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Contents

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Evaluation of the Finnish National Biodiversity Action Plan 1997–2005

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The results of the evaluation of the Finnish National Biodiversity Action Plan 1997–2005 indicate clear changes towards better consideration of biodiversity in the routines and policies of many sectors of the administration and economy. There are many indications that actors across society have recognized the need to safeguard biodiversity and have begun to adjust their practices accordingly. Several concrete measures have been undertaken in forests, agricultural habitats and in other habitats significantly affected by human activities. Biodiversity research has expanded significantly and the knowledge of Finland's biological diversity has increased. In general, the Action Plan has supported public discussion of the need to safeguard biodiversity and this discussion has resulted in more positive attitudes towards nature conservation.

So far, however, the implemented measures have not been sufficiently numerous or efficient to stop the depletion of original biological diversity. Many habitats remain far from their original state. More species will become endangered in the immediate future unless more effective and far-reaching measures are taken. The objective of the EU to halt the decline of biodiversity by 2010 will not be achieved given the current development. Although the deterioration in biodiversity may have slowed down in several cases, many economic activities continue to have a negative impact on biodiversity. The scale of these activities is normally greater than that of the measures taken to manage and restore biodiversity.

The evaluation focused on detecting changes in the administration of key sectors, analysing the recent development of biodiversity and observing interlinkages between these two. The analysis of administrative measures was based on interviews and on examining policy documents, reports and other relevant literature. The analysis covered changes in the administration of nature conservation, forestry, agriculture, land use and regional and development cooperation. The analysis of the development of biodiversity was based on employing 75 pressure, state, impact and response indicators. There were 5 to 15 indicators for each of the nine major habitat types of Finland.

Three separate case studies were made to provide further insights into some key issues: 1) A GIS-analysis was made of the development of land use patterns in North Karelia and south-west Finland between 1990 and 2000, 2) two scenarios on the development of forest structure in North Karelia until 2050 were developed using a special MELA-model and 3) the cost-effectiveness of the agri-environmental support scheme was examined by comparing different land allocation choices and their effects on biodiversity on an average farm in southern Finland. The evaluation also paid special attention to the role of research in safeguarding biodiversity and reflected Finnish experiences against an international background.

Keywords: Biodiversity, evaluation, action plan, environment, habitats, endangered species, indicators, policies, actions, administration, nature conservation, research

1 Introduction

The Finnish National Biodiversity Action Plan 1997–2005 was drawn up by the Commission for Biological Diversity, which operated under the Ministry of the Environment in 1996–1997. The Commission was composed of representatives of ministries, key business sectors, research institutes, environmental organisations and other interest groups. The Finnish National Biodiversity Action Plan 1997–2005 (henceforth the Action Plan) was drafted to fulfil the Finnish Government's Decision-in-Principle of 21.12.1995 and Finland's obligations under the UN Convention on Biological Diversity. The Action Plan included specific measures to be taken in various economic sectors, as well as measures for more cross-cutting activities such as research and monitoring.

The main objectives of the Action Plan were:

1. to preserve viable populations of native species (maintaining their favourable conservation status)
2. to safeguard the diversity of ecosystems and the contiguity of natural habitat types in Finland's biogeographical regions
3. to promote the sustainable use of natural resources and economic opportunities related to the utilisation of biodiversity (employment and enterprise)
4. to improve Finland's international activities in relation to biodiversity

A total of 124 proposals for various measures were drawn up towards these ends. In 1998 the Ministry of the Environment set up a Monitoring Group to follow up the implementation of the Action Plan. The Monitoring Group operated until end of 2005.

To support the coming revision of the Action Plan, in February 2004 the Ministries of the Environment, Agriculture and Forestry, Transport and Communications, and Foreign Affairs jointly commissioned a major evaluation of the impacts of the Action Plan on biodiversity in Finland. The evaluation has been conducted by a team of researchers drawn from the Finnish Environment Institute (SYKE), the University of Helsinki, the Finnish Forest Research Institute, and MTT Agrifood Research Finland, focusing on four wide-ranging and interrelated questions:

- What is the current state of biodiversity in Finland, and what trends have occurred during the implementation period of the Action Plan?
- What parts have the Action Plan and its measures played in these trends, and how effective has the Action Plan been in terms of safeguarding biodiversity in Finland?
- What have been the other environmental and social consequences of the Action Plan and its measures?
- What is the probable development of biodiversity in Finland to 2010, and what kinds of measures could be adopted to safeguard biodiversity in view of this development?

The evaluation was published in October 2005 (Hildén et al. 2005). A cross-sectoral working group started work on a new Action Plan for 2006–2016 in late 2005. The major findings of the evaluation were available to the working group already in the spring of 2005, prior to the evaluation's final publication. The evaluation provided background information for the environmental assessment of the new plan. The environmental assessment of policies, plans and programmes is mandatory in Finland since the enactment of the SEA Act (2004). The basis for a new Action Plan, in the form of a Decision in Principle on a strategy for the protection and sustainable use of biodiversity, was adopted by Council of State 21 December 2006. A new Action Plan with specific measures is due to be completed by the end of 2007.

This document is an extended English summary of the original assessment publication (Hildén et al. 2005). It contains all the major parts of the analysis included in the original publication, although in a much-condensed format. In addition, this report outlines how the key findings and methodological approaches fit into a broader international perspective.

2 Evaluation methods

The evaluation of such a wide-ranging policy programme as the Action Plan necessitates the simultaneous application of several different approaches (Scriven 1999, Hildén et al. 2002). Therefore, we used methods and material from both natural and social sciences. The most important methods and source materials are presented in the following sections.

One of the goals of the evaluation was to present a comprehensive overview of the state of biodiversity in Finland and to identify, according to the DPSIR-framework (see below), the most likely mechanisms causing its change. We sought to analyse how and why the individual measures of the Action Plan have affected or may affect biodiversity in the future. However, due to insufficient knowledge, exact causal relationships could be specified only in a limited number of cases. Furthermore, many factors outside the scope of the Action Plan have had an effect on biodiversity and many measures taken before the Action Plan have continued to influence biodiversity during the Action Plan period.

2.1 DPSIR-framework

As a general approach, this evaluation utilised the DPSIR-framework applied by e.g. the European Environment Agency (Smeets and Weterings 1999). According to DPSIR, broad societal background forces (drivers, D) result in extraction of natural resources, various land uses or emission of harmful substances (pressures, P). These pressures affect different components of biodiversity (state, S), which in turn have various further consequences (impacts, I) such as the decline of threatened and vulnerable species. In a growing number of cases conscious actions (responses, R) are being taken to redress the negative development.

Using the DPSIR-framework requires a broad outlook and forces one to focus attention on the observed or alleged causal relationships driving biodiversity change. In an ideal case the framework allows a rather comprehensive account of causes and consequences. For example, in Finland the development affecting coastal meadows could be described as follows:

Structural changes in agriculture, changes in the Common Agricultural Policy (CAP), general economic and political developments (drivers)

- → cessation or restart of grazing on coastal meadows (pressures)
- → degree of overgrowth of coastal meadows (state)
- → population trends of species associated with open coastal meadows (impact)[1]
- → management of important wetlands and traditional rural biotopes, including special criteria in the EU agri-environmental support scheme (response)

[1] The division of different variables/factors into driver, pressure, state, impact and response indicators is often ambiguous. For example, the population trends of different species can also be used as state indicators.

In many cases, the available knowledge was not sufficient to specify and verify causal chains in detail. Despite this, we considered that using the DPSIR-framework was well justified as it directed attention to policy-relevant issues and also disclosed where the most serious deficiencies in knowledge lie.

The overall goal of the Action Plan has been to abate negative pressures on biodiversity, to increase efforts aimed at safeguarding the diversity of habitats and species as well as to slow down and reverse the decline of populations of endangered species. The task set for this evaluation was to assess how well these goals have been reached. This included assessing the state and development of biodiversity in Finland as well as the effects that the National Action Plan have had on it.

2.2 Impacts and impact mechanisms of the Action Plan

A number of criteria were identified to support the analysis of different measures and groups of measures listed in the Action Plan (Table 1). These criteria were chosen so as to shed light on the different aspects of the implementation and impacts of the measures. Besides allowing for a more detailed analysis of the impact mechanisms, the criteria also helped in discerning the role that the measures had as a part of the whole spectrum of biodiversity conservation-oriented policies.

2.3 Methods used in the evaluation of the state and change of biodiversity

The evaluation of the state and change of biodiversity was based on a collection of indicators (Table 2). Altogether 75 different pressure, state, impact and response indicators were developed for the purposes of this evaluation. The indicators followed the DPSIR-framework, and were organized according to nine main habitat types (see Section 2.3.1). Although we sought to generate as many relevant indicators for each habitat type as possible, the amount of available information limited the choice of indicators in many cases. For example, it turned out to be rather difficult to identify indicators for some habitats such as shores and urban habitats. The response (R) indicators listed in Table 2 mostly describe immediate actions taken to safeguard species and habitats such

Table 1. Criteria used for assessing the impacts and impact mechanisms of the different measures.

Criteria	Interpretation and remarks
Relevance	Has the measure affected a substantial part of biodiversity? Was the part of biodiversity affected previously under threat?
Impact	Has the measure had an impact on biodiversity? Has it had any other impacts? Since in many cases there is a substantial time lag between a measure and its impacts, it may be difficult to evaluate the impacts quantitatively.
Effectiveness	Have the impacts been in accordance with goals both on a short and a long term? Besides local impacts, the action should also have resulted in regional and national impacts.
Cost-effective-ness	Has the input turned into results effectively, i.e. at what cost have practices changed? Due to lack of infor-mation, a comprehensive economic analysis is not possible. Nevertheless, some broad outlines can be sketched out.
Acceptability	Have the actors accepted the measure, or has the measure increased conflicts related to biodiversity man-agement?
Incentive value	Has the measure encouraged further development of management practices or helped in finding new means to maintain biodiversity?
Transparency and opportunities for participation	Have the different actors been able to follow the planning and execution of the measure? Has the measure provided opportunities for taking part in biodiversity management and encouraged public debate on biodi-versity change?
Equity	Has the balance between the costs and benefits of the measure been favourable? Have the costs and benefits been distributed equitably and so that general principles such as the constitutional protection of property and polluter-pays principle have been followed?
Flexibility	Has the implementation of the measure allowed for changes in circumstances?
Predictability	Have the actors been able to predict the consequences of the measure? Have the actors been able to adjust to them?
Permanence	Has the measure resulted in permanent changes or do the changes require continuous inputs?

as the establishment of new protected areas and habitat restoration. The more general and less readily quantifiable responses are described for each sector in Sections 3 and 4.

2.3.1 Changes in the extent and quality of habitats

The extent, quality and rate of change of different habitats play a decisive role in maintaining biodiversity. For this evaluation we divided the Finnish landscape into nine main habitat types: forests, mires, Baltic Sea, inland waters, farmlands, alpine habitats (fells), urban and transport areas, shores and rocky habitats and eskers. These habitat types correspond to the habitat types used in the previous Finnish Red List assessments (Rassi et al. 1986, 1992, 2001) and cover the whole country. Depending on the habitat, their state and change was assessed using 5 to 15 habitat-specific indicators (Table 2).

In terms of statistical data, the most significant information sources have been the Finnish National Forest Inventory (NFI), the Information Centre of the Ministry of Agriculture and Forestry in Finland (TIKE) and the water quality databases maintained by SYKE. Of the research data the information produced by the biodiversity research projects FIBRE and MOSSE (see Section 5.3) as well as a monitoring study examining the effects of the Finnish agri-enviroment support scheme (MYTVAS) stand out in particular. More than 100 experts from SYKE and other Finnish research institutions, governmental organisation and NGOs have been interviewed on different subjects related to the state and change of habitats. Drafts of the report were made available for public commenting (see Section 2.5).

2.3.2 Case study: land use changes

Changes of land use and land cover classes between 1990 and 2000 were determined using satellite images and GIS data. The purpose of the study was to identify large-scale land use changes as well as to evaluate the usefulness of the analysis for biodiversity monitoring. There were two study areas: the southwest coast between Turku and the Porkkala peninsula covering

Table 2. Set of 75 indicators used in assessing the state and change of biodiversity.

■ = pressure, ○ = state, ● = impact, □ = response

Forests

■	FO 1.	Total amount of roundwood removals
■	FO 2.	Total amount of log removals
■	FO 3.	Area of clear fellings
■	FO 4.	Area of soil preparation in regeneration areas
■	FO 5.	Area of artificial forest regeneration
■	FO 6.	Area of prescribed burning
■	FO 7.	Amount of construction of forest roads
○	FO 8.	Amount of dead wood
□	FO 9.	Nature management in commercial forests
○	FO 10.	Level of fragmentation
○	FO 11.	Age structure and species composition of tree stands
□	FO 12.	Area of protected forests
□	FO 13.	Area of restored forests
●	FO 14.	Status of red-listed forest species
●	FO 15.	Status of forest species listed in the EU Habitats and Birds Directives

Mires

■	MI 1.	Use of mires for forestry
■	MI 2.	Use of mires for peat extraction
■	MI 3.	Other uses of mires
○	MI 4.	Level of fragmentation and edge quality
□	MI 5.	Area of protected mires
□	MI 6.	Area of restored mires
●	MI 7.	Status of red-listed mire species
●	MI 8.	Status of mire species listed in the EU Habitats and Birds Directives

Baltic Sea

■	BS 1.	Nutrient loads and concentrations
○	BS 2.	Concentration of chlorophyll-*a*
○	BS 3.	Area of anoxic bottoms
■	BS 4.	Harmful substances
■	BS 5.	Amount of sea traffic and oil transportation
□	BS 6.	Area of protected sea areas
●	BS 7.	Status of red-listed marine species
●	BS 8.	Status of marine species listed in the EU Habitats and Birds Directives

Inland waters

■	IW 1.	Nitrogen load and concentration
■	IW 2.	Phosphorus load and concentration
■	IW 3.	Loading of organic matter
■	IW 4.	Acidification and harmful substances
■	IW 5.	Extent of regulated watercourses
□	IW 6.	Area of protected inland waters
●	IW 7.	Status of red-listed inland water species
●	IW 8.	Status of inland water species listed in the EU Habitats and Birds Directives

Farmlands

■	FA 1.	Number of active farms and their average arable area
■	FA 2.	Number of livestock and cattle farms
■	FA 3.	Amount of pesticides and fertilizers used
■	FA 4.	Area of clearance and reforestation of fields
○	FA 5.	Area of field margins and buffer strips
○	FA 6.	Amount of traditional rural biotopes
□	FA 7.	Extent of management of traditional rural biotopes
□	FA 8.	Area under organic farming
●	FA 9.	Populations of selected farmland species
●	FA 10.	Status of red-listed farmland species
●	FA 11.	Status of farmland species listed in the EU Habitats and Birds Directives

Alpine habitats (fells)

■	AL 1.	Size of reindeer herds
○	AL 2.	Quality of lichen pastures
■	AL 3.	Total amount of tourism
■	AL 4.	Number of snowmobiles and other off-road vehicles in northern Lapland
○	AL 5.	State of wilderness areas
○	AL 6.	Extent of palsa mires
●	AL 7.	Populations of selected alpine species
●	AL 8.	Status of red-listed alpine species
●	AL 9.	Status of alpine species listed in the EU Habitats and Birds Directives

Urban and transport areas

○	UA 1.	Extent of population centres and number of people living in them
○	UA 2.	Land use in population centres and cities
□	UA 3.	Area of national urban parks and protected areas in the biggest cities
●	UA 4.	Status of red-listed urban species
●	UA 5.	Status of urban species listed in the EU Habitats and Birds Directives

Shores

■	SH 1.	Proportion of shoreline used for building
○	SH 2.	Changes in onshore vegetation communities
□	SH 3.	Area of protected shores
●	SH 4.	Status of red-listed shore species
●	SH 5.	Status of shore species listed in the EU Habitats and Birds Directives

Rocky habitats and eskers

■	RE 1.	Extent of mining activities
■	RE 2.	Amount of soil extraction
■	RE 3.	Other uses of rocky habitats and eskers
□	RE 4.	Area of protected rocky habitats and eskers
●	RE 5.	Status of red-listed rocky habitat and esker species
●	RE 6.	Status of rocky habitat and esker species listed in the EU Habitats and Birds Directives

approximately 13 400 km^2 and the province of North Karelia covering approximately 16 600 km^2.

Satellite images were used to identify changes in land cover and GIS data in land use. The land cover and land use classes used in the study were based on the first level of the CORINE classification system (Table 3). Landsat 5 Thematic Mapper images were used for the early 1990s (southwest coast 1989, North Karelia 1992) and Landsat 7 Enhanced Thematic Mapper images of the Finnish IMAGE2000 mosaic for 1999–2002. The images were orthorectified (Härmä et al. 2004) and atmospheric correction was performed using software developed by VTT Technical Research Centre of Finland (Parmes et al. 2004). The spatial resolution of the satellite images was 30 x 30 metres, but these were subsampled to a 25 x 25 metres grid, which was also used by GIS data. The analysis of urban areas was based on information contained in the Building and Dwelling Register, which had been produced by the Finnish Population Register Centre (Mikkola et al. 1999). GIS data on agricultural fields of the early 1990s was based on 1:20 000 topographic maps. Their mapping had been performed during 1965–1989 in North Karelia and 1963–1991 along the southwest coast. Agricultural fields for the early 2000s were based on the Field Parcel Registry of 1999 (Mikkola et al. 1999).

First, land cover and use classifications were created for the years 2000 and 1990. Then, changes in land cover and use were identified by comparing satellite images from different dates. Change detection was performed using the AutoChange program developed by VTT (Häme et. al 2001). Each of the potentially changed areas revealed by the analysis was then studied more closely using the created classifications. If the class of the potentially changed area was same in both classifications, the area was considered unchanged. If there were changes in classes, the type of change was determined according to classifications. Changes affecting areas smaller than 0.5 hectares were excluded from the data.

