore, from the landscape point of view, one of the criteria in assessing the value of a mire area could be the diversity level of site types which it includes: mires with higher diversity may possess a higher value. In this sense, the ombrotrophic bogs surrounded by different types of mixotrophic and/or minerotrophic fens are more important and worth of nature conservation than mire massifs representing only a few habitat types.

In many cases, marginal areas of a mire complex have been turned into pastures, grasslands, drained woodlands, etc., or untouched mires *s.str.* are surrounded by bordering ditches. Therefore, it can be concluded that no completely virgin minerotrophic fen complex may exist in Estonia. In the case of bog complexes the situation is similar: they are usually surrounded by a minerotrophic or mixotrophic fen belt (lagg). Still, some of the best Estonian large mire complexes are not affected by bordering drainage or other human activity (e.g. Leidissoo in north-western Estonia), or are affected by human activities only in some parts (e.g. Lihula in western and Kuresoo in central Estonia, Muraka and Emajõe Suursoo in the eastern part of the country, etc.).

In small depressions in the southeastern Estonian uplands, one can often find numerous wetlands of different types, situated like clusters very close to each other. Similar systems of small mires are typical of western Saaremaa. This kind of wetland-rich landscape pattern again possesses high biodiversity value, but is also important from the educational and scientific point of view. For example, the spring fen systems in Saaremaa are extremely important from the floristic viewpoint, being the only habitat in the World for *Rhinanthus rumelicus* subsp. *osiliensis*, the only one in Estonia for *Juncus subnodulosus*, etc. Therefore, the patterned mire-rich landscapes would be another category, alongside mire complexes, which should be considered from the aspect of protection.

We are of the position that all well-preserved mire complexes and patterned wetland-rich landscapes hold important value because of their high site type diversity, and need to be maintained. It does not mean that they all must be taken under legal protection; sometimes it is enough for preservation not to allow construction of drainage or the establishment of open pits in valuable wetlands and their surroundings. This is an issue of landscape planning on the district level.

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77 Access at: http://bd.eionet.europa.eu/article17/index_html/habitatsummary/?group=Ym9ncywgbWlyZXMgJiBmZW5z&habitat=7110&region= (22.03.2011).

78 Access at: http://bd.eionet.europa.eu/article17/index_html/habitatsummary/?group=Ym9ncywgbWlyZXMgJiBmZW5z&habitat=7210&region= (22.03.2011).

8.5 Recommendations for mire conservation and management

8.5.1 Selected problems and recommendations for amendments in legal acts or administrative system

Legal norms, regulating protection of wetlands, have generally been established in the middle of the 1990s, but have been remarkably amended during last years, especially in connection with the membership in European Union. Quite recently the administrative system of nature protection has been changed several times and therefore the administrative practice is developing continuously. In comparison with 1995, the regulation is significantly more detailed and takes more into account the values and needs of nature protection – a thorough regulation about environmental impact assessment (EIA) has been added, norms for protection of sites of Natura 2000 network have been established, etc.

The main problems, which could affect the state of wetlands, are the gaps in law and administrative practice of permitting procedures and EIA of activities, affecting especially negatively mire areas by extraction of peat and drainage.

In the case of activities with significant environmental impact, EIA must be conducted in order to answer the admissibility of the activity. The refusal of issuing the extraction permits is strictly restricted, the bases are counted in the law (Earth's Crust Act Section 34 subsection 1) and the issuer of the permit does not have remarkable discretion whether to issue permit or not. The extraction permit can be refused, *inter alia*, if the result of EIA shows that the extraction brings along significant environmental impacts and these impacts cannot be avoided or mitigated (Earth's Crust Act Section 34 subsection 1 issue 19). This basis is actually without substance, since in most cases it is always possible to propose mitigation measures for reducing the environmental impact. In practice there are also problems with the quality of EIA. It would be reasonable to amend the basis for refusal from issuance of extraction permit in the Earth's Crust Act. In addition, legal or administrative measures should be foreseen, in order to improve the quality of EIA.

Another problem is that the issuing procedure of extraction permits takes place in multiple stages, giving an opportunity to issue permits, once gained the approval on the basis of previous requirements, without conducting EIA, or leaving some of the impacts out of attention (e.g. in case EIA takes place in the procedure of extraction permit, not in procedure of water permit). This problem has been solved in the newly (16.02.2011) adopted General Part of Environmental Code, foreseeing only one environmental permit for all activities that require a permit, whereas EIA will be (in case it is needed) carried out within this one permit procedure.

In connection with drainage projects there is a problem that EIA is usually not carried out for these projects, on the basis of a claim that drainage is not subject to EIA obligation at all – so that of need for EIA is even not considered. Hence, raising awareness about EIA requirements is needed for administrative bodies, issuing permits for drainage projects.

Another big cluster of problems is related to gaps in adopting decisions about the establishment of mines, whereby decisions might not be sufficiently considered from the point of view of public interest, and follow mainly the private interests of developers. The establishment of mines takes place on the basis of individual decisions without an assessment of the whole impact on a wider surrounding area or without weighing the alternative locations. The determination of the categories of mineral reserves (consumption, reserved and predicted reserves) is not transparent, since the decisions are made without public participation and the public is not even informed about the decisions.

In 2005 the National Audit Office of Estonia published an audit report, according to which Estonia lacks reliable information about peat increment. Supposedly the valid annual limit value of peat extraction exceeds the increment of peat several times.[79] Deriving from the EU renewable energy directive 2009/28/EC and the national Long term Development Plan of Fuel and Energy Sector until 2015, which was adopted by Parliament in 2004, peat must be considered as non-renewable energy resource.[80]

According to the Draft Basis of Protection and Sustainable Use of Estonian Peatlands, the sustainable use of extracted peat presumes a national decision, together with the discussions between different interest groups and institutions, which should define:

1. Economically reasoned annual limit value of peat extraction;
2. For what purpose peat is extracted;
3. What is the technology and the methods of the extraction;
4. Do the technology and methods of the extraction guarantee sustainable extraction, storage and marketing of peat;
5. Restoration plans of residual mires.[81]

According to Section 8 subsection 2 clause 13 of Water Act water permit is necessary for mine water, which is emitted to environment. As mine water is not considered sewage water (look Chapter 2 of the current publication subsection 1.3.2), then emission limit values of pollutants for sewage water are not directly applicable for mine water. Therefore it is necessary to provide emission limit values of pollutants to mine water, which is emitted to environment in order to eliminate too wide discretion of administrative body and to guarantee transparent administrative practice.

8.5.2 Recommendations for protecting buffer zones

The main impact of neighbouring areas on the wetlands is caused by changes of hydrological regime, air pollution and change of local micro-climate. Therefore, it is necessary to create buffer zones around wetlands for their protection. If a wetland is under protection, the buffer zone should be part of the protected area and all activities in the buffer zone should be regulated by the management plan and protection regulation. Buffer zones are to be established to preserve the hydrological regime of wetlands, to ensure ecosystem quality and related protection of species. In the planning process of buffer zones it is important to preserve the hydrological regime that will in most cases also guarantee the protection needs for species and protection against changes of air quality and micro-climate. The need for creating additional larger buffer zones could be caused by the need for additional protection of habitats of certain species or for additional protection of surface and ground water. This need should be evaluated separately for every wetland considering ecological requirements of protected species or requirements for water protection.

From the viewpoint of buffer zones, the wetland itself forms the so called core area. The core area is surrounded by two buffer zones with different protection categories:

zone I – first buffer zone surrounding the core area, economic activities can be performed

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79 Access at: The Basis of Protection and Sustainable Use of Estonian Peatlands. 05.10.2010, page 6. Available online (in Estonian only). – http://www.envir.ee/orb.aw/class=file/action=preview/id=1083186/Turbakontseptsioon_kodulehele_T%C4IENDATUD.pdf (28.03.2011).

80 Access at: The Basis of Protection and Sustainable Use of Estonian Peatlands. 05.10.2010, page 7. – http://www.envir.ee/orb.aw/class=file/action=preview/id=1083186/Turbakontseptsioon_kodulehele_T%C4IENDATUD.pdf (28.03.2011).

81 Access at: The Basis of Protection and Sustainable Use of Estonian Peatlands. 05.10.2010, page 8. –http://www.envir.ee/orb.aw/class=file/action=preview/id=1083186/Turbakontseptsioon_kodulehele_T%C4IENDATUD.pdf (28.03.2011).

only to ensure preservation of the buffer;

zone II – second buffer zone surrounding the buffer zone I; economic activities are strictly regulated according to the management plan of the protection area; clear cutting of forest, peat mining, construction works and melioration works are prohibited.

According to the hydrological regime wetlands can be divided to the three main classes:

class A – with inflow, fed by groundwater (fens, spring fens, part of transitional mires);
class B – with outflow, fed by precipitation (bogs, part of transitional mires);
class C – with overflowing regime (floodplains, coastal meadows).

The width of zone I and II for wetlands of class A (mires) should be in general 500 m (Fig. 30). By creating of buffer zones the hydrological conditions of whole catchment area of the wetland must be considered additionally to the core area. The potential impact of catchment to the wetlands and on the contrary, the role of the wetland in the formation of ground and surface water regime and quality must be assessed. If necessary, the buffering area should be widened.

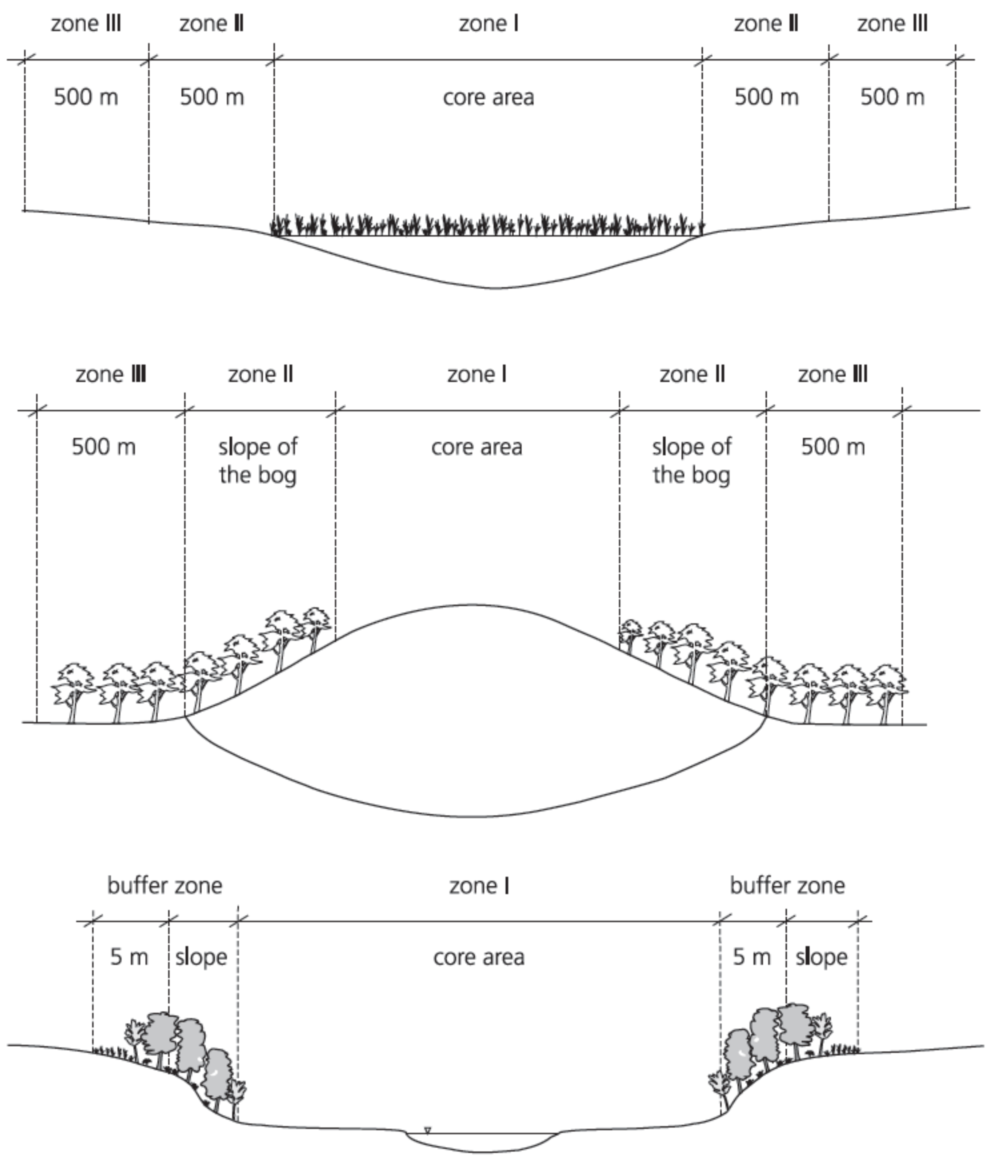

FIGURE 30. Recommended buffer zones by different hydrological regime.

The width of zone I for wetlands of class B should cover the whole slope of the bog until the slope foot. The width of zone II must be at least 500 m. In case of a danger that economic activities in the wider area can cause changes of water regime of the wetland, the buffer zone should be widened.

Wetlands with overflowing water regime (class C) are mostly semi-natural ecosystems that need specific economical activities, mostly extensive agriculture like hay-making and grazing. In such wetlands the riverbanks (if they are well developed) need protection against erosion and nutrient income. The buffer zone must cover the whole slope of the bank and at least 5 m upslope the bank margin. The slope must be covered with trees or bushes (alders, willows, etc.), the upper part of buffer can constitute grass strip. The floodplains also need protection of river valleys up- and downstream, where no changes of river valley can be made to ensure natural fluctuation of water level and flooding regime. For every floodplain the extent of the protected valley where no changes of valley morphology and water regime can be made, should be found by the analyses of the hydrological conditions of the river.

The hydrological regime of a wetland is a result of very complicated natural variabilities/conditions, therefore it should be assessed for every wetland separately. The buffer zones and their management plans should be fixed in spatial planning of local government, in the management plans and protection regulations of protection objects.

8.5.3 Recommendations on mire management

The objective of management for all Estonian mires should be to sustain their ecological, social and economical functions now and in the future. To achieve this, it is necessary to recognize the functions and values of mires in resource planning – in management and economic decision-making. Sound, sustainable management practices in forestry and agriculture are needed. The water-related ecological functions should be given due consideration; the water holding capacity of mires should be given high priority in land use planning. In particular, the destruction of mires should be avoided in the catchment areas of rivers that are likely to cause damaging floods. Rehabilitation of mires should have priority. Destruction or irreversible use of peatland areas should not be permitted without a careful assessment of the long-term costs and benefits of the decision. All this should result in the utilization of mires in a way that enhances the prospects for their sustained and productive use by future generations.

8.5.3.1 Sustainable management of mires

The objects of future protection should mainly be the unprotected mire areas the protection value of which, according to the global assessments used in Natura 2000 data forms, was assessed as excellent (A) or good (B). There are, however, thousands of areas with the global assessment value C (significant). If the latter do not form valuable habitat complexes, usually no specific legal decision on nature conservation will be suggested and implemented. Thus, part of these areas will be used in the economic interests, but many others are not worth of being subject to significant changes in land use or to uncontrolled neighbouring effect. The control of such activities would in most cases be secured through municipal land-use planning (zoning). Environmental Impact Assessment (EIA) regulations or sector specific concession and approval decisions (i.e. permits, decisions on governmental funding and subsidies, etc.) can be used to control the implementation of unwanted projects or new activities.

The most important activities to be avoided in these areas are drainage and other hydrological manipulation (river trimming, flood control, inundation, etc.), peat extraction, building and construction activities like roads, pipelines, powerlines, etc.

The following traditional activities can be continued:

- grazing;
- hay-making;
- sustainable forestry (selective cutting);
- picking of berries and mushrooms;
- tourism.

For example, the economic potential of wild berry resources – both in a commercial and recreational sense – is far from being fully utilized in Estonia. Efforts should be made to find arrangements where nature conservation efforts and berry production and collection can be combined.

Municipal planning might be the most important future instrument for controlling the development on areas of sustainable management. The enforcement would, however, depend on the priority given to nature protection and ecological values by municipal planning authorities and politicians. The influence of central and regional environmental authorities on the process of municipal planning would be less than in the case of preparation of an EIA. The check on development proposals against information of protection and nature value criteria would be the responsibility of regional environmental authorities.

Included in thematic spatial plans, the principles of the "Green Network"[82] should be the most relevant instrument for preserving the more representative part of mires with the global assessment value "C". However, there have been several cases of ignoring the location of an object within the green network if developers have "proved" their interests as of the 1st priority, to decisive authorities.

The compilers of this publication are conscious of the danger of relying on the help of land-use planning today – with its relative legal weakness – to guarantee the survival of mires. Nevertheless, there are encouraging cases from as early as the 1990s. For example, the municipal authorities of Harku (northern Estonia) are well aware of the hydrological importance of Tabasalu mire to its surrounding areas, including the municipality central village, and have avoided any activities that would change the mire negatively, whereas the global assessment value of that mire is not high. Such attitudes have also become known among the authorities of other (often relatively densely populated) municipalities, especially near larger towns, and in such cases the solution is usually positive. There are much more contradictions in rural municipalities if local inhabitants are interested in preserving of their local mire against economic use approved by the decision of the municipality authorities. Successful solutions, often on the basis of compromise, for the latter cases will hopefully become more frequent together with the development of the open civil society.

8.5.3.2 Mires and drainage

The main threat to Estonian mires has come and will come from drainage activities. Until the 1970-1980s, the most important impact on mires has come from agricultural amelioration. During the last two decades, a part of cultivated land has gone out of use and even mineral soil land is taken out of production. This development may slow down or reverse, but it is unlikely that a new boom in agricultural land amelioration will appear in the following decades. Also, assessment of changes in quality of peat soils in agricultural use could change the readiness to continue their use. Probably some of the existing drainage systems will be rehabilitated, but several existing systems will be allowed to collapse and it is unlikely that much will be invested in establishing new schemes. Some drained peatlands, earlier used as agricultural areas, will be afforested by new owners.

At the same time, it is evident that forestry amelioration will continuously have a fundamental effect on

82 Access at: Sepp, K., Jagomägi, J. 2002. Roheline võrgustik. – http://www.siseministeerium.ee/public/roh.vorgustik.pdf (in Estonian) (30.04.2011).

the state and development of Estonian mires. Forested land is deteriorating because of water logging and the lack of maintenance of drainage systems. As timber usage is expected to increase and intensive forest management practices are often recommended it is likely that a pressure to restore the old drainage systems in forests will increase in the future.

Presumably it would be much easier to seek compromises between conservationists and peat extractors, than between environmental authorities and amelioration societies/bureaus. As described previously (Chapter 8.5.1), drainage is usually not a subject to EIA obligation, thus, need for EIA is not considered at all. Even more – in many cases it is not possible to get any timely information of planned drainage activities, especially if they are performed under the label of reconstruction of the existing amelioration objects. But minerotrophic and spring fens may be harmed or damaged even if they are located hundreds of meters from the nearest ditch (depending on local hydrological conditions) – and it is these site types that are among the most threatened mire types in Estonia.

One of the consequences of human activities for mires (and for fens especially) is the increase of certain chemical elements and organic compounds in the runoff waters. The nitrogen content in the outflow from the drainage systems waters may increase up to by 10–60 mg per dm^2 (Tomberg, 1992). The same is valid for phosphorus. Unfortunately, studies and monitoring concerning the effect of agricultural amelioration of peatlands on the state of outflow waters and waterbodies were discontinued in the 1980s, but the need for the continuation of that monitoring is obvious.

Rich fen communities need more thorough investigations aimed at understanding in greater detail the peculiar environmental conditions which favour their existence. Such knowledge is even more important for the restoration of rich fen sites in several areas now affected by drainage. Some examples of best preserved rich fens (e.g. Avaste) should be included into the Estonian Biodiversity Monitoring System. Species and plant communities monitoring must be integrated with monitoring of hydrological conditions.

For the preservation of the biodiversity of certain fens, the continuation or re-establishment of traditional agricultural practices – mowing and grazing – would be needed. Management inhibits the tree and bush layer development and enables more species to grow together in the same plant community. In the present economical situation, traditional management of fens by land-owners is unrealistic even in the case of implementation of agricultural subsidies. Some fens within protected areas may be sample objects for testing of special management (both traditional as well as e.g. winter cutting of trees and bushes, etc.) and monitoring them.

8.5.3.3 Mires and peat industry

For several reasons, peatlands belong to the most threatened nature types in Europe. The main reason is over-exploitation of the remaining peat resources. A number of countries in Europe have no, or very small peat resources left, but the use of peat and peat products is still growing. On a global scale, peat extraction consumes only a small quantity of the available peat resources, but the area of peat extraction is concentrated to a rather small territory in Europe, mainly in nemoral, boreo-nemoral and southern boreal zones. Destruction of peatlands has been promoted by international subsidies and by export of expertise and technology, resulting in loss of biodiversity and a more unfavourable balance in carbon cycles (Joosten 1995).

The policy during the last two decades has been focused to make Estonia less dependent on imported energy resources like oil and gas. In order to diminish the destructive oil shale mining in northeastern Estonia, there is a need for alternatives. One of these is to rely more on bioenergy and peat. The

Development Plan of the Estonian Electricity sector until 2018[83] assumes that the contribution of gas, biofuels and peat (altogether) in the total electric energy budget will increase to 20%. However, according to the National Energy Program until 2020[84], peat could be used as a biofuel only if the sustainability criteria are implemented. It is fixed in the Governmental regulation No. 293 of December 12, 2005, the maximum amount for annual peat extraction is limited to 2.653 million tons. In 1994, the Government of Estonia borrowed 64.5 million USD from the World Bank to rehabilitate a number of municipal heating schemes. These were to be based on local peat and wood resources, substituting heavy oil and natural gas imported from Russia. Nevertheless, the priority of reconstructing these heating systems for peat burning did not realize as planned at first: only 6–8 local heating schemes are based on peat at present (E. Niitlaan, pers. comm.). On the other hand, a joint venture was started in the 1990s between a Swedish power company and an Estonian peat-briquette company, and peat briquettes have been exported annually.

A continuous rise in horticultural peat excavation can be expected. In many European countries, the resources of poorly decomposed *Sphagnum* peat are almost exhausted, but the need for the product is increasing. As the peat excavation infrastructure has developed rather well in Estonia, many western European companies are deeply interested in Estonian *Sphagnum* peat resources. The Government of Estonia and regional authorities are under pressure from peat industry developers to permit new peat extracting plants on intact peatlands. These developments are being supported by the world-wide demand for moss peat and the relatively low price of peat. At the same time, different environmentalists' NGOs of the consumer countries in western Europe are increasingly paying more attention towards the extraction conditions in Estonia and other peat-exporting countries, and are ready to implement boycott actions against the use of peat in horticulture.

According to the EU Renewable Energy Directive 2009/28/EC[85] adopted on April 23, 2009, peat is a non-renewable resource. If earlier the annual quota for peat excavation was based on peat increment (despite how it was estimated), now the territorial concept has been brought to the first plane. This rises from the fact that with excavation certain areas will always be irreversible spoiled.

In 2005 the Estonian State Audit Office audited the activities of the state in planning the use of peat resources and managing their extraction. On that ground it was suggested to the Ministry of the Environment that they should stop issuing of new permissions for mining regarding mires or parts of mires which are not mined yet. This was done in order to sustain the use of peat and preserve valuable sites.

Thus, we need an agreement, concluded on as large a social and scientific basis as possible, which mires must be preserved and which of them will be left free for admissible human activities. To make that kind of crucial decision, the results of the present inventory of all mires should enable to find a compromise between nature conservationists and peat extractors. Ca 115,000 ha of the total area of bogs (>150,000 ha) are situated within different protected areas at the present. The remaining bogs (~35,000 ha) cover an area that is larger than has been used by peat extractors during all the industrial history of Estonia. It is possible to select certain (less valuable) areas for economic use among these 35,000 hectares; since now the results of the present inventory should be of help to find the most relevant areas. After a necessary correction of data about the peat resources in discharged or "free" mires, it will be possible to decide whether and with what intensity the peat resources may be used in the future and on that basis the figures of permitted usage rates can be established.

Since the 1990s, both foreign and Estonian companies have rented several untouched bogs and established new peat-fields, some of them are already in use. The largest of these is Elbu (Nurme) bog in

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83 Access at: https://valitsus.ee/UserFiles/valitsus/et/valitsus/arengukavad/majandus-ja-kommunikatsiooniministeerium/Eesti_elektrimajanduse_arengukava.pdf (30.04.2011).

84 Access at: https://www.riigiteataja.ee/aktilisa/0000/1319/4286/13195400.pdf (30.04.2011).

85 Access at: http://www.r-e-a.net/document-library/thirdparty/rea-and-fqd-documents/REDDoc_090605_Directive_200928EC_OJ.pdf (30.04.2011).

Pärnumaa (southwestern Estonia). Together with older fields, they should meet the needs of peat during at least the next decade. Further extraction fields should be as much as possible designated to the former bog areas (which do not correspond to the Natura habitat type 7110 any more). In the documents of the International Peat Society (IPS) it is stated[86] that pristine mires should be excluded as the future peat extraction fields, and it is fixed in the resolution of the Changwon COP of the Ramsar Convention that peat extraction in the partner countries of the convention should be to aimed at degraded peatlands (Ramsar Convention, 2008). The World Bank Environmental Assessment report, within Estonia – Agriculture Project, advised that peat extraction for energetics (heating) should be concentrated on peatlands that have already been partially drained or used for milled-peat excavation. Though the quality of horticultural peat is presumably lower in such areas (decomposition has started, etc.), peat extraction does not harm any habitats there (where conservation value is already reduced or degraded in most cases) but, on the other hand, enables to stop long-term carbon emission from decomposing peatlands (emissions of CO_2 do not decrease in case peat is used as a fuel, but due to intensive use of degraded peatlands CO_2 is emitted during shorter period). The long-term monitoring of peatlands indicates that peat losses caused by mineralization may be up to 10–15 tons of dry organic matter per hectare per year (Tomberg, 1992). This is at least 4–5 times higher than the peat accumulation in an intact mire. CO_2 emission from Estonian peatlands to the atmosphere is probably in the range of 5×10^6 tons annually (Ilomets, 1996).

Thus, further peat extraction activities should be restricted to bogs of low protection value, and especially to those peatlands which have already been influenced by human activities (former pits, drainage, afforestation which has proved unsuccessful or unfeasible economically, etc.). It should also be emphasized that the development of methods and technologies which enable the maximum utilization of resources in already opened peat extraction areas should highly be encouraged. This aspect is in accordance with the Act on Sustainable Development, and helps to concentrate peat extraction to a smaller number of peatlands thus *inter alia* decreasing the price of later wetland restoration.

86 IPS 2010. Strategy for Responsible Peatland Management. Access at: http://www.peatsociety.org/user_files/files/srpmwebversion.pdf (30.04.2011).

