Metsähallituksen luonnonsuojelujulkaisuja. Sarja A, No 78
Nature Protection Publications of the Finnish Forest and Park Service. Series A No 78

Conservation, monitoring and management of threatened vascular plants and their habitats

– presentations from an Estonian and Finnish natur conservation seminar in Helsinki 17th–18th April, 1996

Tiina Kanerva and Eija Kemppainen (eds.)

METSÄHALLITUS
Luonnonsuojelu

Editors:

Tiina Kanerva
Finnish Forest and Park Service
Nature Protection
Development Unit
P.O. Box 94
FIN-01301 Vantaa
Finland

Eija Kemppainen
Finnish Environmental Institute
Nature and Land Use Division
P.O. Box 140
FIN-00251 Helsinki
Finland

ISSN 1235-6549
ISBN 952-446-030-0

Oy Edita Ab
Helsinki 1997

Cover Picture: Rubus arcticus. Hellevi Salonen.

KUVAILULEHTI

Julkaisija Metsähallitus	Julkaisun päivämäärä 5.9.1997
Tekijät (toimielimestä: toimielimen nimi, puheenjohtaja, sihteeri) Tiina Kanerva ja Eija Kemppainen (toim.)	Julkaisun laji seminaarijulkaisu Toimeksiantaja Toimielimen asettamispvm

Julkaisun nimi

Uhanalaisten putkilokasvien ja niiden elinympäristöjen suojelu, seuranta ja hoito
Viron ja Suomen luonnonsuojeluseminaarissa Helsingissä 17.–18. huhtikuuta 1996 pidetyt esitelmät

Julkaisun osat

Tiivistelmä

Uhanalaisten kasvien seurannasta, hoidosta ja tutkimuksesta tuli osa Viron ja Suomen välistä luonnonsuojeluyhteistyötä vuonna 1996. Helsingissä järjestettiin huhtikuussa seminaari, johon osallistui viisi tutkijaa Virosta ja kahdeksan Suomesta. Seminaarissa käsiteltiin uhanalaisten kasvien suojelutilannetta, seurantamenetelmiä ja tutkimushankkeita sekä tutustuttiin Suomen uhanalaisten lajien tietokantaan (UHEX). Tämä julkaisu on laadittu seminaarissa pidettyjen esitelmien pohjalta.

Järjestelmällistä työtä uhanalaisten kasvien parissa on molemmissa maissa tehty 1980-luvulta alkaen. Suomen uuden luonnonsuojelulain (1997) mukaan luonnonsuojelussa on tähdättävä maamme luontotyyppien ja luonnonvaraisten eliölajien suotuisan suojelutason saavuttamiseen ja säilyttämiseen. Suojelutyöhön osallistuvat eri viranomaistahot ympäristöhallinnossa, mutta vapaaehtoisten kasviharrastajien osuus esimerkiksi esiintymien inventoinnissa ja seurannassa on merkittävä. Uhanalaisten lajien systemaattinen seuranta on Suomen luonnonsuojelulain mukaan viranomaistehtävä. Uhanalaisten putkilokasvien seuranta- ja hoitomenetelmiä kehitetään kummassakin maassa. Pysyviä seuranta-aloja on perustettu useille uhanalaisten lajien kasvupaikoille, esimerkiksi Saarenmaalle Viidumäen luonnonsuojelualueelle ja Kuusamoon Oulangan kansallispuistoon. Joitakin harvinaisten ja uhanalaisten kasvien taksonomiaa, biologiaa ja ekologiaa selvittäviä tutkimuksia on tehty molemmissa maissa, mutta lisätietoja kaivataan yhä erityisesti uhanalaisten lajien ympäristövaatimuksista.

Avainsanat

uhanalaiset kasvit, seuranta, luonnonsuojelu, hoito, luonnonsuojeluyhteistyö, Viro

Muut tiedot

Sarjan nimi ja numero	ISSN	ISBN
Metsähallituksen luonnonsuojelujulkaisuja. Sarja A 78	1235-6549	952-446-030-0

Kokonaissivumäärä	Kieli	Hinta	Luottamuksellisuus
105	englanti	50,-	julkinen

Jakaja	Kustantaja
Metsähallitus, luonnonsuojelu	Metsähallitus

PRESENTATIONSBLAD

Utgivare	Utgivningsdatum
Forststyrelsen	5.9.1997

Författare (uppgifter om organet, organets namn, ordförande, sekreterare)	
Tiina Kanerva och Eija Kemppainen (red.)	Typ av publikation: seminariumpublikation
	Uppdragsgivare:
	Datum för tillsättandet av organet:

Publikation

Hotade kärlväxter och skyddet, uppföljningen och skötseln av deras livsmiljöer
Föredragen vid Estlands och Finlands gemensamma naturskyddsseminarium i Helsingfors den 17.–18. april 1997

Publikationens delar

Referat

Uppföljning och skötsel av och forskning kring hotade växter upptogs år 1996 som en del av naturskyddssamarbetet mellan Estland och Finland. I april 1997 arrangerades det i Helsingfors ett seminarium i vilket det deltog fem forskare från Estland och åtta från Finland. Under seminariet behandlades situationen för skyddet av hotade växter, metoder för uppföljning och forskningsprojekt, vartill deltagarna bekantade sig med databasen för hotade arter i Finland (UHEX). Den här publikationen har sammanställts utgående från de under seminariet hållna föredragen.

Ända sedan början av 1980-talet har det i båda länderna utförts systematiskt arbete kring de hotade växterna. Enligt den nya naturskyddslagen i Finland (1997) skall målet för naturskyddet vara att nå och bibehålla en gynnsam nivå för naturtyperna och de vilda arterna i vårt land. I skyddsarbetet deltar olika myndigheter inom miljöförvaltningen, men frivilliga hobbybotanisters andel i exempelvis inventering och uppföljning av förekomster är betydande. Den systematiska uppföljningen av hotade arter är enligt naturskyddslagen i vårt land en myndighetsuppgift. I såväl Finland som Estland utvecklas metoder för uppföljning och skötsel av hotade kärlväxter. Permanenta uppföljningsytor har inrättats på flera växtplatser för hotade växter, exempelvis inom Viidumäe naturskyddsområde på Ösel och inom Oulanka nationalpark i Kuusamo. I båda länderna har det utförts en del utredningar och studier av sällsynta och hotade arters taxonomi, biologi och ekologi, men fortfarande behövs det mera fakta, särskilt om de krav på miljön de hotade arterna har.

Nyckelord

hotade växter, uppföljning, naturskydd, skötsel, naturskyddssamarbete, Estland

Övriga uppgifter

Seriens namn och nummer		ISSN	ISBN
Metsähallituksen luonnonsuojelujulkaisuja. Sarja A 78		1235-6549	952-446-030-0
Sidoantal	**Språk**	**Pris**	**Sekretessgrad**
105	engelska	50,-	offentlig
Distribution		**Förlag**	
Forststyrelsen, naturskydd		Forststyrelsen	

DOCUMENTATION PAGE

Published by Finnish Forest and Park Service	Date of publication 4.9.1997
Author(s) Tiina Kanerva and Eija Kemppainen (eds.)	Type of publication seminar publication Commissioned by Date of assignment / Date of the research contract

Title of publication

Conservation, monitoring and management of threatened vascular plants and theri habitats
Presentations from an Estonian and Finnish natur conservation seminar in Helsinki 17th–18th April, 1996

Parts of publication

Abstract

In 1996 nature conservation cooperation between Estonia and Finland was extended to monitoring, management and research of threatened plants. Five Estonian and eight Finnish scientists attended a seminar held in Helsinki in April 1996. In the seminar the following items were discussed: conservation status of threatened vascular plants, monitoring methods and recent results of some research projects. The Finnish database of threatened species (UHEX) was also presented. This publication is based on the presentations given in the seminar.

Systematic work with the conservation of threatened plants started in the 1980s in Estonia and in Finland. According to the new Finnish Nature Conservation Legislation (1997), conservation shall focus on monitoring and maintaining the favourable conservation status of natural habitats and of wild fauna and flora. The work is mainly carried out by the national and regional environmental authorities. However, the contribution of amateur botanists has been considerable for example in inventories.

Monitoring and management methods of threatened vascular plants are under development in both countries. Permanent monitoring plots have been established at the sites of several threatened species, for example in Viidumäe Nature Reserve in Saaremaa and Oulanka National Park in Kuusamo. Some research on the taxonomy, biology and ecology of rare and threatened plants is carried out in Estonia and in Finland, but more information is still needed especially on the ecological demands of threatened species.

Keywords

threatened plants, nature conservation co-operation, monitoring, nature conservation, management, Estonia

Other information

Series (key title and no.)		ISSN	ISBN
Metsähallituksen luonnonsuojelujulkaisuja. Sarja A 78		1235-6549	952-446-030-0
Pages 105	Language english	Price 50,-	Confidentiality public
Distributed by Finnish Forest and Park Service, Nature Protection		Publisher Finnish Forest and Park Service	

FOREWORD

The Estonian–Finnish nature conservation cooperation meeting at Viidumäe Nature Reserve, 4th–7th October 1995, proposed joint efforts in the area of management of threatened vascular plants and their habitats. At the next joint meeting in Helsinki, 27th–28th February 1996, the aim of the cooperation was specified in more detail. The theme *Conservation, monitoring and management of threatened plants in Finland and Estonia* was agreed to be developed in the form of a seminar in Finland and a field trip to Estonia in 1996. The cooperation was based on the already established network of conservation institutions in the two countries.

The seminar proceedings in your hands is the evidence of the successful beginning of new cooperation in nature conservation, providing a sound basis for maintaining the flora, vegetation and landscapes of our two countries.

Tiit Randla
Ministry of the Environment
Tallinn

Antti Haapanen
Ministry of the Environment
Helsinki

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1 INTRODUCTION

In September 1995 the first European conference on the conservation of wild plants – Planta Europa in Hyères – brought together plant conservationists from all over the continent. The conference delegates of Estonia and Finland agreed on the necessity to promote cooperation in threatened plant conservation and research. The initiative was brought up during the next meeting of the Estonian–Finnish nature conservation coordinating group in late autumn of the same year in Saaremaa. It was agreed that cooperation in the field of threatened plant conservation will continue in a seminar in Finland and a field trip to Estonia in 1996.

The aim of the cooperation is to develop plant and vegetation management in protected areas, to develop monitoring of threatened plants and to improve knowledge of the population biology and genetic diversity of threatened plants. The cooperation is directed and financed by the Ministries of the Environment of both countries. It is put into practise in Finland by the Threatened Species Unit of the Nature and Land Use Division of the Environment Institute and the Nature Protection Development Unit of the Forest and Park Service, and in Estonia by the Environmental Protection Institute of South Estonia and the Viidumäe Nature Reserve.

In April 1996 a seminar on "*Conservation, monitoring and management of threatened vascular plants and their habitats*" was held in Helsinki. Five Estonian and eight Finnish research scientists and officials participated in the seminar. During the seminar 13 short presentations were given concerning rare plant protection, monitoring, habitat management and the population biology of threatened vascular plants. A four-day field excursion to Estonia was made by four Finnish and five Estonian botanists in June 1996. They visited the Laelatu wooded meadows, Muhu Island and especially the Viidumäe Nature Reserve in Saaremaa. The programme of the visit consisted of both monitoring and management of vascular plants. A brief review of the Saaremaa excursion is published in Lutukka 1997.

Cooperation in the conservation, management and monitoring of threatened vascular plants will continue with a meeting and an excursion to Oulanka National Park in Finland in June 1997. During the coming years the seminars and excursions will be continued. Research should be carried out in both countries to determine the extent of genetic isolation of small and separated populations of some threatened vascular plants. This work will be possible only by unifying the resources in Estonia and Finland as well as in some other neighbouring countries, for example the other Baltic countries, Sweden and the Karelian Republic.

This publication is an account of articles based on the short seminar abstracts. Tiina Kanerva and Eija Kemppainen edited the articles and Michael Bailey checked the English language.

2 PROTECTION OF THREATENED VASCULAR PLANTS

2.1 Protection of threatened vascular plants in Finland

Aulikki Alanen and Heidi Kaipiainen, Finnish Environment Institute & Tiina Kanerva, Forest and Park Service

2.1.1 Red Data books

Systematic work with threatened plants in Finland was started in the 1970s, mainly by WWF-Finland. State participation began in 1983 when the first Committee for the Conservation of Threatened Animals and Plants started its work, leading to the Finnish Red Data Book (Rassi et al.) in 1986 and the revised edition (Rassi et al.) in 1992. These books include all groups of organisms except microbes. In the future the national Red Data Book is planned to be revised every 10 years, the next edition being due in 1999. Meanwhile, the red lists and books of different regions and organism groups are being compiled and published. The work is co-ordinated by the Finnish Environment Institute together with other organizations, especially WWF-Finland, in the form of national working groups.

The number of threatened species in Finland (Rassi et al. 1992) is currently around 1 700. This represents approximately 10 % of the total number of species that are sufficiently well known to be categorized by threat status. The number of threatened vascular plants in different categories (from extinct to species in need of monitoring) is 226, which is almost 17 % of the total Finnish native or established flora of 1 300 species. In other Nordic countries the number of threatened species generally represents the same proportion of the overall indigenous fauna and flora.

Some of the threatened plants in Finland are also listed in international agreements and regulations. In the Bern Convention Appendix I (strictly protected flora species), there are now 10 vascular plants that occur in Finland: *Alisma wahlenbergii, Anemone patens (Pulsatilla patens), Botrychium simplex, Cypripedium calceolus, Liparis loeselii, Najas flexilis, N. tenuissima, Saxifraga hirculus, Silene furcata* subsp. *angustiflora* and *Trisetum subalpestre.* They are all rated as threatened on the national level. There are also six Finnish vascular plants listed in Annexes II and IV of the Habitats Directive of the European Union: *Anemone patens, Bothrychium simplex, Cypripedium calceolus, Liparis loeselii, Najas flexilis* and *Saxifraga hirculus.* In addition, Finland and Sweden have made a proposal to amend the Annexes with several more species, of which 24 vascular plants occur in Finland. The proposal is being considered in the Commission and should be put into force in the near future.

2.1.2 *Threatened species and their pressures*

During recent centuries man has caused great changes in the composition and diversity of species. Traditional agriculture, that was practiced until the late 1880s, increased the total diversity of landscapes, habitats and species, while causing great loss of species and habitat diversity locally by turning the richest forests and fens into arable land. Over the centuries man introduced many new species which adapted to become permanent components of the fauna and flora. Nowadays the development is the reverse. Especially during the past 40 years land use by agriculture, forestry and construction has intensified immensely, based on modern practices including heavy machinery and chemicals. This has caused great losses of diversity in Finnish nature. The species diversity of most natural and semi-natural biotopes is also declining.

The main threat to Finnish species diversity today is land use (Fig. 1). The climatic changes, pollution and other chemical damages are still considered a minor threat, known to affect negatively only about 10 % of all threatened species. Especially the eutrophication of both freshwaters and marine areas is changing the aquatic and coastal habitats in a way which favours fewer species and causes the decline of many others.

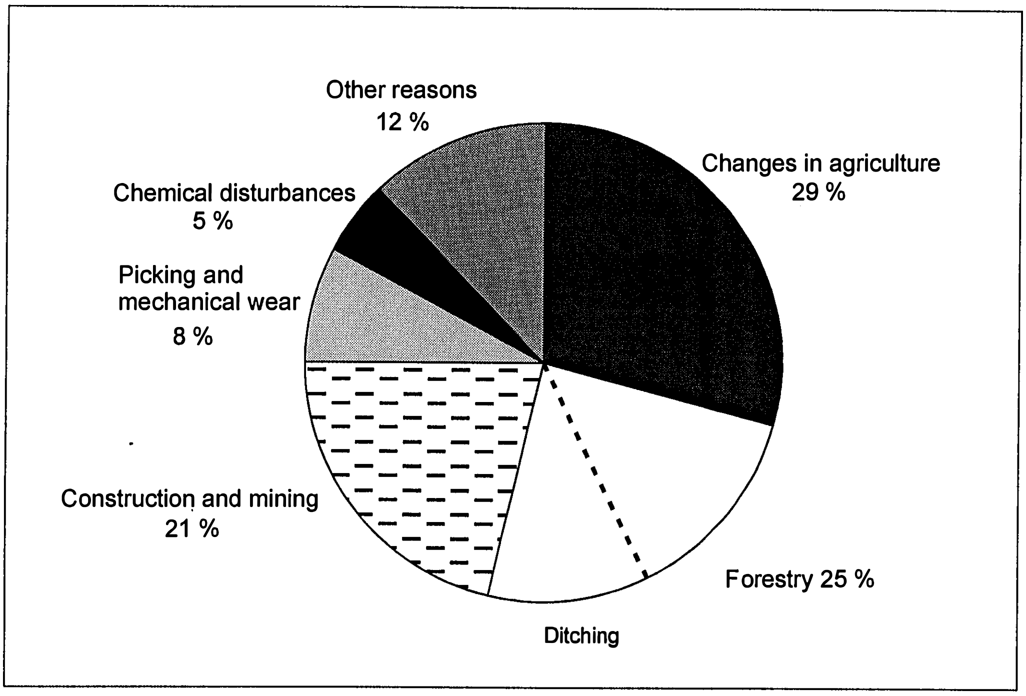

Fig. 1. Main threats and causes of decline of Finnish vascular plants (according to Ryttäri & Kettunen 1997).

Semi-natural grasslands and pastures (under cultural habitats in Fig. 2) are the most important habitat types, based on the number of threatened plants living in them (ca. 30 % of plants). The proportion of these species has continuously increased, partly due to better knowledge but mainly due to the drastic decline of suitable habitats. The decline is caused by overgrowth in abandoned areas and nutrient, especially nitrogen, enrichment in intensive arable areas.

Other important habitats for threatened plants are different kinds of shores (ca. 20 % of species), especially meadows and alluvial shores, which are nowadays often regulated, drained, overgrown or constructed. The third significant group consists of plants growing in forests (19 %), especially herb-rich forests, which nowadays are only small patches being overrun by thick spruce stands which leave no room for the former rich flora. Most of the vascular plants of mires are growing on the rich fens.

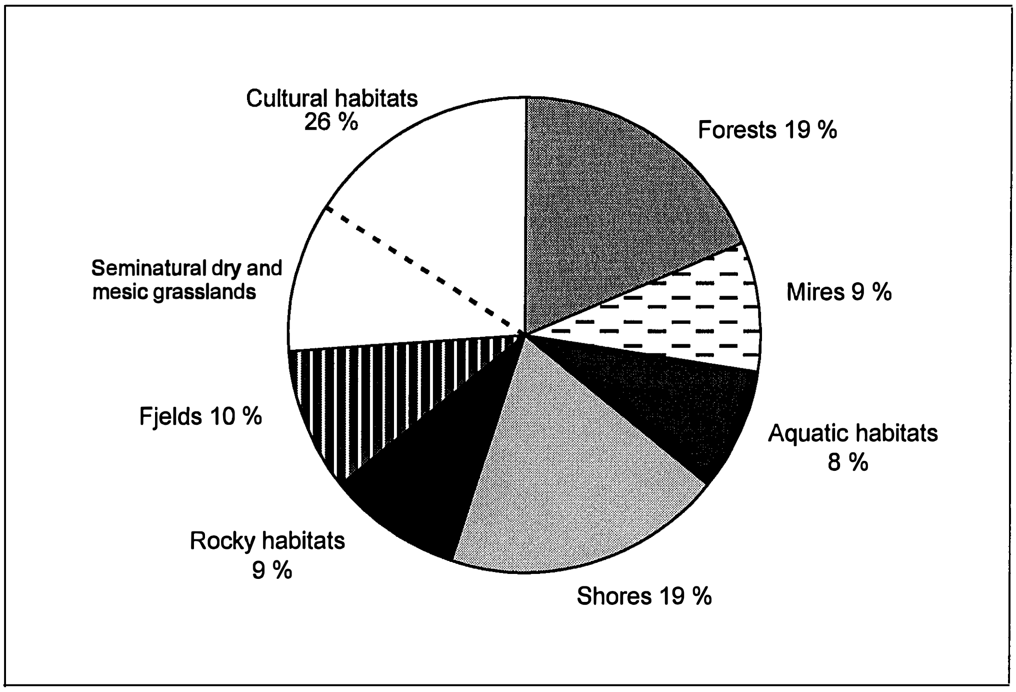

Fig. 2. Habitats of threatened vascular plants in Finland (according to Ryttäri & Kettunen 1997).

2.1.3 *Legislation*

The history of rare plant protection in Finland dates back to the Nature Conservation Act of 1923. Based on the Act, rare plants in increasing numbers (9 species in 1925, 115 species in 1992) have gained legal protection. Basically, protection means prohibition of collecting and picking of the plants. The later alterations to the Act (1987, 89, 91) brought into the legislation the concepts of "Threatened Species" and "Species Under Strict Protection". These categories were kept and clarified in the new Act, which came into force in the beginning of 1997. The new lists of protected species and species under strict protection came into force on the first of March, 1997.

Almost all endangered and vulnerable vascular plants are protected by law and categorized under strict protection (Table 1, see page 20). Special conservation and management (recovery) programmes are prepared when necessary for strictly protected species. The regional environment centres will inform landowners of the sites of these species and the actions that can or cannot be taken in the areas in order to protect the viable populations of the species.

The "living value" was estimated for protected animal and plant species. The living value is based on the threat status, abundance and regeneration capacity of the species. Exact financial values for the animals, but not for the plants were published in the regulation of the Ministry of the Environment 23. 10. 1995. This regulation helps the courts to handle violations of the protection orders and to determine the appropriate fines and financial compensations for violations. The regional environment centres provide their estimates of the appropriate living values of protected plants, case by case.

2.1.4 *Environmental Administration*

The Ministry of the Environment has the main responsibility and is the financing authority in Finnish nature conservation (Fig. 3). The national budget for conservation of threatened species clearly increased in the late 1980s but then decreased again and is still rather low, leaving a great responsibility to WWF-Finland and other voluntary bodies.

The Finnish Environment Institute (FEI), with about 500 employees, is a national research and development centre. It is responsible for national environment research, monitoring and the overall state of the environment in Finland, providing an environmental information service and increasing public awareness of environmental issues. It futher produces expert services for the Ministry of the Environment and the regional authorities.

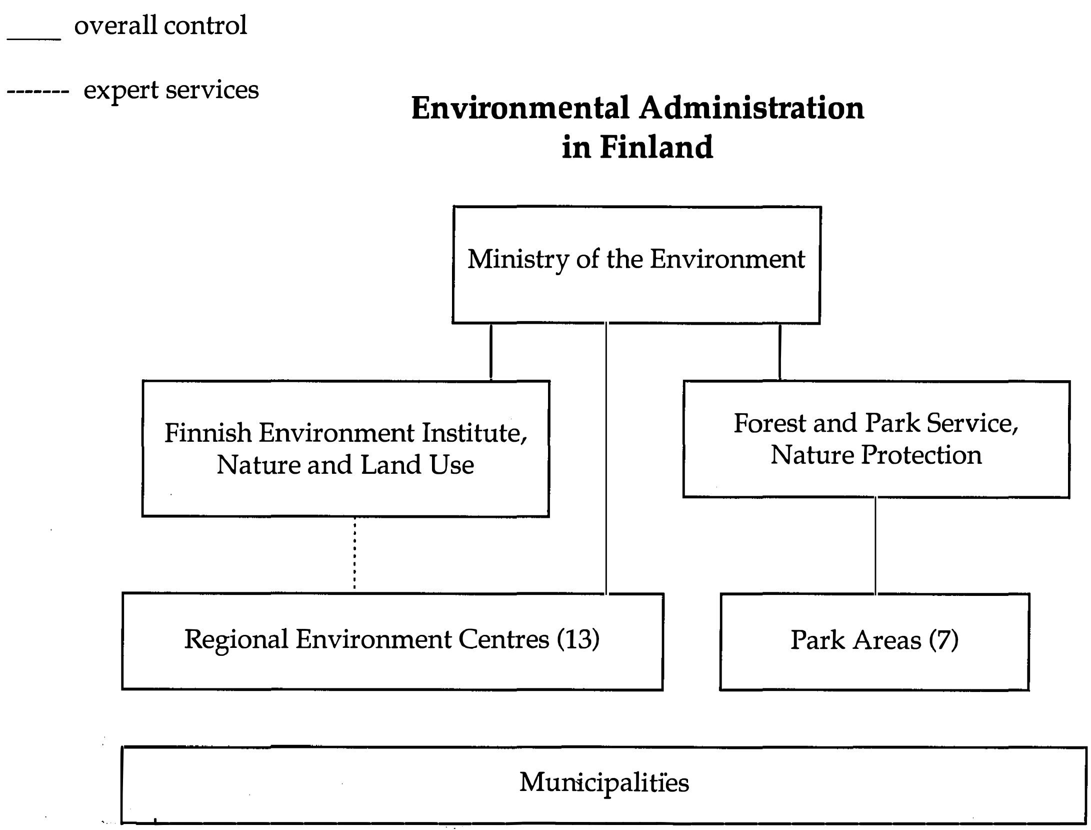

Fig. 3. Environmental Administration in Finland.

