Final Report for EU Contract

Development and review concerning Forest Focus

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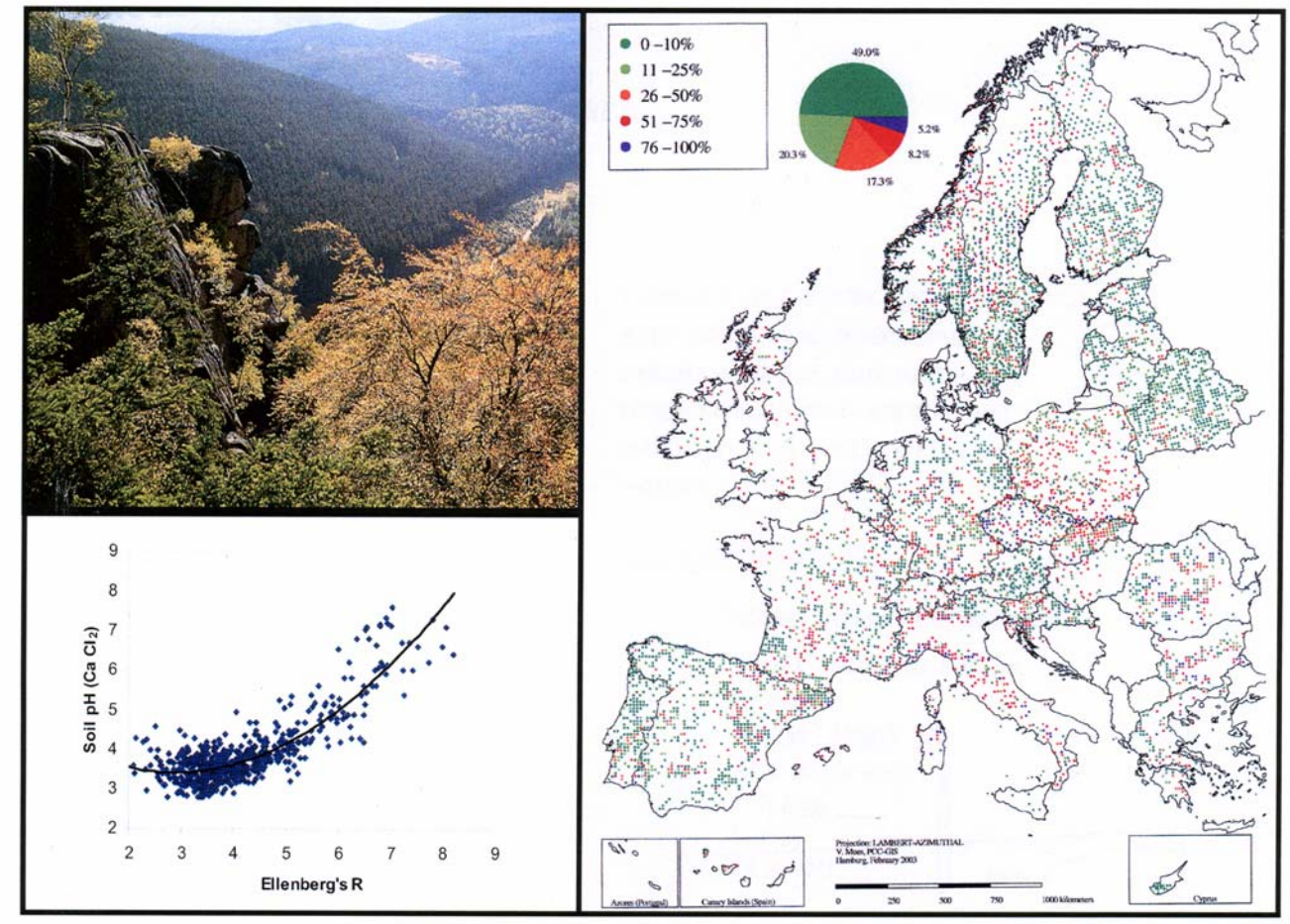

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Executive Summary

A comprehensive and detailed review of the actions undertaken under the EC Forest Focus Regulation ((EC) 2152/2003) has been undertaken and this has included stakeholder consultation. As requested by the CEC particular attention has been placed on recommendation on how forest monitoring might best be conducted after December 2006 when Forest Focus expires (recommendations for improvement and development of future forest monitoring activities at the EU level).

The review concludes that the original objectives of the air pollution and Forest Focus regulations have been largely fulfilled. The Forest Focus monitoring network has been mainly successful in monitoring air pollutant and other damage/impacts to forests. The high spatial coverage and long time series make the data unique and of value to scientists and policy makers. The scheme, as currently in use, is only partially suitable for future monitoring needs.

Progress is being made to develop the network and its interactions with other related monitoring activities (national inventories, remote sensing, MCPFE criteria & indicators, FCCC & Kyoto monitoring), but this work is at an early stage. The Forest Focus networks form a sound basis on which to build an EU Forest Information System within the LIFE+ Programme, but work is required now if effective forest monitoring at the EU level is to be achieved in the future.

Future EU forest monitoring is needed to provide focussed information as required under international obligations, for EU policy development and for the monitoring of EU forestry actions. Such information is needed in four areas: pollution, biodiversity, climate change and sustainability (including the protection functions of forestry within the landscape). Significant added value is achieved through the harmonisation of forest monitoring within the EU. It is recommended that a framework is developed which requires Member States to address forest monitoring in an effective, coherent and integrated way in the National Programmes which are submitted under LIFE+. Current and future information needs are wider, relating to a broader environmental sustainability agenda, not just to air pollution and forest fires. The future system needs to integrate with evaluations of other land uses, to be cost-effective and of an appropriate quality. Resources will be required to achieve this. The review concludes that the monitoring of forest cover and cover by forest type and species, should be addressed through harmonisation of national forest inventories and these need to employ earth observation techniques with appropriate ground truthing. For biodiversity monitoring, forest quality (climate and pollutant impact evaluation), carbon stocks and sustainability, a core framework of monitoring plots within Member States is needed. This should be developed from the existing Forest Focus Network with some specific technical problems being addressed. Perhaps most important of these are the recommendations on cost-effectiveness and that the new scheme needs to be based on the different approaches mentioned above. For many of the attributes which need to be measured using a network of sample plots, this review suggests a stratified sampling scheme based on the recently developed EEA categorisation of forest types and also calls for specific, consideration of protected areas and threatened/rare species. The existing networks need to be modified and enhanced so that they provide more efficient sampling for the new, wider range of objectives (particularly biodiversity and climate change monitoring – both carbon stocks and impacts of climate change).

The ending of the Forest Focus Regulation (December 2006) removes the obligation from Member States to conduct co-ordinated, EU-level forest monitoring and the co-funding of the network. The potential for slippage back into uncoordinated activities which yield poor quality data of the wrong type and of poor spatial and temporal coverage is considerable. There is a strong case for a European-wide framework which allows for efficient management, data recording, analysis, quality control and reporting. Developments are recommended here which require coordination, but would avoid the problems outlined above by moving European forest monitoring forward effectively. This would be a major step in the achievement of sustainable forestry, rural development and environmental protection in Europe.

Introduction

The Community and Member States are committed to implementing internationally agreed activities relating to the conservation and protection of forest. The Community had addressed two of the causes adversely affecting ecosystem conditions by means of Council Regulation (EEC) No. 3528/86 on the protection of the Community's forests against atmospheric pollution, and secondly in Council Regulation (EEC) No. 2158/92 on protection of the Community's forests against fire. Both these regulations expired on 31 December 2002 and, in the general interest of the Community, the monitoring activities which had been established under those regulations were continued and developed by integrating the activities which had been conducted under the two regulations into the new Regulation (EC) 2152/2003 called 'Forest Focus'. Article 4 (1) of the Forest Focus Regulation defines the monitoring networks (Level I and II).

In January 2005 the Commission initiated a review of the actions undertaken under Forest Focus and asked in particular for the review team to make recommendations for the development of the monitoring scheme (Level I & II), and for the continuation of its implementation beyond the fixed period of the regulation (2003 to 2006). At the review kick-off meeting three main work areas (tasks) were agreed for the review as follows:-

Work Area 1

Analyse the requirements of international and European policies for forest monitoring. Provide an overview of the existing forest monitoring initiatives and assess the usefulness of these initiatives to fulfil the requirements of international and European policies for forest monitoring.

Work Area 2

Review the monitoring scheme on air pollution effects on forests.

Work Area 3

Make recommendations for the improvement and development of future forest monitoring activities at the EU level.

- Improving the present monitoring scheme.
- Development of instruments for monitoring of forest biodiversity.

The Review Team's key activities have been to gather and assess the diverse evidence base for the review, to elicit stakeholder views using questionnaires and meetings and to present conclusions for discussion and amend their written reports as necessary. Key milestones have been as follows:-

- Meetings of the Review Team and of the Review Team with the CEC.
- A stakeholder questionnaire (March & April 2005).
- A stakeholder meeting (April 2005).
- Attendance of the Forest Fires Expert Group Meeting in Brussels in February 2005.
- A short presentation to the ICP Forest Task Force meeting in May 2005.
- A questionnaire on published outputs (also sent to the Stakeholders who attended the stakeholder meeting in April 2005).
- A workshop meeting in November 2005.
- Preparation and submission of intermediate reports to the CEC in June 2005 (1st Intermediate Report) and in December 2005 (2nd Intermediate report) which cover work areas 1 and 2 respectively.

- Presentation of an update paper on the review to the EU Standing Forestry Committee in February 2006 and response to the comments received.
- Review team workshop meeting in March 2006.
- Submission of a draft final report in June 2006.
- Presentation of the draft final report to the EU Standing Forestry Committee in July 2006 and response to the comments received.
- Submission of this final report (August 2006).

This final report presents the results of the work undertaken. After the **Executive Summary** and **Introduction**, the report presents a short *summary of the findings* and *specific detailed recommendations for the future* for each of the three work areas (Section 1 **Work Area 1**, Section 2 **Work Area 2** and Section 3 **Work Area 3**), **Overall conclusions from review of the existing programme** (Section 4) and **Overall recommendations for the future** (Section 5). Additional information is presented as **References** and in three **Annexes**.

Work Area 1

Analysis of international conventions & legislation, and overview of existing forest monitoring systems - gap analysis

Aims

Work Area 1 provides an analysis of international and European policies (strategies, resolutions, legislation etc.) relevant to forest monitoring. In so doing, this work strand delivers the prior data required to meet specific objectives of the review, namely:

Objective 1. To produce a review of existing forest monitoring initiatives in Europe and to critically appraise these monitoring programmes and their contribution to implementation of international and European policies (strategies, resolutions, legislation etc.) relevant to forest monitoring. Specifically, the review is to analyse the requirements of international and European policies (strategies, resolutions, legislation, etc.) for forest monitoring.

Objective 2. To assess the monitoring scheme on air pollution effects on forest (Regulations [EEC] 3528/86 and [EC] 2152/2003) taking on board lessons that can be learned from over 10 years of targeted, trans-national forest monitoring efforts.

Work Area 1 is broken down into three distinct activities:

- **Activity 1.1** provides a detailed overview of the information requirements and monitoring needs arising from International Conventions, Pan-European processes and EU legislation.
- **Activity 1.2** provides an overview and analysis of existing monitoring and inventory systems related to forests. This activity includes a stakeholder questionnaire used to assess the usability and exploitation of data collected under the terms of successive EU legislation on forest monitoring.
- **Activity 1.3** undertakes an analysis to define the gaps in monitoring and to identify the additional information and data needed to fulfil Pan European and International obligations.

Activity undertaken under this WP forms the larger part of the First Interim Contract Report dating to June 2005.

Review Work Undertaken

The review is set against a background where Treaties of the European Union (EU) make no provision for a comprehensive common forestry policy. In the EU, forest policies are implemented by Member States within a clearly defined framework of long established ownership rights that accounts for the complex history of national and regional laws and regulations. Yet the EU recognises that the management, conservation and sustainable development of forests and woodlands are of major concern and, as such, should be the subject for common policies. The resulting requirements within the EU have proved crosscutting, spanning from the CAP through to sustainability, rural development environment, trade, internal market, research, industry, international co-operation and energy policies. The review also recognises that forestry policy, its legal framework and the institutional settings of forestry in Europe are undergoing rapid, and incremental dynamic change. This in turn reflects a similar level of global activity, as increased scrutiny and effort is devoted to the broad agendas of sustainability. From the perspective of a strategic overview, it is evident that existing policy processes have several strands, different end states, and the specificity of monitoring tasks and effort in part reflects the stringency of stated policy objectives.

The complex scenario of international obligations articulates the backdrop against which the relevance of current and emerging needs for harmonised information on forests provided by the Forest Focus regulation can be determined.

Under **Activity 1.1** the review specifically focussed on the major, global and European legislative and regulatory processes summarised at Table 1. This activity included the development of a dedicated meta-database supporting downstream analytical components of the review.

Activity 1.2 provides an overview and analysis of existing monitoring and inventory systems related to forests, determining the scale and monitoring activity undertaken, here summarised in Table 2.

Conclusions

Key conclusions for Work Area 1 are that, while accounting for the major, significant increase in international attention undertaken as part of the sustainability agenda, overall information for forest-related reporting needs by international policies and instruments can be considered as converging around broadly similar requirements, here separated into the three categories of:

- *coverage*, where (physical, ecological, social and economic) location, area and boundaries through time are the key attributes and provide the basis for assessing *change*;

- *biomass*, where volume, growth and increment, also determined by (interacting physical, bio-geochemical and ecological) structures and composition, through time are the key attributes and provide the basis for assessing *dynamics*;

- *disturbance / condition*, where biotic damage, abiotic damage and fires through time are the key attributes and provide the basis for assessing *impacts*. Of relevance in this context, *condition* (described either as quality or vitality) forms a subset of this category.

A fourth (generic) category of *miscellaneous* brings together those targeted monitoring activities providing evidence in support of specific policy objectives (e.g. conservation of biodiversity, protection of water resources…).

Underpinning these information needs, that form the quantitative science base for informing, for instance, thematic policy needs (for instance biodiversity, carbon accounting, genetic conservation, etc), lies a universally-recognised driver of strong scientific legitimacy, that reaffirms those perspectives from which data collection are undertaken, and in so doing provide the robustness and confidence required to interpret key findings.

Through comparison and evaluation of the existing provision of forest-related monitoring data and the forest-related reporting requirements of existing international policies and instruments, **Activity 1.3** reached conclusions concerning gaps additional information and data need to fulfil Pan-European and other International obligations in the current monitoring effort, as follows:

- Long-term continuous datasets generated from large-scale monitoring activities are of significant value, and are essential for the continued provision of a scientific evidence-base required for robust policy formulation and evaluation. Yet the capacity of these data to constrain uncertainties in current knowledge and in observed trends, and to transfer this understanding of uncertainty to policy formulation and assessment of policy outcomes, remains undetermined.
- The majority of international obligations require specific indicators and monitoring methods for climate change, biodiversity and protective functions of forests (e.g. Forest Focus, UNFCCC and CBD). Monitoring of forest resources is an essential activity required to deliver the global agenda on sustainability.

- The focus of monitoring is largely on ecological sustainability, with the sustainable use of forest resources identified as the basic driver for forest ecosystem monitoring. Economic, social or cultural sustainability are less covered or rarely taken into account.
- The degree to which existing monitoring networks are representative of forests in Europe has yet to be fully determined quantitatively, making it difficult to assess their suitability for providing the robust evidence base necessary to support objectives of the international sustainability agenda.
- Data collection and reporting are expensive. No comprehensive cost-benefit analyses, implementing agreed and standard methodologies, exist to cover the various individual schemes or the collective monitoring activity. This makes it difficult to evaluate the relative merit of individual schemes or the overall monitoring effort.
- A large number of international institutions and/or networks collate, store and report the data; few are primary data collectors in their own right. Mutual benefits can be defined resulting from the closer co-operation and co-ordination of data collection, storage and reporting. Co-operation would require harmonisation of methods, terms and definitions, making results more comparable and achieving greater efficiencies. Further, this suggests a need to re-balance the financial effort between primary data collection, and data storage, synthesis and evaluation. Alongside this, greater focus is needed to determine generic and specific reporting needs across the forest-related aspects of the sustainability agenda, as the basis for hypothesis formulation/testing and for network and sampling design.
- There is significant variation in data coverage and collection intervals between and within schemes. This has considerable effects on the interpretation of results, the impacts of which are very difficult to assess quantitatively. Known differences in response time between different climatic regions, and the ecosystems they support, have not been fully evaluated or accounted for.
- The requirement to monitor successful implementation of international conventions on air pollution now appears a lower priority in the international agenda. Air pollution monitoring has continued in parallel with focussed political convergence around the internationally agreed environmental agenda, focussing on sustainability.

Table 1. Summary of major international legislative and regulatory processes considered by the review.

AREA	REVIEW CONSIDERATIONS
UN Conventions on Climate Change	• General Background • European Union Decisions • Reporting Guidelines • What is to be reported in the forest sector
UN Convention on Biological Diversity (CBD)	• General background • EU decisions • System of delivery and reporting
Global Forest Policies and the UN Forestry Forum	• United Nations Forum on Forests • Objectives • Reporting requirements
Forest-related EU reporting needs	• General background • EU decisions • Reporting requirements
EC Habitats, Species and Birds Directives	• Background • EU decisions • Reporting guidelines
EU Forest Reproductive Materials Directives	• Background • EU decisions • Reporting guidelines
EU Plant Health Directives	• Background • EU Decisions • Reporting Guidelines
Ministerial Convention on the Protection of Forests in Europe (MCPFE)	• Overall objectives • Reporting requirements relevant to forestry • System for delivery and reporting

Table 2. Forest-related reporting requirements for major international legislative and regulatory processes.