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ANNEXES

Annex I

Worksheet for inspection of mires (translation into English)

Sheet No.. .... **Date**: .... **Investigator(s)**: ....
1. Local name of the mire ....
2. Flora and vegetation: 2.1. Name(s) of habitat type(s)
a) according to Paal 1997 : ....
b) according to Habitats Directive ....
2.2. **Shrub layer:** 0 – absent, 1 – normal to the type, 2 – expanding; density ....

Species (only if density is more than 0,05)	average height (m)	maximum height (m)	density (0–1)	Species (only if density is more than 0,05)	average height (m)	maximum height (m)	density (0–1)
1.				3.			
2.				4.			

2.3. **Tree layer:** 0 - absent, 1 - species composition ....,
density (0 – 1) ...., height (m) average.: ...., max: ....
2.4. Covered by groves ....%; dense shrubbery ....% ; totally open mire .... %
2.5. **Age of tree layer:** 1 – young, 2 – medium, 3 – old/mature, 4 – of various age. Estimate ca .... years
2.6. **Changes in field layer** (estimates for *Phragmites australis*, *Filipendula ulmaria*, etc.):
....: 1 – sparse, 2 – clumps, 3 – dense; coverage ..../........./......... %
....: 1 – sparse, 2 – clumps, 3 – dense; coverage ..../........./......... %
3. Human impact: 3.1. Drainage: 0 – none, 1 – weak, 2 – moderate, 3 – strong
3.2. Mowing: 0 – never, 1 – ceased > 10 y. ago, 2 – ceased 4–10 y. ago, 3 – mowed 1–3 y. ago, 4 – mowed this season. Comments ....
3.3. Grazing: 0 – ceased > 10 y. ago, 1 – ceased 4–10 y. ago, 2 – grazed 1–3 y. ago, 3 – grazed this year, 4 – immoderate, 5 – random, 6 – has never been grazed. Amount of cattle ....
3.4. Burning: 0 – none, 1 – weak, 2 – sporadic, 3 – strong. Comments ....
3.5. Other impacts: buildings, stone fences, trampling, roads, sleddings, rides, (power) lines, peat-cutting, pits, pollution, waste, fertilizing, forest cutting (in comments estimate time/duration of impact)
....
....
3.6. Neighbourhood effects (pos./neg.) ....
4. Field evaluation: 4.1. Conservation status: A – excellent, B – good, C – average or reduced, D – degraded
4.2. Floristic value: 1 – high, 2 – moderate, 3 – low, 0 – lacking/degraded
4.3. Aesthetic value: 1 – high, 2 – moderate, 3 – low, 0 – lacking
4.4. Other values: hydrological features, faunistic value, mycological value, area rich in berries (species: ....), other economic values (which?), development processes, regeneration area, recreational, didactic, ...
4.5. Representativity: A – excellent, B – good, C – significant, D – non-significant
5. Global assessment: A – excellent, B – good, C – significant, D – low or lacking
6. Additional comments (general comments, specifications; restoration possibilities; registered bryophytes, animals and fungi, etc.):

Abi alba	– vulne	– palus	– sylva	Cyno cr	– repan	– uligi	– tatar	Matt st	Pep por	– obtus	– vosag	– verna	– serpy
– balsa	Ape spi	– stagn	– tomen	Cype fu	Euo eur	Goo rep	Lam alb	Med bor	Peta hy	– pecti	Rub arc	– visco	Tili co
– sibir	Aqu vul	Call vu	– vagin	Cypr ca	Eupa ca	Gym co	– ample	– falca	– spuri	– perfo	– caesi	– vulga	Tof cal
Ace neg	Arab th	Calt pa	– vesic	Cys fra	Euph cy	– odora	– hybri	– lupul	Peu ore	– prael	– chama	Ser tin	Tor jap
– plata	Arab gla	Caly se	– virid	Dact as	– esula	Gym dr	– macul	– sativ	– palus	– pusil	– idaeu	Ses coe	Tra pra
– pseud	– plani	Cam mi	– vitil	– glome	– helio	– rober	– purpu	– ×vari	Pha aru	– rutil	– nesse	Set vir	Tric al
Ach mil	– hirsu	– sativ	– vulpi	Dact ba	– palus	Gyp fas	Lapp sq	Mela ar	Phe con	– trich	– saxat	Sil chl	– cespi
– ptarm	Arc lap	Cam cer	Carl int	– cruen	– tomma	– mural	Laps co	– crist	Phi coro	Pote an	Rum ac	– dicho	Trie eu
– salic	– minus	– glome	– longi	– fuchs	Euphras	Hal ped	Las lat	– nemor	Phl nod	– argen	– ac-la	– dioic	Trif al
Aci arv	– tomen	– latif	– vulga	– incar	– bravi	Ham pal	– prute	– polon	– phleo	– crant	– aquat	– nocti	– arven
Acor ca	Arc uva	– patul	Caru ca	– macul	– fenni	Hed hel	Lath sq	– prate	– prate	– erect	– confe	– nutan	– aureu
Act spi	Are pro	– persi	Cat aqu	– russo	– micra	Heli nu	Lath ma	– sylva	Phr aus	– fruti	– crisp	– prate	– campe
Ado mo	– serpy	– rapun	Cent cy	Dan dec	– parvi	Heli are	– linif	Meli nu	Phys op	– heide	– hydro	– tatar	– fragi
Aeg pod	Arme el	– rotun	– jacea	Dap me	– ×reut	Heli pra	– niger	Meli al	Phyt sp	– impol	– longi	– vulga	– hybri
Aes hip	Arm rus	– trach	– phryg	Dau car	– stric	– pubes	– palus	– altis	Pice ab	– inter	– marit	Sina arv	– mediu
Aet cyn	Arr ela	Cap bur	– scabi	Des ces	– sueci	Hep no	– pisif	– denta	Picr hi	– neuma	– obtus	Sis alt	– monta
Agri eu	Art abs	Cara ar	Cent er	– flexu	– verna	Her sibi	– prate	– offic	Pil bauh	– norve	– pseud	– loese	– prate
– pilos	– campe	Car ama	– litto	Des sop	Fal con	– sosno	– sylve	Ment aq	– ×bifu	– palust	– tenui	– offic	– repen
Agro ca	– marit	– bulbi	– pulch	Dia are	– dumet	Herm m	– tuber	– arven	– caesp	– repta	– thyrs	– supin	– spadi
– capill	– rupes	– denta	Cent mi	– delto	Fes alt	Hern gl	– vernu	– longi	– cymos	– ×suba	Rup chi	– volge	Trig ma
– gigan	– vulga	– hirsu	Cep lon	– super	– arund	Hes mat	Lav thu	– ×vert	– echio	Pri far	– marit	Siu lat	– palus
– stolo	Asa eur	– impat	– rubra	Dipl mu	– gigan	Hieraci	Led pal	Meny tr	– ×fenn	– veris	Sag mar	Sola du	Tris fl
– vinea	Aspa of	– palud	Cera ar	Diph co	– ovina	– caesi	Lee ory	Mer per	– ×flori	Pru vul	– nodos	– nigru	Tro eur
Aju pyr	Aspe pr	– prate	– fonta	– trist	– poles	– diaph	Lem gib	Mil eff	– offic	Pru insi	– procu	Soli ca	Tus far
– repta	Aspe tin	Card ar	– pumil	Drab in	– prate	– galba	– minor	Moe tri	– onege	– spino	Sag sag	– virga	Typ ang
Alchemi	Aspl ru	Card dr	– semid	– mural	– rubra	– hjelt	– trisu	Mol coe	– pil-fl	Pte aqu	Sali eu	Son arv	– latif
– acuti	– trich	Card ac	Cera vul	– nemor	– trach	– laevi	– turio	Mone u	– praea	Puc cap	Sali ac	– asper	Ulm gla
– balti	Aste tri	– crisp	Cera de	Drac ru	Fila ar	– mixop	Leon au	Mono h	– schult	– dista	– alba	– olera	– laevi
– cymat	Astr ar	– nutan	Chae mi	– thymi	– minim	– oisto	– danub	Mont fo	– sueci	– marit	– aurit	Sor sor	Urt dio
– filic	– danic	– thoer	Chae ar	Dro ang	Fili de	– patal	– hispi	Myc mu	– vaill	Pulm an	– capre	Sor auc	– urens
– glabra	– glycy	Car ac-a	Cha cal	– inter	– ulmar	– pellu	Leon ca	Myos ar	– zizi	– obscu	– ciner	– inter	Utr aus
– glabri	Ath fil	– acutif	Cha rec	– ×obo	– vulga	– phila	– quinq	– balti	Pim maj	Puls pa	– daphn	– rupic	– inter
– glauc	Atr cal	– appro	– suave	– rotun	Frag mo	– ravus	Lep den	– caesp	– saxif	– prate	– ×dasy	Spa ang	– minor
– glome	– glabr	– aquat	Chel ma	Dry car	– vesca	– rossi	– latif	– ramos	Pin alp	– ×wolf	– fragi	– emers	– vulga
– graci	– horte	– arena	Chen al	– crist	– virid	– silve	– ruder	– scorp	– vulga	Pyr chl	– lappo	– erect	Vac myr
– hepta	– litto	– brunn	– glauc	– dilat	Fran al	– steno	Leu vul	– spars	Pin syl	– media	– myrsi	– glome	– uligi
– hirsu	– longi	– buxba	– hybri	– expan	Frax ex	– umbel	Lev off	– stric	Plan la	– minor	– myrti	– grami	– vitis
– monti	– patul	– canes	– polys	– filix	Fum off	– vulga	Ley are	– sylva	– major	– rotun	– penta	– micro	Vale of
– obtus	– praec	– capil	– rubru	Echi cr	Gag lut	Hier au	Lib mon	Myoso a	– marit	Pyr pyra	– phyli	– minim	Vale loc
– plica	– prost	– caryo	– stric	Echi sp	– minim	– hirta	Ligu sib	Myos m	– media	Que rob	– purpu	– negle	Ver ×co
– propi	Ave fat	– cespi	– sueci	Echi vu	Gale ori	– odora	Lil bulb	Myri gal	– uligi	Ran acr	– repen	Spe arv	– nigru
– sarma	– sativ	– chord	– urbic	Elaea co	Gale lu	Hip vul	– marta	Myri al	– winte	– aquat	– rosma	– sativ	– thaps
– subcr	Ax amar	– daval	Chi um	Ela hyd	Gale bi	Holc lan	Lim aqu	– spica	Plat bi	– auric	– ×rube	Spe rub	Ver agr
Alis gra	Bar arc	– demis	Chr alt	Eleo ac	– ladan	Hon pep	Lina vu	– verti	– chlor	– baudo	– stark	– salin	– anaga
– plant	– stric	– diand	Cich in	– mamil	– speci	Horn pe	Linn bo	Naj mar	Ple aus	– bulbo	– trian	Spiraea	– arven
Alli pet	Bel per	– digit	Cicu vi	– palus	– tetra	Hot pal	Linu ca	Nard st	Poa alp	– cassu	– vimin	– chama	– becca
Alli ole	Berb vu	– dioic	Cin lat	– parvu	Gali ci	Hum lu	Lip loe	Neo nid	– angus	– circi	Sals col	– media	– chama
– schoe	Bert in	– dispe	Circ al	– quinq	– parvi	Hup sel	List co	Nep cat	– annua	– falla	– kali	– salici	– filif
– scoro	Beru er	– dista	Cirs ac	– unigl	Gali al	Hyd mo	– ovata	Nes pan	– compr	– ficar	Salv pr	Spi pol	– heder
– ursin	Bet ×au	– disti	– arven	Elo can	– apari	Hyd vul	Lith off	Nup lut	– nemor	– flamm	– verti	Sta off	– longi
– vineal	– humil	– echin	– heter	Ely can	– borea	Hyo nig	Litt uni	– pumil	– palus	– lanug	Samb ni	– palus	– offic
Aln glu	– nana	– elata	– horri	– farct	– elong	Hype hi	Lob dor	– ×spen	– prate	– lingu	– racem	– sylva	– opaca
– incan	– pendu	– elong	– olera	– fa ×re	– mollu	– macul	Lol mul	Nym alb	– remot	– nemor	Samo va	Ste cra	– persi
– ×pube	– pubes	– erice	– palus	– repens	– odora	– monta	– peren	– candi	– subca	– pelta	Sang mi	– grami	– scute
Alo aeg	Bid cer	– exten	– vulga	Emp he	– palus	– perfo	– remot	Odo lit	– trivi	– polya	– offic	– holos	– serpy
– arund	– radia	– flacc	Cla mar	– nigru	– ×pom	Hyp ma	Lon cae	– verna	Pole ca	– repen	Sani eu	– longi	– spica
– genic	– tripa	– flava	Clin vul	Epi ade	– pumil	– radic	– xylos	– vulga	Poly am	– repta	Sap off	– media	– teucr
– prate	Bly com	– glare	Cni dub	– angus	– rival	Imp nol	Lot amb	Oena aq	– comos	– scele	Sau est	– nemor	– verna
Aly aly	– rufus	– globu	Coel vir	– colli	– rupre	– parvi	– arven	Oeno bi	– vulga	– trich	Sax ads	– palus	Vib opu
– gmeli	Bol mar	– hartm	Colc aut	– hirsu	– spuri	Inu bri	– balti	– rubri	Poly mu	Raph ra	– granu	– uligi	Vic ang
– turkes	Bot lun	– heleo	Coni tat	– monta	– trifid	– salic	– callu	Onob ar	– odora	Res lut	– hircu	Str alo	– cassu
Ama alb	– matri	– hirta	Coni ma	– palus	– trifl	Iri pse	– corni	Onon ar	Poly am	Rey jap	– trida	Sua mar	– cracc
– cauda	– multi	– hosti	Cons re	– parvi	– uligi	– sibir	– rupre	– repen	– arenas	– sacha	Sca col	Suc pra	– hirsu
– retro	Brac pi	– irrig	Conv m	– roseu	– verum	Isa tin	Lun red	Ophi vu	– avicu	Rha cat	Sche pa	Swe per	– sativ
Ame spi	– sylva	– junce	Conv ar	– tetra	– wirtg	Iso lac	Lup pol	Ophr in	– bisto	Rhi min	Scho la	Swi alb	– sepiu
Amma ar	Bras ca	– lasio	Cony ca	Epip at	Cent cr	Jasi mo	Luz cam	Orc mas	– borea	– osilie	– taber	– sangu	– sylva
Anac py	Bri med	– lepid	Cora tr	– helle	– pneum	Jov glo	– luzul	– milit	– calca	– serot	Scho fe	– stolo	– tetra
Anag ar	Bro arv	– lepor	Corn su	– palus	Gen am	Junc al	– multi	– morio	– hydro	Rhy alb	– fe ×ni	Sym alb	– villo
Anc arv	– benek	– limos	Cory in	Epip ap	– lingu	– artic	– palli	– ustul	– lapat	– fusca	– nigri	Sym asp	Vinc mi
– offic	– erect	– lolia	– solid	Equ arv	– uligi	– balti	– pilos	Ori vul	– minus	Rib alp	Scir ra	– offic	Vinc hi
And pol	– horde	– macke	Cory av	– fluvi	Ger luc	– bufon	– sudet	Oro bar	– negle	– nigru	– sylva	Syr vul	Vio arv
And sep	– inerm	– monta	Cot int	– hyema	– molle	– bulbo	Lych fl	– elati	– oxysp	– rubru	Scl ann	Tan vul	– canin
Ane ×li	– secal	– muric	– lucid	– ×lito	– palus	– compr	– visca	– palli	– persi	– spica	– peren	Tar bal	– colli
– nemor	– tecto	– nigra	– niger	– palus	– prate	– congl	Lyco in	Ort sec	– vivip	– uva-cr	Scol fe	– decol	– elati
– ranun	Bugl arv	– omski	– scand	– prate	– pusil	– effus	Lyco an	Oxa ace	Poly vu	Rori am	Scor hu	– eryth	– epips
– sylve	Bun ori	– ornit	Cra mar	– scirp	– rober	– filif	– clava	– corni	Populus	– ×ance	Scr nod	– egreg	– hirta
Ang lit	But um	– palle	Crataeg	– sylve	– sangu	– gerar	Lyco eu	– fonta	– alba	– palus	Scu gal	– offic	– litor
– palust	Cak mar	– panice	– monog	– varie	– sylva	– nodul	Lys num	Oxy mic	– balsa	– sylve	– hasti	– sueci	– mirab
– sylve	Cala ar	– panicu	– rhipi	Erig ac	Geu ale	– ranar	– thyrs	– palus	– ×bero	Ros can	Sed acr	Tax bac	– monta
Ante di	– canes	– pauci	– sangu	Erio an	– ×inte	– squar	– vulga	Oxyt pi	– suave	– ciesi	– album	Tet mar	– odora
Anth ar	– epige	– piluli	Cre bie	– graci	– rival	– stygi	Lyt sal	Pad avi	– tremu	– corii	– maxim	Teu sco	– palus
– tinct	– meins	– praec	– molli	– latif	– urban	– subno	Mai bif	Pap arg	Pota al	– glabr	– telep	Tha aqu	– persic
Anth od	– negle	– pseud	– palud	– vagin	Glad im	– tenui	Mal mo	– dubiu	– berch	– majal	Sela se	– flavu	– pumil
Anth sy	– phrag	– pullic	– praem	Erod ci	Gla mar	Jun com	Malu do	– rhoea	– compr	– molli	Seli ca	– lucid	– reich
Anth ar	– purpu	– remot	– tecto	Erop ve	Gle hed	Kna arv	– sylve	– somni	– crisp	– pimpi	Sen con	– minus	– rivin
– ×balt	– stric	– rhizi	Cruc lae	Eruc ga	Gly flu	Koe gla	Malv al	Pari qu	– filif	– pomif	– fluvi	– simpl	– rupes
– cocci	Call pa	– rhync	Cus epri	Eryn ma	– lithu	– grand	– mosch	Parn pa	– fries	– rubig	– integ	Thel pa	– trico
– ×colo	Callitr	– ripar	– europ	Erys ch	– maxim	– macra	– pusil	Pas syl	– grami	– rugos	– jacob	Thes eb	– uligi
– marit	– copho	– rostr	Cym mu	– hiera	– plica	Lac ser	Matr ma	Ped pal	– lucen	– shera	– palud	Thl arv	Zan pal
– ×polyp	– herma	– spica	Cyno of	– marsc	Gna syl	– sibir	– perfo	– scept	– natan	– subca	– sylva	Thy pul	Zos mar

Eesti taimestiku koondblankett (1260 taksonit). Koostanud Toomas Kukk 1999, parandatud 2000 (tomkukk@zbi.ee, 251/89420)

Annex II

Classification of the Estonian vegetation site types (extract from Paal, 1997).

All those site types, type groups and classes are listed below, which have been mentioned in the text of this publication and/or in Annex III. Site types of mire vegetation are given without omissions and in bold. Those site types, which are absent in Paal, 1997 but used in the database and publication as additional ones, are marked with an asterisk (*).

1 FORESTS
1.1 Dry and fresh forests
1.1.2 Boreal heath forests
- 1.1.2.1 *Cladina* site type
- 1.1.2.2 *Calluna* site type

1.1.4 Fresh boreal forests
- 1.1.4.2 *Oxalis* site type

1.2 Floodplain forests and shrublands
1.2.1 Floodplain forests
- 1.2.1.2 *Carex elongata* site type

1.2.2 Floodplain willow shrublands
- 1.2.2.1 *Salix* site type

1.3 Paludified forests
1.3.1 Rich paludified forests
- 1.3.1.2 *Filipendula* site type
- 1.3.1.3 *Molinia* site type

1.3.2 Poor paludified forests
- 1.3.2.1 *Polytrichum* - *Vaccinium myrtillus* site type
- 1.3.2.2 *Polytrichum* site type
- 1.3.2.3 *Vaccinium uliginosum* site type

1.4 Peatland forests
1.4.1 Minerotrophic swamp forests
- 1.4.1.1 Minerotrophic stagnant water swamp forest site type
- 1.4.1.1A* Spring fen forest site type
- 1.4.1.2 Minerotrophic mobile water swamp forest (*Calla*) site type

1.4.2 Mixotrophic (transitional) bog forests
- 1.4.2.1 Mixotrophic (transitional) bog forest site type

1.43 Ombrotrophic bog forests
- 1.4.3.1 Ombrotrophic bog forest site type

1.5 Drained peatland forests
1.5.1 Drained peatland forests
- 1.5.1.1 *Vaccinium myrtillus* drained peatland site type
- 1.5.1.2 *Oxalis* drained peatland site type

2 GRASSLANDS
2.1 Dry and fresh grasslands
2.1.1 Alvar grasslands
- 2.1.1.1 Dry alvar grassland site type
- 2.1.1.2 Fresh alvar grassland site type

2.1.2 Boreal heath grasslands
- 2.1.2.1 Dry boreal heath grassland site type

2.1.3 Boreal grasslands
- 2.1.3.2 Fresh boreal grassland site type

2.1.4 Boreo-nemoral grasslands

2.1.4.1 Dry boreo-nemoral grassland site type
2.1.4.2 Fresh boreo-nemoral grassland site type
2.1.4.3* Karst grassland site type
2.2 Floodplain grasslands
2.2.1 Floodplain grasslands
2.2.1.1 Fresh floodplain grassland site type
2.2.1.2 Wet floodplain grassland site type
2.2.1.3* Inland *Phragmites* grassland site type (inland reed-beds)
2.2.1.4* Paludified floodplain grassland site type
2.3 Coastal meadows
2.3.1 Coastal meadows
2.3.1.1 Saline coastal meadow site type
2.3.1.2 Suprasaline coastal meadow site type
2.3.1.3* Coastal *Phragmites* meadow site type (coastal reed-beds)
2.4 Paludified grasslands
2.4.1 Paludified grasslands
2.4.1.1 Poor paludified grassland site type
2.4.1.2 Rich paludified grassland site type
3 MIRES
3.1 Fens
3.1.1 Minerotrophic fens
3.1.1.1 Poor fen site type
3.1.1.2 Rich fen site type
3.1.1.3 Minerotrophic quagmire site type
3.1.1.4* Floodplain fen site type
3.1.2 Mixotrophic (transitional) fens
3.1.2.1 Mixotrophic (transitional) grass mire site type
3.1.2.2 Mixotrophic quagmire site type
3.1.3 Spring fens
3.1.3.1 Spring fen site type
3.2 Bogs
3.2.1 Heath moors
3.2.1.1 Heath moor site type
3.2.2 Ombrotrophic raised bogs
3.2.2.1 Hummock bog site type
3.2.2.2 Hollow-ridge bog site type
3.2.2.3 Pool-ridge bog site type
6 VEGETATION OF WATERBODIES
6.1 Vegetation of freshwater waterbodies
6.1.1 Vegetation of lakes and pools
6.1.1.3 Dystrophic waterbody site type
6.1.1.5 Eutrophic waterbody site type
6.1.1.6 Halotrophic waterbody site type
6.1.1.7* Alkalitrophic waterbody site type
6.1.2 Vegetation of watercourses
6.1.2.1 Watercourse site type
6.2 Vegetation of brackish waterbodies
6.2.1 Vegetation of shallow water
6.2.1.1 Shallow water site type
7 RUDERAL VEGETATION
7.3 Vegetation of abandoned fields
7.5* Vegetation of former pits
7.6* Vegetation of milled peat-fields
8 CULTIVATED VEGETATION
8.1 Vegetation of cultivated grasslands
8.1.2 Cultivated haylands

ANNEX III

List of inspected mires

Legend

1 – **Code** (locality number)
2 – **Reference to map** (page number)
3 – **Site type(s)** (as in Annex II)
4 – **Natura 2000 habitat type(s)**
5 – **Surface** (ha)
6 – **Date**
7 – **Expert(s)**
8 – **Representativity**
  A – excellent
  B – good
  C – significant
  D – non-significant
9 – **Impact of drainage**
  0 – none
  1 – weak
  2 – moderate
  3 – strong
10 – **Conservation status**
  A – excellent
  B – good
  C – average or reduced
  D – degraded
11 – **Assessment of floristic value**
  1 – high
  2 – moderate
  3 – low
  0 – lacking/degraded
12 – **Assessment of landscape (aesthetic) value**
  1 – high
  2 – moderate
  3 – low
  0 – lacking
13 – **Global assessment**
  A – excellent
  B – good
  C – significant
  D – low or lacking
14 – **Present protection percentage**

The table with data concerning all 11,034 mires is attached to this publication on CD.

ANNEX IV

Overview of the court cases on peatlands

The Supreme Court

Local protected area of Ess-soo[87]

According to an Order of the Environmental Authority of Võru District of October 14, 2002, it was decided to issue an extraction permit to Public Limited Company Ketal Võru (hereinafter: PLC Ketal Võru) for peat extraction in Võru District, Rural Municipality of Urvaste, Ess-soo production area of peat at Ess-soo peat deposit with the total area of 100 ha. The Government of the Rural Municipality of Urvaste has given its consent for the extraction of mineral resources with an Order of December 19, 2000. On September 27, 2004, the Civil Law Partnership Roheline Urvaste (hereinafter: CLP) submitted a petition to the Government of the Rural Municipality of Urvaste, by which it applied to have the Order, in which the consent for the extraction of mineral resources was given, annulled. The Government of the Rural Municipality of Urvaste dismissed the petition of the CLP.

On September 10, 2004, an authorized representative of the CLP submitted a challenge to the Environmental Authority of Võru District, which was dismissed. On November 22, 2004, the authorized representative of the CLP filed an action with the Administrative Court of Tartu, to have the order of Environmental Authority of Võru District, by which it was decided to issue the extraction permit of mineral resources, annulled. According to the action the order is unlawful because of the following circumstances:

1. During the procedure for issuing the extraction permit, the EIA must have been carried out;
2. There was no consent of the local government for issuing the extraction permit;
3. The Environmental Authority did not have enough information to make a considered decision to issue the extraction permit.

Among other things the representative of the CLP substantiated its standing by referring to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (so-called "Aarhus Convention").

With its judgement of November 30, 2005 the Administrative Court of Tartu dismissed the action brought by the representative of CLP against the Order of the Environmental Authority of Võru District, by which the decision to issue the extraction permit was made. According to the court's opinion the challenged Order complied with the legal provisions and general principles of law applicable at that time. The court found that the PLC Ketal Võru had acquired a constitutional expectation to receive the mineral extraction permit.

The authorized representative of the CLP filed an appeal against the decision of the Administrative Court of Tartu with the District Court of Tartu. The District Court of Tartu satisfied the appeal on March 9, 2006. The district court annulled the decision of the administrative court and made a new decision by which it annulled the Order of the Environmental Authority of Võru District issued on October 14, 2002. The district court substantiated its decision subsequently: *1) in the contested order the considerations, whether the foreseeable harmful impacts of extraction are or are not bigger than the received benefit and whether mining causes significant damage to environment, are missing; 2) Environmental Authority*

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87 Access at: Judgment No 3-3-1-43-06 of the Supreme Court of 28th of November 2006 in the case brought by Civil Law Partenship Roheline Urvaste against the order No 56of the Environmental Service of Võru District of 14th of October 2002 requesting its annulment. – http://www.riigikohus.ee/?id=11&tekst=RK/3-3-1-43-06 (5.04.2011).

did not have enough data for the assessment of environmental impact and therefore it must have requested that an EIA be carried out. On the basis of existing data the Environmental Authority could not conclude that the impact on the environment would be minimal.