2.3.3 Case study: scenarios on the development forest structure

Changes in forest structure are often slow and many of the effects of the Action Plan cannot yet be detected. Therefore future changes in the forests of North Karelia were estimated using the MELA-model, a forest planning tool developed by the Finnish Forest Research Institute (Siitonen et al. 1996, Redsven et al. 2004). Two different scenarios were studied. According to the first scenario (A), the annual targets for logging removals set in the Regional Forest Programme for 2001–2005 would be met until 2050. According to the second scenario (B), logging removals would be in accordance with the Regional Forest Programme between 2001 and 2010, after which the maximum sustainable allowable cut would be removed.

The simulation was based on data acquired from the 9th National Forest Inventory (NFI9). The MELA-model produced several alternative management and development schedules, from which an optimizing program (Lappi 1992) selected the one that maximised the net present value while fulfilling the given removal targets. The models for natural processes employed in the simulation are documented mainly in Hynynen et al. 2002. The simulation of loggings and other forestry practices was in accordance with the recommendations given by the Forestry Development Centre Tapio (2001).

Stand structure was used as a measure of biodiversity, and the effects of different logging practices on stand structure were analysed. The amount of dead

Table 3. First and second level CORINE land use classes (Härmä et al. 2005)

1. Artificial surfaces	3. Forests and semi-natural areas
1.1 Urban fabric	3.1 Forests
1.2 Industrial, commercial and transport units	3.3 Open spaces with little or no vegetation
1.3 Mine, dump and construction sites	3.2 Shrub and/or herbaceous vegetation associations
1.4 Artificial, non-agricultural vegetated areas	4. Wetlands
2. Agricultural areas	4.1 Inland wetlands
2.1 Arable land	4.2 Coastal wetlands
2.2 Permanent crops	5. Water bodies
2.3 Pastures	5.1 Continental waters
2.4 Heterogeneous agricultural areas	5.2 Marine waters

wood at the beginning of the simulation period was estimated according to the measurements made in the NFI9. Only dead trees, both standing and fallen, with a minimum diameter 10 cm at a height of 1.3 m from the bottom of the stem and a minimum height or length of 1.3 m were included in the NFI dead wood statistics. Furthermore, the volume of dead trees was estimated only for the part of the stem with a minimum diameter of 10 cm.

In the MELA simulations the volume of dead trees was estimated somewhat differently from NFI9. In general, the volume consisted of logging residue and dead wood produced by natural mortality. The dead wood estimate included the total volume of all the tree trunks (minimum DBH 10 cm) produced by natural mortality during the simulation period. It also included tree tops of all the harvested trees with a minimum DBH 10 cm prior to their cutting and the volume of cut trees which were left in the forest and of which DBH was at least 10 cm. It was assumed that 2% of the stem volume of dead pines and spruces and 3% of the stem volume of dead birches dissipated annually due to decay (cf. Harmon et al. 2000, Tarasov and Birdsey 2001). The development of living and dead trees was estimated separately for managed and protected forests.

The change of the volume of the dead wood (%/year and m^3/ha/year) was estimated for the calculation period. The change was considered as a constant during the calculation period. The percentage change was estimated using the formula

$$i = ((y/x)^{(1/n)}-1)*100$$

where
i = change of the volume of dead wood (%/year)
y = volume of dead wood in the year 2050
x = volume of dead wood in the year 2000
n = duration of the calculation period

Sensitivity analyses were carried out to study the effect of the underestimation of dead wood volume in the NFI data.

2.3.4 Changes in the status of red-listed species

Of the approximately 50 000 species estimated to occur in Finland, some 44 000 are known at the moment. For this evaluation 19 962 species (45% of the known species) could be assigned to their primary habitat. These relatively well known species are all native to the country. In many cases, assigning a species to a habitat may prove difficult. Many species occur in two or more habitats, and, for example, their foraging habitat may be different from the habitat in which they breed. In these cases the breeding habitat was chosen to be their primary habitat. The classification was made by experts involved in the Red List assessments led by the Ministry of the Environment.

A forecast of the population changes of red-listed species was made for the year 2010 as an expert judgement. The forecast was based on the previous Red List assessments from 1990 and 2000 (Rassi et al. 1992, 2001) and recently collected data. In most cases it rested on an assumption that, in the absence of additional measures, the current trends would continue unchanged until 2010. Due to changes in the IUCN criteria in assessing the status of threatened species, different Red List categories were in use in the 1990 assessment than in the 2000 assessment. For this reason the 1990 assessment using mostly qualitative criteria is not completely comparable with the latter one, which uses quantitative criteria.

The total number and numbers of red-listed species in different habitats in 1990, 2000 and 2010 were compared with the total number of known species and their numbers in different habitats. For a closer examination of the red-listed species in 2000 and 2010, species groups for which data were already sufficient in 2000 were separated from the rest. These so-called well-known species groups consisted of vertebrates, molluscs, butterflies and moths, beetles, vascular plants, bryophytes, fungi and lichens.

All the examined species groups were approximately divided into declining, increasing and stable groups. Habitats that harbour a great amount of endangered species or for which the recent development has been particularly negative or positive were also identified.

2.3.5 Population trends of species listed in the EU Habitats and Birds Directives

The population trends of a number of species listed in the Annexes II and IV to the Habitats Directive and Annex I to the Birds Directive of the European Union were examined to assess, among other things, how well the pan-European responsibility for the protection of species had been met during the Action Plan period. Altogether 79 species of the Habitats Directive (vascular plants, mosses and insects) and 62 species of the Birds Directive were examined. Changes in the populations and distribution of these species were examined for two periods: the 20th century before the Action Plan period (1900–1996) and the Action Plan period 1997–2005. The assessment was carried out by experts from the Finnish Environment Institute and, in the case of birds, also from BirdLife Finland and the Finnish Museum of Natural History.

2.4 Methods used in the evaluation of biodiversity policies

2.4.1 Examined sectors

Along with general development objectives, the Action Plan listed more specific measures for nine different sectors of administration and the economy at large. These were forestry, rural areas and agriculture, transport and urban infrastructure, fisheries, mining, use of water resources, game management and hunting, reindeer husbandry and national defence. In addition to these, there were also measures on more cross-sectoral issues such as in situ and ex situ conservation, education, research and regional and development cooperation (for a complete list of the 124 measures listed in the Action Plan see www.ymparisto.fi/download.asp?contentid=34801&lan=en.) This evaluation employs a slightly different categorisation and contains a closer inspection of the changes in the administration of five key sectors: nature conservation, forestry, agriculture, land use as well as regional and development cooperation (section 3.1)[2]. Issues related to research are discussed separately in Section 5.3.

Two approaches were chosen to examine the effects of the different measures. On the one hand, we considered the actions as measures that have been deliberately designed to change existing or to create new practices. According to the DPSIR-framework we asked how well the actions have succeeded in reducing harmful pressures and in supporting the maintenance of species and habitats. On the other hand, the measures were analysed inductively so that we tried to identify the most important operational changes in different sectors without considering whether they were a result of the Action Plan or not (Patton 1996).

The examination of the implementation and effects of the Action Plan's measures was based mainly on policy documents, reports and literature, specific regional interviews and, in the case of forestry, other available interview data. In addition, we also examined budgetary information. The interviews were made at regional Forest Centres, farming and fishery departments of the regional Employment and Economic Development Centres (T&E Centres), the Finnish Road Administration's regional departments, Regional Councils as well as Regional Environment Centres. These organisations are the central agents in implementing biodiversity-related policies in their respective sectors. All interviews were made in the two case-study areas: southwest coast and North Karelia (see also Section 2.3.2). The 12 interviewees, 6 in each case-study area, were administrators with specific biodiversity conservation responsibilities in their organisations.

The interviewees were given the general topics of the interview in advance. These were: the role of biodiversity in the organisation's operations, goals regarding the maintenance of biodiversity, biodiversity competencies and networking with other organisations. Additional sector-specific issues were also tackled in some cases. The interviews ranged between one and two hours. They were transcribed and analysed with NVivo software (Richards and Richards 1994).

For the examination of the forest sector, two additional previously made sets of interviews were analysed. These interviews made with representatives of the METSO Forest Biodiversity Programme for Southern Finland's Collaborative Network[3] (2003) and Häme-Uusimaa region forestry service providers (2004) provided further insights into backgrounds, goals, actions, skills and communication related to biodiversity management. The interviewees in these cases also included actors outside the regional administration: representatives of Forest Management Associations, educational institutions, Forest Owners' Associations, environmental NGOs and forest industry.

2.4.2 Case study: Cost-effectiveness of the agri-environmental support scheme

Biodiversity policies related to the agri-environmental support scheme carry considerable economic

[2] Besides these five sectors the original evaluation publication (Hildén et al. 2005) included an assessment of the transport and fisheries sectors. These, however, have been omitted from this summary.

[3] For information on the METSO Forest Biodiversity Programme for Southern Finland see wwwb.mmm.fi/metso/international and Section 4.1.

importance. Because of the scope of the issue, a separate analysis of their effects was carried out. In compliance with EU regulations, Finland has had an agri-environmental support scheme in operation since the country joined the EU in 1995. For the first support period emphasis was on issues related to water quality, but since the second period started in 2000, biodiversity has gained importance.

Previous studies have focused on the direct biodiversity effects of the measures included in the agri-environmental support scheme. This analysis focused rather on the incentives provided by the support scheme and the cost-effectiveness of the programme. Farmers' decisions regarding land allocation and cultivation practices are influenced not only by the agri-environmental subsidies, but also by agricultural income support. This analysis acknowledged the joint effects of the two support schemes.

The following questions were addressed:

- Does the agri-environmental support scheme provide incentives for farmers to adopt measures that benefit the maintenance of biodiversity?
- What is the joint effect of agri-environmental subsidies and agricultural income support – do they complement or work against one another?
- Does the agri-environmental support scheme promote the safeguarding of biodiversity cost-effectively?

The evaluation of the agri-environmental support scheme's effects on biodiversity was based on the results of the recent studies carried out in this field (Koikkalainen and Lankoski 2004, Kuussaari et al. 2004, Puurunen 2004, Pyykkönen et al. 2004). The main sources of economic information were the annual statistics produced by the Information Centre of the Ministry of Agriculture and Forestry in Finland (TIKE), the Ministry of Agriculture and Forestry's publications on different financial support schemes as well as related scientific articles produced by MTT Agrifood Research Finland and SYKE.

The environmental and economic performance of the policy measures was evaluated by examining a statistically representative (average) crop farm in southern Finland. The analysis included the crops typically cultivated in the area as well as those measures of the agri-environment scheme which have previously been shown to be beneficial for biodiversity. Attention was paid to farmers' decision making and the incentives provided by environmental and income support measures. In particular, decisions concerning the allocation of land between different crops and the intensity of fertiliser use were analysed taking into account the combined effects of environmental and other subsidies.

2.4.3 The role of research

One of the aims of the evaluation was to clarify the role of research data in biodiversity conservation. Have the accumulated research data advanced biodiversity conservation? Has the amount of available data increased, where do the possible factual deficiencies lie, and on which issues should we focus our research efforts in the future? On the whole, the goal was to evaluate whether the actors have taken advantage of research data more than previously and if so, how has this been manifested in practise and how has it influenced biodiversity conservation.

The study on the role of research in safeguarding biodiversity took advantage of several different approaches and source materials. The main methodological approach was grounded theory, which was used to structure, represent and interpret different meanings and materials (Tuomi and Sarajärvi 2003).

Source material was collected by four different means:

1) A workshop between researchers and end-users of research knowledge was organised April 24th 2004 in Helsinki. Altogether approximately 70 persons took part in the workshop, of whom half were researchers and half end-users. The participants were divided into six groups and given 1.5 hours to answer a set of questions. Afterwards the groups re-united and the results were discussed amongst all the participants. The results presented in this study are based on the minutes from both the different groups' discussions and the common end discussion.
2) Personal questionnaires were handed out at the abovementioned workshop and sent by e-mail to some 200 researchers and information end-users afterwards. Altogether 70 answers were received, including 37 answers from researchers and 33 from information end-users.
3) Existing literature such as the evaluation of the effectiveness of the Finnish Biodiversity Research project, FIBRE (Otronen and Tirkkonen 2002), was also studied. The results of the review on the research section of the European Biodiversity Strategy (EPBRS 2004) were compared with the results of this study.

4) Additional comments were received by e-mail and in several discussions at different biodiversity-related meetings.

2.4.4 Biodiversity in regional and development cooperation

The study on the integration of biodiversity issues into regional and development cooperation was based on written documents and interviews. In the case of regional cooperation, the study drew upon publications and reports by the Ministry of the Environment and Metsähallitus (the Finnish Forest and Park Service) as well as on detailed information received from SYKE and the Friendship Park Research Centre in Kuhmo. For development cooperation, the annual reports of the Finnish development cooperation from 1997 to 2003 were studied alongside other relevant publications (e.g. Ministry for Foreign Affairs of Finland 2002, 2004). Officials from the Ministry for Foreign Affairs and the Ministry of the Environment involved in the programmes were interviewed in semi-structured theme interviews in which the interviewees were given the themes of the discussion beforehand, but the exact form and order of the questions was not decided in advance (Wengraf 2002).

2.5 Public participation

Unresolved conceptual issues are abundant in biodiversity conservation. Furthermore, the willingness to protect biodiversity depends on people's values, which often also reflect their material interests. For this reason the evaluation project included, from the beginning, opportunities for different interest groups to participate and comment on the evaluation work. The main venues were a project kick-off seminar (March 2nd 2004), a workshop on the role of research in safeguarding biodiversity (April 24th 2004), a national seminar on nature conservation (September 7th 2004), a stakeholder hearing organised specifically for this evaluation (December 3rd 2004) and the meetings of the supervising committee for implementation of the National Action Plan for Biodiversity (January 12th 2004 and March 11th 2004).

A draft of the evaluation document was made available online March 4th 2005 on the web pages of LUMONET, the Finnish clearinghouse mechanism for the Convention on Biodiversity (www.environment.fi/lumonet). The public had an opportunity to comment on the draft until March 22nd. The opportunity to comment was advertised by e-mail to approximately 200 people who had previously participated in the general debate on the conservation of biodiversity in Finland. A press release concerning the opportunity to comment was also released. Comments were received from 23 persons or organisations and they averaged 1–2 pages in length (maximum 8 pages). All comments were distributed and discussed amongst the evaluation group and many of them resulted in revisions of the evaluation document.

3 Overview of the Action Plan and its consequences for administration

The Finnish National Biodiversity Action Plan follows the principle promoted by the Convention of Biological Diversity according to which all sectors of society should take responsibility for the integration of biodiversity issues into their everyday agenda. The Action Plan contains 124 different proposals for action. Of these, 10 are general development objectives concerning all sectors of administration, trade and industry, 3 concern legislative reforms and the remaining 111 deal with sector-specific development tasks. The first two of the general development objectives describe the founding principles of the Action Plan aptly:

1. All sectors of administration, trade and industry undertake to promote, as best they can, the conservation and sustainable use of biological diversity within their respective spheres of activity. The conservation of biodiversity should ideally become an integral part of their routine operations.
2. All sectors of administration, trade and industry will assess the impact of their actions and decisions on biological diversity and monitor the implementation of their internal strategies, any specific targets pertaining to the maintenance of biodiversity, and the efficacy of measures taken to this end.

Because of the crosscutting and all-embracing nature of the general principles, all development bearing consequences on biodiversity that has taken place after 1997 could, in a sense, be considered as resulting from the Action Plan. For this evaluation, however, the 111 sector-specific development tasks were more relevant than the general development objectives because they describe in more detail how the objectives of the Action Plans can be reached

Table 4. The number and content of the measures listed for the six key sectors discussed in this evaluation. For a complete list of measures see www.ymparisto.fi/download.asp?contentid=34801&lan=en.

Sector	Total number of Actions	Focus of Actions	Proportion of Actions
Nature conservation	39	• increasing basic knowledge of biodiversity in Finland • developing present practices of nature conservation, including assessment of the existing network of nature conservation areas, and securing funding for the implementation of existing programmes for nature conservation • developing Finland's international role in biodiversity conservation. • setting conditions for the use of biodiversity e.g. by developing operational registries	1/3 1/4 1/4 1/10
Forestry	10	• decreasing forestry-generated pressures on biodiversity • developing legislation, planning, environmental programs, certification etc. • increasing knowledge about the effects of different management practices	2/3 2/3 1/3
Rural areas and agriculture	17	• decreasing risks from genetically modified organisms • securing the preservation of the genetic diversity of cultivated and domesticated species	1/3 1/3
Transport and urban infrastructure	5	• developing planning and management practices	4/5
International cooperation	27	• supporting and strengthening the work of international organisations and conventions • ensuring that development cooperation projects have beneficial consequences for biodiversity • strengthening arctic and Nordic cooperation	1/5 1/5 1/5
Research*	6	• advancing applied biodiversity research	2/3

* Discussed in Section 5.3

in various sections of society. These development tasks represent the practical issues in case of which progress can be evaluated. The following section gives a brief outline of the sector-specific development tasks (measures) listed in the Action Plan and describes how they have affected the everyday functioning of some sectors of the administration.

3.1 Changes in the administration of key sectors

Altogether 72 measures were related to the sectors chosen for a closer inspection, amounting to almost two thirds of all the sector-specific actions listed in the Action Plan (Table 4). Many of the measures within a sector have a similar focus. These foci are listed in the third column of Table 4.

