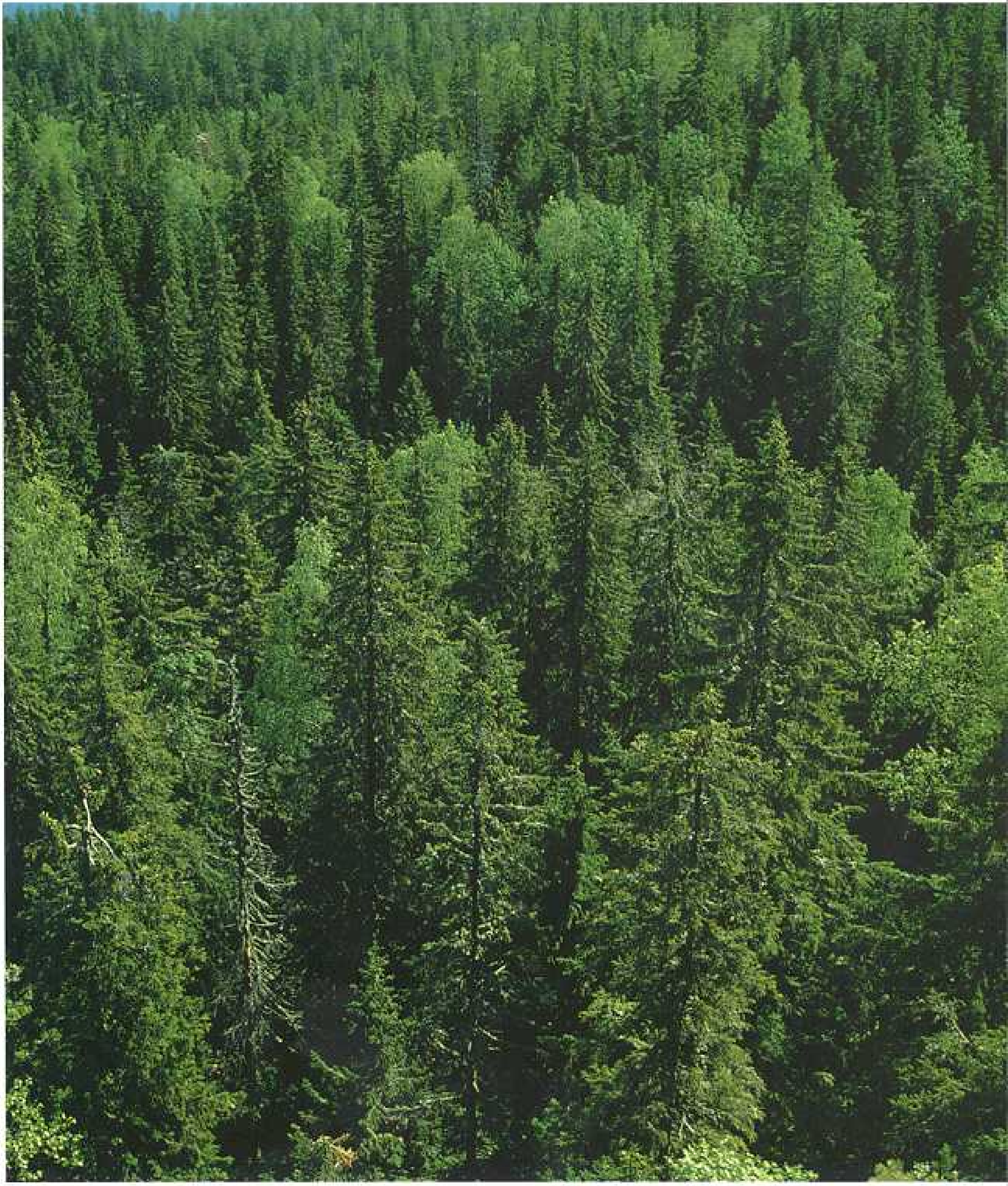
International collaboration on forest genetic resources: the role of Europe

Second EUFORGEN Steering Committee meeting
26-29 November 1998 - Vienna, Austria

J. Turok and Th. Geburek, *editors*

EUFORGEN

European Forest Genetic Resources Programme (EUFORGEN)



IPGRI is an institute of the Consultative Group on International Agricultural Research (CGIAR)

The International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organization, supported by the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of genetic diversity for the well-being of present and future generations. IPGRI's headquarters is based in Rome, Italy, with offices in another 19 countries worldwide. It operates through three programmes: (1) the Plant Genetic Resources Programme, (2) the CGIAR Genetic Resources Support Programme, and (3) the International Network for the Improvement of Banana and Plantain (INIBAP).

The international status of IPGRI is conferred under an Establishment Agreement which, by January 2000, had been signed and ratified by the Governments of Algeria, Australia, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Chile, China, Congo, Costa Rica, Côte d'Ivoire, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Greece, Guinea, Hungary, India, Indonesia, Iran, Israel, Italy, Jordan, Kenya, Malaysia, Mauritania, Morocco, Norway, Pakistan, Panama, Peru, Poland, Portugal, Romania, Russia, Senegal, Slovakia, Sudan, Switzerland, Syria, Tunisia, Turkey, Uganda and Ukraine.

Financial support for the Research Agenda of IPGRI is provided by the Governments of Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, F.R. Yugoslavia (Serbia and Montenegro), Finland, France, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Macedonia (F.Y.R.), Malta, Mexico, the Netherlands, Norway, Peru, the Philippines, Poland, Portugal, Romania, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, the UK, the USA and by the Asian Development Bank, Common Fund for Commodities, Technical Centre for Agricultural and Rural Cooperation (CTA), European Environment Agency (EEA), European Union, Food and Agriculture Organization of the United Nations (FAO), International Development Research Centre (IDRC), International Fund for Agricultural Development (IFAD), Interamerican Development Bank, Natural Resources Institute (NRI), Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Nordic Genebank, Rockefeller Foundation, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), Taiwan Banana Research Institute (TBRI) and the World Bank.

The European Forest Genetic Resources Programme (EUFORGEN) is a collaborative programme among European countries aimed at ensuring the effective conservation and the sustainable utilization of forest genetic resources in Europe. It was established to implement Resolution 2 of the Strasbourg Ministerial Conference on the Protection of Forests in Europe. EUFORGEN is financed by participating countries and is coordinated by IPGRI, in collaboration with the Forestry Department of FAO. It facilitates the dissemination of information and various collaborative initiatives. The Programme operates through networks in which forest geneticists and other forestry specialists work together to analyze needs, exchange experiences and develop conservation objectives and methods for selected species. The networks also contribute to the development of appropriate conservation strategies for the ecosystems to which these species belong. Network members and other scientists and forest managers from participating countries carry out an agreed workplan with their own resources as inputs in kind to the Programme. EUFORGEN is overseen by a Steering Committee composed of National Coordinators nominated by the participating countries.

Citation: Turok, J. and Th. Geburek, editors. 2000. International collaboration on forest genetic resources: the role of Europe. Proceedings of the Second EUFORGEN Steering Committee meeting, 26-29 November 1998, Vienna, Austria. International Plant Genetic Resources Institute, Rome, Italy.

ISBN 92-9043-448-1

IPGRI
Via delle Sette Chiese, 142
00145 Rome, Italy

Contents

Summary of the Steering Committee meeting

Introduction

Four years after the establishment of the European Forest Genetic Resources Programme (EUFORGEN), the second Steering Committee meeting was held from 26 – 29 November 1998, in Vienna, Austria. National Coordinators from 23 participating countries (Austria, Belarus, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Lithuania, Malta, Moldova, Norway, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and Ukraine) attended the meeting, as well as national focal persons from 11 non-participating countries and 12 resource persons and observers. The four additional countries participating in EUFORGEN (Latvia, Luxembourg, Monaco and Switzerland) were unable to attend.

The main objective of the Steering Committee meeting was to review the progress made since the establishment of the Programme in November 1994 and to outline future activities. EUFORGEN was developed as the implementation mechanism of Strasbourg Resolution S2 (Conservation of forest genetic resources) adopted at the first Ministerial Conference on the Protection of Forests in Europe.

The meeting was opened by Mr Rudolf Themessl, Ministerialrat, Forestry Department, Federal Ministry of Agriculture and Forestry. He welcomed the participants and expressed the continuous support of Austria to international collaboration on the conservation of forest genetic resources in Europe. He wished the participants a successful meeting.

In his introductory remarks, Dr Geoffrey Hawtin, Director General of the International Plant Genetic Resources Institute (IPGRI) said that the conservation and sustainable use of forest genetic resources was a subject of global concern. The networking initiative of European countries gave substance to the implementation of Strasbourg Resolution S2, was essential for increasing the scientific knowledge in this area, and stimulated cooperation between national programmes in Europe and other regions. Ms Christel Palmberg-Lerche, Chief, Forest Resources Development Service, Forestry Department, United Nations Food and Agriculture Organization (FAO) also addressed the meeting. She underlined the importance of developing a coherent, country-driven global framework for the conservation, management, sustainable use and enhancement of forest genetic resources.

The first day of the meeting consisted of two technical sessions. Ten papers were presented and discussed. The first two papers focused on the history and role of genetic resources issues as they have been addressed in the process of Ministerial Conferences on the Protection of Forests in Europe. The following four papers reviewed the trends and developments in conserving, monitoring and enhancing genetic diversity of forests in Europe. The last four papers complemented these contributions by referring to the examples of collaborative activities undertaken in the Trans-Caucasus, Central Asia, Sub-Saharan Africa and North America and examined their links with the networking in Europe.

The papers offered a broad overview of the current developments in the area of forest genetic resources and provided a basis for the further discussions specifically related to the role, orientation and management of the EUFORGEN Programme in the future. The workshop papers are published in this volume.

Report of the EUFORGEN Coordinator and presentations by the Chairs of the Networks

Chair of the session: Michel Arbez

Rapporteurs: Bjerne Ditlevsen and Riccardo Alía

Dr Jozef Turok presented a comprehensive report covering the first four years of the EUFORGEN activities (Annex I and II). A total of 27 countries joined the Programme during the period from November 1994 to November 1998. Five Networks have been established, and a total of 18 Network meetings were organized. There has been a generally increasing number of participants (attending members) in the Networks.

The Steering Committee acknowledged the substantial output from the Networks as well as the role of the Secretariat in achieving these results. The EUFORGEN activities are financed through contributions from participating countries. Concern was raised with regard to delayed payments from some of the countries. The EUFORGEN Coordinator informed that the budget and accounts are regularly audited as part of IPGRI's external auditing procedures.

Collaborative linkages developed between EUFORGEN and other regions, with particular reference to the newly independent states of the former Soviet Union, as well as other international organizations, were noted.

It was stressed that EUFORGEN should follow closely and participate in the current discussions concerning the development of Criteria and Indicators for sustainable forest management, particularly with regard to the genetic components of biological diversity.

Brief statements were then presented describing the five EUFORGEN Networks:

- *Populus nigra* Network (François Lefèvre, Chair)
- Noble Hardwoods Network (Gösta Eriksson, Chair)
- *Picea abies* Network (Veikko Koski, Chair)
- *Quercus suber* Network (Maria Carolina Varela, Chair)
- Social Broadleaves Network (Ladislav Paule, Vice-Chair).

These contributions (Annex III) circulated to members of the Steering Committee before the meeting, provided a synthesis of the Networks' activities, including their evolution, potential and perspectives for the future as well as linkages between the individual Networks. Mechanisms to encourage further interaction and information flow between the Networks need to be explored. Collaboration with IUFRO Working Groups was emphasized.

Themes of common interest to all the Networks were mentioned, e.g. population genetic concepts, role of tree breeding in genetic conservation, global climate change, conservation of associated species in ecosystems, species hybridization. The need for exchanging information and coordinating approach to address these issues in general was expressed. One item of particular interest to some present was the development of a glossary of terms and definitions relating to forest genetic resources (FGR).

Response by Steering Committee members and statements by observers

Chair of the session: Sven de Vries

Rapporteurs: Sam Samuel and David Thompson

The afternoon of the second day of the meeting was devoted to a detailed consideration of the Coordinator's report on EUFORGEN during Phase I. Following discussion, participating countries unanimously approved the report.

All countries and organizations present took part in the discussion of the report, which focused on the aspects presented below, in which the combined responses of participating countries (23 present), non-participating countries (11 focal persons present) and international organizations, initiatives and programmes (5 observers present) are summarized.

Non-participating countries expressed their gratitude to EUFORGEN for providing the opportunity to attend not only this Steering Committee meeting but also to participate in Network meetings and activities and in particular for the partial financial support they had received for these purposes.

Fulfillment of the objectives of Strasbourg Resolution S2

It was felt that much had been achieved and that the objectives of the Resolution had been clearly followed. The specific expectations of a number of countries had been met. EUFORGEN was recognized to have developed a good reputation in the short period of time it has been in operation.

Impact on the progress in conservation of FGR at national level

The influence of EUFORGEN was felt to have already had a major effect in some countries and many anticipated positive steps in the implementation of national FGR programmes in the near future. The participation of national governments in EUFORGEN had a positive influence on the focusing of attention on the importance of the conservation of FGR. It was felt that in a number of instances much less would have been achieved without the structure of EUFORGEN to support it. The effects had included the release of increased funding for conservation of FGR, the acceptance of such conservation as an integral part of sustainable forest management and the consolidation of genetic conservation principles into recent forest law.

Funding

National Coordinators are commonly not drawn from those organizations or sectors of government, which have the responsibility of paying for EUFORGEN membership. This applies to those who have not yet joined as well as to already participating countries. Both groups saw the need to relate activities and outputs to S2 objectives as important ways of convincing the respective funding (implementing) agencies that membership involves value for money. This is particularly true for countries that have high contributions. The importance of monitoring and documenting progress in FGR conservation resulting from EUFORGEN activities to national governments needs to be stressed.

Networks

Networks were recognized as an effective mechanism for coordinating the implementation of S2 objectives. Their main activities have been exchange of data and information, dissemination of knowledge, development of strategies and technical guidelines, common minimum information standards, databases, preparation of joint project proposals, exchange of genetic material and the initiation of joint field trials. Although some participants felt that

Networks should remain restricted to their original species, there was stronger support for their extension into wider species groups. An interest in joint meetings was also expressed. Concern over increase in the size of Networks was recognized. A joint "Inter-Network Group" consisting of Chairs and Vice-Chairs of all Networks together with two Management Committee members was proposed and discussed. This group, rather than the Steering Committee, will have the responsibility of harmonizing the direction and activities of the Networks.