The Environmental Authority of Võru District and the PLC Ketal Võru filed an appeal in cassation against the decision of the District Court of Tartu with the Supreme Court. In solving the case, the Supreme Court considered the determinative factor to be that the CLP had contested an administrative act, which had been issued and for which the term for filing an action had expired long before the CLP was founded. Therefore the Supreme Court satisfied the appeal in cassation. As a result of the judgement, the Order of the Environmental Service of Võru District by which it was decided to issue the extraction permit (however the permit was not issued, see the next case), remained in force.

The District Court

Local protected area of Ess-soo[88]

On February 16, 2007, seven social organizations (including CLP), and 17 entrepreneurs made a collective proposal to the Government of the Rural Municipality of Urvaste to initiate the procedure for placing Ess-soo under local protection and to establish a local protected area. The Government of the Rural Municipality of Urvaste ordered an expert assessment to estimate the justification for placing the proposed area under protection and the purposefulness of planned restrictions. In its opinion, the expert considered the proposal to place Ess-soo under local protection to be reasonable.

The Council of the Rural Municipality of Urvaste initiated the procedure to form a local protected area on May 23, 2007. The PLC Ketal Võru, to whom the Environmental Authority had decided to issue the permit for peat extraction within the planned protected area (the actual permit itself had not been issued yet), filed written counterarguments against the formation of the protected area. On March 26, 2008, the Council of the Rural Municipality of Urvaste decided to terminate the procedure for forming the protected area of Ess-soo and to dismiss the proposal to form the protected area. The CPL filed a challenge against the latter decision, which was not satisfied by the Council of the Rural Municipality. On June 20, 2008, the CPL filed an action with the Administrative Court of Tartu requesting the annulment of the decision to refuse the formation of the protected area of Ess-soo.

According to the action, the contested decision is unlawful as the appropriate reasons for the refusal are missing and the considerations on the basis of which the decision has been made are either wrong or insufficient. The Rural Municipality of Urvaste mainly had to consider the public interest to place Ess-soo under protection, which was expressed in the proposal to take the area under protection, and the respective expert assessment on one hand and the private interest of the PLC Ketal Võru to extract peat on the other. According to the action it is not apparent that values of the area and the national interest to use the deposit were sufficiently considered in the contested decision and in the decision on challenge made by the Council of the Rural Municipality of Urvaste. The Council of the Rural Municipality of Urvaste and the PLC Ketal Võru disagreed with the content of the action.

The Administrative Court of Tartu found that when adopting the contested decision the Council of the Rural Municipality of Urvaste had to consider different interests -- the public interest to place Ess-soo under

88 Access at: Judgement No 3-08-1195 of the District Court of Tartu of 9th of April 2009 in the case brought byCLP Roheline Urvaste against the decision No 1-1/10 of the Council of the Rural Municipality of Urvaste of 26th of March 2008 requesting its annullment. – http://kola.just.ee/ (31.03.2011).

protection, which was expressed in the proposal to place the area under the protection and in the expert assessment, the private interest of the PLC Ketal Võru to extract peat and the national interest related to the fact that the contested area is registered in the state register of mineral resources as a peat deposit. The court found that these interests had not been considered with sufficient comprehensiveness. According to the opinion of the court, unreasonable priority had been given to the private interest of the PLC Ketal Võru and the assumed national interest, **but significant potential prerequisites to place Ess-soo under the protection, which were established in the administrative procedure – Ess-soo as the significant element of landscape in the area between Võru and Otepää, its educational and recreational value, which all are important on the regional and the local level – had not been assessed.**

It is noteworthy that in the explanatory memorandum of the Comprehensive Plan of the rural municipality it has been marked **that the expansion of peat production is not recommended**. In November 2004, the opposition of the local community against the large-scale peat extraction in the Ess-soo bog was pointed out in the Development Plan of the Rural Municipality of Urvaste for 2005-2013, which had been approved by the Council of the Rural Municipality. In the same document it is mentioned that the **Council and the Government of the Rural Municipality of Urvaste support the conservation of Ess-soo in its status quo**. In the Action Plan of the Rural Municipality of Urvaste for 2005-2008 it is planned to supervise the use of Ess-soo peat bog and to exhibit the bog to visitors. The court pointed out all these arguments as well and found that the decision of the Council of the Rural Municipality of Urvaste, in which it refused to place Ess-soo under protection was unlawful and therefore annulled the decision. The court required that the Council of the Rural Municipality of Urvaste reconsider the question of placing Ess-soo under protection.

The PLC Ketal Võru filed an appeal against this court decision with the District Court of Tartu, in which it asked to have the decision of the Administrative Court of Tartu repealed. The district court decided that the appeal should be dismissed and the decision of the Administrative Court of Tartu should not be amended. The District Court found that the Administrative Court had assessed the evidence and implemented the law in a right way and the appeal was therefore not founded.

Local protected area of Rehatse[89]

Private limited company Ronette (hereinafter: PLC Ronette) filed an action with the Administrative Court of Tallinn to have the Regulation No 12 of the Council of the Rural Municipality of June 27, 2007, according to which the local protected area of Rehatse was established (hereinafter: the Regulation No 12), annulled.[90]

The protected area partially covers an area for which PLC Ronette has made an application for a permit to extract sand. PLC Ronette claimed in the action that the protection rules violate its rights, non-proportionally restricting its right to engage in enterprise, i.e. in extraction of mineral resources. According to the action, the Regulation No 12 is contrary to the principles of legal certainty and legitimate expectation. The PLC Ronette also claimed that the Rural Municipality of Kuusalu initiated the formation of the protected area in order to impede its development activity, after lodging the application for the extraction permit for mineral resources and not because of considerations of nature protection, therefore giving preference to the holders of extraction permits for existing quarries.

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89 Access at: Judgement of the Administrative Court of Tallinn of 20th of March 2008 No 3-07-1525 in the case brought by PLC Ronette requesting the annulment of the Regulation No 12 of the Council of the Rural Municipality of Kuusalu of 27th of June 2007 No 12 and the annulment of the extraction permit for mineral resources No HARM-079 (L.MK.HA.-164166) issued by the Environmental Authority of Harju District on 29th of October 2007. – http://kola.just.ee/ (31.03.2011). Judgement No 3-07-1525 of the District Court of Tallinn of 8th of October 2009 in the same matter is available online – http://kola.just.ee/ (31.03.2011).
90 PLC Ronette also filed an action to have the mineral extraction permit issued by Environmental Authority of Harju District on 29th of October 2007 annulled. The court adjoined this action to the proceedings of the former action but the dispute over mineral extraction permit is irrelevant in the context of the current publication.

The Council of the Rural Municipality of Kuusalu contested the action, claiming that protection rules do not violate the rights of PLC Ronette because the law does not expressly provide for the right to extract mineral resources and the local government has the discretion to form a protected area. Additionally, PLC Ronette did not submit any counterarguments in the open proceedings for the formation of the protected area. **According to the Council of the Rural Municipality the reason for forming the local protected area of Rehatse was the conservation of forest and mire biotic communities, aesthetical values and the forest landscape nearby the village of Kuusalu.**

The court found that the action to annul the Regulation No 12 was reasoned and backed by evidence and must be satisfied in the extent applied for by the PLC Ronette. According to the opinion of the Administrative Court the statement of grounds of the Regulation No 12 of the Council of the Rural Municipality of Kuusalu is clearly insufficient regarding the factual base of the regulation. According to the court's opinion, it is not clear from the legal act challenged which plant and animal species are to be protected and why these species are considered to appear in the area covered by the Regulation No 12. The decision to place an area under protection is taken by way of discretion, which sets especially high requirements to the obligation of bringing out the reasoning. According to the court's decision, the Regulation No 12 does not meet the requirements to the reasoning, it is substantially unfounded and the need for its adoption is unclear. In court's opinion, the respondent could not submit considerable reasons during the court procedure either; therefore the court decided to annul the decision to enact the Regulation No 12.

The Council of the Rural Municipality of Kuusalu filed an appeal against the decision of the administrative court with the District Court of Tallinn. The District Court of Tallinn annulled the decision of the administrative court in the matter and obligated the administrative court to make a new decision, according to which the action of PLC Ronette should be dismissed. The district court pointed out important and comprehensive considerations of the Council of Rural Municipality for forming the protected area, including two respective expert assessments (pages 11-15 of the decision).[91] From these considerations the rural municipality has pointed out the following as the most important: the protected area has foremost aesthetical value from the point of view of the living environment and recreation opportunities of the local inhabitants; certainly it is also endangered natural object. In conclusion, the District Court of Tallinn found that in the case of the local landscape protection area of Rehatse all the presumptions provided in Nature Conservation Act were fulfilled and the decision was well reasoned.

The District Court of Tallinn also found that the reasons to form the local protected area should first and foremost be the arguments in connection with the living environment, not the nature protection arguments, because the latter are important for reasoning the decisions placing an area under protection on the state level. The purpose of forming a local protected area must be the protection of the aesthetical local living environment.

Suurupi Nature Reserve[92]

PLC Balti Finantseerimiseasutus (hereinafter: BFA) owns real estate in Suurupi hamlet, Rural Municipality of Harku. According to the forest notifications of the Environmental Authority of Harju District of 12th of January 2007 logging was allowed on some of the plots owned by BFA. BFA began with logging in August 2007, but suspended it soon at the request of the Ministry of the Environment.

91 These reasons and considerations were submitted only during the appeal proceedings in the district court.
92 Access at: Judgement No 3-07-2209 of the District Court of Tallinn of 27th of June 2008 in the case brought by PLC Balti Finantseerimisasutus against the Directive No 1171 of the Minister of Environment of 19th of October 2007 requesting establishment of nullity or annulment of the Directive. – http://kola.just.ee/ (31.03.2011).

With a directive of the Minister of the Environment of October 19, 2007 (hereafter: the Directive) supervisory control over the forest notifications was initiated and logging pursuant to them was suspended. According to the Directive such decision has been taken on the basis of the following circumstances. With the Directive of the Minister of the Environment of August 25, 2004 "The Organization of Formation of Protected Areas on the Areas of Natura 2000" the formation of Suurupi landscape protection area has been initiated. According to the above-mentioned forest notifications group selection cutting, clear-cutting and uniform shelterwood cutting was allowed; this directly endangers the conservation of natural values. **According to the expert assessment, which was conducted in 2006, the areas correspond to the criteria of special areas of conservation according to the EU Habitat Directive and the presence of habitat types 9010 (Western taiga) and 9080 (Fennoscandian deciduous swamp woods) have been established.** Additionally, presence of bird species belonging to the Annex I of the EU Birds Directive, for which the Member State must take protective measures according to the Art 4 of the Birds Directive, has been established. Logging causes damage the habitats.

It was found in the Directive that taking into account the clause 41 of the decision of the judgement of the European Court C-96/98 (Commission *vs* France), Member States must guarantee the protection of the areas that correspond to the criteria of the Habitat Directive whether the area has been submitted to the European Commission or not. It was also found in the Directive that damage to the interests of BFA caused by suspending the forest notifications is smaller than the damage to the environment caused by logging. The suspension of the forest notification is a less restrictive and shorter lasting measure than annulling them, but the impact of logging would be irreversible. The forest notifications were decided to be suspended until the results of the public display of the decision to form the protected area and impact assessment of the planned logging are clear.

The BFA filed an action to have the Directive annulled or its nullity established first of all because of the formal mistakes and also for the fact that the Minister of the Environment did not have a legal basis to suspend the forest notification. Additionally the BFA claimed that it had not been given the opportunity to be heard according to the requirements of the administrative procedure; the conduct of EIA is not mandatory according to the EIA legislation, and the forest notifications should not have been suspended taking into account the trust of the BFA.

The Ministry of the Environment asked the court to dismiss the action among other things for the reason that during the process for issuing the forest notification a mistake had been made because no appropriate EIA, which is mandatory according to the law, had been conducted. During the process for issuing the forest notifications possible impacts of the logging activity to the conservation of the habitat type should have been assessed.

The Ministry of the Environment also finds that the Administrative Procedure Act enables taking a decision like the Directive immediately for the protection of the public interest (environmental protection) without providing the parties with an opportunity to be heard.

The Administrative Court of Tallinn found that not giving the BFA an opportunity to be heard was well-founded in the current case and **according to the Directive it has been established that the plots owned by BFA correspond to the criteria of the Special Areas of Conservation of the Habitat Directive and it has been established habitat types of old natural forests and paludified and bog greenwood**. Additionally, presence of bird species of Annex I of the Birds Directive for which protective measures must be taken has been established. According to the court's opinion, the EIA must be carried out because it is mandatory according to the Habitat Directive. The court also found that the Directive was in accordance with the formal requirements applicable to an administrative act and the Ministry of the Environment had the legal basis to suspend the forest notifications. The Administrative Court of Tallinn refused to satisfy the action because of these reasons.

The District Court of Tallinn dismissed the appeal filed by BFA against the decision of the Administrative Court of Tallinn for the same reasons. The District Court of Tallinn remarks in its decision the following: *The administrative court has reasoned in its decision that despite the fact that the area on which the* *real estate owned by the BFA is located has not been proposed by the Government of the Republic to the European Commission to be included into the network of Natura 2000, the protection obligations of the Habitats Directive must be fulfilled.* ***According to the expert assessment, it is an area that corresponds to the criteria of the Habitat Directive.*** *The Ministry of the Environment has explained in its letter of April 25, 2007 how the real estate of BFA is related to the areas of the Natura 2000 network:* ***these are the areas of the first priority in the shadow list of Natura 2000, which has been submitted to the European Commission by non-governmental organizations and the exclusion of such an area from the list of Natura 2000 network areas must be scientifically reasoned by the Member State.*** *The European Commission has not considered the list submitted by the Estonian state as sufficient and thus the state has an obligation to choose additional areas every year until the list is complete.*

In addition to this, the District Court of Tallinn remarks, based on the statements of the respondent, that during the issuance of the forest notifications, the Regulation of the Minister of Environment “The implementation of temporary restrictions on Natura 2000 network areas, which are located outside the protected areas” of April 22, 2004 was in force. According to this Regulation, Suurupi was among temporarily restricted areas and this Regulation prohibited clear-cutting. Therefore the court was of the opinion that the procedure for issuing the forest notifications had not been conducted according to the applicable legislation. **Not carrying out an EIA on the planned nature protection area could also have affected the decision to allow logging.** In conclusion the District Court of Tallinn found that the forest notifications, which were issued to the BFA were unlawful.

Peat extraction in Keressaare[93]

Public Limited Company Tartu Jõujaam (hereinafter: *PLC Tartu Jõujaam*) submitted an application for a permit for the extraction of mineral resources in the northern part of the peat deposit of Keressaare to the District Government of Tartu District. The extraction operation would be situated on the territory of the Rural Municipality of Vara, Tartu district, with an area of 96.03 ha, 123.02 ha with the service land. On December 23, 1997 the District Government of Tartu District decided to issue an extraction permit for the extraction of mineral resources for the peat reserves in the maximum amount of 251 thousand tons and with the maximum annual allowed extraction amount of 12 thousand tons after PLC Tartu Jõujaam has submitted a report of the environmental expert assessment to the Department of Environment of the District Government.

On December 16, 2008 the Council of the Rural Municipality of Vara enacted the Comprehensive Plan of Rural Municipality of Vara (hereinafter: *the Comprehensive Plan*) in which it was decided not to extend the existing peat deposit in Keressaare bog. PLC Tartu Jõujaam had submitted a proposal during the procedure of Comprehensive Plan to exclude the area determined by the extraction permit, but the proposal had been refused. PLC Tartu Jõujaam submitted an action to the administrative court whereby it asked to have the Regulation, which enacted the comprehensive plan (hereinafter: *the Regulation*) partially annulled, i.e. in the part related to Keressaare bog.

According to the action, the guiding function for the land use in Keresaare bog prescribed by the Comprehensive Plan does not enable PLC Tartu Jõujaam to realize its rights, which can be derived from the extraction permit issued to him and for which use the EIA procedure has been initiated. Public authorities (the Government of the Republic and the issuer of the extraction permit) have decided that

93 Access at: Judgement No 3-09-221 of the District Court of Tartu of November 30, 2009 in the administrative case brought by PLC Tartu Jõujaam requesting the partial annulment of the Regulation No 16 of the Council of the Rural Municipality of Vara of December 16, 2008 „The enactment of the Comprehensive Plan of the Rural Municipality of Vara“. – http://kola.just.ee/ (31.03.2011).

the existing peat deposit will be extended and peat will be extracted there if the results of the EIA allow it. District Governor approved only the part of the Comprehensive Plan that does not affect the rights of PLC Tartu Jõujaam. The latter is of the opinion that neither convincing considerations to dismiss the proposal made by it nor the considerations of different interests appear in the Regulation and these constitute significant faults of the discretion.

The respondent found that the Comprehensive Plan did not violate the rights of PLC Tartu Jõujaam, as the refusal of the extraction permit was not decided by it. The partial enactment of the Comprehensive Plan would damage the interests of the rural municipality. In the respondent's opinion, possible interests of PLC Tartu Jõujaam have been given sufficient consideration.

Tartu District Governor, involved in the case by the court, supported the action of PLC Tartu Jõujaam.

The Administrative Court of Tartu satisfied the action in its judgment of April 20, 2009 and annulled the Regulation enacting the Comprehensive Plan partially, i.e. in the part of Keressaare bog. The court reasoned its decision as follows. The District Governor has given its approval to enact the Comprehensive Plan only partially and has not considered it to be possible that the Comprehensive Plan of the Rural Municipality of Vara could be enacted in the part affecting the rights of the PLC Tartu Jõujaam. The respondent did not have the approval of the District Governor to enact the Comprehensive Plan of Vara for the northern part of the Keressaare bog. If the local government cannot enact the Comprehensive Plan as a whole without the approval of the District Governor, then the local government cannot enact the Comprehensive Plan in the part for which the District Governor has not given its approval as well. If this was not the case, the approval of the District Governor as an administrative measure would lose its purpose. Merely the fact that the respondent has violated applicable laws in its enactment of the Comprehensive Plan of the Rural Municipality brings about the satisfaction of the action and the partial annulment of the contested Regulation. The legitimate expectation to receive the extraction permit after the fulfillment of the prerequisites determined in the decision of the District Governor of 1997, has also been violated.

The District Court of Tartu refused to change the judgment of the administrative court, but amended its reasoning. The District Court did not agree with the administrative court in the part of the supervisory competences of the District Governor and found that the enactment of the plan was unlawful because of the mistakes of discretion: *the contested Regulation does not point out the important facts of the case, nor the specific interests and rights of different interested persons that the Council of the Rural Municipality should have considered and did consider. The reasons submitted in the Regulation do not convince the court that in a case where the EIA was still under way in the course of the application for the extension of peat deposit, the consideration of different interests has been conducted rationally and all the important facts and interests have been considered regarding the proposals and the application for partial non-enactment of the Comprehensive Plan submitted by the PLC Tartu Jõujaam.*

Peat extraction in Möllatsi[94]

With the Order of the Environmental Authority of Tartu District of August 25, 2003, permit for extraction of mineral resources for peat extraction in the peat deposit of Möllatsi was issued to PLC Tartu Jõujaam with the total area of 218,4 ha.

94 Access at: Judgment o 2-3-153/2004 of the District Court of Tartu of 15th of September 2004 In the administrative action brought by Peeter Lääne, Natalia Trofimova, Erkki Ergma, Imre Taal, Imants Trofimov, Vahur Siimon, Ene Saluri ja Monika Guk to have the Order No 41-1-4/129 of the Environmental Authority of Tartu District of August 25, 2003 annuled. – http://kola.just.ee/ (6.04.2011).

Peeter Lääne, Natalia Trofimova, Erkki Ergma, Imre Taal, Imants Trofimov, Vahur Siimon, Ene Saluri ja Monika Guk turned to the administrative court and requested to annulment of the above-mentioned order. According to the action *the provisions for the public participation in the process for issuing the extraction permit were violated because the public was not informed about the additional applications for the extraction permit. The public participation rules were also violated in the procedure of EIA. The interested persons were not given enough time to make proposals and to submit written counterarguments. The administrative act is not motivated, the conditions of the extraction permit are loosely worded and therefore the right to clean environment of the local people is not being guaranteed.*

The respondent asked to dismiss the action because it is related to the procedure of an application for an extraction permit that was submitted in 1995 and the public has been informed lawfully. PLC Tartu Jõujaam requested to have the action dismissed, because special conditions determined in the extraction permit include the proposals of the local inhabitants.

The Administrative Court of Tartu refused to satisfy the action with its judgment of March 19, 2004 against which the above-mentioned persons filed an appeal with the District Court of Tartu. The District Court of Tartu also found that there were no grounds for satisfying the appeal and repeated the reasons already presented by the Administrative Court as follows.

1) The application for extraction permit submitted by PLC Tartu Jõujaam on November 29, 2002 must be considered as a specification to the application submitted in 1995 and therefore it was not necessary to repeat the procedural acts that had already been conducted (including notification of the initiation of the procedure); 2) the respondent has not violated the provisions of the Administrative Procedure Act and the principles of the open procedure. The public (including the persons who filed the action) has been informed of the initiation of the EIA as well as of the compilation of the corresponding program and of the finished report according to the applicable law. Through the public discussions the possibility to make proposals has also been guaranteed.

The District Court also found that in the EIA report, which is the basis for the contested administrative act, questions raised by the persons filing the action have been answered sufficiently, specific recommendations on how to reduce the harmful impact (including the potential decrease of the level of ground water, noise, dust) have also been pointed out in the report. As far as harmful impacts are concerned, these recommendations have also been sufficiently considered in the contested order, where the special conditions are determined for PLC Tartu Jõujaam as obligations to guarantee the water supply and to inhibit and monitor the noise and the dust spread. The District Court also found that the persons who filed the action have the opportunity to request the competent authorities to exercise supervision and to issue precepts if excessive harmful impact derives from the peat extraction, as well as use legal remedies of civil law at any time.

The Administrative Court

Alam-Pedja Nature Reserve[95]

The public limited company Kraver (hereinafter: *PLC Kraver*) filed an action to the Administrative Court of Tartu requesting compensation of damage, which had been caused by unlawful activity of the

95 Access at: Judgment No 3-08-76 of the Administrative Court of Tartu of August 15, 2008 in the administrative case brought by PLC Kraver against the Environmental Authority of Viljandi District requesting the compensation for damage. – http://kola.just.ee/ (31.03.2011).

Environmental Authority of Viljandi District. PLC Kraver asked to have damages to the property in the total amount of 588 442 crowns (37 608.3 Euros) awarded from the Environmental Authority of Viljandi District.

PLC Kraver considers the expenses incurred by him in 2002 and 2003 in connection with the geological exploration in the bog of Soosaare as the damage to be awarded. From the point of view of PLC Kraver the Environmental Authority of Viljandi District is the person who caused the damage, behaving in bad faith and unlawfully by giving misleading information that bog of Soosaare will never be placed under protection and on February 5, 2002 issued a permit for geological exploration on the fourth production area of Soosaare.

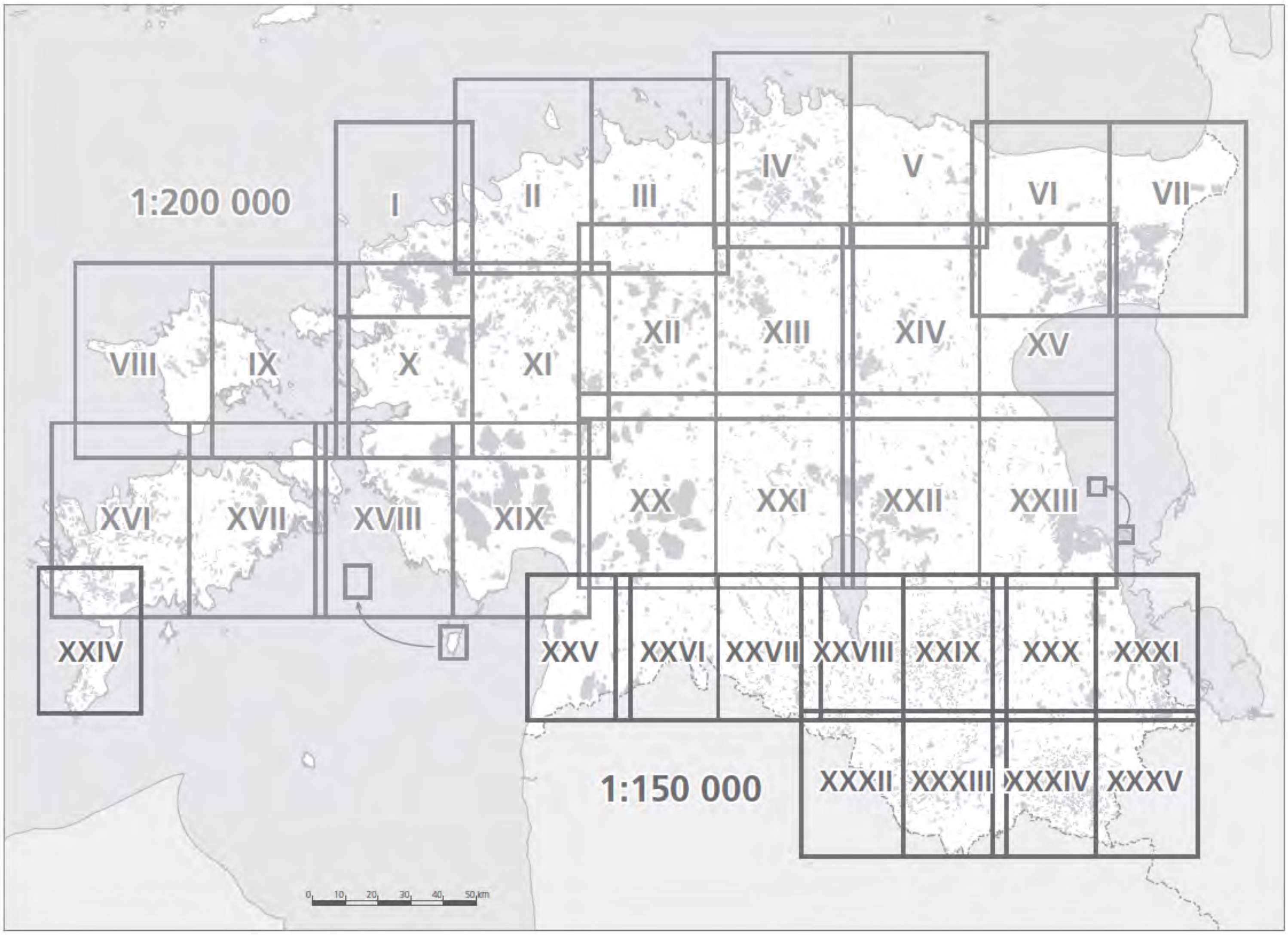
On May 18, 2007, the Government of the Republic adopted the Regulation No 153 "The Protection Rules of Alam-Pedja Nature Reserve" (hereinafter: *the Protection Rules*) According to the Protection Rules the peat extraction and production on the fourth production area in the bog of Soosaare is excluded.