3.1.1 Nature conservation

According to the interviews carried out in the Regional Environment Centres of the North Karelia and Uusimaa districts, nature conservation efforts during the Action Plan period were mainly focused on implementing national nature conservation programmes[4], surveying and delineating habitats listed in the Nature Conservation Act as well as participating in land use planning. Different districts also had their own regional focal species, such as the white-backed woodpecker (*Dendrocopos leucotos*) and eastern nemoral plant species in North Karelia, the conservation of which was their special responsibility. The goals of the Centres' activities were set in a hierarchical fashion through targets defined by the Ministry of the Environment and in their budgetary allocations. According to the interviews, these goals had sometimes been impossible to achieve with the allocated resources but various forms of project funding (e.g. EU`s LIFE-programme) had been applied for to cover budgetary deficits.

The most important practical tool for the Regional Environment Centres was the GIS-based species and habitats database shared by the entire nature conser-

[4] During the Action Plan period there were seven ongoing national nature conservation programmes in Finland, namely a programme for national parks and strict nature reserves as well as programmes for the conservation of mires, waterfowl wetlands, glacifluvial esker formations, shorelines, herb-rich forests and old-growth forests.

vation administration. However, despite its central role, the database was not updated systematically. Some data existed only in miscellaneous folders and was added to the database gradually by project-based labour. Communication and information exchange between Regional Environment Centres and other administration was active on the whole, but some individual problems did occur. For example, some Regional Forestry Centres received updates automatically, whereas others did not acquire up-to-date data at all.

As the implementation of the national nature conservation programmes is now approaching completion, the marginal cost of each additional conservation area will be increasingly high, i.e. as long as the remaining areas are smaller in size, their conservation is relatively more resource intensive. No strategic evaluation of the costs and effects of a full implementation of the programmes has been made. It remains unclear whether traditional policies based almost exclusively on pre-designated conservation areas are the most effective. If the goal is to safeguard biodiversity in more extensive areas, attempts to reduce pressures on biodiversity could be a more feasible strategy.

3.1.2 Forestry

During the Action Plan period, a number of institutional changes took place in the forestry sector. The renewal of the Forest Act in 1996 was followed by the drafting of the National Forest Programme in 1998 and the Regional Forest Programmes in 2000. These programmes, while mainly focusing on promoting forestry and forest sector production, also included targets for securing a favourable conservation status of forest habitats and species. As a part of the National Forest Programme, the METSO Forest Biodiversity Programme for Southern Finland was launched in 2002 (see Section 4.1). Other changes that occurred during the Action Plan period included the inventory of Forest Act habitats (1996–2004) as well as the launching (1997) and further development (2000–2003) of a nationally comprehensive forest certification scheme, the Finnish Forest Certification System (FFCS).

The forestry sector has an elaborate institutionalized policy guidance system, which was originally created to support timber production in privately owned lands (60% of forest land). Its operation rests on the simultaneous use of planning and extension as well as on providing financial support for forestry operations. From the 1990s onwards biodiversity targets were integrated with forestry targets, and significant investment in competencies took place. The management guidelines for privately owned forests were renewed in 2001 and 2006 (Forestry Development Centre Tapio 2001, 2006) and more than 6 000 professionals from the sector were trained in nature management between 1997 and 2004. In general, professionals in the sector assess their capabilities to safeguard forest biodiversity as being very good (Wolf and Primmer 2006).

The interviewed forestry service providers from the Häme-Uusimaa district had positive conceptions of the progress in competencies and practices to date. Almost all felt that the maintenance of significant characteristics of forests was now either at a higher level, or had at least remained on the same level as before. This was considered to be due to increased knowledge, which had resulted in better ability to avoid mistakes in management. In a similar fashion, professionals involved in the implementation of the METSO programme regarded increasing knowledge of the significance of biodiversity as the most important factor behind recent progress in biodiversity conservation. In addition, they underlined the role of the METSO programme, new management guidelines, forest certification and the attitudes of their own organisational personnel as other important influencing factors.

3.1.3 Agriculture

The majority of the measures listed for agriculture were related to agricultural production, particularly to the opportunities and risks of genetically modified organisms and the maintenance of genetic resources. Only two of the 17 measures dealt directly with non-domesticated species and farmland habitats. One concerned the agri-environmental support scheme and was stated in rather general terms: the countryside should be kept active and farmland biodiversity maintained and promoted by means of effective support measures. This measure proved to be central, since during the Action Plan period agri-environmental support measures became the main focus of policies concerned with farmland habitats. The other measure dealing with non-domesticated biodiversity concerned the management of valuable traditional rural biotopes. The active management of traditional rural biotopes was organised mainly by means of special contracts of the agri-environmental support scheme, although some valuable sites outside active farms were also managed by governmental and non-governmental organisations.

The interviews made at the district Employment and Economic Development Centres (T&E Centres) highlighted the central role of the agri-environmental support scheme in framing and directing biodiversity-related activities. The most important means by which the T&E Centres furthered the maintenance of farmland biodiversity were the special support contracts within the scheme. In terms of biodiversity, the most important measures included in these contracts were establishing buffer zones between fields and water bodies, constructing small-scale wetlands, managing traditional rural biotopes, promoting agricultural biodiversity and shifting over to organic framing. However, the Centres did not actively promote these contracts but the approach was rather demand-driven. Although the staff of the T&E Centres dealing with biodiversity issues participated in training programmes, no specialised biodiversity training was provided. Biodiversity conservation had not gained a position in the core of the T&E centres' activities and strategies.

3.1.4 Land use

National land use targets in Finland include targets for maintaining valuable nature areas and securing ecological connections between them. These objectives direct the drafting of regional plans, which, in turn, pass the objectives into land use planning at the municipal level. The regional plans are the central means of directing land use on a wider landscape level. Both municipalities and regional environment centres participate in their preparation process.

The two case-study areas, Uusimaa and North Karelia, differ greatly in terms of their degree of urbanization, industrial and business structure as well as the characteristics of natural landscapes. The regional plan of Uusimaa (Regional Council of Uusimaa 2004) attempts to accommodate intensifying land use pressures and growing population numbers while still maintaining a functionally intact network of green areas. The assessments made of the impacts of the plan on biodiversity maintain that, while the plan does not significantly threaten the preservation of Natura 2000 areas, for example, some parts of the planned ecological network may be jeopardised by the sprawl of infrastructure (Regional Council of Uusimaa 2003, Väre 2003). In the regional plan of North Karelia biodiversity issues have been approached as a part of sustainable development and the corresponding section of the plan concentrates on the sustainable use of natural resources (Regional Council of North Karelia 2003).

The interviews made at regional councils revealed that the political nature of the planning process limited the possibilities to use regional plans as effective means of land use planning. The practical interpretation of the national objectives remained somewhat vague. Safeguarding of biodiversity was further hindered by the status of the issue as a secondary goal. Primary goals such as the development of enterprises were politically easier to argue for. On the local scale municipalities were rather independent in land use planning. Therefore there was great diversity in their actions due to e.g. available resources, management traditions and local political climates.

3.1.5 Regional and development cooperation

The Action Plan lists altogether 27 measures dealing with international cooperation. Almost half of these involve Finland participating in some general biodiversity policy forum as a member of the international community. The implementation and effectiveness of such measures is difficult to evaluate since the task may have been formally fulfilled merely by participating in respective meetings. In general, Finland's role in the international fora has been rather passive except for forest-related issues, in which Finland has significantly assisted the forest work programme of the Convention on Biological Diversity.

The interviews of government professionals revealed that biodiversity was often difficult to integrate with poverty alleviation targets. In development cooperation the safeguarding of biodiversity was normally dealt with as a part of the normal project assessment process and the projects' effects on biodiversity were not evaluated separately. The staff of the Ministry of Foreign Affairs did not have environmental training and the entire ministry had only one employee whose job description featured biodiversity issues. Access to additional information on the subject depended on the officials' individual activity and resources.

In multilateral development cooperation Finland financed the Global Environment Facility (GEF), World Bank and the United Nations Environment

Programme (UNEP) and participated in different UN decision-making bodies. The financing given to UN organisations went to their general budgets and was not directed in detail. The main partner nations in Finland's bilateral development cooperation projects were Ethiopia, Kenya, Tanzania, Zambia, Mozambique, Namibia, South-Africa, Nepal, Vietnam and Nicaragua. Of the total 300 million euros used for bilateral development cooperation between 1997 and 2003, slightly over 3% was allocated to projects in which biodiversity conservation was a primary goal. Other environmental projects with biodiversity as a partial goal received an additional 23%. Recently the most important biodiversity-related development projects have included the preparation of a Programme for the Sustainable Use of Biodiversity in the Peruvian Amazon and a Mountain Forest Protection Programme in East-Usambara, Tanzania. (Massa and Einola-Head 2004.)

The main target areas for biodiversity-related regional cooperation were northeast Russia and the Baltic countries. The cooperation in these areas also provided benefits to Finland: especially the decisions regarding forestry and nature conservation in Russia were relevant to the whole northern taiga ecosystem. The funding for the most important cooperation programme between Finland and Russia, the Finnish-Russian Development Programme on Sustainable Forest Management and Conservation of Biological Diversity in Northwest Russia, was c. 2.3 million euros at the time of this assessment. The programme aims at extending the network of protected areas, promoting nature tourism and education as well as supporting Russian biodiversity research and the publication of its results. The cooperation has yielded considerable results including the establishment of the Kalevala National Park and, in general, the introduction of biodiversity issues into the forest debate in Russia (Silfverberg and Alhojärvi 2004).

During the Action Plan period Finland assisted the Baltic countries in joining the EU. Due to EU requirements this has consequentially advanced the integration of conservation targets into these countries' general development targets. Cooperation with the Baltic countries in which biodiversity was explicitly addressed, concentrated on implementation of the Natura 2000 Network and the harmonisation of legislation with that of the EU (Ministry of the Environment 2001). The total funding for environmental regional cooperation between Finland and the Baltic countries between 1991 and 2002 was 57 million euros, but most of the projects funded had some other primary focus than biodiversity.

4 Impacts on biodiversity

In this section observations arising from the examination of the measures taken in key sectors (Section 3) as well as the indicator-based examination of the state and change of biodiversity[5] are brought together. We present a condensed outline of the recent development of biodiversity in Finland together with an account of the Action Plan's most important impacts. The assessments have been organised according to different habitats beginning from the most extensive in area (forests) and ending with least extensive (rocky habitats and eskers).

4.1 Forests

Forests are the most common and species-rich habitat type in Finland and therefore central to the maintenance of biodiversity. Forests on mineral soils cover 36% of the total area of Finland[6] (49% of land area) and harbour 42% of all well-known species. Changes in forest biodiversity normally develop over long time spans. Even in managed commercial forests the rotation cycle from planting to regeneration felling averages 60–120 years depending on the forest type and geographical location. The Action Plan period has therefore been much too short to demonstrate marked changes, for example, in stand structures, species compositions, degree of fragmentation etc. Many management measures which were initiated in the 1950s, continue to affect forest biodiversity today.

The biggest threat to Finnish forest biodiversity is commercial forestry. For the past five to six decades relatively strong measures have been employed in order to increase timber production, which has remained by far the most economically profitable use of forest land. For example, during the past 30 years one fourth of the total area of managed forests has been subject to either clear cutting or seed tree

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[5] Not included in full in this edition. All indicators are described in the original assessment publication (Hildén et al. 2005).

[6] The total area of Finland includes inland waters and the Finnish Exclusive Economic Zone of the Baltic Sea.

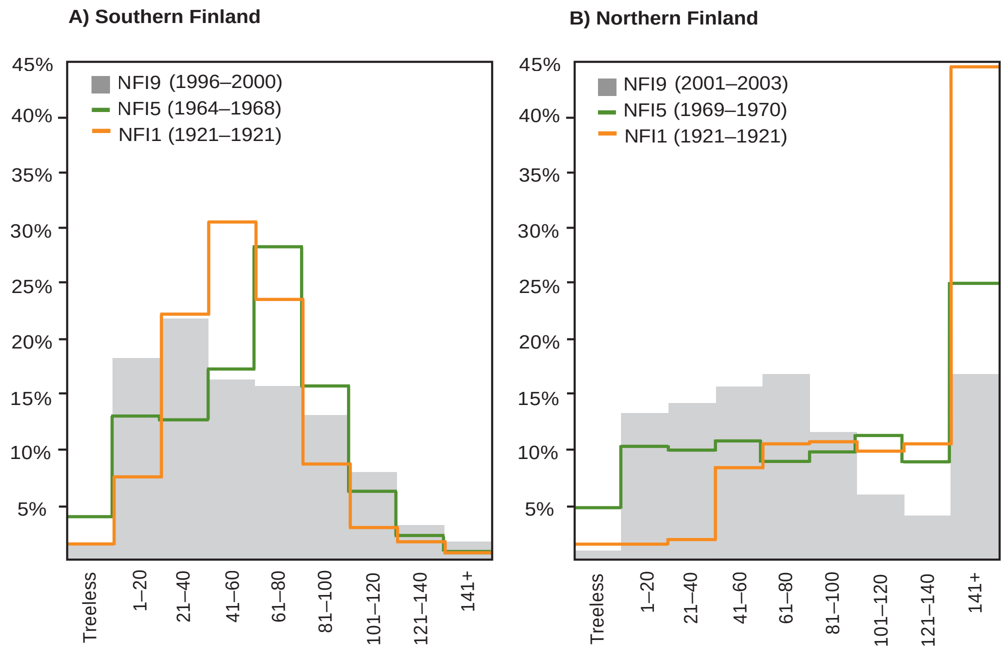

Fig. 1. The development of forest age class distribution in southern and northern Finland according to three National Forest Inventories 1921–2005. The distribution has shifted towards younger cohorts in the whole country. In northern Finland the amount old-growth forests has halved since the 1920s. In the southern part of the country old-growth forests were already scarce in the 1920s mainly due to intensive slash-and-burn cultivation.

and shelterwood fellings. During the same period the soils of three quarters of this area have been ploughed or otherwise scarified (Peltola 2004). If these practices continue with the same intensity they will affect almost the whole area of managed forests within one rotation cycle.

Although forestry in Finland is based on the use of domestic tree species and nowadays also on the maintenance of partly mixed forests, forest management has greatly diminished the natural variability of forest structure (Kuuluvainen 2002, Kuuluvainen et al. 2004). Managed forest stands (95% of forest land) tend to be even-aged and have very small amounts of dead and decaying wood.[7] Together with fragmentation, the decline of dead wood and other features of natural forests has been one of the main reasons for some 560 forest species having become endangered in Finland (Rassi et al. 2001). Another historically important reason has been the clearance of herb-rich forests for agriculture in earlier centuries. Herb-rich forests remain a hotspot for forest biodiversity with almost one third of all well-known forest species and only one percent of the total area of forests on mineral soils.

Regarding forestry practices and biodiversity management, many changes have taken place during the Action Plan period. In state-owned lands (26% of forest land) natural resource planning and ecological landscape planning have been applied for the whole area. These have advanced the identification and safeguarding of valuable biotopes and introduced new practices such as maintenance of connectivity. New ambitious goals for the amount of dead wood in state-owned forests have also been set and new guidelines for management practices composed (Heinonen et al. 2004).

In lands owned by private citizens and forest companies (69% of forest land) the survey of key forests biotopes has increased environmental awareness and furthered the conservation of some small-scale habitats. Key biotopes found in the survey cover approximately 0.5% of all privately owned forestry

[7] Often less than 5 m^3/ha, whereas natural forests have 50–120 m^3/ha depending on forest type and location (Siitonen 2001)

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• intensified use of natural resources • high profitability of timber production compared to other possible land uses • the historical clearance of farm-land continues to affect forest biodiversity in southern Finland • growth of timber stock exceeds exploitation; this provides opportunities for conservation • implementation of uniform forestry practices on most forested land has continued • continuing conflicts between forestry and reindeer herding	• continuing decline in species associated with natural forest features, especially decaying wood • continuing decline in herb-rich woodlands valuable for biodiversity, although this trend may have slowed down • continuing habitat loss and fragmentation of old-growth forests in southern Finland	• expansion of protected areas, especially in northern Finland • identification and survey of key biotopes in managed forests • natural resource planning and landscape ecological planning for state-owned lands and habitat restoration in protected areas; in privately owned forests these measures are difficult to implement • gradual changes in forestry practices, e.g. lighter soil preparation methods, reduced construction of new forest roads, maintenance of key biotopes • new measures for biodiversity conservation are being tested in privately owned lands as a part of the METSO programme • a considerable amount of new monitoring and research data has become available; biodiversity-related parameters have been included in the NFI • the FFCS forest certification has been applied to almost all privately owned lands

land (Yrjönen 2004). The Finnish Forest Certification System (FFCS)[8] was introduced in 1997 and today covers more than 95% of privately owned forests. However, the certification standards have not been very demanding with respect to biodiversity conservation and the FFCS certification scheme has been criticized as insufficient from an ecological viewpoint.

The area of protected forests has increased especially in the north. The deficiencies in the network of protected forest in the southern part of the country have been acknowledged (Etelä-Suomen… 2000), but new protected areas are difficult to establish due to fragmented private landownership, high value of land and prioritisation of timber production over other uses of forest land. A particular METSO Forest Biodiversity Programme for Southern Finland was launched in 2003 (wwwb.mmm.fi/metso/international) in order to advance biodiversity management in managed forests as well as restoration, research and monitoring in protected areas. The METSO programme also included pilot projects, in which several new approaches to forest protection based on voluntary commitment by private landowners were tested during 2003–2006. The new approaches included nature values trading and competitive tendering, which result mainly in temporary protection contracts for 10 or 20 years at a time. New forms of collaborative efforts were also initiated. Four regional collaborative networks consisting of various combinations of organizations were established with the aim of concentrating conservation efforts and strengthening cooperation (Primmer and Keinonen 2006).