Publications

There was commendation of the quality of publications that were felt to be appropriate and well produced. However, it was recognized that they served a more specialist audience such as Steering Committee and Network members or their scientific colleagues. Some members considered publications appeared too slowly after meetings. Two areas in particular were felt to warrant more attention. Firstly, executive summaries of larger publications in generally more lay terms would be useful for policy-makers and non-scientific levels of government. Secondly, this material and other more specific information would also be useful to be produced in further languages. The production of technical guidelines for the management of forest genetic resources by each of the Networks was seen as a key output of the Programme.

The wider influences of EUFORGEN

In specific cases, Networks have been effective fora in developing proposals for external funding of cooperative projects among a number of countries. EUFORGEN has the potential to enhance greater collaboration between European Union countries and non-EU members mainly from eastern Europe and the former Soviet Union. It was also recognized that EUFORGEN had played a major role as an example for similar genetic resources initiatives in other regions of the world and that it could continue to do so in areas where such work has not yet been developed.

Public awareness

Raising awareness about the importance of forest genetic resources in the pan-European process on forests and at other political fora was confirmed to be one of the objectives of EUFORGEN. It was felt that EUFORGEN was well equipped to take on the task of promoting better awareness, particularly among decision-makers and forest managers in European countries. It was recognized that there was a specific need to provide better understanding of the effects of using the product of tree breeding and improvement in relation to genetic conservation principles and to try to bridge the gap between forest managers and environmentalists in the same subject area.

Training

There was some discussion of training needs with a firm interest shown by a number of countries in the prospects of training courses at general, species and national levels. There were problems in budgeting for such work; a decision was made on this topic when Phase II was discussed (see below).

Challenges

One of the main challenges that will face EUFORGEN in the future will be the implementation of the technical guidelines developed by the Networks. Several participants expressed concerns about how this implementation will take place at national level.

Development of national programmes on forest genetic resources in Europe

Chair of the session: Christel Palmberg-Lerche

Rapporteur: Csaba Mátyás

The EUFORGEN Coordinator presented results of the survey on the status of the conservation and management of FGR in Europe, which was conducted prior to the meeting (September-October 1998). It was divided into three parts (conservation of genetic resources in the forestry practice, coordination at national level and international coordination). Response was received from 37 countries. The European Forest Genetic Resources Workshop held in November 1995 in Sopron, Hungary had, among others, recommended that each country develop a national strategy for the conservation of FGR. One of the objectives of the survey (part II) was to assess how that recommendation was being implemented in the participating countries.

While considerable differences were evident among countries, all reported some advances ranging from the development, and in some cases, implementation, of comprehensive national forest genetic resources programmes, to initial steps taken towards this goal. Major challenges for the national strategies/programmes were to ensure that genetic considerations be integrated into national forestry policies and practices, to involve all relevant stakeholders and achieve efficient coordination among their activities.

While recognizing that the present survey was the first of its kind and that no previous baseline data with which to compare the results therefore existed, the Steering Committee requested that the Secretariat extract highlights from the survey and from other available sources and, based on quantifiable data, provides a summary of the progress made for the attention of Committee members and for decision-makers in EUFORGEN countries. The Committee further recommended that the Secretariat regularly monitor progress in important criteria (e.g. establishment of a formal national programme, commitment, coordination, links, impact) against the baseline data, paying due attention to varying initial levels of development in the national forest genetic resources strategies/programmes. Several members stressed that, in addition to its technical and scientific value, such factual analysis of progress was likely to also strengthen or motivate the necessary political commitment of signatory governments of Resolution S2 to forest genetic resources.

The third part of the survey focused on international collaboration, including a question about the effectiveness of EUFORGEN in contributing to the conservation and management of forest genetic resources in Europe. It was noted that countries, in general, had rated highest those activities that had been originally specified in its programme, i.e. the objectives of Resolution S2. Results of the survey also indicated areas in which EUFORGEN might become involved in the future. Providing a regional forum for the exchange of experience, knowledge and information; planning and implementation of joint Network tasks; and thus encouraging countries to ensure the conservation and sustainable use of their FGR received the highest rating.

Proposal for a second phase of EUFORGEN

Chair of the session: Tore Skrøppa

Rapporteurs: Hojka Kraigher and Karel Vancura

Needs for a second phase

There was unanimous support for a second Phase of EUFORGEN. The increasing number of participating countries during Phase I, the technical outputs provided and their impact as well as the need for further coordinating and promoting the gene conservation efforts made by European countries provide strong justification for the continuation of EUFORGEN. A new Letter of Agreement for the Phase II will need to be formally approved by governments. This will cover the period from 1 January 2000 to 31 December 2004. Some participants mentioned that there might be difficulties with seeking formal approval for a new agreement, especially if the existing one (Phase I) was made only recently. It was recommended that the Secretariat prepares and submits the new Letter of Agreement well in advance of time during 1999 (last year of Phase I), in order to allow the necessary procedure at the national level. The accompanying correspondence should make it clear that the second Phase is an expected extension of the existing Programme, and not a new mechanism.

Objectives

It was agreed widely that EUFORGEN should concentrate all efforts on implementing the original objectives stated in Strasbourg Resolution S2, refer to them and avoid expanding work into new areas which are not directly associated. The objectives of Resolution S2 were discussed at length. It was noted that there has been a clear distinction regarding the commitment made by signing S2 between national responsibilities and the international implementation. While EUFORGEN is directly responsible for implementing the international collaboration aspects of Resolution S2 (see Annex IV), it is recognized that decisions on forest genetic resources, their management and financing are entirely under the responsibility of the national programmes. EUFORGEN assists countries to develop and implement effective national strategies/programmes.

Milestones

The Steering Committee requested the Secretariat to compile an overview of the outputs provided during the past 4 years against the operational objectives of EUFORGEN (expectations based on S2). This would help to illustrate the progress made at both national level and internationally. Such overview would also clearly present the needs for continuation and lay down the concrete operational objectives for Phase II. It is important to have a baseline because different countries are in different stages of developing their national programmes on forest genetic resources (see above section). It was recommended that a report on what was achieved in the implementation of S2 by countries (at the national level) and by the EUFORGEN Secretariat (at the international level) be prepared for each Steering Committee meeting.

Mode of operation

It is described in the "EUFORGEN Document" which forms part of the Letter of Agreement and is regularly reviewed at Steering Committee meetings (Annex IV). It was discussed on the basis of the proposal prepared by the Secretariat and sent to members of the Steering Committee in advance before the meeting. The recommendations resulting from this discussion are incorporated in the version endorsed (Annex IV). Some members raised their concern over relatively little time devoted to this item at the meeting.

The main level and tool for implementing the objectives of EUFORGEN remain to be the species Networks. The Steering Committee stressed that this was a practically oriented, well-established approach. The participants were reminded that the species chosen for the individual Networks were "pilot", i.e. representing different gene conservation problems and situations and hence not based on criteria such as the level of threats to individual species. The broadening of the scope of the Networks with regard to species should be driven from within the Networks, under the overall guidance by the Inter-Network Group. It was noted that Networks already made first steps towards broadening their species scope: *Quercus suber* Network and Mediterranean oaks, *Populus nigra* Network and *P. alba*, *Picea abies* Network and other conifers. The Steering Committee expressed satisfaction with these developments. Some participants raised concerns about the increased size of meetings associated with the broader scope of Networks involving more countries. The mechanism adopted in the EUFORGEN Document was considered adequate to ensure a good balance. A survey will be conducted before the next Steering Committee meeting in order to re-assess the priorities given by countries to species that have, or have not been covered by the EUFORGEN Networks.

While it was agreed that synergies should be created between all the EUFORGEN Networks in addressing certain themes (such as genetic resources in view of the global climate change, common methodologies), thematically-oriented Networks should not be developed. The Steering Committee recommended to further incorporating the most pertinent themes into the context of ongoing activities of the Networks. This arrangement takes into consideration the fact that the five Networks are differently advanced and may work with different intensity. The Inter-Network Group will also be responsible for harmonizing thematic priorities and action among the Networks. The Steering Committee encouraged that occasional joint Network meetings (two or more Networks) are organized, according to the needs and operational possibilities.

The Steering Committee requested that each Network provide a brief overview of its objectives, workplan with milestones and outputs. These will enable to indicate progress, separately for Phase I and expected for Phase II (especially the three Networks with changing scope).

It was agreed that Chair of a Network is to be elected for a period between 3 (minimum) to 5 (maximum) years, depending on the frequency of meetings. A new Chair and a new Vice-Chair are not to be elected at the same time so as to avoid any disruption in the Network's leadership.

It was suggested that the possibilities of electronic media (particularly Internet) be further explored to improve the communication and exchange of information by the Networks.

The motivated involvement and various inputs in kind by a large number of Network members in fulfilling the tasks of the workplans were acknowledged by the Steering Committee.

The possibility for developing "complementary modules" was proposed to the Steering Committee by the Secretariat with the intention to mobilize additional resources in support of the tasks of the workplans in individual Networks, organize training etc. First option foresaw that funding for these activities are raised independently from the annual financial contributions of participating countries and on a voluntary basis. Second option foresaw funding of the modules from increased annual contributions. While some countries confirmed that additional resources for increased contributions might be available for Phase II, it was decided not to change the present mode of operation and not to introduce complementary modules into the structure of EUFORGEN.

Budget

The annual budget and contributions for Phase II as given in EUFORGEN Document were endorsed by the Steering Committee (Annex IV).

Conclusions

The revised EUFORGEN Document was circulated. It was discussed and endorsed by members of the Steering Committee with modifications (see Annex IV).

Dr Thomas Geburek, Austria's National Coordinator, chairing the final session, thanked all participants for their work and all the inputs during the meeting. Dr Geoffrey Hawtin expressed his wish to see the collaborative work on forest genetic resources in Europe continued and further strengthened.

The Steering Committee thanked the host and the organizers for their arrangements of the meeting.

Workshop papers

Implementation of the Strasbourg Resolution S2 on the conservation of forest genetic resources in Europe

Michel Arbez
INRA Station de recherches forestières, Pierroton, Gazinet, France

Introduction

Ten years ago, in 1989, we started to be aware of the major threats affecting forests and forest biodiversity: acid rain, uncontrolled forest genetic erosion, forest fires, decline of mountain forests, lack of research and scientific knowledge about forest tree physiology and forest ecosystems. But at the same time, European countries realized that they could share their experience regarding all these problems, with the common will to solve them, and the opportunities of using similar analyses and common strategies to reach this aim. Owing to these reasons, Finland and France agreed to convene a Ministerial Conference on the Protection of Forests in Europe in Strasbourg in December 1990. It was the beginning of a long and innovative process; but at first there were countries and people who were sceptical about its chances of success.

Nevertheless, it was the first time that the need to protect European forests was recognized at the ministerial level. Ministers responsible for forests committed themselves to technical and scientific cooperation, through a clear programme that could be periodically evaluated.

This programme focused on a limited number of actions, scientifically relevant and politically attractive, illustrated by six different resolutions, with a follow-up process:

- Resolution 1 - European network of permanent sample plots for monitoring of forest ecosystems
- Resolution 2 - Conservation of forest genetic resources
- Resolution 3 - Decentralized European data bank on forest fires
- Resolution 4 - Adapting the management of mountain forests to new environmental conditions
- Resolution 5 - Expansion of the Eurosilva network for research on tree physiology
- Resolution 6 - European network for research into forest ecosystems.

Resolution 2 of the Strasbourg Conference

This resolution dealt with the conservation of forest genetic resources and contained three parts:

The commitment

The Signatory States and international institutions "***commit themselves to implement in their own countries, using whatever methods seem most appropriate, a policy for the conservation of forest genetic resources.***"

The principles

- **Immediate actions** without waiting for all the scientific answers
- Simple, stable and long-lasting methods
- **Conservation of the total genotypic variability** (between species, races and individuals)
- ***In situ* conservation** emphasized and integrated in the field of forest management, combined when necessary with *ex situ* conservation
- **Preserving also forest ecosystems and rare forest species**

- **Practical recommendations** on the silviculture practice in each country
- Adequate financial support to the national programmes dealing with conservation of forest genetic resources.

An instrument of international cooperation

During the two pre-conferences in Geneva, the national delegates agreed on the need for a functional but voluntary instrument of international cooperation, from the existing relevant organizations

"*to promote and coordinate:*

- **in situ** *and* **ex situ** *methods to conserve the genetic diversity of European forests*
- *exchanges of reproductive materials*
- *monitoring of progress in these fields."*

The way followed since the Strasbourg Conference (1990)

The Ministerial Conference of Strasbourg adopted six basic resolutions to protect the forests in Europe. At this stage, the commitments were general and needed complementary thoughts to become operational.

Regarding Resolution 2 and the conservation of forest genetic resources in Europe, this work was conducted by the Follow-up Committee composed of four members: M. Arbez (France), Chair, V. Koski (Finland), Co-Chair, M.C. Varela (Portugal) and J. Matras (Poland). The Committee met three times (Warsaw 1991, Rome 1992 and Brussels 1993).

It was assisted in its mission by several personalities from the Forestry Department of FAO (C. Palmberg, O. Souvannavong), IBPGR (E. Frison) and the European Commission (F. Kremer, DG VI). This group also received help and advice from scientists (H. Muhs, G. Eriksson). To clarify the actual situation of forest genetic resources in Europe, to identify the most threatened resources and the nature of their threats, a questionnaire was prepared and sent to all national coordinators of the 31 signatory countries of Resolution S2.

The analysis of the corresponding results and their use for further recommendations benefited from technical and financial support from the Forestry Department of FAO and from the Commission of the European Union (DG VI). The work was performed by the group, first between December 1990 (Strasbourg Conference) and June 1993 (Helsinki Conference) using two pre-conferences in Geneva and a general meeting of the Follow-up Committee in Lisbon.