The PLC Kraver claimed that it would not have applied for the exploration permit if it would have known that it cannot extract mineral resources there in the future. The PLC found that the Environmental Authority should have been aware of the plans to place the area under protection, but did not give any information about it to PLC Kraver.

The respondent contested the action with the argument that **during the procedure for issuing the exploration permit grounds for its refusal were not present**. Earth Crust's Act enabled the refusal to issue exploration permit in cases, when the area has been placed under the protection or an application to place the area under protection has been submitted. During the procedure for issuing the exploration permit there was no application to place area under protection and other grounds for refusal to issue the permit were also absent. Thus the permit had to be issued. **During the procedure for issuing the exploration permit the respondent did not know that the area may become a pre-selection area of Natura 2000.** The exploration permit was issued on February 5, 2002, whereas the inventory of the area was made on July 10, 2002 and the final selection of the pre-selection areas was made by the Government of Republic yet on August 5, 2004.

The administrative court found that the Environmental Authority of Viljandi District had not violated the rules of due diligence and good administrative practice. According to the opinion of the Court, the activity of the Environmental Authority, due to which the alleged damage has occurred, has been lawful on the grounds pointed out above by the respondent. The respondent has not violated the rights of PLC Kraver as the exploration permit does not cause a legitimate expectation towards receiving the extraction permit and the expenses of the exploration must be incurred by the person whether it receives the extraction permit later or not.

PLC Kraver filed an appeal on the court's decision with the District Court of Tartu, who refused to change the decision of the Administrative Court of Tartu of August 15, 2008 on the same grounds as the Administrative Court.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LEGEND

Areas less than 6 ha are depicted as symbols. Their colour marks global assessment and shape marks habitat type group.
Areas over 6 ha are depicted as polygons. Their colour marks global assessment and raster marks habitat type group.

Global assessment:

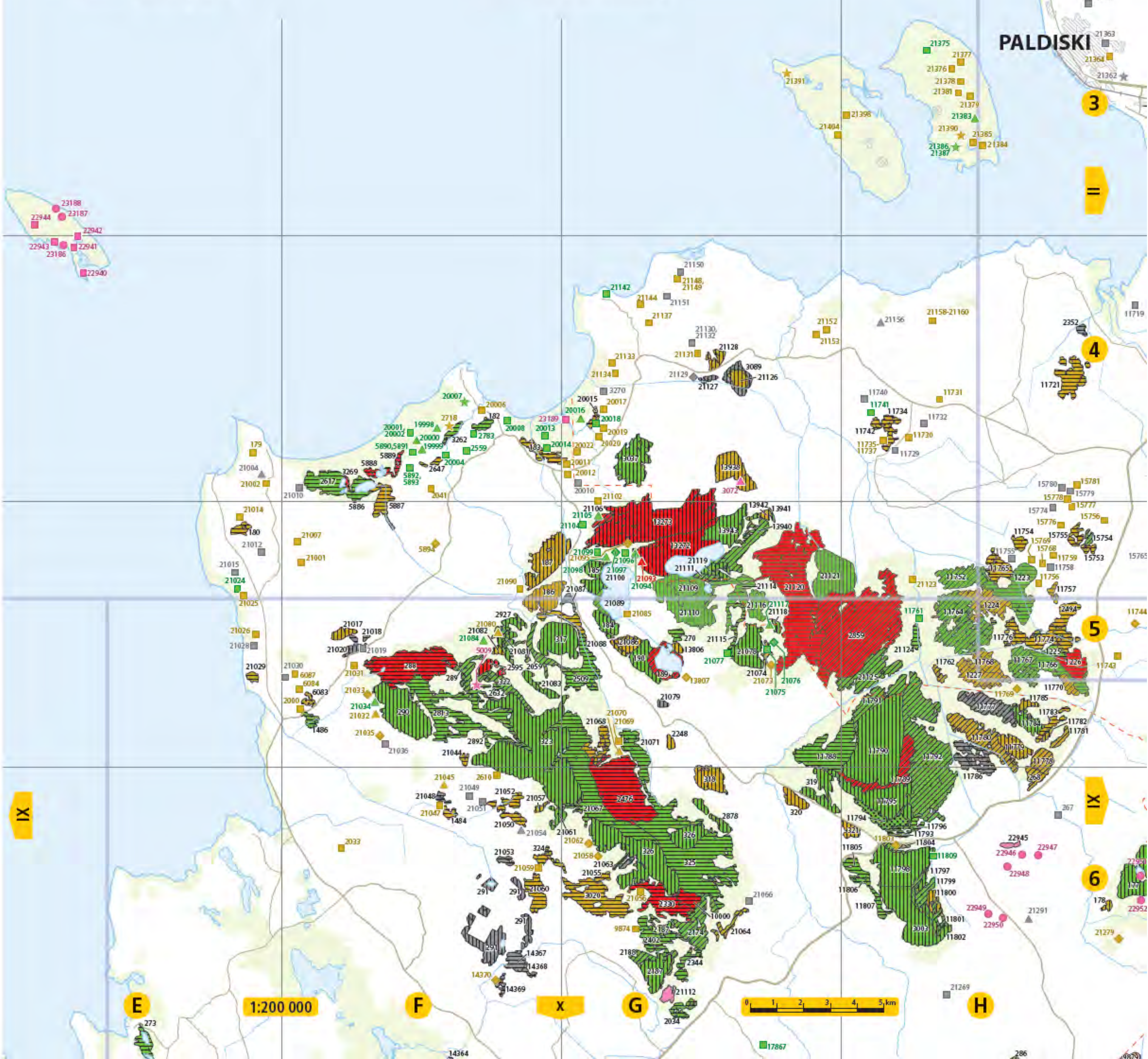
- A - Excellent value
- B - Good value
- C - Significant value
- D - Low or lacking value
- ? - Unknown value

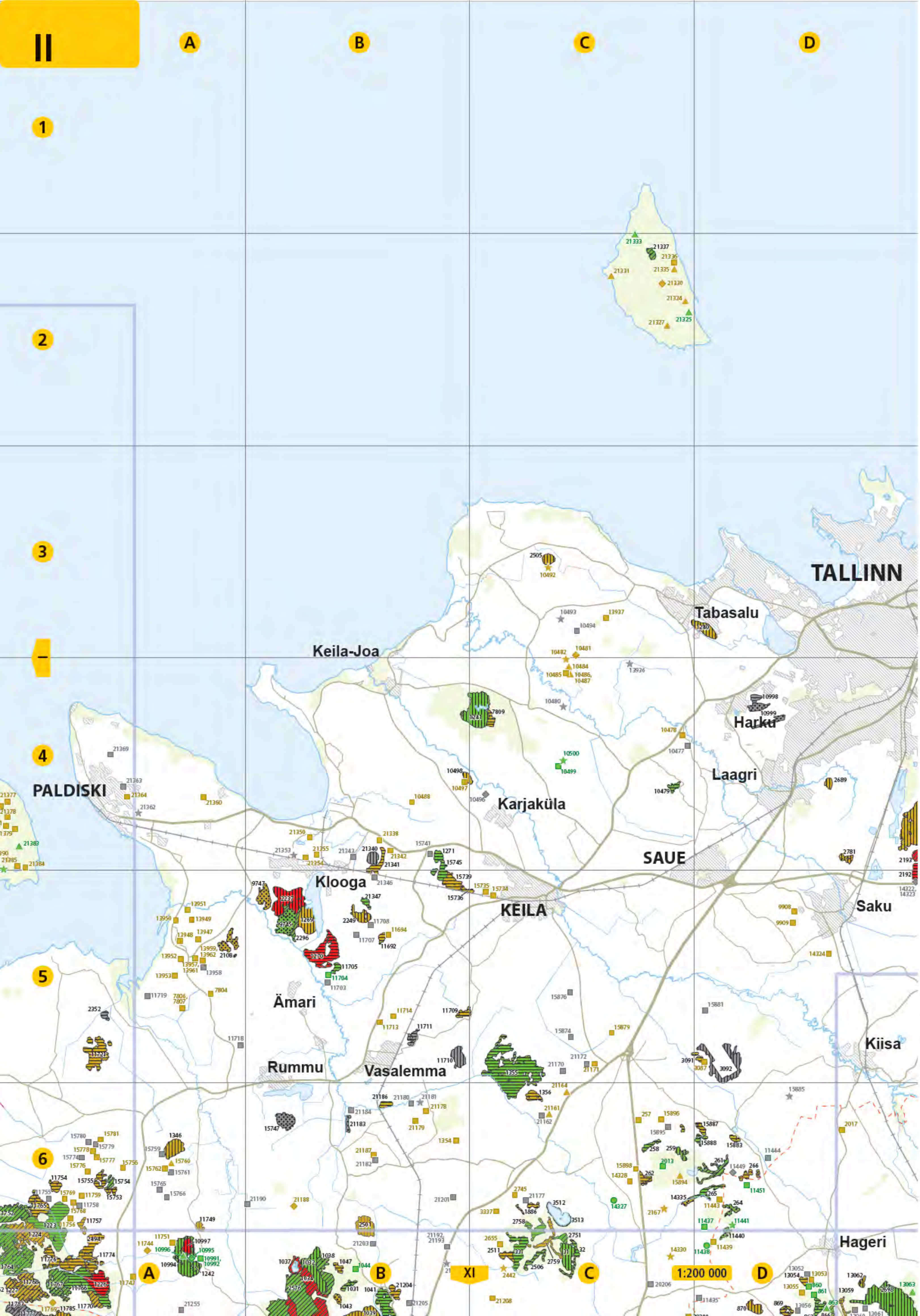
Habitat type groups:

- □ Minerotrophic mire (fen)
- △ Mixotrophic (transition) mire
- ◇ Ombrotrophic mire (bog)
- ○ Mire of unclear type
- ☆ Other habitat partly including a mire

- Protected area
- Built-up area

- District boundary
- National boundary

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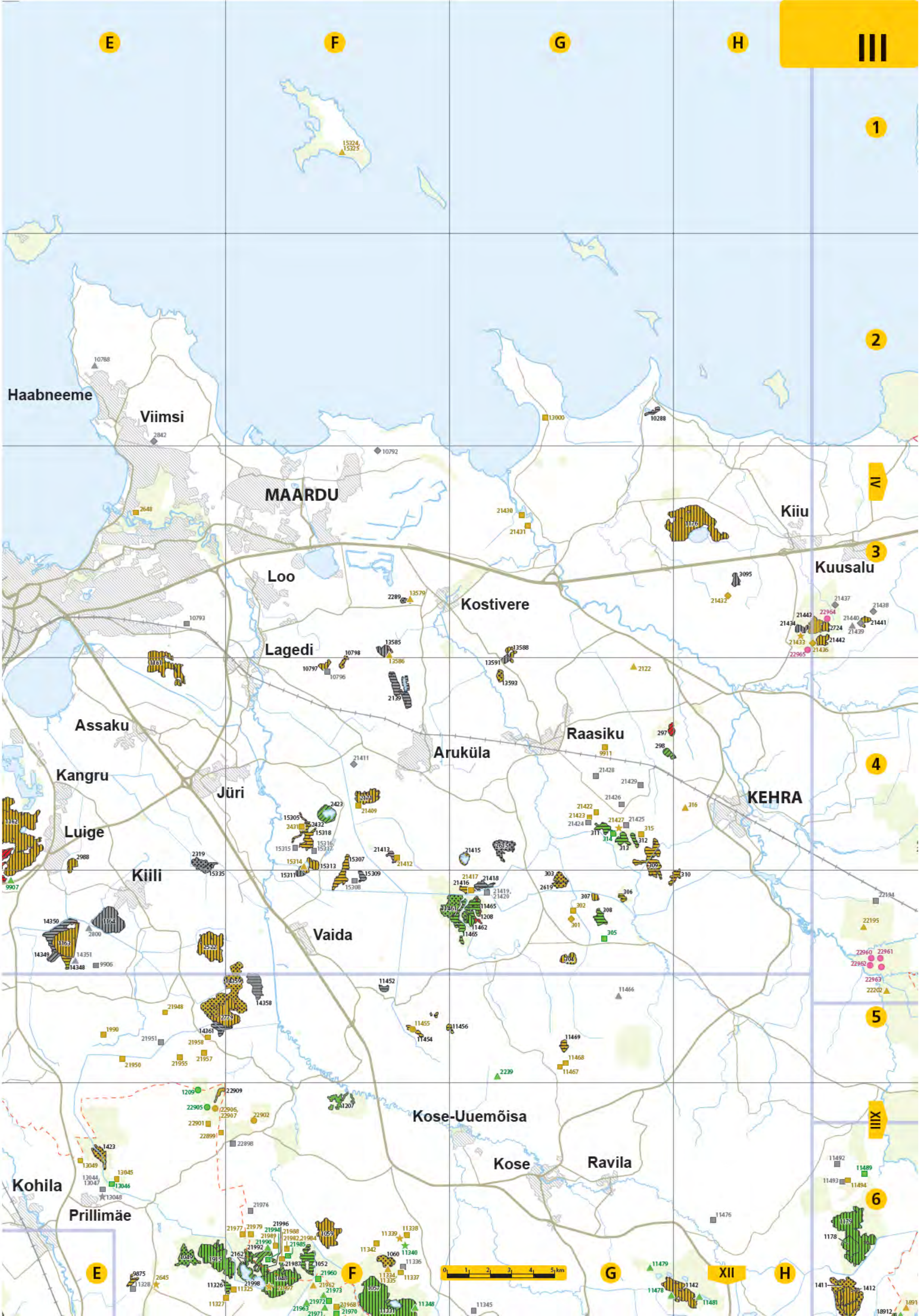