Locally driven implementations and voluntary contracts proved popular among landowners (Primmer and Keinonen 2006, Mönkkönen and Primmer 2006). The main challenge related to the type of voluntary protection initiated by the METSO programme lies in the contradiction between conservation aims and the fixed term condition of the contracts. Whereas short-term contracts serve for conserving some of the more dynamic forest characteristics, many of the targeted features typically require decades to develop (Mönkkönen and Primmer 2006). According to the evaluation of the programme, the conditions of the contracts need to be further developed, and connectivity between protected areas requires special attention in the future (Syrjänen et al. 2006).

[8] In Finland the FFCS certification (http://www.ffcs-finland.org/pages/english/current-situation.ph) is dominant. The FSC certification covers only a small proportion of forest land and the Finnish FSC standard (http://www.fsc-finland.org/fsc.htm) has only recently (June 2006) been approved by the FSC.

Box 1. Scenarios on the development forest structure

In order to analyse the effects of management guidelines (Forestry Development Centre Tapio 2001) on the future characteristics of Finnish forests, the development of forests in North Karelia during the next 50 years was estimated with the aid of the MELA model (Siitonen et al. 1996, Redsven et al. 2004). Two different logging scenarios were used in the simulation:

A) Logging removals for 2000–2050 as set in the Regional Forest Programme for 2001–2005

B) Logging removals for 2000–2010 as set in the Regional Forest Programme for 2001–2005 and for 2011–2050 according to the maximum sustainable allowable cut.

Both scenarios aimed at the maximisation of net present value and assumed a 4% interest rate. According to the simulation the total volume of living trees in managed forests would increase markedly: by 88% according to scenario A and by 21% according to scenario B (Table 5). The planting of Scots pine (*Pinus sylvestris*) has been particularly common in regeneration areas during recent decades, and thus the volume of pines would more than double in 50 years according to scenario A and increase by 40% according to scenario B. In 50 years there would be more pine-dominated forests than at present. The volume of deciduous trees would increase by 35% according to scenario A, but would decline by 11% according to scenario B. The volume of common aspen (*Populus tremula*) would either stay at the present level (A) or decline by 47% (B).

Table 5. The volumes of living trees in managed forests in North Karelia in the years 2000 (National Forest Inventory, NFI) and 2050 (MELA model).

	Beginning of the calculation period, year 2000 (NFI9)	End of the calculation period, year 2050 (MELA-model)	
		Scenario A	Scenario B
Living trees, million m^3	152.0	285.6	184.9
• Scots Pine (*Pinus sylvestris*)	76.0	185.3	106.2
• Norway Spruce (*Picea abies*)	45.6	59.3	51.5
• deciduous trees	30.4	41.0	27.2

The volume of dead wood in managed forests would increase according to both scenarios (Table 6). This is based on the assumption that all dead wood is left in the forest and not harvested as fire or energy wood nor destroyed or buried in the process of soil preparation in regeneration cuttings and other management practices (for the significance of these practices see e.g. Hautala et al. 2004, Salomäki 2005, Hetemäki et al. 2006, Kurttila and Hänninen 2006). At the beginning of the calculation period 59% of the dead wood on forest land consisted of pine and most of the dead wood would also be pine at the end of the simulation period. According to both scenarios the proportion of birch (*Betula pendula* and *B. pubescens*) of the total volume of dead wood would increase, as would the area of ≥ 120-yr old managed forests.

Table 6. Annual increase of the volume of dead wood (%/year and m3/ha/year) in managed forests in North Karelia during the calculation period.

	Calculation period 2000–2050			
	Scenario A		Scenario B	
Dead wood	%/year*	m^3/ha/year**	%/year*	m^3/ha/year**
≤ 80 years old forests	2.6	0.17	2.0	0.11
> 80 years old forests	1.7	0.20	0.9	0.08

* The total volume of dead wood is underestimated in the year 2000 because the volume of the stem parts less than 10 cm in diameter is excluded from the NFI data. Therefore, the percentage increase of dead wood per year is overestimated in the table. The estimates are too large especially in young stands and recently cut areas. The estimates were 0.1–0.5 percentage units lower if the volume of dead wood was increased by 10–30% in the year 2000.

** The estimates were 0.01–0.03 m^3/ha/year smaller if the volume of dead wood was increased by 10–30% in the year 2000.

In protected forests the volume of living trees would more than double by 2050. The increase would be greatest for aspen and spruce (2.7 and 2.6 fold increase, respectively). The amount of pine-dominated forests would decrease slightly. In protected forests the volume of dead wood would increase 1.8 %/year on forest land during the calculation period.

The scenario A shows that the volume of dead trees in managed forests could increase markedly from the present levels measured by the NFI – 3.5 m^3/ha in younger (≤ 80 years old) forests and around 7.5 m^3/ha in older forests (> 80 years old) – if the management guidelines (Forestry Development Centre Tapio 2001) were followed for the next 50 years. In 2050 there could be enough dead wood (i.e. well above 10 m^3/ha) in the older managed forests to support a more diverse saproxylic species community than at present, yet the habitat criteria of the most demanding species would still be met only in protected areas (see Penttilä 2004). The decay models used in the simulation may give an underestimate of the dissipation rate of dead tree material and thus lead to an overestimate of the amount of remaining dead wood. Mortality models were derived from data which represent only managed forests. Furthermore, the volume of dead trees removed from managed forests is not predicted here. In practice, dead trees in managed forests have alternative uses as commercial energy wood or as domestic firewood. As a result of these factors the volume of dead wood that may be registered by a future ”NFI 2050” is likely to be smaller than predicted by the model, unless additional efforts are made to increase the amount of dead wood.

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4.2 Mires

Mires cover 20% of the total area of the country (28% of the land area) making Finland proportionately the most mire-rich country in the world. Although widespread and common, mires are relatively species-poor environments – only 4% of all well-known species have mires as their primary habitat. However, especially many forest species are also found on mires. A considerable proportion of the species (18%) for which Finland has a special responsibility within the EU are mire species.

Altogether over 60% of the original mire area has been used for forestry, agriculture and peat extraction or has fallen under hydropower reservoirs and infrastructure (Vasander 1996, Peltola 2004). The disappearance of natural mires has been particularly pronounced in southern Finland, where currently nearly 80% of the original mire area has been drained to allow for greater forest growth. Before modern

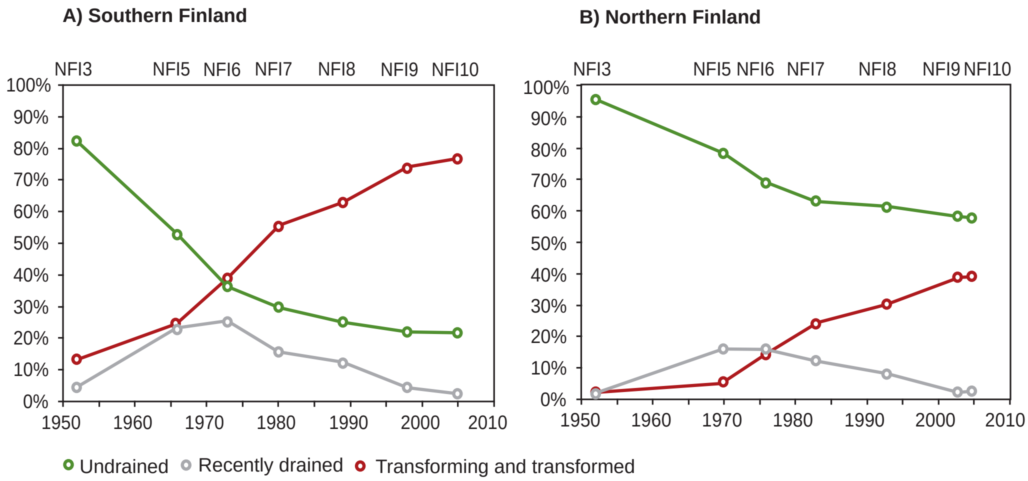

Fig. 2. The draining of mires in southern and northern Finland according to the 3rd and 5th–9th National Forest Inventories 1951–2003. In southern Finland the decline of undrained mires has been particularly dramatic, but in the northern part of the country almost 40% of mires have also been drained. The decline of recently drained mires by NFI9 indicates the slowing down of new draining activities.

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• intensified use of natural resources: wooded mires are largely managed as forests • attempts to make mire habitats more productive: especially drainage for timber production → emphasis recently on ditch clearing and supplementary drainage • peat extraction continues to exert local and regional pressures	• many species in decline, especially species of nutrient-rich mires • mire habitats have declined and become fragmented especially in southern Finland; this process is, however, slowing down • adverse successional changes on drained mires continue • natural features of wooded mires (e.g. dead wood) have continued to decline	• first-time drainage has nearly stopped • protected mire and wetland areas have increased • changes in forest management practices, e.g. survey and maintenance of key biotopes • natural resource planning and landscape ecological planning for State-owned lands include mire areas • habitat restoration has begun in protected areas

forestry practices a substantial part of mires (approximately 0.7 million hectares) were converted into arable land (Myllys and Sinkkonen 2004, Vasander 2006). This affected especially the most nutrient-rich habitats such as rich fens, which today amount to less than 2% of the total mire area.

During the Action Plan period a major change has taken place in relation to the use of mires: the drainage of pristine mires was largely given up in 2001. In the absence of large-scale construction projects (e.g. hydropower reservoirs) the total area of natural mires can be expected to remain almost stable for the first time in decades, if not centuries. In forestry, emphasis has recently been put on ditch clearing and supplementary ditching. Without these practices part of the drained mires would gradually regain their original water balance and vegetation. The average annual amount of ditch clearing and supplementary ditching during the Action Plan period was 77 00 hectares (Peltola 2004).

In protected areas almost 12 000 hectares of drained mires have been restored between 1997 and 2005. This represents almost half of the estimated need for restoration (Ennallistamistyöryhmä 2003, Hokkanen et al. 2005). The network of protected mires is relatively extensive and representative, especially in the northern part of the country. Greater deficiencies include nutrient-rich mires (especially rich fens) and spruce mires in southern Finland, successive mire series created by land uplift along the Bothnian Bay, small-scale mire and forest mosaics as well as sloping fens (Aapala 2001, Heikkilä and Lindholm 2004). Some of these deficiencies have been addressed in the METSO programme. Another weakness of the network is that the wooded margins of mires have often not been included within the boundaries of protected areas, and have consequently been altered by forestry practices. Furthermore the high degree of habitat fragmentation especially in the southern parts of the country poses a problem for mire conservation (e.g. Keränen et al. 1995, Aapala and Lindholm 1999, Aapala 2001).

4.3 Baltic Sea

Finnish territorial waters and the Finnish Exclusive Economic Zone (EEZ) cover nearly 20% (81 650 km^2) of the total surface area of the Baltic Sea. Although ecologically difficult to approach as a separate entity, this area is the administrative unit in which Finnish laws apply and which Finland thus has responsibility for. Just under 300 marine species (1.4% of all well-known species) have been listed from the area, although this is a severe underestimation in several respects. Perhaps some 5 000 species of poorly known micro algae not included in the above figure occur in the Finnish territorial waters and EEZ. Due to low salinity levels many fresh water species also thrive in the Baltic Sea.

The most serious threat facing the Baltic Sea is eutrophication. For Finnish coastal waters this is particularly true of the Gulf of Finland and the Archipelago Sea, where increased water turbidity and lowered oxygen concentrations, among other things, cause extensive changes in plant and animal communities (e.g. Kauppila and Bäck 2001). Eutrophication is slightly less acute in the Bothnian Sea and Bothnian Bay, where there is less loading from communities and agriculture. Of the anthropogenic nitrogen and phosphorus loading entering the Baltic Sea from Finnish territory, 45 to 80 percent originates from agriculture (Kauppila et al. 2004). Other threats to the northern parts of the Baltic Sea include harmful substances, building of infrastructure for navigation and holiday residences as well as the rising risk of oil spills due to increased transportation on the Gulf of Finland.

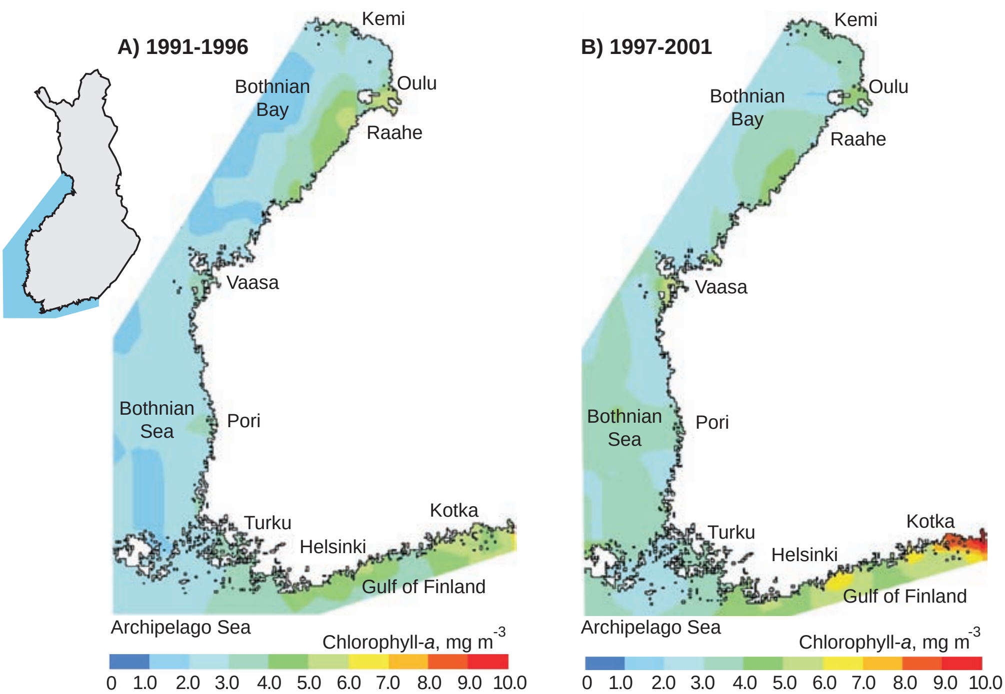

Fig. 3. Chlorophyll-*a* concentrations along the Finnish coastline as an average of two periods 1991–1996 and 1997–2001. During the Action Plan period chlorophyll-*a* concentrations have slightly decreased in parts of the Bothnian Bay, but on the whole concentrations have increased, especially in the eastern Gulf of Finland.

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• increased diffuse nutrient loads from intensified agriculture and forestry • increasing wastewater loads due to rising living standards • increasing risk of oil spills due to growth in transportation volumes • high internal loading • concentrations of some harmful substances have decreased (e.g. PCB, DDT), but others remain relatively high (e.g. dioxins)	• extensive changes in plant and animal communities in the Gulf of Finland and the Archipelago Sea due to eutrophication, for example blooms of blue-green algae are common • changes in biodiversity continuing (e.g. spread of invasive species) • winter-time oxygen levels of near-bottom water have decreased in the Gulf of Finland	• expansion of protected marine areas • reductions in wastewater loads (esp. from point sources), although impacts on the state of the sea have become evident only in limited areas • risks related to marine transportation have been addressed • new research data available • a large-scale survey of marine underwater habitats has been initiated

Within the past three decades loading from point sources has decreased substantially as a result of improved wastewater collection and treatment both in communities and the industry. There have also been attempts to control the amount of nutrients entering the Baltic Sea from arable lands (especially as a part of the agri-environmental support scheme – see Section 3.1.3 and Box 2), but these have yielded only limited results (e.g. Pyykkönen et al. 2004). Since 1991 Finland has actively supported the building of wastewater collection and treatment facilities in Saint Petersburg, which has been identified as the biggest single point-source polluter within the whole Baltic Sea region (Vikman 2002). During the Action Plan period risks related to oil transportation on the Gulf of Finland have been assessed (Hänninen and Rytkönen 2004) and new oil spill combating equipment has been acquired.

Knowledge regarding Finnish marine underwater biodiversity has been lacking for a long time. To fill-in the largest gaps in knowledge, a large-scale survey of benthic habitats and fish breeding grounds was initiated in 2005 (see www.environment.fi/velmu). Another major research effort has been the BIREME Baltic Sea Research Programme, which between 2003 and 2005 funded 25 different research projects aiming at preventing problems caused by eutrophication and harmful substances as well as advancing the maintenance of biodiversity and sustainable use of marine resources (see www.aka.fi/bireme). During the Action Plan period the first protected underwater areas have been established and protected areas, which include above-surface marine and coastal habitats, have been substantially expanded.

4.4 Inland waters

The total surface area of inland waters in Finland is approximately 3.4 million hectares, making inland waters the fourth most extensive habitat type in the country. There are almost 190 000 lakes and ponds of over 0.1 hectares in size and 600 rivers with a mean flow over 2 m^3/s (Kuusisto 2004). In addition to lakes and rivers, Finnish inland waters include a great number of brooks, springs and ponds. Of all well-known species 6% have inland waters as their primary habitat.

The most important factors affecting inland waters have been changes in water quality as well as the construction and regulation of water bodies. With decreasing loading from point sources the nutrient concentrations of many larger lakes and rivers have declined, whereas smaller rivers and lakes next to extensive areas of arable land continue to eutrophicate (Räike et al. 2003). Airborne acidification, which formerly affected many clear-watered watershed lakes, is no longer considered a threat to biodiversity (Mannio and Vuorenmaa 2004).[9] Most Finnish rivers were cleared of rocks for timber floating in the late 19th and early 20th centuries, and most large rivers were dammed for hydropower between 1930 and 1980 (e.g. Yrjänä 2003). Water level regulation also affects almost one third of Finnish lakes by area and a much larger proportion of the water volume, since most of the larger watercourses are regulated (Marttunen et al. 2001).