LEGISLATIVE & REGULATORY PROCESS	MONITORING DATA SOURCES	MONITORING DETAIL
Forest-related reporting for the UN Conventions on Climate Change	Data drawn largely from National Forest Inventories (NFI), supplemented by specific networks developed at national, or sub-national scales	Monitor annual changes in: • forest land area • aboveground biomass C pools • belowground biomass C pools • dead wood C pools • litter C pools • soil C pools & non-CO2 GHGs
Forest-related reporting for the UN Convention on Biological Diversity (CBD)	Data for national reports collected from different sources with no systematic standardisation between countries on data collection	• Monitor the components of biological diversity • Monitor processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity
UNCED Statement of Principles for the Global Consensus on the Management (Global Forest Policy and the UN Forestry Forum)	Data largely from National Forest Inventories (NFI), supplemented by specific networks developed at national, or sub-national scales, with no systematic standardisation between countries on data collection	• Monitoring of forestry programmes, policies and strategies • Monitoring of forest health, productivity, cover
FAO Global Forest Resource Assessment		Monitoring of forest area, area change, wood volume, woody biomass, plantations, trees outside the forest, biodiversity, managed forests, forests in protected areas, forest fires, wood supply and non-wood forest products
EC regulation no 2152/2003 Forest Focus	Dedicated, joint plot scale network	• Air pollution monitoring, air pollution effects and other agents and biotic and abiotic factors of anthropogenic origin impacting on forests • Monitoring of forest fires, their causes and effects • Monitoring of soils, climate change effects and biodiveristy, carbon sequestration, and the protective functions of forests
Convention on Long-Range Transboundary Air Pollution (CLRTAP)		• LI plots monitor forest health status through tree crown condition, soil chemistry and foliar nutrients • LII plots monitor ecosystem functioning through ambient air quality and forest health status
Ministerial Convention on the Protection of Forests in Europe (MCPFE)	• Forest Resources dataset of the United Nations Economic Commission for Europe (UNECE/FAO), obtained from national sources and mainly National Forest Inventories with no systematic standardisation between countries on data collection • Genetic resource data is obtained from the International Genetic Resources Institute • Additional data from ICP Forests plot scale network	• C1: Maintenance and Appropriate Enhancement of Forest Resources and their Contribution toGlobal Carbon Cycles • C2: Maintenance of Forest Ecosystem Health and Vitality • C3: Maintenance and Encouragement of Productive Functions of Forests • C4: Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest • Ecosystems • C5: Maintenance and Appropriate Enhancement of Protective Functions in Forest Management • C6: Maintenance of other socio-economic functions and conditions

Work Area 2

2.1 Quality of Forest Focus Sampling Scheme

Aims and methodology

To assess the quality of the Network, data were assembled from both the Level I and Level II Networks. The distribution of sites, the variability in measured attributes and the relationship between attributes and corresponding national statistics were considered.

Level I plots were observed annually from 1987, in 36 countries and included 125 species on a total of 82758 plots resulting in 1844554 trees assessments.

For the Level II network that was set up in 1994 the assessments were from 37 countries, included 43 species giving a total of 822 assessments.

The following aspects of the plots were considered in more detail.

1. The locations of the plots.
2. The species observed.
3. The number of plots in relation to the forest area (see figure 1).
4. The size of the plots and tree density.
5. The variability between plots for selected variables.

For most but not all countries the Level I plots are on a systematic grid (usually 16 km by 16 km but can vary from 4 km by 4 km to 24 km by 32 km). However these patterns are imposed upon the spatial distribution of the forests. The effect of the combination sampling strategy and the forest distribution is to give more complex spatial pattern.

The plots in Germany are placed on a grid and the nearest neighbour distance distribution shows a major peak at around 9-10 km with a minor one at about 3.5 km, neither appear to correspond to the planned grid of 4km or 16km. However, the overall pattern is clustered. Similarly France shows a clustered distribution but with a different pattern. In the UK the national Level I plots show a spatial pattern which is approximately compatible with complete spatial randomness as indicated by the K function. How far these differences in pattern reflect the different distributions in the countries and how far they represent the implementation of the sampling scheme requires further investigation using the spatial distribution of forests within each country.

When considering the effectiveness of the location of plots the following aspects need to be considered in addition to the spatial distribution of sample points.

1. The spatial distribution of key ecological factors, which requires a European wide map of such factors.
2. Need for local replication, which requires quantitatively expressed specification of the requirements of the network.

For Level I plots of the 125 species 23 species account for over 90% of the total assessments while the lowest 34 account for only 0.1% of the assessments. The dominant genus are: Pinus, Picea, Quercus and Fagus. The uneven distribution of species within the sample implies that many species will have too low a replication for there to be a reasonable probability of being able to detect changes.

For Level II plots 90% of the assessments are for 11 out of the 43 species while the lowest 9 represent only 0.1% of the assessments. The dominant genus are again : Pinus, Picea, Quercus and Fagus. The distribution of species is different from the Level I plots with a

greater proportion of Picea in Level I and a greater proportion of Fagus in Level II. Again there is the issue of the adequacy of the replication of the majority of the species.

Using the Level I summary information, the relationship between number of plots and forest area in each country was examined. Romania was seen to be an extreme case with 3840 sample plots (0.61 sample plots per 1000ha of forest) compared to an average of 0.08 sample plots per 1000ha of forest. Apart from Romania there is still noticeable variation in the ratio, with some countries such as Sweden and Norway having considerably more sites per unit area of forest. However, the total forest area should not be the major determinant in the sample size selection. More important factors are variability of key indicators and range of forest types within a country. Using the variation recorded in the UK results for crown condition as an indicator of variation a sample size of 150 gives a 90% chance of detecting a 10% difference. About 50% of countries have fewer sample plots and so are potentially ineffective in detecting differences within the country. While for five countries with sample sizes of over a 1000, there is a probability of 99% or more of detecting a change of 5%.

While the median plot size (ground area or number of trees) in the Level II network is reasonably consistent there are some examples, most noticeably Germany, of extremely large Level II plots. The size of the plots is of less importance than their homogeneity as information can always be weighted by size. Clearly larger plots are more likely to be heterogeneous and leading to the requirement of the use of sub-plots within them. There are noticeable differences in the range of tree densities between countries. In the absence of further information we cannot conclude whether or not this reflects the variation in density within the countries as a whole.

In order to examine the range of variation, and thus the required sample sizes for different parameters, six variables (foliar concentrations of N, P, K, Fe, Cu and Mn) were selected from Level I plots' foliar data for 1995 and a measure of variation was computed. For one country the mean value for foliar nitrogen was out of line with other countries leading to the very high coefficient of variation. Some countries have consistently low variation, others vary from variable to variable even within this limited range of attributes. While an element of the difference in variation could be due to different levels of measurement error, it is likely that the most of the variation is due to inherent spatial variability. Those countries with higher spatial variability are likely to need higher replication. Also with a range of the percentage coefficient of variation between attributes is over 20, this indicates that the required sample sizes may vary by as much as 500 times, or with fixed sample size the power will vary considerably.

In the absence of detailed information on a forest type classification (see recommended actions in section 3.2) a simple broadleaves /conifers categorisation was considered. While there are country differences between the proportion of sites with broadleaves and the areas of broadleaves none of these differences is large enough to be considered abnormal.

Summary and conclusions

Any analysis of the Level I and Level II networks will be limited by the lack of an agreed European-wide classification of forests. What is required is the ability to estimate the extent, variability and importance of each classification type for each response of interest. From that it would be possible to calculate the efficiency of the current design and whether or not there is sufficient power for key comparisons to enable the design to be effective. In the absence of such information a selection of measures has been examined and from these measures it has been concluded that:

- A large amount of data is available from Levels I and II plots but they do not provide a uniform coverage across Europe. However, they do provide a useful resource as part of a long-term assessment of trends.

- The spatial distribution of sites between countries is variable but this is not necessarily critical to the quality of the network. However, this does need to be taken into account in future analyses of the data.

- The variability of attributes differs between countries, and this may reflect inherent spatial ecosystem variability. This could be important when considering optimal sample sizes. While it is reasonable for sample sizes to vary between countries an understanding of the ecological variability within the country and Europe is needed in order to correctly interpret the results and in considering design of future monitoring.

- The variability differs between recorded attributes. This would indicate that a single sample size is not appropriate for all attributes.

2.2 Quality of reporting and results of EU/ICP Forests Technical and Executive Reports

Aims

The aims of this part of the review were to examine how effective the written outputs from the EU/ICP Forests forest monitoring programme were, both to inform and influence policy makers and scientists.

Methodology

The quality of reporting was examined in the following ways:

- Analysis of key documentation and websites;
- Responses from invited European stakeholders at a meeting in Brussels on 29th April 2005;
- Questionnaire survey to all participating National Focal Centres and Ministry contacts;
- Detailed interaction with personnel responsible for Technical and Executive Reports (R. Fischer, E. Vel);
- Analysis of literature citation information;
- Evaluation of the scientific thoroughness and probity of EU/ICP Forests Technical and Executive Reports.

Results of questionnaire and citation surveys

The reporting system appears to be a comparative success. The reports achieve defined objectives, in terms of reaching the target audience of policy-makers and scientists. Report recipients were relatively pleased with the quality of the reports and make regular use of the data and analysis contained within them. A significant view was that reports should make more use of the wider scientific literature when drawing conclusions from the results – they are a little introspective.

Probably the weakest area of the report process is the distribution, which is largely dependent on member countries, who have varying capacity and willingness to distribute the reports effectively. Restricting publication to the English language also reduces opportunities for report readership and utilisation.

A main finding of the review was that the target audience for forest monitoring outputs is much wider than is currently envisaged. Climate change and biodiversity were ranked as more important forestry policy issues than air pollution amongst policy makers. The target audience needs redefining to include new groups of stakeholders and tighter definitions of existing ones, e.g. the kind of scientists/policy-makers.

Another criticism of the reports related to their objectives more than the actual report content. Presenting a summary of the results was almost seen as an end in itself. Some respondents felt that reporting objectives also need to focus on how results can influence policy, enabling supporting actions to be taken to effect change in the way forests are managed and to ensure that policy decisions taken elsewhere in government, e.g. in economic development, do not adversely affect forest health.

Citation and questionnaire surveys suggested a significant uptake of reported results for use in scientific circles, though there was no evidence for widespread use. Greater thought could be given to promulgating the results of the monitoring programme to the scientific community.

Scientific thoroughness and probity

The aims of this part of the study were to: 1) evaluate the scientific basis of the results presented in the reports of EU/ICP Forests, 2) show significant and non-significant tree health responses to the independent variables, 3) summarize the other main results presented in the Technical and Executive reports, 4) evaluate the novelty and soundness of the scientific results and conclusions, 5) evaluate the scientific basis of the conclusions in the Executive Reports, and 6) evaluate the quality of the participation in the editorial process of the reports.
The following EU/ICP Forests reports were evaluated: 1) Forest Condition in Europe, the results of the 2000-2003 large-scale surveys published as Technical Reports, 2) Intensive Monitoring of Forest Ecosystems in Europe, published as Technical Reports from the years 2000 - 2003, and 3) Forest Condition in Europe from the years 2000-2004, published as Executive Reports and summarizing the results of the previous reports. The work consisted of summarising the data analyses and results presented in the reports, and evaluating the soundness of the scientific results and conclusions.

Conclusions and recommendations

- The results presented in reports from the forest monitoring programme have enormously increased our knowledge on the status of European forest ecosystems and the effects of atmospheric deposition.

- Despite comparative success, more effort should be given to tailoring reports to a wider range of stakeholders interested in Sustainable Forest Management than those particularly interested in the effects of air pollution.

- The readership of the reports and utilisation of the monitoring data could be further increased by reviewing the mechanism for report distribution, and exploring the use of other media, especially electronic.

- The methods used in the collecting, analysing and reporting the data are generally appropriate, but could and should be further developed. An analysis of the reliability of the results should be further explored.

- There is need to increase basic research on the factors and mechanisms causing the forest damage as well as the importance of the observed symptoms.

- The datasets are unique and very large and they can and should be further utilized, e.g. supporting modelling and prediction tools to explore future scenarios. These could be of particular value for policy makers. The high spatial coverage compared to similar datasets and the long time series for many of the data make them especially unique.

2.3 Effectiveness and efficiency of the forest focus scheme

2.3.1. The EU Forest Focus budget for 2003 and 2004

Funding for the Forest Focus programme in the 2003 and 2004 EU budgets totalled 29,756,225 (€). These funds represented the EU budget allocation for monitoring activities, forest fire information systems and forest fire prevention measures, and special studies to be carried out in the member states during 2003 and 2004. The special studies were to have originally been carried out during 2003 – 2004 but, owing to delays in approving the implementation regulation, the studies are in fact being implemented during 2005 – 2006. The breakdown of the budget was as follows:

National monitoring programmes 2003	6,536,354
National monitoring programmes 2004	15,737,871
Joint Research Centre	6,382,000
Support to ICP Forests	750,000
Forest Focus Review	350,000
Total	29,756,225

The national programmes consist of 1) co-ordination and management (including overheads), 2) systematic monitoring (extensive monitoring at Level I), 3) intensive monitoring (Level II), 4) forest fire information system and forest fire prevention measures, and 5) studies, experiments and demonstration projects. Co-funding for items 1) – 4) is set at 50%, and for item 5) between 50 and 75%, depending on the nature of the study, experiment or demonstration project. The breakdown of the co-funding for the national monitoring programmes in 2003 and 2004 was as follows:

	2003	2004	
1) Co-ordination and management	476,574	936,821	
2) Systematic	881,599	1,177,924	
3) Intensive monitoring	4,428,181	5,291,738	
4) Forest fires	750,000	3,399,977	
5) Studies		4,931,411	
Total	6,536,354	15,737,871	22,274,225

Thus the EU allocated over 22 million euros to the member states for co-funding activities directly associated with the Forest Focus programme for 2003 and 2004. The allocation for co-ordination and management of the programme appears to be relatively high (6%), but this sum includes overheads (7% of all costs) for all the other activities (2 – 5). Furthermore, there is considerable variation in how the member states have distributed their costs between co-ordination and management and other activities in the national monitoring programme.

2.3.2. Total recognisable costs of the Level I and Level II activities in 2003 and 2004

The number of member states participating in the programme in 2003 was 15, but increased to 24 in 2004 following the inclusion of 9 new member states (Malta is not participating in the programme) on 1.5.2004. As a result, the size of the allocation used for co-funding in 2004 was higher than that in 2003: the new member states were of course not eligible for co-funding in 2003, and the recognisable costs for the new member states in 2004 also included considerable additional outlays for the establishment of their networks.

The total costs of the programme (excluding studies etc.) carried out in the member states (according to their applications for co-funding) amounted to approximately € 63 million. This sum does not include the cost estimates submitted by the member states for studies, experiments and demonstration projects because, in contrast to the monitoring and forest fire

information services and forest fire prevention activities, many of the projects were not included in the final list of co-funded studies, experiments and demonstration projects.

The total costs presented in the following are not the same as the total costs submitted by the member states for the individual national programmes (totalling € 63 million), but are so-called “recognisable costs”. This is a term used to refer to the costs accepted by the Commission, which trimmed the allowable total costs for all the member states to fit in with the overall budget of the Forest Focus programme. The total recognisable costs for 2003 and 2004 amounted to almost € 43 million. The breakdown of the total recognisable costs in 2003 and 2004 was as follows:

	2003	2004	.
1) Coordination and management	953,147	1,873,643	
2) Systematic monitoring	1,763,198	2,355,847	
3) Intensive monitoring	8,856,363	10,583,475	
4) Forest fire information systems and forest fire prevention activities	1,500,000	6,799,954	
5) Studies, experiments, demonstration projects		8,155,612	
Total	13,072,708	29,768,531	42,841,239

There was an extremely large increase (2.3-fold) in the total recognisable costs in 2004 compared to the situation in 2003. The increase in the total costs for forest fire information systems and forest fire prevention activities and for studies, experiments and demonstration projects is due to budgetary reasons; the overall EU Forest Focus budget for 2004 was much larger than that for 2003, and therefore more funds were allocated for co-funding these activities in 2004. The total costs for systematic monitoring and intensive monitoring increased in 2004 as a result of the increase in the number of participating member states from 15 in 2003 to 24 in 2004. The 50% increase in co-ordination and management costs in 2004 is caused by the fact that this also includes overheads (7%) for forest fires and studies. These activities were either not funded in 2003 or were funded at a considerably lower level.

2.3.3. Co-funding criteria applied by the EU

Each member state submitted a request for co-funding for the period 2003-2004. The proportion of co-funding provided by the Commission varied from 50 - 75%, depending on the type of action (e.g. for monitoring etc. 50%, and 75% for certain types of special project). The application form for co-funding was divided into 5 sections: 1) co-ordination and management costs, 2) systematic monitoring (Level I), 3) intensive monitoring (Level II), 4) forest fire information system and forest fire prevention activities, and 5) studies, experiments, demonstration projects. The criteria applied in determining the co-funding for the individual sections varied to some extent.

When deciding on the co-financing allocation for co-ordination and management costs, no costs “ceiling” was applied. This means that there were significant differences in the costs allocated for this section between the member states. No evaluation was made of these costs, although in the case of extremely high individual cost items, the Commission did ask the member states for clarification.

The principle applied in allocating co-funding for the Level I and II parts of the programme was based on calculating the average costs per plot for each monitoring activity. This average was calculated on the basis of the estimated total costs in the individual applications, and the ceiling for recognisable costs was then set at 80% of this average value. The overall strategy was obviously to ensure that the total co-funding for the individual actions in the whole programme fitted the budget. There was tremendous variation in the estimated costs submitted by the individual countries, and no evaluation was carried out on the costs for individual monitoring activities in each member state. The weak point in this

type of approach is that the inclusion of exceptionally high costs, which may in fact have not been fully justified on the basis of the Forest Focus regulation, means that the average costs level used in the calculations is artificially high. It would appear that the Commission made no attempt to exclude such exceptionally high cost levels when calculating the average costs per action per plot.

2.3.4. Amount of co-funding allocated to the individual member states in 2003

Co-ordination and management consists of four sections:

1) co-ordination of the national programme,2) travel costs, 3) data management and data transmission to the Commission, and 4) the mid-term review.

The major factor reducing the overall cost effectiveness of this part of the programme is that, although there were 15 member states implementing the programme in 2003 and 24 in 2005, there were in fact 30 (9 in 2004) separate entities (countries, länders or autonomic regions) receiving co-funding for co-ordinating and managing the programme. In Germany, for instance, each of the 14 federal states has its own programme, and both Portugal (Mainland and the Azores) and Belgium (Wallonia and Flanders) have two completely independent programmes. Cost effectiveness in these countries could undoubtedly be considerably increased by integrating co-ordination and management at the national level. Prior to the Forest Focus programme, each country applied their own overheads percentage, which varied considerably from country to country. Overheads are now restricted to 7% of the total costs, which means that more co-funding is available for operational monitoring activities. There appears to be some unnecessary duplication in the programme concerning data management and data transmission to the Commission. The member states can apply separately for co-funding for this item under 1) Coordination and management, 2) Systematic monitoring, and 3) Intensive monitoring. This of course reflects the different stages in the collection and processing of the data before it is sent to the Commission, but it does raise the point about whether duplicate co-funding is being unnecessarily provided for the same purpose.

Systematic monitoring (Level I activities) consists of three sections:
1) to install and maintain plots of the systematic gridnet, 2) to establish and execute an inventory of the crown condition, and 3) data management and data transmission to the Commission.