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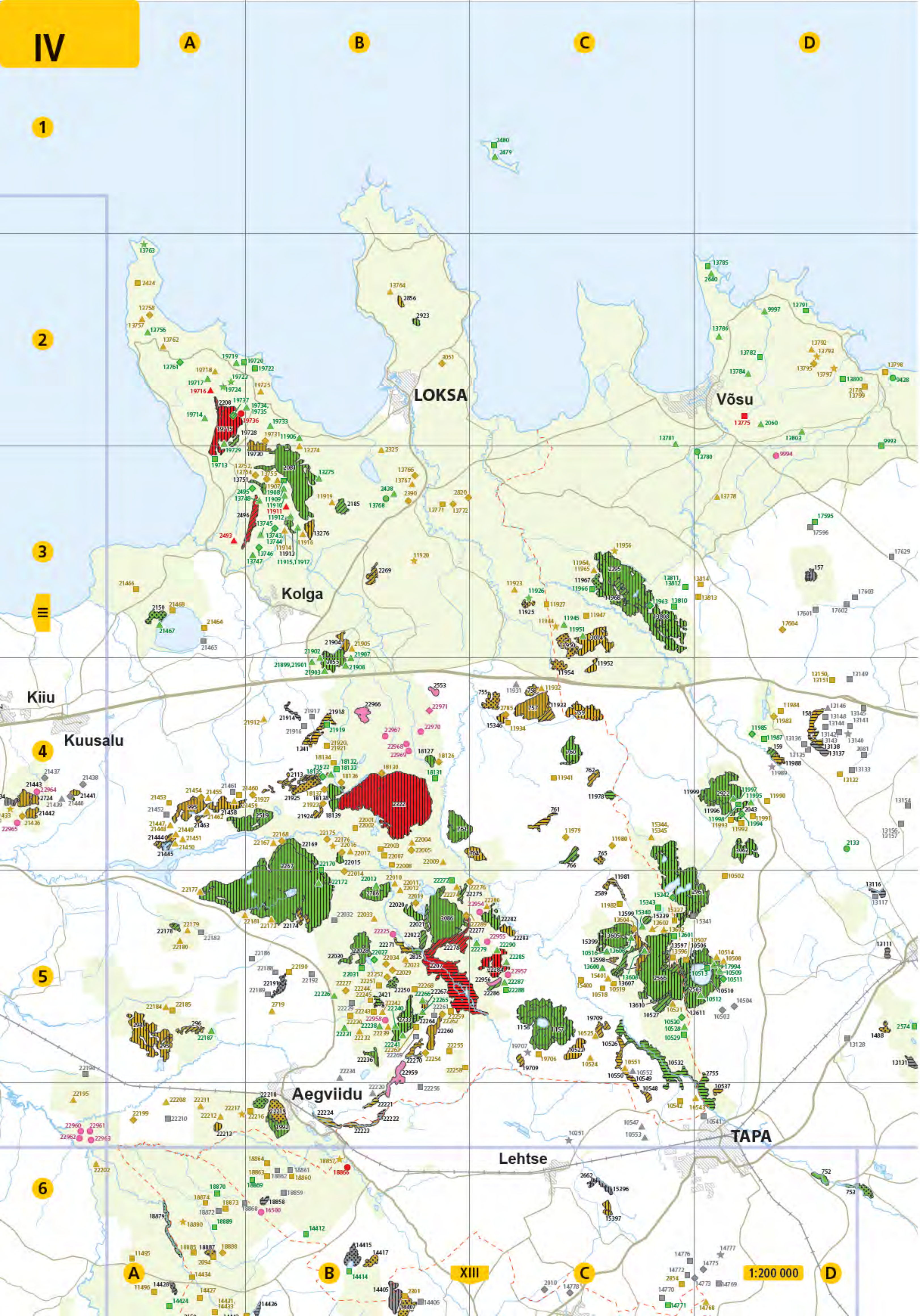
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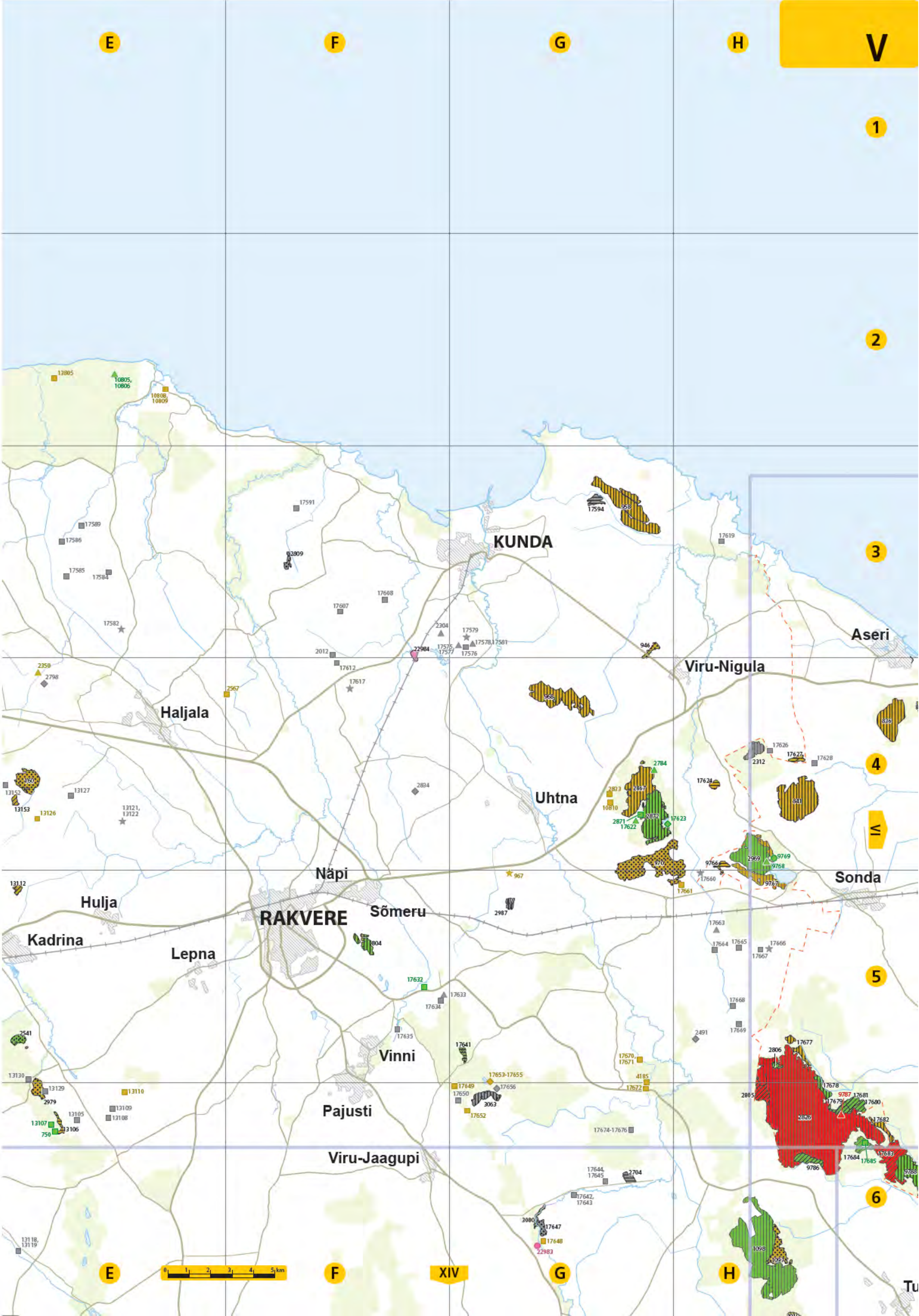
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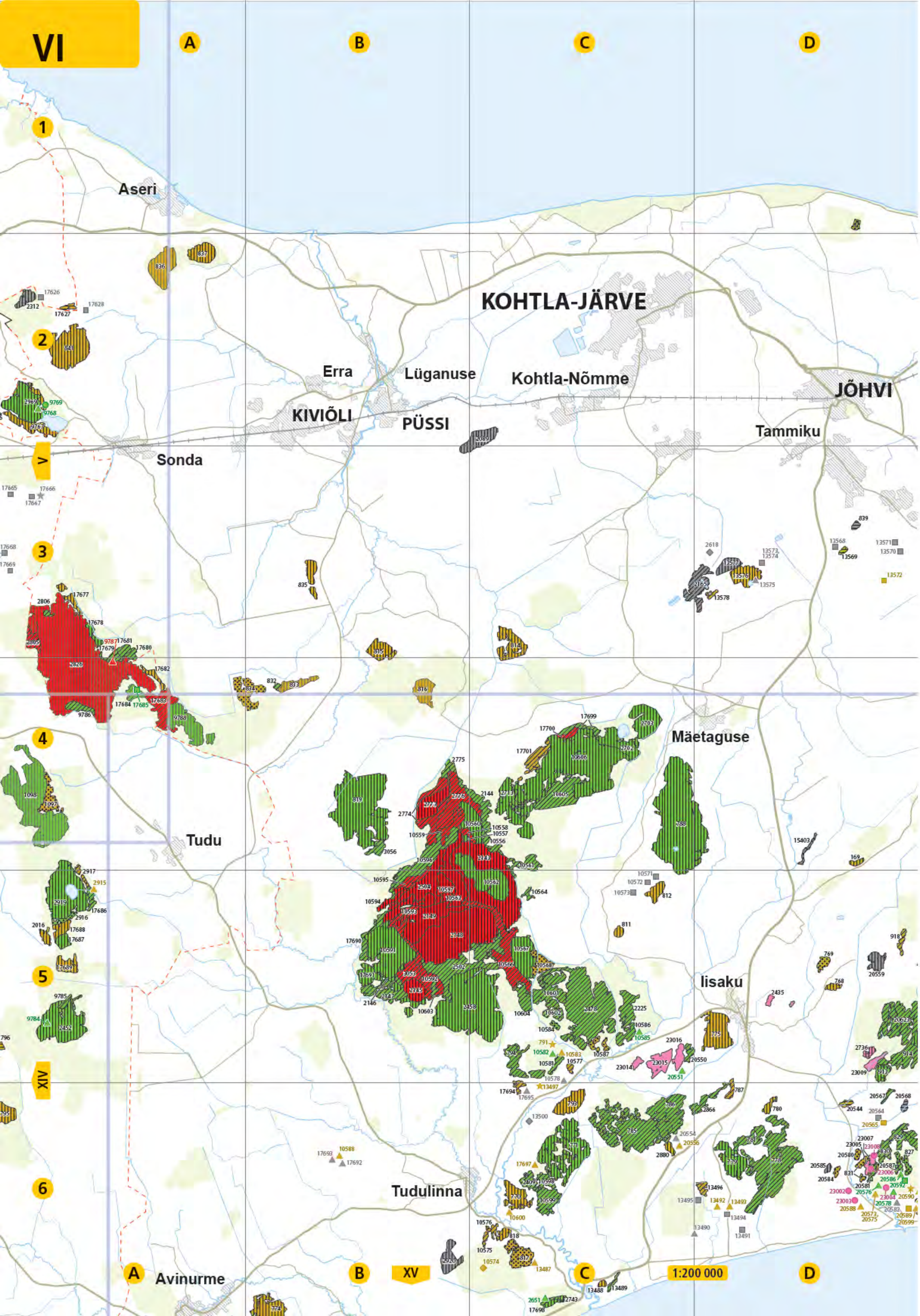
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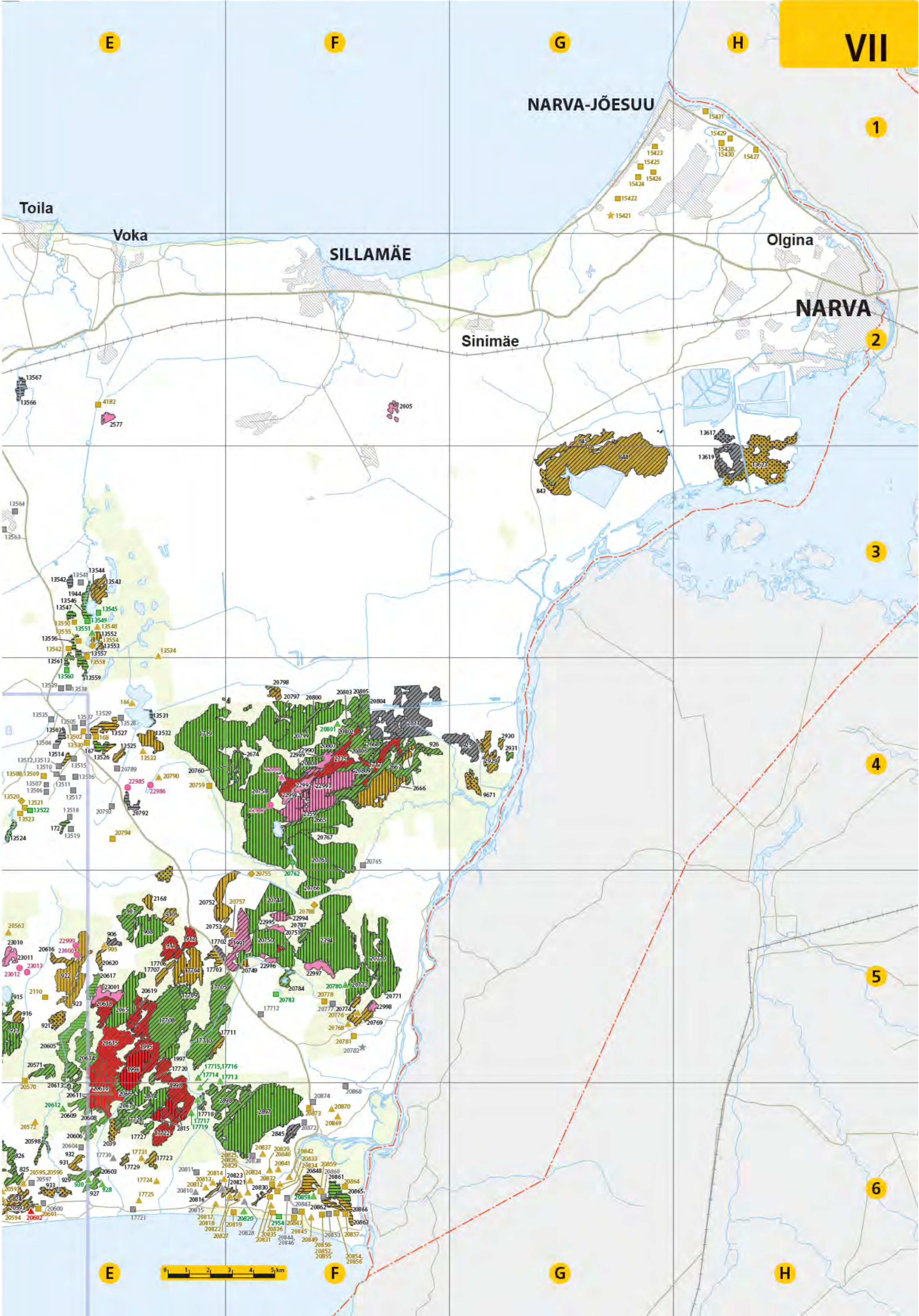
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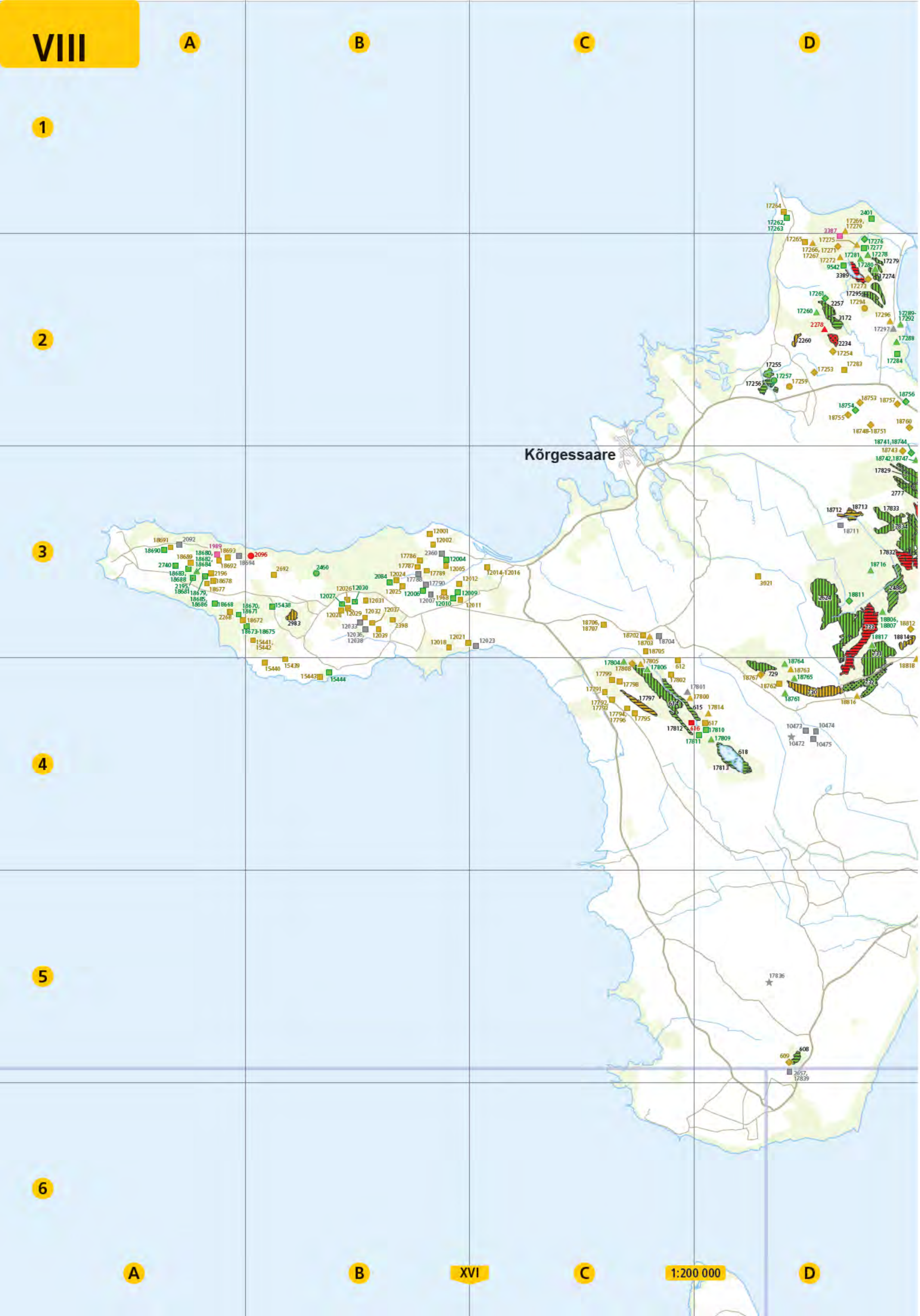
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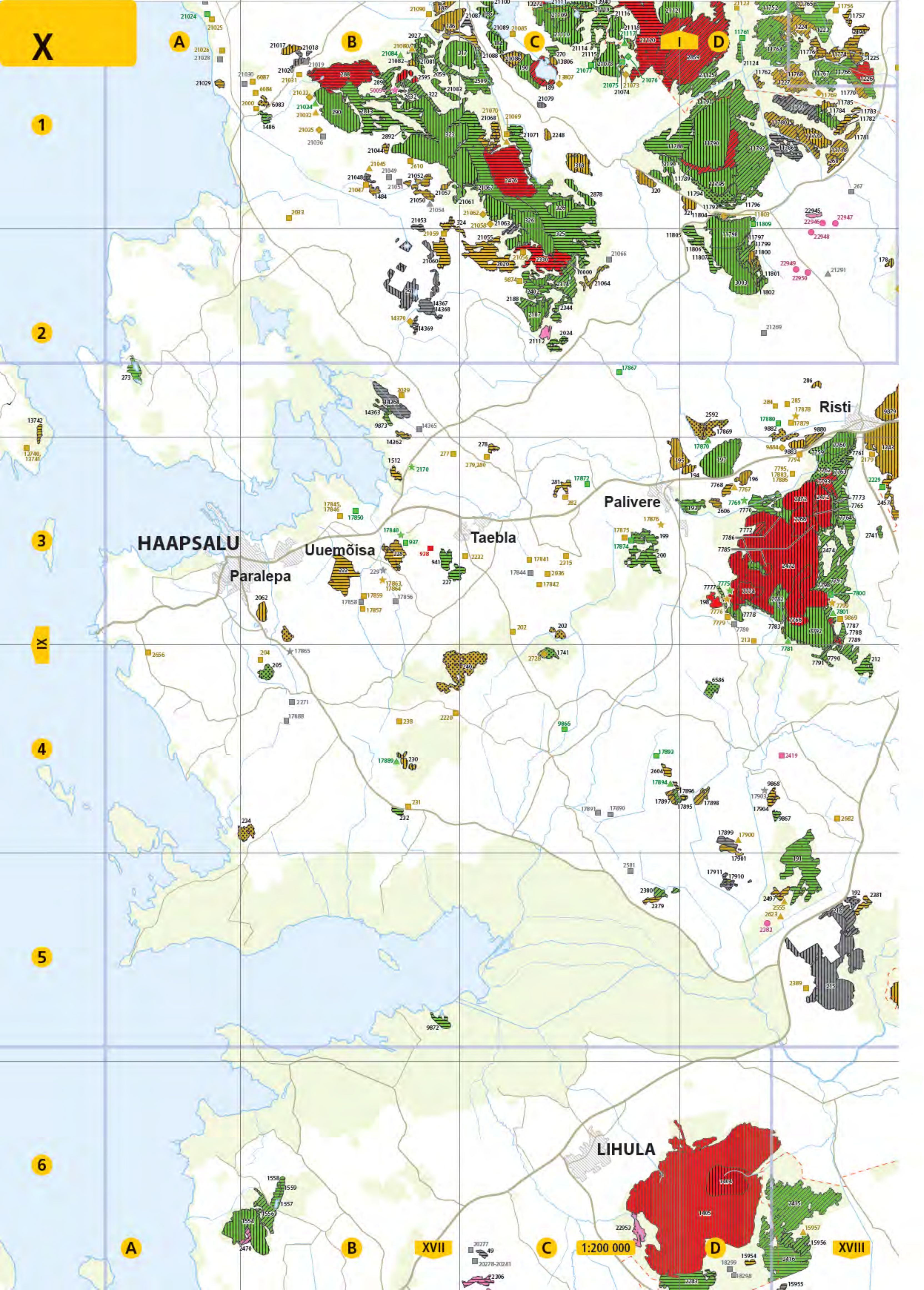
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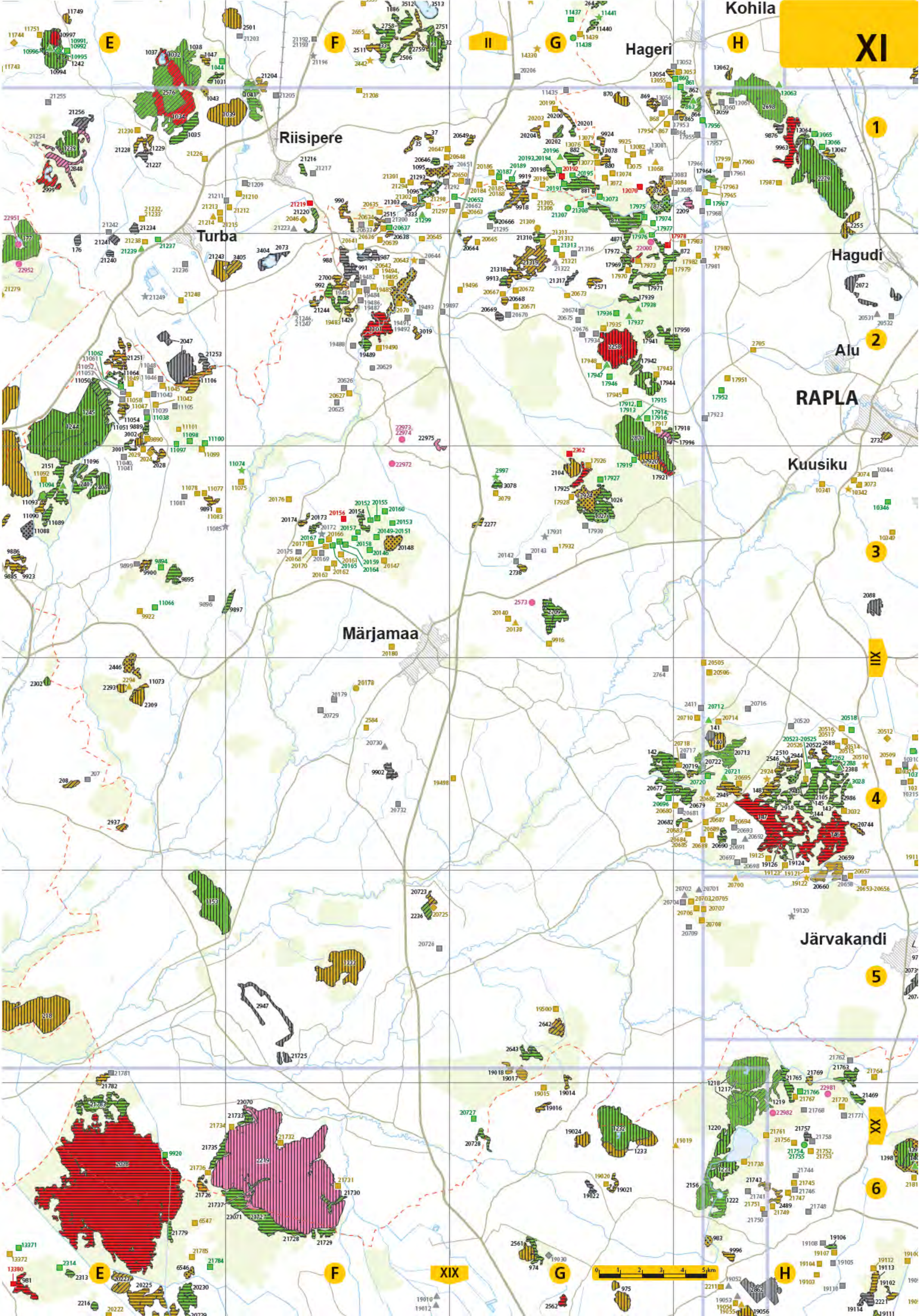
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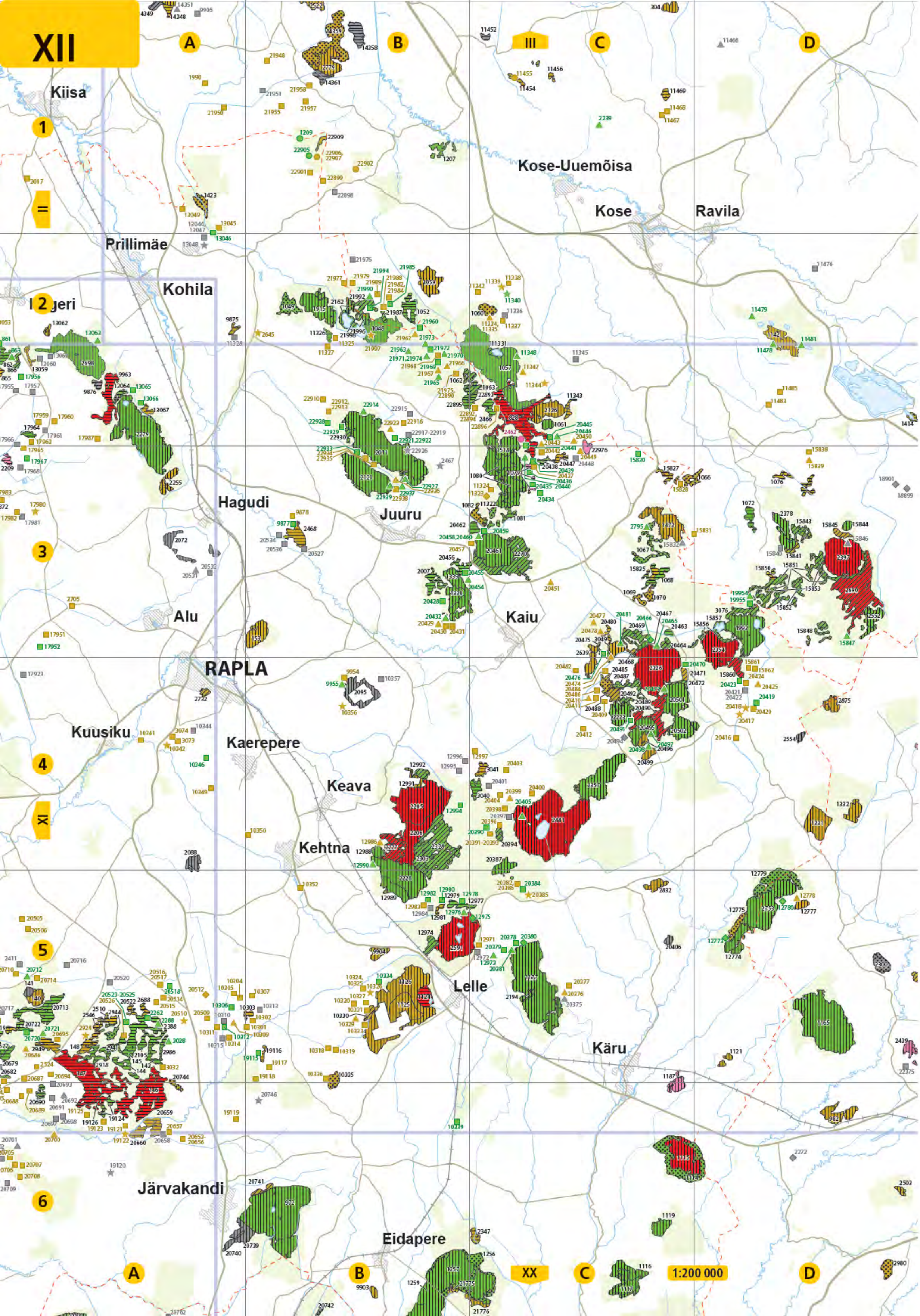
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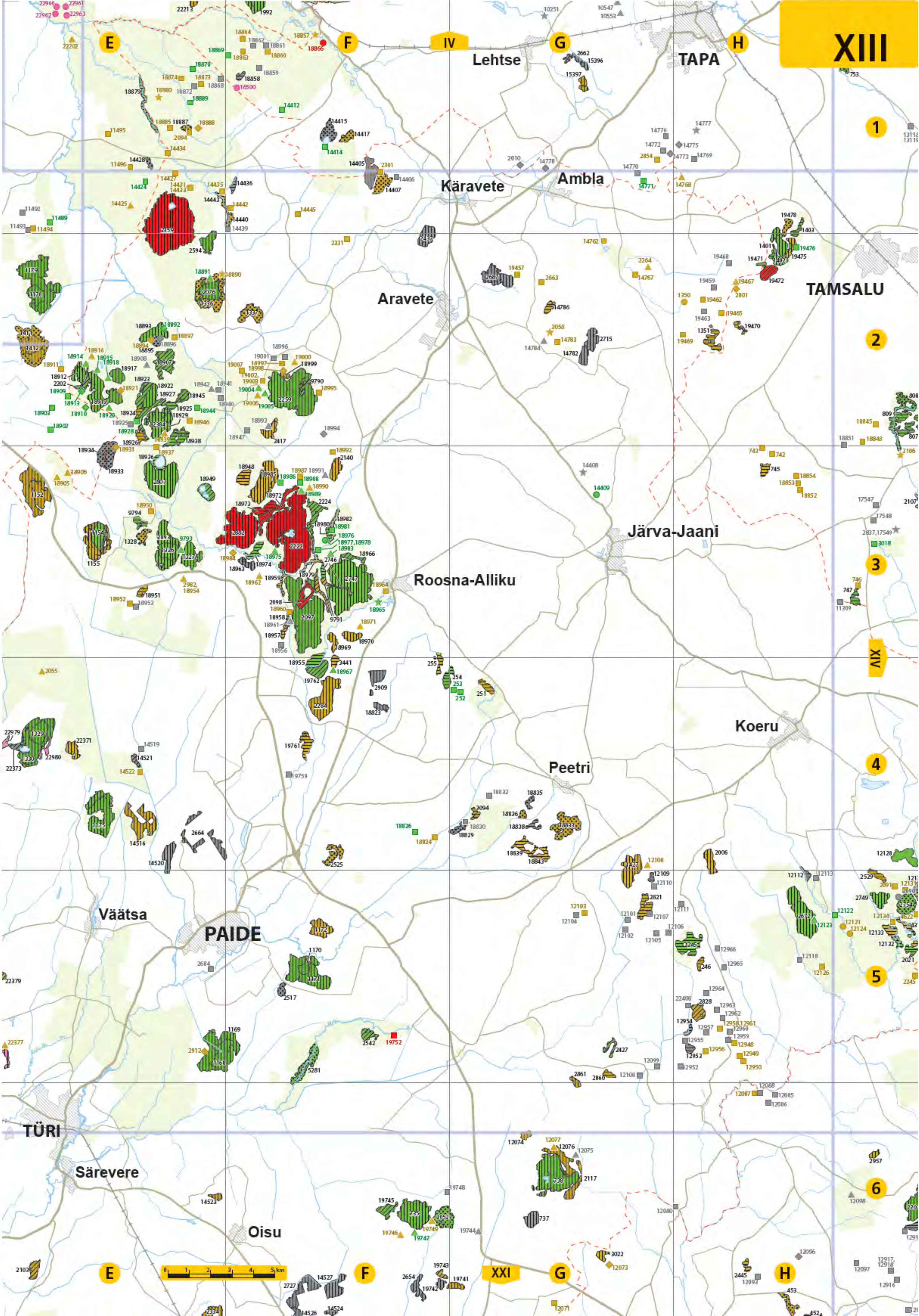