The analysis of the results from the Resolution S2 questionnaire was presented to the national coordinators attending the second pre-conference of Geneva. According to the information obtained, some important forest species appeared to be threatened in some countries at the population level, which required urgent measures to be taken for their preservation. The species most frequently mentioned were: *Ulmus* sp., *Picea abies, Abies nebrodensis* and *Abies alba*, several noble hardwoods especially the wild fruit trees Rosaceae, *Populus nigra, Quercus* sp., *Pinus nigra, Pinus sylvestris* and *Taxus baccata.*

From this survey, it appeared that:

- human activities are most often responsible for the threats to forest genetic resources
- national programmes specifically aimed at medium and long-term conservation were scarce and often very recent (Finland, Sweden, Germany, France, etc.)
- most of the forest stands declared as *in situ* genetic reserves were combining conservation and other objectives (performance evaluation, wood production, seed production)
- most of the signatory countries of the Resolution S2 also declared their will to cooperate in a European programme focusing on forest genetic resources conservation.

Keeping in mind the principle according to which every country is responsible for its own forest genetic resources, the added value of a European collaborative programme would be mainly networking among national programmes, common passport data, databases, and creation of optimal conditions for a continuous progress in forest gene conservation methods.

To cover most of the scientific and operational problems to be solved at the level of the national "species-oriented gene conservation networks", the idea was to choose a very limited number of species, representative of the different geographic, biological and genetic situations. With such an approach, and taking into account the information obtained and the national priorities identified through the analysis of the questionnaire, four case study or 'pilot' species (including one group of species: Norway spruce, cork oak, black poplar and Noble Hardwoods) were then proposed. The national delegates participating in the second Geneva pre-conference accepted this proposal, which was consequently endorsed by the Second Ministerial Conference in Helsinki, in June 1993.

The first four 'pilot' forest gene conservation Networks

- **Norway spruce *(Picea abies)*** has a large distribution in northern and central Europe. It occurs in dense forest stands, at low elevation in the North and high elevation in the South (Alpine and Carpathian ranges). It is a monoecious, wind-pollinated conifer, often represented in large and continuous forests. With regard to the large area covered, this is a major species for its ecological and economical importance. Severe decline due to acid rains has occurred in central Europe, and genetic conservation measures must be undertaken urgently. On the other hand, severe damages due to global warning could be expected in boreal areas and marginal high elevation populations of the alpine zone. Old international provenance experiments exist (established in 1938 and 1968). Results from old progeny tests are also available in various countries, providing interesting data on which to base the conservation strategy.
- **Cork oak *(Quercus suber)*** has a typically western Mediterranean distribution. The economic importance of the species is great in some areas (Sardinia, southern Spain and Portugal, northwestern Morocco). This species is presently endangered by a complex decline, extended to most of these areas. This is also a monoecious wind-pollinated species, with heavy seeds closely dispersed around the mother trees (when not planted). Only limited data are available about the structure of the genetic diversity in this species, and urgent conservation measures are needed. The advanced genetic studies performed on *Quercus petraea* would provide a useful model. New opportunities for close links could be developed with the recently established Social Broadleaves Network (European beech and oaks).
- **Black poplar *(Populus nigra)*** is an original model species with linear repartition along rivers; it is dioecious with wind pollination. Black poplar is a pioneer species, expected to be a good case study for the metapopulation genetic model. Local populations are often threatened in their natural habitat by riverside management; they are pollinated by the closely located cultivated and genetically related Euramerican hybrids. From the economic aspect, *Populus nigra* populations provide a gene source to improve disease resistances and to create new hybrids. *Populus nigra* could be a good model to develop dynamic *ex situ* conservation strategies.
- **Noble Hardwoods:** numerous species with valuable timber used mostly for furniture are often known under this common name. Among them, the wild forest fruit trees from the family Rosaceae are the most homogeneous group regarding biological and genetic characteristics. The species belonging to the *Prunus*, *Sorbus*, *Malus* and *Pyrus* genera are all characterized by scattered spatial distribution and insect-pollination. Fruits are eaten and spatially dispersed by small mammals or birds. These tree species, often threatened

by a recent evolution of the silvicultural practices (even-aged monospecific forests) are particularly important to maintain a sufficient level of biodiversity within the temperate forest ecosystems.

These four pilot forest gene conservation Networks proposed initially were established and developed within the EUFORGEN Programme. A fifth Network, concerning Social Broadleaves was created some years later (1997).

EUFORGEN: a functional but voluntary instrument of international cooperation

The Second Ministerial Conference in Helsinki endorsed the proposals prepared by the Follow-up Committee of Resolution S2, and endorsed the EUFORGEN project presented by IBPGR (International Board for Plant Genetic Resources, now IPGRI) and the Forestry Department of FAO. This project was prepared and presented by E. Frison (IPGRI) and C. Palmberg (FAO), then developed with success by J. Turok at IPGRI since 1995.

Conclusion

This short travel back to the initial Strasbourg Resolution S2 helps us to measure the progress achieved during eight years. Thanks to IPGRI and FAO, EUFORGEN became the efficient tool for international cooperation in the field of conservation of forest genetic resources in Europe. We must continue in the same direction for the coming years.

But beside this impressive work at the international level (motivating and strengthening national programmes, encouraging collaboration between countries, improving strategies and methods, providing scientific information) we must not forget that the most important job remains the conservation of genetic diversity itself, to be done within and by each country.

To ‘conserve’ the full efficiency of EUFORGEN, the programme should not be requested to focus on too many new species of interest. The pilot species were chosen to represent as many biological and genetic situations as possible. Thanks to the work already achieved within each Network, significant progress has been made with regard to this aim.

We should probably identify general themes of common interest for the different Networks and hold joint meetings between the Networks. The species groups could then be concentrated on specific themes most relevant for each group alone.

The work undertaken with the minor or economically less important species seems to me particularly relevant, with special mention of the Noble Hardwoods.

We have numerous subjects to explore together, both from the scientific and practical perspectives:

- Establishment in each country of a safe system to ascertain the regeneration and the continuity of our gene resources and tree seed banks
- Initiation of national research projects to predict the impact of global change on the evolution of the forest cover and its genetic composition and structure, and to predict the effects of silvicultural practices on the genetic diversity in the production forests, as well as in the gene conservation units
- This will be achieved thanks to increased linkages between genetics (population genetics, marker genes) and ecosystem studies.

Rather than accepting without scientific proofs that strict protection and natural regeneration only are always the best tools for genetic conservation, let us think about new scientific approaches and experimental designs; let us think dynamic conservation, integrated in production forests, with relevant consideration of the possible silvicultural practices, the parallel tree breeding programmes and the possible impact of national and international rules for collecting, trade, and use of forest genetic materials.

Beside genetic conservation methods proper, first applied to forest gene reserve management, to be efficient we also need to integrate these methods in our regular activities within the forest and wood production context. In our old continent, the forests are essentially cultivated and most of them are small forests, privately owned: such an important social aspect needs to be integrated into our communication strategy.

Private forest owner associations as well as national forest services must be considered to improve professional awareness about forest genetic resources conservation and management.

Finally, EUFORGEN was and remains an excellent tool to cooperate and to transfer operational and scientific information towards non-EU countries, especially those in eastern Europe and in the Mediterranean basin. This is also its mission and a challenge for the future.

Further reading

Anonymous. 1990. Ministerial Conference Strasbourg. Actes de la Conférence Ministérielle pour la Protection des Forêts en Europe, 18 Décembre 1990, Strasbourg. Ministère de l'Agriculture et des Forêts, Paris, France. 255pp.

Anonymous. 1993. Ministerial Conference Helsinki. Report on the follow-up of the Strasbourg Resolution. Ministerial Conference on the Protection of Forests in Europe. Helsinki, 16-17 June 1993. Ministry of Agriculture and Forestry of Finland. 203pp.

Anonymous. 1993. Report on the follow-up of the Strasbourg Resolutions. Conference Secretariat. Ministry of Agriculture and Forestry, Helsinki, Finland.

Arbez, M. 1992. Un programme national de conservation des ressources génétiques forestières. Pp. 33-43 *in* Conservation et gestion des ressources génétiques végétales en France. BRG/CTPS, Paris, France.

Arbez, M. 1994. Fondement et organisation des réseaux européens de conservation des ressources génétiques forestières. Genet. Sel. Evol. 26(1):3015-3314.

Arbez, M. and F. Lefèvre. 1997. The European forest genetic resource programme. Objectives and general concept. A case study concerning the black poplar (*Populus nigra* L.). Bocconea 7:389-398.

Bureau des Ressources Génétiques et Commission des Ressources Génétiques Forestières. 1997. A charter for the conservation of forest tree genetic resources in France. BRG, Paris. [Leaflet]. 10pp.

Eriksson, G., G. Namkoong and J.M. Roberds. 1993. Dynamic gene conservation for uncertain futures. For. Ecol. Manage. 62:15-37.

Forest Genetic Resources Working Group. 1992. A report on gene resources of forest trees. NEJS (Nordisk Ministerrad).

Koski, V. 1991. Preservation of genetic resources of forest trees in Finland. [Manuscript].

Ledig, F.T. 1991. The role of genetic diversity in maintaining the global ecosystem. Pp. 71-78 *in* Proceedings from the 10th World Forestry Congress, Paris, 17-26 September 1991. RFF Nancy Vol. 2.

Namkoong, G. 1988. Population genetics and the dynamics of conservation. Pp. 161-181 *in* Biotic diversity and germplasm preservation, global imperatives. Paper presented at a symposium May 9-11, 1988, Beltsville Agricultural Research Center, Beltsville, Maryland (L. Knutson and A.K. Stoner, eds.). Kluwer Academic Publisher, Dordrecht, The Netherlands.

Palmberg, C. and J.T. Esquinas-Alcazar. 1990. The role of the United Nations Agencies and the other international organizations in the conservation of plant genetic resources. For. Ecol. Manage. 35(1-2)171-197.

Turok, J., C. Palmberg-Lerche, Cs. Mátyás, M. Arbez and E. Frison, compilers. 1995. European Forest Genetic Resources Programme (EUFORGEN). Report of the Steering Committee. First meeting, 19-20 November 1995, Sopron, Hungary. International Plant Genetic Resources Institute, Rome, Italy.

Genetic aspects of the Helsinki and Lisbon Resolutions – Second and Third Ministerial Conferences on the Protection of Forests in Europe

Thomas Geburek[1] *and Ferdinand Müller*[2]

[1] *Institute of Forest Genetics, Federal Forest Research Centre, Vienna, Austria*
[2] *Institute of Silviculture, Federal Forest Research Centre, Vienna, Austria*

Introduction

Environmental issues have attracted increasing interest throughout the world, largely as a result of serious concern that the Earth's biological system is of fundamental importance to humankind. The augmenting public awareness has finally resulted in several international legally-binding instruments, such as the Convention on Biological Diversity (CBD) and the Convention on the Conservation of European Wildlife and Natural Habitats.

In the forestry sector, strategies for biodiversity conservation to slow down the loss of biodiversity and to enhance its contribution to a further development should embrace (1) the preservation of biodiversity, (2) the sustainable use, and (3) the equitable sharing of benefits. In Europe, these objectives should be attained through the implementation of politically-binding resolutions (soft laws) adopted at three Ministerial Conferences on the Protection of Forests in Europe. These agreements have been known as the Strasbourg, Helsinki and Lisbon Resolutions according to the location where the respective Ministerial Conference was held.

Biodiversity has been given high attention in this pan-European process (Lust 1995, Turok 1997, Geburek 1998). Thus starting with the First Ministerial Conference in Strasbourg (Anonymous 1990), the conservation of forest genetic resources has been explicitly mentioned in Resolution S2. Specific actions such as (1) *in situ* and *ex situ* measures, (2) the exchange of genetic material, and (3) regular assessment of progress should strengthen the conservation of biodiversity at the genetic level. Technically, the S2 Follow-up Process on European level has mainly been implemented via the European Forest Genetic Resources Programme (EUFORGEN) and its network activities (see Turok 1997). The Second and Third Ministerial Conferences in Helsinki and Lisbon have also tackled the problem of forest biodiversity conservation (Anonymous 1993a,b, 1996a, 1998a,b).

Decision-makers have realized that forest genetics play an important role when sustainability of forests in Europe is at stake, and forestry policy and science deal increasingly with biodiversity related issues (e.g. Glück 1984, 1998). This becomes lucid because sustainable use of forests is impossible unless forest genetic resources are sufficiently regarded and several Resolutions directly address issues related to forest genetics. The objective of this paper is to point out these aspects of the Resolutions agreed upon during the last two Ministerial Conferences on the Protection of Forests in Europe.

Role and Resolutions of the Second Ministerial Conference on the Protection of Forests in Europe (Helsinki)

The role of the Conference was twofold: (i) it was a forum for the assessment of the Follow-up Process of its predecessor; (ii) it was an opportunity to consider the implementation of the United Nations Conferences on the Environment and Development (UNCED) for forests on a European level. The Signatory States and the European Community (EC) re-confirmed all Strasbourg Resolutions and agreed upon four additional resolutions:

- H1 - General Guidelines for the Sustainable Management of Forests in Europe
- H2 - General Guidelines for the Conservation of Biodiversity of European Forests
- H3 - Forestry Cooperation with Countries with Economies in Transition
- H4 - Strategies for a Process of Long-Term Adaptation of Forests in Europe to Climate Change.

H1, H2 and H3 were signed by 37 European countries and the EC, while H4 was not signed by France and Sweden. Albania, Macedonia FYR and Moldova did not sign the resolutions. All the Helsinki Resolutions are relevant from a genetic point of view. Although terms like 'genetic diversity' or 'genetic resources' are rarely used as such, it has to be pointed out that whenever the term 'biodiversity' is used in the official documents this term also refers to genetic diversity.

This is particularly so because the Ministerial Conference adopted the definition of the term 'biodiversity' as provided in the Convention on Biological Diversity. The term thus comprises *genetic* and *interspecific diversity* as well as the *variability of ecosystems*.

Box 1. Definition of biodiversity according to the Helsinki Resolutions

"The Signatory States and the European Community, (...) recalling the definition of biological diversity agreed upon in the Convention on Biological Diversity.