This part of the programme is specifically targeted at implementing an annual inventory of the crown condition. There is a relatively strong relationship between the area of forest land and the number of Level I plots (Fig. 1) because the plots are located systematically on a 16 x 16 km grid (except for a 32 x 24 km grid in northern Sweden and Finland).

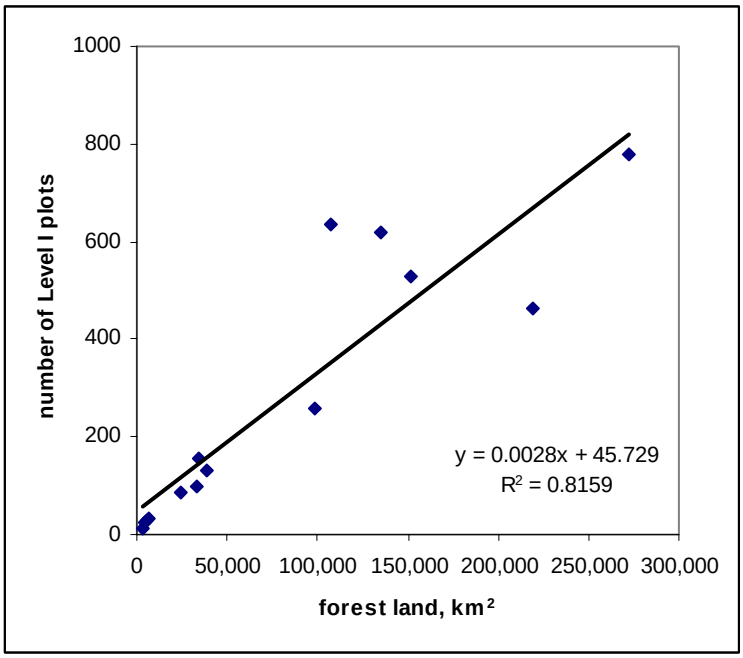

Fig. 1. Number of plots in relation to the area of forest land in the individual member states.

According to this relationship, Germany and Spain have too many, and Finland too few plots in relation to the forest area. However, there are undoubtedly justifiable reasons for this apparent discrepancy. The allocation for Level I activities in most of the member states in 2003 was less than €300/plot, which appears to be a relatively reasonable allocation level. The highest allocation per plot made to one MS was close to €1,000/plot. In Germany there was an almost ten-fold range (88€ to €805) in the allocation/plot for the individual länders. The extreme range of the allocation/plot in Germany is certainly striking, and suggests that cost-effectiveness could be considerably improved by integration of the monitoring at the federal level. Despite the rather confusing situation in a very limited number of countries, the Systematic monitoring (Level I) activities appear, overall, to be relatively cost effective.

Intensive monitoring (Level II activities) consists of 13 sections:
1) to install and maintain plots for the intensive monitoring, 2) to establish and execute an inventory of the crown condition, 3) to establish and execute a survey on the chemical contents of the needles and leaves, 4) to establish and execute increment change measurements/ permanent increment measurement, 5) to establish and execute deposition monitoring, 6) to establish and execute meteorological monitoring, 7) to establish and execute soil solution monitoring, 8) to establish and execute ground vegetation surveys, 9) to establish and execute ambient air quality measurements, 10) to establish and execute assessment on visible ozone injury, 11) to establish and execute phenological observations, 12) to establish and execute assessment on litterfall, and 13) data management and data transmission to the Commission.

This part of the monitoring activities is carried out on so-called intensive monitoring plots. Part of the monitoring is continuous (e.g. deposition, soil solution, meteorology), part is carried out once a year (crown condition, ground vegetation), and part at two- (foliar chemistry) or five-year intervals (growth). The Commission was not able, because the new implementation regulation had not come into force, to provide co-funding for the activities under sections 9-12. As the activity covered by section 3 (needle and leaf chemistry) is carried out at two-year intervals, the application for co-funding of this activity in many of the member states subsequently only concerned costs for 2003.

This is by far the most expensive part of the monitoring programme: Level II activities receive 77% of the total amount of co-funding provided for monitoring purposes (excluding, of course, Forest fires and Special studies). Deposition, meteorology and soil solution are the most expensive activities in Level II, primarily because they are carried out continuously and involve considerable investments in field installations and a high volume of chemical analyses. The maximum number of Level II plots eligible for co-funding is 10% of the number of Level I plots, and 50% of the Level II plots are in turn eligible for co-funding for the most expensive activities (deposition, meteorology, soil solution). However, the actual number of Level II plots in the member states is well below the 10% limit. The Commission's policy of applying individual ceilings for recognisable costs to the separate activities of the Level II monitoring activities undoubtedly makes a considerable contribution to ensuring high cost effectiveness, but the Commission has no direct control over how many plots for which the member states actually apply for co-funding.

Despite strict control of financial management (external auditing), there is insufficient control over what monitoring activities are actually performed in member states. There has been no control over whether member states have in fact have monitored all the "obligatory" parameters, and whether the member states have used EU co-funding for monitoring "optional" parameters.

2.3.5. Studies, experiments and demonstration projects

In addition to the monitoring program, Forest Focus also co-funded studies, experiments, demonstration projects and pilot phases from the 2004 budget. The studies etc. were divided into four categories: Studies on the identification of causes and dynamics of forest fires (C1), Studies, experiments, demonstration projects to further develop the scheme (C2), Studies, experiments, demonstration projects to promote harmonised data collection and delivery, to improve data evaluation as well as data quality including calibrations courses and ring tests (C3), and Monitoring test phases (C4).

The co-funding was expressly intended to promote and develop the Forest Focus programme, and not to support projects of purely national interest. When deciding which projects would be co-funded, the emphasis was to be on those studies which would provide the maximum added value to the programme, and specifically those which addressed the new elements in the programme (climate change, biodiversity etc.). The Commission originally intended that the Scientific Advisory Group (SAG) would be responsible for assessing and integrating the proposals made by the member states. Unfortunately, however, the SAG was never set up. The review process was instead carried out as a joint effort between the NFCs and the Commission. Each NFC was asked to review the proposals, together with national experts, and to rank them according to a number of criteria. The applications for co-funding submitted to the Commission totalled over €8 million, and the total budget available for co-funding was €4,931,411. Almost all of the projects that were subsequently co-funded were addressed at climate change, carbon sequestration and biodiversity, as well as a number of multi-national projects directly designed to contribute to e.g. method development, improving data quality etc. However, the list of co-funded projects included a number of projects of clearly limited value to the Forest Focus programme.

There was a lack of consistency in the proportion of co-funding provided for categories C1-C4. For instance, most of the categories received 75% co-funding, while those in C3 received only 50% co-funding. This was despite the fact that C3 projects were clearly designed to improve the quality of the Forest Focus programme as a whole, while the projects in e.g. category C2 undoubtedly had a stronger national emphasis. However, this criticism is not directed at the Commission, because the co-funding percentages for the individual categories are laid down in the regulations, which were approved by all the member states.

There are a number of factors that will undoubtedly reduce the cost-effectiveness of this part of the programme. Clear rules and regulations are laid down in the regulations concerning the financial management of the funds provided for implementing the pilot studies and test projects. However, no administration procedures have been established to ensure that the results of the projects are taken into account in developing the later stages of the Forest Forest programme, despite that fact that this was the express reason for co-funding the projects. Evaluation of the projects was undoubtedly carried out on a scientifically sound basis, but there was no effort made to encourage integration of the projects in order to prevent duplication. In fact, owing to the delay in implementing the regulation, the results of the studies will not become available before the Forest Focus programme finishes at the end of 2006.

2.3.6. **Conclusions**

1. Overall, the Forest Focus programme 2003 – 2004 has been relatively cost effective. However, there are a number of areas where cost effectiveness could be considerably increased.
2. The major factor reducing the overall cost effectiveness of the programme is that, although there were 15 member states implementing the programme in 2003 and 24 in 2004, there were in fact 30 (39 in 2004) separate entities (countries, länders or autonomic regions) receiving co-funding. Cost effectiveness could undoubtedly be increased considerably by integrating all the activities at the national level. There were considerable differences in the costs per plot per monitoring activity in the individual countries. This means that there have been real differences in work rate, quality or quantity, which have not been predictable or evaluated in any formal process. Clearly some countries may be working in excess of basic requirements, others not.
3. Despite strict control of financial management (external auditing), there is insufficient control over what monitoring activities are actually performed in member states. There has been no control over whether member states have in fact have monitored all the ”obligatory” parameters, and whether the member states have used EU co-funding for monitoring ”optional” parameters.
4. Clear rules and regulations are laid down in the regulations concerning the financial management of the funds provided for implementing the pilot studies and test projects. However, no administration procedures have been established to ensure that the results of the projects are taken into account in developing the Forest Focus programme, despite that fact that this was the express reason for co-funding the projects. Evaluation of the projects was undoubtedly carried out on a scientifically sound basis, but there was no effort made to encourage integration of the projects in order to prevent duplication. In fact, owing to the delay in implementing the regulation, the results of the studies will not become available before the programme finishes at the end of 2006.

Work Area 3

3.1 Improving the present monitoring system

The work described in Sections 1 and 2 (above) has implications for the design of a new network.

In considering the design of a new network the key stages are:

1. To be clear over the objectives of the monitoring programme, such that a set of quantifiable (measurable) parameters can be defined.
2. Defining strata[1], in this instance the forest types for stratified sampling.

Given these, an efficient allocation (numbers and locations) of sample plots can be constructed, without these the quality of any proposed design cannot be properly assessed. The current sampling design does not include strata and as there are many distinctive forest types a stratified design would be more efficient[2]. Further, as some important strata may have a relatively low area they may be inadequately represented in a completely random sample or systematic sample for comparisons to be made with adequate power.

In defining strata the important aspect is the ecological classification of the area rather than any political/administrative classification. For practical purposes a matrix of ecological types by administrative regions may be required. Comparisons between and within ecological classes across Europe are of major importance. However these may also have to be on an individual country basis. So the sample sizes in the country by type may be as important as the marginal values. As individual countries will also have their own requirements and as a consequence their own sample size specifications, a European level agreement would need to specify a minimum number for each cell, i.e., the sample size for each ecological type for each country. The appropriate European statistics can then be computed by applying appropriate weights to all the information available, that is, not just the minimum required.

However the required sample sizes (number of monitoring plots) will vary by attribute. As reported in section 2.1, this may be of the order of several hundred times to obtain similar precision, with a reasonable sample size per stratum varying from 25 to 6000. The required accuracy of an attribute has to be decided upon on the basis of policy requirements. The importance of the attribute also needs to be considered if it requires a significantly larger than average sample size.

The key then is to formulate and apply an agreed European-wide strata based on an ecological classification system along with a forest management classification. The resulting classification system must cover natural, semi-natural and managed forests. The requirements of such a classification system are that:

1. There are an appropriate number of classes (strata). A simple top level classification of conifers, broadleaves and mixed is inadequate while a system with many subtypes would produce too many classes for adequate sampling from each class.
2. The need for a complete classification across Europe means that the classification must be based on data that is already available (ie an established classification) or can be cost effectively acquired. For example,
   - Satellite and remote sensing
   - Existing national inventories

There are potential classification frameworks available or being developed, for example the EEA forest types – see table 4, the Natura 2000 classification and the EUNIS habitat

[1] Strata ≡ subpopulation for sampling

[2] statistical efficiency ≡ a design which gives the greatest accuracy for a given resource

classifications and ForestBIOTA. Classification of natural types needs to be combined with management systems that have been imposed. Classes such as coppice, clear fell, continuous cover management etc. need to be cross-classified by natural types.

In addition to aiding the design of monitoring systems extensive data available form lower cost sources should be used to produced enhance information. Data fusion methods should be used to combine extensive but low definition information from remote sensing with intensive ground based information from limited numbers of sites.

With noticeable differences between the properties of attributes of interest and different aims, is a single design possible? A design that is suitable for studying a European wide property as in Forest Focus may not be suitable for studying a forest sub-system, e.g., biodiversity in natural woodland, where specific environments may have too low a replication. Even within the limited aims of the existing network there are noticeable differences in efficiency.

A uniformly efficient system from a range of requirements is unlikely to be possible. So compromises will be needed. This may involve having a core set of sites with other supersets required for estimating some attributes. It is possible that the overlap between the requirements of some attributes may be so low as to render the reality of a common single core inappropriate. However, while the sites may be different a strong case can be made for a common framework that will allow for the efficient management, data recording, management, analysis and QA.

If it were possible to design an effective monitoring system would that replace the existing monitoring, i.e., start from scratch, or would it enhance the existing system? In studying change, having time series of key attributes over a sufficiently long period is essential. As the current studies hold useful information over a number of years, there is a substantial case for continuing to increase the period over which at least some of the data are available and not to discard them. By making use of appropriate weights it should be possible to make use of those data while accounting for their inherent inefficiency. However, we are aware that for some attributes the current design is likely to be very inefficient, so it would be inefficient to maintain the current design unmodified. This suggests the adaptation where possible of the existing design to meet new challenges. For example, adding sampling points in strata of interest that do not have adequate representation.

Summary and recommendations

While the quality of the network is adequate for its original use, there are weakness and the network as it stands is unlikely to be suitable for future monitoring activities which have wide policy objectives (see section 1 of this report).

- European ecologically-based strata are needed to create an efficient design. Information available from other sources (e.g., national inventories, soil surveys, meteorological data, remote sensing information) will be needed to create the strata.
- Objectives for future studies have to be adequately quantified in order to compute appropriate minimum sample sizes so that the network is effective.
- Different objectives are likely to lead to different designs, but where possible a common core should be instigated, making sure the design satisfies the minimum requirements for any of the agreed objectives.
- A common framework for the network is required with an effective QA system that can generate required meta-data for further data integration.
- Data from different sources and levels needs to be combined using data fusion techniques. Data from the network should be viewed as only one part of a data warehouse that is needed to answer the environmental questions.
- An evolutionary or sequential design approach is recommended, that is, enhancing and modifying the existing design so that it provides a more efficient sampling for a wider range of objectives.

3.2 Recommendations for biodiversity monitoring in the future

Objectives

This section of the report reviews the effectiveness of the current Forest Focus network for biodiversity monitoring and makes recommendations for future improvements. The specific objectives of the review are:

1. To present a short synthesis of EU polices and information needs with respect to biodiversity
2. To evaluate the effectiveness of the current network in delivering policy relevant information on biodiversity
3. To recommend changes to the network which will improve its effectiveness for monitoring forest biodiversity

EU Policy and information requirements

The impetus for monitoring biodiversity in European forests arises from five key policy processes: the Convention on Biological Diversity (CBD), the UN Forum on Forests; the Ministerial Conferences on the Protection of Forests in Europe (MCPFE), the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), and the implementation of the Natura 2000 Network. Requirements of these policy processes can be translated into broad policy needs and information requirements at the EU level (Table 3).

Table 3 - EU policy and information requirements in relation to biodiversity

EU policy	**Information need**
Maintaining/restoring Natura 2000 network and extending to the whole of EU-25;	Monitoring habitat extent and condition (also part of the SEBI2010[1] indicators)
Developing/implementing the Pan-European Ecological Network (PEEN)	Assessing progress in buffering, extending and connecting Natura sites
2010 Target to halt loss of biodiversity	Change in SEBI2010 Indicators
Integrating biodiversity considerations into all sectors	Monitoring compliance through the MCPFE sustainable forestry indicators

[1]Streamlining European Biodiversity Indicators

The contribution of the forest focus network to the four information needs highlighted in Table 3 was evaluated.

Current monitoring of biodiversity under Forest Focus

A number of demonstration projects have been initiated under the Forest Focus Regulation. Forest Biota is examining the relationships between biodiversity indicators on Level II plots in selected member states. BioSoil is testing the operationalisation of selected indicators in the Level I network across a wider range of member states. Both schemes are plot-based (~0.25 ha) and aim to make a *contribution* to the acquisition of biodiversity information rather than being comprehensive data gathering exercises in their own right.

Representivity of the network

Larsson (2001) have emphasised the importance of forest type in determining the relevance of different biodiversity indicators. To be effective as an EU-wide scheme for forest biodiversity monitoring, the Forest Focus network needs to cover a representative sample of the range of European forest types. A new forest type classification is under development

(see Annex 1), but as yet there has been no systematic mapping of the distribution of these forest types in Europe. A pilot study (Annex 3) was carried out on the Polish data to test the representivity of the network in terms of the new forest type scheme (Table 4).

Table 4 - Classification of Level I and Level II Forest Focus plots in Poland by EEA Forest type (see Annex 1 for description of forest types)

Forest Type	**Level I** **No of plots (%)**	**Level II** **No of plots (%)**
Hemi-boreal and nemoral Scots pine forest	219 (50.6)	42 (48.8)
Atlantic and nemoral Oakwood	33 (7.6)	6 (6.9)
Oak hornbeam forest	30 (6.9%)	7 (8.1)
Beech forest	2 (0.46)	13 (15.1)
Others	7 (1.6%)	5 (5.8)
Not determined	142 (32.7)	13 (15.1)
Total	433	86

There was considerable difficulty in ascribing some of the plots to forest type due to lack of data. Preliminary analysis suggests that there is under-representation of most forest types in Poland (excluding Scots pine), although the area and distribution of the types has not yet been mapped.

Monitoring conservation status of the Natura 2000 network and development of the PEEN

The Natura 2000 network is the main delivery mechanism for the EU Habitats and Species Directive and the Wild Birds Directive. The focus of monitoring is to assess changes in conservation status of designated habitats and species. Currently there is no harmonised approach to defining conservation status and member states are at liberty to develop their own system of assessments. A central plank of EU policy is to implement the Natura 2000 network in the new member states (IUCN, 2005). Poland was chosen as a case study area in order to estimate the contribution of the Forest Focus network to Natura 2000 monitoring. An analysis of the congruence between the network and Natura 2000 habitats and sites was undertaken. The data reported here (Table 5) are for the "official" Natura pSCIs. An extended "shadow" pSCI list exists, but has not yet been agreed (Michalak and Pawlaczyk, 2006).

Table 5 - Level I and Level II plots coinciding with Natura woodland habitat and official sites in Poland. Please note - Natura sites are not necessarily universally covered by Natura habitats.

Natura habitats/sites	**Level I** **No of plots (%)**	**Level II** **No of plots (%)**
Coinciding with Natura sites and habitats	7 (1.6)	4 (4.7)
Coinciding with Natura sites but not habitats	12 (2.8)	5 (5.8)
Coinciding with Natura habitats outwith sites	64 (15)	28 (33)
No relation to Natura	350 (81)	49 (57)
Total	433	86

Very few plots coincided with both Natura habitats and sites (Table 5) and there was under-representation of many of the specific habitat types (Michalak and Pawlaczyk, 2006). This is likely to be the case in other member states. For example, only one Level II plot coincides with a Natura site in the UK. The network is therefore currently of little relevance to the monitoring of favourable condition status of Natura sites.