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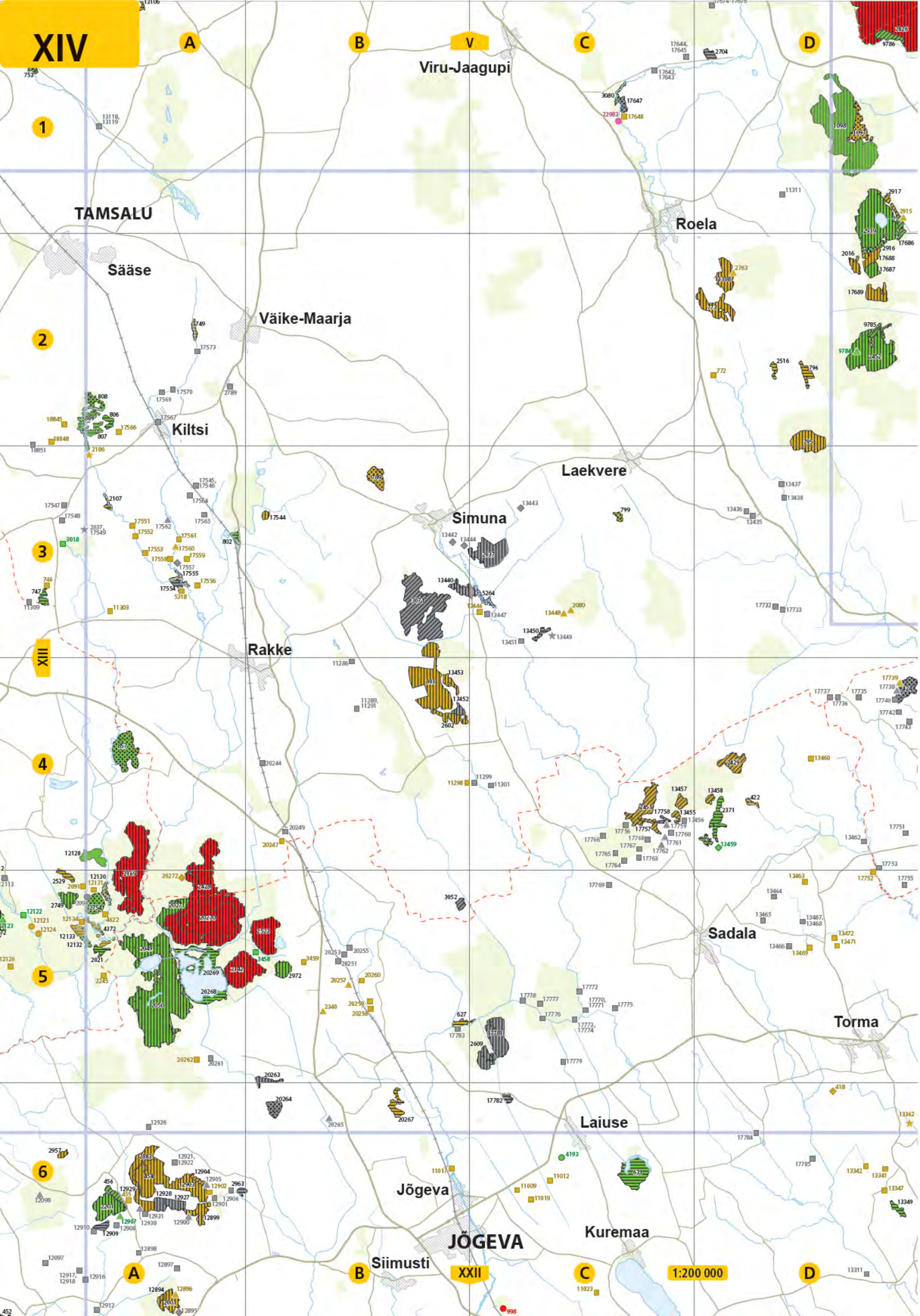
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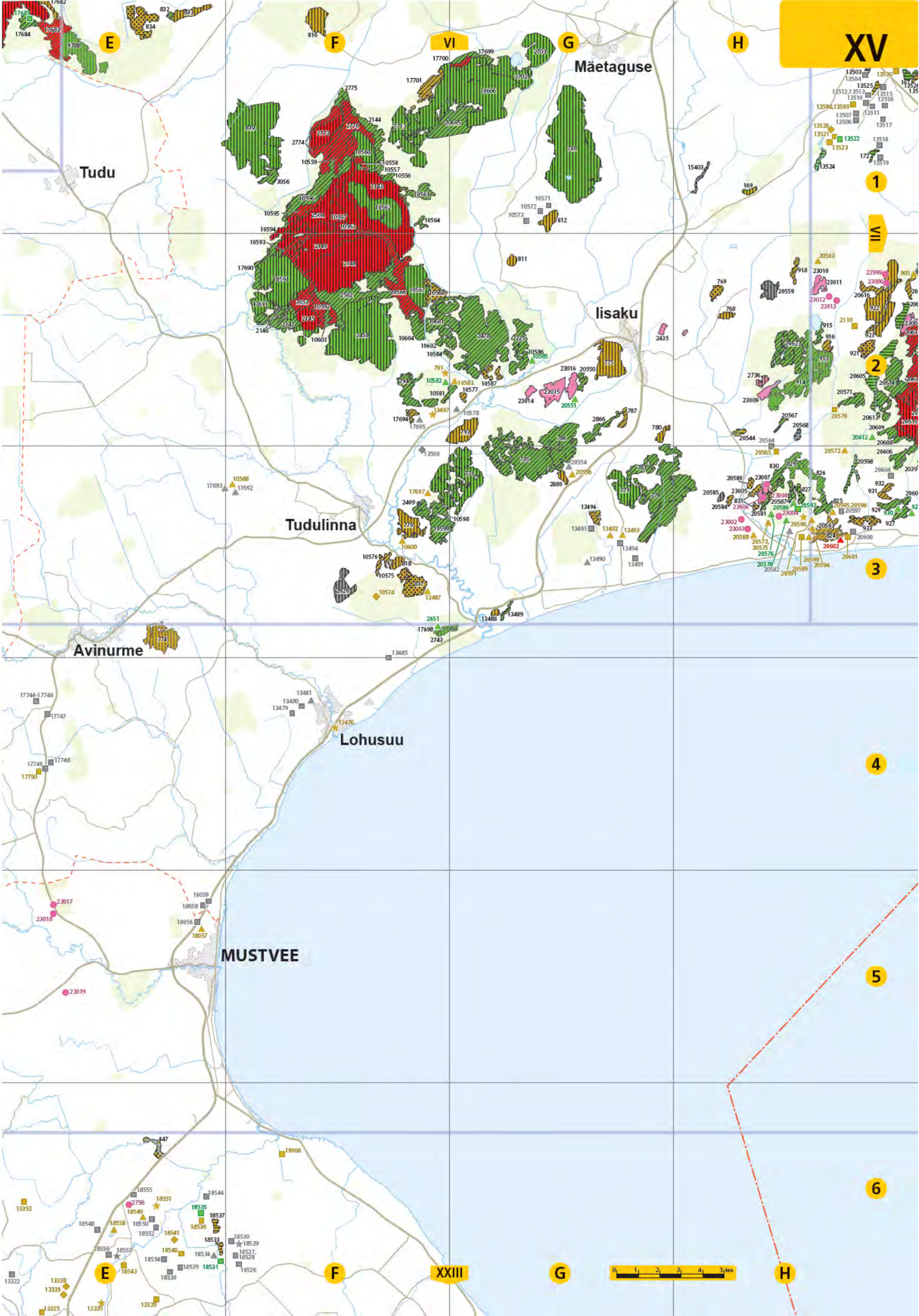
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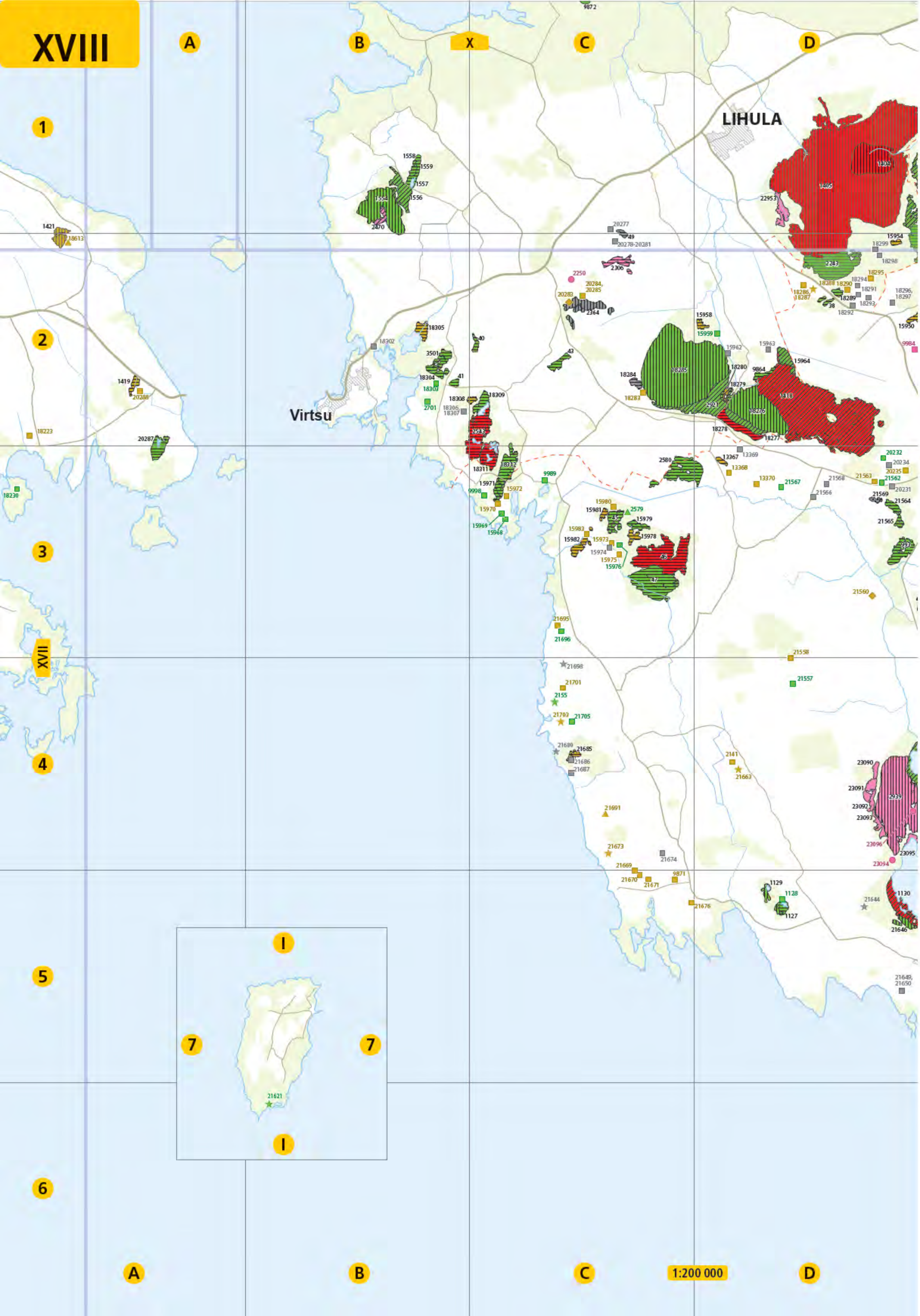
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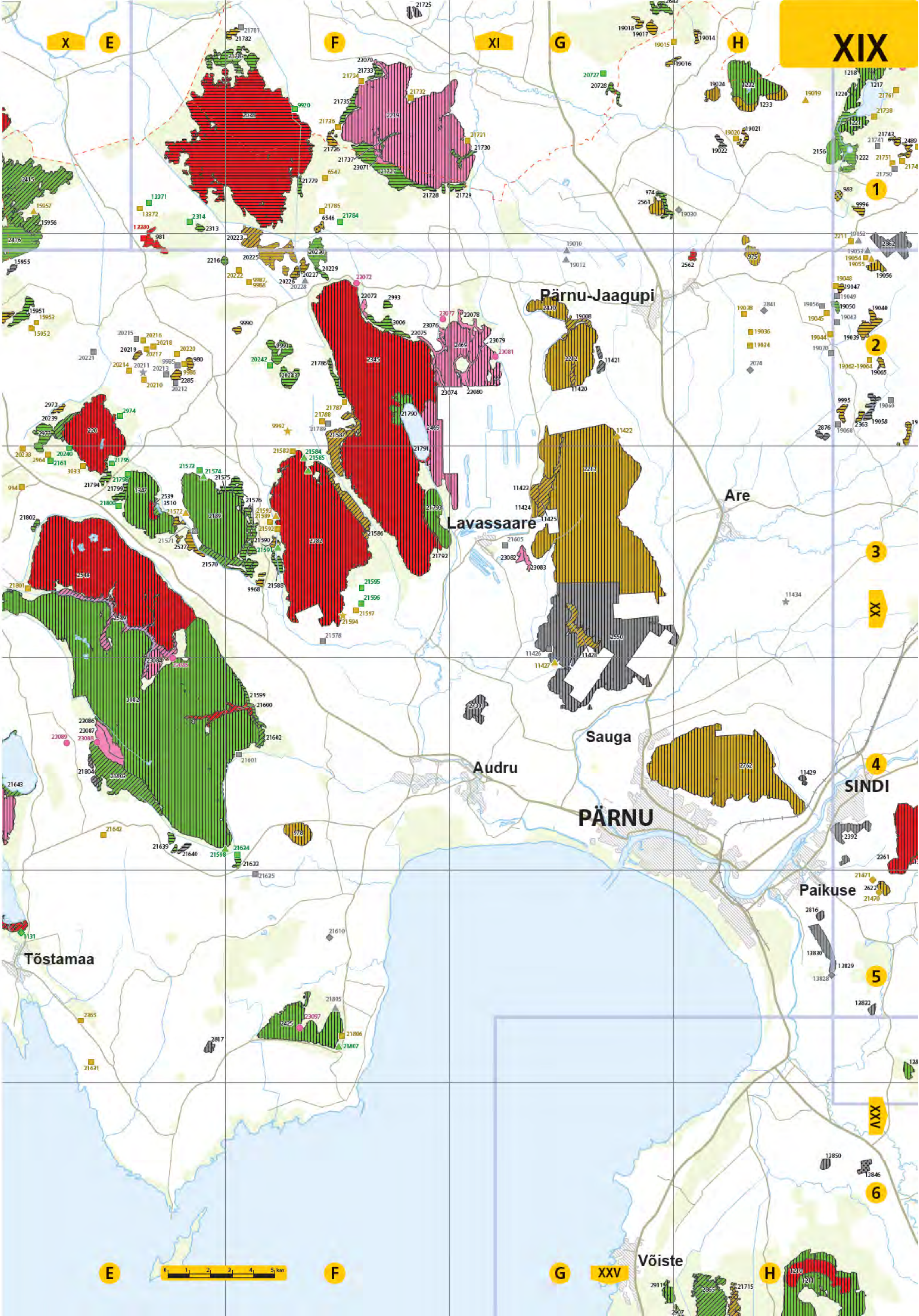
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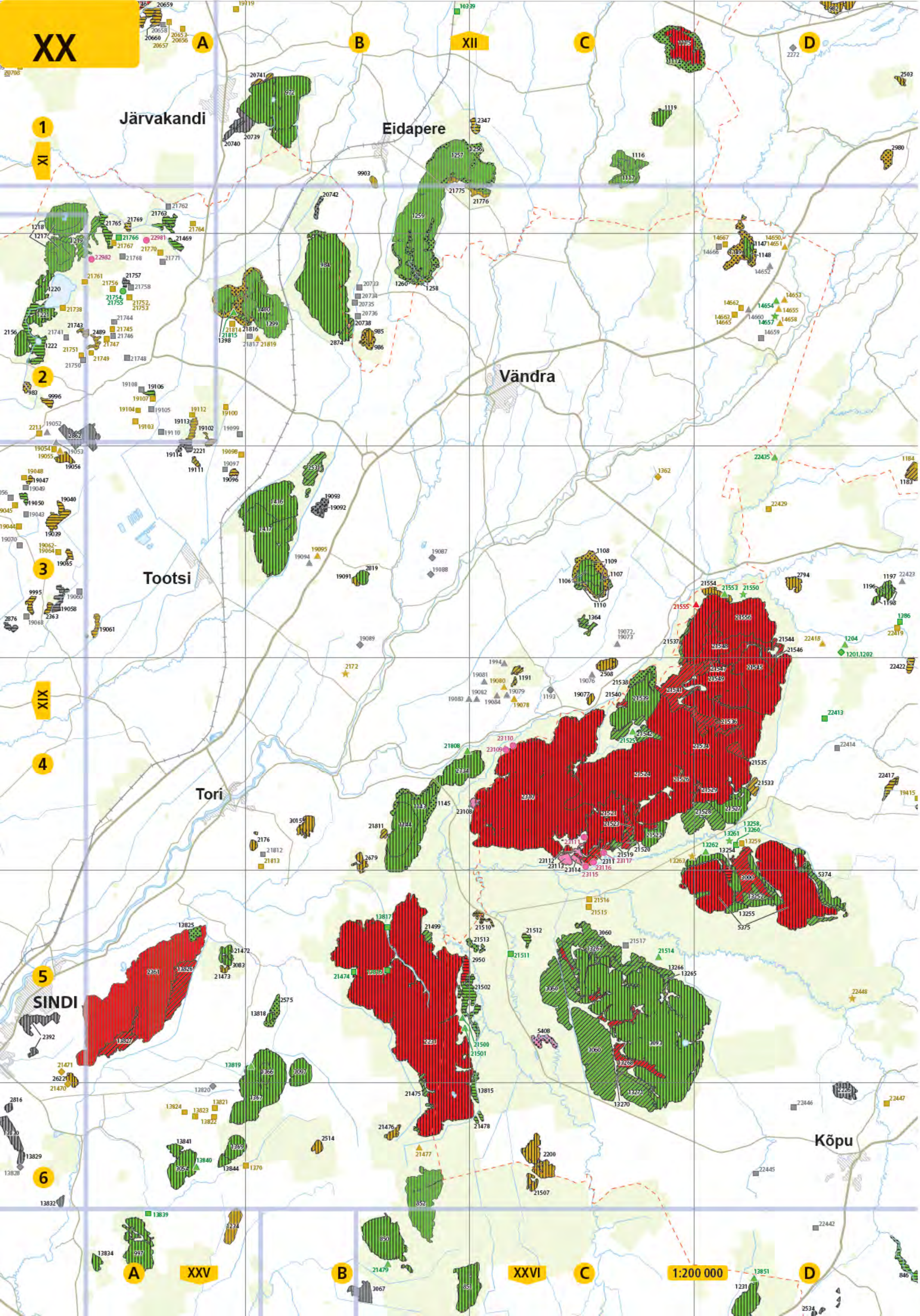
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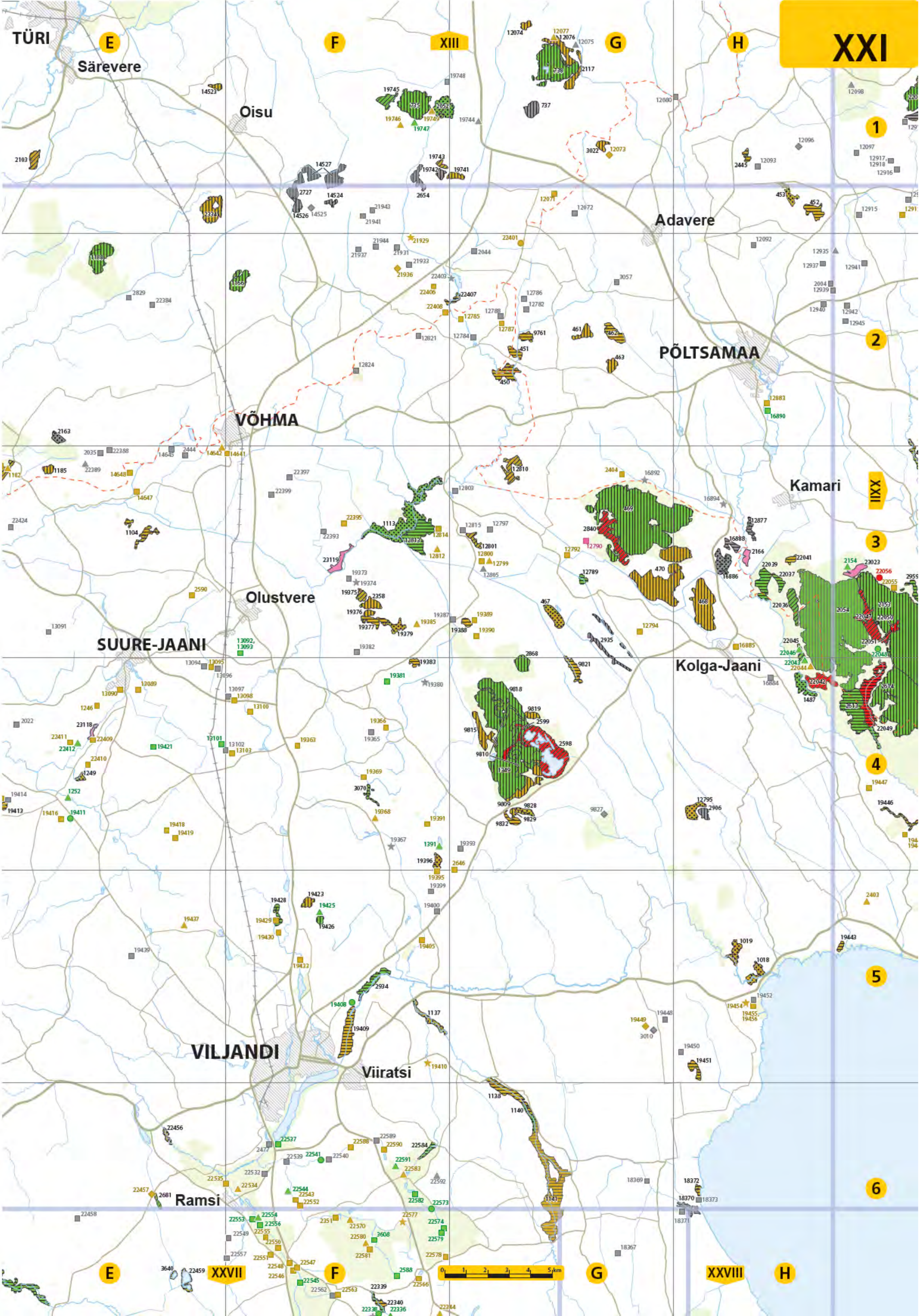
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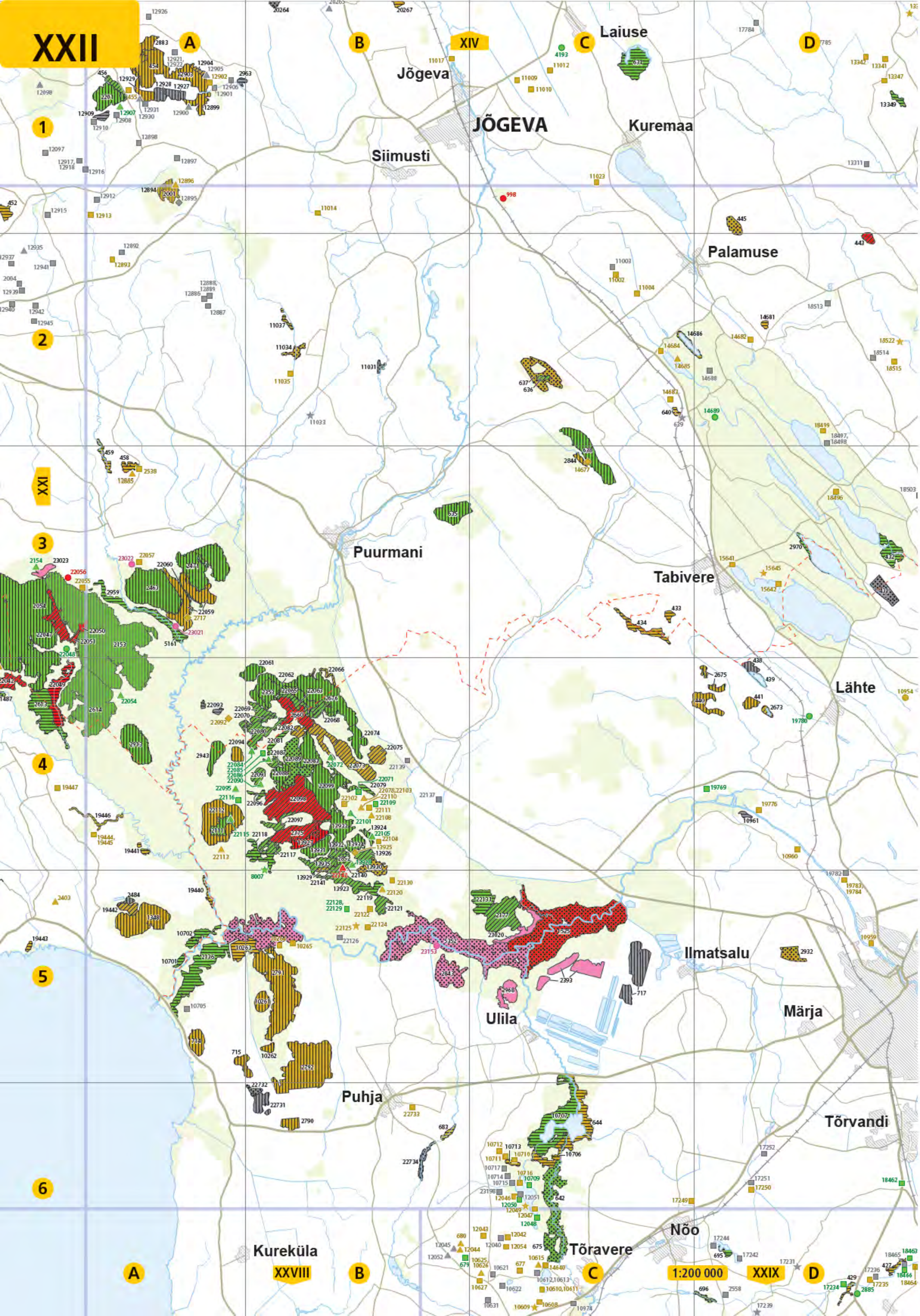