"Biological Diversity means the variability among living organisms from all sources including, inter alia, *terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." (...)* (Anonymous 1993b: p. 26)

Unfortunately, 'biodiversity' is frequently interpreted as diversity of species. In order to further clarify the genetic component of biodiversity, its significance in the ecosystem function, i.e. the role of the single specimen, must first be understood. It is self-evident though rarely clearly recognized that single trees and not species act in forest ecosystems. Single trees live or die, capture energy and serve as energy supply for other individual plants or animals. Individuals (genotypes) interact with their environment (genotype-environment interactions) and/or can serve as an environmental factor for others. Ecological communities (e.g. forest vegetation types) are rarely recognized as assemblages of individuals of a single species but rather as species assemblages. Species are not monolithic, invariant or static, but are constantly changing ecological entities. Although a more individual-based ecology is slowly emerging (e.g. Rose *et al.* 1993), the individual (genotypic) role is still insufficiently understood. Moreover, the significance of genetic diversity is not limited within a single species, but through intraspecific and interspecific genetic adaptation it influences the emergence and functioning of higher order ecological systems. Regrettably, these evolutionary aspects – the intra- and interspecific genetic functions and processes - are not explicitly mentioned in the CBD definition of biodiversity (cf. definitions of biodiversity in UNEP (1995), chapter 2).

H1: General Guidelines for the Sustainable Management of Forests in Europe

The overall objective of this Resolution is the implementation of the non-legally-binding authoritative statement of principles for global consensus on the management of conservation and sustainable development of all types of forests (UNCED) in Europe. In a number of statements, the Signatory States and the EC pointed out that sustainable forest management has to be carried out in such a way that biodiversity is secured over the long term. The concrete requirements are as follows:

- Genetic selection (...) should not favour performance traits at the expense of adaptive ones, except in particular cultures where intensive care may protect them against damage
- Native species and local provenances should be preferred where appropriate. The use of species, provenances, varieties or ecotypes outside their natural range should be discouraged where their introduction would endanger important/valuable indigenous ecosystems, flora and fauna. Introduced species may be used when their potential negative impacts have been assessed and evaluated over sufficient time (...)

- Whenever introduced species are used to replace local ecosystems, sufficient action should be taken at the same time to conserve native flora and fauna.

It should be stressed that the implementation of these commitments at the national level is difficult in some cases. The existing Council Directive on the marketing of forest reproductive material (66/404/EEC) authorizes a Member State to prohibit the marketing of forest reproductive material only if there is reason to believe that the use has an adverse effect on forestry in all or part of the Member State (Anonymous 1966). This authorization requires a procedure, which has not been implemented so far. The problem is that the single Member State has the burden of proof and the statement on that matter is based on very limited knowledge. There are non-binding provenance recommendations for foreign tree species, for instance in Austria (e.g. Raschka 1997). However, there is no information as to which extent their growth endangers indigenous tree species or if a potential risk to the indigenous flora would be justified because of higher yield. In most cases only small-scale growth of foreign tree species will not cause a risk, or threat, to the indigenous tree species. In certain cases, however, for instance in the case of growing black poplar hybrids in a riparian forest where also *Populus nigra* occur, this cannot be called in accordance with the Resolution (cf. Heinze submitted). Further, it seems difficult to interpret the regulation that local provenances should be preferred to foreign provenances. From a technical viewpoint, it should be noted in this context that, contrary to the common view in forestry, local provenances do not necessarily have the highest degree of adaptedness to the respective environmental conditions (e.g. Mátyás 1991, 1996). This means that local provenances may be replaced by non-autochthonous material, for instance in cases where the genetic adaptedness of the future stand has to be valued higher than the conservation of the naturally occurring population. With a view to the climate change, this possibility should be critically examined.

Box 2. Sustainable use of forest genetic resources and the precautionary principle

Sustainable use of forest genetic resources means the use of forest tree populations in a way and at a rate that does not lead to the long-term decline of genetic diversity, thereby maintaining its genetic potential to meet needs and aspirations of present and future generations. This does not entail that genetic diversity can be handed on to future generations completely unchanged, since virtually all forms of forestry management lead to some changes or losses. However, the long-term genetic adaptability of forest tree populations must remain unaffected by the use of forest tree populations. Noting that where there is a threat of significant reduction or loss of genetic diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat (precautionary principle).

H2: General Guidelines for the Conservation of Biodiversity of European Forests

Regarding forest genetics, this Resolution is clearly most comprehensive. The General Guidelines of H2 include:

- The conservation and appropriate enhancement of genetic diversity should be an essential operational element in sustainable forest management, (...) in forestry policies and legislation. For instance, Austria has tried to satisfy this requirement, in connection with the forest law provisions on the transportation of forest reproductive material by the introduction of statutory minimum numbers of seed trees to be harvested and establishment of the additional category "Increased Genetic Multiplicity" (Anonymous 1996b,c)

- The conservation and appropriate enhancement of genetic diversity should be based both on specific, practical, cost-effective and efficient biodiversity appraisal systems, and on methods for evaluating the impact on biodiversity of chosen forest development and management techniques
- The conservation of genetic resources of forest species, both those currently exploited for economic purposes and those considered secondary or rare as detailed in Resolution 2 of the Strasbourg Conference, and (...) the protection of threatened forest species and ecosystems, as listed nationally or locally, in the formulation of national forest policies
- The Signatory States and the European Community will establish at national or regional levels a coherent ecological network of climax, primary and other special forests aimed at maintaining or re-establishing ecosystems that are representative or threatened.

Apart from national measures taken to conserve forest genetic resources and the activities within the framework of EUFORGEN, several Signatory States are currently building ecological networks of climax, primary and other special forests. These networks can also strengthen forest gene conservation. However, the objective of ecological networks is often the conservation of certain types of forest vegetation; species diversity is thus more to be to the fore. In many cases, certain forest reserves are established without sufficient consideration of genetic aspects. Selection criteria of the forest sites are the sizes of the forests stands, their numbers and distribution, statistical sampling, and other features. Species are not infrequently seen as static entities and thus reserves cannot always fulfil genetic demands. Especially small forest reserves (<5 ha) covering several species are of limited use for the conservation of intraspecific variability. The minimum size of a forest reserve is often determined pragmatically. Recently the potential use of nature reserves has been discussed thoroughly by Frank (1998), also in view of the conservation of genetic diversity.

In Austria, the size of forest reserves is mainly determined in a way that all stages and phases of forest succession are continuously present (Koop 1989). Hence, this size depends on the forest vegetation type (species composition) and results, for instance, in 10 ha for linden-hornbeam mixtures or in 40 ha for certain beech-oak stands. Ecological forest networks, if not designed for genetic purposes, are of varying value. In principle, every single specimen as a carrier of genetic information is a genetic resource. However, when gene resources of forest tree populations are to be conserved, small areas are of limited value. This means that with decreasing size of the reserve the certainty and/or time scale within which the given conservation purpose can be fulfilled are diminishing. Hence, sizes of 10 to 40 ha may be appropriate for social broadleaves and most conifers when a mid-term (100 years) gene conservation purpose of that particular local population is aimed at. The above-mentioned size frame may however be inappropriate when genetic resources of scattered tree species are concerned, the time scale is prolonged, or no other supplementary action (e.g. sustainable forest management) is carried out.

H4: Strategies for a Process of Long-Term Adaptation of Forests in Europe to Climate Change

This Resolution is laid out in a particularly heterogeneous way, making an effort, in accordance with the Framework Convention on Climate Change of the United Nations, to contribute particularly by means of a coordinated research, to a reduction of the effects caused by the climate change. H4 comprises seven research areas:

1. Linkages between climate change and forest ecosystems.
2. Role of forests in the global carbon cycle.
3. Studies on genetic variability of regionally important tree species in response to changes in climate and increased concentration of carbon dioxide, and on the degree and rate of evolutionary processes and adaptation, by means of genetic changes.

4. Studies on the dynamic equilibrium of host-parasite relationships in new climatic environments.
5. Studies on soil formation processes, including the mineralization of organic matter and leaching, in response to climate change.
6. Development of process-based predictive ecosystem models.
7. Forest management systems to optimize adaptation to climate change.

In order to identify knowledge gaps in research area 3, a small working group of forest geneticists (H.-R. Gregorius, Cs. Mátyás, J. Turok, G.G. Vendramin, Th. Geburek) was formed. This working group has elaborated the following research proposals described in greater detail by Gregorius and Geburek (1998). The research goals were to orientate themselves by the fact that ecosystem stability depends considerably on the adaptive potential of the dominant species in a system (Templeton 1995, Gregorius 1996). Because forest tree species take this key position in forest ecosystems, the investigation of their genetic potential to adapt is in the forefront. Physiological mechanisms and their genetic conditions and mechanisms therefore have to be investigated at the population level; how genetic polymorphisms and, consequently, genetic adaptive potential can be maintained over many generations is of particular importance. In the case of forest trees, adaptation processes and their essential components are still inadequately known. So far, short-term studies on the genetic structures of seed trees/sources of seed material have been carried out, comprising seeds and seedlings, provenance tests and investigations on the genetic distinction between different tree groups. These investigations have permitted interesting insights. However, the testing and/or modelling of adaptive processes to the climate change is extremely difficult.

The focus was thus put on the following areas of forest genetics:

1. Evaluation of provenance tests and of studies on the reproduction, norms of reaction, glacial migration, the transfer of seed material, etc. with respect to their significance for adaptive processes.
2. Further development of genetic criteria, indicators, and verificators, including genetic-demographic properties or other surrogates, identification of genetic properties which can serve as indicators for specific evolutionary processes of adaptation.
3. Investigations on the heritability of properties relevant for adaptation.
4. Initiation and advancement of long-term experiments suited to indicate trends and directions of adaptive processes.

The first two of these are of particular importance. Research area (1) provides insight into the physiological homoeostasis, which can be described by the extent of a population's phenotypic stability over different environments, whereas research area (2), by the survey of different genetic and genetic-demographic indicators, aims at the collective or genetic homoeostasis. Research area (1) thus describes the norms of reaction when rather constant genetic structures are provided, while research area (2) aims at quantifying environment-related changes. Four indicators with their respective verificators are proposed for evaluating whether genetic sustainability has been achieved also under the warning of climatic change. In this context, an indicator is defined as a variable which serves to examine a particular development, condition, or other facts. A verificator can be used to check if there is an indication of something, i.e. a certain variable which serves in particular to examine a certain indication. This procedure is based on a proposal worked out by the Center for International Forestry Research (CIFOR) with substantial contribution of Canadian and Australian forest geneticists (Namkoong *et al.* submitted). For many detailed questions (e.g. critical limits of the verificators) no final answers are available from research yet, not even experts being of the same opinion.

The approach of research area (3) is based on the fact that evolutionary processes proceed faster when the genetic component of the variance observed with an adaptation-relevant trait is high than when the environment is the main modifying factor of the trait. In this context, adaptation-related traits are defined as phenological, morphological and physiological properties enabling the population to survive over the generations, under the existing environmental conditions. Research area (4) comprises long-term experiments which, by means of surveying genetic changes over the time, leads to quantitative-genetic statements on adaptive processes.

Role and Resolutions of the Third Ministerial Conference on the Protection of Forests in Europe (Lisbon)

In 1998, the Third Ministerial Conference was held in Lisbon, Portugal. The Conference evaluated the progress achieved in the implementation of the Resolution from previous Conferences in Strasbourg and Helsinki, with particular emphasis on major aspects of sustainable forest management in Europe. The 36 participating European States and the EC committed themselves to the elaboration and to further implementation of the working programmes to implement the adopted Resolutions.

Two resolutions were adopted in Lisbon:

- L1 - Enhancement of socioeconomic aspects of sustainable forest management
- L2 - Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management.

For the implementation of H1 and H2, a pan-European cooperation was previously initiated (Anonymous 1998b). The most significant achievements included the development and adoption of criteria and indicators for sustainable forest management. These were accepted at two Expert Level Follow-Up Meetings of the Helsinki Conference held in Geneva (1994) and Antalya (1995). Finally, the criteria, indicators and operational level guidelines for sustainable forest management were adopted as L2.

Out of the six criteria for sustainable forest management, the criterion '*Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems*' is of particular relevance to forest genetics.

Under the concept area 'General Conditions' indicators are described as follows:

- Existence and capacity of an institutional framework to maintain, conserve and appropriately enhance biological diversity at the ecosystem, species and genetic levels
- Existence of informal means to implement the policy framework, and the capacity to:
  - develop new inventories and ecological impact assessments on biological diversity, and
  - develop tools to assess the effect of forest management on biological diversity.

From a genetic point of view the Concept Area 'Threatened Species' and 'Biological Diversity in Production Forests' is of importance. Quantitative and descriptive indicators to be periodically reported should pinpoint at biodiversity changes and trigger action.

Descriptive indicators refer primarily to:

- Existence of an appropriate legal or regulatory framework that provides legal instruments
- Existence and capacity to develop and maintain the institutional framework
- Existence of economic incentives
- Existence of informal means to implement the respective policy framework, to protect threatened species or to ensure biological diversity in production forests.

As quantitative indicators are mentioned:

1. Changes in the number and percentage of threatened species in relation to total number of forest tree species.
2. Changes in the proportions of stands managed for conservation and utilization of forest genetic resources (gene reserve forests, seed collection stands, etc.); differentiation between indigenous and introduced species.
3. Changes in the proportions of mixed stands of 2-3 tree species.
4. In relation to the total area regenerated, proportions of annual area of natural regeneration.

The UN-ECE/FAO has cooperated with the pan-European process in the collection of information on these quantitative indicators by adapting the ongoing Temperate and Boreal Forest Resources Assessment 2000 (TBFRA). Nevertheless, information on some indicators could not be collected, chiefly because it became clear that harmonized reporting was not possible.

Ad 1. Reference lists such as the IUCN Red Books and the IUCN Categories of Endangered Species should be used. The IUCN categories have already been accepted by different governmental organizations and other NGOs to asses locally (e.g. Gunatilleke and Gunatilleke 1991) or on a more global scale (e.g. Farjon *et al.* 1993) the risk driving tree species to, or close to, extinction. The TBFRA data on this issue are questionable. At a first glance, it looks simple to harmonize reports but the TBFRA has reported on this issue that in the UK 140 forest tree species occur in total, of which one species is endangered, while in Ireland 1000 different forest tree species should occur in total, none of them being close to extinction (Anonymous 1998b). These contrasting figures demonstrate the difficulties in reporting and make comparisons among different countries tricky.