The PEEN is currently being implemented across Member States and is focused on strengthening and extending the Natura 2000 network. As the Forest Focus network is plot-based, the contribution to monitoring improvements in landscape connectivity is limited. Evaluating landscape connectivity is more appropriately tackled by remote sensing supported by targeted ground-truthing.

SEBI2010 and MCPFE Indicators

The SEBI2010 and MCPFE Indicators are listed in Annex 2. Currently, the Forest Focus network does not make a significant contribution to SEBI2010 or MCPFE information needs. This is largely due to the limitations of plot-based assessments. There is little potential to provide information for area-based measures such as extent of ecosystems, habitats or area of forest under sustainable management. The SEBI 2010 species indicator 1 focuses on selected groups such as woodland/wild birds requiring much larger plot sizes. It is also unlikely that the Forest Focus network could make a significant contribution to monitoring of threatened/protected species (species indicator 2). Many of these species are by definition, rare and invariably restricted to geographically distinct "hot spots" and therefore not suited to monitoring through a regular grid-based system as used by the network.

Although limited in geographical extent, the Level II network has a role in providing information on the link between nitrogen deposition and selected measures of biodiversity. Currently there are no alternative monitoring schemes which have the potential to provide this information at the EU scale.

The invasive species indicator is still under development and is likely to include understory/ground vegetation species as well as tree species. Current species data being collected on Level I and II plots will provide records of occurrence of invasive species if the distribution of these species coincides with the plot network. Given that this indicator is still under development, it is too early to say whether the Forest Focus network could provide useful data to feed into this indicator.

In contrast, the network is well-placed to provide information on forest structure and composition. Both ForestBiota and BioSoil projects will provide detailed and extensive data on quality and quantity of deadwood. Deadwood data are also collected through the National Forest Inventories (NFIs) and efforts are in pace to harmonise the delivery of these data through the Cost Action 43 (Harmonisation of National Forest Inventories in Europe). However, the extent to which NFI data collection methodologies might be harmonised across countries is still open to question. The advantage of the Forest Focus network approach (through BioSoil) is that deadwood assessment methods (as well as data analysis and delivery format) would be harmonised across countries.

Conclusions and recommendations

1. In its current form the Forest Focus network has limited potential for delivering policy-relevant information on changes in forest area, the area of protected forests and changes in populations of rare/threatened species. Such data are not readily obtainable by a regular small plot/point based monitoring system and no changes to the network are recommended in this respect.

2. Based on limited case-study data, it appears that a small percentage of the network currently overlaps Natura 2000 habitats and sites. The BioSoil project demonstrates that the network could generate biodiversity information (e.g. deadwood volume/stand structure and composition) relevant to the assessment of favourable conservation status on Natura 2000 sites. However, the network would have to be considerably extended to achieve satsifactory coverage of Natura sites. As Natura reporting is a responsibility of member states, coverage could be achieved more efficiently by using NFI plot data, and other national monitoring initiatives (as is already the case).
3. An analysis of the representivity of the network with respect to forest type was inconclusive due to the difficulty of matching the Level I stand descriptions to the new EEA forest type scheme. In the Polish case study, it appears that a signficant number of forest types are under represented.

   It is recommended that:
   - The EEA forest type scheme (or similar) is adopted as an ecological framework during the evolution of the Forest Focus network within LIFE+. This is vital in giving context to reporting on biodiversity indicators. NFIs should also be encouraged to adopt this framework.
   - As a matter of urgency, a project should be initiated to map the distribution and extent of EEA forest types across member states, and to classify all Level I and Level II plots by forest type. These are essential first steps in informing the design of a **revised core network of forest monitoring plots** at the EU level.
4. If the Forest Focus network could be redesigned to provide greater ecological representivity, then it has the potential to provide extremely useful data relevant to the sustainable management of forests for biodiversity (e.g. by providing information on changes in stand structure and composition over time).

   It is recommended that:
   - A project be initiated to design a revised **core network of forest monitoring plots (Level I)**
   - The **core network of monitoring plots** should be organised and maintained at the EU level to ensure harmonisation of both data collection and reporting, focusing on a number of key indicators. (The BioSoil project is currently demonstrating the potential for harmonising data collection methods)
   - The core network should be drawn from a subset of NFI plots to take advantage of efficiencies in data collection, and to allow comparison between national and EU level data
5. Detailed biodiversity data are currently being collected on the Level II plots through the ForestBiota project. These data could be correlated with atmospheric pollution deposition data also being collected on the Level II plots. This would help meet the EU requirements for information on the long-term effects of nitrogen deposition on biodiversity. However, the ForestBiota project is restricted in extent and only covers some key forest types in selected EU countries. The ForestBiota approach could be extended to move EU countries if the project proves successful.

   It is recommended that:
   - Under LIFE+ a core set of measures on Level II plots should be made to allow the relative impacts of pollution, climate change and forest succession on biodiversity to be explored with respect to EEA forest type.

6. An International conference was held in Florence in 2004 "*Monitoring and indicators of forest biodiversity in Europe - from ideas to operationality*" (Marchetti, 2004). This conference was instrumental in taking forward work on the development and implementation of biodiversity indicators.

   It is recommended that:
   - A follow up conference is held to review progress with indicator development since the Florence meeting and to identify priorities for further work.

3.3 Carbon sequestration and stocks, and climate change impacts; recommendations for future monitoring

Rationale and objectives

Very specific needs for reporting greenhouse gas (GHG) sinks and sources of the Land Use Land Use Change and Forestry (LULUCF) arise from the United Nations Framework Convention on Climate Change (UNFCCC 1992), and the Kyoto Protocol (1997) that was ratified in 2005. In the European Union the Kyoto Protocol to the UNFCCC was approved by the Council Decision (2002), and the present rules for reporting are given in the Commission Decision (2005).

Each country has to establish its level of carbon stocks in 1990 and enable an estimate of changes in carbon stocks in forest land in subsequent years. The National Inventory Reporting in the LULUCF sector follows guidelines given in the Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF; IPCC 2003).

The objectives for the National Inventory Reporting in the LULUCF sector are to monitor:
annual changes in emissions of:

- above ground biomass C pools
- below ground biomass C pools
- dead wood C pools
- litter C pools
- soil C pools & non-CO_2 GHGs

Annual changes in activity data:

- forest land area
- forest land conversion to other land use categories.

Additionally, KP reporting (Kyoto Protocol…1997) requires definition and monitoring of afforestation, reforestation and deforestation land (ARD, Article 3.3) and possible “additional human induced activities” e.g. forest management (Article 3.4.). Reporting for Article 3.3 requires more specific activity data monitoring.

Analysis of work done

Carbon stock assessment

Assessment of net carbon sequestration in European forests, to improve the assessment of the global carbon balance and to evaluate the influence of changes in the climate due to atmospheric greenhouse gases on the forest ecosystem, was given as a specific objective of the Intensive Monitoring Programme (ICP-Level II) (De Vries *et al.* 2003).

The technical report 2003 of the Intensive Monitoring shows an exercise of the carbon stock assessment within Forest Focus level I and II sites. (De Vries *et al*. 2003). Tree stand C sequestration was calculated from repeated growth inventories in 120 level II plots and upscaled using 6000 level I plots.

Carbon changes in soils were calculated from N retention in Level II plot data assuming constant C to N ratio. The result obtained, 0.0138 Gt C , is only ca. 10% of results by other pan-European soil carbon sequestration estimates (Forest Condition in Europe 2003).

The BioSoil project, starting in 2006 in 22 MS’s will measure carbon stocks in dead wood, litter and soil, and will thus provide useful information for reporting the “base year” situation, when the data become available.

The Forest Focus Pilot projects, started in 2006, and related to climate change questions, may provide useful material both for carbon stock change and impact assessment are shown in Table 6 below.

Table 6 – Forest Focus Pilot projects related to climate change questions.

Member State	**Project**
DK	Litterfall monitoring
AT	SoilbioParams – effects on soil storage
EL	Effects of forest fires on carbon sequestration
FI	Monitoring changes in carbon stocks
FI	The role of understory and litterfall in carbon and nitrogen fluxes.
IT	Biorefugia – response of tree species to climate change.
IT	Carbon flux
D-BY	Soil respiration
D-BW	Carbon stocks – soil
D-BB	Simulation model carbon balance
D-BB	Regionalisation of soil change due to a lowering of the water table.
D-BB	Fine root inventory on soil profile pit
D-NW	Carbon stocks monitoring
D-HE	Humus dynamic
D-HE	Litterfall and carbon cycles
D-HE	Carbon stocks – soil
D-NI	Carbon stocks – soil
D-NI	Carbon flux
NL	Predict changes in forest growth and carbon stocks.

Climate Change impacts on forests

Two Pan-European programmes have recently published their reports on these questions: ”Advanced Terrestrial Ecosystem Analysis and Modelling”, ATEAM (2001-2004) (EVK2-2000-00075), reports that in the forestry sector climate and land use changes are anticipated to have an overall positive effect on growing stocks in Northern Europe. However, negative effects were projected in other regions, e.g. drought and fire pose an increasing risk to Mediterranean forests. Management is paramount in the development of growing stock and forest productivity -- intensive, sustainable forest management keeps the net annual increment at a high level. These predictions were based on scenarios and modelling exercises.

“Silvicultural Response Strategies to Climatic Change in Management of European Forests” EVK2-2000-00723 (SilviStrat), similarly predicts that the simulated change of growth in future climate compared to the current is more positive when including the effect of elevated CO_2. Also, elevated CO_2 can mitigate potential negative effects of changes in climate. The latter being the case in areas in Central European and Mediterranean regions.

However, it should be noted that possible negative impacts of extreme events were not included in the scenarios. The impacts of the extreme events on forests will require new monitoring data to be made available for pan-European scale assessment.

Conclusions

General considerations

1. International Climate Change Conventions set the minimum level for reporting/ monitoring and require both Member State level reporting and an EU level report. Only part of the reporting needs are feasible to monitor directly. For instance, European programmes, such as CarboInvent (2002 – 2005) appear to regard cost-effectiveness of direct monitoring of annual changes in soil C stocks as doubtful within the time frame of GHG reporting. Consequently, other methods (e.g. modelling) may be required for assessing changes in below-ground components. Validation of the models is crucial for verifiable results, and a Pan-European programme would be needed to produce comparable and verifiable reporting of below-ground C stocks and non-CO_2 GHG's among the Member States.
2. The BioSoil Forest Focus demonstration project will improve the soil carbon stock estimates in the Member States, and the monitoring grid may be developed to provide test material for soil model validation. Forest Focus pilot projects may produce improved, cost-efficient methods for soil C stock assessment.
3. National Forest Inventories (NFI´s) in most countries can be developed to provide the required monitoring data concerning the above-ground C stock estimates of trees. Ground vegetation C stock assessment may require new approaches, such as modelling. Merging NFI grids with the Forest Focus level I grid may provide added value. Most NFI's do not measure any soil or root parameters except, for example, the Swedish RSI system that combines tree stand and soil monitoring. The activity data (areas and changes in areas of land-use classes) can usually be produced by NFI's, possibly merged with Level I and II grids, and combined with remote sensing data.
4. It can be concluded that assessment of changes in below-ground biomass components and soil C stocks together with non-CO_2 GHG's requires an approach different from the direct measuring and monitoring, routinely carried out in inventory systems.

How to produce estimates for soil C stock changes and non-CO_2 GHG's?

1. Estimation of C inputs into soil

Litter from trees, ground vegetation and mosses form the C input into soil. Above-ground inputs are rather easily measurable, except for the moss layer. Litter fall data is not routinely produced in inventories, however, in some Forest Focus Level II plots tree stand litter fall is monitored. Large annual variations in litter production suggest the need for a modelling approach. Data for ground vegetation and moss layer litter production are scarce and require further measurements.

Roots form an important component of the soil C balance but root dynamics are very difficult to monitor, and models are required for production estimates. A crucial task is to produce test materials for model validation.

2. Rate of change in soil C stocks

Soil models, linked to simulation results of litter production models, may be used in producing estimates for soil C changes. Several soil models exist and are to a varying extent used for such simulations. However, these models are generally parameterized based on local and often insufficient databases. Improved parameterization and validation of these models is

therefore a major task in developing the soil C reporting. Accounting for regional – macroclimatic conditions in the parameterization in a pan-European scale is crucial.

3. Non-CO_2 gases

Generally, that is in a non-forestry context, methane (CH_4) and nitrous oxide (N_2O) may be important GHG's, especially from organic rich peat soils with varying levels of water-logging. These soils are widespread in northern European Member States where more than one third of forest land may be on peat.

For these gases, parameterization of available process models are required, and this is especially important for N_2O estimation. Again, new material for model development has to be made available.

Recommendation for development of soil C stock monitoring

1. Model development

Representative sample plot networks in a pan-European scale for parameterization and validation of models have to be established, based on potential merging of NFI and Forest Focus grids. It is possible that the networks might be based on the sample plot grid similar to that used in the Forest Focus BioSoil project and could form the core/thematic networks in the future LIFE+ platform.

A multi-year campaign for measuring the following C flux components should be carried out in the plots of the grid to be established:

- tree stand and ground vegetation C pools
- litterfall of different vegetation layers (trees, ground vegetation, moss layer)
- coarse and fine root production of trees and ground vegetation
- soil C stocks
- leaching of DOC
- soil respiration using chamber methods and stable isotopes for distinguishing between "new" and "old" carbon.
- where relevant, CH_4 and N_2O exchange using chamber methods
- monitoring of climatic variables

2. Validation of monitoring results

Model simulations produce the required C stock components. Model validations show the degree of uncertainty involved in simulations but independent control material is needed for assessing the long-term reliability of the result. The sample plot network created for model development data may be used for repeated C stock samplings with intervals of 5 to 10 years, and the observed changes compared to the simulation result.

The sum of the different C pool component changes from simulations shows the net exchange of the forest ecosystem at the stand level. These should be compared with CO_2 exchange measurements with eddy covariance technique where possible. The Long Term Ecological Research (LTER) network sites should be developed to produce control data for simulation results.

Monitoring of future climate change impacts

The validated process-based models, used for carbon stock change simulations, have climate related factors as driving variables, and can also be used in predicting impacts of changing climate on soil processes.

Phenological processes are the most clearly climate related, and can be easily observed in a monitoring network. Most countries have long-term phenological observation series which have been to some degree coordinated by European Phenology Network (EPN). Where

feasible, Forest Focus phenology monitoring schemes (Level II) should be linked to the EPN metadatabase.

Extreme weather events, such as droughts have been predicted to increase with warming climate. Monitoring relationships of these with observed forest indicators, such as crown condition and tree growth, should be included in the monitoring programmes in the permanent plot networks, such as the present Forest Focus Level II grid.

4. **Overall conclusions on review of the Forest Focus Regulation and Programme**

Following detailed consultation, analysis and review, as set out in the intermediate reports of this contract and summarised as above, it is the Review Team's view that:

- The original objectives of the **Air Pollution and Forest Focus Regulations** appear ***largely fulfilled*** through concerted activity within and beyond the programme run between 1986 and 2006 in compliance with EC 3528/86, subsequent air pollution and forest fire regulations and Forest Focus.

- The monitoring network (the Level I & II networks established by Council Regulation (EC) 3528/86, and subsequent EU regulations including Forest Focus) has been ***mainly successful*** in achieving its original intended objectives, which related mainly to monitoring air pollutant damage/impacts to forests. The network has successfully monitored forest condition but has in the main not provided robust cause/effect relationships except at the regional level.

- ***The datasets are unique and large, and they can be and should be further utilized*** e.g. for making scenarios for the future. The high spatial coverage and long time series compared to other datasets make the data unique and of value to scientists and policy makers.

- Activities under the Forest Focus Regulation (2003 – 2006) have been only ***partially successful*** in bringing European forest monitoring activities to a point where they meet the needs of the current international agenda and thus the scheme, as currently in use, is ***only partially suitable for future monitoring needs.***

- The current design and protocols of the level I and II networks place real constraints on their value for the monitoring of biodiversity, climate change and the protection function of forests. Some progress is currently being made in developing of the network and with its interactions with other related monitoring activities (national inventories, remote sensing, MCPFE criteria & indicators, FCCC & Kyoto monitoring requirements etc.), but much of this work is at an early stage. **The networks form a very sound basis on which to build an EU Forest Information System within the LIFE+ Programme.**

5. Overall recommendations for the future

- **Substantial change is required to the current European forest monitoring programme in order for it to meet the current monitoring needs.** The framework within which this can be achieved is becoming clearer with the establishment of an EU Forest Information System which should be developed through demonstration projects within the new LIFE+ Programme. Further work is required to ensure a satisfactory outcome – effective forest monitoring at the EU level in future - within this framework.

- The above conclusion has major implications for the management, organisation framework, design of the monitoring system and specific protocols, and the overall balancing of resources. **Significantly, such developments need to yield focussed information required by international forestry obligations, for EU policy development and for the monitoring of EU forestry actions. Such information is needed in the four areas of pollution, biodiversity, climate change (including C budgeting) and sustainability (including the protection functions of forestry within the landscape).** In addition, greater emphasis should be placed on ensuring effective knowledge transfer across the science-policy interface. The development of these new structures and protocols represents a significant amount of work which is well beyond the scope of this review (technical work, identification of priorities & methods and preparation & implementation). The Review Team recommend that this work can and should be undertaken. This will require resourcing and organisation.

- The ending of the Forest Focus Regulation in December 2006 will remove the legal obligation of EU Member States to undertake the Level I and II monitoring programme, but not the obligation of signatory countries to report to the MCPFE, CBD and UNFF. Forest monitoring will continue to be required to fulfil commitments to these international initiatives and also under the CLRTAP and FCCC (Kyoto Protocol), for EU policy formulation and for monitoring of EU forestry actions. However, there is a real danger of inconsistent, poor quality, gaps in coverage and inefficiency if activities are not co-ordinated at the European level. **We strongly recommend that a framework is developed which requires Member States to address forest monitoring in an effective, coherent and integrated way in the National Programmes which are submitted under LIFE+.**

- Broadly MSs and the EU have international forestry obligations in four overlapping areas - pollution, biodiversity, climate change (including C budgeting) and sustainability (environmental – including the protection functions of forests -, social & economic). In some of these areas monitoring methodology and reporting frameworks are well defined (e.g. under the ICP Forests protocols within the CLRTAP Working Group on Effects and the LULUC methodology associated with the Kyoto Protocol of the FCCC); in others there is currently less prescription and more flexibility over how methodology and reporting should develop (e.g. biodiversity monitoring under MCPFE initiatives and monitoring of sustainable forestry under UNFF reporting needs). This state of affairs suggests that **significant added value can be provided through the harmonization of forest monitoring within the EU.** In short, **some enduring data requirements will prove common across different political needs and, in any event, there is potential for considerable synergy (mutual benefit) where related monitoring occurs at the same sites and plots** (provided the monitoring platform is fit for purpose).