The main national coordinator of plant conservation activities is the Nature and Land Use Division of the Finnish Environment Institute, from where the WWF plant working group also operates together with the University of Helsinki and all other experts, amateurs and their organizations. The main tasks of FEI in the field of plant protection today are

- compilation and publishing of the Red Data Book of vascular plants in May 1997
- preparation of conservation programmes for vascular plants (5 published in 1993–1996, about 3 due in 1997)
- compilation and upkeep of the national database of threatened species (see page 17)
- co-ordination of research, management and monitoring projects of threatened plants (monitoring methods to be compiled in 1997)
- various international tasks, especially those connected with the EU, EEA, IUCN, Bern and CITES conventions and the Red Data Books of the Baltic and Eastern Fennoscandian regions.

The main organizations in charge of the protection, management and monitoring activities in the field are the thirteen **regional environment centres** and the seven park areas of the Finnish Forest and Park Service (Appendix 2). The FEI works together with these authorities, discussing the priorities and methods of conservation, management and monitoring of threatened species.

The Finnish Forest and Park Service (FPS, earlier The National Board of Forestry) was established in 1859 for the management of state-owened forests. In 1994 it became a state-owned enterprise which also has social and official duties. Its tasks include the sustainable use of State forests, recreational services and nature conservation. The tasks of the Nature Protection division of the Forest and Park Service include the management of protected areas as well as the protection and management of threatened species. The Nature Protection Units also promote biodiversity and the conservation of threatened species in commercial forests belonging to the FPS.

The organization of the Nature Protection division of FPS consists of the Central and Development Units, the six Park Areas and the Northern Lapland District for Wilderness Management. At each park area there is one botanist, who is responsible for the monitoring and management of threatened plants. These botanists also belong to the Plant Team that discusses the guidelines of plant conservation within the FPS and develops the monitoring methods of threatened plants together with the Finnish Environment Institute.

2.1.5 The Finnish Database of threatened species

One of the main tasks of the Finnish Environment Istitute (FEI) is to compile data of nationally threatened species and their sites and to record this data in a national database. The database of threatened species is necessary especially for conservation authorities when planning conservation and management activities in the sites. It is also important that the data of threatened species and their sites are rapidly available for land use planners. The database includes very little detailed information on biology or on changes in populations.

The field observation forms (specially designed for the vascular plants, mosses, lichens, fungi, birds and invertebrates, Fig. 4, page 24) are the most important data sources but literature and herbariums are also used as sources when the information is gathered and recorded. The research scientists, volunteer specialists and amateurs use the forms to submit their observations to the FEI, where the information is entered into the database.

The FEI maintains an archive of original observation forms and other source material. This archive also contains site maps, because at the moment it is impossible to produce maps from the database (information from the maps has not yet been digitised). The database is accessible to the regional environment centres and the park areas of the Finnish Forest and Park Service, which participate in data recording and compile the data of regionally threatened species.

Due to lack of resources, data gathering and recording is proceeding very slowly. By the end of February 1997 the database of threatened species stored data from 18 700 sites (the total number in Finland is estimated to be 50 000) and 28 100 observations of 1 100 different species. Recording is most complete in the case of vascular plants, for which about 10 000 sites have been recorded. The database also stores a rather large amount of information about mosses, lichens, fungi, beetles, butterflies and birds.

The database of threatened species contains data on species, sites and observations of all threatened plants and animals in Finland. In addition to the so-called basic data (scientific and national name of the species, threat categories, threats etc.), **species data** contains information on the biological characteristics, special requirements and distribution of the species. **Site data** includes a precise description of the geographical location (coordinates in the uniform grid system, Grid 27 ^{O}E), number of the topographic map, municipality, biogeographical province, altitude of the site above sea level etc. and verbal descriptions for example of the habitat, associated species and the need for conservation and management of the site. **Observation data** contains the date of observation, the name of the observer and the kind of observation made in each site (Table 2, page 27).

2.1.6 Protected areas

One quarter of Finland's land surface area, about 8.5 million hectares, is state-owned and managed by the Forest and Park Service (FPS). About 15 percent of the land managed by the FPS, about 1 360 000 hectares, is protected by law (Table 3). The area of the 12 wilderness areas in Lapland is about 1 490 000 hectares. The management of the nature protection areas is financed from the national budget and directed by the Ministry of the Environment. With a few exceptions the FPS manages the protected areas owned by the state. For historical reasons the three oldest national parks and five strict nature reserves are managed by the Finnish Forest Research Institute.

The national network of existing and planned nature conservation areas covers some important areas (especially Lapland) and habitats (mires, herb-rich forests etc.) reasonably well, securing many of the species of those habitats. However, the conservation status of many species is still insufficiently known. There are still large gaps in the network, especially concerning the species of aquatic and coastal habitats, rocky habitats and semi-natural grasslands and pastures. Furthermore the network, particularly in the south, is not sufficiently dense to secure enough natural areas for individuals of a species to migrate from one population to another and to invade new areas etc., although this mobility is essential for the viability of many species.

Table 3. Protected area and wilderness areas managed by the Forest and Park Service, 1.1.1997.

	Amount	Area, ha
National Parks	28	666 000
Strict Nature Reserves	14	143 000
Peatland Reserves	173	416 000
Protected herb-rich forests	45	1 000
Other areas protected by law	117	60 000
Total	**377**	**1 286 000**
Wilderness areas	12	1 489 000

The recent sites of many threatened species are only tiny fractions of their former natural areas, and the conservation value of the habitats and landscape in the site is often very small. Creating nature reserves is not sufficient for many endangered species, which may also need some sort of management or recovery actions combined with monitoring of the populations.

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Ryttäri, T. & Kettunen, T. (eds.) 1997: Uhanalaiset kasvimme. – Kirjayhtymä, Helsinki. 335 p.

Table 1. Threatened and protected vascular plants in Finland (Nature Conservation Decree 1997).

*Species are listed in alphaphetic order, nomenclature according to Hämet-Ahti et al. 1986 and Ryttäri & Kettunen 1997. * The threatend species determined "Under Strict Protection". Threat categories (Rassi et al. 1992): E = endangered, V = vulnerable, St = In need of monitoring, declining, Sh = In need of monitoring, rare. P = protected in Mainland Finland (Decree 1997), Å = protected in the Åland Islands (Decision of the provincial government of the Åland Islands, 1990).*
Disappeared (H) species and species in need of monitoring, poorly known (Sp) as well as species growing only in Åland Islands are not included in the decree. They are listed in the end of the table.

Nature Conservation Decree 1997:

	Threat *category	Protected (P, Å)
Aconitum lycoctonum (*A. septentrionale*)	Sh	P
Agrimonia pilosa	* E	P
Agrimonia procera	St	
Agrostis clavata	Sh	
Alchemilla hirsuticaulis	St	
Alisma wahlenbergii	* St	P
Allium schoenoprasum var. *sibiricum*	Sh	
Allium ursinum	Sh	
Ammophila arenaria	Sh	
Anagallis minima	V	
Androsace septentrionalis	* V	PÅ
Anemone patens (*Pulsatilla patens*)	St	P
Anemone trifolia	Sh	P
Anemone vernalis		P
Antennaria lanata	Sh	P
Antennaria nordhageniana	Sh	
Antennaria porsildii	Sh	
Anthyllis vulneraria subsp. *lapponica*	Sh	P
Anthyllis vulneraria subsp. *polyphylla*	* V	P
Arctagrostis latifolia	Sh	P
Arctium nemorosum	St	
Arctophila fulva var. *pendulina*	* E	P
Arenaria norvegica	Sh	P
Arenaria pseudofrigida (*A. ciliata* subsp. *pseudofrigida*)	Sh	P
Armeria maritima subsp. *elongata*	* V	P
Armeria maritima subsp. *intermedia*	* V	P
Armeria maritima subsp. *sibirica*	V	P
Arnica angustifolia subsp. *alpina*	* V	P
Artemisia campestris subsp. *bottnica*	V	P
Asarum europaeum	Sh	P
Asperula tinctoria	* V	PÅ
Asplenium adulterinum	* V	P
Asplenium ruta-muraria	Sh	Å
Bistorta major (*Polygonum bistorta*)	* V	P
Botrychium lanceolatum	St	
Botrychium matricariifolium	St	
Botrychium simplex	* E	PÅ
Botrychium virginianum	* V	P
Bromus benekenii	* E	PÅ
Calypso bulbosa	St	P
Campanula cervicaria	St	
Campanula latifolia		Å
Campanula uniflora	Sh	P
Cardamine flexuosa	* E	P
Cardamine impatiens	* V	P
Cardamine parviflora	* V	P
Carduus nutans	E	P
Carex atherodes	Sh	
Carex buxbaumii		Å
Carex hartmanii	* E	PÅ
Carex heleonastes	St	
Carex holostoma		P
Carex lepidocarpa subsp. *jemtlandica*	St	PÅ
Carex microglochin	St	
Carex paniculata	Sh	P
Carex riparia	Sh	Å
Carex viridula var. *bergrothii*	St	

	Threat *category	Protected (P, Å)
Carex vulpina	* V	PÅ
Carlina biebersteinii (*C. vulgaris* subsp. *longifolia*)	* V	P
Carlina vulgaris (*C. vulgaris* subsp. *vulgaris*)	Sh	P
Catabrosa aquatica	Sh	[1] P
Cephalanthera rubra	* E	P
Cerastium fontanum subsp. *vulgare* var. *kajanense*	* V	
Chamorchis alpina	Sh	P
Chenopodium bonus-henricus	St	
Cinna latifolia	Sh	P
Cladium mariscus	* V	PÅ
Clematis alpina subsp. *sibirica* (*C. alpina*)	Sh	P
Crepis praemorsa	* E	PÅ
Crepis tectorum subsp. *nigrescens*	* V	P
Cynoglossum officinale	V	P
Cypripedium calceolus	St	PÅ
Dactylorhiza incarnata subsp. *cruenta*	St	P
Dactylorhiza majalis		P
Dactylorhiza sambucina		P
Dactylorhiza traunsteineri	St	[1] PÅ
Daphne mezereum		Å
Dianthus arenarius subsp. *borussicus*	St	P
Diphasiastrum tristachyum (*D. complanatum* subsp. *chamaecyparissus*)	Sh	
Diplazium sibiricum		P
Draba alpina	Sh	P
Draba cinerea	Sh	P
Draba lactea	Sh	
Draba nemorosa	St	
Dryopteris fragrans	Sh	P
Elatine alsinastrum	V	
Elymus alaskanus subsp. *scandicus*	Sh	
Elymus farctus subsp. *boreali-atlanticus*	* V	P
Epilobium laestadii	* V	
Epilobium lamyi	Sh	
Epilobium obscurum	V	P
Epipactis atrorubens	Sh	P
Epipactis helleborine		P
Epipactis palustris	* St	PÅ
Epipogium aphyllum	St	P

	Threat *category	Protected (P, Å)
Equisetum x trachyodon	Sh	
Equisetum variegatum		Å
Erica tetralix	* E	P
Erigeron acer subsp. *decoloratus*	Sh	
Erigeron borealis	* E	P
Euphorbia palustris		P
Euphrasia micrantha	St	
Euphrasia rostkoviana subsp. *fennica*	St	
Euphrasia salisburgensis	Sh	
Festuca gigantea	* E	P
Galium saxatile	* E	P
Gentianella amarella	* St	
Gentianella campestris	* V	
Gentianella tenella	Sh	P
Gentianella uliginosa	St	
Gymnocarpium continentale (*G. jessoënse* subsp. *parvulum*)	Sh	
Gymnocarpium robertianum	Sh	
Gypsophila fastigiata	St	P
Gypsophila muralis	St	
Hammarbya paludosa		P
Helianthemum nummularium		P
Herniaria glabra	St	
Hippuris tetraphylla	St	P
Hypericum montanum	* E	P
Juncus x montellii	Sh	
Kobresia myosuroides	Sh	
Kobresia simpliciuscula	* V	P
Lappula deflexa	Sh	P
Lathrea squamaria		P
Lathyrus niger		Å
Leersia oryzoides	* E	P
Lepidium latifolium	St	PÅ
Listera ovata		P
Lithospermum arvense	St	
Lonicera caerulea subsp. *pallasii*	* V	P
Lychnis alpina var. *serpentinicola*	Sh	
Malus sylvestris	St	P
Malva pusilla	St	
Melampyrum arvense	Sh	P
Melica ciliata	* E	P
Melica picta		Å
Melilotus altissimus	V	
Mercurialis perennis		Å
Microstylis monophyllos	* V	PÅ
Moehringia lateriflora	St	P

	Threat *category	Protected (P, Å)
Myosotis nemorosa	St	
Myricaria germanica	Sh	
Najas flexilis	* E	P
Najas tenuissima	* V	P
Neottia nidus-avis		P
red flowered forms of *Nymphaea*		P
Odontites vernus	E	
Oenanthe aquatica	Sh	Å
Ononis arvensis	* E	P
Ophrys insectifera	E	PÅ
Orchis militaris		P
Oxytropis lapponica	Sh	P
Petasites spurius	* V	
Phleum phleoides	St	Å
Pilularia globulifera	Sh	
Platanthera bifolia		P
Platanthera chlorantha		P
Pimpinella major	* E	P
Polygala vulgaris		P
Polygonum foliosum		P
Polygonum oxyspermum (*P. oxyspermum* subsp. *oxyspermum*)	* V	P
Polystichum lonchitis		P
Potamogeton friesii	Sh	
Potamogeton polygonifolius	Sh	
Potamogeton rutilus	Sh	
Potentilla anglica	St	
Potentilla neumanniana	* V	PÅ
Potentilla nivea subsp. *chamissonis* (*P. chamissonis*)	Sh	P
Potentilla nivea subsp. *nivea* (*P. nivea*)	Sh	P
Potentilla subarenaria	* V	PÅ
Primula nutans	St	P
Pseudorchis albida	Sh	P
Puccinellia phryganodes	* V	P
Ranunculus aquatilis var. *diffusus* (*R. trichophyllus* subsp. *trichophyllus*)	St	
Ranunculus glacialis		P
Ranunculus lapponicus		P
Ranunculus reptabundus (*R. sceleratus* subsp. *reptabundus*)	V	
Ranunculus sulphureus	Sh	
Rhododendron lapponicum	Sh	P
Rumex maritimus	Sh	
Sagina maritima	Sh	
Salix pyrolifolia	* E	P
Salix triandra	St	
Salsola kali subsp. *kali*	* V	P
Samolus valerandi	Sh	P
Saxifraga adscendens	Sh	P
Saxifraga hirculus	St	P
Schoenus ferrugineus	St	PÅ
Scirpus radicans	V	
Scleranthus perennis	E	P
Sedum villosum	* E	P
Silene furcata subsp. *angustiflora*	* E	P
Silene tatarica	St	
Silene wahlbergella (*S. uralensis* subsp. *apetala*)	Sh	P
Sium latifolium	* E	P
Sorbus intermedia	Sh	
Sparganium erectum subsp. *erectum*	Sh	
Stellaria crassifolia var. *minor* (*S. crassifolia* var. *brevifolia*)	* V	
Stellaria fennica	Sh	
Thalictrum aquilegiifolium	* V	P
Thalictrum lucidum	* V	
Thalictrum minus subsp. *kemense* (*T. kemense*)	Sh	P
Tilia cordata		Å
Trisetum subalpestre	* V	P
Ulmus glabra	St	PÅ
Ulmus laevis	Sh	P
Veratrum album	* E	P
Veronica fruticans		P
Vicia cassubica	* V	P
Viola collina	* E	P
Viola persicifolia	St	PÅ
Viola rupestris subsp. *relicta*	Sh	P
Viola uliginosa	* V	PÅ

[1)] Protected only in the southern part of Finland. Other vascular plants protected in southern Finland are: *Angelica archangelica* subsp. *archangelica*, *Dactylorhiza incarnata* subsp. *incarnata*, *Dianthus suberbus*, *Gymnadenia conopsea* (Å), *Saxifraga cespitosa*, *Saxifraga nivalis* and *Woodsia alpina*.

Threatened vascular plants not included in the Decree 1997:

	Threat Category	Protected in Åland (Å)
Aira praecox	V	* Å
Alchemilla propinqua	Sp	
Anemone pulsatilla (Pulsatilla vulgaris)	H	
Anthemis cotula	Sp	
Blechnum spicant	H	* Å
Carex hostiana	St	* Å
Carex lepidocarpa subsp. *lepidocarpa*	V	* Å
Carex maritima	H	
Carex montana	H	
Carex ornithopoda	E	* Å
Carex otrubae	V	* Å
Carex remota	V	* Å
Cephalanthera longifolia	Sh	* Å
Chenopodium urbicum	H	
Dactylorhiza lapponica	Sp	
Fritillaria meleagris	V	* Å
Fumaria vaillantii	E	
Geranium columbinum	H	
Geranium dissectum	St	
Herminium monorchis	H	* Å
Lepidium campestre	St	
Liparis loeselii	E	* Å
Melica uniflora	V	* Å

	Threat Category	Protected in Åland
Mentha aquatica var. *aquatica*	E	
Monotropa hypopitys var. *glabra*	Sp	
Orchis mascula	Sh	Å
Poa supina	V	
Polygala comosa	E	* Å
Polystichum aculeatum	H	
Primula farinosa	St	
Rosa canina	Sp	
Rosa sherardii	Sh	
Rubus humulifolius	H	
Rubus aureolus (R. pruinosus)	Sh	Å
Salix arbuscula	Sp	
Sorbus teodori	Sp	Å
Suaeda maritima	V	
Stellaria humifusa	H	
Taxus baccata	St	Å
Torilis japonica	V	* Å
Veronica anagallis-aguatica	E	* Å
Vicia lathyroides	Sh	* Å
Viola reichenbachiana	V	* Å

Only in northern Finland are protected: *Anemone nemorosa, Asplenium ruta-muraria, Corydalis intermedia, Impatiens noli-tangere, Iris pseudacorus, Poa remota, Polygonatum odoratum* and *Thelypteris palustris*. They are not threatened.

Commersial use of *Daphne mezereum, Hepatica nobilis, Hippophae rhamnoides, Lathyrus vernus, Pulmonaria obscura, Primula veris* and tree and pillar-like *Juniperus communis* is prohibited (Decision of the Ministry of the Environment 1997).

Figure 4. Finnish field observation form for vascular plants (FEI 1997).

Suomen ympäristökeskus
Luonto- ja maankäyttöyksikkö
PL 140, 00251 Helsinki /
Finnish Environment Institute,
Nature and Land Use
P. O. Box 140, FIN-00251 Helsinki

UHANALAISTEN LAJIEN MAASTOLOMAKE
PUTKILOKASVIT /
FIELD OBSERVATION FORM
VASCULAR PLANTS

Päivämäärä / **Date**_________ ☐ Ensi-käynti / **Mapping visit** ☐ Seuranta-käynti / **Monitoring visit** Uhan-alaisuus / **Threat category**

LAJI / **Species**____

Havainnoitsijan nimi / **Name of observer:**______________________________

Osoite ja puhelin, **Address, tel.:** ______________________________

ESIINTYMÄN NIMI / **Site name:** ______________________________

ESIINTYMÄN SIJAINTI / GEOGRAPHICAL LOCATION

Kunta / **Municipality:**	Lääni / **Province:**
Rekisterikylä / **Register village:**	Eliömaakunta / **Biogeographical province:**
Karttalehti / **Number of topographical map:**	
Yhtenäiskoordinaatit / **Coordinates (Grid 27 ° E):**	:3
Tila (RN:o) / **Register number of real estate:**	
Maanomistaja(t) / **Landowner(s):**	
Onko maanomistajaan oltu yhteydessä / **Contact with the landowner:**	☐ kyllä / **Yes** ☐ ei / **No**
Suojelualue / **Protected area (name):**	

LAJIA EI LÖYTYNYT / **PLANT WAS NOT FOUND** ☐	LAJIA EI ETSITTY / **PLANT WAS NOT SEARCHED** ☐
Esiintymispaikka tuhoutunut / **Site was destroyed** ☐	Syy / **Reason** ______________________
Esiintymispaikka muuttunut / **Site was changed** ☐	Miten / **How ?** ______________________
Muusta syystä, mistä? / **Other reasons, what?** ☐	______________________

KOPIO / **COPY:** ☐ ALUE-KESKUS / **Regional Env. Centre** ☐ MH / **Forest and Park Service** ☐ MUU / **Others** TALL. / **Name of recorder and date**

ESIINTYMÄN KUVAUS / SITE DESCRIPTION

TARKEMPI SIJAINTI (karttakopio, piirros) / **PRECISE GEOGRAPHICAL LOCATION (map, drawing)**

LAJILLE SOVELIAAN ALUEEN PINTA-ALA / **SIZE OF SUITABLE AREA FOR THE SPECIES**

YLEISKUVAUS (kasvillisuustyyppi, puusto, maalaji, kosteus, ravinteisuus, kalkkivaikutus, kallioisuus, pinnanmuodot, ekspositio, avoimuus tai sulkeutuneisuus jne.) /
HABITAT DESCRIPTION (e.g. vegetation, trees, soil, moisture, exposition)

Ympäristötyyppi / **Habitat type (code):**

Seuralaislajit: valtalajit, luonnehtijat / **Associated species: dominant or characteristic species**

Harvinaiset ja muut uhanalaiset lajit / **Rare and other threatened species:**

Kilpailevat lajit / **Competitive species:**

ESIINTYMÄN JAKAUTUMINEN OSIIN / **SUBDIVISION OF THE SITE**

UHKATEKIJÄT / **THREATS**

SUOJELU- JA HOITOSUOSITUKSET / **NEED FOR CONSERVATION AND MANAGEMENT**

TOTEUTETUT SUOJELU- JA HOITOTOIMET / **CONSERVATION AND MANAGEMENT ACTIVITIES ALREADY CARRIED OUT**

AIEMMAT TIEDOT ESIINTYMÄSTÄ / **HISTORY OF THE SITE**

HAVAINTOTIEDOT / OBSERVATIONS

ESIINTYMÄN TAI ESIINTYMÄN OSIEN LAAJUUS / **AREA OR COVERAGE OF THE SITE OR SUBSITE**

YKSILÖ- TAI VERSOMÄÄRÄ (steriilien, fertiilien määrä tai osuus) / **NUMBER OF INDIVIDUALS (sterile, fertile), SHOOTS OR TUSSOCKS etc.**

YKSILÖIDEN TAI VERSOJEN IKÄ, KOKO (taimien määrä, mättäiden koko jne.) JA KUNTO / **AGE OR SIZE OF INDIVIDUALS (seedlings, tussocks) AND THEIR CONDITION**

KUKINNAN VAIHE (nuppujen, kukkien, siementen määrä/osuus) / **FLOWERING (number or proportion of buds, flowers, seeds)**

ARVIO SIEMENTUOTOSTA / **ESTIMATED SEED SET**

HAVAINNOT EDELLISVUOTISISTA YKSILÖISTÄ / **INDIVIDUALS OF PREVIOUS YEAR**

LISÄTIETOJA (näytteet, valokuvat jne.) / OTHER INFORMATION (herbarium sheets, protographs etc.)

Sketch map or drawing on the fourth page

Table 2. Contents of the threatened species database (the Finnish Environment Institute, Nature and Land Use division, 23th February, 1997).