One of the greatest changes regarding inland waters has been the clearing and straightening of small streams and brooks to improve forest drainage. Many springs have also been altered mainly for water supply. In addition to the alteration of stream courses, forestry practices have also affected biodiversity

[9] On the western coast acidification continues to affect biodiversity as a result of the cultivation of acid sulphate soils – in Finland there are more than 3 000 km^2 of these soils and many rivers in the central-western part of the country are affected by the run-off from acid sulphate soils (Åström et al. 2005).

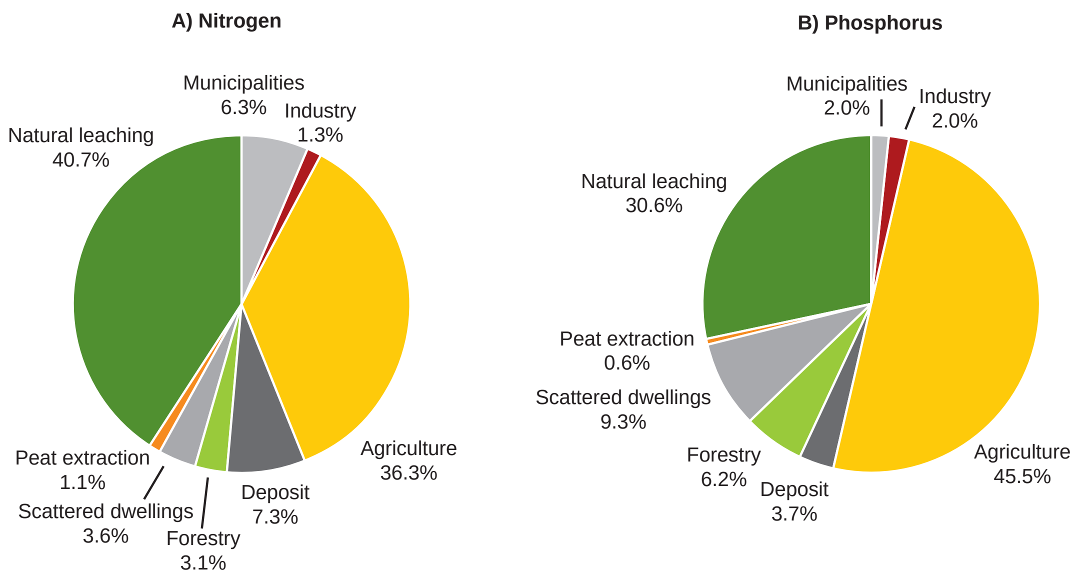

Fig. 4. Sources of nitrogen and phosphorus loading entering the Baltic Sea from Finnish rivers as an average of the years 1993–2002. Loading from agriculture accounted for over 60% of all anthropogenic loading for both nutrients. In the case of nitrogen airborne loading and loading from municipalities was also important. For phosphorus, loading from scattered dwellings and forestry remain the greatest challenges in addition to agriculture.

associated with small water bodies by changing the light conditions and microclimate of the habitats. During the Action Plan period steps have been taken both in agriculture and forestry to decrease the amount of nutrients entering inland waters. These have included leaving buffer strips along waterways and better practices in the use of fertilizers. The positive development in terms of decreasing nutrient loading from point sources has continued (Niemi et al. 2004).

There have been a multitude of projects for restoring built and eutrophicated rivers and lakes, although most of these have had some other primary goal besides safeguarding biodiversity (Eloranta 2004, Keto et al. 2004). During the Action Plan period the first biodiversity-oriented restoration projects were carried out alongside many studies to this end (e.g. Jormola et al. 2003). Less detrimental water level regulation practices have also been developed and studied (e.g Marttunen and Järvinen 1999, Hellsten 2000, Yrjänä et al. 2000, Marttunen et al. 2004a, b).

The network of protected inland water and shore areas has expanded as a result of Natura 2000 and is now considered representative in many respects

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• the construction and regulation of water-courses affects one third of all inland waters (measured by surface area) • increased diffuse nutrient loads from intensified agriculture and forestry • increased wastewater loads from rural settlements and holiday residences due to rising living standards • uncontrolled introductions related to inland water fisheries • small water bodies widely affected by forest management	• declines of habitats and populations associated with small water bodies, natural rivers, and nutrient-poor lakes • the general decline of inland water biodiversity slowed down and in many places halted • previously acidified lakes are now recovering	• expansion of protected water and shore areas • reductions in pollution loads from point sources • restoration work has begun in lakes, rivers and river systems • growing concern for small water bodies in forestry • new research concerning better water level regulation and restoration practices

(Toivonen et al. 2004). The situation concerning the conservation of small water bodies remains less satisfactory, albeit no comprehensive survey of their state has been conducted. Recently there has been growing concern for these habitats within forestry and, for example, the survey of key biotopes has improved the situation to some degree (Yrjönen 2004).

4.5 Farmlands

Because of the country's northern location, agriculture in Finland is largely concentrated in the southwestern and western plains. Altogether farmlands[10] cover 7% of the total area of Finland, but in the southwestern province of Varsinais-Suomi the amount of farmland accounts for more than one quarter of the land area. Farmland habitats harbour 16% of all well-known species, making farmlands the second most species-rich habitat type in Finland. Traditional agricultural biotopes are especially important for many species, including almost 18% of all threatened species (Rassi et al. 2001).

Having been created by human activities, farmlands are dependent on continuous human interference with the physical landscape. The nature of this interference is a key question for farmland biodiversity. Traditional low-intensity farming practices created many diverse habitats, which partly resemble natural open habitats and to which species have had time to adapt. In Finland traditional farming practices practically ceased during the 20th century (Pykälä 2001). Changes associated with the intensification and industrialisation of agriculture – the disappearance of meadows, open ditches, field margins and the decrease in the number of small farms and grazing livestock, among other things – are the most important factors threatening farmland biodiversity.

The second period of the EU agri-environmental support scheme (2000–2006) included a clear shift towards maintaining and increasing biodiversity on active farms. Measures related to the agri-environmental support scheme have been the most important actions taken to safeguard farmland biodiversity during the Action Plan period. Other important actions include completion of the survey of traditional rural biotopes (Vainio et al. 2001) and the several, albeit small and largely uncoordinated, management projects that have followed. Expansion

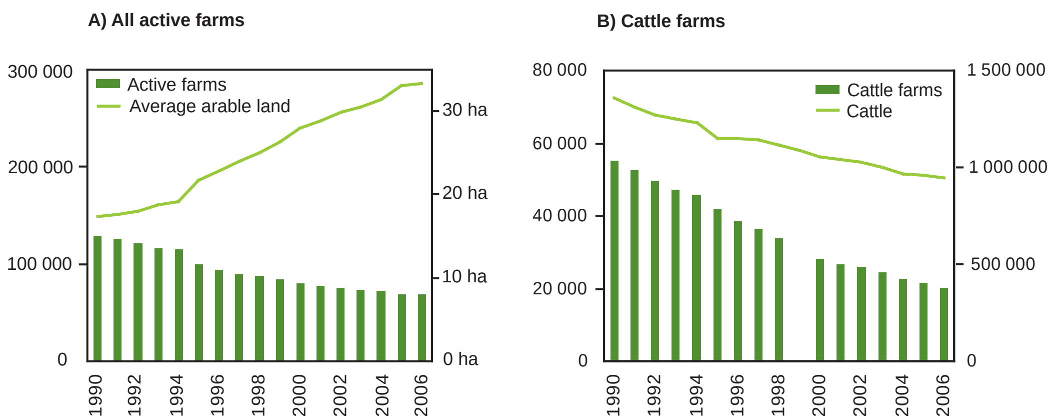

Fig. 5. The number of all active farms and their average arable land area 1990–2004 (A) and the number of cattle farms and the total amount of cattle 1990–2004 (B). During the past two decades small farms have largely disappeared and the remaining ones are larger than before. The numbers of cattle farms and cattle have declined, although the number of cattle has not declined as rapidly as the number cattle farms. The intensification of farming practices and decrease in the number of grazing cattle have resulted in the decline of many habitats important for biodiversity (e.g. field margins and meadows).

[10] Includes open fields and adjoining semi-open areas.

Box 2. Cost-effectiveness of the agri-environmental support scheme

In Finland 98% of all arable land is covered by the basic measures of the agri-environmental support scheme. Because of the high coverage, the effects of the measures cannot be evaluated by comparing farms participating and those not participating in the scheme. Instead, an economic model was used to analyse the effects of different policy options available within the scheme. A representative arable farm from southern Finland was developed for modelling purposes. The farm had 38 hectares of arable area, which was divided into 19 differential land productivity classes. These were further allocated to seven different land uses (winter wheat, spring wheat, oats, barley, rape, sugar beet, green fallow). Three policy options were included in the analysis:

1) The farm receives income support based on arable area (CAP, LFA and national supports), but does not participate in the agri-environmental support scheme.
2) The farm implements basic and additional measures of the agri-environmental support scheme, which include leaving 0.6 metres wide field edges and 3 metres wide buffer strips between fields and water bodies.
3) The farm implements special measures of the agri-environmental support scheme, which include forest margins and 15 metres wide buffer zones between sloping fields and water bodies.

The biodiversity effects of different land allocation options were estimated using data from the literature (Ma et al. 2002, Kuussaari and Heliölä 2004). The numbers of vascular plant and butterfly species in different habitats together with corresponding Shannon's diversity indices were used as indicators of biodiversity. According to the results, there were no great differences between policy 1 and 2. The number of plant species and Shannon's diversity index were the same or almost the same in both cases (Table 6). Since the basic measures of environmental support were mainly designed to advance water pollution control, the only significant differences between the options occurred in the amounts of nutrient leaching – especially the leaching of nitrogen declined as a result of policy option 2.

Table 6. Summary of the economic value and environmental consequences of different policy options.

	Policy option 1	Policy option 2	Policy option 3
Economic variables			
Value of output	€ 15 059	€ 13 967	€ 13 472
Profit	€ 11 756	€ 15 093	€ 14 997
Environmental support received	-	€ 3 744	€ 4 134
Profit without environmental support	-	€ 11 349	€ 10 863
Environmental variables			
Shannon's diversity index	1.89	1.89	1.97
Number of plant species	250	260	283
Total leaching of nitrogen	351 kg	267 kg	234 kg
Total leaching of phosphorus	54 kg	51 kg	49 kg

The best results in terms of both biodiversity and water pollution prevention were reached as an outcome of policy option 3. Shannon's diversity index was slightly higher and the number of plant species 13% higher in policy option 3 than if measures of the environmental support scheme were not implemented at all (policy option 1). The value of the farm's output declined as more arable land was allocated to field verges, buffer strips and buffer zones. The environmental support nevertheless more than compensated for these losses and, ultimately, policy options 2 and 3 appeared clearly more attractive to the farmer in economic terms than policy option 1

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Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• increased production pressures in farming → fewer farms but bigger unit sizes and intensified land-use (e.g. sub-surface draining) • trends in agri-environmental support schemes hard to predict • the number of livestock and livestock farms is in continuous decline	• increasing uniformity of habitats and impoverishment of species diversity, although these have slowed down in some cases • the number of red-listed farmland species is increasing and many common species are also declining (e.g. birds and butterflies associated with meadows) • the extent of meadows has crashed historically and continues to decline	• gradual changes in farming practices • management of traditional agricultural biotopes has been initiated with the help of a special agri-environmental support scheme • new field margins and buffer zones have been established as a result of the agri-environmental support scheme; however, their total amount has declined due to intensification of farming practices • proportion of organic farming is increasing • decreasing amount of fertilizers used, increase of biological control, fluctuating trends in the use of pesticides • new monitoring and research data has become available

of organic farming as well as the decreasing amounts of fertilizers and increasing amounts of biological control used have also created better conditions for many farmland species.

The effects of the agri-environmental support scheme have been studied in detail during the Action Plan period (Kuussaari et al. 2004). In general, the effects of the scheme have been in the desired direction, but have not been strong enough to match up with the previous and partly still continuing decline in farmland biodiversity. For example, the establishment of uncultivated field margins - one of the key measures of the support scheme - has resulted in approximately 9 000 to 17 500 hectares of field margins being left outside cultivation (based on a survey from 2002; Puurunen 2004). However, this amount was mainly added at once at the beginning of the first support period in 1995. Since then the loss of field margins as a result of general intensification of the use of farmlands (subsurface draining in particular) has probably exceeded the establishment of new areas due to the agri-environmental support scheme.

Of all the measures included in the Finnish agri-environmental support scheme the special contracts for the maintenance of traditional rural biotopes have been considered most effective in terms of their effect on biodiversity (Puurunen et al. 2004). In 2003 these voluntary special contracts included 22 345 hectares on 2503 farms (Karja 2004). Their quality and management were evaluated in 2004 in a case study covering one tenth of the total contract area (Schulman et al. 2006). As a main result, the enhancement of biodiversity was judged purposeful in as much as 95% of the contract area.

4.6 Alpine habitats (fells)

Finland has approximately 1.5 million hectares of alpine habitats (4% of the total area of the country), of which one half are open fell habitats and the other half semi-open mountain birch stands. These habitats cover the very northernmost parts of Finland as well as the more southern separate fells rising above the tree line, which in Finland is at approximately 400 to 500 metres. In general, the Finnish fells are relatively low and gently sloping, and consist of nutrient-poor acid soils. The fells of the very north-western corner of the country are an exception, with a starker relief and calcareous soils. Alpine habitats harbour 3% of all well-known species.

Large areas of fell habitats remain in an undeveloped and relatively pristine condition. Apart from the emerging effects of climate change, the only truly widespread human-induced change has been the vegetation changes caused by reindeer herding. Reindeer husbandry has been the principal means of livelihood of the indigenous Sami people for centuries. The effects of grazing reindeer became much stronger, however, only during the 1970s and 1980s when reindeer herds more than doubled from their post-war levels (e.g. Bernes 1996, Suominen and Olofson 2000). Today reindeer herds remain large and alpine lichen grounds – the basis of the reindeer winter diet – are heavily depleted. At best one third of the biomass of lichen remains, at worst only 3% (Kumpula et al. 2004).

Today the maximum sizes of reindeer herds are closely regulated and lichen grounds are monitored periodically. During the Action Plan period the maximum permitted reindeer numbers were decreased three times, in 1997, 1998 and 2000. Despite these measures, grazing pressure continues to cause changes in plant species composition, results in local erosion and partly prevents the rejuvenation of mountain birch stands previously killed by Autumnal moth (*Epirrita autumnata*) outbreaks (e.g. Suominen and Olofson 2000, Holtmeier et al. 2003, Tenow et al. 2005).

During the past decade the numbers of tourists visiting the alpine areas of Lapland have increased substantially. In northwest Lapland visitor numbers increased in ten years even by 160%. The number of

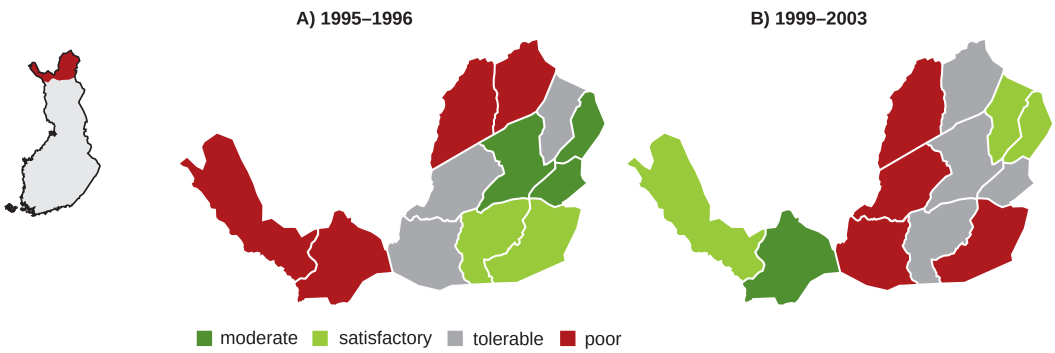

Fig. 6. The state of lichen grounds of the twelve northernmost reindeer herding cooperatives (”paliskunta”) according to surveys made in 1995–1996 and 1999–2003. During the first half of the 1990s the reindeer herds of the two westernmost co-operatives were clearly below the maximum numbers allowed (1.7 reindeer per km^2). The lichen grounds in these areas appear to have recovered to some extent rather rapidly. Lichen grounds in the areas of the eastern co-operatives, where reindeer densities have remained high (2.6 reindeer per km^2), have generally deteriorated further (Kumpula et al. 1997, 2004).

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• profitability pressures in reindeer husbandry have resulted in large herds and intense (local) grazing pressures • although the total amount of reindeer has decreased since the early 1990s, grazing pressure is still very high in many places • recreational land use pressures, especially off-road traffic (snow mobiles and ATVs) are increasing • climate change	• alpine lichen heaths suffer widely from reindeer herding, although in some areas conditions have improved • palsa mires are disappearing increasingly rapidly as permafrost cores in palsas melt • incipient changes in alpine timberline • alpine bird populations possibly declining	• improved planning of management and use of protected areas • gradual changes in land use practices • increasing emphasis on biodiversity-related tourism • monitoring schemes on selected species and lichen grounds • management of National parks and wilderness areas is developing; opportunities for local communities to participation are better than earlier

people visiting the northernmost national parks has in some instances increased at almost the same rate (Saarinen and Vaara 2002). The effects of tourism on alpine biodiversity are difficult to evaluate. Depending on the type of tourism the effects may vary from harmful (e.g. extensive off-road traffic) to beneficial (increased conservation efforts as the demand for unspoiled nature increases). In any case, the numbers of snowmobiles, all-terrain vehicles (ATVs) and helicopter flights have been increasing steadily during the Action Plan period.