- The existing Forest Focus network derives principally from the air pollution and forest fire requirements (although the objectives for level II were somewhat broader), and the plot selection, measurement methodology and reporting structures reflect this. However, to meet information needs of the current wider environmental agenda, the Forest Focus Regulation (2003 to 2006) attempted to address this by extending its range of measurements and analysis through Pilot or Demonstration projects (e.g. Biosol). This

broadening of approach, methodology and structure falls short of current and emerging information requirements (which are beyond the original remit). This suggests **the need for greater coordination (through integration) across the four areas over which forest monitoring needs must be achieved in the future. This integration is necessary to ensure that pan-European monitoring of forests is aligned with effects evaluation for other land uses, yet is cost-effective and of an appropriate quality.**

- The proposal of the LIFE + Regulation within which future forest monitoring activities may be coordinated and funded, sets the timeframe and context. Development work and coordination (capacity building) appears to us to be urgent, suggesting that the Standing Forestry Committee and DG Environment should move this forward at an early stage. There needs to be a smooth transition and a continuity of monitoring. Activities need to include the organisation of properly focused workshops, steering committees for developing LIFE+ proposals, an executive secretariat, administrative support, data management and reporting across the science-policy interface. **We recommend that resources need to be identified for support of the Forest Information System within the LIFE+ regulation.**

- As a result of detailed review of the existing Forest Focus monitoring network and system, **we** (the Review Team) are able to **suggest some indications on the design of monitoring structure which will be required:**

    1. Some of the elements of the system are in place or developing as a result of recent work under Forest Focus (e.g. forest fire monitoring EFFIS etc., Level I & Level II database management). The reporting on the status of Natura 2000 sites could also be achieved efficiently using NFI plot data and other national monitoring initiatives. **We believe that the monitoring of forest cover and cover by forest type and species should be addressed through harmonization of national inventories, and should increasingly make use of earth observation (EO) techniques (with appropriate ground truthing).** Work has started on the harmonization of NFIs under COST Action E43 and is to be commended, with capacity building required to integrate with ongoing EO initiatives (e.g. GMES). Progress and coordination of this activity (harmonization of forest inventories and EO integration) are important and the LIFE+ Regulation provides the framework for taking such initiatives forward.

    2. **For biodiversity monitoring, forest quality/condition (climate and pollutant impact** evaluation), **carbon stocks, and sustainability** (soil, terrestrial, water cycle, interface with aquatic systems, other terrestrial land uses and the atmosphere) **a core framework of monitoring plots within MSs will be of high value. This should be developed from the existing Forest Focus Network (Level I & II) integrated with a subset of National Inventory plots to address forest growth, carbon sequestration and biodiversity monitoring.** However there are specific problems with the existing network which have been identified in the work areas of this review. These include problems of inconsistency of design between MSs, of balancing geopolitical with ecological boundaries, of the need for sample density to be appropriate to the variability of the parameter being measured, of cost effectiveness and of reporting and management structures. These issues need to be addressed in developing the new forest monitoring framework which, as a result, is likely to be substantially different from the existing Level I and II platforms. We consider that there may be a need for thematic networks to be built around the core framework and that these could be specific projects coordinated under LIFE+.

3. The networks run since 1986 have provided a significant amount of valuable data and experience has also been gained in the organisation, data management and science/policy interface requirements. There is a need for an organisational structure and scheme/framework for data provision of the type shown in Figure 2 and Table 7 respectively. Detailed analysis of the achievements under Forest Focus and its predecessor regulations and of the current requirements for forest monitoring suggest that **the new network needs to be based on a stratified sampling scheme** (see Section 3.1 of this report). **We have proposed stratification based on the newly developed, EEA classification of European Forest Types** (Section 3.2 and Annex 1). A major advantage of this is that it would give context to the data reported, particularly the biodiversity data. We consider that protected areas and rare/threatened species need to be specifically, perhaps separately, considered. If the network is redesigned to give greater ecological representivity then it could provide relevant data on sustainable management of forests for biodiversity. Under LIFE+, a core set of measurements on Level II plots could allow exploration of the relative impacts on biodiversity, pollution, climate change and forest succession. A follow-up conference is needed to review progress since the meeting in Florence in 2004 'Monitoring and indicators of forest biodiversity in Europe – from ideas to operationality'. **We have also suggested a nested design such that the need to monitor specific parameters at any plot and the plot replication is based on the variability associated with the parameter** (not just obligatory or mandatory). This is a very significant development from the current system and we have thus proposed an evolutionary or sequential design approach. That is **enhancing and modifying the existing design so that it provides more efficient sampling for the new, wider range of objectives.**

- In forest monitoring, and environmental monitoring more widely, many organisations have made use of Forest Focus data, but the EU Level I and II networks are one of only very few comprehensive systems for collection, storage and analysis of primary data. **We are concerned that the ending of the Forest Focus Regulation in December 2006 removes both the obligation from Member States for co-ordinated, EU-level forest monitoring and the co-funding for the network. The potential for slippage back into uncoordinated activities which yield poor quality data with inconsistent coverage (both spatially and over time) is considerable.** These types of problems have been clearly seen elsewhere in reporting against international environmental obligations. The pulling together of disorganised data sets which have been collected at the national level in order to meet the specific needs of various different international obligations, is the least effective and cost efficient option. Such an approach could mitigate against the achievement of sustainable forestry and of the proper integration of forestry with other land uses to achieve sustainable rural development and environmental protection.

Fig. 2 – Proposed structure of a new EU Forest Information System (FIS)

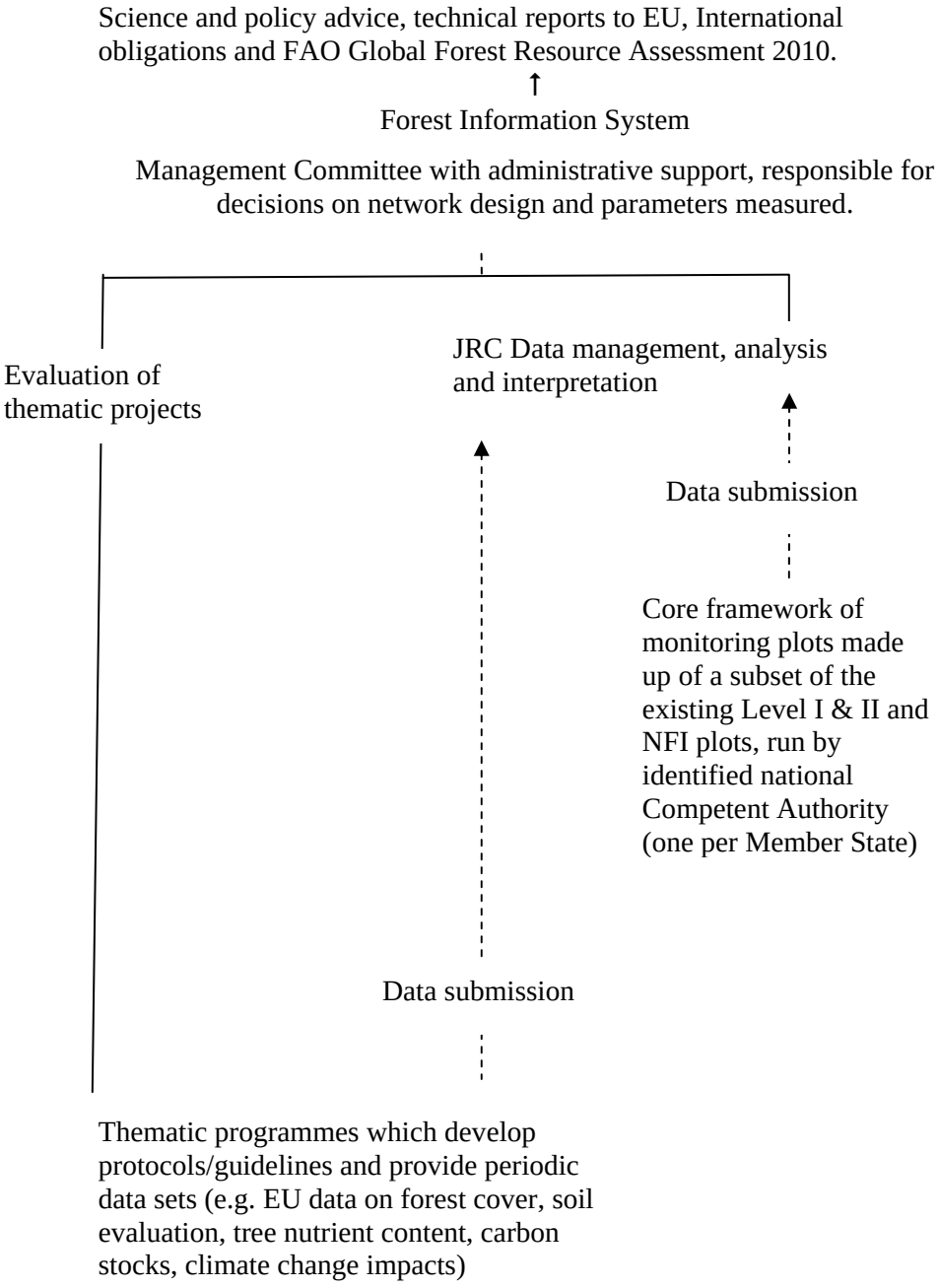

Table 7 - Scheme of data provision & parameters measured under proposed EU F1S

Core Framework	Associated Thematic projects

• Biodiversity selected indicators as specified by MCPFI protocols; indicator species
• Evaluation of growth using NFI/PSP methodology
• Evaluation of C stocks using IPCC, LUCUCF, GPG, soil carbon on a five year cycle methodology
• Water & nutrient fluxes some key soil, soil water and deposition parameters
• Climate change impacts
  • Crown condition and discolouration
  • Phenology
• Integration with ground truthing of EO data.
• Integration with catchment level monitoring
	• EO analysis of forest cover, cover by forest type
	• Periodic full soil analysis of core framework plots.
	• Design of biodiversity monitoring based EEA forestry types, NFIs & MCPFE indicators.
	• Analysis of ground vegetation, lichens, woodland birds etc.
	• Monitoring of threatened and endangered species.
	• Eddy co-variance measurements for CO_2 balance validation of reporting results.
	• Monitoring of protected areas (ground area and condition)
	• Social and economic monitoring.

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Annex 1 – The revised scheme of European Forest Types nomenclature for biodiversity assessment (from Barbati et al., 2005).

Categories	*Types*
1. Boreal forest	1.1 Spruce taiga forest 1.2 Pine taiga forest 1.3 Boreal birch forest
2. Hemiboreal and nemoral Scots pine forest	2.1 Hemiboreal forest 2.2 Nemoral Pinus sylvestris forest
3. Alpine coniferous forest	3.1 Subalpine larch (*Larix decidua*)-stone pine (*Pinus cembra*) and dwarf pine (*Pinus uncinata*) forests 3.2 Subalpine and montane spruce (*Picea abies*) and montane mixed spruce-Silver fir (*Abies alba*)-forests 3.3 Scots pine (*Pinus silvestris*) and Black pine (*Pinus nigra*) forests
4. Atlantic and nemoral oakwoods, Atlantic ashwoods and dune forest	4.1 Atlantic and nemoral oakwoods 4.2 Atlantic ashwoods 4.3 Atlantic dune forests
5. Oak-hornbeam forest	5.1 Pedunculate oak (*Quercus robur*)–hornbeam (*Carpinus betulus*) forests 5.2 Sessil oak (*Quercus petraea*) – hornbeam (*Carpinus betulus*) forests
6. Beech forest	6.1 Lowland beech forests of S-Scandinavia and north central Europe 6.2 Atlantic and subatlantic lowland beech forests 6.3 Subatlantic submontane beech forests 6.4 Central European submontane beech forests 6.5 Carpathian submontane beech forests 6.6 Illyrian submontane beech forests 6.7 Moesian submontane beech forests
7. Montane beech forest	7.1 SW-European montane beech forests (Cantabrians – Pyrenees – Central Massif – SW-Alps) 7.2 Central European montane beech forests 7.3 Apennine-Corsican montane beech forests 7.4 Illyrian montane beech forests 7.5 Carpathian montane beech forests 7.6 Moesian montane beech forests 7.7 Crimean montane beech forests 7.7 Oriental beech and hornbeam-Oriental beech forests
8. Thermophilous deciduos forest	8.1 Downy oak (*Quercus pubescens*) forests 8.2 Supra-mediterranean oakwoods 8.3 Pyrenean oak (*Quercus pyrenaica*) forests 8.4 *Quercus faginea* and *Quercus canariensis* Iberian forests 8.5 Trojan oak (*Quercus trojana*) 8.6 Valonia oak (*Quercus ithaburensis spp. macrolepis*) forests 8.7 Chestnut forests (*Castanea sativa*) 8.8 Other deciduous woods
10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions	10.1 Mediterranean pine woodland 10.2 Mediterranean and Anatolian black pine woodland 10.3 Canarian pine woodland 10.4 Mediterranean and Anatolian Scots pine woodland 10.5 Alti-Mediterranean pine woodland 10.6 Mediterranean and Anatolian fir woodland 10.7 Juniperus woodland 10.8 Cupressus sempervirens woodland 10.9 Cedar woodland 10.10 Tetraclinis articulata stands 10.11 Mediterranean yew stands
11. Swamp forest	11.1 Boreal pine or spruce dominated mires 11.2 Alder dominated swamp and fen forest 11.3 Birch dominated swamp and fen forest
12. Floodplain forest	12.1 Riparian forest 12.2 Fluvial forest 12.3 Mediterranean and Macaronesian riparian forest
13. Native plantations	
14. Exotic plantations and woodlands	

Annex 2 - MCPFE and SEBI 2010 indicators relevant to forestry (ECNC, 2006) and current contribution of the Forest Focus network

MCPFE Indicators		
Tree species composition	area of forest and other wooded land by species and forest type	Limited
Regeneration	area within stands	Limited
Naturalness	area classified by undisturbed; semi-natural; plantation	Limited
Introduced tree species	area dominated by introduced species	Possible – would give frequency estimate
Deadwood	volumes by forest type	Significant
Genetic resources	area managed for conservation of genetic resources	Limited
Landscape pattern	spatial pattern of forest cover	Limited
Threatened forest species	IUCN red list species	Limited
Protected forests	area protected for biodiversity	Limited

Indicator group	**Details**	**Current contribution of Forest Focus network**
SEBI2010 Indicators		
1. Trends in abundance and distribution of selected species	Pan-European Common Bird Index European Butterfly Indicator	Limited
2. Change in status of protected/threatened species	Red list index; threatened bird index	Limited
3. Trends in extent of selected biomes, ecosystems and habitats	Trends in extent of major habitats (e.g. forests, peatlands etc.) (Natura2000); connectivity/fragmentation of ecosystems;	Limited
4. Trends in genetic diversity of domesticated animals, cultivated plants, fish	Likely to focus on domesticated animals	Limited
5. Coverage of protected areas	Data from UNEP-WCMC (Natura 2000 etc.)	Limited
6. Nitrogen	nitrogen deposition	Possible through Level II
7. Number and costs of invasive alien species	Cumulative list of alien species; worst invasive alien species in Europe; cost of invasive alien species; awareness of invasive aline species	Possible through Level I/II
8. Impact of climate change on biodiversity	EEA considering proposals	Possible through Level II
10. Connectivity/fragmentation of ecosystems	Data availability being explored; specific focus on forests, wetlands and rivers	Limited
12. Area of forest under sustainable management Sustainable management	EEA considering proposals	Limited

Forest Monitoring Plots
(I and II level)
vs
Natura 2000 sites
and
European Environmental Agency forest types
Case Study – Poland

Roman Michalak (FRI) / Pawel Pawlaczyk (PNC)

Cooperation

Robert Hilderbrand (FRI)

Jerzy Wawrzoniak (FRI)

Jonathan Humphrey (FR)

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1. Forest monitoring in Poland
2. Forest Focus plots vs Natura 2000 sites & habitats
3. EEA forest categories representations in forest monitoring plots in Poland

Warszawa, 5 May 2006

1. Forest monitoring in Poland

Monitoring of the health condition of, and the level of threat to forests aimed at reliable forecasting of changes to those two elements is one of the requirements of the State policy on forest in the situation of climatic uncertainty. This requirement is implemented under the forest monitoring programme which has been gathering information on the condition of forests in Poland for over 15 years. Permanent observation plots ("POPs") form the main element to the structure of the forest monitoring system. There are 1461 of them within Poland's forests (Fig. 1) in Scots pine, spruce, fir, oak, beech and birch stands aged 20 years and over - giving an average of one plot per c. 60 km^2 of the area of Poland under forest. Within the total, some 433 permanent observation plots corresponding to a 16 x 16 km grid system fall within the Europe wide monitoring network. First-level POPs comprise groups of 20 numbered trees selected from the predominating stand. The centres of the plots are marked permanently in the field. Overall, the distribution of POPs reflects the forest types, species and age structures of Poland's forest ecosystems.

In 1996, a selection was made of 148 plots from among the First-level POPs located in coniferous and broadleaved stands. Second-level permanent observation plots were established here (100 of pine, 22 of spruce, 15 of oak and 11 of beech). The second-level POPs (148 in total) are subject to a research programme with a considerably expanded scope of observation and analysis. The second-level POPs are located in such a way that each natural-forest sub-district of Poland is represented by 2 or (in the case of certain very extensive districts) 3 plots.

The perspectives of development of this programme in the upcoming years are associated with the adjustment of both, the programme structure and measurement ranges of individual components to the recommendations of EU Regulation No. 2152/2003 (Forest Focus) [17] and integration of forest monitoring with the large-scale forest condition inventory. Adjustment of the forest monitoring programme to the recommendations of the Forest Focus Regulation will take place during the development of the National Programme 2005-2006. The Programme’s main assumptions consist in a differentiation between the national monitoring level, where tasks resulting from the requirements of forest condition evaluation in the country are implemented, and the European monitoring level, where tasks resulting from the requirements of the Forest Focus Regulation are implemented. This differentiation is needed due to the different level of interpretation of collected data. Forest condition evaluation for national needs requires not only the all-country level information, but also the regional unit level data. Such data should be collected from a plot with grid density 8 x 8 km. This grid density guarantees the national monitoring programme is integrated with the large-scale forest condition inventory. The requirement of information about forest condition resulting from the Forest Focus Regulation refers to all-country level and can be implemented in the 16 x 16 km plot grid.