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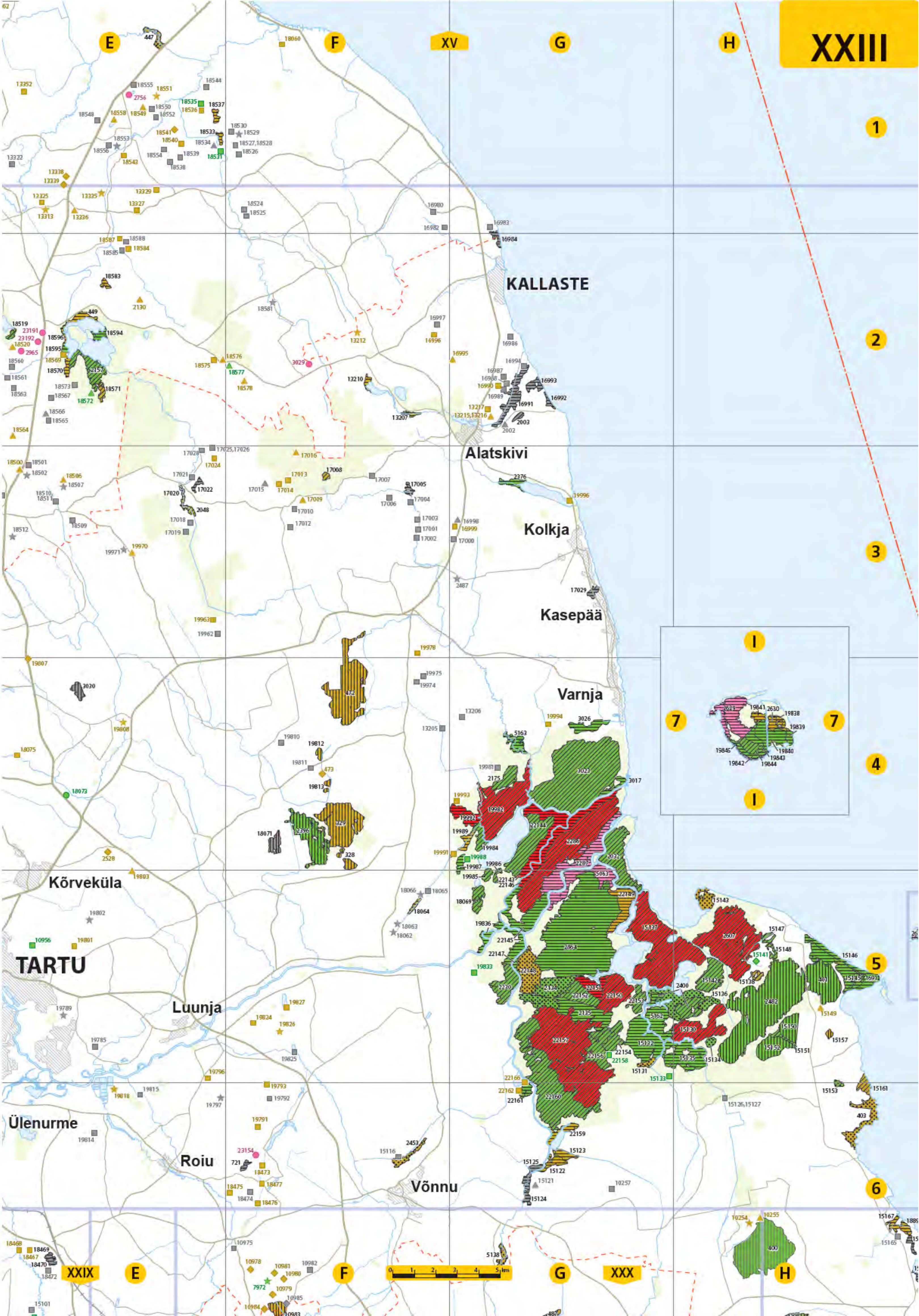
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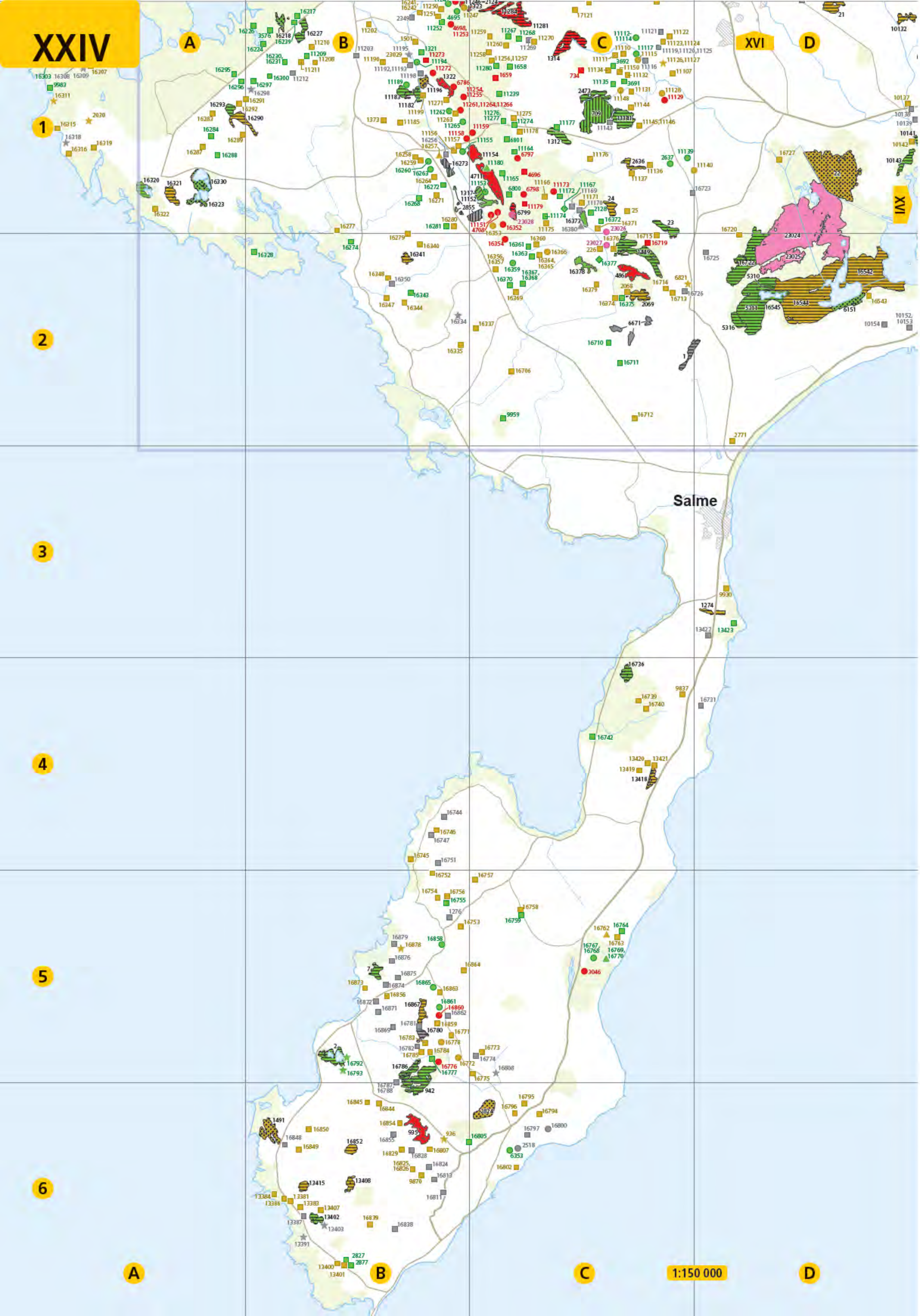
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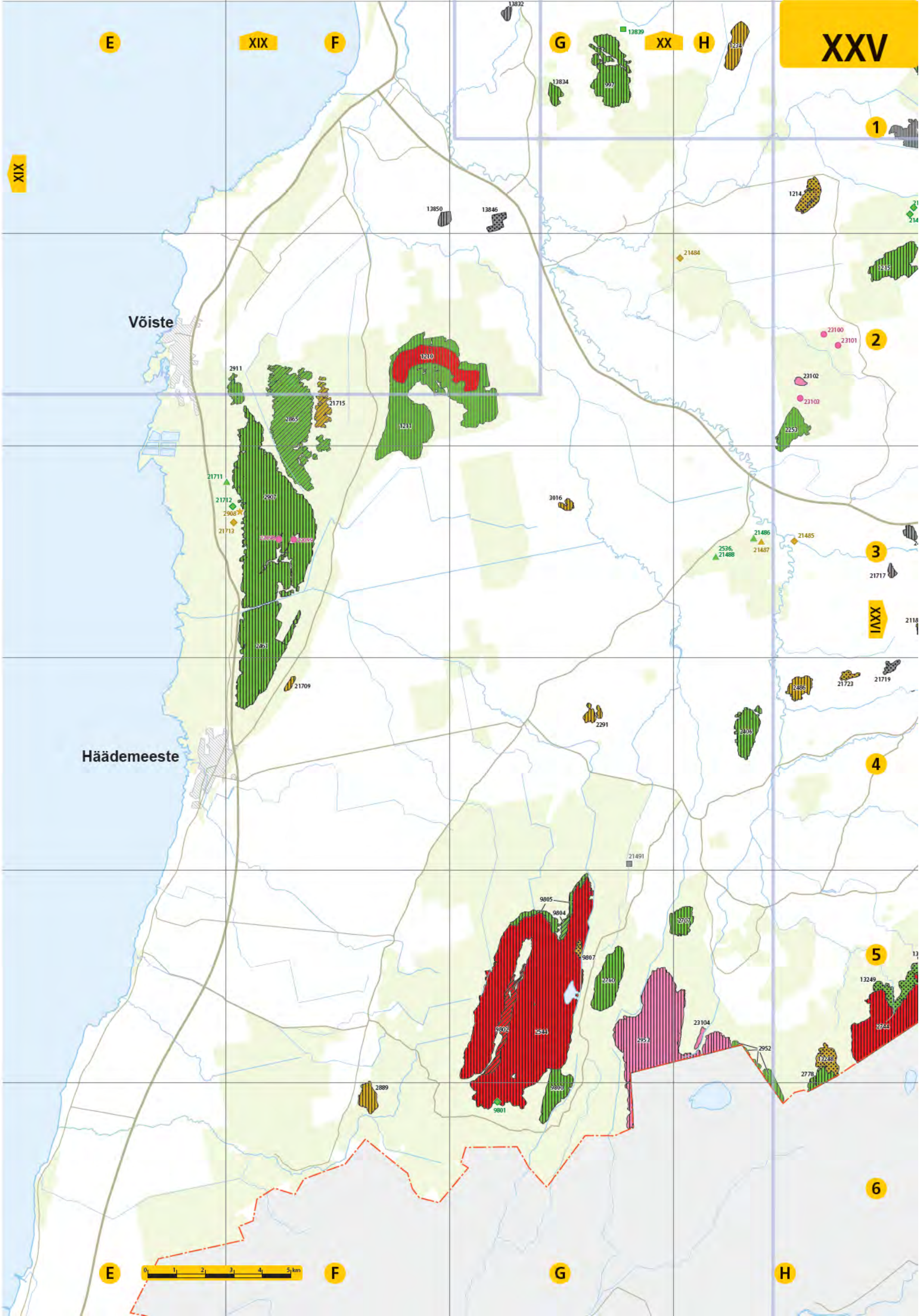
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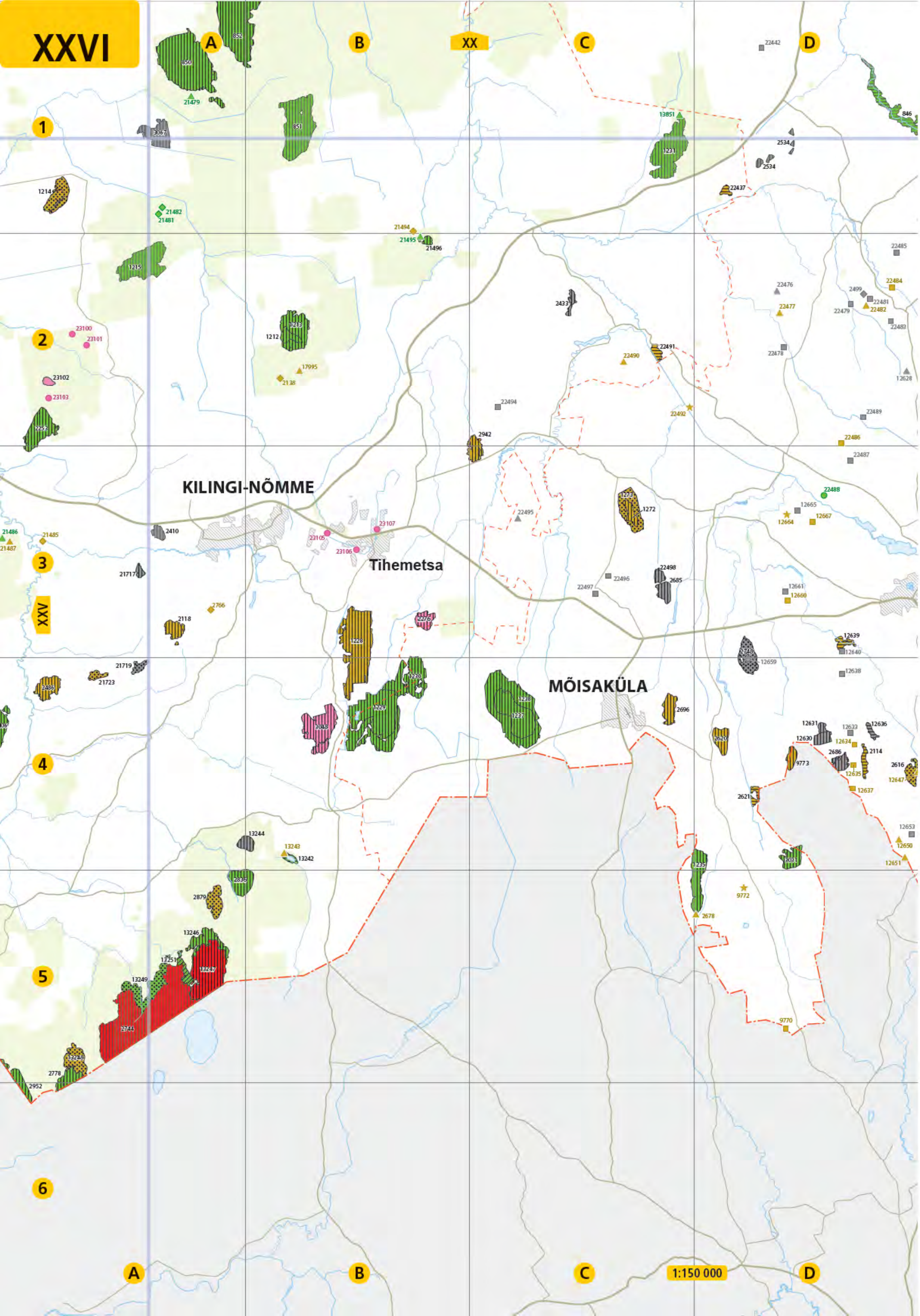
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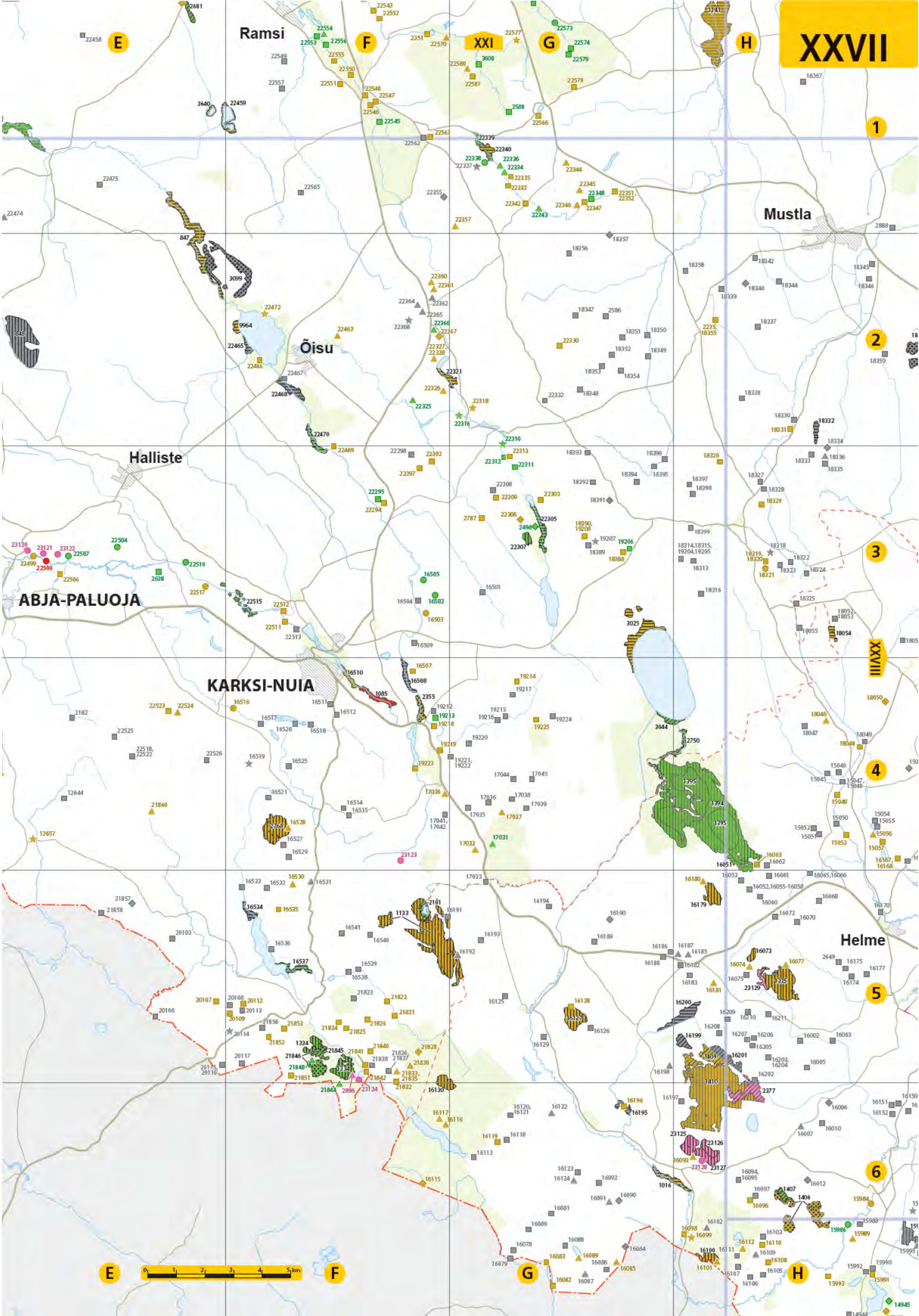
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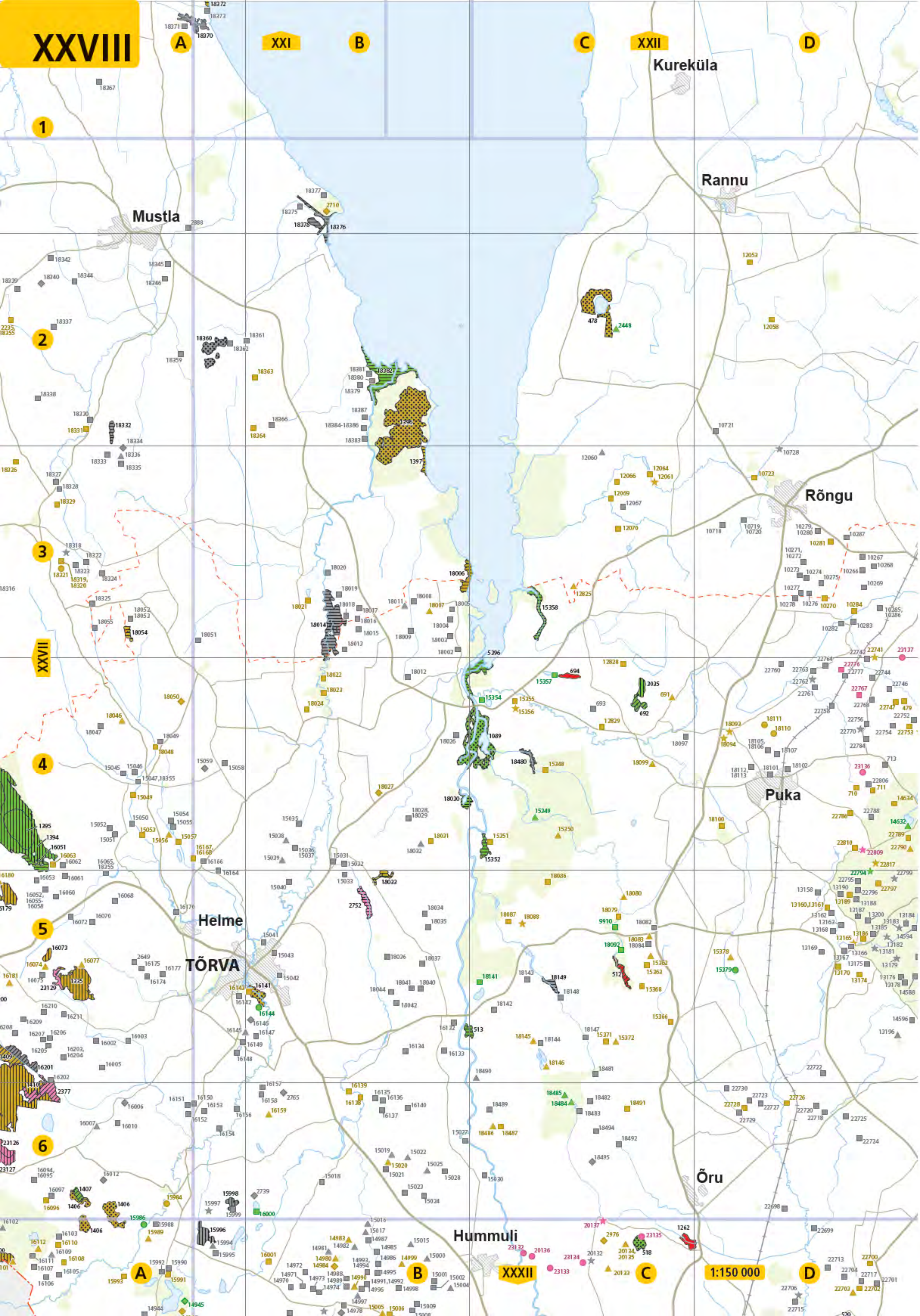
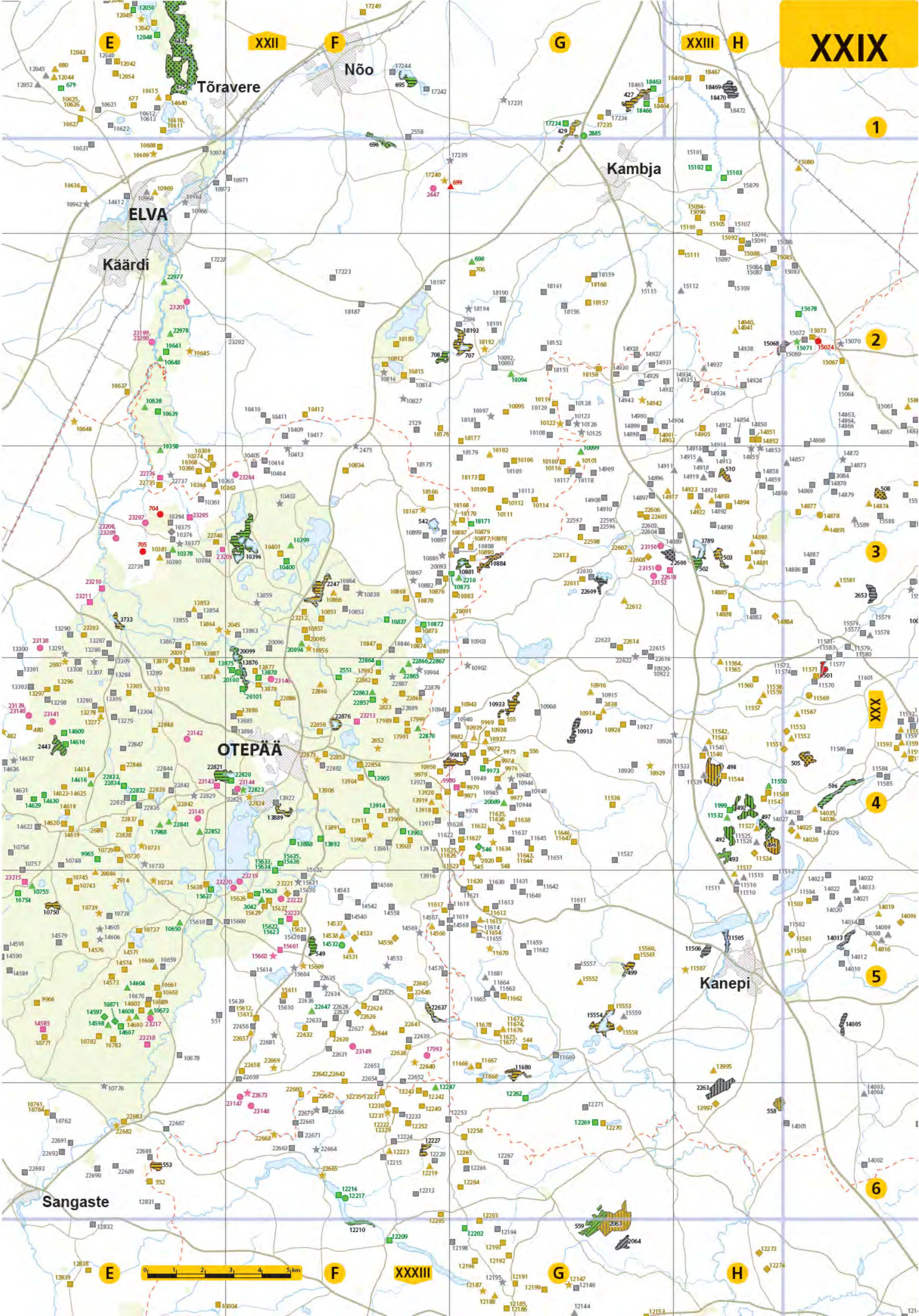
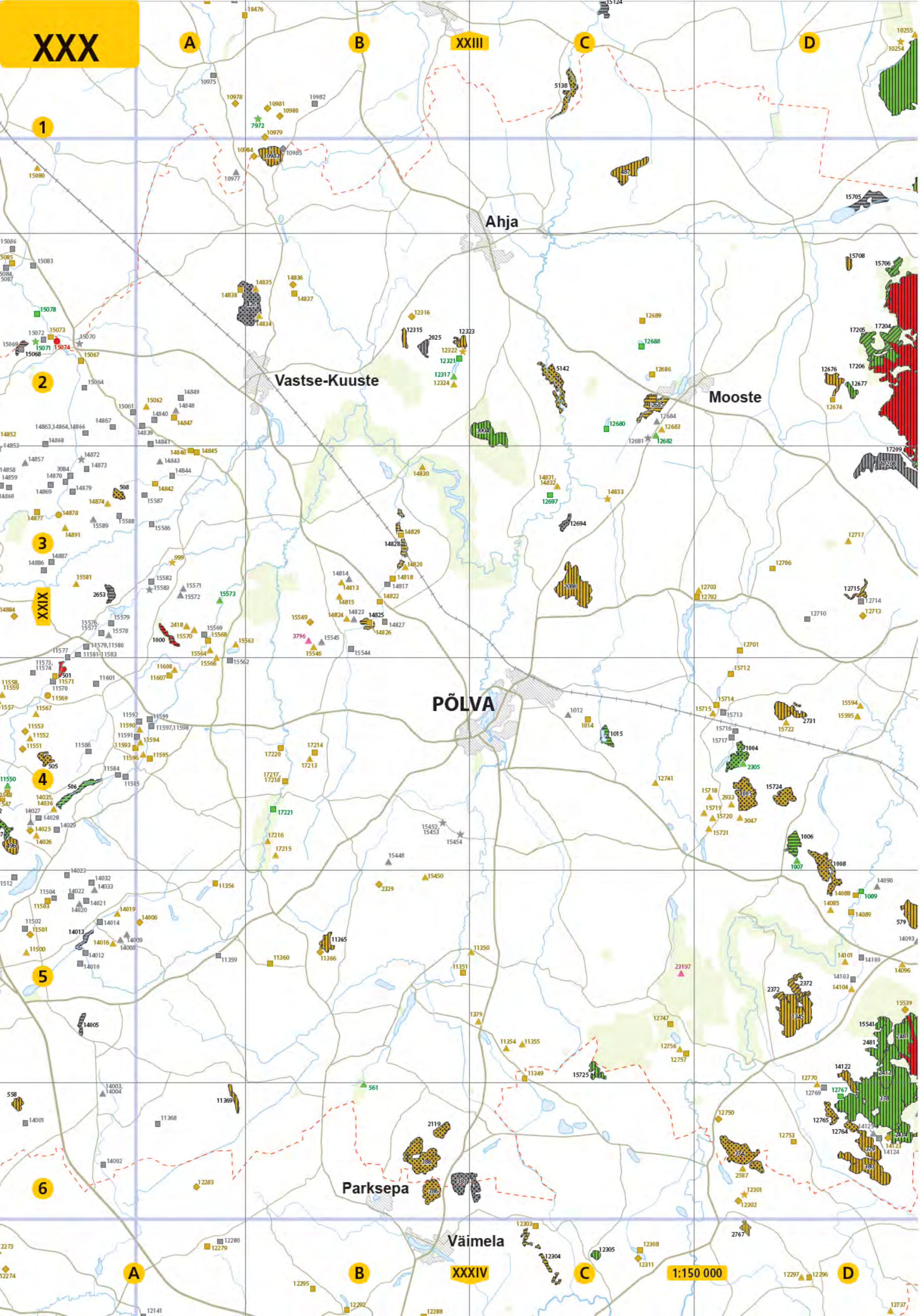
Helme
0 1 2 3 4 5 km