Ad 2. Problems may occur when proportions of area are compared among Signatory States. Management intensities of gene conservation stands may vary from strictly protected stands (cf. IUCN category I – strict nature reserve) to forest stands which have to be naturally regenerated but are still utilized according to local standards (cf. IUCN category IV – managed resource protected area). To harmonize reporting, Signatory States have to develop commonly accepted technical terminology, for instance it has to be agreed upon when the term *forest gene reserve* can be used.

Conditions to be checked when forest gene reserves were pragmatically declared:

- Secured long-term ownership – Can we expect continuity in the status of ownership? Would securing by contract help and, if so, how can this be done with due regard to the accruing costs? How do we consider the right of access to the gene resource?
- Continuity of natural regeneration – Is the existing extent of regeneration sufficient? Is it necessary to introduce measures supporting regeneration (e.g. fencing, reduction of game stock)?
- No goals that conflict over the medium term – Are there goals which conflict with forestry, the protection of nature, or any other forms of utilization requiring space (settlements, traffic)?
- Sufficient representativity for certain provenances – Are there sufficient numbers of stands for areas considered substantially homogenous (provenance region)?
- Autochthonous origin – Is it possible to provide information on the autochthonous/indigenous origin of a stand?
- High degree of hemeroby – How should the existing stock be assessed with regard to the natural plant association?
- Reasons of exclusion due to earlier forms of management – In which way(s) was the stand managed in the past? Are selective uses and/or forms of management with low numbers of trees potential reasons for exclusion?

- Necessity of coordination with international programmes and networks aiming at the conservation of genetic diversity – To which extent do the pending measures complement international efforts?

Genetic conditions to be assessed when forest gene reserves are declared:

- Sufficient genetic variety with respect to fitness-relevant properties – Are results from field experiments available and in which ways can the findings contribute in the selection of the resource populations?
- Sufficient size of stands – Which size does the stand in question have? Will it be necessary that small stands, or even groups of trees, are also considered for conservation because of the rarity of a tree species? How many seed trees are involved in natural regeneration (census of the seed-bearing trees)? How many trees provide pollen (census of the male reproductive trees)?
- Location of the stand within its natural habitat – What is the exact location of the stand at our disposal? Can we expect high adaptive potential because of the stand having an optimum location, or rather high adaptedness because the stand is located at the natural fringe of an area?
- Measures of conservation consider sufficiently tree-specific variation patterns – In which ways are clinal and/or ecotype-specific variations with different properties considered in gene conservation measures?
- Isolation – How is the location of the relevant stand with respect to other stands of the same tree species? Is migration desired or rather undesired? How are pollen and seed vectors to be assessed and in which ways could such assessment influence the selection of the necessary buffer zone? Is the non-availability of the buffer zone the decisive factor regarding its value for conservation?
- Sufficient genetic variation of adaptive genetic markers – Are there results from genetic inventories regarding adaptive genetic markers? In particular, qualitative or at least pronounced clinal differences between regions can be very valuable.
- Sufficient genetic variation of selective neutral genetic markers – Results from inventories including neutral genetic markers can be used to subdivide existing regions into smaller conservation units. Findings about the post-glacial immigration and the degree of migration can indirectly contribute to the selection of the resource populations.

The above list demonstrates how manifold the requirements are that have to be examined prior to the selection of *in situ* stands that are worth conservation. Simply reporting the area designated as gene reserve in a Signatory State does not make sense unless the quality of *in situ* means are mentioned. The list also makes clear that the implementation of national and international gene conservation programmes meets with numerous difficulties. Relying on schematism, there will probably not be an optimal realization of any of the programmes. Each of them will need the setting of priorities, thereby taking account of the country-specific requirements of each programme.

As far as reporting on changes in seed stand proportions is concerned, similar problems may occur. Among EU-Member States, which comprise approximately one half of all Signatory States, harmonization has been realized because the EC Directive 404/66 (Anonymous 1966) has been brought into force by national laws. However, comparisons of data derived from Non-Member Signatory States with data originating from Member States remain vague. Harmonization in this matter is a must. This task should be implemented as soon as possible in the course of Expert Level Meetings in the framework of the Ministerial Conferences and in close cooperation with EUFORGEN.

Ad 3. This refers to species diversity and is of less genetic relevance. Data on area and spatial distribution pattern of rare species are meaningful. However, it may be very difficult to report reliable data on this issue. In those Signatory States where forest inventories were performed periodically, data will be available whilst in countries where this information is gathered based on national-wide forest management working plans or based on other descriptions (e.g. flora description), travel reports reliability of data is much more questionable.

Ad 4. The degree of natural regeneration of a forest is doubtless a good indicator of sustainable forest management. The ability of forest tree populations to produce viable seeds and to create a viable new tree generation is extremely important. Trees may be badly-shaped or may not produce desirable wood products, but provided they are able to exist over generations by transmitting their genes, undesirable traits are meaningless from an evolutionary point of view. Since under appropriate environments also well-shaped trees have these capabilities of regeneration, the genepool in naturally regenerated stands is well conserved. Although this theorem has not yet been studied over full generations, the current state has not falsified this view. However, the same reluctance concerning the trustworthiness of data reported by Signatory States as mentioned above (Ad 3) is certainly advisable.

As **descriptive indicator** is mentioned "Existence of a legal/regulatory framework that provides for legal instruments to ensure regeneration of managed forests". In many Signatory Countries the respective Forestry Act ensures that clearings or stands after clear felling or selective cutting are to be reforested.

Conclusion

Political decision-makers have realized that a broad genetic basis is indispensable for the long-term stability of forests. Hence, many of the Resolutions agreed upon at the two Ministerial Conferences held in Helsinki (1993) and Lisbon (1998) are of conspicuous relevance to forest genetics, i.e. the Helsinki Resolutions H1 (*General Guidelines for the Sustainable Management of Forests in Europe*), H2 (*General Guidelines for the Conservation of Biodiversity of European Forests*) and H4 (*Strategies for a Process of Long-Term Adaptation of Forests in Europe to Climate Change*) as well as the Lisbon Resolution L2 (*Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management*) refer to genetic diversity of forest tree populations. While H1 addresses mainly the preservation of well-functioning forest ecosystems through the use of appropriate forest reproductive material, H2 focuses on the conservation and enhancement of biological diversity *per se*. H4 encourages research in forest genetics related to adaptation processes under the scenario of a global climate change. Lisbon Resolution L2 describes criteria and indicators on an operational level. Due to pragmatic reasons, these criteria and indicators mainly aim at species diversity; however, the criterion *Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems* is of particular genetic relevance because certain indicators, such as the existence and capacity of the institutional framework to conserve and enhance genetic diversity, or the periodical reporting of changes in the proportion of stands managed for conservation of genetic resources, are outlined in L2. While implementation of the Lisbon Resolutions cannot be expected yet, progress in the follow-up action of the Helsinki Resolution is still unsatisfactory. Maybe this is linked to specific genetic problems or due to the fact that conferences more and more become political and that the technical implementation of the solutions of problems identified is dealt with in course of follow-up processes.

References

Anonymous. 1990. Ministerial Conference on the Protection of Forests in Europe, 18 Dec. 1990, Strasbourg. Ministère de l'Agriculture et des Forêts, Paris.

Anonymous. 1966. Council Directive of June 1966 on the Marketing of Forest Reproductive Material (66/404/EEC). Off. J. Eur. Comm. 2326/66:161-167.

Anonymous. 1993. Sound Forestry - Sustainable Development. Report on the Follow-up Ministerial Conference on the Protection of Forests in Europe, 16-17 June 1993 in Helsinki of the Strasbourg Resolutions of the Ministerial Conference in December 1990. Ministry of Agriculture and Forestry. 203pp.

Anonymous. 1993b. Ministerial Conference on the Protection of Forests in Europe, 16-17 June 1993 in Helsinki. Sound Forestry - Sustainable Development. Conference Proceedings. Ministry of Agriculture and Forestry, Ministerial Conference on the Protection of Forests in Europe, Liaison Unit in Helsinki. 186pp.

Anonymous. 1996a. Ministerial Conference on the Protection of Forests in Europe. Progress Report. Ministry of Agriculture, Rural Development and Fisheries, Ministerial Conference on the Protection of Forests in Europe Liaison Unit in Lisbon. 62pp.

Anonymous. 1996b. Bundesgesetzblatt für die Republik Österreich, Jahrgang 1996(419). Bundesgesetz über forstliches Vermehrungsgut (Forstliches Vermehrungsgutgesetz), Bundesgesetz, mit dem das Forstgesetz 1975 geändert wird, und Bundesgesetz, mit dem das Düngemittelgesetz 1994 geändert wird.

Anonymous. 1996c. Bundesgesetzblatt für die Republik Österreich, Jahrgang 1996(512). Verordnung: Forstliches Vermehrungsgut.

Anonymous. 1998a. Third Ministerial Conference on the Protection of Forests in Europe. General declaration and resolutions adopted. Published by the Ministry of Agriculture, Rural Development and Fisheries of Portugal. 64pp.

Anonymous. 1998b. Follow-up reports of the Ministerial Conferences on the Protection of Forests in Europe. Vol. II. 32pp + Appendix.

Farjon, A., C.N. Page and N. Schellevis. 1993. A preliminary world list of threatened conifer taxa. Biodivers. Conserv. 2:304-326.

Frank, G. 1998. Naturwaldreservate und biologische Diversität. Pp. 205-238 *in* Erhaltung genetischer Ressourcen im Wald. Normen, Programme, Maßnahmen (Th. Geburek and B. Heinze, eds.). Ecomed, Landsberg.

Geburek, Th. 1998. Forstgenetische Aspekte der Strasbourg und Helsinki-Resolutionen. Pp. 64-76 *in* Erhaltung genetischer Ressourcen im Wald. Normen, Programme, Maßnahmen (Th. Geburek and B. Heinze, eds.). Ecomed, Landsberg.

Geburek, Th. [2000]. Überlegungen zur Auswahl von *ex-situ* Ressourcenpopulationen im Rahmen der forstlichen Generhaltung.WSL-Berichte (*in press*).

Gunatilleke, I.A.U.N. and C.V.S. Gunatilleke. 1991. Threatened woody endemics of the wet lowlands of Sri Lanka and their conservation. Biol. Conserv. 55:17-36.

Glück, P. 1994. Entstehung eines internationalen Waldregimes. Cbl. ges. Forstwes. 111:75-92.

Glück, P. 1999. National forest programmes – Significance of a forest policy framework. Pp. 39-52 *in* Formulation and implementation of national forest programmes (P. Glück, G. Oesten, H. Schanz and K.-R. Volz, eds.). EFI Proceedings No. 30, Vol. I. Joensuu, Finland.

Gregorius, H.-R. 1996. The contribution of genetics of populations to ecosystem stability. Silvae Genet. 45:67-271.

Gregorius, H.-R. and Th. Geburek. 1998. Studies on genetic variability of regionally important tree species in response to changes in climate and increased concentration of carbon dioxide, and on the degree and rate of evolutionary processes and adaptation, by means of genetic changes. Pp.12-17 *in* Annex to the International Report on Resolution H4, Lisboa 98, 2,3 and 4 of June. Third Ministerial Conference on the Protection of Forests in Europe.

Heinze, B. Genetic traces of cultivated hybrid poplars in native black poplar offspring in Austria. Mol. Ecol. (*in preparation*).

Koop, H. 1989. Forest Dynamics. Silvi Star: A Comprehensive Monitoring System. Springer, New York, Heidelberg. 230pp.

Lust, N. 1995. Nachhaltigkeit und Biodiversität von Strassburg über Rio nach Helsinki. Silva Gandavensis 60:37-56.

Mátyás, Cs. 1991. Adaptation lag: a general feature of natural populations. Proc. Joint Meeting WFGA and IUFRO Wp, Olympia, Wa, USA Aug. 20-25, 1990. Pap. No. 2. 226.

Mátyás, Cs. 1996. Climatic adaptation of trees: rediscovering provenance test data. Euphytica 92:45-54.

Namkoong, G., T. Boyle, Y. El-Kassaby, G. Eriksson, H.-R. Gregorius, H. Joly, A. Kremer, O. Savolainen, R. Wickneswari, A. Young, M. Zeh-Nlo and R. Prabhu. Criteria and indicators for assessing the sustainability of forest management: conservation of genetic diversity. Ambio (*submitted*).

Raschka, H.-D. 1997. Forstliche Biomasseproduktion im Kurzumtrieb. FBVA-Berichte 97. 27pp.

Rose, K.A., S.W. Christensen and D.L. Deangelis. 1993. Individual-based modelling of populations with high mortality – a new method based on following a fixed number of model individuals. Ecol. Modelling 68:273-292.

Templeton, A.R. 1995. Genetic diversity and ecosystem functioning. Pp. 285-288 *in* Global Biodiversity Assessment. UNEP (United Nations Environment Programme). Cambridge University Press. 1140pp.

Turok, J. 1997. International collaboration on the conservation of forest genetic resources in Europe. Pp. 149-157 *in* Perspectives of Forest Genetics and Tree Breeding in a Changing World (Cs. Mátyás, ed.). IUFRO World Series Vol. 6.

UNEP. 1992. Convention on Biological Diversity. UNEP/BioDiv/CONF/L.2

UNEP. 1995. Global Biodiversity Assessment. Cambridge University Press. 114pp.

Potential mechanisms for enhancing biological diversity in forest ecosystems in Europe

Peter Glück

Institute of Forest Sector Policy and Economics, University of Agricultural Sciences (BOKU), Vienna, Austria

Introduction

For a long time foresters were regarded as trustees of sustainable forest management in the sense that provision of timber is sustainably ensured by appropriate management of forests. The notion of sustained timber production and its practical application had an extraordinarily stimulating effect on the development of forest sciences, particularly forest inventory, forest growth research and forest economics. In the context of the environmental movement of the 1960s, the timber-oriented perception of forests was challenged by an ecosystem-orientation focusing on the maintenance and enhancement of biological diversity. The environmental movement that not only seized the management of forests, but comprised all natural resources, peaked in the UN-sponsored Conference on Man and the Environment in 1972 in Stockholm. It reflected the high common concern for the protection and conservation of the global environment by establishing a new UN agency, the United Nations Environment Program (UNEP). In the follow-up of the Stockholm Conference, ministries of environment were established in almost every country around the world. In concurrence with environmental NGOs the strength and power of these ministries increased significantly over the years, and they now play a central role in formulating and influencing national and global policies related to forestry. Since the Stockholm Conference, forest politics at the national, European and global levels has been characterized by two stances with different interests in the use of forests: the economic interest in timber production and the ecological interest in maintaining and enhancing environmental values such as biological diversity. The following policy analysis aims at detecting options for bridging the gap between these two positions.