Under the developed national forest monitoring programme, the structure and measurement range on second-level level POPs will change. These changes will aim at differentiation of two levels of those plots: national and European. Selected forest monitoring procedures, such as soil monitoring, forest ground vegetation and natural regeneration monitoring, chemistry of assimilatory apparatus monitoring, as well as stand volume and volume increment monitoring is implemented in the current cycles on the existing, national level, 148 second-level POPs. Of this number, 86 second-level level POPs belong to the European level where the Forest Focus Regulation’s goals are fulfilled.

In developing the national forest monitoring programme, attention is drawn to the necessity to create the possibilities of implementing the new goals set in the Forest Focus Regulation, such as: evaluation of the effect of climatic change on forests, determination of the carbon pool in forests, evaluation of the biological diversity of forest ecosystems or evaluation of the protective functions of forests. Pilot programmes foreseen in the Forest Focus Regulation will be the main tool for developing the rules and methods of including those elements in the monitoring programme. Integration of forest monitoring with national forest inventory will be a priority task. Implementation of this task would make it possible to create in the future a uniform system of collecting information on the condition of forests representing different ownership categories and to make significant savings.

2. Forest Focus plots vs Natura 2000 sites & habitats

Only the "habitat part" of Natura 2000 network is taken into consideration in the following analysis. It should be noted that the “Official” proposition for the Polish Natura 2000 network (data for 2006, April, 20) is considered insufficient by some sectors and a “shadow” network has been produced. Therefore two separate analyses have been carried out – one using the "full Natura 2000 proposition" – i.e. the set of all potential Natura 2000 SCIs (official + shadow list) and one based on the on the official list. The Official Natura 2000 Polish proposition contains 184 sites covers 4,20% of Polish territory. "Full potential Natura 2000 SCIs list" contains 466 sites and covers 9,45% of Polish territory

2.1 The 1st level permanent observation plots

The following analysis is based on the habitat identification using 1st level information only. For each plot only basic stand parameters are available, which is in some cases not enough for reliable identification of natural habitat.. Note that in some cases, using the 2nd level information for the same plot could improve the identification. Annex I habitats are not represented on approximately 80% of plots (Fig 1).

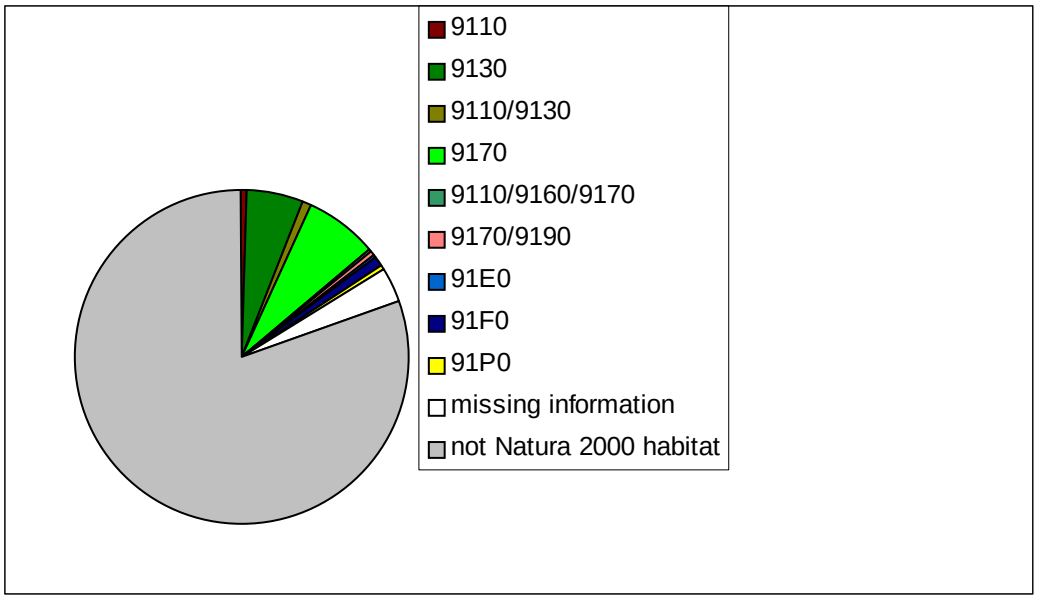


Fig. 1. Habitats represented by 1st level plots in Poland (see European Commission, 2003 for key to habitat codes)

71 plots (from 433) on the whole Polish territory can be identified as representing Annex I habitats. Habitats 9170 and 9130 are relatively well represented (30 and 24 plots), remaining habitats are represented by 1-3 plots only (Fig.2)

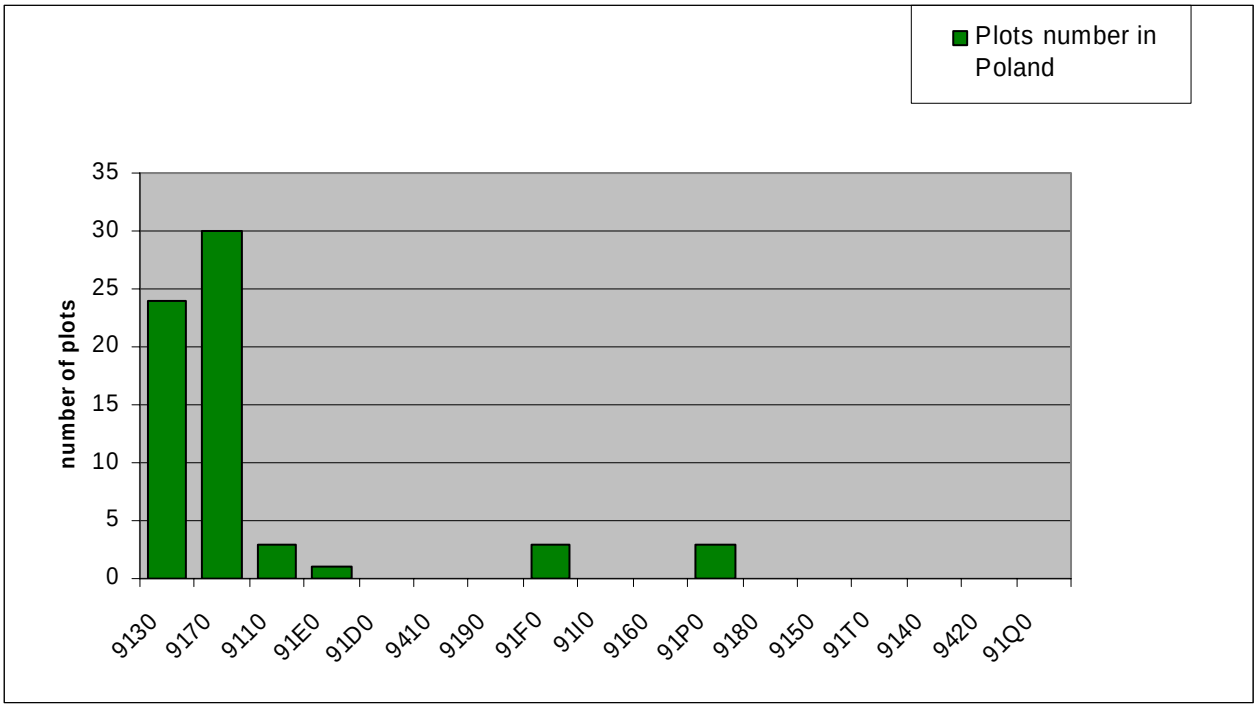


Fig. 2. Distribution of plots according to Annex 1 habitats in Poland

If we analyze the spatial distribution of the plots, only 19 from 433 plots (4,3%) are located inside Natura 2000 official sites (Fig. 3). This ratio is the same as % of Polish Natura 2000 official sites in the whole Polish territory (Fig.2).

If we consider the full Natura 2000 potential sites list, 73 plots (16%) are located in the Natura 2000 potential sites (potential sites cover 9,45% of Polish territory) (Fig.2, 3):

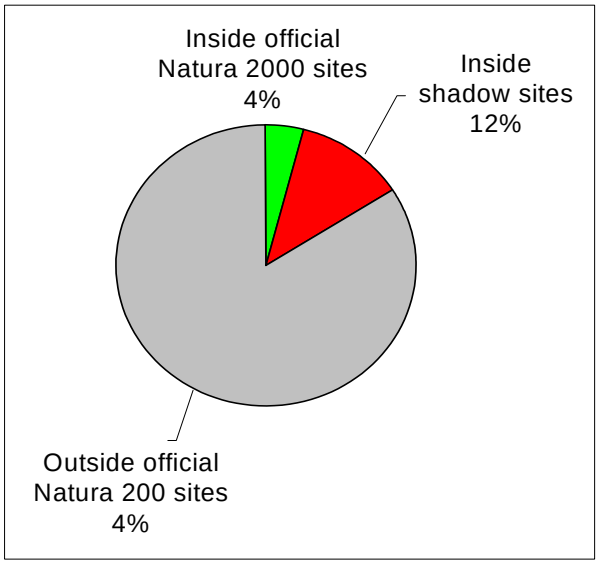


Fig. 3 Number of 1st level plots in Natura areas

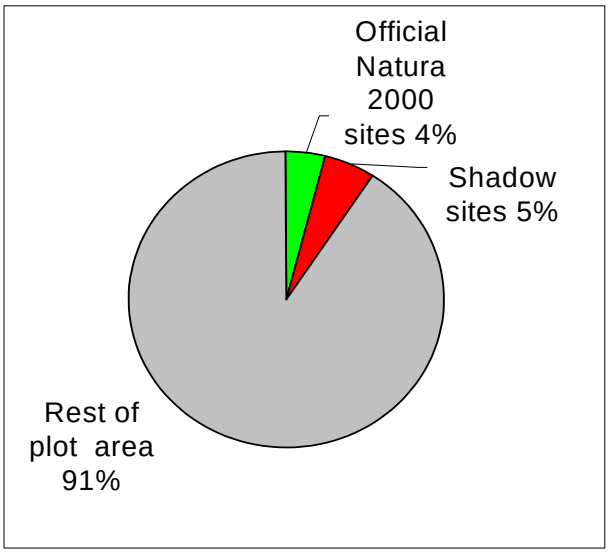


Fig .4 Share of the Nature 2000 area

Of the 19 plots located in official Natura 2000 sites, 11 plots do not represent Natura 2000 habitats, and for one plot habitat identification is not possible. Habitat 9130 is represented by 3 plots inside the official Natura 2000 sites, and habitats 9110 and 9130 are represented by single plots. Other habitats are not represented (or not identified) at all, even if their area in the Natura 2000 network is significant (Fig.5, 6)

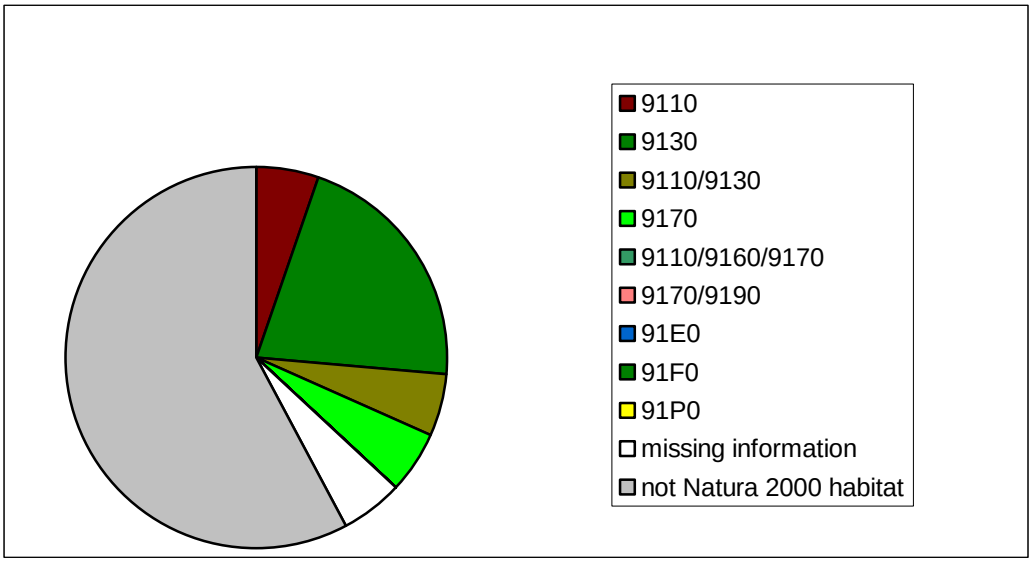


Fig. 5. Habitats represented by 1st level plots in the official Polish Natura sites

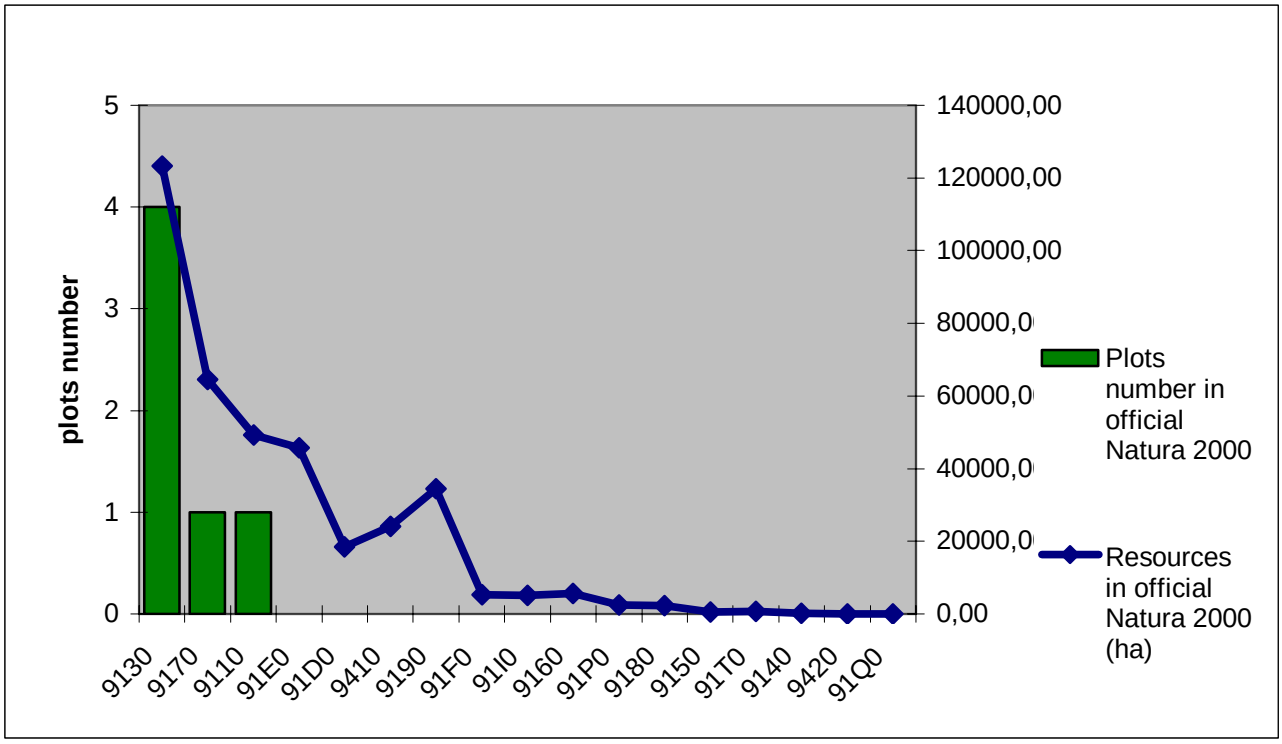


Fig.6 Official Nature 2000 Network

From 73 plots located in potential Natura 2000 sites, 43 do not represent Natura 2000 habitats (Map 1) and for 6 plots the habitat identification seems to be impossible.

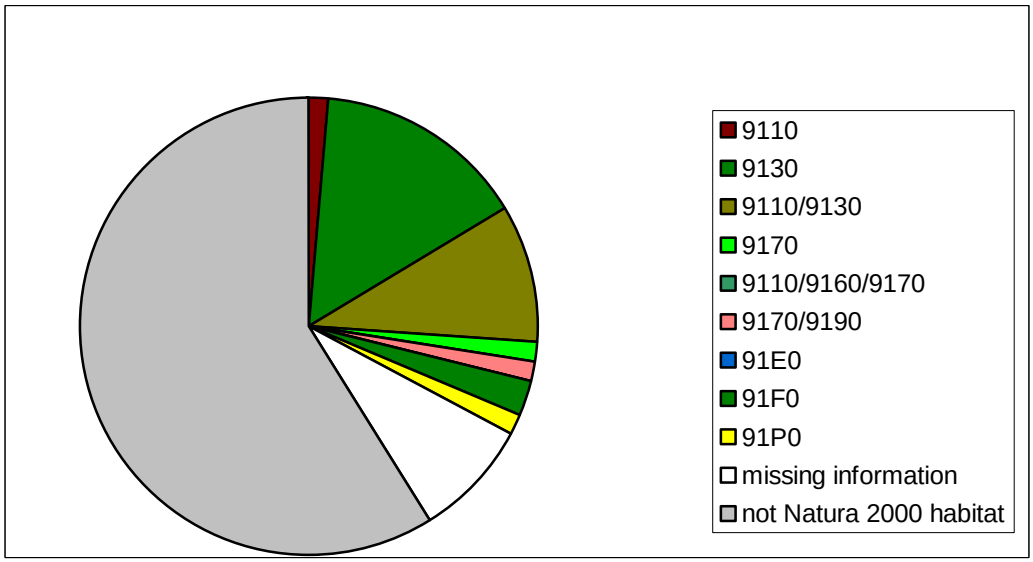
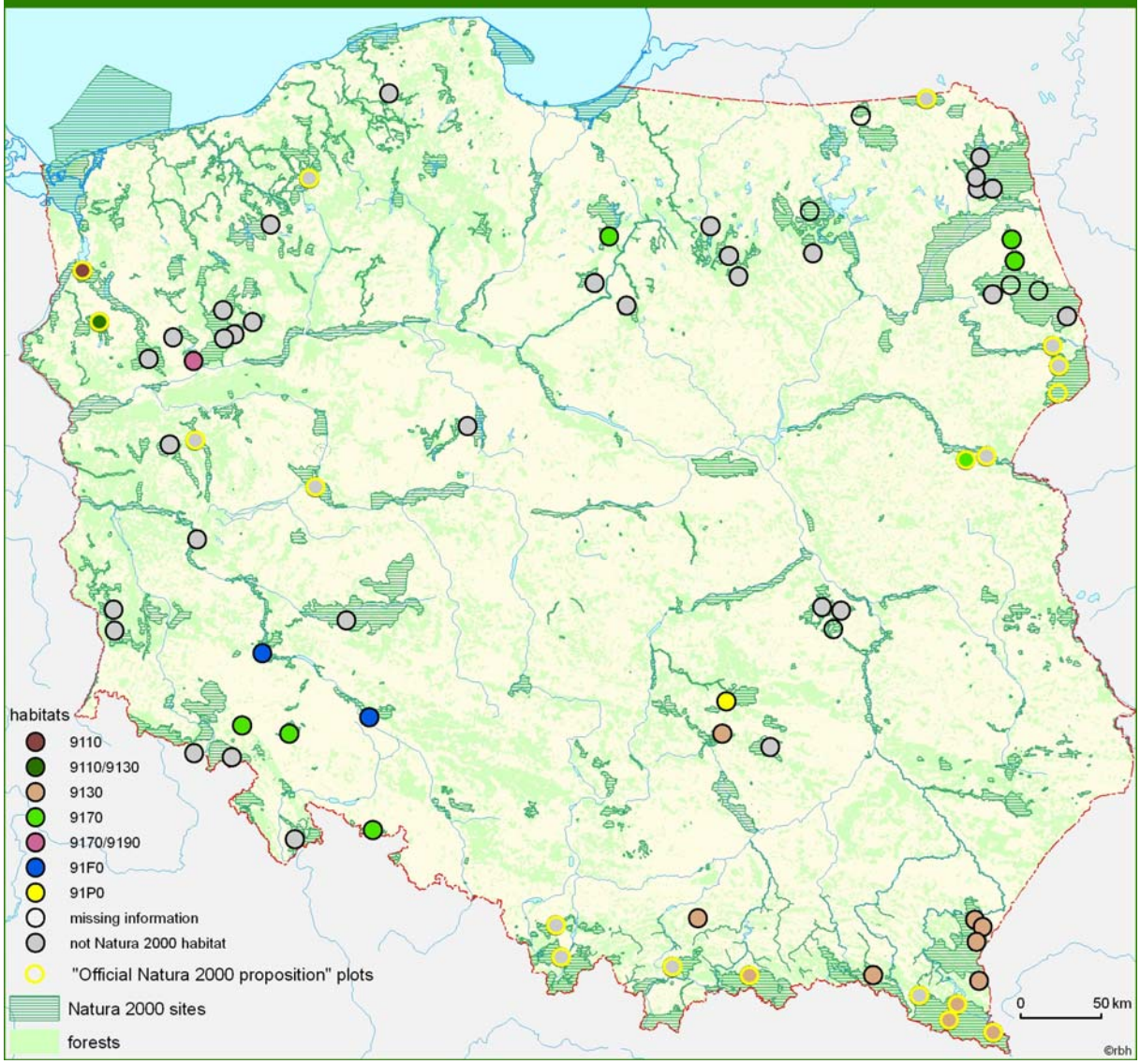