1. Information about the species:
- Internal number of species
- Species rubincode (Nordic codesystem)
- Code for different plant and animal (taxonomic) groups (e.g. B4, vascular plants)
- Scientific name
- Finnish name
- Swedish name
- Family
- Threat category in Finland
- Publicity code of species: information stricly confidental ... information public (codes)
- Nature Conservation Decree (1997): threatened / specially protected species
- Legal protection reference of the species
- Living value of the protected species

Further information about the species:
- Biology (description, distribution etc.)
- Threat categories in different parts of Finland
- Causes of decline (codes)
- Habitat types in the whole country (codes)

2. Sites of threatened species
- Species rubincode
- Internal number of the site
- Site name
- Municipality
- Regional environment centre
- Register village
- Biogeographical province
- Number of the topografic map (1:20 000)
- UTM square (e.g. F1, MN2)
- Coordinates, uniform grid system (Grid 27^{O}E)
- The code of the drainage basin
- Habitat type (codes)
- Altitude of the site
- Size of potential area for the species
- The unit of (surface) area
- Host species
- Code of the protected area
- Land use plans (codes)
- Landowner: private / community / state
- Does the site still exist? Yes (+), uncertain (?), no (-)
- Urgency of site management
- Urgency of site protection
- Occasional find (x)
- Register number of the real estate (e.g. 9:5)
- Landowner (name, adress)
- Contact with the landowner (+ or -)

More detailed information of the site:
- Geographical location of the site
- Subdivision of the site, habitat description (vegetation, soil, etc.)
- Associated species (species lists)
- Threats of the site
- The need for conservation and management
- Conservation and management activities already carried out on the site
- History of the site
- Land use plans (detailed description)

3. Observations
- Species rubincode
- Internal number of the site
- Site name
- Code for subsites (e.g. A, B etc.)
- Date of observation
- Precision of the date (codes)
- The species was not found (X)
- Explanation of why the species was not found
- Coordinates
- Area/coverage of the site or subsite
- Unit of the area/coverage
- Number of individuals
- Unit (individuals, shoots, tussocks etc.)
- Source of information/observation, e.g. herbarium specimen, field observation
- Explanation of the foregoing
- Observer name
- Determiner name

Detailed description of the observation:
- Population size and its changes
- The state/condition of individuals/population
- Reproduction
- Further comments/information concerning the observation

Additional fields concerning invertebrates:
- Sampling techniques
- Food plants and nectar sources

Description of bird observation
Description of mammal observation

2.2 The rare plant protection scheme in Estonia

Mart Külvik, Environmental Protection Institute of South Estonia

Protection of wild plants in Estonia takes place in many different ways. In the following, the measures are described in two groups. Firstly, the lists of different protected (or threatened) species are reviewed. Secondly, the restrictive measures of land use for conservation are presented.

2.2.1 *Species lists*

Legally protected vascular plant species are included in three categories. Category I includes 22 plant species (The Act on Protected Natural Objects, 1994, hereafter APNO)[1], Category II 122 species and Category III 41 species (The Government Regulation On the Species Lists of Protection Categories II and III, 1995 [2] (see Table 1, page 36).

All the legal means currently in use were introduced during the past three or four years. However, the coming years should see further developments in this area. APNO is currently one of the main instruments of nature conservation (see text box below).

According to the APNO the investigation, marking or improvement/changing of growth environment conditions, extraction from natural environments, artificial reproduction, maintenance in non-natural (artificial) conditions and photography of Category I Species is forbidden except under license issued according to a procedure established by the Government of Estonia. Publication of information concerning the exact location of the growth or habitat of a species under Protection Category I is prohibited in cases where the subject might be endangered as a result. Upon receipt of information concerning a newly discovered, unprotected growth, breeding or maturation site of a species of Protection Category I, and according to a procedure established by the Government of Estonia, a temporary protection zone may be established for two months during which all human activity is suspended within the zone, which may be up to 50 m in diameter. The feasibility of establishing a protected area, its type and boundaries are determined within the two month period.

The picking of plants and fungi under Protection Category II, their purchase, sale and other movement, and the destruction or damage of their growth sites to an extent which endangers the survival of the relevant species at the site is prohibited. Purchase, sales and other movements of these species, and destroying or damaging their permanent growing sites to an extent which endangers the survival of the species at the site in question is prohibited. Special permits for performing the activities listed above for scientific or educational purposes are issued according to a relevant procedure. Publication of information concerning the exact habitat of a Category II Protected Species is prohibited in cases where the subject might be endangered as a result of this. A protected area may be established in order to guarantee the preservation of a species of Protection Category II in a particular site.

The picking, damaging in their natural sites and selling of plants of Protection Category III is prohibited. Special permits for the above activities for scientific or educational purposes or for trade are issued according to a relevant procedure. A protected area may be established at the growth site of a species of Protection Category III in cases in which their preservation in Estonia is unlikely to be achieved using other protection measures.

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1 published in *Riigi Teataja* I, 1994, nr 46, art. 773.

2 published in *Riigi Teataja* I, 1995, nr 94, art. 1610; in *Riigi Teataja Lisa*, 1995, nr 36.

The list of species for which compensation taxes are levied is determined by the Government regulation on the Rates of Compensation for Damage Caused to Wild Fauna and Flora (1995)[3]. This enactment fixes the compensation obligation for damages caused to 90 selected wild plant species (see Table 2, page 39). This instrument can be considered as the only one creating economical incentives for plant conservation in Estonia (Külvik 1995).

The Estonian plant species included in the Bern Convention Appendix I have had legal significance for conservation since 1992/1993, when Estonia became a Party to the Convention. There are 10 relevant phanerogam and five moss species found in the country. One of the moss species was discovered in 1995. Two of the species are listed in Protection Category I (*Ligularia sibirica, Najas flexilis)*, two in Protection Category II (*Saxifraga hirculus* and *Liparis loeselii*) and two in Protection Category III (*Cypripedium calceolus* and *Pulsatilla patens*). The tenth phanerogam, *Botrychium simplex*, was last found more than 60 years ago, hence placing it in the Category "Ex" of the Red Data Book of Estonia (Kukk 1995).

The Estonian Red Data Book lists (public version: Kumari 1982) are currently under reassessment following the recommendations of IUCN Species Survival Commission (IUCN 1995). Hopefully the work will be completed during 1997. The Red Data Book has no legal status in Estonia but merely an advocative one. The Red Data Book of the Baltic Region (Ingelög et al. 1993) has mainly heuristic and scientific value in Estonia.

2.2.2 Protected areas

Many kinds of protected areas also offer refuge for plants. Currently about 424 300 ha [4] or 7.4 % (excluding the West Estonian Archipelago Biosphere Reserve territory) of Estonia is protected according to the terms of APNO. Other forms of territory protection are:

Botanical and botanical-zoological reserves, according to the earlier classification. Reserves existed at both national and local levels. At the national level in 1991 the country had two botanical reserves:

- The wooded meadows of the River Koiva – 226 ha and
- The wooded meadows of Tagamõisa – 148 ha

and six botanical-zoological reserves:

- The broad-leaved forest of the Island of Abruka – 92 ha
- The wooded meadows of Virtsu–Laelatu–Puhtu – 3 609 ha
- The primeval forest of Järvselja – 19 ha

3 published in *Riigi Teataja* I, 1995, nr 63, art. 1062.
4 all area concerning data after the Estonian Nature Conservation Register and of September 1996, courtesy of Mr. Are Kaasik. Due to the land reform and the Protected Objects Revision currently going on the status of numeral information above is intensely dynamic.

- The oak wood of Mihkli – 125 ha
- The hump of Virussaare – 505 ha
- The bog of Nehatu soo – 410 ha.

In addition to these, about 85 protected areas of special botanical value have been established at the district level. It is proposed that after the revision (foreseeably during 1997) the above structure and units of protected areas will no longer be used.

Protected area zones often also include protected plant species. According to the APNO the protected areas include national parks, nature protection areas, protected landscapes (nature parks) and programmme areas. Types of zones include strict nature reserves (in national parks and nature protection areas only), special management zones, limited management zones and general programme area zones. No recent data on the number, area, specialty and other characteristics of protected area zones are available.

Protected natural monuments is another category of protected sites which frequently includes valuable botanical rarities. According to the APNO a protected natural monument is a natural object such as a tree, boulder, waterfall, cliff, terrace, cave, rock outcrop or karst landform, or a group of these. Parks are also considered to belong to this group. A restricted management zone of up to 50 meters is established around a natural monument when it is assigned extended protection. About 1 460 natural monuments including 542 parks have recently been registered.

Ramsar Convention areas are wetland territories of high conservation value, especially ornithological ones but also including some important botanical sites. The only designated Ramsar site in Estonia is the Matsalu Wetland (est. 1975), but eleven new sites were proposed at the Brisbane Conference by the Estonian delegation. Recently the Government approved the National Programme of Ramsar Convention Implementation (1997)[5], which included the list of newly established Ramsar Areas in Estonia. These areas are:

- Soomaa National Park
- Vilsandi National Park
- Endla Nature Reserve
- Alam–Pedja Nature Reserve
- Nigula Nature Reserve
- The Hiiumaa Islets Nature Reserve with Käina Bay
- Emajõe Suursoo Protected Nature Area
- Muraka Protected Nature Area
- Puhtu–Laelatu–Nehatu Protected Nature Area.

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[5] published in *Riigi Taetaja* I, 1997, nr 18, art 303.

In addition to these listed sites a commitment to nominate 14 concrete sites as Ramsar Areas by the year 2010 was taken by the Government (ibid.).

Forest categories with management restrictions also serve as favoured areas for plant protection. In many cases the restrictions are set for botanical reasons. According to the Forest Act (1993)[6] the forest categories with management restrictions are divided as follows (Table 3):

– Protected forest category (hoiumets) includes reserves and forests which are in need of special protection. Improvement felling, selection felling and final felling in the form of regeneration felling or strip felling (up to 30 m) may be permissible in these areas.

– Protection forest category (kaitsemets) mainly includes forest stands which protect soil, water, settlements, roads, landscapes etc. Improvement felling, selection felling and final felling within the limits of prescribed yield and in the form of regeneration felling or strip felling (up to 30 m) may be permissible.

Table 3. Areal distribution among different forest categories with management restrictions expressed in thousands of hectares / percentage of total forest area. The total forest area in Estonia is taken here as 2 143.7 thousand ha (after Örd 1996).

	Inside protected areas	**Outside protected areas**	**Sum**
Protected forest	100 / 4.6	136 / 6.3	236 / 10.9
Protection forest	42 / 2	88 / 4.1	130 / 6.1
Sum	142 / 6.6	224 / 10.4	366 / 17

In addition an another categorization system, the principal function classification, is currently being prepared. All the forests of Estonia are surveyed every 10 years. Ideally, a survey of areas requiring conservation (including plant conservation) should also be conducted.

6 published in *Riigi Teataja*, 1993, nr 69, art. 990; amendments in 1995,53,845; 57,977.

Water protection belts: The Protection of Marine and Freshwater Coasts, Shores and Banks Act (1994)[7] establishes a strip generally 100 meters from the high water line along the coast, where construction is prohibited. The Act also establishes buffer zones along lake and river shores. However, it is intended that the protected belt will not necessarily be of the exact width specified in the Act, but that its exact boundary will be determined by physical planning taking into account the terrain, natural assets, recreational interests, existing settlements and other local circumstances (Nordberg 1994). Currently there are no area data available on this topic. Among other biotopes about 150 000 ha of water protection forest are included (Örd 1996).

Recreation areas: Currently there is no updated information available on this topic. Among other biotopes about 47 000 ha of recreation forest are included (Örd 1996).

Heritage areas: The Ministry of Culture is currently compiling a new list of heritage areas.

Monitoring sites in the framework of the National Environmental Monitoring Programme, launched in 1994, also come into consideration in relation to nature protection, especially in the case of terrestrial and freshwater biota. The general requirements of a monitoring site include non-disturbance and continuity of ecological conditions over a long period of observation. Among the sites currently in use are:

- integrated monitoring sites: 2 existing and 4 prospective sites
- species and community monitoring sub-programme sites, since 1994: 101 sites for threatened plant species only, 727 sites for overall monitoring within the sub-programme (Külvik et al. 1996).

2.2.3 *Organization of threatened plant and habitat conservation in Estonia*

Plant conservation as a part of nature conservation is administered in Estonia by the Nature Protection Department of the Ministry of the Environment in the central level and by the environmental departments of the county governments (Fig. 1, see also the address list in Appendix 3). In addition there are individual administrative units for protected areas located at eighteen sites (see the address list in Appendix 4).

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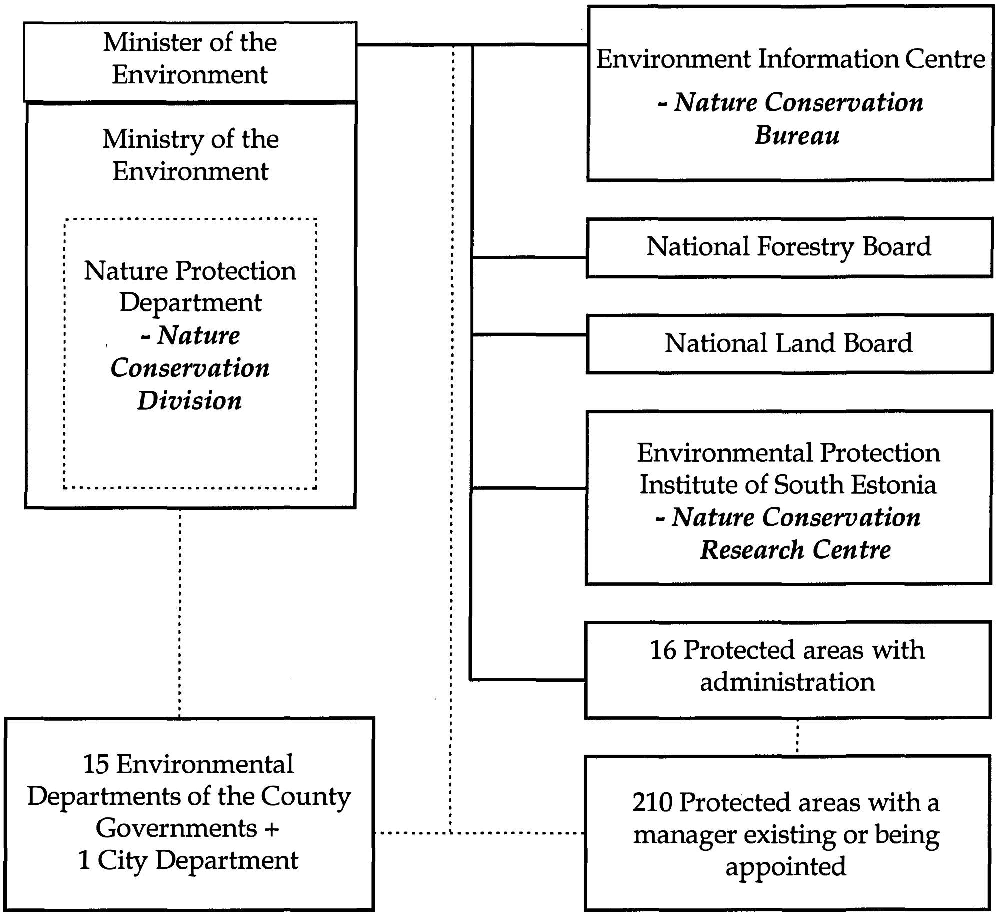
[7] published in *Riigi Teataja* I, 1995, nr 31, art. 382.

**Environmental Administration in Estonia
Organizations dealing with conservation of
threatened plants**



The most important organizations in plant conservation are written in italics

Fig. 1. Environmental administration in Estonia. Main organizations dealing with the conservation of threatened plants. The most important organizations in plant conservation are written in italics.

2.2.4 *Guidelines for future development*

National wild plant protection can be developed with the help of many different instruments and mechanisms.

Legal and policy instruments: In the development of a rare plant protection scheme in Estonia full use could be made of four already existing and widely accepted legislative acts: the Act on Protected Natural Objects (1994), the Act on Sustainable Development (1995), the Act on Protection of Marine and Freshwater Coasts, Shores and Banks (1995) and the Forest Act (1993), and of three international agreements which Estonia has joined: the Convention on Biological Diversity, the Bern Convention and the Ramsar Convention.

National program and actions strive towards the protection of wild plant diversity. The National Biodiversity Strategy should be completed by the end of 1997. Other relevant mechanisms are the Estonian Environmental Strategy (to be completed during 1997), the Biodiversity Country Study (1997), the Biodiversity Action Plan (1998), and cross-sectoral support of the Estonian Forest Policy (1997) and the Estonian Agriculture Policy (1997).

International program and actions aim to enhance national conservation processes: for example the Pan-European Biological and Landscape Diversity Strategy, the IUCN European Programme and Action Plan for Protected Areas, the UN ECE Environmental Programme for Europe, EECONET and the CORINE Programme.

National, bilateral or multilateral funds and other forms of assistance: The existing administrative machinery for allocating domestic funds for plant protection could be more effectively used; a range of technical assistance, training and exchange program of multilateral and bilateral bodies is available; the use of Global Environmental Facility program and EU measures such as LIFE could be developed further.

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Table 1. Protected plants in Estonia.

Protection Category I

Aconitum lasiostomum
Ajuga pyramidalis
Asplenium septentrionale
Botrychium matricariifolium
Carex rhizina
Cerastium alpinum
Cystopteris sudetica
Dactylorhiza praetermissa
Dactylorhiza ruthei
Dactylorhiza sambucina
Epipogium aphyllum
*Equisetum * trachyodon*
Isoëtes echinospora
Ligularia sibirica
Littorella uniflora
Najas flexilis
Oxytropis sordida
Polystichum lonchitis
Pulmonaria angustifolia
Radiola linoides
Swertia perennis
Woodsia ilvensis

Protection Category II

Ajuga reptans
Allium vineale
Alyssum gmelinii
Anacamptis pyramidalis
Anthyllis coccinea
Arenaria procera
Artemisia maritima
Asplenium ruta-muraria
Asplenium trichomanes
Astragalus arenarius
Berula erecta
Bidens radiata
Botrychium multifidum
Bromopsis benekenii
Bupleurum tenuissimum
Cardamine hirsuta
Carex extensa
Carex glareosa
Carex ligerica
Carex mackenziei
Cephalanthera longifolia
Cephalanthera rubra
Cerastium pumilum
Chaerophyllum temulum
Cinna latifolia
Circaea lutetiana
Cladium mariscus
Cochlearia danica
Coeloglossum viride
Corallorhiza trifida
Corydalis intermedia
Crepis mollis
Cruciata glabra
Cyperus fuscus
Dactylorhiza baltica
Dactylorhiza cruenta
Dactylorhiza russowii
Dianthus superbus
Draba muralis
Dracocephalum ruyschiana
Elytrigia junceiformis
*Equisetum * moorei*
Equisetum scirpoides
Eryngium maritimum
Euonymus europeus
Festuca altissima
Gentiana pneumonanthe
Geranium lucidum
Gymnadenia odoratissima
Gymnocarpium robertianum
Halimione pedunculata
Hedera helix
Helichrysum arenarium
Herminium monorchis
Holcus mollis
Hornungia petraea
Hydrocotyle vulgaris
Hypericum montanum
Isoetes lacustris
Jovibarba sobolifera
Juncus squarrosus
Juncus subnodulosus

Koeleria gracilis
Laserpitium prutenicum
Lathyrus montanus
Lathyrus niger
Lemna gibba
Liparis loeselii
Listera cordata
Lobelia dortmanna
Lycopodiella inundata
Malaxis monophyllos
Malaxis paludosa
Moehringia lateriflora
Mulgedium sibiricum
Myriophyllum alterniflorum
Najas marina subsp.*intermedia*
Nuphar pumila
Onobrychis arenaria
Ophrys insectifera
Orchis mascula
Orchis morio
Orchis ustulata
Oxytropis pilosa
Peucedanum oreoselinum
Pinguicula alpina
Pleurospermum austriacum
Poa alpina
Polygonum oxyspermum
Prunus spinosa
Ranunculus lanuginosus
Ranunculus nemorosus
Rhinanthus osiliensis
Rhynchospora fusca
Rubus arcticus
Sagina maritima
Salix repens
Samolus valerandi
Saussurea esthonica
Saxifraga adscendens
Saxifraga hirculus
Scabiosa columbaria
Schoenus nigricans
Scirpus radicans
Selaginella selaginoides
Serratula tinctoria
Silene chlorantha
Sorbus rupicola
Sparganium angustifolium
Sparganium gramineum
Suaeda maritima
Taxus baccata
Thlaspi alpestre
Trifolium alpestre
Trifolium campestre
Trisetum sibiricum
Vicia cassubica
Vicia lathyroides
Vicia tenuifolia
Vincetoxicum hirundinaria
Viola elatior
Viola selkirkii

Protection Category III

Allium ursinum
Arctium nemorosum
Armeria elongata
Colchicum autumnale
Cotoneaster niger
Cypripedium calceolus
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Daphne mezereum
Diphasium complanatum
Diphasium tristachyum
Epipactis atrorubens
Epipactis helleborine
Epipactis palustris
Gladiolus imbricatus
Goodyera repens
Gymnadenia conopsea
Huperzia selago
Iris sibirica
Lathyrus japonicus
Listera ovata
Lunaria rediviva
Lycopodium clavatum
Malus sylvestris
Myrica gale
Neottia nidus-avis
Nymphaea alba
Nymphaea candida
Orchis militaris
Petasites spurius
Phyteuma spicata
Platanthera bifolia
Platanthera chlorantha
Potentilla fruticosa
Pulsatilla patens
Pulsatilla pratensis
Pyrus pyraster
Silene tatarica
Silene viscosa
Spergularia maritima
Tetragonolobus maritimus
Thalictrum lucidum
Ulmus laevis
Viola uliginosa

Table 2. Rates of compensation for damage caused to wild flora (in Estonian Kroons).

Compensation rate 1 800

Hedera helix
Taxus baccata

Compensation rate 600

Anacamptis pyramidalis
Dactylorhiza praetermissa
Euonymus europaea
Malus sylvestris

Compensation rate 300

Cephalanthera longifolia
Cephalanthera rubra
Cypripedium calceolus
Eryngium maritimum
Gladiolus imbricatus
Gymnadenia odoratissima
Pinquicula alpina
Prunus spinosa
Pulmonaria angustifolia
Pyrus pyraster
Rubus arcticus
Sorbus rupicola

Compensation rate 180

Aconitum lasiostomum
Cerastium alpinum
Colchicum autumnale
Dactylorhiza baltica
Dactylorhiza cruenta
Dactylorhiza russowii
Dactylorhiza ruthei
Dactylorhiza sambucina
Daphne mezereum
Dracocephalum ruyschiana
Epipogium aphyllum
Gentiana pneumonanthe
Iris sibirica
Isoetes echinospora
Isoetes lacustris
Jovibarba sobolifera
Ligularia sibirica
Littorella uniflora
Lobelia dortmanna
Lunaria rediviva
Najas flexilis
Ophrys insectifera
Orchis mascula
Orchis militaris
Orchis morio
Orchis ustulata
Oxytropis sordida
Swertia perennis

Compensation rate 60

Ajuga pyramidalis
Asplenium ruta-muraria
Asplenium septentrionale
Asplenium trichomanes
Botrychium matricariifolium
Botrychium multifidum
Carex rhizina
Coeloglossum viride
Corallorhiza trifida
Cystopteris sudetica
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Diphasium complanatum
Diphasium tristachyum
Epipactis atrorubens
Epipactis helleborine
Epipactis palustris
Equisetum moorei
Equisetum scirpoides
Equisetum trachyodon
Gymnadenia conopsea
Gymnocarpium robertianum
Herminium monorchis
Liparis loeselii
Listera cordata
Lycopodiella inundata
Lycopodium clavatum
Malaxis monophyllos
Malaxis paludosa
Nuphar pumila
Nymphaea alba
Nymphaea candida
Platanthera bifolia
Platanthera chlorantha
Polystichum lonchitis
Pulsatilla patens
Radiola linoides
Rhinanthus osiliensis
Selaginella selaginoides
Woodsia ilvensis

Compensation rate 30

Dianthus superbus
Helichrysum arenarium
Pulsatilla pratensis

Other protected wild species* **Compensation rate 5**

* in sense of the Act on Protected Nature Objects,1994

3 MONITORING OF THREATENED VASCULAR PLANTS

3.1 Monitoring of rare vascular plants in Estonia

Ülle Kukk, Environmental Protection Institute of South Estonia

3.1.1 *Introduction*

Collecting of data and monitoring of growth sites of rare and threatened plants have been carried out by several organizations in Estonia. The Estonian Naturalists' Society has organized the collection of long-term biophenological data. A great amount of data on the species of flora and fauna has been collected in state nature reserves over many years. The mapping of habitats of rare plants can also be regarded as monitoring in the broad sense. The inventory and mapping of habitats has been performed during the past 20 years.