Joint production of forest goods and services

Forests produce not only timber but a whole variety of other goods and services (Table 1). Some of them are marketable, such as berries and Christmas trees, others are not marketable or not easy to sell, such as biodiversity or protection against avalanches. The marketability of goods is a given physical fact having to do with the exclusion of the goods and the rivalry of consumers. If one can easily exclude those from consumption, who do not pay ("free riders"), one can market a good. This is the case for *private goods* as well as for club or toll goods. *Club goods* differ from private goods in that they are non-rival in part. Examples are recreation facilities, national parks, and forest roads, since exclusion can be practiced and, although non-rivalling at low levels of usage, they are partially in competition because crowding occurs with more intensive use. The second feature determining the type of good, the rivalry in consumption of the individual consumers or the clubs, has an impact on the price. Rivalry in consumption triggers scarcity of a good which is an incentive to produce more of it – or to increase the price.

Biological diversity means "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the technological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Art. 2 of the Convention on Biological Diversity). As we can see from Table 1, biodiversity is a *public good*. Once biodiversity is provided, it is difficult or costly to prevent others from enjoying it. If one benefits from biodiversity, there is no rivalry in consumption, assuming there are no crowding effects which turns biodiversity into a *common-poll good* (McKean 1998: p. 26). In most cases public goods including biodiversity result from the fact that they occur as *positive externalities* of production or consumption processes which have positive impacts to third parties. It follows that the market may fail in providing sufficient quantities of public goods of a certain quality. If more of these goods are needed, the welfare-optimizing state has to intervene by appropriate means, unless non-governmental organizations take care of their provision, e.g. by means of forest certification ("private policy-making"). However, the latter aspect is beyond the scope of this paper.

Table 1. Classification of goods according to physical characteristics

		Exclusion	
		Difficult or costly	**easy**
Consumer rivalry	**high**	Common-pool goods (e.g. forest, pasture, groundwater aquifers)	Private goods (e.g. timber, Christmas trees)
	low	Public goods (e.g. biological diversity, protection against avalanches)	Club or Toll goods (e.g. forest road, recreation facility, national park)

Source: Ostrom *et al*. (1994: p. 7), McKean (1998: p. 25)

Policy means for ensuring biological diversity

Intervention of the welfare-optimizing state into forest management will depend on the paradigm of forest management. In the prevailing *forest paradigm* of multiple-use forestry the objective function is to maximize periodic benefits minus costs of sale of wood and non-wood goods and services. State intervention has to ensure the minimum supply of non-marketable forest services such as protection against erosion and biodiversity. The opposing *environmental paradigm* of forest ecosystem management is based on the principle of ecological sustainability. The objective function is to maximize resistance and resilience of forest ecosystems (including conservation of biodiversity) subject to minimum requirements of timber and non-timber products and services such as game and recreation which have to be ensured by legal regulations.

The constraints aiming at the maintenance and enhancement of health, vitality and biological diversity of forest ecosystems, laid down in national forest and nature conservation laws, have been under development for centuries. They reflect the will of society to ensure positive and avoid negative externalities of forest management. From 1972 until recently this development has been strengthened at the European and international levels by legally- and non-legally-binding instruments related to forests (Table 2), which have a more or less severe impact on the results of the objective function through national legislation. In the follow-up of the UN Conference on the Environment and Development (UNCED, held 1992 in Rio de Janeiro) most of the forest acts of European countries were changed (Anonymous 1998: p. 7). In the following, the most significant international and European policy means which were initiated by one of the two camps are presented (see Tarasofsky 1995).

The environmental paradigm

Faced with the global problems of deforestation and forest degradation, since the 1970s the environmentalists were proactive in passing legally-binding instruments and non-legally-binding initiatives pursuing the objectives of preservation, conservation and protection of forest ecosystems. They developed massive pressure at the international and European levels.

Table 2. International and European legally-binding instruments and non-legally-binding initiatives ("soft law") for ensuring biological diversity in forest ecosystems

		Legally-binding instruments	**Non-legally-binding initiatives ("soft law")**
Global level	**Environmental paradigm**	Ramsar Convention (1972) World Heritage Convention (1972) CITES (1973) Convention on Biological Diversity (1993)	World Charter for Nature (1982) Statement of Forest Principles (1992) Agenda 21, Chapter 11 on Combating Deforestation (1992) IUCN Protected Area Management Categories (1994)
	Forest paradigm	ITTA (1983, 1994)	
European level	**Environmental paradigm**	EU Birds Directive (1979) EU Fauna and Flora Habitats Directive (1992)	The Pan-European Biological and Landscape Diversity Strategy (1995)
	Forest paradigm	Protocol on Mountain Forests of the Alpine Convention (1991) – not yet in force	Strasbourg Resolution S2 on the Conservation of Forest Genetic Resources (1990) Helsinki Resolution H2 on the Conservation of the Biodiversity in European Forests (1993) Lisbon Resolution L2 on Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management (1998) Work Programme on the Conservation and Enhancement of Biological and Landscape Diversity in Forest Ecosystems 1997-2000 (1997)

International legislation began in 1972 with the *Ramsar Convention on Wetlands* which promotes the conservation of listed wetlands and the "wise use" of wetlands. In the same year the Stockholm Conference passed two international conventions, namely the *World Heritage Convention* and the *Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)*. The former provides for the protection of such heritage which is of "outstanding universal value" from several points of view, the second focuses specifically and exclusively on trade. International legislation of biodiversity peaked in the 1993 when it adopted the *Convention on Biological Diversity* which is the global treaty with the most significant potential effect on the conservation and sustainable management of forest resources. The preamble of the *Convention on Biological Diversity* (CBD) states that the conservation of biological diversity is a "common concern of humankind", and that, while nations have sovereign rights over their biological resources, they also bear a responsibility for conserving their biological diversity and sustainably using their biological resources. The CBD imposes obligations in relation to *in situ* conservation (within natural surroundings) and *ex situ* conservation (e.g. botanical gardens and genebanks) of species, habitats, and ecosystems. The implementation of the CBD is facilitated by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) as well as by new and additional financial resources to be provided by developed countries and administered by the Global Environmental Facility (GEF). The funds should primarily enable developing countries to meet the requirements of the CBD.

At the European level, the European Council has passed the *Fauna and Flora Habitats (FHH) Directive 92/43* which should effectively supplement the preceding *Birds Directive 79/409*. Both form the legal framework for the establishment of a coherent ecological network of special protection areas in all of Europe, better known as *Natura 2000*.

Not less important than the legally-binding instruments on forests is the "*soft law*" of the environmental paradigm. The *World Charter for Nature* was proclaimed in the United Nations in 1982. It is the first international instrument that is intended to protect nature holistically for its own sake. The *Statement of Forest Principles* of UNCED is a breakthrough in the new understanding of sustainable forest management. It comprises the sustainable management, conservation and sustainable development of all types of forests "(...) to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. These needs pertain to forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and other forest products." Although time was not yet ripe to achieve consensus on a global forest convention, the forest principles and norms based on the inclusive understanding of sustainable forest management had far-reaching effects on the international deliberations on forests.

Chapter 11 of Agenda 21 on Combating Deforestation of UNCED strives to promote efficient utilization and assessment in order to recover the full value of the goods and services provided by forests (part C). Forest resources should be managed in a manner that is compatible with environmental conservation (par. 11.20). Improving recognition of the social, economic and ecological values of trees is one of the objectives (par. 11.21.a).

In 1994, the World Conservation Union (IUCN) with the assistance of the World Conservation Monitoring Centre (WCMC) published the *Guidelines for Protected Area Management* consisting of six categories which replace the former 10 IUCN categories published in 1978. These categories imply a gradation of human impacts: while the categories I-III are mainly concerned with the protection of natural areas where direct human intervention and modification of the environment has been limited, in categories IV-VI significantly greater intervention and modification has taken place.

The *Pan-European Biological and Landscape Diversity Strategy* was adopted by the ministers of environment of 55 European countries in 1995 in Sofia, Bulgaria. It aims to reduce the threat and increase the resilience of Europe's biological and landscape diversity, to strengthen the ecological coherence of Europe as a whole, and ensure full public involvement in the conservation of the various aspects of biological and landscape diversity. In order to reach these aims, a sophisticated planning process is proposed, which mobilizes efforts and initiatives at all levels under one umbrella and breaks down a 20-year vision into 5-year Action Plans. The Action Plan 1996-2000 refers to 11 action themes; six of them deal with landscape and ecosystems (and one with forest ecosystems).

The forest paradigm

Faced with the environmental activities for anchoring the new understanding of "sustainable forest management", the forest community tried to avoid too severe restrictions of efficient timber production by taking its own initiatives. Thus its activities were more reactive than anticipatory in the biodiversity issue.

In the last 20 years two **legally-binding instruments** were passed or negotiated at the international and European levels. In 1983, the *International Tropical Timber Agreement (ITTA)* was adopted and renegotiated in 1994. The ITTA is primarily intended to be a commodity agreement between producer and consumer countries, and has established the International Tropical Timber Organisation (ITTO).

The European *Protocol on Mountain Forests* of the Alpine Convention (1991) which is still not in force seeks to ensure healthy and stable mountain forests and provides financial incentives for appropriate mountain forest management.

Non-legally-binding initiatives were driven by the Statement of Forest Principles which strongly influenced the Resolutions H1 and H2 of the Second Ministerial Conference on the Protection of Forests in Europe 1993 in Helsinki signed by 34 European countries and the European Union. *Helsinki Resolution H1 on Sustainable Forest Management* accepts and further develops the term "sustainable forest management." It "means the stewardship and use of forests and forest lands in a way and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems." *Helsinki Resolution H2 on Conservation of Biodiversity* accepts the CBD's definition of biological diversity and states that the conservation and appropriate enhancement of biodiversity should be an essential operational element in sustainable forest management. In the follow-up of the Helsinki Conference, political agreement was achieved on six pan-European criteria and 20 indicators of sustainable forest management at the national level. Criterion 4 deals with the Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems which is measured by five indicators.

The political agreement on sustainable forest management at the national level was the basis for the *Lisbon Resolution L2 on Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management* of the Third Ministerial Conference on the Protection of Forests in Europe held in 1998. It provides guidelines for sustainable forest management planning and practices at the sub-national level. The voluntary guidelines follow the pan-European criteria for sustainable forest management. The guidelines can be used as a reference tool for advising forest owners and forest managers in planning forest practices and supervising their implementation. It is planned that the Pan-European Forest Certification (PEFC) will refer to these guidelines.

Both Pan-European Processes on the Protection of Forests and the Environment agreed in 1997 to a *Work-Programme on the Conservation and Enhancement of Biological and Landscape Diversity in Forest Ecosystems 1997-2000*.

It should be noted that the European Union has signed all the international and European initiatives on sustainable forest management. Thus, the obligations to ensure sustainable forest management and biological diversity are integral parts of the Forestry Strategy for the European Union and the Regulation on Support of Rural Development (see below).

Bridging the gap

The regulation activities from both the environmental and forest sides at the international (global), European and national levels cannot hide their underlying differing interests in forests which will certainly influence implementation and, therefore, policy impacts and outcome. As long as both sides seek to maximize their short-term self-interest and are not prepared for compromises, *societal dilemma situations* occur which leave all participants worse off than feasible alternatives. Rational choice theory, common-pool regimes, and the belief systems approach are three theoretical approaches that help to understand and overcome such situations.

Rational choice approach

It does not make sense for an individual forest owner to employ silvicultural measures for the maintenance or even enhancement of biological diversity on its own, unless all competitors in the timber market do the same. As there is a free world market for timber, the efficiency of the individual owner's costly measures could be annihilated due to the impact of low-priced timber from competitors with environmentally harmful production methods. The egoistic rational behaviour of individual participants leads to a result which is not desired by any of them. The behaviour or the "moves" of each participating player depend on the moves of the other. It is true that the best collective result can only be achieved by cooperation, but the individual participant is even better off, if the others cooperate and he does not. As a "free-rider," he would benefit from the advantages of cooperation without having to bear the cost. As everyone thinks accordingly, cooperation does not arise, and this is the worst collective variant. The individual forest owners are captured in a *prisoner´s dilemma situation*.

There are several possibilities for overcoming such a dilemma situation. If there is a central authority, the provision of public goods can be ensured by state intervention, either by regulatory, economic and/or informational instruments. For forest issues, there is a central authority at the national, but not yet at the pan-European – it is the EU Council for the level of the European Union – and international levels.

At the *national level* the provision of public goods can be enforced by means of the forest law, nature conservation law, hunting law etc.

At the *pan-European level* the Work Programme of the Pan-European Processes is a promising departure for cooperation. It forces the environmental and forest parties to formulate a common report on the achievements as regards biodiversity, but it does not intend to become a central authority for mitigating conflicts of forest uses.

Finally, at the *international level* the situation is further developed. From the preparatory meetings of the UNCED until the international forest policy dialogue within the Intergovernmental Panel on Forests (IPF) and its follow-up, the Intergovernmental Forum an Forests (IFF), the topic of an international legally-binding instrument for forests has been on the agenda. Although there is no central authority at the international level, there is an incentive for a group of states to overcome the problematic situation through agreement to adhere to common principles and norms, rules and decision-making procedures (Krasner 1982: p. 186). Such an agreement constitutes an international regime (Glück 1994: p. 85). The international regime on forests in a wider sense consists of the sum total of international instruments and institutions that create the framework for international activities as regards forests (e.g. Ramsar Convention, ITTA, and the Convention on Biological Diversity). In a narrower sense, the international forest regime would be the *global forest convention* which is still under discussion.

Although there are many options for strengthening the existing international regime for forests (Glück *et al*. 1998), many European states as well as the European Union endorse a global forest convention. It is argued that a global forest convention would be the most inclusive international instrument on forests, because it comprises not only sustainable management, but also the conservation and sustainable development of all types of forests. A convention could fill in the gaps left by the existing international instruments for forests and, in particular, it could address problems of coordination. If no agreement on standards for the maintenance and enhancement of biodiversity in the context of sustainable forest management can be achieved, this could be left to the conference of parties. For the purpose of coordination national forest programmes would be extremely useful.