Fig. 7 Habitats represent. by 1st level plots in Poland's potential Natura 2000 list

Map 1 - Habitats represented by 1-st level plots in Poland



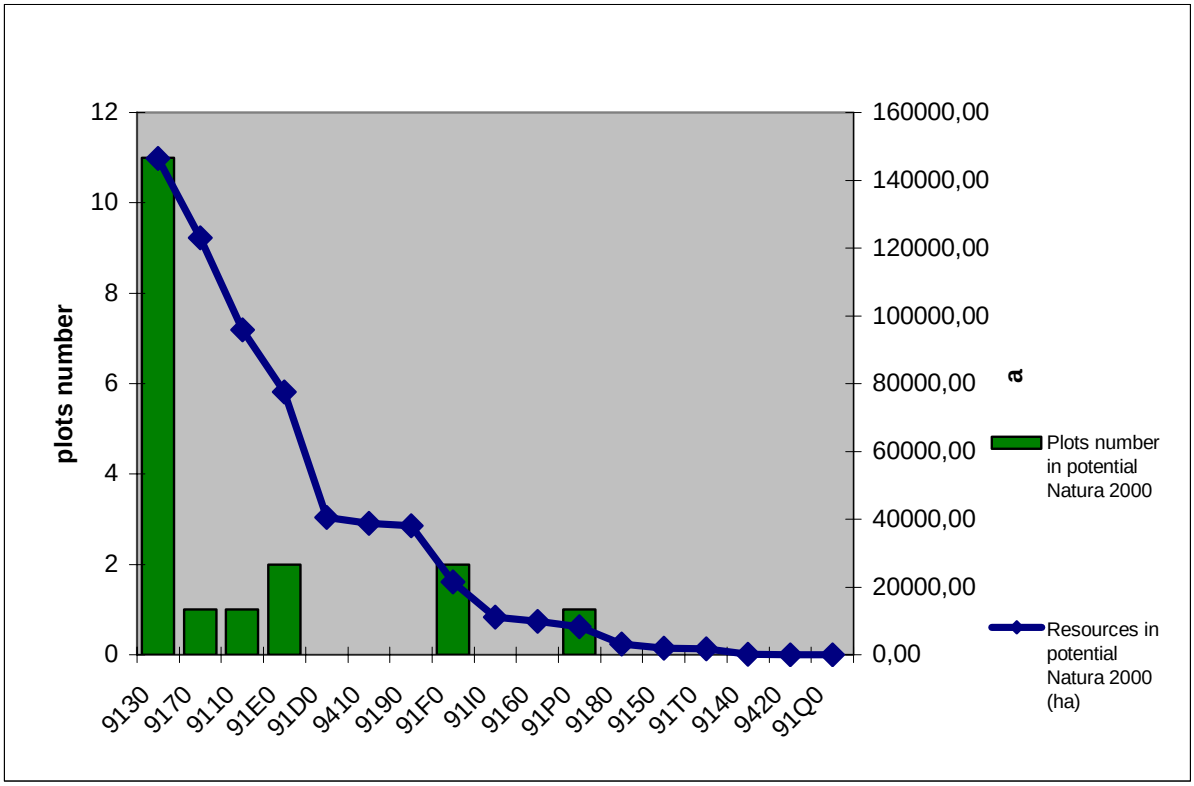


Fig. 8. Potential Natura 2000 sites

The habitat 9130 is relatively well represented, but for other habitats only 1-2 plots can be identified, even if the resources of habitats in sites are relatively big (Fig.7,8). Localization of the 1-level plots in Natura 2000 areas is presented in Map.1.

2.2. The 2nd level permanent observation plots

Because forest vegetation (phytosociological community) is identified for each plots by field analysis, the identification of natural habitat for each plot is easy and there are no important doubts. In terms of the general habitat resources (both inside and outside the Natura 2000 sites): - 52 plots (60,4%) represents not-Annex I habitats; - 7 plots represents 9110 habitat - 7 plots represents 9130 habitat - 6 plots represents 9170 habitat - 6 plots represents 9190 habitat - 3 plots represents 9410 habitat - 91F0, 91T0 and 9160 habitats are represented each by a single plot (Fig.9, 10). The distribution of the 2nd plots according to Nature 2000 areas is presented in Map.2.

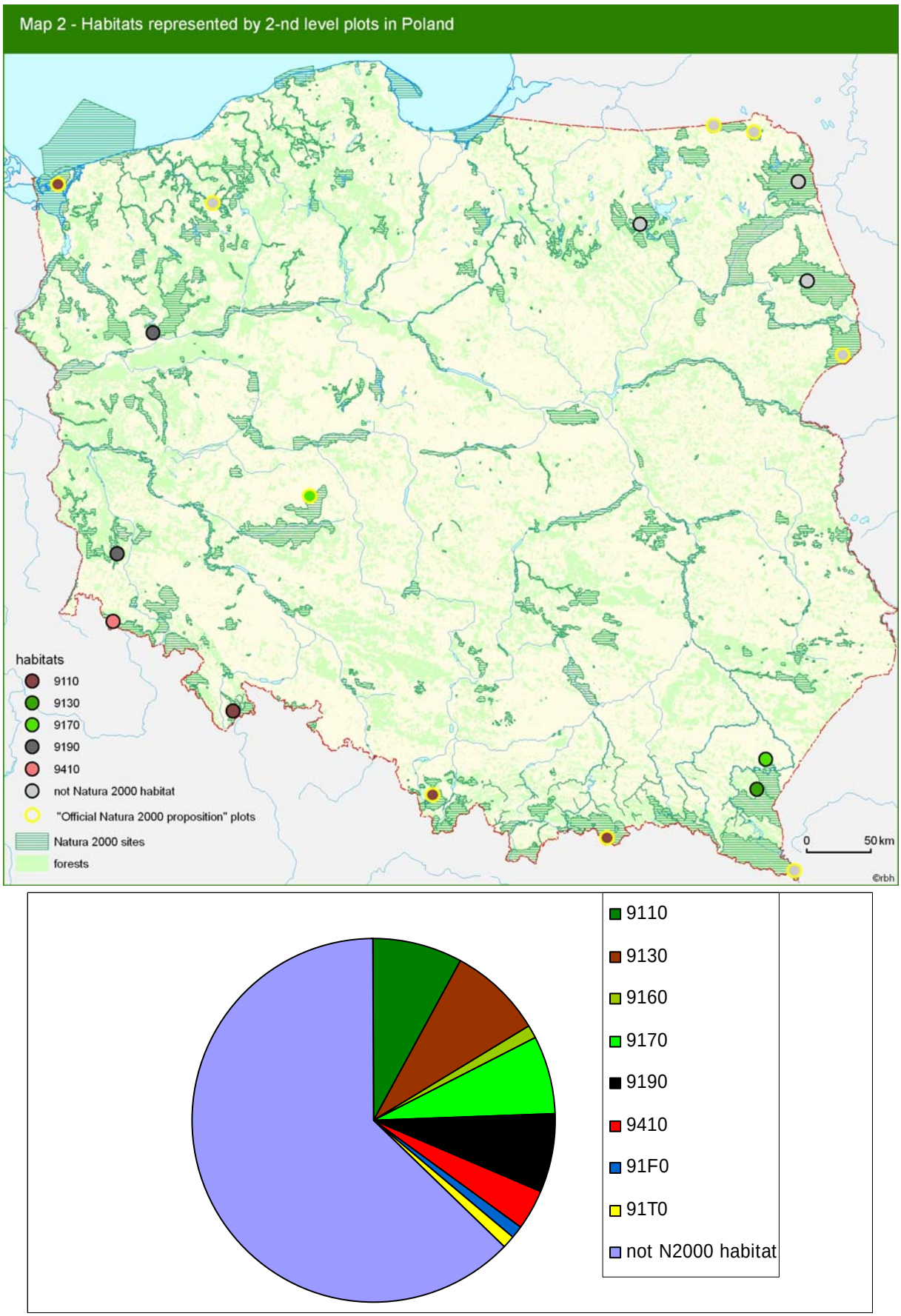


Fig. 9. Habitats represented by 2nd level plots in Poland

The ratio of Annex I habitats to non-Annex I habitats is higher for 2nd level plots than for 1st level plots The Annex I habitats covered by the 2nd level plots are shown in Figure 10.

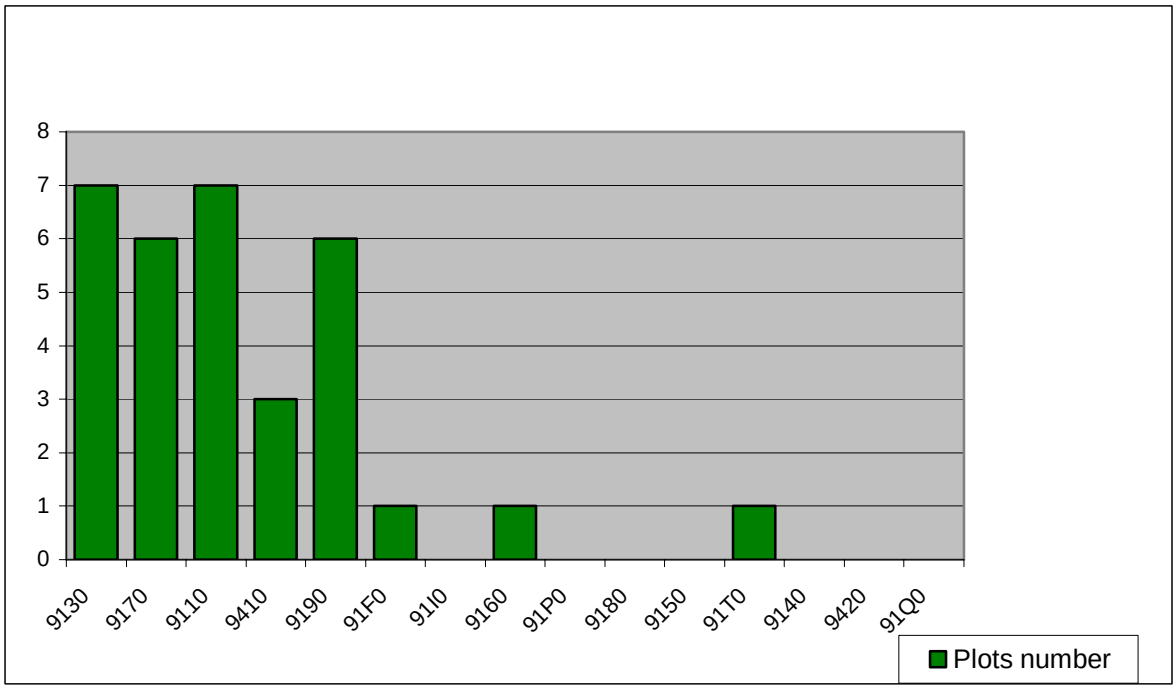
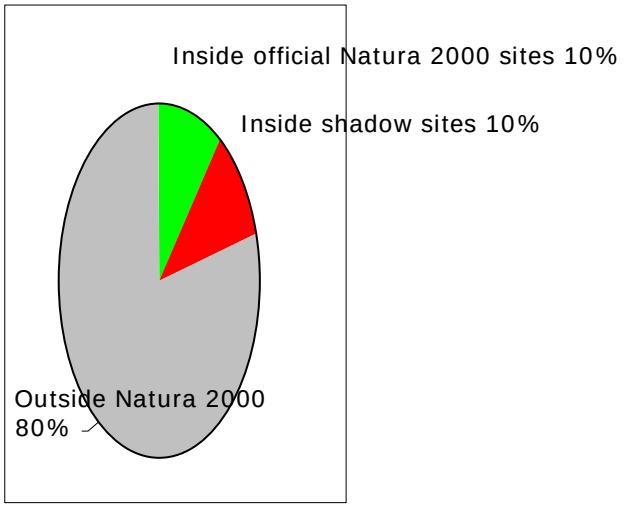


Fig. 10. Distribution of 2nd level plots according to Annex 1 habitats in Poland

If we analyze the spatial distribution of the plots, only 9 from 86 plots (10,5%) are located inside Natura 2000 official sites (Fig. 11,12). Only 4,8% of Natura 2000 sites have a 2nd level plot inside. From these 9 plots located in Natura 2000 sites, 5 plots do not represent Natura 2000 habitats. Four plots represents Natura 2000 habitats: 3 for 9110 and one for 9170. Other habitats are not covered. More detail analyze have no sense as a result of their being too small a sample size. It is clear that such set of plots is useless for any Natura 2000 habitats & sites monitoring.



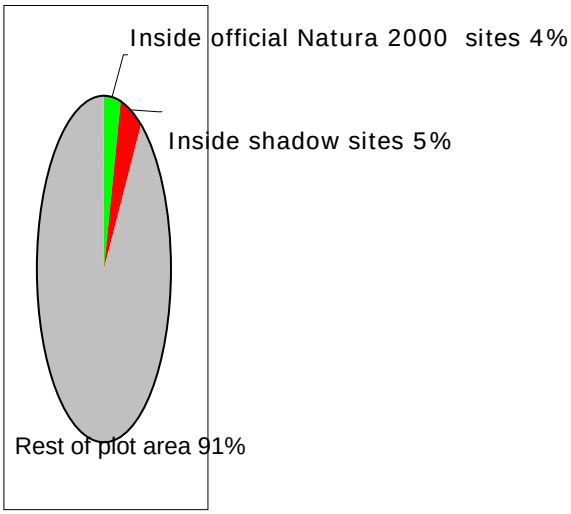


Fig.11 2nd level plots - number in Natura sites Fig.12 2nd level plots in Natura sites by area

If we take under consideration the full Natura 2000 potential sites list, 18 plots (20,9%) are located in the Natura 2000 potential sites, representing 17 sites (3,6% of the total site number). From these plots, 8 do not represent Natura 2000 habitats; 4 plots represent 9110 habitat, 2 - 9190 habitat, 2 - 9170 habitat, one plot - 9130 habitat and one plot - 9410 habitat (Fig.11,12). The habitat 9190 seems to be overrepresented in comparison to its resources identified in Natura 2000 sites. This is probably a result of some problems with this habitat interpretation and identification (as a result, resources are probably underestimated).