The national environmental monitoring programme supported by the government was launched in Estonia in 1994. The aim of this programme is to obtain as complete and large-scale information as possible about the prevailing situation and changes in the environment. The monitoring programme consists of many different sub-programmes, one of them being the monitoring of species and communities. This sub-programme includes a number of various projects, among them a project for rare plants.

3.1.2 *The aim and main tasks of the monitoring of rare plants*

The aim of monitoring is to obtain regular information about the state of populations of rare and threatened plants in Estonia, as well as about changes in their structure and growth conditions. The obtained data will be used as a scientific basis for conservation and as a basis for detecting the effects of environmental impacts. Rare, often relic plant species grow at the boundaries of their distribution areas. They have become adapted to a narrow range of ecological conditions and respond extremely sensitively to environmental changes.

The main tasks of monitoring are:

- to assess the abundance and state of populations on the basis of certain parameters
- to analyse data with a view to establishing the causes of changes in the structure of populations
- to compile periodical reviews of the state of rare plant populations for submission to the environmental monitoring centre.

3.1.3 Selection of taxa for monitoring

The Estonian flora consists of more than 1300 native vascular plant species. 245 of these have been proposed for inclusion in the Red Data Book of Estonia. 210 plant species (185 species of seed plants and 25 species of mosses) are protected in different ways. Hitherto it has been possible to start monitoring of about 1/3 of these species, although it would be necessary to monitor all of them regularly. When selecting plant species and monitoring sites we have taken into account the rarity of each species and the intensity of the threat to its survival.

Especially rare and endangered plant species have only 1–5 localities in Estonia. There are more than 50 plant species in Estonia which grow only in one or in very few localities. According to the list of the Estonian Red Data Book compiled in 1995 (in manuscript form), 42 species of vascular plants are considered as endangered and 25 species as vulnerable. These numbers are not final, because the composition of the Estonian RDB continues and will be completed 1997. 22 of the species have been taken under protection in Category I as particularly endangered species. Monitoring has been planned in all the localities of these species, for example *Cystopteris sudetica, Polystichum lonchitis, Cerastium alpinum, Aconitum lasiostomum, Oxytropis campestris.*

It would also be advisable to continue the monitoring of **species which have been objects of long-term observation** in Estonia. Some botanical research objects, such as rare plants growing in nature reserves and species that have been observed for a long period, are included in this list, e.g. *Rhinanthus osiliensis, Cephalanthera longifolia* and *Orchis morio.*

Monitoring would provide useful data on the ecology and biology of **rare plant species growing in different growth and land use conditions,** for example *Ophrys insectifera, Cypripedium calceolus* and *Pulsatilla patens.*

The monitoring of some **indicator plants** essential for the assessment of the stability of a community or an ecosystem shoud be continued. Such plants include for example plants inhabiting oligotrophic waterbodies, such as *Lobelia dortmanna, Isoetes lacustris* and lime-rich fens, such as *Carex davalliana* and *Dactylorhiza russowii.*

The total number of plant species to be monitored is about 100. In the first two years monitoring plots were set up in 156 sites of 85 species. It is planned to establish monitoring plots in up to five habitats for every plant species. Many plant species designed to be monitored have only a few (1–5) localities in Estonia. In the case of plants with more than five localities, we have selected five different sites which are different in terms of anthropogenic impact and geographical and ecological conditions.

The location of monitoring sites depends primarily on the geographical distribution of the monitored species. If possible, the sites will be established in nature reserves and in other protected areas. It is recommended to establish monitoring stations in areas of integrated monitoring (5 areas in Estonia: in the national parks of Vilsandi, Lahemaa, Karula and Soomaa, and in the Voore Landscape Reserve). The monitoring sites are situated in nearly 20 different biotopes in all counties of Estonia.

3.1.4 *Methodology*

Methods of monitoring have been worked out using previous experience and literature data. They should reflect changes in the general state and structure of populations as well as in their growth conditions. The main principles and instructions for monitoring field works are as follows:

Selection of monitoring times and sites. Since it is essential that the monitoring sites are permanent, it is preferable to establish them in protected areas whenever possible. Other aspects to be taken into consideration are:

- The flowering period is the best time for monitoring in cases when a habitat can be studied only once a year. If there are several monitoring plots for one species, it is recommended to monitor them at the same time.
- Monitoring sites and plots should be marked as exactly as possible both in nature and on maps in order to make it easier for botanists to find them in future.
- The size of a monitoring plot depends on the life-form of the plant. We generally recommend a 10 x 10 m^2 plot in the case of herbs and 50 x 50 m^2 or 10 x 250 m^2 in the case of shrubs and trees.
- The shape of a plot can be a square or a rectangle, but for example the azimuth method is also acceptable, depending on the contour of a population, on relief and on other conditions.
- A unified method has been elaborated for the description of monitoring sites. Thus the parameters described (measured) provide information on the monitoring area, habitat, population and specimens of the plant species monitored.

Monitoring area. The following data should be specified (see the monitoring form in Fig. 1, page 46): landowner, the name of the village and village community, the name of the county and in the case of a state forest the name of the forest district, range, compartment, subcompartment and the year of the last forest survey. It is essential to describe special signs and landmarks for better retrieval and inspection in future.

Habitat. The following parameters should be determined:

- vegetation type (according to the vegetation type classification used in Estonia), description of vegetation, list of associated species and their abundance. More emphasis will be placed on competing plants, apophytes and anthropophytes.
- growth conditions: water regime, light-to-shade ratio, soil properties etc.
- surrounding habitation and sources of human impact: farms, other buildings, roads, ponds, ditches, fire sites etc.

Population. Area of the population (m^2) and the total number of individuals should be counted if possible. The abundance, coverage and status in the plant community of the species should be determined.

Description of monitoring plot. In the case of small populations all specimens should be counted and mapped, in other cases all individuals growing on the monitoring plot should be registered. If there are many small plants, carpet plants or runner plants, only 5–10 plots of one square metre should be counted and marked on a scheme.

The following data of the monitored specimens should be recorded (see Fig. 1):

- height of flowering/adult individuals
- phenophase and the number of specimens in different age groups (flowering, vegetative, juvenile)
- percentage coverage (excluding trees)
- abundance on a 5-point scale
- viability on a 3-point scale
- type of human impact on a 3-point scale
- damages , their character, causes and extent.

The abundance of associated species and the coverage of mosses and lichens on the plot should be recorded.

Maps. The monitoring site should be marked on a 1:10 000 map. If a population is sufficiently large, its contours should be marked on the map. The monitoring plot should be drawn separately at a scale of 1:100, in the case of trees and shrubs 1:1 000. The sites of individuals should be marked on the high-resolution scheme; in cases of high density, the population contours should be outlined. Monitoring sites should be marked on a UTM map and accompanied by geographical coordinates.

According to the proposed methodology, the **monitoring interval** is:

- 3 years for very rare and endangered species (in some cases annual monitoring may be necessary)
- 3 consecutive years at 3 or 5 year intervals, depending on the level of rarity, for orchids, broomrapes, annuals and biennials
- 5 years for other perennials.

The total number of monitoring sites in the project will be approximately 300–350 in 1998. The success of the plan will depend both on governmental resources and on the facilities and initiative of botanists.

3.1.5 *Results of the first two years*

During the primary monitoring the initial situation was fixed and described. The repeated monitoring in 1995 provided the possibility to compare the data of two years. The year 1995 was exceptionally favourable for orchids. The populations of most of the species under observation were numerous and vital. The number of flowering plants was double or even fourfold compared with previous years. However, wild boars had damaged some populations of *Anacamptis pyramidalis, Ophrys insectifera* and other orchids. The activities of these animals represent a great danger for native orchids. *Epipogium aphyllum* and *Coeloglossum viride* are now seriosly threatened in Estonia and they have become extinct in many localities.

Coeloglossum viride currently has only two certain localities. 31 individuals were registered in Hiiumaa in 1995. This habitat is damaged by pasturing and wild boars. The second locality was discovered recently in Matsalu, where only two individuals were growing. The number of localities of *Epipogium aphyllum* is unclear because of the mysterious life cycle of this species. Individuals do not appear above the ground every year.

The populations of annuals and biennials are stable, except in the case of *Rhinanthus osiliensis*, which is damaged by wild boar. The wild boar eat the stem tops with inflorescences, and therefore generative reproduction has diminished and the number of individuals has declined. Fortunately, the situation improved in 1996.

The available information on the state and dynamics of the populations of rare vascular plants monitored in Estonia is of short temporal duration and too fragmentary for making firm conclusions. We hope that coming years will provide additional information concerning the plants monitored, which would help further studies of their status and provide a basis for recommendations for protection.

Fig. 1. Monitoring form for threatened species in Estonia.

SEIREJAAM SJ **Site of monitoring and the species**		Esmasseire / **First visit** Kordusseire / **Renewal**
Maakond / **County**:		
Vald.küla / **Municipality, village:** Metskond. kv. / **Forest district, range, compartment:**		
Maaomanik / **Land owner:**		
Geogr. koordinaadid / **Coordinates:**	Lat. / **Latitude:**	Long / **Longitude:**
UTM:		Alt / **Altitude:**
Orientiirid / **Site description:**		
Biotoobi kirjeldus / **Biotope description** Taimkatteühik / **Vegetation type:**		
Veereziim / **Water regime:**		
Valgus / **Light:**		
Muld. Tüüp / **Soil type:**	Liik:	
Ümbritsev asustus / **Surrounding settlement:**		
Kaaslasliigid, ohtrus / **Associated species and their abundance:**		
s.h. haruld. liigid. ohtrus / **Rare species and their abundance:**		
SL populatsiooni suurus / **Area of the population or total number of specimens:**		
SL ei leitud. Miks? / **The plant was not found. Why?**		

Seireruut / **Monitoring plot** (100 m^2)										
SL is. arv [1]	Fenofaas / **Phase of phenology:**							Areng. / **Phase of development**		
	~ [2]	^ [3]	) [4]	o [5]	([6]	+ [7]	# [8]	juvenile	vegetative	generative

Katvus / **Percentage cover (%):**					
Ohtrus / **Abundance:**	1	2	3	4	5
Vitaalsus / **Vitality:**			1	2	3
Inimmoju: liik / **Human impact:**					
Inimmoju: aste / **Degree of human impact:**			1	2	3
Kahjustused: liik / **Damage or herbivory**					
Kahjustused: aste / **Degree of damage or herbivory**			1	2	3

Skeem / **Map drawn on millimeter paper**

[1] Number of shoots or individuals
[2] ~ = vegetative
[3] ^ = buds
[4]) = beginning of flowering
[5] o = flowering
[6] (= end of flowering
[7] + = first fruits
[8] # = full fruit phase

Kuupäev / **Date:**	Seiraja nimi / **Name of observer:**
	Aadress, telefon / **Address, tel.:**
LISA: Asukoha plaan 1:10 000 / **Appendix: Map 1:10 000**	

SL isendid SR-1 / **Detailed monitoring**						
1 m^2 ruudu tähis, is nr./ **Codes of 1 m^2 squares and individuals in the plot**	Asukoht ruudus/ **coordinates of a 1 m^2 square**	Korgus / **height of the shoot, cm**		Fenofaas / **Phase of phenology** vastav märk / **Codes, see previous page**	Varte arv puhmikus / **Number of shoots in a tussock**	Katvus / **Cover** (%)
		lehed / **leaves**	taim / **shoot**			

3.2 Monitoring of threatened vascular plants in Finland: development of methodology

Terhi Ryttäri, Finnish Environment Institute

3.2.1 Background and problems

Since 1991 the Finnish Nature Conservation Act has obliged authorities to monitor populations of threatened species. Monitoring is necessary to register changes in population size and structure and to improve biological knowledge of the species and thus create a basis for its successful management and conservation. In the *'Report on the monitoring of Threatened Animals and Plants in Finland'* (Rassi et al. 1992), monitoring is defined as *"constant observation of the conditions of all known threatened species populations"*.

Some preliminary instructions for monitoring threatened vascular plants and their habitats have already been published (Uotila & Kemppainen 1987, Kemppainen et al. 1993, Ryttäri et al. 1993), but their application in practice has not always been very successful. The instructions are often considered too demanding and time-consuming. On the other hand, these general instructions have not been applicable to biologically varying species with different types of life cycles and growth forms – annuals, biennials, perennials, clonal plants, shrubs etc.

In Finland, individual plant populations have been monitored for about ten years. During this period several populations of about 70 species have been mapped at least once and many of the populations have also been monitored after the first mapping. Valuable information on the biology of the species has been obtained from part of the data, whereas some data have been practically useless for various reasons. The problems of monitoring are numerous and can be divided into three main groups: repeatability, choice of the monitored parameters and comparability.

3.2.2 Problems in monitoring

3.2.2.1 Repeatability

Repeating the mappings of each population in exactly the same way every year has proved to be very difficult. The main reason for this is that established permanent plots or mapping lines have not been marked well enough. Marking of the plants and the plots is a challenging task especially in some biotopes, e.g. in seashores where heavy waves and ice floes may destroy the marks, on steep and eroding rocks where falling stones break the marks, in high and dense vegetation where the marks easily get lost and in all areas with human activities.

On some pastures for example, land owners have denied the use of any kind of marking sticks because they are afraid of their animals getting hurt.

Another factor affecting repeatability and complicating the collection of matrix data is the fact that defining a plant individual is not simple or even possible in most plant species. The majority of perennial plants form some kinds of clones, which may vary greatly in size. Even in the case of small annuals it is not always simple to distinguish individuals.

Varying conditions, for example weather, and different personnel (from lazy professionals to hard-working amateurs and vice versa) as well as unsystematic plans and varying standards of documentation weaken the repeatability. For example, different persons may distinguish individual plants in different ways.

3.2.2.2 Choosing parameters for monitoring

Knowledge of the biology, especially of life cycles, clonal growth and life stages of species is often insufficient. We do not always know which parameters (size of the plant, size or number of leaves or shoots, number of flowers etc.) best correlate with for example the vitality of the plant. Furthermore, identifying different life stages, for example distinguishing seedlings from clonal growth or juvenile vegetative plants from senescent vegetative plants, can be difficult. In many cases, identifying or even finding the seedlings in dense vegetation may be an almost impossible task.

Identifying the environmental parameters essential for the monitored plant population is also often difficult. Very different variables (vegetation, groundwater level, land use) must be taken into account, not only from the environment surrounding the population but sometimes also from the whole catchment area. Collecting this data is very time-consuming.

3.2.2.3 Comparability

Most of the populations of our threatened plants are very small both in number – from a couple to some hundreds of individuals – and in area – from one to some tens of square meters. The numbers of populations of each species may also vary from one to tens of populations. Making comparability even more difficult, there may also be great variation between the few growing sites of the same species.

All the factors described above make interpretation of the monitoring results difficult and in some cases unreliable.

3.2.3 *Development of methods*

The development of methods for monitoring of threatened plants started in April 1996 in the Finnish Environment Institute in cooperation with the Finnish Forest and Park Service. The aim of the project is to compile new comprehensive monitoring instructions in order to achieve the best results considering the resources available for monitoring.

We should be able to

1) obtain reliable and repeatable data of changes in population structure and viability as well as to relate the data to possible changes in the environment
2 gain more information of life cycles and life phases and their relevance in different circumstances
3) assimilate data of cause and effect relationships to determine the critical points of population survival.

Furthermore, we should evaluate the amount and quality of knowledge available concerning different species. In particular, information about the ecology and population biology of a species is necessary for compiling a suitable monitoring programme. A priority order for the species should also be prepared in order to direct resources to species of particular concern. A national monitoring plan should be made in the near future so that the minimal resources can be reasonably used.

In the present work we shall analyze all the previously collected monitoring data and hopefully thus learn from our mistakes. In the field, established monitoring projects will be continued and some new ones started. In the first stage we must deal with each species separately. Later on we shall try to develop a classification system based on certain biological characteristics (e.g. life cycle types) to give general but more detailed instructions for the monitoring of different types of plants.

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3.3 Monitoring program of some threatened plants in Oulanka National Park, Finland

Anne Jäkäläniemi, Finnish Forest and Park Service

3.3.1 *Introduction*

The Finnish Forest and Park Service has started a special monitoring programme of threatened vascular plants in Oulanka National Park. Seven of eight strictly protected species growing in the park are included in the programme. The aims of the programme are to observe the development of populations and to study the ecologies and life cycles of the plants and effect of management of the growing sites. Monitoring of the sites and species started in 1989. *Gentianella amarella* has several new localities along the Liikasenvaara road within the park and is therefore not yet included in the special monitoring programme.

Some of the species, such as *Kobresia simpliciuscula* and *Silene furcata* subsp. *angustiflora,* have their only Finnish localities in Oulanka National Park. *Arnica angustifolia* subsp. *alpina, Crepis tectorum* subsp. *nigrescens, Lonicera caerulea* and *Salix pyrolifolia* have only a few localities outside the park. *Epilobium laestadii* grows only in Northern Finland, but only a few of its localities are in the park.

3.3.2 *Flora of Oulanka National Park*

Oulanka National Park is situated in north-eastern Finland. The rivers, hills, canyons, large old-growth forests and aapamires including the eutrophic peatlands are typical of the park. The park is famous for its special flora and fauna, which derive their origin from the calcium-rich bedrock, rugged ground and the geographical location between the distribution areas of the southern and northern flora and fauna. Several species have their extreme northern, southern or western outposts in the park (Söyrinki & Saari 1980, Hämet-Ahti et al. 1986, Jäkäläniemi 1993).

A large number of plant species with strict nutrient requirements grow in Oulanka National Park, mainly due to the occurrence of calcareous bedrock (Silvennoinen 1982) and the specific mesoclimate. According to Koutaniemi (1983) the sharp climatic differences in the Oulankajoki valley are due to its steep relief. The slopes facing south and southeast are almost constantly exposed to direct solar radiation, whereas the slopes on the opposite side of the valley receive sunshine only early in the morning or late in the evening.

Since the valley functions as the groundwater collection channel, there are a large number of springs discharging cold groundwater to the slopes. This phenomenon makes its own special contribution to the surroundings, which are in any case exceptional considering the climatic conditions of the area.

The number of threatened species in the park is rather high. The threatened vascular plants are growing mainly on limestone rock outcrops and on nutrient-rich soils and peatlands. In the park there are 87 vascular plants that are nationally or provincially threatened (Table 1). Eight of these are officially listed as under strict protection: *Arnica angustifolia* Vahl subsp. *alpina* (L.) I. K. Ferguson, *Silene furcata* Rafin. subsp. *angustiflora* Walters, *Kobresia simpliciuscula* (Wahlenb.) Mackenzie, *Epilobium laestadii* Kytöv., *Salix pyrolifolia* Ledeb., *Crepis tectorum* L. subsp. *nigrescens* (Pohle) P. D. Sell, *Gentianella amarella* (L.) Börner and *Lonicera caerulea* L. (Ledeb.) Browicz (Rassi et al. 1992).

Table 1. Nationally threatened vascular plants in Oulanka National Park.

E	*Salix pyrolifolia**
E[1]	*Silene furcata* subsp. *angustiflora**
V	*Arnica angustifolia* subsp. *alpina**
V	*Crepis tectorum* subsp. *nigrescens**
V	*Epilobium laestadii**
V	*Gentianella amarella**
V[1]	*Kobresia simpliciuscula**
V	*Lonicera caerulea**
St	*Botrychium lanceolatum*
St	*Calypso bulbosa*
St	*Carex heleonastes*
St	*Carex lepidocarpa* subsp. *jemtlandica*
St	*Carex viridula* subsp. *bergrothii*
St	*Cypripedium calceolus*
St	*Dactylorhiza incarnata* subsp. *cruenta*
St	*Dactylorhiza traunsteineri*
St	*Epipogium aphyllum*
St	*Gypsophila fastigiata*
St	*Ranunculus aquatilis* var. *diffusus*
St	*Saxifraga hirculus*
St	*Schoenus ferrugineus*
St	*Silene tatarica*
Sh	*Anthyllis vulneraria* subsp. *lapponica*
Sh[1]	*Arenaria pseudofrigida*
Sh	*Asplenium ruta-muraria*
Sh[1]	*Draba cinerea*
Sh[1]	*Equisetum x trachyodon*
Sh	*Elymus alaskanus*
Sh	*Epipactis atrorubens*
Sh[1]	*Erigeron acer* subps. *decoloratus*
Sh	*Gymnocarpium continentale*
Sh[1]	*Gymnocarpium robertianum*
Sh	*Lappula deflexa*
Sh	*Potentilla nivea* subsp. *chamissonis*
Sh	*Potentilla nivea* subsp. *nivea*

Total number of species 35

* = specially protected species
1 = growing only in Kuusamo in Finland
E = endangered
V = vulnerable
St = in need of monitoring, declined
Sh = in need of monitoring, rare

Some of the species, such as *Arnica angustifolia* subsp. *alpina*, apparently spread from the north and northeast soon after the ice had retreated during the Dryas period about 10 700–10 000 years ago (Söyrinki 1970). They have remained as relicts in the coniferous zone, growing on shady rocks in canyons and beside streams and cold springs. *Lonicera caerulea* and *Crepis tectorum* subsp. *nigrescens* belong to the eastern distribution group. *Epilobium laestadii* was first described as a species in 1979 (Kytövuori 1979).

3.3.3 Population size

Population size and variation in the number of individuals between different years are the most important elements in the monitoring of threatened plants. In the first stage of monitoring the size of the whole population was counted, including the number of sterile and fertile individuals or shoots in each population or sub-population. Thereafter some permanent monitoring sites were founded, which will be monitored annually by counting the number of fertile and sterile shoots.

Crepis tectorum subsp. ***nigrescens*** has only two growing sites in Finland: in Oulanka National Park and in the Kevo Strict Nature Reserve. It grows on the weathering slopes and shelves of south-west exposed and rather massive rock outcrops. In Oulanka there are two populations.

At the beginning of the monitoring the number of individuals growing on rock walls and shelves was counted using binoculars. This method was rather inaccurate because only the fertile individuals could be seen. For example, when counting individuals of *C. tectorum* subsp. *nigrescens* by binoculars in 1990–1992 only 30–32 fertile individuals were recorded. In 1995 the same population was mapped by using climbing equipment, and a total of 718 sterile and 225 fertile individuals were found. In 1996 two permanent monitoring site was founded.

In Kevo 227 fertile individuals of *C. tectorum* subsp. *nigrescens* were recorded in 1996. The individuals in Kevo have more flower heads and shoots per individual than those in Oulanka. In Kevo the flower heads are also smaller.

One growing site of *C. tectorum* subsp. *nigrescens* is also known in Paanajärvi National Park, located in Russia rather near to Oulanka. 33 fertile individuals were recorded when counted by binoculars in 1996. The material of this south-exposed cliff is rapidly weathering and it is very difficult to map. The habitat and morphological features of individuals are rather similar to those in Oulanka.

Arnica angustifolia subsp. ***alpina*** has 14 growing sites in or near the Oulanka National Park. The species grows on the shelves of calcareous rock walls in canyons. The monitoring started in five locations (Table 2). The smallest monitored population includes 89 sterile rosettes and the largest one over 2500 sterile and about 50 fertile individuals.

Table 2. The sizes of monitored populations and the number of monitoring sites of Arnica angustifolia subsp. alpina in Oulanka National Park.

Site	Fertile shoots	Sterile shoots	Total number of shoots	Number of monitoring plots
A	8	1368	1376	7
B	49	2507	2556	24
C	24	1270	3932	11
D	20	1279	1299	4
Es	0	89	89	5

In the permanent monitoring site in the bottom of the canyon of Juuma there are 8 sub-populations (Fig. 1). In 1996 the average number of rosette leaves in Juuma (Table 3) was 4, the average height of the shoots 30.8 cm, the average breadth of the widest leaf 1.0 cm and the average length of the longest leaf 11.4 cm.