XXVIII
A
XXI
B
C
XXII
D
Kureküla
1
Rannu
Mustla
2
Rõngu
3
XXVII
4
Puka
5
Helme
TÕRVA
6
Õru
Hummuli
XXXII
1:150 000


XXIX
XXII
XXIII
XXX
XXXIII
E
F
G
H
1
2
3
4
5
6
Tõravere
Nõo
Kambja
ELVA
Käärdi
OTEPÄÄ
Kanepi
Sangaste
km


XXX
A
B
XXIII
C
D
1
Ahja
2
Vastse-Kuuste
Mooste
3
XXIX
PÕLVA
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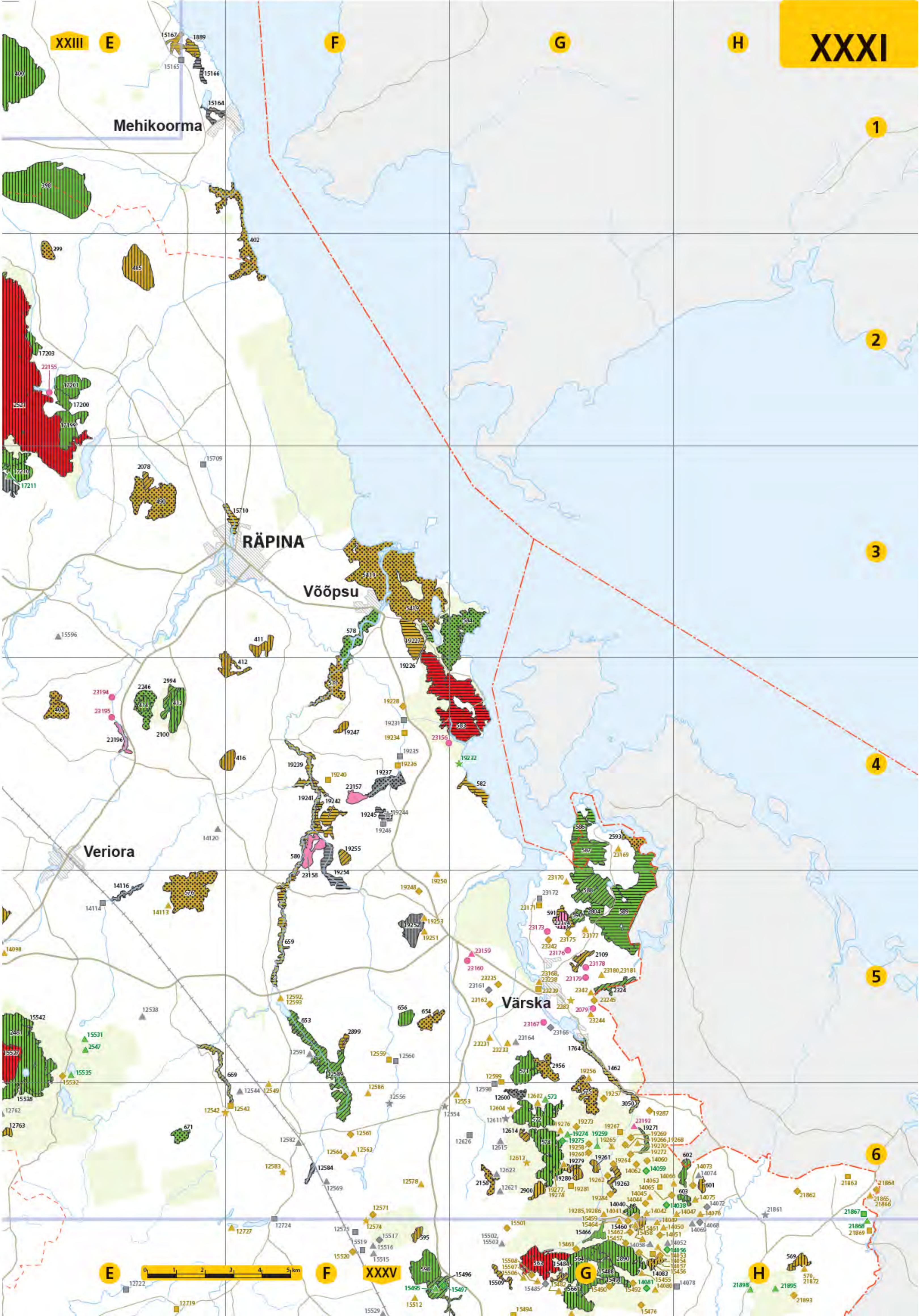
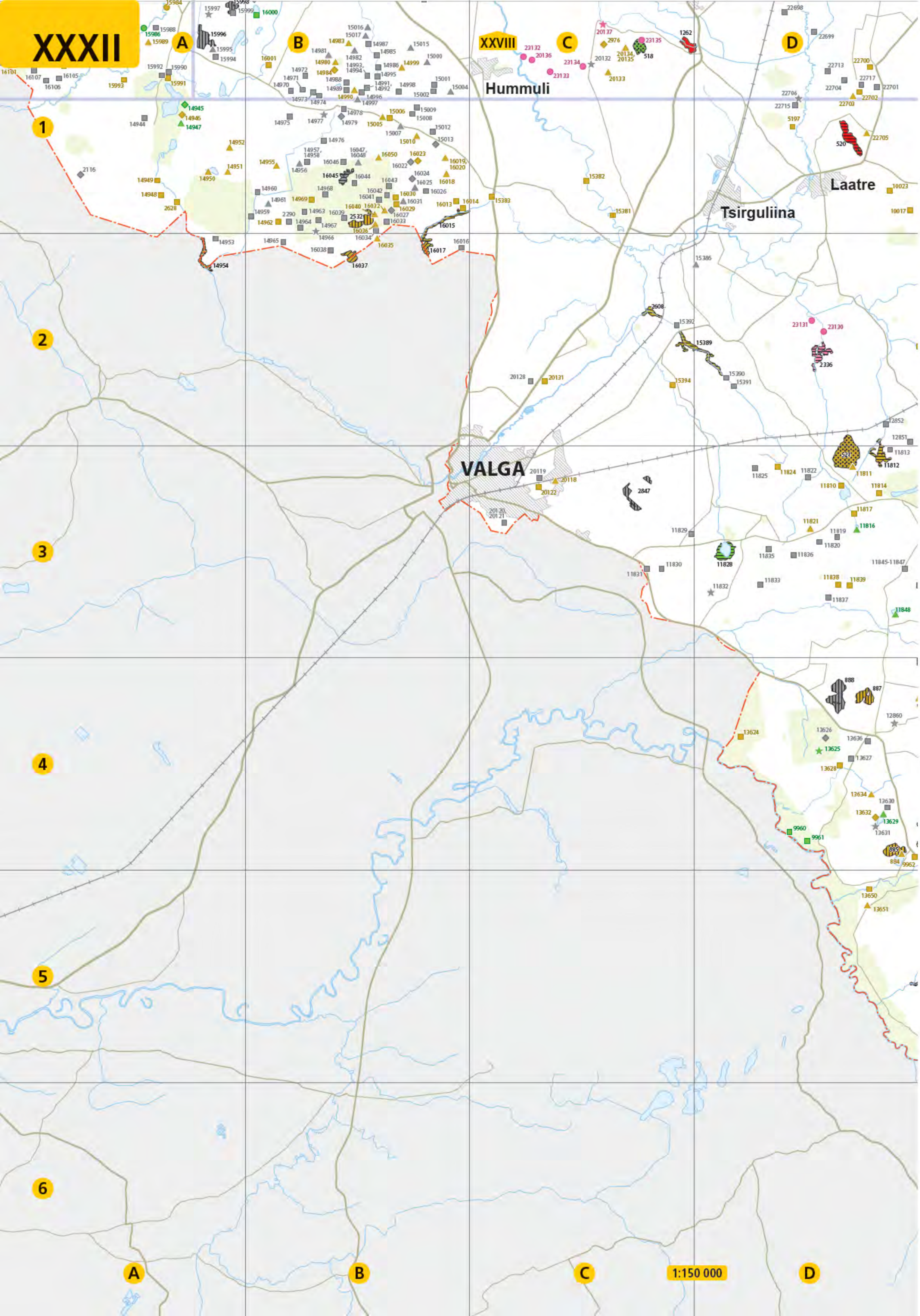
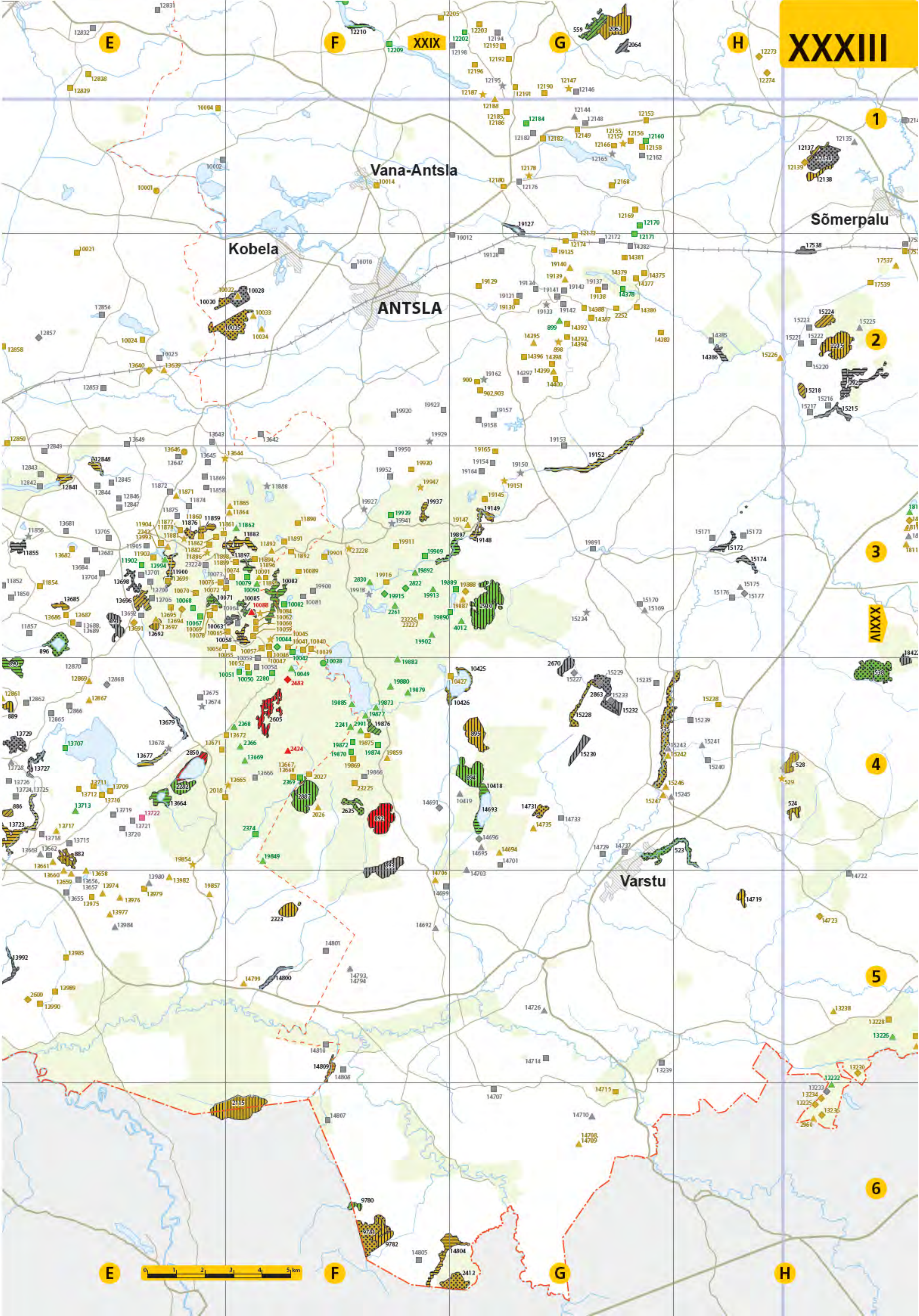
5
6
Parksepa
Väimela
XXXIV
1:150 000

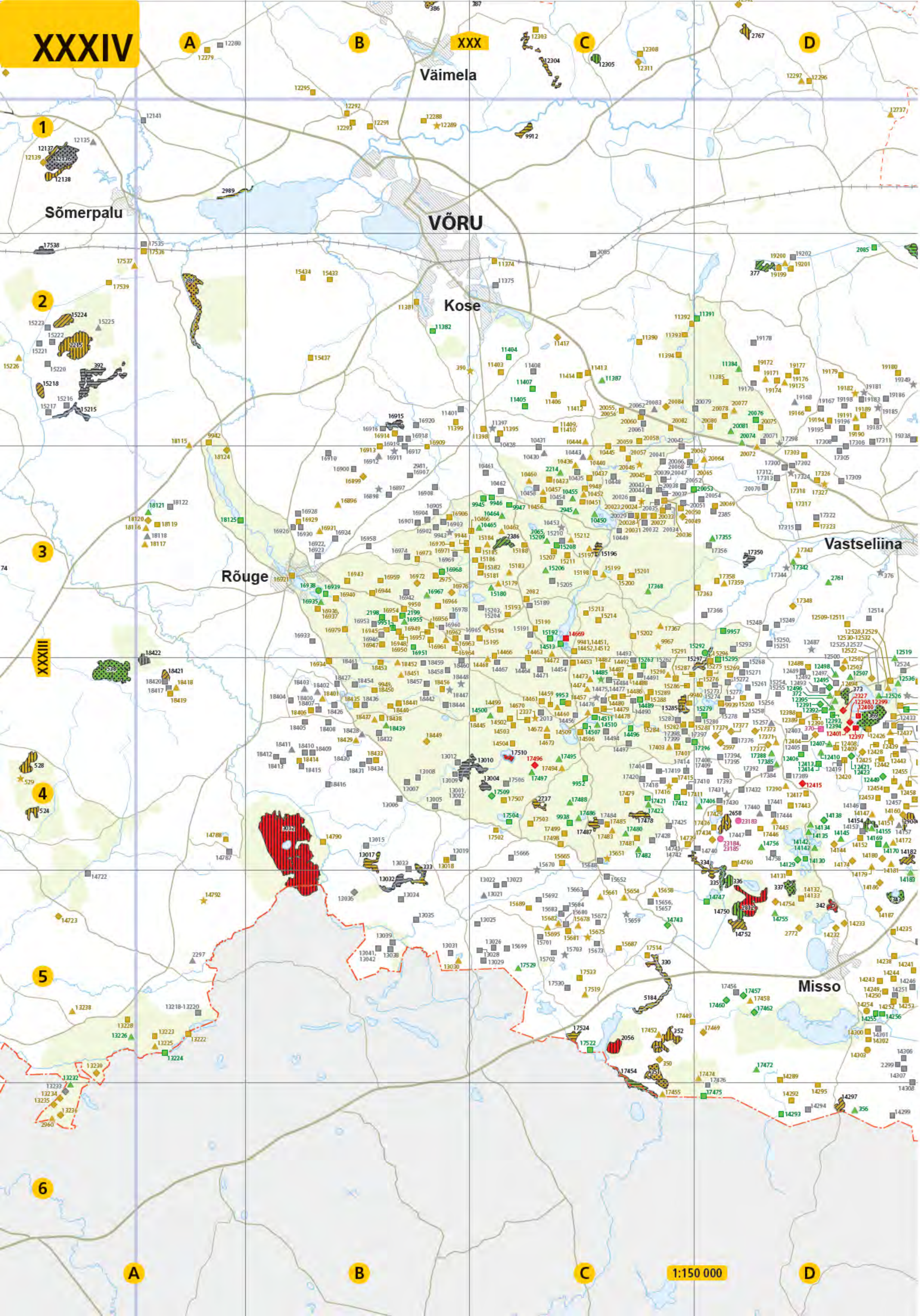


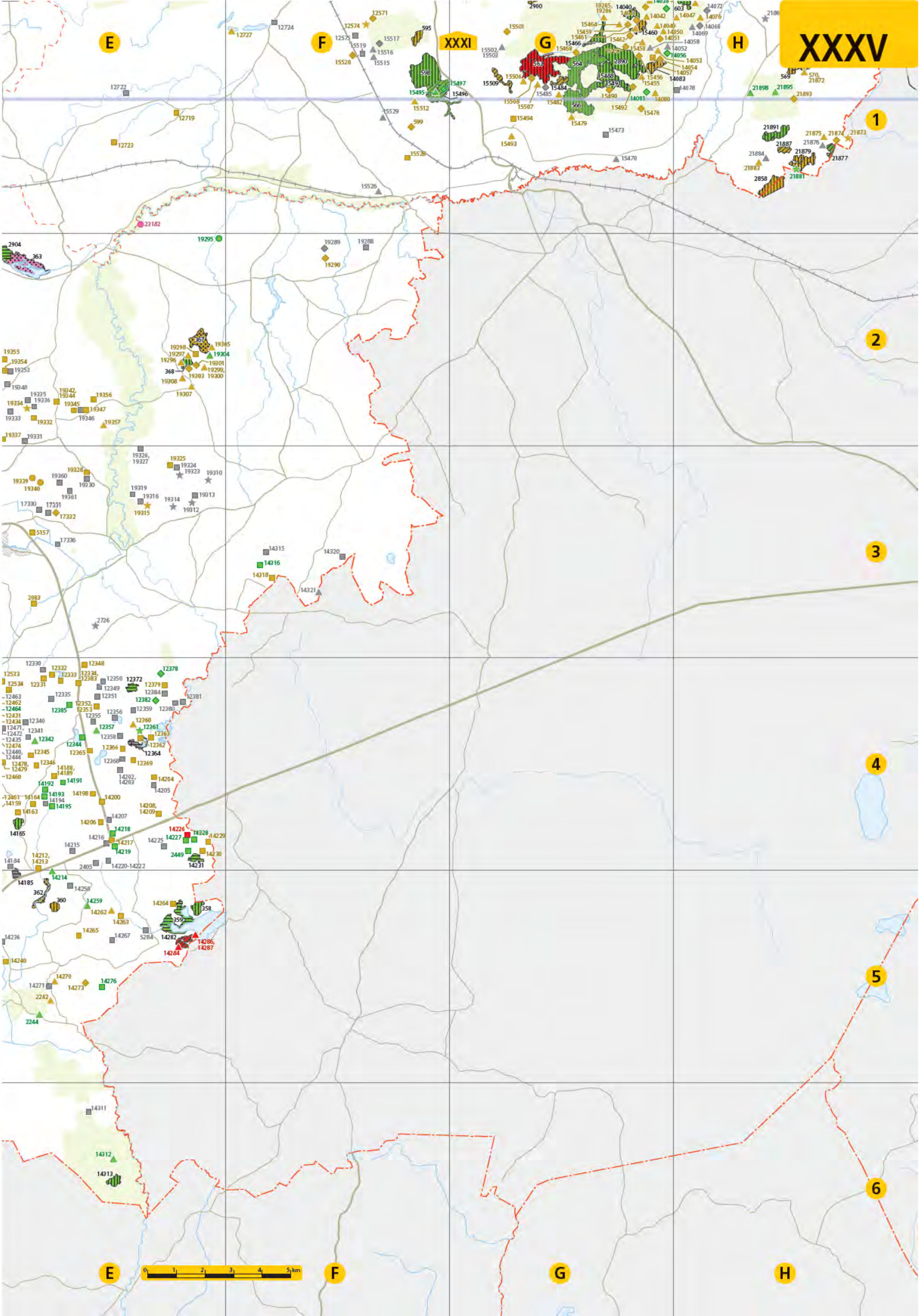
XXXI
XXIII
XXXV
E
F
G
H
1
2
3
4
5
6
Mehikoorma
RÄPINA
Võõpsu
Veriora
Värska
0 1 2 3 4 5 km


XXXII
A
B
C
D
XXVIII
Hummuli
Laatre
Tsirguliina
VALGA
1
2
3
4
5
6
1:150 000



XXXIII
XXIX
XXXIV
E
F
G
H
1
2
3
4
5
6
Vana-Antsla
Kobela
ANTSLA
Sõmerpalu
Varstu
0 1 2 3 4 5 km


XXXIV
A
B
C
D
XXX
Väimela
Sõmerpalu
VÕRU
Kose
Rõuge
Vastseliina
Misso
XXXIII
1
2
3
4
5
6
1:150 000


XXXV
XXXI
E
F
G
H
1
2
3
4
5
6
0 1 2 3 4 5 km

PHOTOS
PALUDIFYING GRASSLANDS

1 Species poor paludifying grassland. Near Lake Muti, Tarvastu parish. Photo Toivo Sepp.

2 Paludifying grassland. Ruusmäe village, Haanja commune. Photo Raili Hansen.

3 A typical paludifying grassland between the cupolas in southern Estonia. Kilvagu, Mõniste commune. Photo Tiit Hallikma.

4 *Lythrum salicaria* grows on paludifying meadows and fens. Photo Jaanus Paal.

5 *Dactylorhiza fuchsii* is a rather common species on paludifying fens. Photo Jaanus Paal.

4

5

6 *Eupatorium cannabinum*. Photo Jaanus Paal.

7 *Iris sibirica*. Photo Jaanus Paal.

6

7

MINEROTROPHIC FENS

8 *Phragmites australis* dominated fen. Mõisamõtsa Nature Reserve, Mõniste commune. Photo Tiit Hallikma.

9 *Betula pubescens–Equisetum fluviatile* community. Otepää commune. Photo Kalle Remm.

10 *Carex lasiocarpa* dominated fen. Otepää commune. Photo Kalle Remm.

11 Quaking fen. Northern shore of Lake Ubajärve, Karula National Park. Photo Heidi Öövel.

12 *Carex psudocyperus.* Photo Taimi Paal.

13 *Carex cespitosa* hummock. Photo Jaanus Paal.

12

13

TRANSITIONAL (MIXOTROPHIC) MIRES

14 Transitional quagmire. Photo Jaanus Paal.

15 Transitional mire dominated by *Trichoporum alpinum* and *Carex vesicaria*. Photo Jaanus Paal.

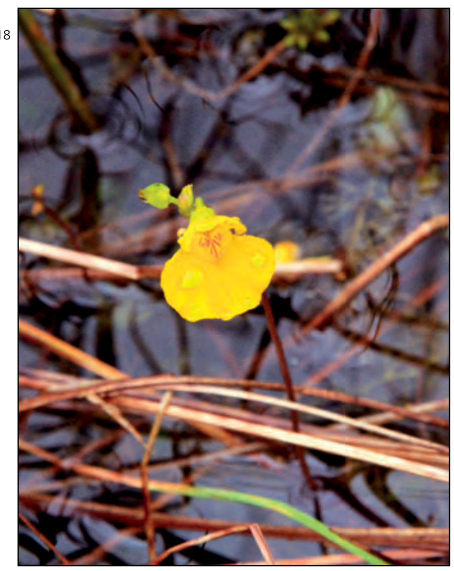
16 Transitional mire.
Mahtra mire,
Juuru parish.
Photo Jaanus Paal.

17 *Eriophorum vaginatum*.
Photo Jaanus Paal.

18 *Utricularia intermedia.*
Photo Jaanus Paal.

17

18



19 *Oxycoccus palustris.*
Photo Jaanus Paal.

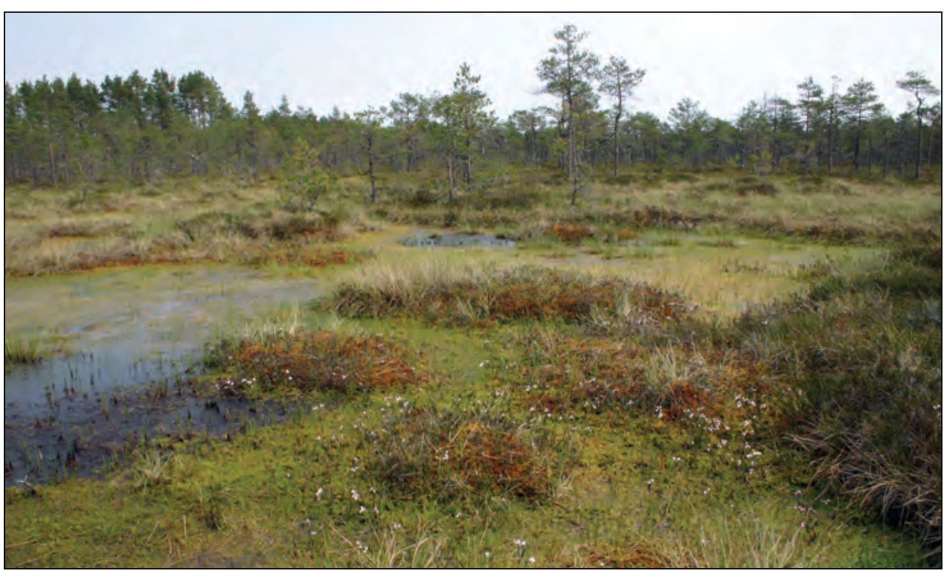
20 *Molinea caerulea.*
Photo Jaanus Paal.

19

20

BOGS (OMBROTROPHIC MIRES)

21 Treed hummock-hollow-pool bog. Männikjärve bog, Endla Nature Reserve. Photo Jaanus Paal.



22 Treed hummock-hollow-pool bog. Luhasoo, Rõuge parish. Photo Jaanus Paal.

23 Bog forest.
Near Sälliku,
Iisaku commune.
Photo Ants Animägi.

24 *Calluna vulgaris.*
Photo Jaanus Paal.

25 *Chamaedaphne calyculata* is characteristic for bogs in eastern Estonia.
Photo Jaanus Paal.

24

25

26 *Empetrum nigrum.*
Photo Jaanus Paal.

27 *Carex pauciflora.*
Photo Jaanus Paal.

26

27

HUMAN AND BEAVER IMPACT ON MIRES

28 When mowing has ceased the paludifying grasslands and fens with shallow peat layer will start to overgrow with bushes. Photo Jaanus Paal.

29 The power line crossing a mire is an example of human impact. A transitional mire in Aela-Viirika Landscape Reserve, Kaiu commune. Photo Toivo Sepp.

30 A manifestation of human impact on mires are roads and tracks. Transitional mire close to Valgõjärve mire, Meremäe commune. Photo Kairi Sepp.

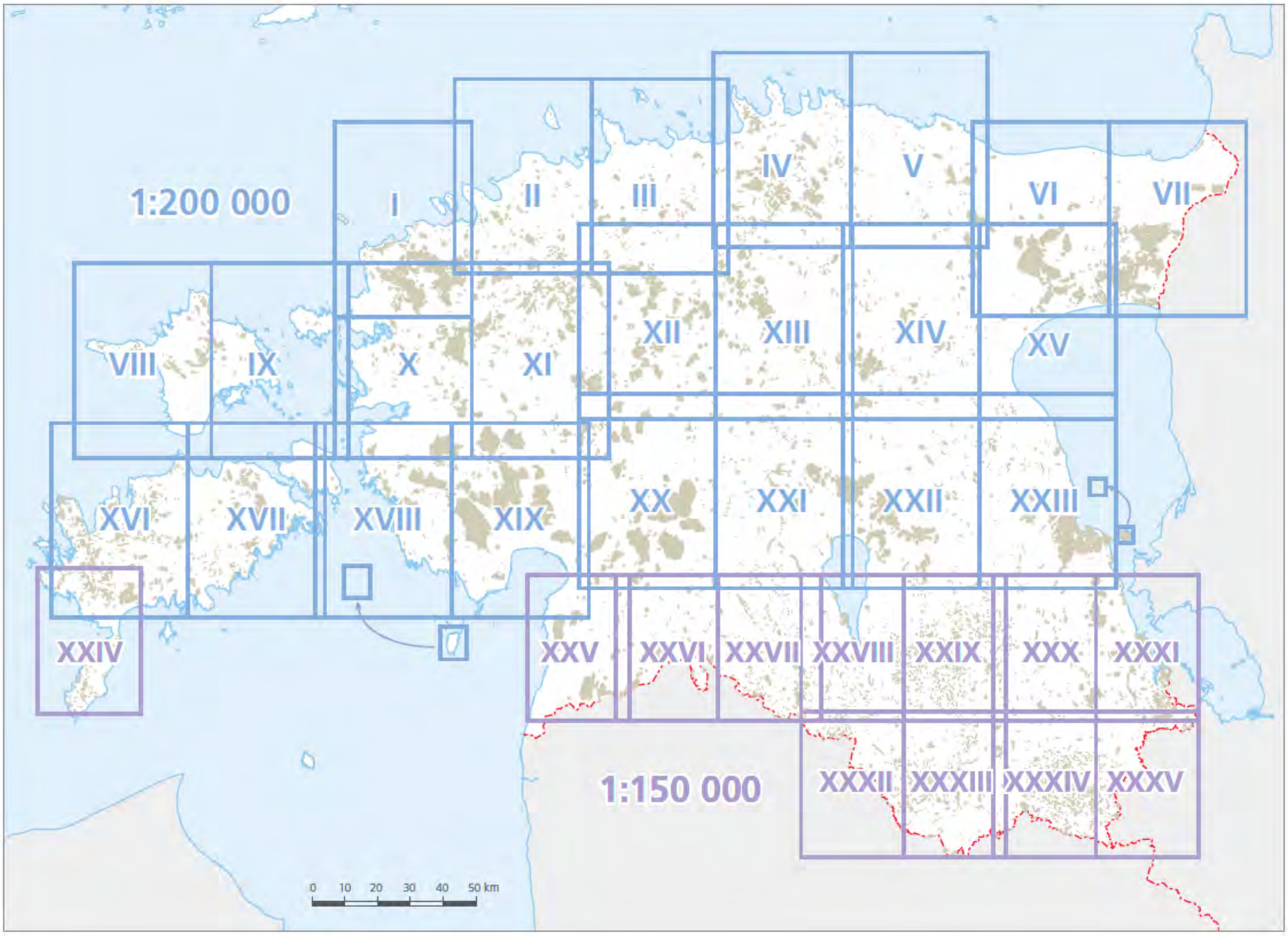
31 Drained treed bog. A bog nearby Alajõe, Ida-Virumaa district. Photo Ants Animägi.

32 Some mires or parts of them have been turned to pools. Soolätte village, Varstu commune. Photo Tiit Hallikma.

33 Milled peat extraction area. Photo Jaanus Paal.

34 In northeastern Estonia large mire areas have been dramatically destroyed by oil shale quarries. Photo Jaanus Paal.

35 Numerous mires are influenced by beavers damming up the streams. Karula National Park. Photo Jaanus Paal.



LEGEND

Areas less than 6 ha are depicted as symbols. Their colour marks global assessment and shape marks habitat type group. Areas over 6 ha are depicted as polygons. Their colour marks global assessment and raster marks habitat type group.

Global assessment:

- A - Excellent value
- B - Good value
- C - Significant value
- D - Low or lacking value
- ? - Unknown value

Habitat type groups:

- □ Minerotrophic mire (fen)
- △ Mixotrophic (transition) mire
- ◇ Ombrotrophic mire (bog)
- ○ Mire of unclear type
- ☆ Other habitat partly including a mire

- Protected area
- Built-up area

- District boundary
- National boundary