Several area-specific plans aimed at an integrated and purposeful management of protected and wilderness areas have been drafted during the Action Plan period. The established wilderness areas have mostly retained their integrity, and local communities have been better integrated into the planning of their management (Gilligan et al. 2005). The first signs of climate change-induced biodiversity losses have become apparent during recent years. For example, a greater amount of existing frozen cores of palsa hummocks are melting than new ones are forming, and palsa mires are now at risk of disappearing from Finland (Luoto et al. 2004). Palsa mires are especially important for wading birds. There have also been signs of a more widespread decline in the populations of breeding birds in alpine habitats.

4.7 Urban and transport areas

Compared to most other European countries the population density in Finland is low (17 inhabitants per km^2 on average) and the Finnish cities and other population centres are small and far apart. Even the largest cities appear relatively green, with undeveloped patches among the infrastructure and adjoining fields and forests always close to city centres. Urban and transport areas, which cover all developed lands (population centres, roads, industrial areas etc.), cover 3% of the total area of Finland and harbour 11% of all well-known species. Urban areas are thus markedly species-rich environments, although many of the species occurring in urban areas are not native to the country.

In a sense, there are two opposing kinds of biodiversity in urban areas: biodiversity, which is there because of human influence and biodiversity, which is there despite it. Finnish towns and cities often have more species than any area of the adjoining countryside of the same size (e.g. Kurtto and Uotila 1999, Vähä-Piikkiö et al. 2004). This can be accredited to e.g. the greater diversity of man-made habitats and the high frequency of disturbances, which maintain early successional stages in urban environments (Rebele 1994, Trepl 1995, Niemelä 1999). In Finland parks, gardens and ruderal environments also offer a secondary habitat to many native specialist insect species.[11] Man-made habitats are dependent upon a certain degree of interference, but become unsuitable with more intense development. The other kind of biodiversity found in Finnish cities and population centres is what remains of the original habitats within their boundaries. This biodiversity is threatened most by the spread of infrastructure.

During the Action Plan period increasing attention has been paid to original biodiversity in urban areas.

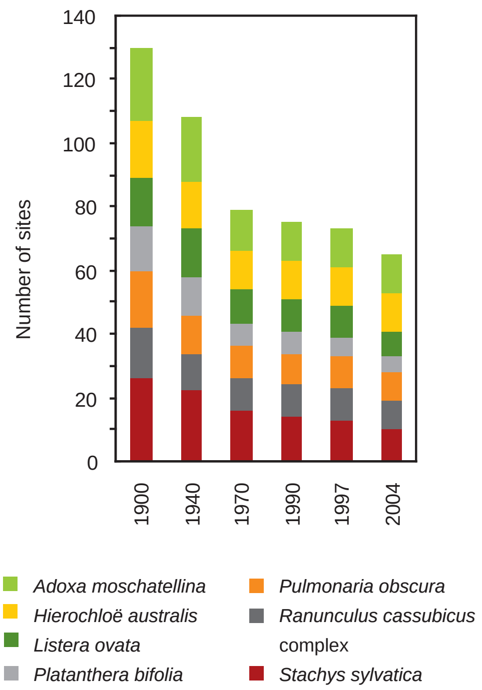

Fig. 7. The number of sites with species characteristic to herb-rich forests in Helsinki, 1900–2004. The disappearance of suitable habitats for these species has continued since 1997, although the city of Helsinki has coordinated a GIS database of important sites.

[11] Especially of the Lepidoptera, Coleoptera, Hymenoptera and Diptera orders (Rassi et al. 2001).

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• expansion of infrastructure, infill in existing built-up areas, and other intensification of land use	• natural habitats have been built over • green areas, open ruderal environments and older low-density housing areas are shrinking • increasing amounts of highly developed areas • some species have moved into newly built-up areas	• gradual changes in building activities with, for example, greater attention to landscape characteristics • increasing attention to biodiversity values in city planning • first comprehensive surveys of urban biodiversity completed in some cities • establishment of the first National Urban Parks

Comprehensive surveys have been carried out of some aspects of biodiversity in some of the largest cities (e.g. Kurtto and Helynranta 1998, Vähä-Piikkiö 2002, Tynjälä 2004, Väre et al. 2005), biodiversity information databases have been developed to support city planning and new protected areas have been established.[12] Representing a new approach to conservation, the first three National Urban Parks were established in 2001 and 2002. These parks are not conventional protected areas, but rather aim at safeguarding a continuum from natural habitats to heavily modified parks by setting limitations for city planning. Their total area is slightly over 2 600 hectares.

New approaches have also been taken, for example, in building, landscape planning and water channel construction. These have included better recognition of natural landscapes and creation of natural-like built elements. The purposeful management of special urban habitats, such as ruderates, depots, harbour areas etc., remains mostly unrealised.

4.8 Shores

The exact delimitation and measurement of the area of shore habitats is difficult. We estimated that there could be approximately 800 000 hectares of shore areas (2% of the total area of Finland) between normal water level and the 1.5 metres contour line, which represents the average maximum high water along the Finnish coastline. This area consists mainly of open and semi-open shore biotopes such as coastal meadows, marshlands, gravel fields, sand dunes, willow thickets etc. Relative to their extent in area, shores constitute a biodiversity hotspot habitat with 11% of all well-known species.

Finnish shore habitats are threatened most importantly by the cessation of traditional farming practices on coastal meadows, eutrophication, building of holiday residences and other development projects. Traditional farming practices, which were still relatively widespread during the 1950s and 1960s, created and maintained open coastal meadows (Pykälä 2001). These habitats have since become overgrown by reeds (esp. *Phragmites australis*) and willows. Coastal meadows are important habitats for many vascular plants, insects and birds, many of which are now threatened. Shore habitats also appear to

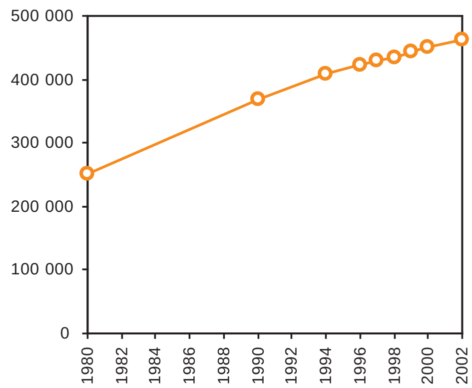

Fig. 8. The number of holiday residences in Finland, 1980–2002. The building of holiday residences is often harmful to shore species due to disturbance, management of riparian forests, building of the shoreline (quays and boat havens) etc. However, owners of holiday residences may also contribute to the management of coastal meadows and undertake other biodiversity-friendly activities.

[12] Between 1997 and 2004 the total area of protected areas in six biggest cities increased by 37%.

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• decline in grazing and mowing of shore meadows • building activities spreading along shores both in rural and built-up areas	• impoverishment of species diversity in shore habitats due to overgrowth and construction, although these trends have slowed down in some places	• gradual changes in regulating shore construction • the agri-environmental support scheme has made the management of some coastal meadows possible • several projects aiming at restoring and maintaining important coastal bird areas have been started or completed

be particularly susceptible to the harmful effects of invasive species.

A national shore conservation programme from 1992 and a waterfowl wetland conservation programme from 1982 have guaranteed that the approximately 220 000 hectares of shore habitats and adjoining waters areas included in the programmes have retained their more or less natural state. During the Action Plan period especially new areas included in the Natura 2000 Network have increased the representativeness of the network of protected shore areas substantially. In 2004 on average 16% of the shoreline of inland waters was included in the network (Kallio 2004).

Some coastal meadows are now being managed as a result of the agri-environmental support scheme. Several projects have also been carried out by the environmental administration, Metsähallitus (Finnish Forest and Park Service) and NGOs, which have aimed at restoring and managing important coastal bird areas. Some of these have received LIFE funding from the EU. In general, knowledge regarding the extent and state of shore biodiversity is scanty in many cases.

4.9 Rocky habitats and eskers

Rocky habitats and glacifluvial eskers have many common features related to e.g. exposure to sunlight and microclimate, but are also quite distinct in some other respects. Finland has approximately 0.5 million hectares of open to semi-open rocky habitats (1% of the total area of Finland) and 0.8 to 1.7 million hectares of eskers, depending on the criteria used. Relative to their total area, rocky habitats are especially important for species diversity: 6% of well-known species have rocky habitats as their primary habitat. Eskers outside the northernmost parts of the country are covered with forests. Since many species found on eskers also live in other types of forest habitats there are rather few species exclusive to eskers.

The main threats to biodiversity in rocky habitats and eskers are similar. Extraction of sand, gravel and bedrock affect both habitats and constitute a serious threat to them with irreversible consequences. Another main factor affecting the biodiversity of rocky habitats and eskers is the management of forests growing on them. Particularly harmful are dense young tree stands following artificial regeneration and the prevention of forest fires, both increasing shading and altering the microclimate. Rocky habitats are also threatened by mining activities, which, however, have been generally decreasing during the past two decades and now have only limited consequences for biodiversity. They continue to threaten rare and specialised communities found especially on limestone and ultra-alkaline rock. Eskers have traditionally been suitable grounds for building roads and houses. Several of the largest cities in Finland are located on eskers.

In Finland eskers have been protected by a national conservation programme for glacifluvial esker formations from 1984, which includes 159 representative esker areas totalling 97 000 hectares. The protection of these areas has been enacted in the Land Extraction Act, which does not issue strict limitations on the use and alteration of vegetation growing on eskers. During the Action Plan Period the conservation status of many of these areas has improved, and today 10% of their total area has been included in nature conservation areas and 60% in the Natura 2000 Network (Rintala 2006). Furthermore the protection of valuable rocky habitats has advanced as the regional surveys of important rocky outcrop areas have been completed. In the survey altogether 1 049 nationally valuable rocky outcrops were identified, amounting to almost 110 000 hectares. Although in most cases the Nature Conservation Act does not protect the sites, the survey results

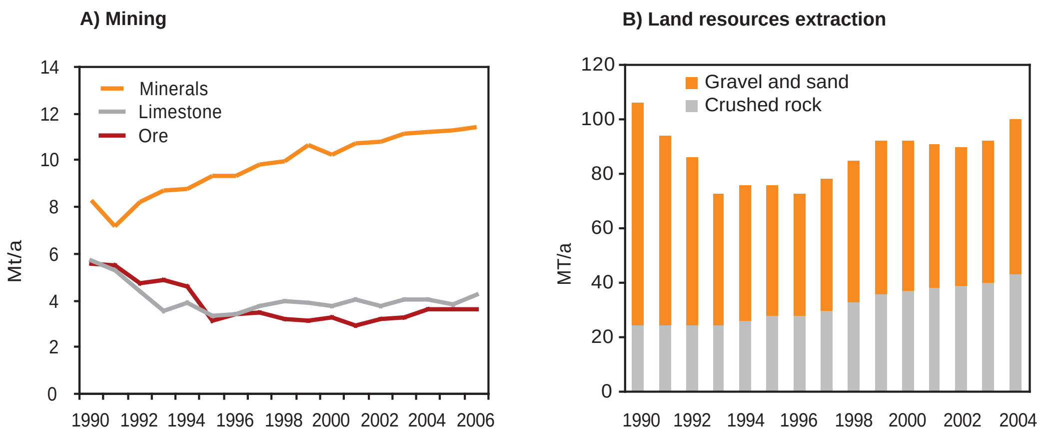

Fig. 9. Volumes of mining and land resource extraction, 1990–2002. Mining of limestone and ore have been declining whereas mining of minerals, mainly soapstone and apatite, has increased. The extraction of sand and gravel from eskers has been partly substituted by the extraction and crushing of bedrock.

Development of pressures and related factors	Changes in biodiversity during the Action Plan period	Key measures related to the Action Plan (1997–2005)
• large amounts of esker areas have been used for building • extraction of sand, gravel and bedrock have changed rocky and esker habitats permanently • forest management has intensified on eskers • forest fires are prevented almost completely	• loss of rocky and esker habitats has slowed down • many specialist species of rocky and esker habitats have declined • poor prospects for species dependent on forest fire dynamics	• expansion of protected areas and better protection of valuable areas outside protected areas • marked changes in extraction practices (gravel increasingly replaced by crushed rock) • survey of valuable rocky habitats • gradual changes in the management of forests growing on eskers and rocky outcrops • survey of forest key biotopes has advanced the conservation of some small-scale rocky and sandy habitats

have been widely utilised as background data when considering rock extraction permits.

During the Action Plan period extraction practices have been changing and the recycling of land resources has increased. More crushed bedrock is now being used instead of gravel. This can mainly be considered as a desirable development since most of the rocky habitats used for extraction are of some relatively common and species poor type. New management guidelines for state-owned forests (Heinonen et al. 2004) include special instructions for the management of forests growing on eskers and rocky outcrops. The survey of key forest biotopes in privately owned lands included rocky outcrops and rocks, sandy areas, cliffs and ravines. Altogether approximately 14 000 hectares of these biotopes were found. The Forest Act prohibits the alteration of their main characteristics.

4.10 General land use changes

The two case-study areas examined in the analysis of land use changes – the southwest coast and North Karelia – are quite distinct in terms of pressures affecting biodiversity. The southwest coast is an area with a relatively high demand for development and strong competition between different land uses. Land use in North Karelia, on the other hand, is dominated by forestry throughout the province expect for the few population centres.

In terms of development, the overall situation was relatively stable during the ten-year period between 1990 and 2000 in both areas (Table 7). The amount of built-up area increased by 1.1% in the southwest coast (156 km^2) and by 0.3% in North Karelia (52 km^2). At the same time, the population of the province of North Karelia decreased by 4% whereas the populations of the provinces of Varsinais-Suomi and Uusimaa - approximately the southwestern coast area included in the analysis – increased by 7% and 19%, respectively. These changes indicate that, whereas development was still spreading in North Karelia despite declining population numbers, the construction of new areas had been somewhat less extensive along the southwest coast than what the growing population numbers might lead to expect. In North Karelia uninhabited farmhouses are still used as summer cottages and new cottages are also being built by people living outside the area.

In both areas the use of forests was intensive. In North Karelia 7.1% of the closed canopy forests (1 200 km^2) turned into treeless and semi-open areas. In the south-west coast the corresponding figure was 5.2% (700 km^2). However, the total amount of forests did not change since approximately the same amount of land, which was either treeless or semi-open in 1990, had turned into closed canopy forest by 2000. Despite the balance, the changes are relevant in terms of biodiversity. In both areas a large proportion of forest land was subject to intensive changes during the ten year period as a result of clear fellings.

Separate analyses were also made of the structure of the closed canopy forests and of the building of shorelines. According to the former, only few extensive areas of continuous forests remain. Larger areas with a proportion of closed canopy forests exceeding 90% covered only 3% of all areas. The majority of the forests in both case-study areas consisted of small mosaic-like patches. The analysis of changes in built-up areas shows that new areas were largely concentrated along the shoreline. Depending on the scale of the analysis, 3.0 to 4.7 percent of the shoreline was used for building in ten years. In 2000 the proportion of undeveloped shoreline was between 83.0 and 72.0 percent in the southwest coast and between

Table 7. Land use changes between 1990 and 2000 in the southwest coast (A) and North Karelia (B). Figures denote percentages of land area.

A) Southwest coast (13 400 km^2)

1990 \ 2000	Built areas	Arable lands	Closed canopy forests	Marshes and open mires	Treeless and Semi-open areas	Total
Built areas	6.8	-	-	-	-	6.8
Arable lands	0.2	27.6	0.2	-	0.3	28.3
Closed canopy forests	0.5	-	43.1	-	5.2	48.9
Marshes and open mires	-	-	-	1.5	-	1.5
Treeless and Semi-open areas	0.4	0.4	4.9	-	8.7	14.5
Total	8.0	28.0	48.3	1.5	14.2	100.0

B) North Karelia (16 600 km^2)

1990 \ 2000	Built areas	Arable lands	Closed canopy forests	Marshes and open mires	Treeless and Semi-open areas	Total
Built areas	2.2	-	-	-	-	2.2
Arable lands	-	5.9	1.2	-	0.5	7.7
Closed canopy forests	0.2	-	56.9	-	7.1	64.2
Marshes and open mires	-	-	-	5.5	-	5.5
Treeless and semi-open areas	0.1	0.4	7.6	-	12.2	20.3
Total	2.5	6.3	65.8	5.5	19.9	100.0

89.4 and 83.6 percent in North Karelia. Relatively large extents of the shoreline thus appear to remain undeveloped, but on the other hand a large proportion of the total shoreline is unsuitable for building (e.g. rocks, islets and small islands). Therefore the demand for development was concentrated on a limited part and type of the shoreline.

4.11 Red-listed species

An evaluation of the changes in the status of red-listed species was made by comparing Red List data from the last completed Red List of Finnish Species (Rassi et al. 2001) with those of an expert judgement forecast for the year 2010, which was made specifically for this evaluation. The data from the 1990 Red List assessment (Rassi et al. 1992) were deemed incomparable due to changes in assessment methods and were not used. The evaluation was complicated by the different numbers of species in the 2000 and 2010 Red Lists – the status of 16 057 species was assessed in 2000 whereas the 2010 assessment included 18 314 species.

When comparing all species, most of the increase in the number of red-listed species appeared to be caused by the increasing research and monitoring of previously poorly known insect groups. Therefore the comparisons presented below were made by including only those taxonomic groups, which were already known relatively well in 2000. These were vertebrates, molluscs, butterflies, beetles, vascular plants, bryophytes, fungi and lichens. The well-known groups contained 13 366 species in 2000 and 13 790 in 2010, representing a 3% increase between the assessments.

The number of red-listed species[13] was estimated to increase by 157 species (11.7%) by 2010. When this figure is proportioned with the number of species assessed, the growth rate would be 8.3%. On the whole, the increase would mean that whereas in 2000 approximately 10% of all species were red-listed in 2010 this figure would be expected to increase to 11%. The largest taxonomic group among the new red-listed species would be butterflies, with 51 species found mostly in forests, shores and aquatic habitats (Figure 10B). The second largest would be fungi (44 species living mainly in forests, farmlands and mires) and the third largest beetles (27 species). Proportionately to the total species count the greatest changes would occur among molluscs (35%), birds (25%) and butterflies (21%).