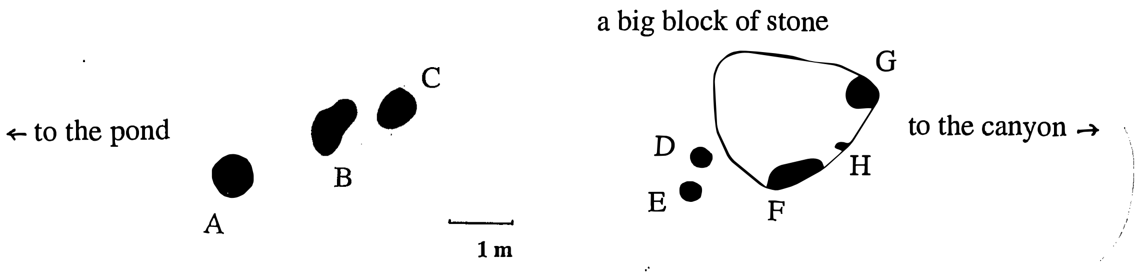


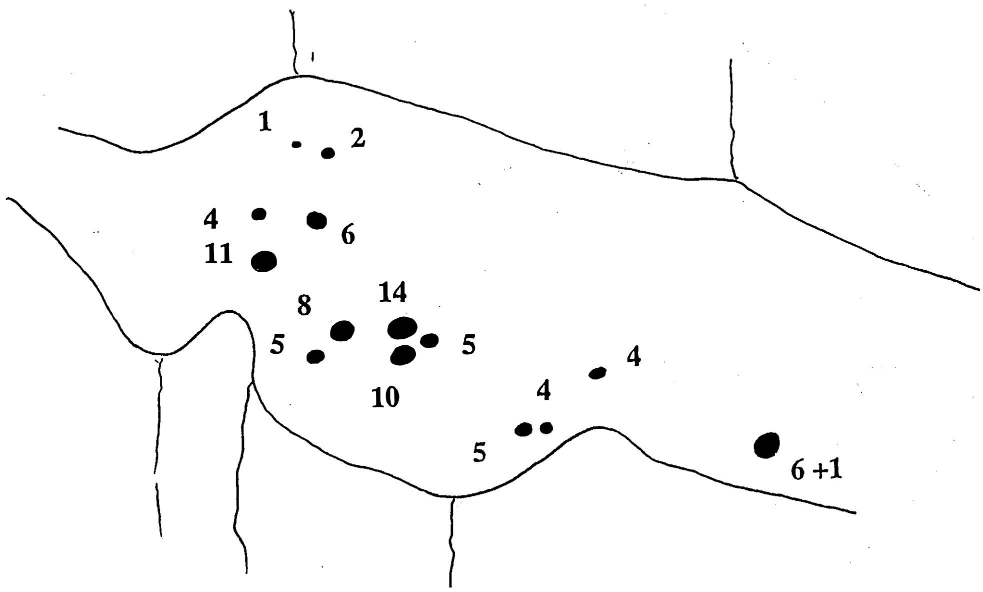
Fig. 1. The permanent monitoring site of Arnica angustifolia subsp. alpina in Juuma in the bottom of the canyon.

Silene furcata subsp. ***angustiflora*** grows in Finland only in Oulanka National Park. It thrives on the calcareous rock wall crevices and shelves. In 1995 the total population size was 172 fertile shoots and 917 sterile rosettes, growing in 180 separate groups. In 1996 seven permanent monitoring sites were founded (Fig. 2).

Kobresia simpliciuscula is an arctic-alpine species which has only one locality in Finland, in Oulanka National Park. It grows on the peat shores of calcareus spring streams. The population size of *K. simpliciuscula* was estimated using three 1 m^2 squares, which also form the permanent monitoring sites (Fig. 3). In 1995 the total number of individuals was estimated to be about 500 fertile and 1200 sterile tussocks.

Table 3. The number of fertile and sterile shoots of Arnica angustifolia subsp. alpina in the permanent monitoring site in the bottom of the canyon in Juuma in 1996.

Subpopulation	Fertile shoots	Sterile shoots	Total number of shoots
A	5	0	5
B	1	43	44
C	2	9	11
D	0	3	3
E	0	2	2
F	3	65	68
G	10	0	10
H	1	0	1
Total	22	122	144



6 + 1 = 6 sterile shoots and 1 fertile shoot
11 = 11 sterile shoots

Fig. 2. The permanent monitoring site of Silene furcata subsp. angustiflora on the rock shelf.

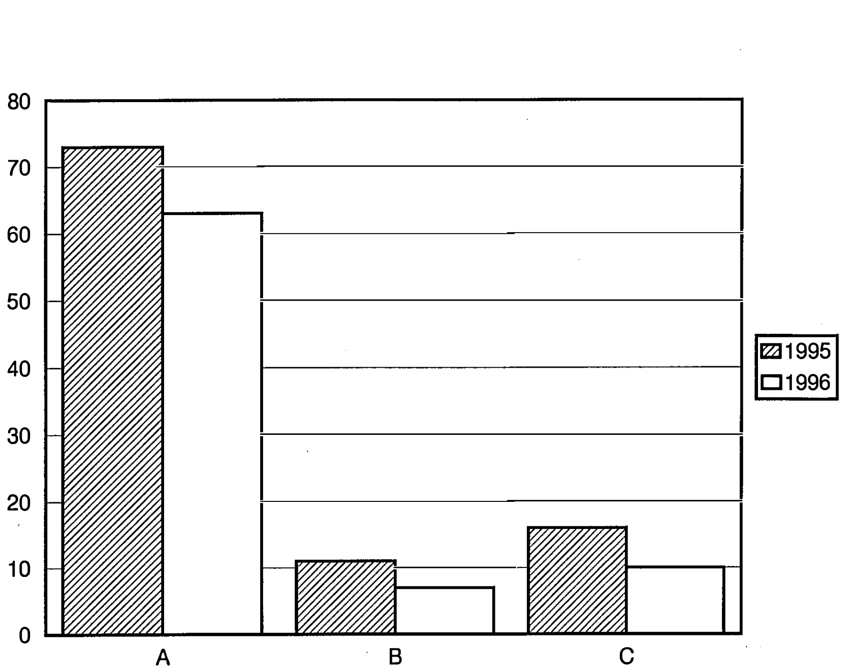


Fig. 3. The number of Kobresia simpliciuscula tussocks in monitoring squares (A, B, C) was about 20 % less in 1996 than in 1995.

Salix pyrolifolia has two populations in Finland. In Oulanka National Park only one individual is growing on eutrophic peatland near a small spring stream. The annual growth as well as the length and the diameter of different trunks was measured in 1995. The tree had two large main branches, of which the north-facing one was dead. The living branch had three smaller branches and one dead branch. Some of the branches were chosen for the monitoring of annual growth.

3.3.4 *Life cycle studies*

About 20 individuals or shoots in different stages of their life cycles were marked in some populations of *Arnica angustifolia* subsp. *alpina, Kobresia simpliciuscula, Silene furcata* subsp. *angustiflora* and *Crepis tectorum* subsp. *nigrescens* in 1995 and 1996. The height of the shoots, the length of the longest leaf and the breadth of the widest leaf were measured. The number of flowers or flower heads and possible seedsets were also counted (Table 4).

A. angustifolia subsp. *alpina* grows in sites of denser vegetation than *C. tectorum* subsp. *nigrescens* and *S. furcata* subsp. *angustiflora.* The depth of the humus layer of each *Arnica* population was measured. However, no correlation between the depth of the humus layer and the vitality of the rosettes was observed.

Table 4. An example of monitored features and some results of the life span studies of Arnica angustifolia subsp. alpina.

Population	Average					
	depth of humus layer	height of the shoot	number of rosette leaves	length of the longest leaf	breadth of the widest leaf	flower heads /individual
Purkuputaanoja	12 cm	–	3.5	9 cm	6 mm	none
Puikko-oja	10.5 cm	30 cm	3	10.5 cm	13 mm	1
Ahvenperä		40 cm	4.5	12 cm	17 mm	2.6

3.3.5 *Population vitality*

Knowledge of the vitality and reproduction potential of populations and sub-populations is an essential component of plant protection. Very preliminary versions of a vitality index and a reproduction index are presented in the following. They can both be calculated using the averages of estimated factors in each population or sub-population.

(1)
$$\text{Vitality Index} = L \times B + R$$

L = length of the longest leaf (cm)
B = breadth of the widest leaf (mm)
R = number of rosette leaves

(2)
$$\text{Reproduction Index} = \frac{Se}{Fl} \times Fe + St$$

Se = number of seeds
Fl = number of flowers
Fe = number of fertile individuals
St = number of sterile individuals

The use of both indices will be tested by comparing the results of the next few years.

The meadows along the Oulanka river were rather intensively utilised about 40 years ago. Nowadays mechanical hay-making is concentrated near the farms. ***Lonicera caerulea,*** which has eight localities in the park, has its natural growing sites in the riverside meadows. It is probably suffering from overgrowth of the meadows.

Six populations of *L. caerulea* are included in the management programme. The aim of management is to remove some of the shadowing shrubs and trees. We began with the estimation of the shadowing area. In each management site one *Lonicera* shrub was chosen randomly and used as a centre shrub. All the trees and shrubs were then mapped in a circular area around the centre shrub (Fig. 4). The diameter of the circle was five meters. Inside the circle the height and the average diameter of the trees and shrubs and their distance from the centre shrub were estimated. The shadowing area of each tree and shrub was calculated using equation (3). The shadowing index of the sample plot is the sum of the shadowing areas of each tree and shrub (Table 5).

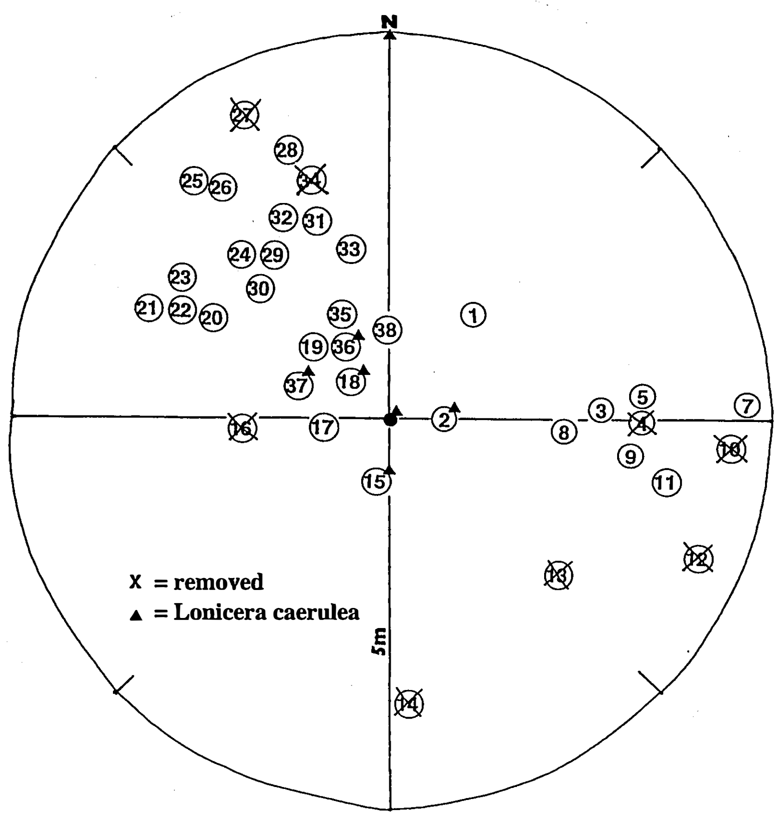


Fig. 4. The management and monitoring plot of Lonicera caerulea on the old river bank of Oulanka. 72 % of shadowing trees and bushes have been removed from this plot.

$$(3) \qquad \text{Shadowing area} = \frac{\text{height (m)} \times \text{average diameter (m)}}{\text{distance to the centre bush (m)}}$$

Different amounts of shadowing trees and bushes around the *Lonicera* shrubs were cut down in order to provide information about the best lighting conditions for the species (Table 5). The effects of management are monitored by measuring the annual growth of the centre bushes.

Table 5. Original shadowing indices of the sample plots and the percentage removal of shadoving trees and bushes.

Site	Original shadowing index	Removal %
A	70	44.95
B	27	9.03
C	180	42.42
D	120	66.81
E	63	72.2
F	45	0

The only individual of ***Salix pyrolifolia*** is clearly suffering from thickening of the moss cover. In 1987 part of the moss cover was removed within a diameter of one meter around the tree. This management had visible positive effects on the growth of the plant.

3.3.7 Studies

Knowledge of the taxonomic position of a species is important when defining the need for conservation and management of the species. A study of the genetic variability of *Crepis tectorum* subsp. *nigrescens* has been started in cooperation with the University of Oulu. The aim is to compare the populations inside the disjunct distribution area of the taxon. The differences between the original, natural populations of subsp. *nigrescens* and the populations of subsp. *tectorum* growing in cultural habitats will be clarified.

A study of micropropagation is planned in an attempt to preserve the genome of *Salix pyrolifolia*. The work will be carried out in close cooperation with the Botanical Gardens of the University of Oulu.

Cooperation with students from the Department of Botany in the University of Oulu is also in progress. Two studies will be finished in 1997 and 1998. One of these is concerned with the cold water dependence and the competive capacity of *Epilobium laestadii* and the other with the effects of management of the growing sites on the populations of *Cypripedium calceolus* and *Saxifraga hirculus*.

The breeding system sets the limit to the evolutionary potential of a species (Koelewijn 1993). The reproductive biology, population dynamics and stochasticity of these threatened populations will be studied in future within the limits of available resources. The actual and potential habitats will be investigated and for example the sensitivity of the species to weathering of the bedrock will be estimated.

3.3.8 Problems

The methods of monitoring and management of threatened species are rather variable. Interpretation of the results is difficult because of insufficient knowledge of the biology of species. For example, what is the critical level of population size with regard to population extinction? Or what is the critical number of individuals when management of the sites and micropropagation or other *ex situ* -conservation methods must be used? Currently only *in situ* -conservation methods are used. For example it could be said that if the number of individuals or fertile shoots is on occasion below one thousand, the population begins to suffer from lack of genetic variation.

The definition of individuals within a population is in many cases difficult because of the unknown underground root and stem system. Counting the number of tussocks, shoots or leaves is the most practical way to estimate population size, but it does not give a reliable indication of the genetic variability of the population. Sometimes the whole population can consist of one genetic unit.

The monitoring and studying of threatened species is challenging work. It must be carried out using the best available knowledge of the ecology and biology of the species and relevant monitoring methods. This is one of the challenges for the near future.

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4 CONSERVATION AND MANAGEMENT OF THREATENED PLANTS AND THEIR HABITATS

4.1 Plant and vegetation management in Viidumäe Nature Reserve, Estonia

Mari Reitalu, Viidumäe Nature Reserve

4.1.1 Diversity of local conditions in Viidumäe Nature Reserve

Viidumäe Nature Reserve was founded in the south-western part of Saaremaa in 1957 to further the protection and study of rare plant species and plant communities. The Nature Reserve is situated in the West Saaremaa Upland, 25 km from the town of Kuressaare, capital of Saare County. At present its area is 1 873 hectares.

Saaremaa is well known among the botanists of Scandinavian and the Baltic countries as an island with rich flora. About three quarters of all Estonian vascular plant species grow on the island. The floral diversity of Saaremaa is due to several factors. The influence of the sea is one of the most important. The climate in West Saaremaa is maritime, with a mean temperature of -3.5 °C in February. Different habitat conditions occur along the long coastline and many halophytes and nitrophiles grow in this zone. The Silurian bedrock is rich in lime and offers opportunities for the growth of many calciphilous species.

The geographical location of Saaremaa is also important: the flora includes many Central and Western European species. These plants grow in the eastern, northern or north-eastern boundaries of their distribution. Several relict plant species from different climatic periods of the Estonian geological past also occur.

The western part of Saaremaa is crossed by the oldest and highest upland range, which is indented by postglacial Baltic Sea coastal formations such as terraces, beach ridges and dunes. In several sites the belt of springs surrounds the foot of the former coastal escarpment. Viidumäe Nature Reserve is situated in this part of the West Saaremaa Upland. The variable relief creates diversity of habitats for plant species with different requirements. Among these are many protected rare plants.

4.1.2 The flora of Viidumäe Nature Reserve

The flora of Viidumäe Nature Reserve includes over 660 vascular plants, of which 58 are protected in Estonia (Table 1). Two plant species are included in the most strictly protected Category I. The only Estonian sites of hybrid horsetail *Equisetum x trachyodon* occur in the reserve in sandy, sometimes over-moist pine forests. Viidumäe is one of the three sites in Estonia where *Dactylorhiza sambucina* was reintroduced from Åland in 1989. In Category II there are several relicts from different postglacial climatic periods, for example species of preboreal climatic conditions such as *Pinguicula alpina* and relicts from atlantic and subatlantic climate periods including *Juncus subnodulosus* and *Hedera helix*. One endemic species of Saaremaa, *Rhinanthus osiliensis*, was found in 1933 in the Viidumäe spring fen.

Table 1. Protected vascular plants in Viidumäe Nature Reserve.

Category I:
Dactylorhiza sambucina
Equisetum x trachyodon

Category II:
Asplenium trichomanes
Bromus benekenii
Cardamine hirsuta
Carex ligerica
Cephalanthera longifolia
Cephalanthera rubra
Cladium mariscus
Corydalis intermedia
Dactylorhiza baltica
Dactylorhiza cruenta
Dactylorhiza russowii
Festuca altissima
Gymnadenia odoratissima
Hedera helix
Hypericum montanum
Juncus subnodulosus
Lathyrus niger
Liparis loeselii
Ophrys insectifera
Orchis mascula
Oxytropis pilosa
Pinguicula alpina
Rhinanthus osiliensis
Scabiosa columbaria
Schoenus nigricans
Sorbus rupicola
Taxus baccata
Trifolium alpestre
Vicia cassubica
Vicia lathyroides
Vicia tenuifolia
Vincetoxicum hirundinaria

Category III:
Allium ursinum
Cypripedium calceolus
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Daphne mezereum
Diphasium complanatum
Epipactis atrorubens
Epipactis helleborine
Epipactis palustris
Goodyera repens
Gymnadenia conopsea
Huperzia selago
Iris sibirica
Listera ovata
Lycopodium clavatum
Malus sylvestris
Myrica gale
Neottia nidus-avis
Orchis militaris
Platanthera bifolia
Platanthera chlorantha
Pulsatilla pratensis
Tetragonolobus maritimus

The most interesting plant communities are found in the spring fens. In spring fens the combination of microclimate, moisture and soil conditions creates suitable habitats for many rare plant species. Communities of *Ulmus scabra, Acer platanoides, Tilia cordata, Quercus robur* and *Fraxinus excelsior* may occur in fragments of broad-leaved forests. Nemoral species such as *Festuca altissima, Bromus benekenii, Allium ursinum, Cardamine bulbifera, Asperula odorata* and *Corydalis intermedia* grow in the herb layers of these forests. Pine woods with oak in the second layer are botanical rarities in Viidumäe. They are considered as relict plant communities from warmer climatic periods.

Overgrowth of wooded meadows is common throughout Saaremaa. Currently circa 5 ha of wooded meadows are cleared of shrubs and mowed annually in Viidumäe. Traditionally *Quercus robur, Betula pendula* and *Corylus avellana* have grown on moderately moist wooded meadows and *Fraxinus excelsior* and *Alnus glutinosa* in wetter lands. Up to 55 vascular plant species per square meter have been recorded in the herb layer of wooded meadows in Viidumäe.

4.1.3 Investigation of the flora and vegetation

***Botanical inventories*:** Investigations of Viidumäe flora have been based on the main principles of Estonian nature reserves. It is considered essential to make a detailed study of the whole natural complex as well as to maintain permanent plots and lines. During the general inventory of the Nature Reserve several diploma papers were prepared by students of the Tartu University. Thanks to this at least 287 algae, 207 lichens and 137 moss species are known to grow in Viidumäe. The most abundant data are those relating to vascular plants. In order to gain a more comprehensive review of flora a catalogue of localities has been prepared and is updated continuously. Additional plans have been made for the localities of certain species, for example *Sorbus rupicola.*

A useful method to prepare a more thorough review of the vegetation is detailed mapping. This work was also performed by students of Tartu University. The student diploma papers describe different plant communities: spring fens and pine woods with oak in the second layer. Descriptions of vegetation units are collected in the card catalogue. All data of botanical inventories will be standardized during the creation of databases in the near future.

***Permanent observations*:** The longest series (since 1961) of permanent observations are phytophenological data. They were collected in various parts of the relief and include most of the threatened plant species in Viidumäe. The description of permanent plots in various plant communities has been made periodically since 1966. After the storm in 1969 wind-damaged permanent plots were added. A profile of 1.3 km in length passing through different parts of the landscape was set up in 1988. Water regime, soil, vegetation and microclimate were studied in detail at 32 points along this profile topography. The work was repeated in 1993 by the Institute of Ecology.

In 1994 Viidumäe Nature Reserve was linked to a monitoring program of species and communities (see page 41). Plant communities (e.g. in spring fens, wooded meadows and oak forests) and rare plant species (e.g. *Rhinanthus osiliensis* (2 sites), *Carex davalliana, Equisetum x trachyodon, Dactylorhiza sambucina, Gymnadenia odoratissima, Hypericum montanum, Vicia lathyroides, Pinguicula alpina* and *Oxytropis pilosa)* are monitored.

4.1.4 Conservation and management of vascular plants

In addition to its scientific importance, the collected data about rare plant species and communities also has practical importance in planning the protection and management of plants and habitats. The first statute of Viidumäe was drawn up in 1958. Enlargement of the nature reserve in 1979, accompanied by a new statute, was based on information about the proximal surroundings of Viidumäe. Necessary measures for the conservation of species and communities are defined in periodically compiled forest management plans. For example

- in 1966 the shelterwood cutting was planned in old pine woods used for resin tapping before the foundation of the nature reserve
- in 1976 a change of arable land was made in habitats of *Vicia lathyroides*
- in 1986 thinning of planted forest was planned to improve habitat conditions of light-loving rarities, e.g. *Vicia cassubica, Trifolium alpestre* and *Hypericum montanum*.

Relying on the Act concerning Protected Natural Objects (1994), the Estonian Government defined the outer boundary, the zoning and the protection rules of Viidumäe Nature Reserve. The nature reserve is divided into the following zones:

1) strict nature reserve zones, where all kinds of activity are prohibited and human presence is permitted only for rescue, supervision and research work
2) special management zones, where only activities to maintain or improve habitat conditions of threatened species or preservation of semi-natural communities (wooded meadows) are permitted
3) limited management zones, where activities can take place with restrictions shown in protection rules.

Zoning, a correction of the outer boundary of the Nature Reserve as well as setting restrictions and necessary activities, is based on information collected over several decades.

4.1.5 *Future plans*

The most pressing tasks in organizing the protection of plant species and communities in Viidumäe Nature Reserve are the following:

- to create modern databases
- to prepare a forest survey plan for the next ten years; the main attention in this plan must be paid to the transformation of planted pinewoods into stands of different ages
- to preserve habitats of threatened plant species and communities
- to make a management plan for the nature reserve; the plan must contain economically analyzed activities for preservation of all the local natural complex, particularly botanical objects.

Discussion of these problems with Finnish colleagues is considered important.

4.2 Habitat management of threatened plants in protected areas

Tiina Kanerva, Finnish Forest and Park Service

The primary goal in the management of protected areas is the protection or increasing of biodiversity. Preserving the populations and habitats of threatened species is also one of the principal tasks of protected area management. The easiest kind of conservation of threatened plants, for example in the case of some mire species, does not need any active management measures. However, in many cases conservation involves interfering with natural succession. Restoration and management work in various forms are carried out in the Finnish Forest and Park Service (FPS), for example:

- restoration of mires or forests
- management of herb-rich forests
- use of traditional agricultural methods in heritage landscapes
- management of growing sites of threatened species

4.2.1 Restoration of mires

About nine per cent of all threatened vascular plant species grow in different kinds of mires. Drainage of mires has been the main threat or reason for decline for 11 % of vascular plant species. In Finland about 6 million hectares of mires have been drained mainly for forestry. This area is about 60 % of the peatland area of Finland. The drainage was carried out mainly in the 1960s and 1970s.

Currently there are about 6 000 hectares of drained mires in the protected areas of the Forest and Park Service. When all the mires belonging to the national mire protection programme are protected, the area of drained mires in protected areas is estimated to be about 50 000 hectares. The restoration of mires is thus an essential part of the management of peatlands.

The Forest and Park Service has been restoring mires that have been drained for approximately ten years. The restoration started in infertile mires in Seitseminen National Park. The restoring methods are described in two publications of the FPS (Seppä et al. 1993, Heikkilä & Lindholm 1995). The aim of mire restoration may be the restoration of landscape, vegetation, fauna or the site of a single species. The restoration of mire hydrology is essential for achieving these goals. The most important restoration methods are filling of ditches and felling of trees that have grown after drainage. Sometimes other methods, such as harvesting of undergrowth vegetation, are also needed. A completely restored mire is geologically, hydrologically and functionally in its natural state and the species composition is also natural.