National forest programmes (NFPs) can be described as a generic expression for a wide range of approaches to the process of planning, programming and implementing forest activities in countries. The novelty of NFPs constitutes their focus on sustainable management, conservation and sustainable development of forests and a comprehensive policy framework applicable at the national and sub-national levels. The latter consists of basic principles developed by FAO (1996) and the IPF process, such as participation, continuous interactive planning process, and a holistic and intersectoral approach. NFPs are the revival of the old concept of policy planning in order to render politics more rational, long-term oriented and better coordinated (Glück 1998, Glück 1999).

Just recently, NFPs received special attention by the European Union for the coordination of forest uses as well as of impacts from other sectors of the economy (e.g. industry, agriculture) on forestry. National forest programmes serve the European Union to enforce the obligations which the European Union has taken by signing the international documents on forests. The EU Council Resolution on a Forestry Strategy for the European Union identifies under point 5d "the implementation of international commitments, principles and recommendations through national or sub-national forest programmes or appropriate instruments developed by the Member States" as substantial elements of the common Forestry Strategy. Furthermore, the EU Regulation on Support of Rural Developments demands the elaboration of national forest programmes for the provision of financial incentives (Art. 29, par. 4).

Common-property regimes

We know from forest history of European countries that mountainous villagers engaged in collective action to sustainably manage their forests for timber and protection against torrents and avalanches without an external authority to offer incentives or impose sanctions. In the course of time, by trial and error the villagers have found a particular property rights arrangement, in which a group of resource users share rights and duties toward a resource. McKean (1998: p. 28) calls such social institutions a "common-property regime" and asserts that "common-property regimes may be what we need to create for the management of common-pool resources, at least if we can identify the factors and conditions that lead to successful regimes" (McKean 1998: p. 30). Common-property regimes are also promising institutions for reconciling the forest use in a restricted area for timber and biodiversity.

In the traditional forest thinking it is difficult to grasp forests as common-pool resources like groundwater aquifers or any environmental sink over time. The reason is that foresters are not used to separate the physical characteristics of a good from the type of a right (private or public) and the owners of rights (private or public body). If one looks at the physical characteristics of forests, one will find that it is difficult or costly to exclude those from the use of forests who are interested in public goods such as protection against natural forces, amenity values or biodiversity. Furthermore, due to the competing relationships of timber production and other forest services there is rivalry in consumption of the various goods and services. The attribute of competing uses and high population pressure requiring coordination among users to cope with externalities makes vesting property rights in group more efficient than vesting those rights to either in a single individual or trying to parcel the resource into individually titled patches (Gibson *et al.* 1998: p. 6). It is important to point out that common property is shared private property, although in Switzerland the "Burgergemeinden" are allocated to public forests in the forest ownership statistics. The property rights in a common-property regime fulfil all the requirements of private property rights: they can be clearly specified (are not vague), they are secure (not subject to whimsical confiscation) if they receive appropriate legal support from governments, they are by definition exclusive to the co-owners of the rights (others than the members of the group are excluded from benefits), and in some settings they are fully alienable through sale or bequest (McKean 1998: p. 31).

In comparison to individual private property or public property rights, according to McKean (1998: p. 32), common-property regimes on forests have some advantages. Firstly, they are a way of providing the rights to goods (e.g. timber, protection against natural forces) without privatizing or parcelling the rights to the resource itself. The group members "share ownership of the productive stock without chopping it in half, and they parcel the flow of use units into individually owned rights (equivalent to shared private ownership, or common property)" (McKean 1998: p. 33). Secondly, by leaving forest unparcelled and managing them in large units, common-property regimes multiply public goods such as biodiversity, compared to managing the same area in separated parcels. Thirdly, in a common-property regime the multiple negative externalities that are implicit in forest management can be internalized by making forest management decisions jointly. Then the uphill forests will be managed in such a way that the gain in protection of the downhill village against natural forces will be greater than the sacrifice of timber.

"Joint resource management through common-property regimes may enhance efficiency by internalizing externalities, just as Coaseian exchange permits people to enhance their joint efficiency by dealing directly with an externality" (McKean 1998: p. 34). The difference between both collective actions is that the actors of Coaseian negotiations hold their individual property rights whereas the members of a common-property regime adhere to a particular property-rights arrangement. Both approaches share the high transaction cost for achieving a compromise. Common-property regimes have the additional weakness of internal collective action problems, because they are comprised of more than one individual owner. Temptations to cheat on community rules may arise inside a common-property regime. Supervision by state officials and financial incentives can reduce these shortcomings. Then, productive efficiency through team production and economies of scale may outweigh losses due to shirking and cheating.

Based on the work of Ostrom *et al.* (1994) and others, McKean enumerates a series of attributes of successful common-property regimes which she summarizes in the following propositions for devising common-property regimes (McKean 1998: p. 43):

- Community of users is already accustomed to negotiating and cooperating with each other on other problems
- Existing, but recently weakened institutions where the habits and techniques of negotiation and compromise are still in evidence
- Local and national elites, or significant portions of them, are sympathetic to the attempt
- Financial support is probably undesirable because it might well undermine local cooperation
- To create non-overlapping commons for different communities is preferable rather than to have several communities sharing a single huge commons.

A common-property regime promises to be a highly efficient tenure system for simultaneously managing a forest resource for private and public goods within a certain area. Although most of the existing common-property regimes on forests aim at sustained yield of timber, and in some cases also sustained protection against natural forces, their objectives can be expanded to also cover other public goods such as biodiversity.

Belief systems approach

A third promising theoretical approach to explain the activities of the two camps is Sabatier´s (1988) *Advocacy Coalition Framework* (ACF). It is a theoretical concept to explain policy change within a time perspective of a decade or more. It emphasizes the importance of values and beliefs of the participating actors and asks about the conditions for their development and change (Hogl 1999: p. 166). The focus is on policy subsystems, which are defined as the interactions of actors from different institutions seeking to influence governmental decisions in a given policy area, e.g. forest policy. Within the subsystem, the ACF assumes that actors can be aggregated into a number (usually two or three) of networks, so called *"advocacy coalitions"*, composed of people from various governmental and private organizations who share a set of normative and causal beliefs and who often act in concert (Jenkins-Smith and Sabatier 1994: p. 180). In the forest policy area we can find again our two camps in the "timber production coalition" and the "forest conservation coalition" (see Hogl 1999, Elliott 1999).

Sabatier distinguishes between three categories of beliefs which are organized into a hierarchical structure. He calls the highest level the "deep core" of the belief system, which includes basic ontological and normative beliefs. On the next level are "policy core" beliefs which represent a coalition's normative commitments and causal perceptions across an entire policy domain or a sub-system. The third level consists of "secondary aspects" of a coalition's belief system. They comprise policy preferences regarding desirable policy regulations and the design of specific institutions etc., for pursuing the policy core.

In general, *deep core beliefs* operate across all policy subsystems; they function almost like a religion. Examples are the beliefs in democratic values such as freedom, equality and solidarity, the limitation of natural resources, etc.

A coalition´s *policy core beliefs* represent a coalition´s basic normative commitments and causal perceptions across a subsystem. They include fundamental value priorities, such as primacy of timber production of the timber production coalition (Glück 1987) or environmental protection of the forest conservation coalition.

Beliefs in secondary aspects of a coalition within a specific subsystem comprise a large set of narrower beliefs concerning the seriousness of the problem or the impacts of policy means (e.g. appropriate certification approach for ensuring biodiversity).

Each coalition attempts to influence the behaviour of one or more governmental institutions in order to make them more consistent with its policy objectives. In the case of conflicts *"policy brokers"* may occur whose main concern is to find a compromise. This is possible because the coalitions are prepared to learn from experience. Jenkins-Smith and Sabatier (1994: p. 182) call that *"policy-oriented learning"* and assume that the reluctance to change decreases from the deep core beliefs to the secondary aspects of a coalition. Whereas deep core beliefs are very resistant to change, change of policy core beliefs can occur if empirical accumulation of evidence reveals serious anomalies. Beliefs in secondary aspects are assumed to be more readily adjusted in the light of new data, experience, or changing strategic considerations. To sum up, policy-oriented learning is an important aspect of policy change, and can often alter secondary aspects of a coalition´s belief system, but changes in the policy core aspects of a governmental programme are usually the results of perturbations external to the subsystem (Jenkins-Smith and Sabatier 1994: p. 183).

The probability of policy-oriented learning is a function of three variables: the level of conflict (hypothesis 6), the analytical tractability of the issue (hypotheses 7 and 8), and the presence of a professional forum (hypothesis 9). In detail, the ACF hypotheses are as follows.

Hypothesis 6: Policy-oriented learning across belief systems is most likely when there is an intermediate level of informed conflict between the two coalitions. This requires that (i) each have the technical resources to engage in such a debate; and that (ii) the conflict be between secondary aspects of one belief system and core elements of the other or, alternatively, between important secondary aspects of the two belief systems.

Hypothesis 7: Problems for which quantitative data and theory exist are more conducive to policy-oriented learning across belief systems than those in which data and theory are generally qualitative, quite subjective, or altogether lacking.

Hypothesis 8: Problems involving natural systems are more conducive to policy-oriented learning across belief systems than those involving purely social or political systems because in the former many of the critical variables are not themselves active strategists and because controlled experimentation is more feasible.

Hypothesis 9: Policy-oriented learning across belief systems is most likely when there exists a forum which is (i) prestigious enough to force professionals from different coalitions to participate; and (ii) dominated by professional norms.

Elliott (1999: p. 429) found in his analyses of the development of certification programmes in three countries (Indonesia, Canada and Sweden), using the ACF as a theoretical reference framework, that referring to hypothesis 6 "there has clearly been policy-oriented learning across belief systems in Sweden as evidenced by the identification of biodiversity conservation as a key issue. Both coalitions had the technical resources to engage in the debate and the level of conflict was generally intermediate". As regards hypotheses 7 and 8 he ascertains that "the collection of quantitative information on biodiversity conservation by scientists and NGOs catalyzed changes in policy core beliefs in both coalitions." As to hypothesis 9 he states that "the Swedish FSC working group provided such a forum, and its effectiveness can be attributed in large part to the fact that it met both these criteria". The four hypotheses on policy-oriented learning are also supported, at least in part, by Indonesia and Canada.

Conclusions

Although this paper deals only with biodiversity, there is an increasing demand and even pressure on forest management to provide more public goods of a certain quality than are provided as positive externalities of exclusive timber production. This development raises a series of questions with potentially far-reaching impacts. Some of them are the following: Will the market forces meet the increasing demand? Are institutional consequences as regards forest tenure to be expected in the long term? Is mediation possible between the traditional and new forest uses? Does international and European forest policy benefit from this development? The three theoretical approaches discussed above allow us to draw some conclusions, at least about the direction in which the development goes.

The market mechanism fails in the appropriate production of public goods. As their price is zero, the forest owner has no incentive to produce more of them than is supplied as positive externalities of timber production. However, some of the forest public goods are transformed into impure public goods (local public goods and club goods), for which a price can be charged, but this does not hold for all of them. Furthermore, if society demands timber from sustainably managed forests, the societal demand could be reflected by a market demand for certified timber. However, as existing surveys have found (Pajari *et al.* 1999), the consumers do not take much care from which forests the commodities come from. Thus, the conclusion can be drawn that the market potential should be fully utilized, but it cannot solve the sufficient provision of additional demands for all forest public goods.

These findings have unavoidably triggered discussions on the appropriate combination of property rights and forest goods. There is an overwhelming consensus among economists and social scientists that private property is an inadequate arrangement for public goods for the above reasons, but an appropriate one for private goods such as timber products. As timber will not lose its economic importance in the future, but the relative importance of public goods will increase, new forms of forest ownership such as common-property regimes may develop. Such an institutional change in property rights on forests depends on the extent to which (i) private and public forest owners do not meet the new demands, (ii) the new demands on forest public goods increase, and (iii) the attributes of successful common-property regimes will be investigated.

The latent conflicts between the timber production and the nature conservation network should not be underestimated. They are based on ideological beliefs on both sides and, therefore, difficult to change. However, the advocacy coalition framework assumes that the coalitions are prepared to learn from experience and to make compromises. This process can be supported by independent mediators ("policy brokers"), professional discussion forums as well as by empirical, scientifically based studies on the issues in question.

The *international instruments,* initiatives and discussions on forests reveal that (i) many forest issues, such as pollution of forests or loss of biodiversity in forests, are global issues which affect the common heritage of mankind ("common public goods") which cannot be left to national jurisdictions, and (ii) the sovereign states were not able to solve these issues. An internationally-binding instrument on forests could certainly be an appropriate option when sufficient agreement is achieved on the content of obligations intended to be legally-binding.

In this context national forest programmes gain importance for the implementation and evaluation of internationally achieved agreements. As regards the European Union, the employment of NFPs provides the European Union with additional influence in forest policy issues.

Acknowledgements
I would like to thank my colleagues Karl Hogl and Michael Pregernig for their helpful comments.

References

Anonymous. 1998. Forest laws in Europe. EFI News 6 (2):7.

Elliott, C. 1999. Forest certification: analysis from a policy network perspective. Doctoral dissertation. Ecole Polytechnique Fédérale de Lausanne, Lausanne.

FAO. 1996. Formulation, execution and revision of national forestry programmes: basic principles and operational guidelines. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gibson, C., M.A. McKean and E. Ostrom. 1998. Explaining deforestation: the role of local institutions. Pp. 23-47 *in* Forest resources and institutions (C. Gibson, M.A. McKean and E. Ostrom, eds.). Center of the Study of Institutions, Population, and Environmental Change (CIPEC), Workshop in Political Theory and Policy Analysis Forests, Trees and People Programme Working Paper No. 3. Bloomington, Indiana.

Glück, P. 1987. Social values in forestry. Ambio 16(2-3):158-160.

Glück, P. 1994. Entstehung eines internationalen Waldregimes [Establishment of an international forest regime]. Centralblatt für das gesamte Forstwesen 111(2):75-92.