In different habitats the greatest increase in the number red-listed species (1.7%) would occur in shores. (Figure 10A). Otherwise the increases would occur rather evenly in all habitats, with only changes in forests and alpine habitats (0.9% increase) standing out somewhat from the changes in other habitats (0.7–0.5% increase). The number of extinct species would also grow by 2010. Altogether 12 species of beetles and 3 species of fungi are expected to have

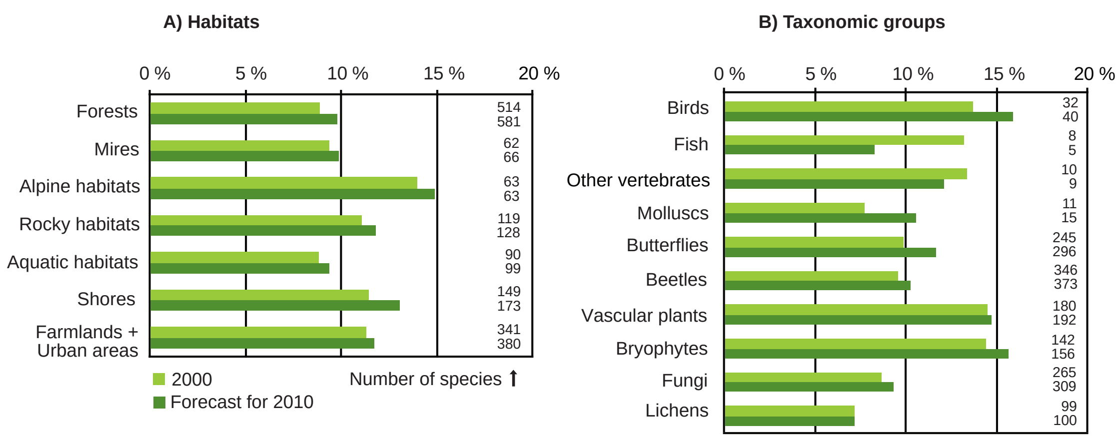

Fig. 10. The proportion and number of red listed species in different habitats (A) and in taxonomic groups (B) in 2000 and as forecast for 2010.

[13] Including categories critically endangered (CR), endangered (EN) and vulnerable (VU). For definitions of the categories, see IUCN 2001.

disappeared by 2010, whereas in some other groups certain species will probably be re-established.

4.12 Species listed in the EU Habitats and Birds Directives

The analysis of the changes in the distribution area and population numbers of species listed in the EU directives included 79 species of the Habitats Directive and 62 species of the Birds Directive. During the 19th century (1900–1996) the distribution area of more than 50% of the Habitats Directive species and almost 20% of Birds Directive species contracted (Table 8). During the same period no Habitats Directive species were able expand their range whereas 27% of Birds Directive species did so. The population trends of these species during the 20th century were similar to the changes in their distribution area, the only marked difference being that 40% instead of 20% of Birds Directive species experienced a population decline.

The occurrence of Habitats Directive species was studied and monitored in much more detail during the Action Plan period than previously. Despite the increased research effort, their recent population trends are difficult to evaluate. This is partly due to the short duration of the period in question and partly due to inconsistencies between the older and more recent data caused, among other things, by increased research activities.

Development during the Action Plan period was mixed. Marked changes in the distribution areas of both Habitats and Birds Directives species were few. The populations of 17 Habitats Directive species declined, whereas only 5 species experienced a population increase. In the case of Birds Directive species there were more decreasing and increasing trends, almost equally in both directions.

5 Summarising evaluation of goals and measures

Despite the many steps that have been taken to safeguard species and habitats, the Action Plan has not succeeded in reversing all negative trends. It has, however, initiated many measures towards this end. To support the compilation of a new biodiversity action plan and the designing of related future efforts it is particularly interesting to know which of the measures taken during the Action Plan period 1997–2005 have been most successful and what these measures may have in common. This section begins with a short summary of the overall development of biodiversity in Finland during the past decade, which is followed by an analysis of the Action Plan's actions in the light of specific assessment criteria. The role of research in affecting and supporting biodiversity policies is discussed at the end of the section.

5.1 General goals of the Action Plan

The assessment of the development of biodiversity in different habitats and of the most important steps taken to protect biodiversity (Section 4) shows that the first two goals of the Action Plan – to preserve viable populations of native species and to safeguard the diversity of Finnish ecosystems – have not been fully reached. Even if the baseline for comparison is set at the beginning of the Action Plan period,

Table 8. Number of species listed in the EU Habitats and Birds Directives with increasing (+), relatively stable (0) and decreasing (-) trends in distribution area and population numbers in Finland during the 20th century (1900–1997) and the Action Plan period (1997–2005). The trends of some Habitats Directive species remained unknown for both periods.

		20th century (1900–1996)		Action Plan period (1997–2005)	
		Area	Population	Area	Population
Habitats Directive species (n=79)	+	-	1	3	5
	0	30	22	67	50
	-	42	48	5	17
Birds Directive species (n=62)	+	17	21	5	19
	0	33	17	53	25
	-	12	24	4	18

biodiversity has probably deteriorated. This has been caused most importantly by the general societal development and the consequent pressures to exploit natural resources. Consequently, it has become more difficult to maintain the historical composition and level of biodiversity.

Land use and exploitation of natural resources have resulted in wider and more homogeneous areas that often have less variation and fewer smaller-scale features than in the past. Measures to increase the productivity of easily exploitable natural resources such as timber have affected biodiversity at the landscape, habitat and species levels. The evaluation indicates that the 3rd objective of the Action Plan – to promote the sustainable use of natural resources and economic opportunities related to the utilisation of biodiversity – has been achieved with regard to the commercial production and use of certain natural resources, but that the diversity of natural habitats and their plant and animal communities has correspondingly declined.

Finland's current biodiversity is the product of many factors and processes. Trends in farming, for example, have led to a decline in traditional low-productivity elements in farmland landscapes. Forest management practices are nowadays more uniform and affect much wider areas than previously. Such trends have benefited species that can thrive in intensively managed habitats, but, on the whole, a large part of the historical diversity has declined. Some species have been able to move into new habitats. For example some plants and insects which were previously found in traditional rural habitats, are today more likely to occur in built-up areas along roadside verges or in green areas in towns and cities. Other species have had their numbers reinforced through the spread of populations from neighbouring regions, and new species have spread into Finland due to natural processes and assisted by human activities. A warmer climate in recent past has also favoured a number of species, and under continued climate change the total species count is even likely to increase in Finland. Historical biodiversity, however, is likely to be reduced since many native species face the risk of being substituted by southern, invasive and more common species.

5.2 Assessment of the measures in the light of the assessment criteria

The Action Plan has not sought to alter wider societal trends behind the pressures and related factors that affect biodiversity. It has, however, attempted to guide and redirect some of these pressures by providing relevant information, setting limitations on various activities and promoting concrete measures to improve the conservation of biodiversity. About half of all the Action Plan's 124 measures concern producing more information. Almost one third of the measures have at least partly consisted of concrete measures to promote biodiversity; more than a quarter include measures related to regulation and control; and almost one third have also incorporated the general concept of considering biodiversity in all activities.

The following criteria were used in evaluating the measures:

- Relevance (targeting of measures)
- Impact
- Cost-effectiveness (efficiency)
- Approvability
- Transparency and opportunities for participation
- Equitability
- Flexibility
- Predictability
- Permanence (continuity)
- Incentive value

Although it has not been possible to achieve a favourable conservation status for all of Finland's native species and habitats, this does not mean that the Action Plan has not enhanced the safeguarding of biodiversity. The evaluation has indicated that most effective and relevant measures in terms of maintaining biodiversity have been those measures which:

- have led to favourable changes over wider areas – examples include new forest management recommendations, natural resource planning in state-owned lands (by Metsähallitus, the Finnish Forest and Park Service), habitat restoration schemes in protected areas, and the agri-environmental support scheme.
- have improved the knowledge base for future changes by showing how activities can be developed to maintain biodiversity – examples include new research data on farmland and forest biodiversity, and its application in management planning.
- have helped to shape attitudes that will favour biodiversity in the long term – examples include the implementation of nature conservation programmes as well as the training and communication related to the survey of forest key biotopes.

- have focused on habitats that are particularly important for biodiversity – examples include the Natura 2000 Network, special contracts of the agri-environmental support scheme, and changes in legislation on nature conservation and forestry, which have significantly improved the prospects for the preservation of these habitats.

The most effective measures (as summarised in Table 9) have generally been measures that have enjoyed widespread societal acceptance. The implementation of such measures has been transparent and has in many cases included opportunities for public participation. The financing scheme for the implementation of national nature conservation programmes and various subsidies obtained from the EU (e.g. LIFE) have helped to create a more favourable climate for the preservation of biodiversity and have resulted in measures that have generally been seen as equitable. A contrary example is the Natura 2000 Network. Its introduction in Finland polarised attitudes and caused conflicts concerning the legitimacy of the whole process. However, as its implementation proceeds to area specific planning, many of the conflicts may be resolved.

A common feature of many of the most effective and relevant measures is that they aim at increasing knowledge about biodiversity. The successful information-gathering measures have also generally been rather flexible, although it has in some cases been difficult to include new issues in extensive research programmes once they are up and running. It is also difficult to assess the cost-effectiveness and impact of data production. For example, building up taxonomic and distribution knowledge on poorly known species and species groups can be a rather costly process. This data alone is often an insufficient basis for the planning of measures to safeguard biodiversity. Such data can, however, draw attention to habitats, natural features or management practices, which importance for biodiversity has not been recognised previously. Basic research can thus provide a suitable long-term basis for more applied research and help to increase general awareness of biodiversity. Increased knowledge is also significant in itself, as it adds to our appreciation of biodiversity, which can in turn improve attitudes and increase the acceptability of measures to maintain biodiversity.

In cases in which specific measures to safeguard particular species or habitats are thought to be needed urgently, research should be carefully prioritised and planned, with judicious consideration given to the roles of different actors in producing and applying research data. Such systematic planning was not conducted during the Action Plan period. It would have been particularly useful to examine the division of work between the organisations that guide and support basic research (the Ministry of Education, the Academy of Finland, foundations) and the authorities that support more applied research (the Ministry of the Environment and the Ministry of Agriculture and Forestry). Joint funding has been used for larger research programmes, but enhanced co-operation between the various research funding organisations and between funding organisations and researchers is needed to improve the efficiency of the use of research resources.

When the measures included in the Action Plan were originally planned their cost-effectiveness was not systematically examined. Conservation programmes based on land acquisition, for example, have not always been very cost-effective or flexible. Problems are likely to arise during the last phases of the implementation of these programmes, when purchasing the remaining few hectares may require unjustifiably great administrative expenditures. It would be important to assess how genuinely unique the designated sites are. Assessments of the special agri-environmental support scheme have also indicated that the present scheme has not been as cost-effective as it could be with regard to sustaining biodiversity.

Permanence of impact has been achieved for measures that have led to significant changes in economic activities. Examples include the exclusion of new mire drainage projects from forestry plans and subsidy schemes. This has greatly reduced the historically most important threat to mire biodiversity.[14] Permanent changes adopted in working practices in forestry and road maintenance may also favour biodiversity. Such improvements are undoubtedly significant, but will not alone be sufficient to maintain biodiversity to the extent envisaged in the objectives of the Action Plan. Little information is available as yet on the longer-term impacts of such changes. Other socio-economic pressures related to commercial forestry could in future reduce the permanence and continuity of these improvements. A major increase in the use of wood for bioenergy, for example, could be problematic if it ultimately leads to a more large-

[14] Future subsidies for restoration work on drainage ditches may, however, detract to some extent from the permanence of these measures

Table 9. The most effective measures taken during the Action Plan period.

Habitats	Measures taken over extensive areas	General grounds for changing activities, and measures taken to promote favourable attitudes	More specifically targeted measures
All habitats	• implementation of nature conservation programmes	• drafting of the Action Plan • recognition of the value of biodiversity by society • EU funding (e.g. LIFE projects) • research into various aspects of biodiversity, including research in the social sciences • improved training and education	• planning and implementation of the Natura 2000 Network
Forests	• new forest management recommendations • natural resource planning on state-owned lands and management of protected areas (by Metsähallitus) • management of military areas according to Metsähallitus Nature Heritage Services specifications	• research on forest biodiversity, especially on species dependent on decaying wood • research related to habitat restoration • training on natural forest management • further identification and testing of voluntary conservation measures in the METSO programme	• revision and implementation of legislation on forests and nature conservation • old-growth and herb-rich forest conservation programmes • surveys of forest key biotopes • ending of commercial forestry in forests within the mire protection programme in state-owned lands • habitat restoration in protected areas
Mires	• ending of large-scale draining of pristine mires	• research on the biodiversity of mire habitats • research related to habitat restoration	• implementation of the mire protection programme • habitat restoration in protected areas (2 000 ha annually).
Baltic Sea	• water protection plans	• research into biodiversity • research into Baltic Sea ecosystems • Academy of Finland's Bireme Research Programme and other research efforts • publicity and the Government's Programme for the Protection of the Baltic Sea	• Natura 2000 Network • extensive surveys of biodiversity (inc. underwater habitats)
Inland waters	• water protection plans	• research on aquatic biodiversity • research on water protection, watercourse restoration and sustainable lake regulation practices • water protection programmes • restoration of natural lakes and rivers	• Natura 2000 Network • shore protection programme • protection of small water bodies through paragraph 10 of the Forest Act, and the Water Act
Farmlands	• agri-environmental support scheme • expansion of organic farming	• research on farming practices, farmland biodiversity and effects of the agri-environmental support scheme • environmental programme for agriculture, agri-environmental support schemes, with landscape values recognised in rural development schemes	• special contracts in the agri-environmental support scheme • programmes for the conservation of genetic resources
Alpine habitats (fells)	• implementation of the Wilderness Areas Act • stricter control over reindeer numbers	• support for nature-based livelihoods • research on reindeer husbandry and its effects on biodiversity • land use and management planning in protected areas	• land use and management plans for wilderness areas
Urban and transport areas	• Land Use and Building Act • regional land use plans and local master plans	• identification of recreational values • research on biodiversity in built-up areas and opportunities to develop favourable land management practices • greater importance given to green areas at the municipal level • biodiversity issues included in the planning and management of transport areas	• Land Use and Building Act • management measures for local forests and other green areas within population centres
Shores	• Land Use and Building Act	• expansion of research into shore ecosystems, especially around the coasts of the Baltic Sea	• shore conservation programme • Land Use and Building Act
Rocky habitats and eskers			• Mineral Extraction Act, Forest Act (paragraph 10) • surveys of ecologically valuable rocky habitats • implementation of the esker protection programme

scale and systematic exploitation of tree stumps and harvesting residues, or to a reduction in the amount of decaying wood in managed forests.

Measures taken to safeguard biodiversity in farmlands require continued efforts, since much of this diversity depends for its existence on habitats that have been shaped and maintained by farmers. Because support schemes are relatively long lasting, it would be useful to include safeguarding biodiversity as one of their key objectives. In order to ensure that key actors accept this, the other foreseeable consequences of such an objective would also have to be assessed.

The incentive value of the Action Plan's measures greatly affects the prospects for their extension. The Action Plan has not yet succeeded in this respect, since its measures have not actively supported the search for new solutions and innovations to maintain biodiversity. The production of new knowledge can facilitate such innovations, but most of the recently generated data have been survey data, which will support the creation of new solutions only in the long term. The METSO Forest Biodiversity Programme for Southern Finland is an example of a conscious effort to create incentives for biodiversity protection. The agricultural support scheme could clearly be improved in this respect. Environmental management systems could also provide more incentives for various actors to safeguard biodiversity, for example in road maintenance. This lack of incentives is probably one reason why the general objective ”to promote economic opportunities related to the sustainable use of biodiversity (employment and enterprise)” has been given relatively little emphasis during the Action Plan period, except in the context of businesses providing tourist services linked to national parks.

5.3 The role of research

A considerable amount of biodiversity-related research was conducted in Finland during the Action Plan period. For example, an extensive interdisciplinary research effort, The Finnish Biodiversity Research Programme (FIBRE), was organised in 1997–2002. Other research-related measures included in the Action Plan were the initiation of a research programme dealing with genetically modified organisms as well as the furthering of research related to poorly known species, habitat restoration and management, forest certification and endangered species. Questionnaires sent to researchers and information end-users (37 and 33 respondents, respectively) revealed that whereas the FIBRE programme was seen as highly or moderately relevant to biodiversity conservation by most of the respondents (93%), research efforts related to genetically modified organisms and forest certification were less so (50% and 65% of respondents, respectively).

The FIBRE programme included altogether 73 consortia or research projects, half of which focused on forest biodiversity, forest management, conservation biology and systematic biology (37 projects). Other fields included in the programme were the biodiversity of aquatic environments (18 projects), agrobiodiversity, traditional rural landscapes and urban environments (10 projects), biodiversity and developing countries (4 projects) and other fields including environmental law (4 projects). Approximately 600 researchers participated in FIBRE projects and altogether 140 doctoral students and 20 postdocs were financed through the programme. For a general programme description and a complete list of projects see Markkanen et al. (2002).