Successful restoration depends on many factors. The most important are the time elapsing after drainage, the degree of change in the mire and the possibility of obtaining sufficient water flow to the mire. Different mires – raised bogs, aapa mires, spruce mires and rich fens – must be restored taking their typical features into account. It is comparatively easy to restore the central part of an ombrotrophic raised bog, where no tree growth occurs, the vegetational changes are small and the ecosystem is independent of the surroundings. On the other hand small tree-covered bogs, from which tree-cover and hollow trees have long since dissappeared, may be very hard to restore.

It is important to monitor succession in the mire in order to determine whether the restoration has been successful. Often at least the vegetation succession is monitored by permanent sample plots.

4.2.2 Restoration of forests

Forestry in heath forest has not constituted a threat to many vascular plant species, although it has drastically affected many other groups, for example fungi and lichens. Restoration of heath forests growing on mineral soil has been carried out in the FPS for an even shorter time than restoration of mires. Many of the forests in protected areas have earlier been used for commercial wood production and different silvicultural measures have taken place. The former commercial forests are often dominated by pine or spruce and there is a lack of deciduous trees. The trees are more or less of the same age. Dead, hollow decaying trees still standing or rotting trees lying on the ground are missing. The aim of restoration is to obtain a forest with the natural forest structure and ensure a continuity of old trees, dead wood and special microclimate that old-growth forest species require.

In some protected areas natural fires have been imitated in an attempt to obtain a new, more natural start to forest succession. At the same time habitats have been created for threatened species living in burned forests. There are also other methods of forest restoration that have been excamined, such as cutting and decaying trees. For example in Seitseminen National Park small patches of different size have been cut in young cultivated stands of forests and different amounts of dying trees have been left in the clearcuts. Dying and decaying trees have been produced in Konianvuori by making ring-damages in the bark of living trees and by inserting tree-rotting fungi to drilled holes in trees. The slow death of the trees offers habitats for species depending on dying trees of different decaying levels.

Several different groups of insects, fungi and lichens are monitored in the restoration areas of forests. The FPS has published a guide to the estimation of the natural state of forests (Lindholm & Tuominen 1993), but no guide to restoration or monitoring of forests is still under preparation.

4.2.3 *The management of herb-rich forests*

About 69 % of all forest plants grow in herb-rich forests. Herb-rich forests currently account for only 1% of Finland's forest area and they are concentrated in southern Finland and in certain areas of the more fertile herb-rich forest centres. However, they are the main habitat for 13 % of threatened vascular plant species. They are also important for threatened fungi and cryptogams. Many of these threatened species need some kind of management of their growing sites.

The need for management of herb-rich forests varies in different parts of Finland. In southern Finland the herb-rich forests have often been in some kind of traditional use, e.g. for cattle grazing. When the traditional use has been discontinued the spruces have started to grow. The growing spruces shadow the herbs and the falling needles increase acidification of the soil. Furthermore the microclimate also changes when more spruces grow in a forest earlier dominated by broadleaf trees.

In order to keep the growing conditions favourable for the threatened plants there may be a need to cut the spruces from the herb-rich stands of forests. Because spruce belongs in some amounts to the natural sucession of herb-rich forests even in southern Finland, not all herb-rich forests should be managed in the same way. The cutting of spruces has been practised for only about ten years in some protected areas in southern Finland. Usually there is less need for management in herb-rich forests of central and northern Finland, because of their land use history and species composition. However, as in the case of the heath forests there is also a need to increase the amount of dead and decaying trees in the herb-rich forests.

The Forest and Park Service has published a guide to the management of herb-rich forests (Alanen et al. 1995).

4.2.4 *The management of traditional landscapes*

Overgrowth of meadows, natural pastures and semi-open woodlands is the main threat or reason for decline to about 25 % of vascular plant species. Traditional rural land-use methods have been changing with increasing rapidity during the twentieth century. Although the number of traditional landscapes in protected areas is rather small, various kinds of traditional landscapes have been taken care of in some protected areas. Such traditional landscapes are:

- dry and wet meadows
- natural pastures
- forests grazed by domestic animals
- semi-open meadows where leafy twigs are gathered for winter fodder
- forests burned for cultivating of cereals (slash-and-burn forests).

Whenever possible, traditional land-use methods in mowing, grazing and hay making are used. Because of lack of manpower, modern machinery must also be used, but the aim is always to achieve the same kind of influence on vegetation as that of the traditional methods.

In some protected areas – such as the National Parks of the Archipelago, Liesjärvi, Isojärvi, Seitseminen, Linnansaari and the protected area of Telkkämäki – some old buildings (dwellings and outbuildings) and the surrounding gardens and courtyards are also restored. In some cases it is possible to transfer threatened species to such cultural landscapes. In principle it is possible to transfer threatened plants of the same origin to protected areas in which they have grown earlier but since disappeared. The transferring of species not known to have grown in the protected area can only be done in cultural landscapes. In these cases the species are usually heritage biotope species, which cannot survive without constant care. Such plantings have been performed in Isojärvi National Park (*Agrimonia pilosa*), Linnansaari National Park (*Carlina biebersteinii*) and Mälhamn Island in Archipelago National Park (e.g. *Agrimonia procera, Draba nemorosa, Malus sylvestris, Potentilla anglica*).

An inventory of the traditional landscapes of the FPS was started in 1993 and completed in 1997. A guide to monitoring the vegetation of traditonal landscapes is in print (Hakalisto & Nieminen 1997).

4.2.5 Monitoring and management of growing sites of threatened plants

The Forest and Park Service is responsible for monitoring of the threatened plants occurring in its areas. Although the FPS has rather good information about the growing sites of endangered and vulnerable vascular plant species, the vascular plants in need of monitoring or other plant or animal groups are less well known. Over 30 known endangered or vulnerable vascular plant species and over 60 species in need of monitoring grow on land managed by the FPS. Of these five endangered, 18 vulnerable and four species in need of monitoring are monitored regularly by botanists of the FPS (Table 1).

*Table 1. Plant species monitored regularly by the Forest and Park Service. Explanations: E = endangered, V = vulnerable, St = in need of monitoring, declined, Sh = in need of monitoring, rare (Rassi et al. 1992), * = the species was transfered to the protected area*

Agrimonia pilosa	E *	*Kobresia simpliciuscula*	V
Melica ciliata	E	*Lonicera caerulea*	V
Salix pyrolifolia	E	*Microstylis monophyllos*	V
Sedum villosum	E	*Polygonum oxyspermum*	V
Silene furcata	E	*Potentilla subarenaria*	V
		Salsola kali	V
Armeria maritima		*Stellaria crassifolia*	
subsp. *elongata*	V	var. *minor*	V
Anagallis minima	V	*Viola uliginosa*	V
Arnica angustifolia	V		
Carlina biebersteinii	V	*Cypripedium calceolus*	St
Crepis tectorum		*Epipactris atrorubens*	Sh
subsp. *nigrescens*	V	*E. palustris*	St
Epilobium laestadii	V	*Gentianella amarella*	St
Gentianella campestris	V		

The FPS has started the management of growing sites of threatened plants with *Salix pyrolifolia, Armeria maritima* subsp. *elongata, Gentianella campestris, Lonicera caerulea* and *Viola uliginosa (S. pyrolifolia* and *L. caerulea,* see p. 52*)*.

At the growing site of *Armeria maritima* in the Nature Protection Area of Uddskatan, pines have been cut and experiment plots have been cleared of pine needles, other vascular plants or lichenes or mosses. In the mire reserve of Santalankorpi, where *Viola uliginosa* grows, a dam was built in a drainage ditch to raise the water back to its level before the ditching.

In Isojärvi National Park trees and bushes have been cut from the surroundings of *Gentianella campestris.* The land surrounding flowering plants has been cleared of vegetation so that the seeds have had a possibility to reach the mineral soil and germinate. Sheep have also been brought to graze the old fields and pastures near the growing sites of *G. campestris.*

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5 POPULATION BIOLOGY OF RARE AND THREATENED VASCULAR PLANTS

5.1 Cytotaxonomy and breeding systems in some neoendemic angiosperm taxa of the Baltic region

Ülle Reier, Tartu University

5.1.1 *Endemic plant species in Estonia*

The first part of the Red Data Book of the Baltic Region (Ingelög et al. 1993) gives a list of 64 endemic taxa (including species) of this region. 12 (more accurately 13: *Allium schoenoprasum* L. var. *alvarense* Hyl. should be added to the list) of them occur in Estonia:

Anthyllis vulneraria L. subsp. *maritima* (Schweigger) Corbiere
Arabidopsis suecica (Fries) Norrlin
Artemisia maritima L. subsp. *humifusa* (Hartman) K. Persson
Atriplex prostrata Boucher ex DC. subsp. *calotheca* (Rafn) M.Gust
Cacile maritima Scop. subsp. *baltica* (Rouy & Fouc.) P.W.Ball
Carex bergrothii Palmgr.
Dianthus arenarius subsp. *arenarius*
Hierochloë odorata (L.) Beauv. subsp. *baltica* G.Weim.
Myosotis laxa Lehm. subsp. *baltica* (Sam.) Nordh.
Rhinanthus osiliensis (Ronniger & Saarson) Vassilcz.
Saussurea alpina (L.) DC. subsp. *esthonica* (Baer ex Rupr.) Kuppfer
Sorbus intermedia (Ehrh.) Pers.

Only some of these plants have been given the status of species, which correlates well with the notion that the relatively short post-glacial period has not been long enough for plant speciation higher than the subspecies level (Jonsell 1988).

Most of the endemic taxa listed here occur throughout the Baltic Sea Region, although four of them, *Artemisia maritima* L. subsp. *humifusa* (Hartman) K. Persson, *Dianthus arenarius* subsp. *arenarius, Saussurea alpina* (L.) DC. subsp. *esthonica* (Baer ex Rupr.) Kuppfer and *Allium schoenoprasum* L. var. *alvarense* Hyl., occur in only 2–3 localities in the region in addition to Estonia. *Rhinanthus osiliensis* (Ronniger & Saarson) Vassilcz. is found only in Estonia. The extent to which different endemic taxa of the Baltic Region have been studied varies considerably. There are excellent examples of such investigations from Finland, Sweden and Norway, but we still know very little about the endemic taxa that are distributed only (or mainly) south of the Gulf of Finland.

The best known examples of the Estonian endemics are *Rhinanthus osiliensis* (Ronniger et Saarson) Vassilcz., found only on the island of Saaremaa, and *Saussurea esthonica* (Baer ex Rupr.) Kuppfer, occurring in Estonia, Latvia (only one locality near Tukums) and reputedly in the vicinity of St. Petersburg. However, these plants still belong to the "indeterminate" category, for which we know almost nothing about their mode of reproduction, the existence of any reproductive barriers between taxa or even their number of chromosomes. It is the responsibility of Estonian botanists to study these taxa and thus contribute to collaboration on the threatened species of the Baltic Region.

5.1.2 Biological characteristics of endemic angiosperms in Estonia – a new research project

The lack of material from the south-eastern parts of the Baltic Sea Region has already lead to some erroneous conclusions, for example the reports of Schuster (1967) and later Apelgren (1990, 1991) about the absence of typical *Myosotis laxa* Lehm. subsp. *baltica* (Sam.) Nordh. specimens in Estonia.

In order to fill in these gaps in our knowledge we have started a three-year project (1996–1998) in the Institute of Zoology and Botany, financed by the Estonian Science Foundation, to collect data on the biological characteristics of some of the endemic angiosperms of Estonia. Karyological investigations connected with the study of plant breeding systems (sexuality) on a population level will be used in this mainly taxonomic research.

Special attention will be given to the in-depth investigation of *Rhinanthus osiliensis*. More detailed study of this sexually reproducing annual species may, due to its higher evolutionary rate compared to long-lived and mostly vegetatively spreading perennials, provide a good example of the post-glacial plant speciation processes in the Baltic Sea Region as a whole. Other Estonian endemics selected for particularly intensive studies are *Saussurea esthonica, Orchis ustulata* s.l. and *Gymnadenia conopsea* s.l.

Rhinanthus osiliensis was first discovered in 1933 by an amateur botanist B. Saarson (Saarson 1934). He identified it as *Rhinanthus rumelicus* Vel. and sent it to K. Ronniger in Vienna for verification. The latter found it to be a new subspecies (Ronniger 1934). K. Eichwald ranked it as a species in 1953 but because he did not publish it validly the author of the species is Vassilchenko, who ranked it as a species in the Flora of the USSR published in 1955 (Kask 1981). In addition to its special morphological characteristics it is also situated thousands of kilometers from the main distribution area of the nearest glandulous hairy species *R. rumelicus* Vel., which is distributed in the Eastern Carpathians and Thüring. There are also differences in its typical habitats. In Estonia *R. osiliensis* mainly grows in calcareous spring fens (Eichwald 1960). *R. osiliensis* seems actually to be expanding its distribution area in Estonia, which is a further piece of evidence indicating that it is a neoendemic rather than a relic species here.

Since 1958 *R. osiliensis* has been under protection in Estonia and its main habitats are located within the Viidumäe Nature Reserve.

Saussurea esthonica was first discovered by K. E. von Baer in 1844 and described as a new species by F. J. Ruprecht. Although it was given the status of subspecies by K. R. Kuppfer in 1902 (Kuppfer 1902), the taxon is treated as a species in the Flora of the Estonian SSR (Kuusk 1978) as well as in the Flora of the Latvian SSR (Petersone 1955), the Flora of the USSR (Lipschitz 1962, Czerepanov 1995) and in the monograpical study of the genus by Lipschitz (1979). Suprisingly the latter author gave it the status of subspecies in the Flora Europaea (Lipschitz 1976). S. Lipschitz also made the intriguing statement that the nearest species according to morphological characteristics seems to be *S. stubbendorffii* Herd., which occurs in Eastern Siberia (Lipschitz 1979). Whether or not the population of *Saussurea* that was first found in 1914 near Pudost (Leningrad district) is *S. esthonica* is also unresolved. Some authors consider it to be typical *S. alpina* (L.) DC. (Yuzepschuk 1955, Sokolovskaya 1965). S. Lipschitz considers it possible that some specimens resembling *S. esthonica* are also to be found in the Leningrad district, especially in calcareous habitats (Lipschitz 1979). The species is distributed in north-western Estonia and is not found on the islands (incl. Saaremaa and Hiiumaa).

Saussurea alpina s.l. has an interesting distribution pattern in the Baltic Sea area. It is absent in the southern part of Finland, but has almost continuous distribution in the southern part of Russian Karelia (Hultén 1971). *S. alpina* s.l. is a very polymorphic species and is in need of a special monographic study throughout its very wide area of distribution (Lipschitz 1979). Its number of chromosomes (2n) varies from 26 to 76 (Tahtajan 1990): Lid & Lid (1994) give the numbers 26, 36?, 52–54, 76?. As we are unable to carry out an in-depth study of *S. alpina* s.l. in the short course of this project we shall concentrate mainly on the cytotaxonomical and breeding system study of *S. esthonica.*

5.1.3 Reaseach as a basis for protection

The inclusion of apomictic groups in the "red" list of a region varies considerably between countries and depends mainly on how well these groups have been studied in each country. In the course of the PhD studies of Malle Leht and Toomas Kukk we should also obtain new information about the neoendemic taxa of the genera *Potentilla* and *Pilosella* in Estonia.

The taxa which we have selected for investigation are important for the preservation of biodiversity not only in Estonia but also in the Baltic region as a whole. The majority of the taxa studied are also included in the Estonian State Monitoring Program. The results of our study should provide scientific motivation for the organization of protection and further monitoring of these species.

It is also necessary for nature conservation legislation purposes to obtain more information about the species under protection, the complex investigation of which may cast new light on their taxonomic status as well as on the biological value of the protected taxa.

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5.2 Population biology of threatened vascular plants in Finland – some case studies

Eija Kemppainen, Finnish Environment Institute

5.2.1 *Background*

In the first Red Data Book of the threatened animal and plant taxa in Finland (Rassi et al. 1986) the knowledge of the population biology of the threatened taxa was found to be insufficient. A four-year project was therefore started in 1986 to fill some of the gaps and to collect biological data on threatened vascular plants in Finland. The background and some of the results have been published earlier in English (Lahti et al. 1991, Uotila et al. 1990) and in Finnish (Kemppainen 1996, Kemppainen et al. 1991, Kemppainen et al. 1993). The aims of the project, financed by the Academy of Finland, were to build a database of the biological, ecological and biogeographical characteristics of threatened vascular plants and to study the population biology and life-cycles of selected species. In close collaboration with the project, the preparation of protection and management plans was started in 1987, financed by the Ministry of the Environment.

5.2.2 *Biological characteristics of threatened vascular plants*

Data on the biological characteristics of threatened vascular plants were collected from published literature and from the botanical archives and the herbarium specimens of the Botanical Museum of the University of Helsinki. Most of the data was included in the Floristic Database of the Botanical Museum. For each threatened taxon a more common, taxonomically close relative was chosen. The distributions and various biological characteristics of the species were compared within each pair of a threatened and a more common taxon. The threatened taxa were revealed to be geographically rather strictly restricted to the western half of the Eurasian continent, whereas most of the "common taxa" had wider distribution areas (Lahti et al. 1991). In Finland the threatened taxa are located mainly in the southern part of the country.

Only a few biological characteristics were found to distinguish threatened taxa as a group from their more common relatives (Lahti et al. 1991):

- Threatened plants have shorter flowering seasons than common species.
- Threatened species are generally more difficult to observe than the common ones. This is probably due to their shorter flowering time, and often also to the smaller size of the threatened taxa.
- Edaphic requirements of the threatened plant group clearly differ from those of the group of common species. This suggests that the rarity of threatened taxa may largely be a result of physiological factors limiting their growth in the marginal areas of their distribution. Similar results

were also obtained in the study of threatened vascular plants in Sweden (Gustafsson 1994). Suitable habitats are not always available, and they are situated at rather great distances from each other. Thus, loss of existing habitats must be minimized by conservation and management.

5.2.3 *Biology of selected species*

Four grassland species, *Agrimonia pilosa, Androsace septentrionalis, Carlina biebersteinii* (*C. vulgaris* subsp. *longifolia*) and *Crepis praemorsa*, were selected for detailed studies. The population biology of these species was studied in order to plan conservation and management of their populations and habitats. All four species are regarded as archaeophytes in Finland. They usually grow on roadsides, in field margins and on pastures, and even in yards. During the past few decades most of their populations have declined due to overgrowth of meadows following cessation of grazing or hay cutting. In Finland all the species are growing on the northern or western edges of their ranges, and their habitat requirements appear to be rather strict.

5.2.3.1 *Methods*

Populations of *Agrimonia pilosa, Androsace septentrionalis, Carlina biebersteinii* and *Crepis praemorsa* were studied and mapped, and some of the populations were investigated twice a year or even monthly from 1986 to 1989. The aim of the study was to clarify the life cycles of the species concerned and reasons for their decline. The main aspects studied in the field were:

- habitat requirements: exposure, soil properties and human influence
- vegetation: percentage cover by layers and species in the flowering season of the studied species, actual and potential competitors
- population structure: area, total number and density of shoots, proportions and heights of sterile and flowering shoots, proportions of damaged shoots per individual
- population dynamics: sexual and vegetative reproduction, pollination, seed set, germinability of seeds, number of seedlings, development of seedlings and mortality in different life stages.

In addition, the needs for monitoring and management were estimated, threats were evaluated and some small-scale management and sowing experiments were performed.

A few sites of the studied species have also been monitored annually during the 1990s. Since the study period some management experiments have been carried out by local authorities and land owners. A few sites are protected by law.

5.2.3.2 *Results*

Androsace septentrionalis (Primulaceae) is an annual herb with a basal rosette. It has 13 indigenous or established populations in Finland. Due to its seed bank, the species seems to survive quite well providing that the sites are not drastically altered by overgrowth or construction. The annual life cycle on warm and dry esker slopes is extremely short. Flowering and seed set vary considerably between years (Kemppainen et al. 1991, Kemppainen 1996). Natural seed dispersal of the species seems to be rather inefficient. Most of the sites are greatly influenced by man. Management, e.g. mowing and some kind of small-scale disturbance (trampling), is often needed to maintain the populations.

Agrimonia pilosa (Rosaceae) is a perennial rhizomatous herb. A total of 11 very small populations are known in Finland within a small area west of Lake Päijänne (South Häme). Individuals may grow to old age, and in many sites the same large tussocks have survived throughout the 10-year monitoring period (Kemppainen et al. 1993). Seedlings were observed only in habitats managed by mowing, along road-sides, or in other open sites with human disturbances. Flowering and seed set are weakened by unsuitable climatic conditions, e.g. the early summer drought or the late summer cold period. Selfing is common in small isolated populations. Dispersal of hypanthia with hooked bristles must earlier have been efficient near pastures and yards, but nowadays most of them remain close to their parent plants. Management is needed for flowering and for the survival of seedlings. Especially in shady habitats a clonal growth mode with sterile, separate shoots is clearly evident.

Carlina biebersteinii (*C. vulgaris* subsp. *longifolia;* Asteraceae) has about 15 localities in Finland, all of them in the east. Many of the extant populations are growing in former pastures, in field margins, or in areas that used to be under slash-and-burn cultivation. The close relative *C. vulgaris* (*C. vulgaris* subsp. *vulgaris*) is still relatively abundant in the Åland Islands in the extreme southwest. Both species are monocarpic (individuals die after flowering).

C. biebersteinii, which has commonly been considered biennial, actually grows several years as a vegetative rosette before flowering. Flowering is clearly dependent on the size of the rosette. During the study period 1987–1989 half of the individuals with a small rosette remained small from one year to the next, most of the intermediate rosettes remained intermediate and only some of the large rosettes flowered in the subsequent year. Due to poor seed dispersal, rosettes usually form dense groups. Flowering, seed set and seed dispersal are greatly affected by shade caused by the surrounding vegetation and by weather conditions. It is also possible that the seed set has decreased because of inbreeding in small, isolated populations. Management efforts, for example mowing and gradual thinning of bushes and trees, are needed in most of the sites.

Crepis praemorsa (Asteraceae) has only one population in the Åland Islands and five closely distributed populations in Hämeenlinna, South Häme. The species has a short rootstock, but in favourable conditions individuals spread effectively with subterranean runners. The small patches of rosettes found in the field may consist of only one or a few clonally spreading individuals. Flowering, seed set and seedling survival of *C. praemorsa* are favoured by open habitats. However, established individuals are able to survive and spread clonally even for decades in shaded sites. A management experiment made in one locality in 1994 had no impact on flowering in 1995. However, in the second year, 1996, flowering was abundant. Seed set is probably rather poor in Finland, or at least it varies between years.

5.2.3.3 Conclusions

Fluctuations in population size of perennial long-lived species, e.g. *Agrimonia pilosa* and *Crepis praemorsa*, are usually small and the changes are slow. Populations of short-lived perennials, e.g. *Carlina biebersteinii*, may decline in a single decade due to overgrowth if the species is not able to find new suitable habitats. Species with a persistent seed bank, e.g. *Androsace septentrionalis*, are able to survive in their sites for decades despite considerable fluctuations between years. At least *A. pilosa* and *C. praemorsa* have clearly benefited from management efforts.

However, too little is still known about the biology of the species in consideration to detect all the causes of decline. Cessation of pasturing in the meadows and forests may often be the main reason. In small populations it may be difficult to distinguish natural variation from threats caused by man. The intensity of management efforts required is not easy to decide. Furthermore, nothing is known about possible genetic differences between these isolated small populations and larger interbreeding populations in the main distribution areas of the species.

Acknowledgements

The author thanks Arto Kurtto and Pertti Uotila for reading the manuscript and making useful comments.

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5.3 Population studies of native orchids in Estonia

Tiiu Kull, Tartu University

5.3.1 Introduction

During the past two decades since the work of Harper (1977), the number of population studies of different plant species has expanded, which has necessitated their reviewing. Population studies of orchids in Estonia have concentrated mainly on problems of demography. Long-term data have been obtained on the species *Cephalanthera rubra, C. longifolia, Epipactis atrorubens, Neottia nidus-avis, Cypripedium calceolus* and *Orchis ustulata*. Within a state monitoring programme, data on the demographic behaviour of 16 more species (*Orchis morio, O. mascula, Coeloglossum viride, Malaxis monophyllos, M. paludosa, Liparis loeselii, Anacamptis pyramidalis, Dactylorhiza cruenta, D. praetermissa, D. ruthei, D. sambucina, Gymnadenia odoratissima, Epipactis helleborine, Listera cordata, Ophrys insecifera, Epipogium aphyllum*) were collected during the summers of 1994–1996.