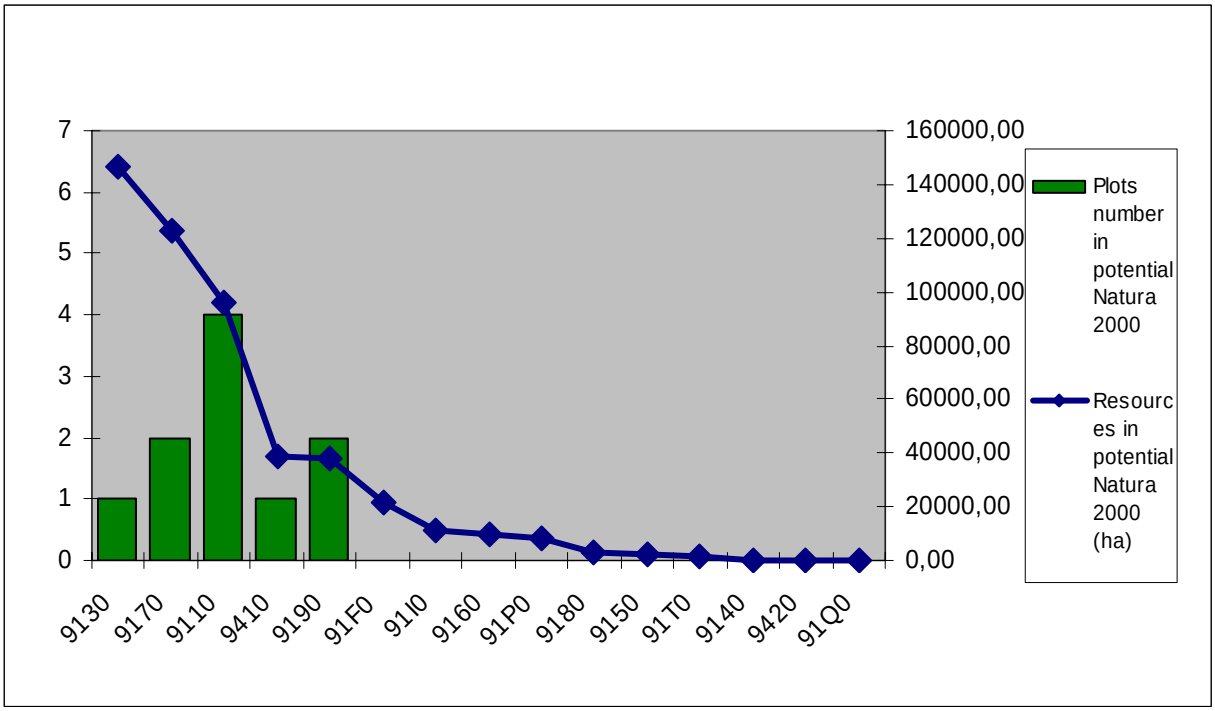
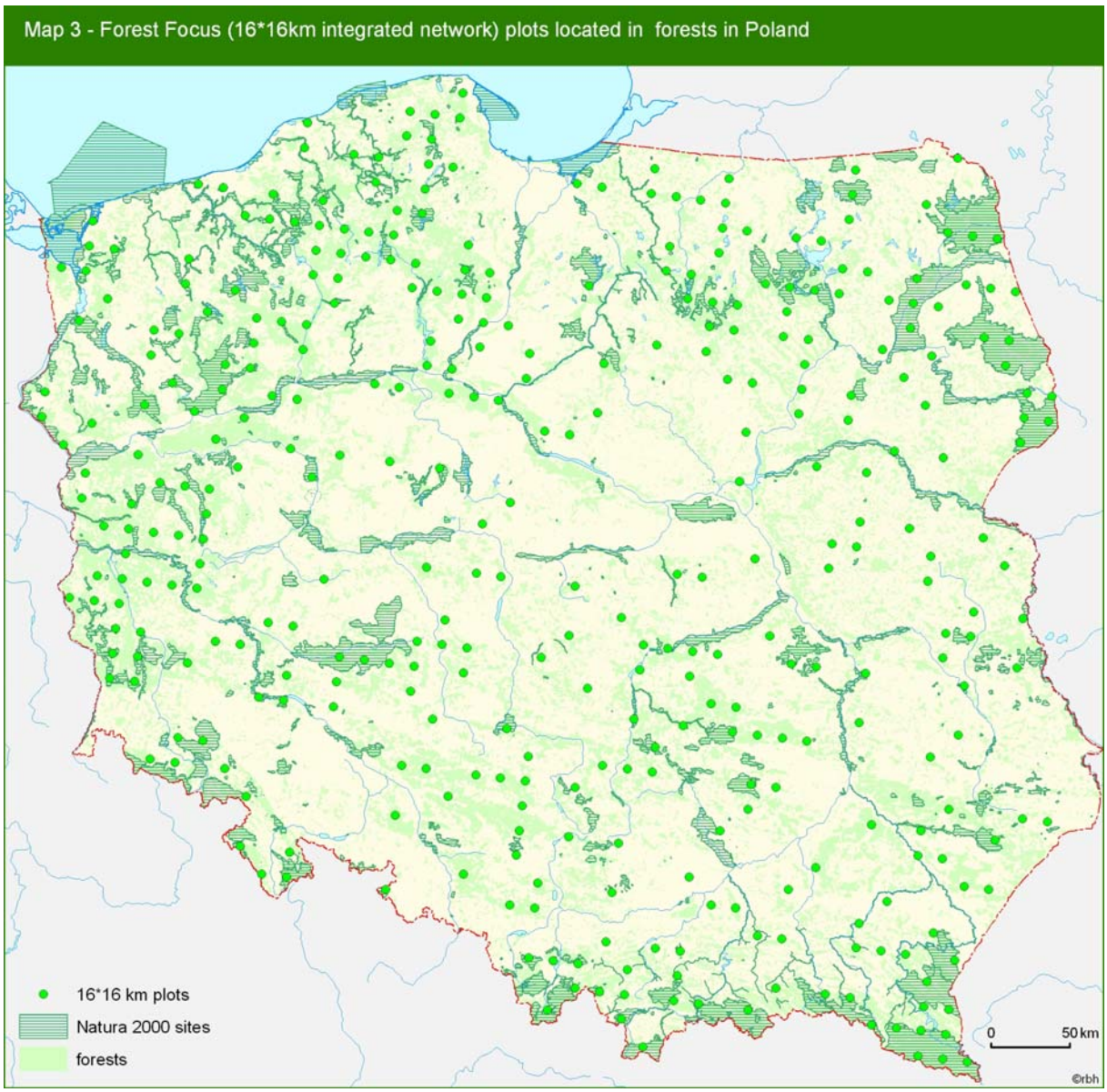


Fig.13. 2nd level plots in potential Nature 2000 sites by Annex 1 habitat

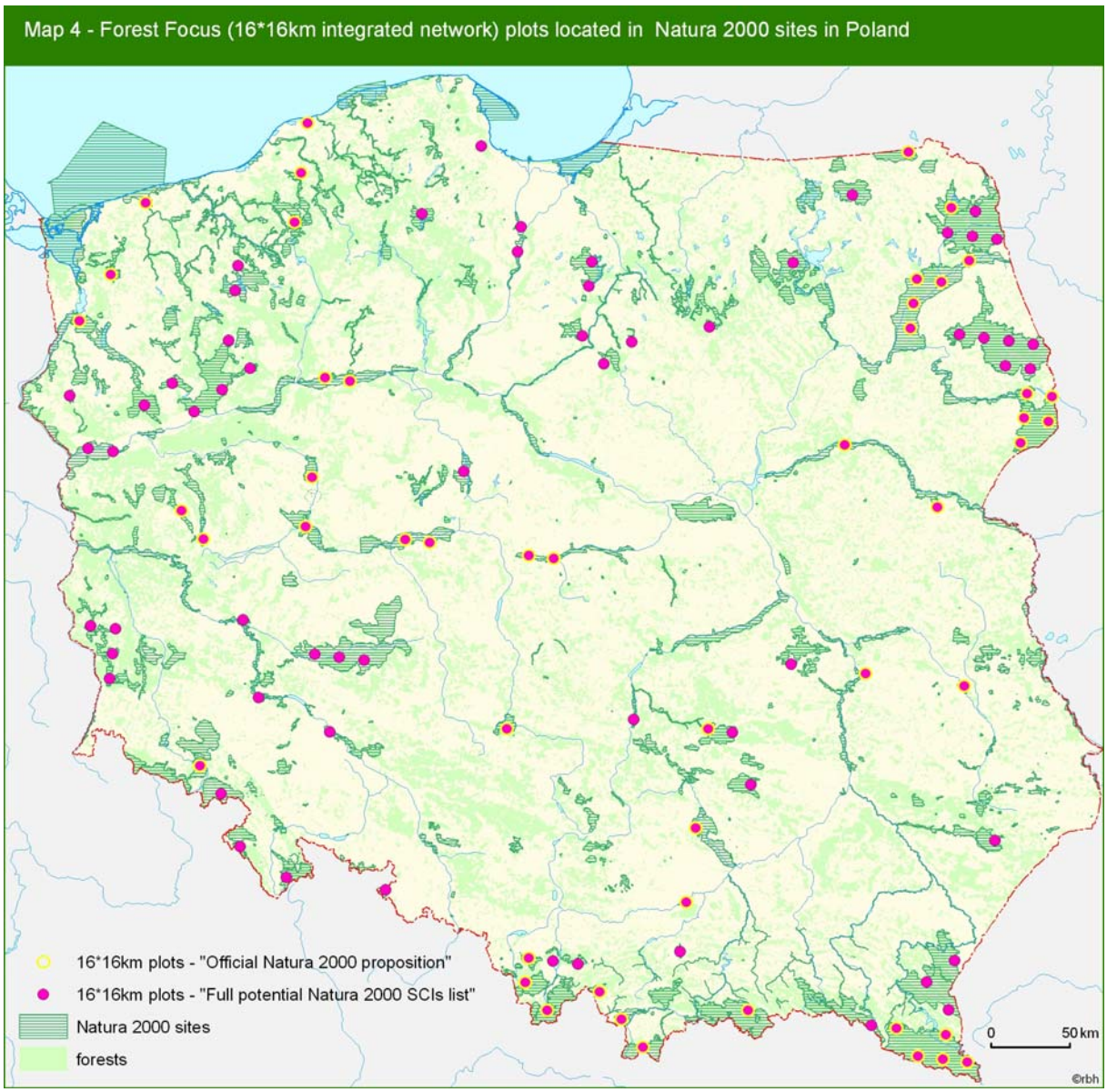
The habitats 91D0 and 91E0, although rather well-represented in potential Natura 2000 sites, are totally not represented by the 2nd plots. The habitats 9130 and 9170, although dominating in the Natura 2000 potential network, seem to be underrepresented (Fig.13).

2.3. The integrated network 1-level permanent observation plots

Integration of the First level permanent observation network of the forest monitoring program and network of the new national inventory of the forest will take place in 2006. The new network will cover all categories of forest ownership and all type of protective regulations and will be strictly fitted to ICP coordinates. In the integrated network a total of about 367 1st level permanent observation plots will be established (Map.3).



Among the plots, 49 (13,3%) fall in the "Official Nature 2000" areas and 109 plots (29,7%) in the "Potential Nature 2000 SCIs list" (Map.4). Identification of the habitats on the 1st level permanent observation plots in the integrated network is not possible because a lack of data.

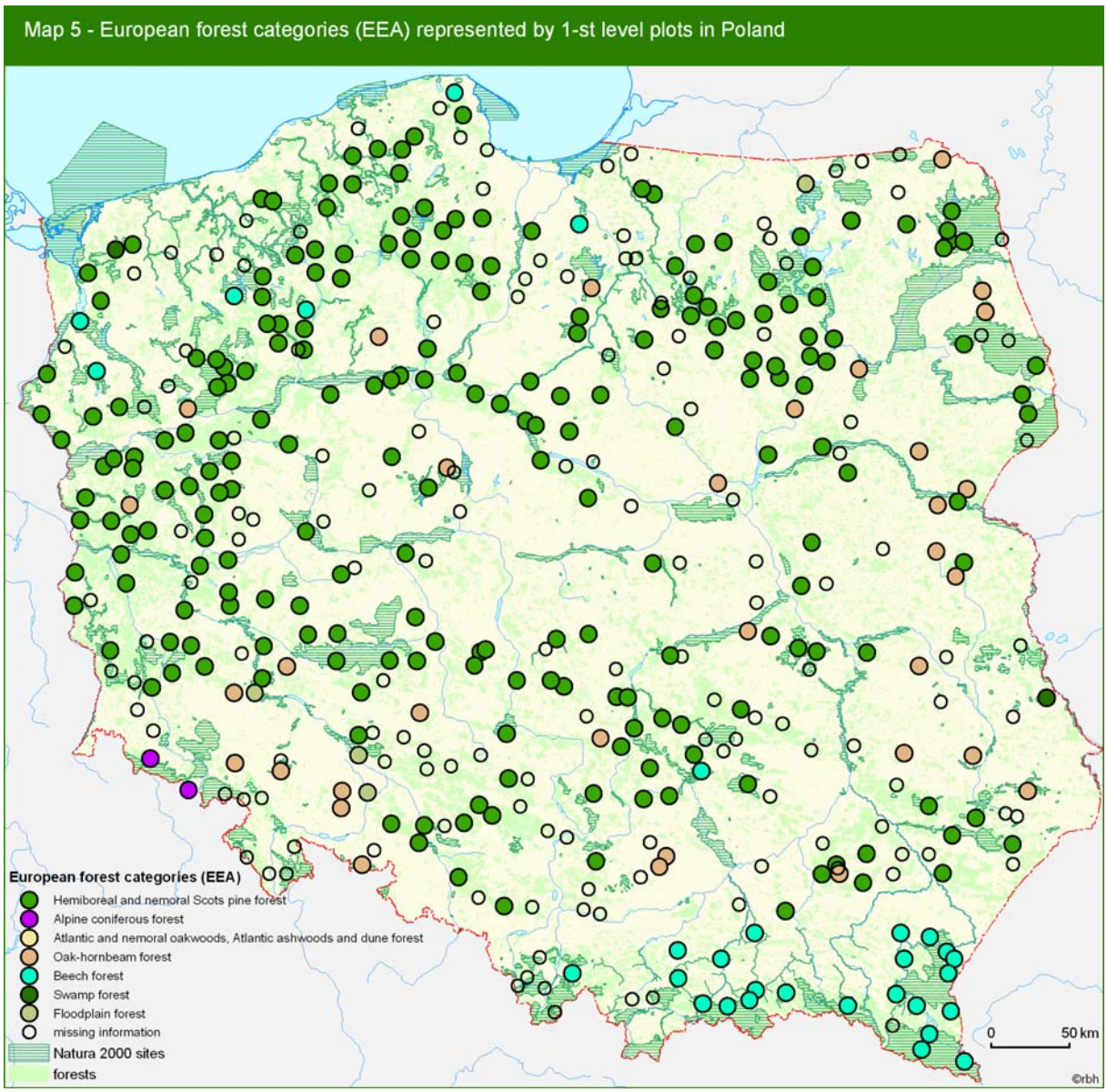


3. EEA forest categories representations in forest monitoring plots in Poland

The European Environmental Agency proposal for forest type arrangement was the reference for classification of forest monitoring plots in Poland (Barbati et al., 2005). Due to some ambiguity of the EEA system, as well as incompleteness of information, assignment of forest type (category) for a some of the plots was difficult.

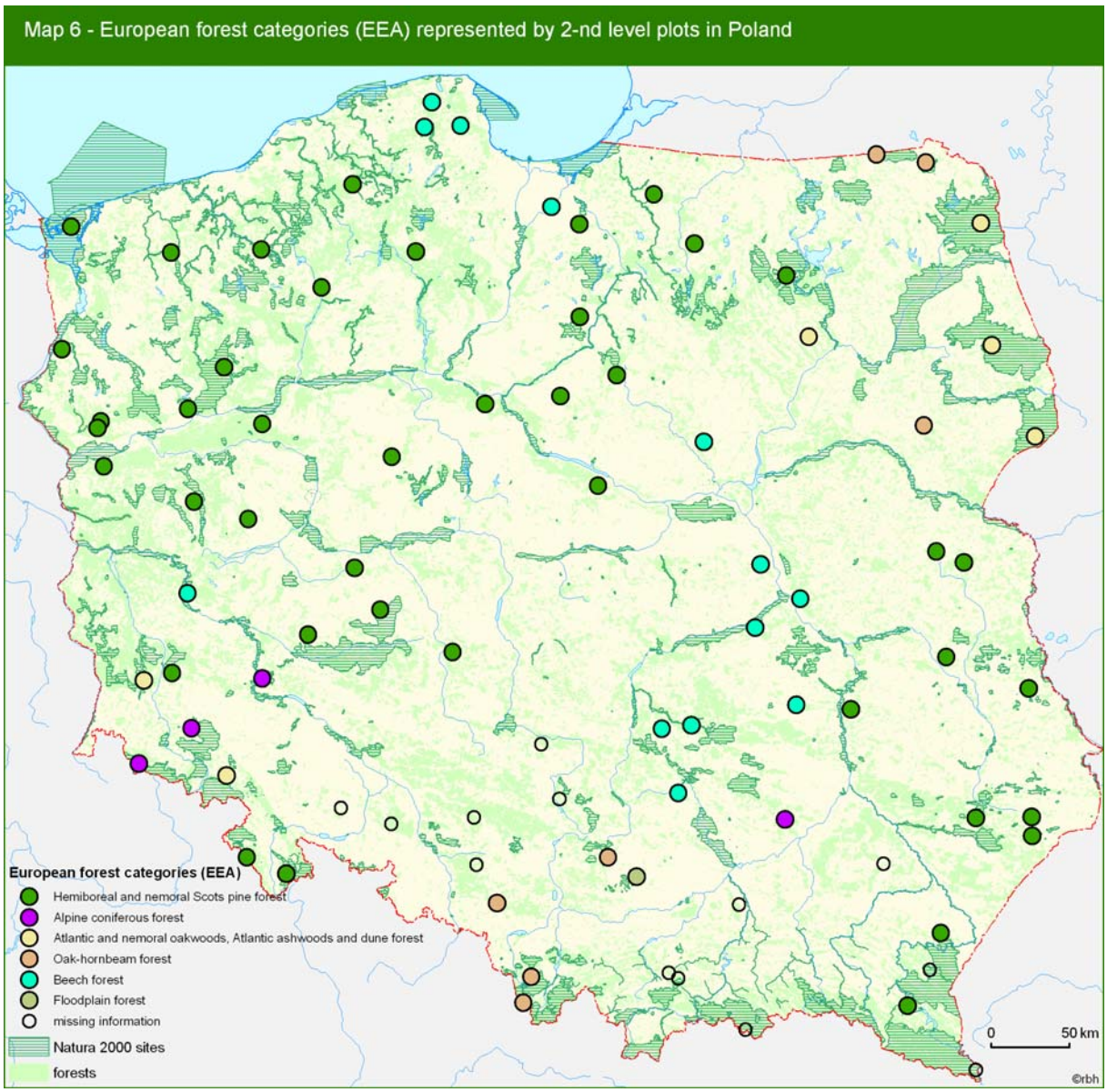
3.1. EEA forest categories representations in 1st level plots

The most common EEA forest category in the 1st level plots is Hemiboreal and nemoral Scots pine forests represented by 219 plots (50,6%). Less frequent categories are Atlantic and nemoral oakwoods represented by 33 plots (7,6%) and Oak hornbeam forests represented by 30 plots (6,9%). Only a few plots represent Swamp forest – 4 plots, Beech forest – 2 plots and Floodplain forest – 1 plot. Many plots (142) were not determined because of missing information (Map.5).



3.2. EEA forest categories representations in 2nd level plots

The prevailing EEA forest category in 2nd level plots is Hemiboreal and nemoral Scots pine forests represented by 42 plots (48,8%). Second frequent category is Beech forest represented by 13 plots (15,1%). Oak hornbeam forest is represented by 7 plots (8,1%) and Atlantic and nemoral oakwoods – 6 plots (6,9%). Alpine coniferous forests was represented by 4 plots (4,6%) and Floodplain forest by 1 plot (1,1%). Forest category of 13 plots (15,1%) were not determined because of missing information (Map.6).



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European Commission, 2003. Interpretation Manual of European Union Habitats - EUR25. European Commission, DG Environment, Brussels.