Although the FIBRE programme was seen as a useful groundbreaker for biodiversity research, many regarded it as wanting with respect to the applicability of its results. This was emphasised both in the working group discussions organised for this evaluation as well as in the earlier evaluation of the programme (Otronen and Tirkkonen 2002). During the Action Plan period concerns were also expressed that research-based knowledge on many of the key processes related to biodiversity is still missing (Kangas et al. 2000). The results of this evaluation point to problems in adjusting research to the practical needs of biodiversity conservation. Researchers commonly felt that it is difficult to deliver research data to end-users. The BITUMI project (The Applicability of Biodiversity Research) of the FIBRE programme was an attempt to overcome this problem. BITUMI, for example, produced three extensive books on forest, agricultural and aquatic biodiversity (Kuuluvainen et al. 2004, Tiainen et al. 2004, Walls and Rönkä 2004). Some researchers, however, would not participate in BITUMI. This may have been due to their reluctance or insufficient skills to participate in societal debates. Similar findings were also made in the evaluation of the EU Biodiversity Strategy (EPBRS 2004).

The impact of the FIBRE programme was weakened by the fact that the programme was not explicitly linked to other biodiversity-related processes. Many conservation efforts have continued on their separate courses unaffected by FIBRE. On the other hand, some of the experts interviewed for the evaluation felt that the impact of the research programme on decision-making probably could not have been greater, since political decisions are affected by many other factors besides research-based knowledge (Otronen and Tirkkonen 2002). Problems related to adjusting research to policy are also caused by the different logics and time-scales concerning these fields.

The FIBRE programme was succeeded by a more applied research-oriented programme MOSSE, financed mainly by the Ministry of Agriculture and Forestry and the Ministry of the Environment. The MOSSE programme ran between 2003 and 2006 and included more than 60 projects. In MOSSE the scientific level of proposed projects was first reviewed by distinguished scientists, after which the funding ministries made decisions largely on the basis of the applicability of the projects' expected results. In this way the ministries were able to ensure that the projects included in the programme best corresponded with their own practical information needs. Dissemination of research results was an integral part of MOSSE throughout the course of the programme. Interim results were reported in 2005 and final results in 2006 (Otsamo 2005, Horne et al. 2006).

Research concerning forest certification highlights some of the tensions in the relationship between research and practical decision-making. On the one hand, concerns were raised that there are only scant research results on which to base certification measures, and even when research is conducted for this end it cannot keep up with the rapid development of certification standards. On the other hand, some end-users commented that the certification criteria are not based on research but are rather political agreements made on economic and strategic grounds. Researchers will only waste their time in trying to affect them.

In general, research may be expected to affect biodiversity conservation by providing better factual grounds for actors to change their behaviour willingly and also for decision-makers for setting limits to economic and other activities through legislation. Research-based knowledge is also important for the effective channelling of resources. Furthermore, the accumulation of knowledge can be seen as a value in itself: it is valuable for us to be acquainted with the biodiversity that surrounds us and to understand the processes which sustain it. The accumulation of knowledge commonly increases appreciation of biodiversity, which in turn advances its conservation.

The majority of the respondents to the survey made for this evaluation felt that research-based knowledge on biodiversity had increased (77% of respondents) and that research had contributed to biodiversity conservation during the Action Plan period at least to some degree (80% of respondents). The increase in knowledge had been most notable regarding technical issues, e.g. habitat requirements of forest species and the importance of decaying wood, retention trees and forest key biotopes. On the other hand, knowledge was in their view still largely missing e.g. for genetic diversity, connections of biodiversity with society as well for biodiversity on the level of habitats and ecosystems. Although the amount of information has increased, it remains fragmented. This limits the application of research-based knowledge.

6 Future challenges to the safeguarding of biodiversity in Finland

One of the tasks of the evaluation was to assess the probable development of biodiversity in Finland until 2010. Based on the preceding analyses of recent policies, measures and trends an overall picture of the situation in 2010 can be given (Section 6.1). A general conclusion from this picture is that biodiversity in Finland is likely to continue to decline, although the rate of decline may be slowing down in some cases. Building on these observations some major remaining challenges and possible future measures can be identified (Section 6.2.). This leads to recommendations to be considered in the new Action Plan for 2006–2016 and in implementing biodiversity policies in the future in general (Section 6.3).

6.1 Scenario for 2010

The EU aims to halt the ongoing loss of biodiversity by 2010 (European Commission 2001). Some stakeholders with active interests in the efficient exploitation of natural resources are confident that the measures previously or currently implemented to maintain biodiversity will be sufficient to achieve reasonable success with regard to this key objective. According to this view the growing lists of threatened species primarily reflect either increased knowledge or an ongoing and acceptable dynamic process between man and nature: the increasingly intensive extraction of natural resources necessitated by wider socio-economic trends variously affects the populations of species in Finland, making some species more rare and others more common. Such trends can thus be seen as inevitable and acceptable since society and the environment are in a state of constant adaptation. There is no longer any truly original ”natural state”. According to this view, species and habitats can also be adequately preserved by means of active management in existing protected areas even if their populations decline elsewhere.

This evaluation indicates that such perceptions of the adequacy of present measures cannot be justified scientifically. In the light of current trends, we have drawn the following conclusions:

- Habitats in Finland have changed and continue to change both quantitatively and qualitatively, with clear negative impacts on native biodiversity. More native species and habitats are consequently coming under threat to varying degrees, although for some habitats the rate of decline has slowed down.
- The greatest changes are occurring in farmlands and other human-created habitats as well as in forests and on shores. Without further measures these ongoing trends will lead to a decline in historical biodiversity contrary to the Action Plan's objectives.
- In well-known species groups the declining trends are relatively slow. The proportion of threatened species, which was 10% of the assessed species in 2000, can be expected to increase to around 11% by 2010 under business as usual assumptions. This would mean that some 150 more species will be classified as threatened unless their population trends change from the present. The rates of increase in the proportions of red listed species vary considerably between species groups. The greatest increases are expected for certain groups of insects and fungi.
- This evaluation has been able to use information on more than 2200 species that were either not assessed or taxonomically or ecologically too poorly known to be included in the last red list assessment (Rassi et al. 2001). Nearly 400 of these species are expected to become threatened or extinct by 2010 but there is no certainty concerning trends in their conservation status during the Action Plan period.
- The numbers of extinct species will evidently increase, even in well-known species groups.

In the light of such trends the EU target is very challenging. Present measures, whereas they have yielded significant results, are not sufficient to achieve the target, not even in the longer term.

6.2 Remaining challenges

Effective implementation of sector responsibilities

Analysis of the changes in the administration of key sectors (Section 3.1) has shown that not all sectors have taken full responsibility for biodiversity conservation in their own areas. The Action Plan was largely based on continuing established practices in different organisations. Therefore few organisations have critically debated the allocation of resources or considered the role of biodiversity conservation in their own day-to-day operations.

In general terms the Action Plan did succeed in legitimising the biodiversity issue, which has thus become a shared public interest. It also summarized many mainstream biodiversity policies and strengthened them. The Action Plan and its follow-up processes provide a good framework for dialogue between various stakeholders. The next challenge is to identify those measures within each sector that truly contribute to the safeguarding of biodiversity in cost-effective ways, and to focus on those. To this end existing measures should be critically assessed, new measures should be explored, research should be continuously re-focused, and functioning feedback mechanisms should be established.

New measures

Several exploitation and management practices with negative effects on biodiversity are still implemented rather schematically over large areas, especially in forestry and agriculture. Although some new requirements have been set for these practices e.g. as a result of forest certification, protection of forest key biotopes and the agri-environmental support scheme, the harmful effects of these practices on biodiversity still dominate over the positive effects of specific actions taken to protect threatened species and habitats (e.g. the establishment of protected areas and the management of traditional rural biotopes).

In order to remedy this situation two kinds of measures are needed. First, the minimum requirements for practices affecting large areas need to be developed further. For example, basic measures included in the agri-environmental support scheme should be adjusted in the light of recent studies of their effectiveness (Kuussaari et al. 2004), landscape planning should be encouraged particularly in privately-owned forests and maximum allowed numbers of reindeer should be set to reflect the condition of lichen grounds revealed by monitoring studies (Kumpula et al. 1997, 2004). Second, new and more diverse practices should be developed to allow for more options in the management of natural resources. Since most of the land in Finland is privately owned and the average size of properties is small, there are many landowners and the aspirations of landowners are accordingly diverse. This should be seen as a major potential for biodiversity management.

There are several ways of developing concrete measures for safeguarding biodiversity. Forestry extension should offer several alternative management options, including those emphasising the maintenance and enhancement of biodiversity. Foresters (often companies) should also adopt their harvesting practices accordingly. Owners of summer cottages can be encouraged to manage their properties in ways which favour threatened and declining shore species. Farmers should be encouraged to implement novel biodiversity measures within the agri-environmental support scheme and management practices in urban parks and suburban areas can be adjusted to increase their biodiversity values.

Since biodiversity is in many ways affected by human activities, and human activities also create favourable conditions for many species, the diversity of human action is vital for biodiversity. The general direction in the exploitation and management of natural resources should be away from uniform practices applied over large areas and towards greater appreciation of local circumstances. Single-truth command-and-control philosophy has proven to be an unsatisfactory basis for natural resource management and should be avoided (Walker 2005).

Additional research and evaluations

Recently Pullin et al. (2004) and Sutherland et al. (2004), among others, have demanded that conservation efforts should be based on more solid evidence than previously. In the UK, these studies claim, the consequences of conservation efforts are rarely documented, systematic reviews of previous experiences are seldom made and research data are scantly utilised when new management plans are drafted.
In Finland the Action Plan and related activities have led to research-based biodiversity management plans and studies on the effects of management measures. Local plans have been rather effectively directed by national management and restoration guidelines (e.g. Ennallistamistyöryhmä 2003) and the effects of the measures outlined in these have been monitored and studied (e.g. Hokkanen et al. 2005, Horne et al. 2006). In the case of forests, the effects of nature management measures have also been studied in managed areas (Horne et al. 2006).

Despite these advances, many important questions remain unanswered. There are significant uncertainties, for example, related to the cost-effectiveness of different types of measures. Climate change and economic and social development are also likely to change the contexts for biodiversity conservation and to introduce new uncertainties. Thus novel research is needed, for example, to assess the need for new protected areas in more detail[15]. This should involve analyses of existing vs. historical areas of different habitats and their characteristic features, species habitat requirements and population viabilities under different future scenarios (cf. Miljövårdsberedningen 1997, Angelstam and Andersson 2001). As a part of such an assessment the delineation of previously protected areas should also be re-evaluated, especially in the case of mire complexes.

More research is particularly needed on the societal aspects of biodiversity conservation. As conservation depends on the values associated with it, people's reactions to different types of incentives need to be analysed. Furthermore the pressures that economic and societal drivers generate should be

[15] The general need for new protected areas (esp. forests) has been clearly demonstrated in many previous studies (e.g. Virkkala and Toivonen 1999, Virkkala et al. 2000). What is needed, however, is a detailed analysis of the required amount and distribution of protected areas in different biogeographical zones.

studied more closely. This research would provide a basis for new and more diverse types of policy instruments. Interdisciplinary biodiversity research integrating natural and social sciences is also needed.

One major task is to turn new research-based information into practice. A number of important surveys, evaluations and research projects on biodiversity have been completed recently or are still under way. These include nationwide surveys of rocky outcrops, sand dunes and underwater marine habitats, a national assessment of threatened habitats and several pilot projects in forest conservation. The challenge is to translate the findings of these projects into practical measures, but this also requires a profound understanding of the practices which are to be changed.

The need for further research should also be examined in the light of the needs of policy makers and professionals responsible for the implementation of policies. In the UK a list of 100 key issues has been produced in a participatory process involving governmental and non-governmental actors (Sutherland et al. 2006). Several of the questions are likely to be relevant in Finland too. Some of these issues are already being studied[16], whereas others remain central topics to be studied in the future[17]. However, the maintenance of regular dialogues between actors on questions and results of studies is likely to be more important than any single question.

Because of the overall principle of sector responsibility and the general phrasing of most measures, the achievements of the Action Plan are difficult to estimate on the whole. It is in many cases difficult to say what would have been different if the Action Plan had not been drafted at all (cf. Ferrano and Pattanayak 2006). More concrete articulation of goals and measures should be attempted in future. The effective monitoring of the effects of the measures should also receive attention when new measures are being planned. The need for integrated quantitative monitoring of outcomes has been sharply underlined, for example, by Brooks et al. (2006) in the context of conservation-oriented development projects. In many such projects considerable financial resources are spent without any monitoring-based verification of the presumed outcomes of the implemented measures.

Further, focused research and evaluations can help to specify objectives and to make the measures more detailed. Practically oriented research provides feedback for adaptive management of natural resources (on adaptive management see Holling 1978, Walters 1986, Walters and Holling 1990, Lee 1999) and thus fosters a social learning process. Care should be taken to ensure systematic recording of applied biodiversity research. An example of such an initiative is ConservationEvidence.com[18] that aims at collecting world-wide results of conservation measures.

Biodiversity monitoring and indicators

The process of compiling this evaluation has shown that many important factors affecting biodiversity, as well as changes in biodiversity itself, are not being monitored at a level that would allow a balanced evaluation of all measures and their effects. Lack of monitoring effort has hindered the effective evaluation of, for example, the state of shore habitats and effects of land-use decisions on biodiversity in urban areas. The vital need for effective indicators of the effects of human interventions and the development of biodiversity has been stated in many international contexts, most notably by the Millennium Assessment (Carpenter et al. 2006).

Although biodiversity monitoring in Finland is rather comprehensive, it is also fragmentary. There are gaps in the monitoring schemes of habitats and species (e.g. shores, rocky outcrops, vascular plants), and there are problems in using existing data from the point of view of biodiversity monitoring. Some of the most comprehensive habitat level monitoring schemes have had biodiversity monitoring only as a secondary goal (e.g. the National Forest Inventory), and measurements focusing explicitly on biodiversity

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[16] Examples of such questions are: ”15. What lessons can be learnt from agri-environment schemes to optimize their biodiversity gain and ecological benefit?”, ”70. How effective is the current UK protected area network for protecting wildlife under current conditions?” (Sutherland et al. 2006.)

[17] Examples of such questions are: ”36. How can provision for wildlife be maximized in existing and new urban development, urban greenspace and brownfield sites?”, ”40. What criteria should be used to determine when to intervene to deal with invasive species?”, ”60. How can we increase the resilience of habitats and species to cope with climate change?” and ”83. How do recreated habitats differ from their semi-natural analogues?” (Sutherland et al. 2006.)

[18] See http://conservationevidence.com/index.shtm

have been added to their programme only in recent years. This has restricted the use of monitoring data for the verification of models, for example, on the development of decaying wood (c.f. Box 1). Many species-level monitoring schemes have originally stemmed from interests in the occurrence of certain species themselves rather than in the study of more general trends. These gaps and problems mean that the overall status of biodiversity must be deduced from a combination of many partly incomplete sources.

Recently there have been attempts to view biodiversity monitoring in Finland as a whole (Toivonen and Liukko 2005, Auvinen and Toivonen 2006). The need for the further development of biodiversity indicators has also been acknowledged and suggestions on how this could be made have been presented (Auvinen and Toivonen 2006). An essential prerequisite for a solid biodiversity monitoring scheme is the identification of those variables which best reflect changes on a wider scale. According to the findings made in this evaluation, threatened species, which have been a key parameter used in Finnish biodiversity policies since the 1980s, are not the best indicators of habitat level changes. Their population estimates often contain considerable amounts of uncertainty and the causal relationships underlying their population trends can only seldom be identified with clarity.

Methods are needed which utilise the best available data on the extent and quality of habitats as well as on the population trends and ecology of well-known selected species. The monitoring of nature protection areas (Heinonen 2006) provides one reference, but monitoring is also needed in non-protected areas as they harbour in any case the greater part of total biodiversity. Due to the slow processes and partly uncertain cause-effect relationships it is essential that the responses to biodiversity decline are also systematically recorded and monitored, including the costs of the measures. Such monitoring provides a basis for future evaluations of measures.

Many good examples of promising national and international biodiversity monitoring methods exist (e.g. Haines-Young et al. 2000, Hinterman et al. 2002, RIVM 2002, de Heer et al. 2005, Gregory et al. 2005, Loh et al. 2005). The challenge is to develop effective monitoring without increasing the expenditures on monitoring. Maintaining and further encouraging volunteers to monitor and developing of multipurpose monitoring schemes can contribute to effective monitoring at reasonable costs (c.f. Danielsen et al. 2005). The development of remote sensing techniques is likely to provide good support for biodiversity monitoring especially at the landscape level. The pilot analysis carried out for this evaluation gave promising indications that the CORINE-results can be used for general monitoring purposes, in combination with other detailed spatial data.

6.3 Conclusions and recommendations

- The loss of biodiversity will not be halted by 2010 and the current measures will have to be developed further in order to achieve the objective in a longer-term perspective. Sector responsibility should be emphasised in the implementation.
- New measures are needed to limit the negative effects of resource exploitation on biodiversity. Social, cultural and economic incentives to preserve biodiversity should be created and developed.
- Participation, innovation and social learning should be emphasised in new measures and in the development of existing measures.
- Research will continue to accumulate knowledge of the dynamics of biodiversity as well as on drivers, pressures and responses related to biodiversity change. Research on economic and social aspects of biodiversity and specific measures should receive special attention.
- Future measures should be planned in such a way that their effectiveness can be more easily assessed. Evaluations of specific measures should be part of the research agenda.
- Dialogues between stakeholders should be maintained to identify pertinent research topics and to debate findings and their implications.
- Changing conditions will require adaptation of measures for safeguarding biodiversity.
- Well designed monitoring is a key to effective feedback processes for adaptive management of biodiversity. Accumulating monitoring data is indispensable for model validation and for reduction of uncertainties concerning the development of biodiversity.
- Systematic monitoring should cover pressures, states, impacts and responses in order to provide a basis for future evaluations.
- New monitoring methods and methods integrating different types of monitoring, such as spatial analyses supported by remote sensing and volunteer field work, should be developed further.

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