In order to understand the demographic processes and the genet-ramet structure in a population, clear knowledge should be acquired about the structure of the underground organs of a species; whether the species is clonal and by what means vegetative reproduction occurs. In this aspect, our most detailed studies deal with the rhizomatous species *Cypripedium calceolus, Cephalanthera longifolia* and *C. rubra*. Here we give a short description of the data collected for five investigated species.

5.3.2 Data collection

Data for demographic studies have been collected using mainly the following four types of methods:

1. counting of specimens of a population in a more or less fixed territory; usually, only flowering specimens have been counted
2. marked specimens method – individual marking of specimens (more exactly clones) for the description of their dynamics in subsequent years; this method is particularly useful if specimens in a population are sparsely located in a widespread territory; usually not all of the specimens of an area are marked
3. permanent plot method – all ramets on a fixed plot are counted (and sometimes measured) every year (or after some longer period); different sizes of plots have been used (from 1 to 200 sq. m)
4. permanent plots with ramet mapping – the combination of methods (2) and (3); all ramets on the plot are mapped (e.g. using the coordinate method).

The monitoring programme used in this work applied method (4) on 10 x 10 m^2 plots, together with description of plant communities.

Dactylorhiza ruthei grows in only one locality in western Estonia. Probably, it is the only locality of the species in the world (Kuusk 1994). The population is situated on a coastal meadow that is occasionally flooded and was previously regularly mowed. Currently, mowing is organized once every few years. The territory of the population is about 0.5 ha. The number of flowering specimens has been monitored since 1981 (Fig. 1).

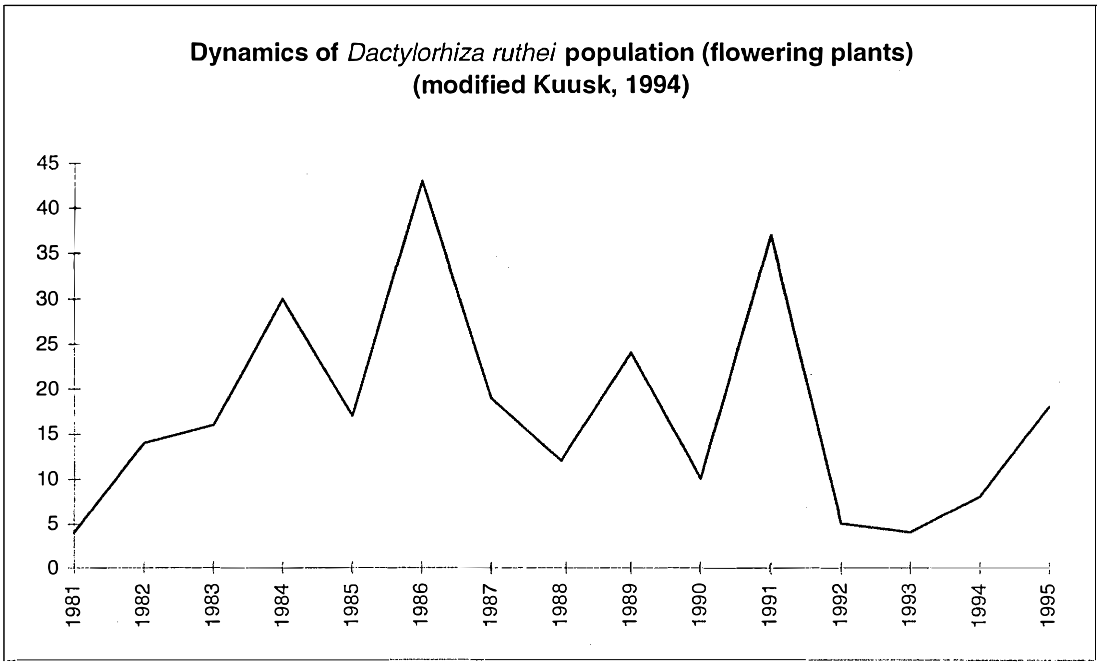

Fig. 1. Dynamics of flowering specimens of Dactylorhiza ruthei (Kuusk 1994, modified).

There are two subspecies of ***Orchis ustulata*** in Estonia, which differ mainly in their flowering time (Tali 1994). The early-flowering populations are mainly distributed on Muhu Island and in eastern Saaremaa, whereas the late-flowering populations are found on the mainland, on the island of Hiiumaa and in western Saaremaa. The method of marked specimens was applied in 1993 with one early-flowering and one late-flowering population. Since 1994 studies of four more populations have been carried out by the same method. Detailed mapping using the monitoring method was also performed (see the paper by Ülle Kukk in this volume). The number of specimens in populations has hitherto increased. 35.2 % of the flowering plants set fruit, but only 0.5 % of the flowers produce capsules (Tali 1995, manuscript).

Nine different populations of ***Cypripedium calceolus*** were monitored in various habitats. The study started with one population in 1978 and was continued with seven populations included in 1984 and 1985 and one more in 1991. The permanent plot method was used, but the sizes of plots differed depending on the structure and size of the population (Kull & Kull 1991). The studied populations differed considerably in their percentages of flowering ramets (mean 17.8–71.9 %), and variation was greater between populations than within a particular population in different years (Kull 1989, Kull 1995a).

Sexual reproduction in *C. calceolus* is usually rare. However, in two studied populations the number of young seedlings was rather high although fruit-set in these populations was only 9 % per flower (the average of all studied populations was 10.5 %). Favourable sites for the establishment of *Cypripedium calceolus* seedlings are characterized by an extensive moss cover and a less extensive vascular plant cover and by good moisture and light conditions (light penetration coefficient > 0.30).

Genetic variability in populations of *C. calceolus* is high (Kull 1995b). Fluctuations in population size are mainly the result of changes in the sizes of genets. Vegetative reproduction dominates over sexual reproduction, and populations are rather stable (Kull 1995c). The dormancy of a whole genet is a rare phenomenon in *C. calceolus*, but may occur in small clones with few branches.

Cephalanthera longifolia grows on western islands and in only one site on the mainland, in the Laelatu wooded meadow where it has been studied since 1987 by using mainly the method of marked specimens. Since 1994, 10 x 10 m^2 monitoring plots have been monitored at Laelatu and in western Saaremaa.

The rhizome of *C. longifolia* is short (Püttsepp 1994). The annual increment of the rhizome is small, and the ramet of the subsequent year emerges close to the previous one. The oldest part of the rhizome is pulled into a deeper soil. The observations of 1987–1995 do not indicate vegetative mobility. In different populations (Laelatu, West-Saaremaa) a genet has most frequently one flowering ramet (57–65 %) or one ramet with leaves only (9–20 %). Genets with two flowering ramets make up 10–16 % of a population, and 5–6 % of genets have more than two ramets. As in many other orchids, periodic below-ground dormancy is expressed in this species. On average 9.1 % of genets miss a season in a population of *Cephalanthera longifolia* at Laelatu. The status of genets that have been missing for three or more years is not clear. Long-lasting dormancy, senility or death are all possible explanations. In *C. longifolia* 6.4 % of the flowering ramets set fruit, whereas only 0.8 % of the flowers produce capsules (Püttsepp, personal communication).

Cephalanthera rubra is a rare species growing sparsely in western and northern parts of Estonia. The nearly vertical rhizome is short. Yearly increments may vary greatly, but due to the vertical position above-ground shoots emerge almost in the same spot in different years. Branching of the rhizome is rather unusual (Kull & Tuulik 1994). The dynamics of seven plants of *C. rubra* on a 1 m^2 plot in

Hiiumaa over a 15-year period are displayed in Fig. 2. All the plants have missed at least one season, and some smaller and weaker plants have missed several times during the study period but never more than on two consecutive years. By now, most of these plants are probably dead, as the habitat has been changed as a result of the construction of a new road.

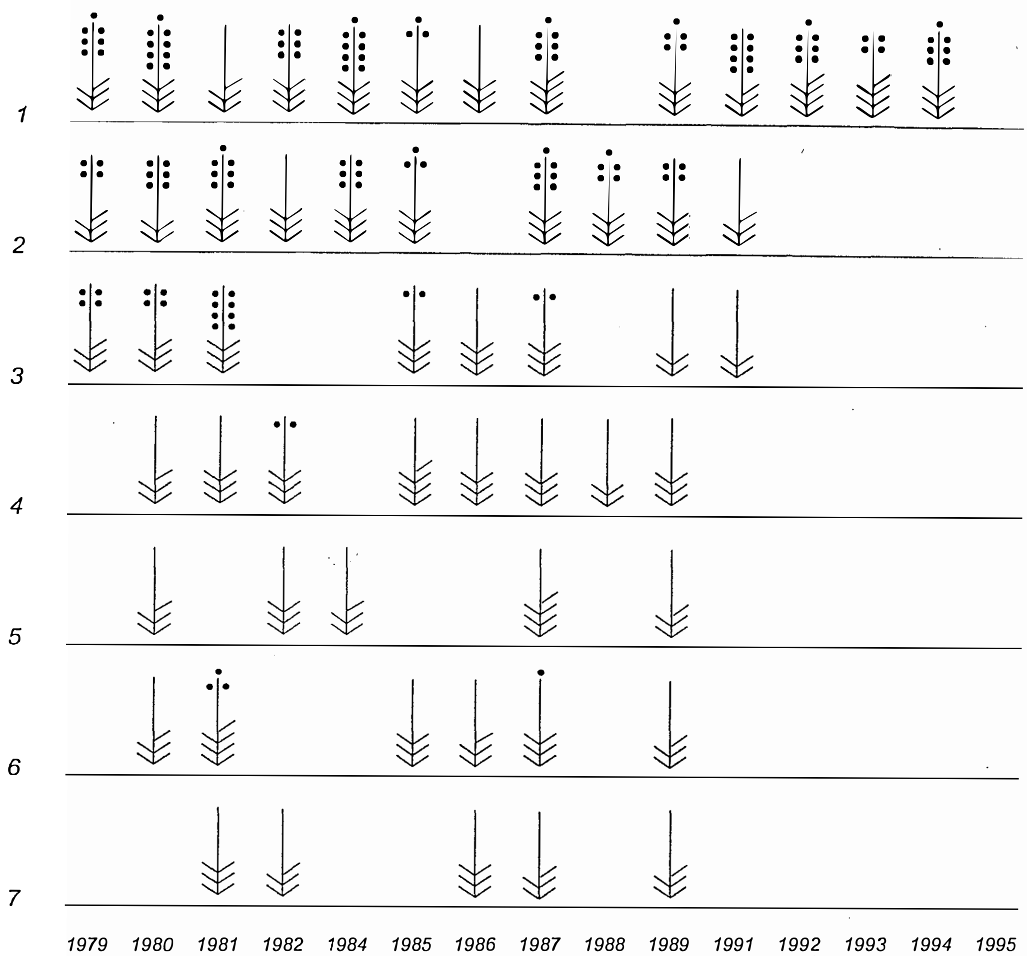

Fig. 2. Dynamics of seven plants of Cephalanthera rubra on a plot in Hiiumaa in 1979–1995. The number of flowers and leaves on every plant is shown.

Acknowledgements

I thank my colleagues Vilma Kuusk, Ülle Püttsepp, Kadri Tali and Taavi Tuulik for cooperation.

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5.4 The importance of reproductive success to population persistence of threatened orchids in Finland

Antti Lammi, University of Jyväskylä / Southwest Finland Regional Environment Centre

5.4.1 Threatened orchids in Finland

Orchids have attracted botanists for a long time also in Finland because of their colourful floral display and special adaptations in flowering. Their distribution and abundance in Finland are therefore rather well known compared with some other plant families. At the moment there are 34 species of orchids belonging to 21 different genera in the Finnish flora. Some species, such as *Pseudorchis albida* and *Chamorchis alpina,* have a northern distribution, but most of the species occur in southern Finland. Several species such as *Cephalanthera longifolia* and *Dactylorhiza sambucina* occur only or mostly in the Åland Archipelago, in extreme south-western Finland.

The orchids occur in several habitat types. *Epipactis helleborine* and *Cephalanthera rubra* inhabit mostly deciduous forests on rich soil and e.g. *Epipactis atrorubens* is allmost totally dependent on calcareous soil. Some genera, e.g. *Dactylorhiza,* occur in nutrient-rich mires. Several orchid species depend on agricultural environments and *Gymnadenia conopsea* has declined in Finland as the succession of vegetation has proceeded in dry meadows. However, all the species are not habitat specialists, e.g. *Goodyera repens* and *Corallorhiza trifida* do not have such restrictive habitat requirements.

Different distribution patterns and habitat requirements have important consequences for the endangeredness and rarity of the species. The distribution patterns are affected by selective habitat destruction which has taken place in Finland during recent decades. Particularly agricultural environments, mires and deciduous forests on rich soil have decreased in Finland during the twentieth century (Rassi et al. 1992).

There are currently 18 nationally threatened orchid species in Finland (Rassi et al. 1992). One orchid, *Herminium monorchis,* has even become extinct in Finland during the past 40 years. The most endangered orchids in Finland are now *Cephalanthera rubra, Ophrys insectifera* and *Liparis loeselii. Microstylis monophyllos* is concidered as vulnerable (Table 1). Many other orchid species are also listed as regionally threatened. The proportion of threatened species in the family *Orchidaceae* (52.9 %) is one of the highest in the Finnish flora. The only "common" orchids in Finland are *Dactylorhiza maculata* and *Goodyera repens.*

Table 1. The Finnish orchids, their threat categories, main modes of reproduction and pollination systems. National threat categories H = extinct, E = endangered, V = vulnerable, S = in need of monitoring (Rassi et al. 1992). The symbol n in the last column means that the species is nectarless.

Species	**Threat category**	**Mostly sexual reproduction**	**Insect pollinated**
Calypso bulbosa	S	X	Xn
Cephalanthera longifolia	S	X	Xn
Cephalanthera rubra	E	X	Xn
Chamaeorchis alpina	S	X	X
Coeloglossum viride		X	X
Corallorhiza trifida		X	
Cypripedium calceolus	S	X	X
Dactylorhiza baltica		X	Xn
Dactylorhiza cruenta	S	X	Xn
Dactylorhiza fuchsii		X	Xn
Dactylorhiza incarnata	S	X	Xn
Dactylorhiza lapponica	S	X	Xn
Dactylorhiza maculata		X	Xn
Dactylorhiza sambucina		X	Xn
Dactylorhiza traunsteineri	S	X	Xn
Epipactis atrorubens	S	X	X
Epipactis helleborine		X	X
Epipactis palustris	S	X	X
Epipogium aphyllum	S	X	X
Goodyera repens		X	X
Gymnadenia conopsea		X	X
Herminium monorchis	H	X	X
Liparis loeselii	E		X
Listera cordata		X	X
Listera ovata		X	X
Malaxis paludosa		X	X
Microstylis monophyllos	V	X	X
Neottia nidus-avis		X	X
Ophrys insectifera	E	X	X
Orchis mascula	S	X	X
Orchis militaris		X	X
Platanthera bifolia		X	X
Platanthera chlorantha		X	X
Pseudorchis albida	S	X	X

5.4.2 *Problems in small orchid populations*

In general, there are three main factors which will determine the future of small and isolated orchid populations. First, genetic problems assosiated with small population size include the loss of genetic variation, which is often caused by genetic drift or a bottleneck effect. This process will decrease the ability of a population to respond to environmental changes (Ellstrand 1992, Ellstrand & Elam 1993). The loss of genetic variation is often closely associated with inbreeding depression: more matings between close relatives occur, leading to lower reproductive success (Charlesworth & Charlesworth 1987). Secondly, demographic stochasticity may lead to declining population trends because of a skewed death/birth ratio or age/size distribution within a population (Menges 1990). Thirdly, environmental stochasticity, a sudden change in the habitat of the species, may be a cause of species or population extinction (Boyce 1992).

The reproductive success of orchids may be closely related to genetic and demographic problems in the populations. All the Finnish orchids rely mainly or at least partly on the sexual mode of reproduction. Some genera such as *Dactylorhiza* rely only on sexual reproduction. Allthough there is always a chance of failure in animal pollination, all the Finnish orchids except the selfers *Coralloriza trifida* and *Liparis loeselii* require animal pollinators for their pollination (Korhonen & Vuokko 1987). In contrast, the vegetative mode of reproduction is more prevalent in some species such as *Cypripedium calceolus* and *Goodyera repens*, giving these species more reproductive assuarance (Mehrhoff 1983).

5.4.3 *Reproductive success of Dactylorhiza incarnata*

The orchids are well known for their variable ways of rewarding and also deceiving their pollinators (Dafni 1984, Ackerman 1986). In the Finnish flora there are 11 species which offer no nectar for their pollinators, yet they are pollinated by insects and rely totally on sexual reproduction.

The reproductive success of nectarless *Dactylorhiza incarnata* has been studied in the University of Jyväskylä since 1989. The aims of these studies have been to clarify:

1) the conditions in which the pollination system will function best
2) the importance of pollen quality, quantity and crossing distance to reproductive success
3) the relationship between reproductive success and population persistence.

The results will be first published elsewhere, but the main findings are briefly discussed below.

The study species, *D. incarnata,* is a threatened nectarless orchid adapted to deceive food-foraging behaviour of inexperienced bumble bee workers (Nilsson 1981, Fritz & Nilsson 1994). The fruit set is usually rather low and low reproductive success probably also has some effects on population dynamics and extinctions (Fiedler 1987, Calvo & Horvitz 1990, Calvo 1993).

5.4.4 The hypotheses

There are two contrasting hypotheses concerning the basis of deceptive pollination in populations of nectarless species. The magnet-species theory (Thomson 1978, Ratchke 1983) predicts that nectarless species benefit from growing in the vicinity of a nectar-containing species. On the other hand the remote-habitats hypothesis (Nilsson 1981) predicts that deceptive pollination system will function best in remote habitats, where there are no other attractive species for pollinators.

Many deceptive orchids exploit pollinator foraging behaviour by attracting insects with a variety of dummy signals and nectarless or pollenless structures (Dafni 1984, Ackerman 1986). How this deceptive pollination system has evolved is enigmatic. There are several hypotheses concerning the evolution of deceptive pollination (Nilsson 1992), all of which agree that the lack of pollinator reward reduces pollinator activity and that the reduction in pollinator visitation must be outweight by some other advantages.

One hypothesis for the evolution of deceptive pollination is the greater outcrossing achieved due to the longer flight distances of deceived pollinators between successively visited flowers. This outcrossing-hypothesis emphasizes the importance of pollen quality to reproductive success in deceptive orchids. Another hypothesis for the evolution of deceptive flowers proposes that pollinia allow such a great pollination success from single visits (emphasizing pollen quantity), that no reward for a pollinator is needed. Other hypotheses, which are not discussed here, concentrate on plant density, pollen wastage and costs of reproduction (Nilsson 1992).

5.4.5 How to study reproductive success experimentally

Experimental studies provide several benefits compared to traditional observation studies. Perhaps the most important advantages are the ability to control one or several independent variables and the possibility to obtain results over a shorter period of time.

The effects of co-occurring, nectar-containing species on reproductive success of *D. incarnata* was studied by adding purple-red and light blue, nectar-containing violets (*Viola x wittrockiana*) to three orchid populations. One area served as a control without any addition. During this 3-year experiment the study areas received a different treatment each year. In this way we were able to manipulate the whole pollinator community.

In the two other experiments the effects of pollen quality and quantity on reproductive success were studied by hand-pollination experiments. This kind of experiments can be performed for most of the Finnish orchids. In the first hand-pollination experiment, plants were pollinated by an equal amount of pollen from different crossing distances (autogamy, 20 m, 16 km and also *Dactylorhiza maculata* pollen). All the four pollination treatments were performed within an individual plant. We pollinated 2–3 flowers/plant in random positions of the inflorescence with the same pollen source. About 60 % of the flowers were hand-pollinated to stress the maternal plants equally (see Zimmerman & Pyke 1988).

In the second hand-pollination experiment the effect of the number of pollinia received per flower (half pollinia, two or three pollinia) was studied. In this experiment only one type of treatment was done for each experimental plant. In this and in the previous experiment reproductive success was measured as

1) percentage of fruit set
2) amount of seeds and
3) percentage of seeds with well-developed embryos.

5.4.6 Factors determining reproductive success

The results of the orchid-violet experiment indicated that the deceptive pollination system of *D. incarnata* functions best in remote habitats such as mires, where there are no other concurrently flowering plants attractive to pollinators (Lammi & Kuitunen 1995). Therefore the results supported the remote habitats hypothesis, bacause pollination success was adversely affected by the presence of nectar-containing species. In the experiment the violets drew pollinators away from orchids and the competition for pollinators increased.

The quality of pollen and the crossing distances had no effect on reproductive success in *D. incarnata* and there were no differences between pollination treatments in the number of fruits, the amount of seeds or the proportion of seeds with well-developed embryos (Lammi et al. unpublished data). Therefore our results did not support the outcrossing-hypothesis as an explanation for the evolution of deceptive flowers. However, it is possible that the negative effects of autogamy and inbreeding depression are expressed at later life stages (e.g. seedlings).

The amount of pollen received per flower had an effect on reproductive success, suggesting that the quantity of pollen received is important. This indicates that orchids with pollinia also have the potential for multiple paternity.

5.4.7 *Implications for conservation*

At the community level the pollination success of *D. incarnata* is negatively affected by other co-occurring flowering plant species. Therefore changes in plant species composition in orchid habitats (e.g. after peatland drainage) may have severe consequences for reproductive success and probably also for persistance of populations.

The results of the hand-pollination experiments indicated no evidence for inbreeding or outbreeding depression. It appears that there was no subdivision in the genetic structure of the population or enforced inbreeding for several generations might have eliminated lethal recessive alleles causing inbreeding depression.

On the basis of these studies, the abundance of pollinators and the amount of pollen received appeared to be more important for reproductive success in *D. incarnata* than the genetic quality of pollen received. Management activities should perhaps concentrate more on demographic than genetic stochasticity of the species. Clearly, more research is needed before management recommendations for other orchids can be given.

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Participants of the seminar and excursion in 1996

Aulikki Alanen: The Finnish Environment Institute, Nature and Land Use Division, P.O. Box 140, FIN-00251 Helsinki, Finland
Tel. +358 9 4030 0738, fax +358 9 4030 0791, e-mail: aulikki.alanen@vyh.fi

Kaija Eisto: The Finnish Forest and Park Service, Eastern Finland Park Area, P.O. Box 28, FIN-87701 Lieksa, Finland
Tel. +358 13 520 5600, fax +358 13 520 5701, e-mail: kaija.eisto@metsa.fi

Anne Jäkäläniemi: The Finnish Forest and Park Service, Ostrobothnia Park Area, Torangintaival 2, FIN-93600 Kuusamo, Finland
Tel. +358 8 852 3241, fax +358 8 852 2422, e-mail: anne.jakalaniemi@metsa.fi

Heidi Kaipiainen: The Finnish Environment Institute, Nature and Land Use Division, P.O. Box 140, FIN-00251 Helsinki, Finland
Tel. +358 9 4030 0739, fax +358 9 4030 0791, e-mail: heidi.kaipiainen@vyh.fi

Tiina Kanerva: The Finnish Forest and Park Service, Nature Protection Development Unit, P.O. Box 94, FIN-01301 Vantaa, Finland
Tel. +358 9 857 841, fax +358 9 8578 4350, e-mail: tiina.kanerva@metsa.fi

Eija Kemppainen: The Finnish Environment Institute, Nature and Land Use Division, P.O. Box 140, FIN-00251 Helsinki, Finland
Tel. +358 9 4030 0737, fax +358 9 4030 0791, e-mail: eija.kemppainen@vyh.fi

Ülle Kukk: Environmental Protection Institute of South Estonia, Nature Conservation Research Centre, P.O. Box 222, EE2400 Tartu, Estonia
Tel. +372 7 436 385, fax +372 7 436 103, e-mail: ylle@lkuk.tartu.ee

Tiiu Kull: Institute of Botany and Ecology, Tartu University, Riia 181, EE2400 Tartu, Estonia
Tel. +372 7 477172, fax +372 7 38 3013, e-mail: tiiu@zbi.ee

Mart Külvik: Environmental Protection Institute of South Estonia, Nature Conservation Research Centre, P.O. Box 222, EE2400 Tartu, Estonia
Tel. +372 7 436 385, fax +372 7 436 103, e-mail: ylle@lkuk.tartu.ee

Arto Kurtto: Botanical Museum, University of Helsinki, P.O. Box 7 (Unioninkatu 44), FIN-00014 Helsinki
Tel. +358 9 191 8630, fax + 358 9 191 8656, e-mail: arto.kurtto@helsinki.fi

Antti Lammi: Southwest Finland Regional Environment Centre. P.O. Box 47, FIN-20801 Turku. Finland
Tel. +358 2 266 1687, fax +358 2 266 1730, e-mail: antti.lammi@vyh.fi

Sirje Lillemets: Environmental Information Center, Tallinn, Mustamäe tee 33, EE0006, Estonia
Tel. +372 2 527 577, e-mail: sirje@ic.envir.ee
Lahemaa National Park, Lääne-Virumaa, Viitna, EE 2128, Lahemaa Rahvuspark
Tel. +372 32 44675

Sirkka-Liisa Peltonen: The Finnish Environment Institute, Nature and Land Use Division, P.O. Box 140, FIN-00251 Helsinki, Finland
Tel. +358 9 4030 0736, fax +358 9 4030 0791, e-mail: sirkka-liisa.peltonen@vyh.fi

Ülle Püttsepp: Institute of Zoology and Botany, University of Tartu, Riia 181, EE2400 Tartu, Estonia
Tel. + 372 7 428 619, e-mail: ylle@park.tartu.ee

Ülle Reier: Institute of Botany and Zoology, Tartu University, Lai Str.40, EE 2400 Tartu, Estonia
Tel. +372 7 431 370, fax +372 7 477 172, e-mail: reier@park.tartu.ee, reier@madli.ut.ee

Mari Reitalu: Viidumäe Nature Reserve, EE 3335 Lümanda, Saaremaa, Estonia
Tel. & fax +372 45 76 321, e-mail: talvi@viidu.oesel.ee

Terhi Ryttäri: The Finnish Environment Institute, Nature and Land Use Division, P.O. Box 140, FIN-00251 Helsinki, Finland
Tel. +358 9 4030 0736, fax +358 9 4030 0791, e-mail: terhi.ryttari@vyh.fi
The Finnish Forest and Park Service, South Coast Park Area, P.O. Box 94, FIN-01301 Vantaa, Finland
Tel. +358 9 857 841, fax +358 9 8578 4350

Pertti Uotila: Botanical Museum, University of Helsinki, P.O. Box 7 (Unioninkatu 44), FIN-00014 Helsinki
Tel. +358 9 191 8620, fax +358 9 191 8656, e-mail: pertti.uotila@helsinki.fi

Environmental administration in Finland

MINISTRY OF THE ENVIRONMENT
P. O. Box 399
00121 Helsinki
Tel. +358 9 19911
Telefax +358 9 1991 9545

FINNISH ENVIRONMENT INSTITUTE
P. O. Box 140
00251 Helsinki
Tel. +358 9 403 000
Telefax +358 9 4030 0190

Finnish Regional Environment Centres

1 **Lapland Regional Environment Centre**
P. O. Box 8060
96101 Rovaniemi
Tel. +358 16 329 4111
Telefax +358 16 310 340

2 **North Ostrobothnia Regional Environment Centre**
P. O. Box 124
90101 Oulu
Tel. +358 8 315 8300
Telefax +358 8 315 8305

3 **Kainuu Regional Environment Centre**
P. O. Box 115
87101 Kajaani
Tel. +358 8 616 31
Telefax +358 8 616 3629

4 **Central Ostrobothnia Regional Environment Centre**
Torikatu 40
67100 Kokkola
Tel. +358 6 827 9111
Telefax +358 6 827 9237

5 **West Finland Regional Environment Centre**
P. O. Box 262
65101 Vaasa
Tel. +358 6 325 6511
Telefax +358 6 325 6596

* Seinäjoki office
P. O. Box 156
60101 Seinäjoki
Tel. +358 6 325 6511
Telefax +358 6 325 6791

6 **Central Finland Regional Environment Centre**
P. O. Box 110
40101 Jyväskylä
Tel. +358 14 697 211
Telefax +358 14 614 273

7 **North Savo Regional Environment Centre**
P. O. Box 1049
70101 Kuopio
Tel. +358 17 164 411
Telefax +358 17 262 5464

8 **North Karelia Regional Environment Centre**
P. O. Box 69
80101 Joensuu
Tel. +358 13 1411
Telefax +358 13 123 622

9 **South Savo Regional Environment Centre**
Jääkärinkatu 14
50100 Mikkeli
Tel. +358 15 1911
Telefax +358 15 363 915

10 **Southeast Finland Regional Environment Centre**
P. O. Box 1023
45101 Kouvola
Tel. +358 5 7761
Telefax +358 5 371 0893

* Lappeenranta office
Laserkatu 6
53850 Lappeenranta
Tel. +358 5 624 3290
Telefax +358 5 412 0949

11 **Häme Regional Environment Centre**
P. O. Box 131
13101 Hämeenlinna
Tel +358 3 242 0111
Telefax +358 3 242 0500

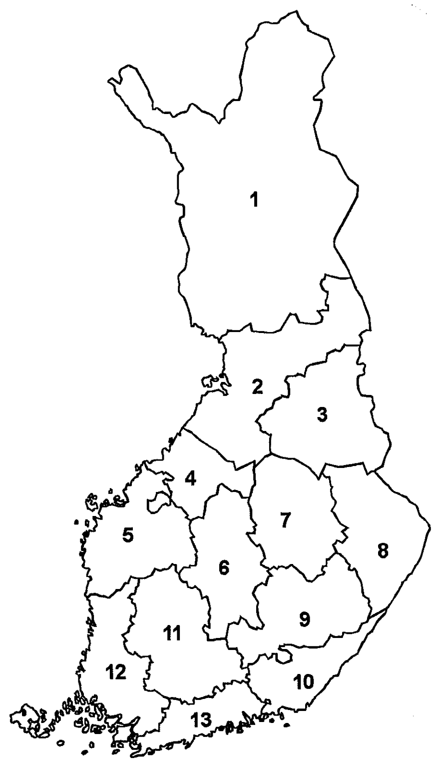
* Tampere office
P. O. Box 297
33101 Tampere
Tel. +358 3 242 0111
Telefax +358 3 242 0266

* Lahti office
P. O. Box 29
15141 Lahti
Tel. +358 3 242 0111
Telefax +358 3 242 0300

12 **Southwest Finland Regional Environment Centre**
P. O. Box 47
20801 Turku
Tel. +358 2 266 1777
Telefax +358 2 266 1635

* Pori office
Valtakatu 6
28100 Pori
Tel. +358 2 630 0700
Telefax +358 2 630 0730

13 **Uusimaa Regional Environment Centre**
P. O. Box 36
00521 Helsinki
Tel. +358 9 148 881
Telefax +358 9 1488 829



Forest and Park Service, Nature Protection, Park Areas and Offices 1.9.1997

● OSTROBOTHNIA PARK AREA

Metsähallitus
Uusikatu 53
P.O. Box 81
FIN-90101 OULU
Tel. + 358 8 886 6600
Telefax + 358 8 886 6670

● **Metsähallitus**
Torangintaival 2
FIN-93601 KUUSAMO
Tel. + 358 8 852 3241
Telefax + 358 8 852 2422

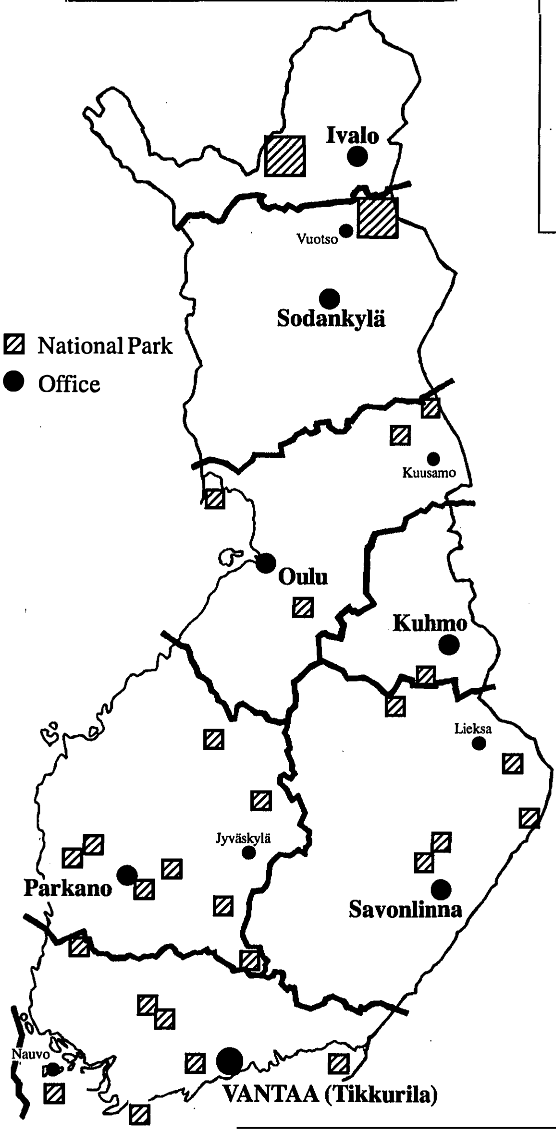
● NORTHERN LAPLAND DISTRICT FOR WILDERNESS MANAGEMENT

Metsähallitus
Ivalontie 10
P.O. Box 36
FIN-99801 IVALO
Tel. + 358 16 687 700
Telefax + 358 16 662 648

● NORTHERN FINLAND PARK AREA

Metsähallitus
P.O. Box 57
FIN-99601 SODANKYLÄ
Tel. + 358 16 6191
Telefax + 358 16 611 060

● **Metsähallitus**
FIN-99690 VUOTSO
Tel. + 358 16 626 241
Telefax + 358 16 626 255



● WESTERN FINLAND PARK AREA

Metsähallitus
Satakunnankatu 25
P.O. Box 38
FIN-39701 PARKANO
Tel. + 358 3 448 1821
Telefax + 358 3 448 1642

● **Metsähallitus**
Tellervonkatu 5
P.O. Box 36
FIN-40101 JYVÄSKYLÄ
Tel. + 358 14 654 111
Telefax + 358 14 654 152

● KAINUU PARK AREA

Metsähallitus
Tönölä
FIN-88900 KUHMO
Tel. + 358 8 877 6390
Telefax + 358 8 877 6391

● SOUTH COAST PARK AREA

Metsähallitus
Vernissakatu 4
P.O. Box 94
FIN-01301 VANTAA
Tel. + 358 9 857 841
Telefax + 358 9 8578 4350

● **Metsähallitus**
Virastokeskus
FIN-21660 NAUVO
Tel. + 358 2 465 1860
Telefax + 358 2 465 1861

● EASTERN FINLAND PARK AREA

Metsähallitus
Akselinkatu 8
P.O. Box 28
FIN-57131 SAVONLINNA
Tel. + 358 15 576 810
Telefax + 358 15 514 064

● **Metsähallitus**
Urheilukatu 3 A
P.O. Box 28
FIN-81701 LIEKSA
Tel. + 358 13 520 5600
Telefax + 358 13 520 5601

● NATURE PROTECTION DEVELOPMENT UNIT

Metsähallitus
Vernissakatu 4
P.O. Box 94
FIN-01301 VANTAA
Tel. + 358 9 857 841
Telefax + 358 9 8578 4349

● NATURE PROTECTION CENTRAL UNIT

Metsähallitus
Vernissakatu 4
P.O. Box 94
FIN-01301 VANTAA
Tel.+ 358 9 857 841
Telefax + 358 9 8578 4350

Environmental Administration in Estonia

MINISTRY OF THE ENVIRONMENT
Toompuiestee 24,
EE0100 Tallinn,
Tel. +372 6262 802
Telefax +372 6262 801

ENVIRONMENT INFORMATION CENTRE
Mustamäe tee 33,
EE0013 Tallinn,
Tel. +372 6564 151
Telefax +372 6564 071

Environmental Departments of the County Governments

Harju County Environmental Department
Viljandi mnt. 16,
EE0103 Tallinn
Tel. +372 2 771 237

Hiiu County Environmental Department
Kõrgessaare mnt. 18,
EE3200 Kärdla,
Tel. +372 46 91 663
Telefax +372 46 91 030

Ida–Viru County Environmental Department
Pargi 15,
EE2045 Jõhvi,
Tel. +372 33 22 485
Telefax +372 33 70 272

Järva County Environmental Department
Wiedemanni 13,
EE2810 Türi,
Tel. +372 38 57 115
Telefax +372 38 57 118

Lääne County Environmental Department
Kiltsi tee 12,
EE3170 Haapsalu,
Tel. +372 47 44 255
Telefax +372 47 44 958

Lääne–Viru County Environmental Department
Kreutzwaldi 5a,
EE2100 rakvere,
Tel. +372 32 43 096
Telefax +372 32 23 464

Põlva County Environmental Department
Apteegi 14,
EE2611 Räpina,
Tel. +372 79 62 000
Telefax +372 79 95 481

Pärnu County Environmental Department
P.Kerese 4,
EE3600 Pärnu,
Tel. +372 44 31447
Telefax +372 44 31448

Rapla County Environmental Department
Tallinna mnt. 14,
EE3500 Rapla,
Tel. +372 48 55 807
Telefax +372 48 55 672

Saare County Environmental Department
Lossipargi 1, p/k 224
EE3300 Kuressaare,
Tel. +372 45 59751
Telefax +372 45 59854

Tallinn City Environmental Department
Harju 13,
EE0001 Tallinn,
Tel. +372 6313 204
Telefax +372 6313 204

Tartu County Environmental Department
Akadeemia 4,
EE2400 Tartu,
Tel. +372 7 430 017
Telefax +372 7 430 017

Valga County Environmental Department
Kesk 12,
EE2500 Valga,
Tel. +372 76 43 907
Telefax +372 76 61 021

Viljandi County Environmental Department
Vabaduse plats 2,
EE2900 Viljandi,
Tel. +372 43 33 461
Telefax +372 43 33 461

Võru County Environmental Department
Karja 17a,
EE2710 Võru,
Tel. +372 78 23 841
Telefax +372 78 23 605

Protected areas in Estonia
(with Administrations)

ALAM-PEDJA NATURE RESERVE *	Pk. 404, EE-2400 TARTU	
	Contact:	EINAR TAMMUR
	Phone:	+372-7-428 149
via "Kotkas"	NMT:	+372-5-255 929
	Fax:	+372-7-428 166
ENDLA NATURE RESERVE *	Pk. 726-5, EE-2350 KURISTA, Jõgevamaa	
	Director:	ÄRNI KUUSIK
	Phone:	+372-77-45 339
	Deputy Dir.:	KAI KIMMEL
	NMT:	+372-5-253 555
	Fax:	+372-77-45 339
HAANJA NATURE PARK *	Pk. 37, EE-2710 VÕRU	
	Director:	MATI KIVISTIK
	Phone:	+372-78-29 090
HIIUMAA ISLETS LANDSCAPE RESERVE *	Salinõmme, EE-3211 SUUREMÕISA sj.,Hiiumaa	
	Director:	ANDRES MILLER
	Phone:	+372-46-94 299
	E-mail:	andres@laiud.hiiumaa.ee
KARULA NATIONAL PARK *	Ähijärve, EE-2723 HAABSAARE sj., Võrumaa	
	Director:	PILLE TOMSON
	Phone:	+372-78-52 456
	NMT:	+372-5-251 552
	NMT:	+372-5-251 247
	Fax:	+372-78-52 456
KÕRVEMAA LANDSCAPE RESERVE *	Pärnu 75, EE-2820 PAIDE	
	Director:	IVER ASAROV
	Phone:	+372-38-53 139
LAHEMAA NATIONAL PARK ***	EE-2128 VIITNA, Lääne-Virumaa	
	Director:	ARNE KAASIK
	NMT:	+372-5-238 577
	Deputy Dir.:	TEET KOITJÄRV
	Phones:	+372-32-23 640 +372-32-44 675
	Visitor Centre:	+372-32-34 196
	Fax:	+372-32-44 575
	E-mail:	ekal@estpak.ee

WEST-ESTONIAN ARCHIPELAGO BIOSPHERE RESERVE HIIUMAA CENTRE *

Vabrikuväljak 1, EE-3200 KÄRDLA

Director:	RUUBEN POST
Phone:	+372-46-96 276
E-mail:	ruuben@bka.hiiumaa.ee
Deputy Dir.:	TOOMAS KOKOVKIN
Phone:	+372-46-96 269
E-mail:	toomas@bka.hiiumaa.ee
Phone:	+372-46-96 260
Fax:	+372-46-96 269
URL:	http://www.hiiumaa.ee/bka/

WEST-ESTONIAN ARCHIPELAGO BIOSPHERE RESERVE LÄÄNEMAA CENTRE *

Kiltsi tee 12, EE-3170 HAAPSALU

Director:	ANDRES KALAMEES
Phone:	+372-47-57 593
Fax:	+372-47-57 593
E-mail:	bka@webs.ee

WEST-ESTONIAN ARCHIPELAGO BIOSPHERE RESERVE SAAREMAA CENTRE *

Ringtee 15, EE-3300 KURESSAARE

Director:	MART HERMAN
Phone:	+372-45-57 768
GSM (cellular):	+372-50-91 521
Phone of specialists:	+372-45-55 862
Fax:	+372-45-55 863
E-mail:	bka@biosph.oesel.ee

MATSALU NATURE RESERVE *

EE-3190 LIHULA, Läänemaa

Director:	TAIVO KASTEPÕLD
Phone:	+372-47-78 413
Deputy Dir.:	ALEKSEI LOTMAN
Phone:	+372-47-78 124
Fax:	+372-47-78 413
E-mail:	matsalu@webs.ee

NIGULA NATURE RESERVE *

Pärnu 2, EE-3622 KILINGI-NÕMME, Pärnumaa

Director:	ENN VILBASTE
Phone:	+372-44-91 664
NMT:	+372-25-245 891
Deputy Dir.:	AGU LEIVITS
Phone:	+372-44-92 470
Fax:	+372-44-92 470
E-mail:	agu@nigula.tartu.ee
URL:	http://www.loodus.ee/nigula/

OTEPÄÄ FORESTRY - NATURE PARK *

Kolga tee 28, EE-2513 OTEPÄÄ, Valgamaa

Forester:	ENE VAHTER
Phone:	+372-76-55284
Deputy For.:	TARMO EVESTUS
Phone:	+372-76-55 876
Fax:	+372-76-55 876
E-kiri:	otemets@estpak.ee

PANDIVERE HYDROLOGICAL RESERVE *
via Environmental Department of the Lääne-Viru County Admin.

Kreutzwaldi 5a, EE-2100 RAKVERE

Contact:	JAAK JÜRGENSON
Phone:	+372-32-40 396
Fax:	+372-32-23 464
E-kiri:	jaak@lvimkko.envir.ee

REBALA HISTORICAL-CULTURAL RESERVE *

EE-3003 JÕELÄHTME, Harjumaa

Director:	MARGIT PÄRTEL
Phone:	+372-2-723 897

SOOMAA NATIONAL PARK *

Pargi 2, EE-2900 VILJANDI

Director:	TÕNU KÜTT
Phone:	+372-43-49 022
Fax:	+372-43-49 022
E-mail:	tonu@soomaa.vil.ee
URL:	http://www.vil.ee/esoomaa/

VIIDUMÄE NATURE RESERVE *

Viidu, EE-3335 LÜMANDA sj., Saaremaa

Director:	MARI REITALU
Phone:	+372-45-76 321
Deputy Dir.:	TÕNU TALVI
Phone:	+372-45-76 462
E-mail:	talvi@viidu.oesel.ee

VILSANDI NATIONAL PARK *

EE-3334 KIHELKONNA, Saaremaa

Director:	ARVO KULLAPERE
NMT:	+372-5-241 235
Deputy Dir.:	ANDRES JÕEORG
Info:	+372-45-76 554
Biostation:	+372-45-23 007
Monitoring:	+372-45-23 012
Fax:	+372-45-76 554

UNION OF PROTECTED AREAS OF ESTONIA (EKAL)	EE-2128 VIITNA, Lääne-Virumaa, ESTONIA	
	Chair of Council:	ARNE KAASIK
	NMT:	+372-5-238 577
	Secretary:	TEET KOITJÄRV
	Phone:	+372-32-44 675
	Fax:	+372-32-44 575
	E-mail:	ekal@estpak.ee
	URL:	http://www.estpak.ee/~ekal/

ASSOCIATION OF BALTIC NATIONAL PARKS (ABNP)	EE-2128 VIITNA, Lääne-Virumaa, ESTONIA	
	Secretary:	TEET KOITJÄRV
	Phone:	+372-32-44 675
	Fax:	+372-32-44 575
	E-mail:	ekal@estpak.ee
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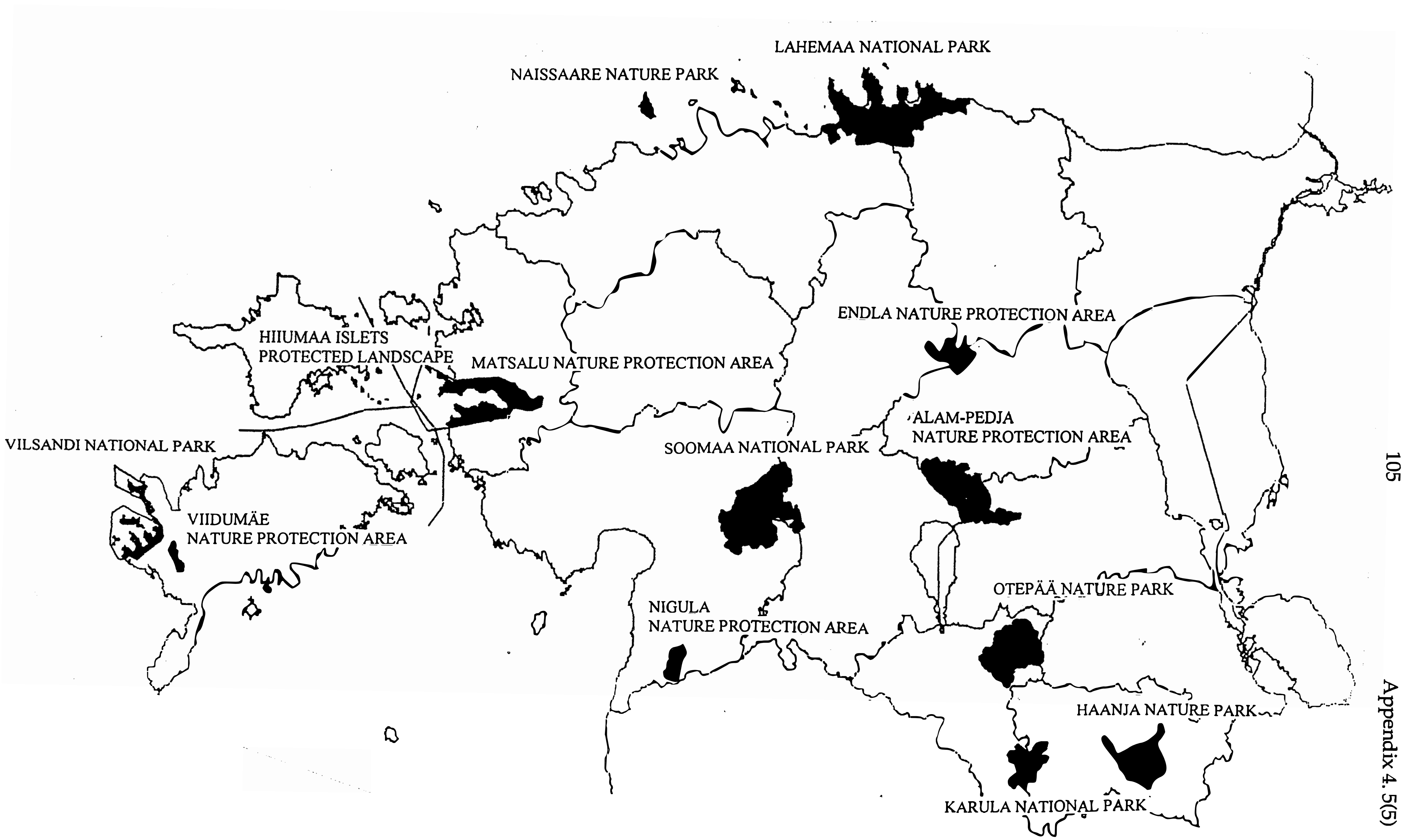

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