Glück, P. 1998. European forest politics in progress. Pp. 95-106 *in* Future forest politics in Europe – Balancing economic and ecological demands (I. Tikkanen and B. Pajari, eds.). EFI Proceedings No. 22. Joensuu, Finland.

Glück, P. 1999. National forest programmes – Significance of a forest policy framework. Pp. 39-52 *in* Formulation and implementation of national forest programmes (P. Glück, G. Oesten, H. Schanz and K.-R. Volz, eds.). EFI Proceedings No. 30, Vol. I. Joensuu, Finland.

Glück, P., R. Tarasofsky, N. Byron and I. Tikkanen. 1997. Options for strengthening the international legal regime for forests. A report prepared for the European Commission under the study contract B7-8110/96/00221/D4. European Forest Institute, Joensuu, Finland. 78pp.

Hogl, K. 1999. National forest programmes – a request for inter-sectoral and multi-level coordination. Some actor-focused considerations. Pp. 163-183 *in* Formulation and implementation of national forest programmes (P. Glück, G. Oesten, H. Schanz and K.-R. Volz, eds.). EFI Proceedings No. 30, Vol. I. Joensuu, Finalnd.

Jenkins-Smith, H.C. and P.A. Sabatier. 1994. Evaluating the advocacy coalition framework. Journal of Public Policy 14(2):175-203.

Krasner, S.D. 1982. Structural causes and regime consequences: regimes intervening variables. International Organization 36:185-206.

McKean, M.A. 1998. Common property: what is it, what is it good for, and what makes it work? Pp. 23-47 *in* Forest resources and institutions (C. Gibson, M.A. McKean and E. Ostrom, eds.). Center of the Study of Institutions, Population, and Environmental Change (CIPEC), Workshop in Political Theory and Policy Analysis. Forests, Trees and People Programme Working Paper No. 3. Bloomington, Indiana.

Ostrom, E., R. Gardner and J. Walker. 1994. Rules, games, and common-pool resources. Ann Arbor.

Pajari, B., T. Peck and E. Rametsteiner. 1999. Potential markets for certified forest products in Europe. EFI Proceedings No. 25. Joensuu, Finland.

Sabatier, P.A. 1988. An advocacy coalition framework of policy change and the role of policy-oriented learning therein. Policy Sciences 21:129-168.

Tarasofsky, R. 1995. The international forest regime: legal and policy issues. IUCN, Gland.

To survive or not survive under global warming?

Gösta Eriksson

Department of Forest Genetics, Swedish University of Agricultural Sciences, Uppsala, Sweden

Introduction

The environmental conditions under which species exist are a result of the ambient abiotic conditions as well as the biotic components of that ecosystem. As components of an ecosystem, trees and other living organisms are continuously exposed to global changes. The changes connected with a greenhouse effect are more a question of degree than of new types of genetic processes differing from those occurring under "normal" environmental changes.

During the first part of my presentation I shall comment on the dispersal ability which has been much discussed by ecologists. Secondly I shall discuss the ability to acclimate in a broad sense and finally I shall discuss the ability to respond genetically. Most of the time will be devoted to the genetic ability. Any of these abilities may help a species to survive in the long term. However, the ability to acclimate has its greatest significance for short-term survival. After that I will briefly discuss methods of gene conservation.

Before discussing the different abilities it is useful to present some definitions. *Fitness* is the contribution of an individual to the next generation in relation to the contribution of others to the next generation. *Adaptability* is the ability of a population to respond genetically or phenotypically to any change in the environment. *Adaptation* is the process of becoming adapted.

Dispersal ability

The dispersal ability is dependent on the vectors transferring the seeds, acorns, nuts, or other propagules. Generally, species with wind transfer have the capacity to spread their propagules over wider distances than species with animals as vectors. There is no definite border between the two. Also the size or the weight of the propagules will influence the dispersal ability.

In many papers treating the ecological consequences of global warming the dispersal ability takes a prominent position. In my opinion many treat the consequences in a very simplistic way. Mostly the question is "Where will the present climatic conditions be found after global warming?" Based on this, the new distribution area is predicted without any consideration of the potential to acclimate or to evolve. Generally it is a question of pushing the southern border of a species northward as in the case of Norway spruce which in one prediction will have its southern border in Scandinavia close to latitude 60ºN instead of 56ºN which is the border today.

Many ecologists fear that most species will not be able to migrate fast enough to cope with the speed of change in the environment expected after global warming. This is based on knowledge about previous rates of migration of different species. If this is true species mainly have to rely on the ability to respond genetically.

The ability to acclimate or phenotypic plasticity

As seen from Figure 1 phenotypic plasticity is the amplitude of a trait that a genotype can take when studied in several different environments. There is a variation in phenotypic plasticity among traits. The stronger the genetic control of a trait, the less the phenotypic plasticity. Trees with their indeterminate growth have a large potential to develop large phenotypic plasticity in growth traits. It is generally assumed that generative traits show a lower phenotypic plasticity than growth traits.

Growth over a broad span of site conditions will probably contribute to the development of phenotypic plasticity. If this is accompanied by a continuous distribution and wind pollination the ideal combination for development of a large phenotypic plasticity prevails. Under such conditions phenotypic plasticity is expected to contribute to fitness. There is probably a difference between annual plants and long-lived tree species because the former can respond genetically to the changes in environmental conditions between years. Phenotypic plasticity does not contribute to fitness in annual plants in the same way as it does for tree species which have to endure large fluctuations among years in environmental conditions. Based on these assumptions it is expected that long-lived tree species such as Norway spruce, Scots pine and birches have a large phenotypic plasticity, since they are wind-pollinated with a continuous distribution and they grow over a broad range of climatic and sometimes edaphic conditions. Tree species with scattered distribution, with short-flying animals as pollen vectors, and which are demanding with respect to site conditions will probably have less phenotypic plasticity. Thus through adaptation they might have become specifically adapted to particular site conditions, which means that various ecotypes might be found in such species.

The role of phenotypic plasticity is complex since it may be regarded as a disguise of the genotype, in this way so to say ‘fooling‘ natural selection. Natural selection is most efficient when there is a close relationship between genotype and phenotype. In recent decades it has become more and more evident that not only traits are regulated genetically but also their phenotypic plasticity as well.

It is assumed that phenotypic plasticity contributes to fitness in species with certain combinations of ecological characteristics. This is why there is a dashed arrow in Figure 1 pointing from the ability to acclimate to the ability to respond genetically.

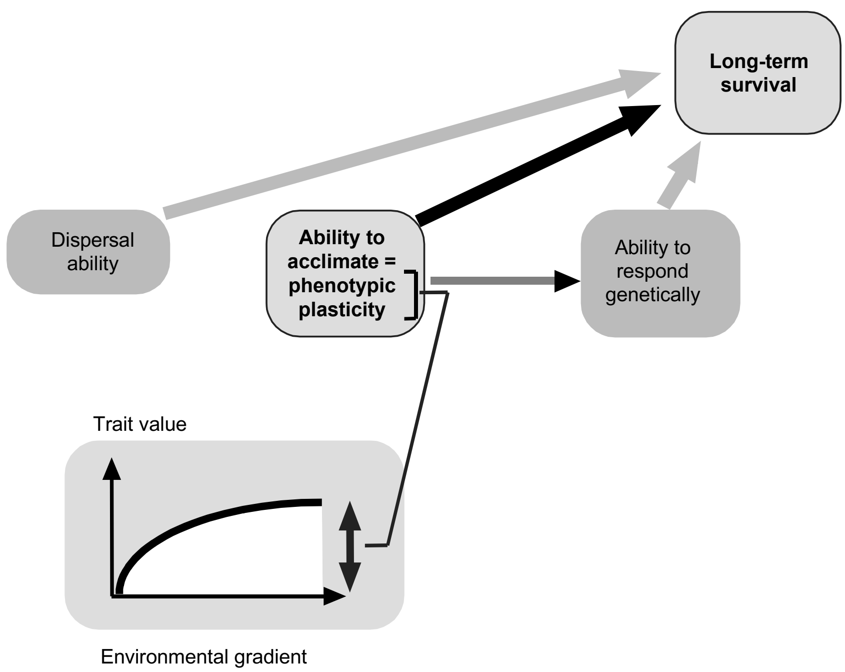


Fig. 1. Schematic illustration of the abilities needed for survival under global warming with special emphasis on phenotypic plasticity.

The ability to respond genetically

This ability is dependent on the presence of additive variance. Additive variance is that part of the genetic variation that can be influenced by natural selection. (According to the definition additive variance is the variance of breeding values. The breeding value of a genotype is the double deviation of its progeny from the global mean of all progenies tested in the same experiment.).

From Figure 2 it is evident that available additive variance depends on genetic drift which is a random process leading to homozygosity. It increases exponentially with decreasing number of mating individuals. Increase in homozygosity at the cost of heterozygosity reduces the amount of additive variance. Genetic drift is a strong evolutionary force in populations with less than 20 mating trees. In principle inbreeding causes the same effect as genetic drift. When genetic drift or inbreeding dominate, the amount of additive variance is low. In this context it might be of interest to discuss how many mating trees are needed for a good sample of additive variance in a species. This number is also dependent on random genetic drift which at high numbers does not influence additive variance much. Thus a random sample of 500 mating trees will capture 99.9% of the additive variance while addition of another 500 trees will only raise this figure to 99.95%. Therefore, some population geneticists talk about the magic number of 500. This figure has recently been challenged because some of the additive variance might reduce the fitness of its carrier. To overcome this, 5000 trees would be a better estimate of the number needed. On the other hand, directional selection over 100 generations in much smaller populations than 500 has resulted in a continuous response to this kind of selection. It indicates that enough additive variance was available during all these generations. If one prefers a conservative approach to sampling, then the larger number is needed. However, this means that enough trees will seldom be available for gene conservation of rare and less common tree species.

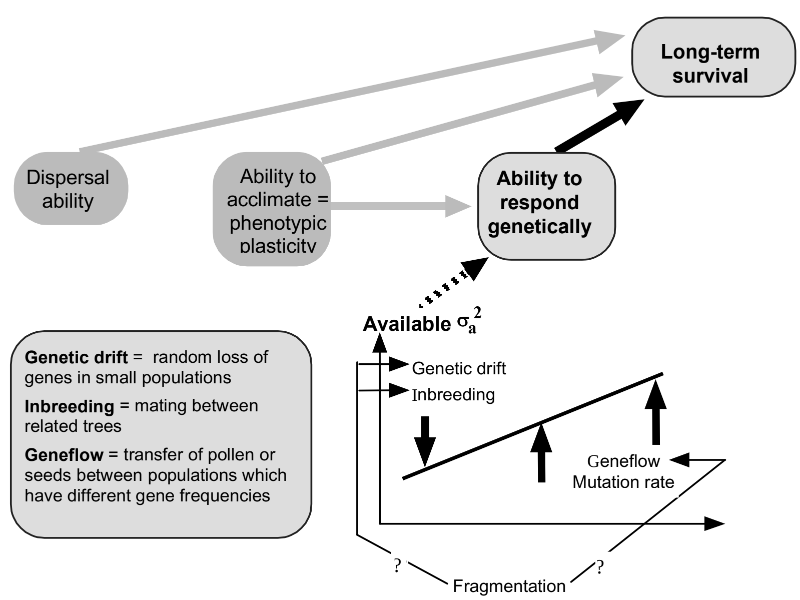


Fig. 2. Schematic illustration of the abilities needed for survival under global warming with special emphasis on factors influencing the available additive variance positively or negatively.

Mutations at individual loci occur at a low rate, varying between one per ten thousand to one per million per generation. Therefore, mutations give a small contribution to the additive variance. However, the summed mutation rates in all loci influencing a quantitative trait are estimated to be several times higher. Fertilization with pollen coming from other populations may increase the additive variance considerably. This is referred to as geneflow.

A species with continuous distribution before global warming may be fragmented owing to global warming. Therefore, species with this kind of distribution are more likely to be affected by global warming than species with an already scattered or disjunct distribution. Fragmentation may influence the genetic drift, inbreeding, and geneflow.

A schematic illustration of the effect of fragmentation is given in Figure 3. The two central populations become extinct after global warming. The strength of the geneflow is indicated by the breadth of the arrows. The figure illustrates that the strength of the geneflow decreases with the distance between the populations. There is no geneflow between the two most distant populations before fragmentation. Intuitively it is believed that such fragmentation will lead to a complete isolation of the two surviving populations with an accompanied decrease of additive variance. However, there are a few investigations showing that there was a stronger geneflow between previously isolated populations. In consequence, fragmentation will lead to increased additive variance in the remaining populations. Therefore, we cannot state that fragmentation is detrimental in all cases for the continued survival of a species.

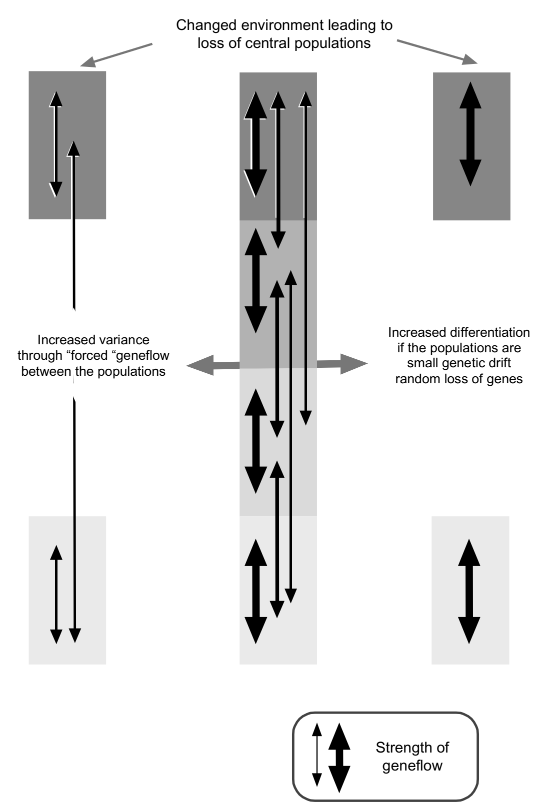


Fig. 3. Two contrasting consequences of loss of two central populations on the additive variance in the fragmented species (see also text).

Even if I have praised additive variance as most essential for the ability to respond genetically in changed environmental conditions, there is another side of the coin. In the short run a homogeneous population without any additive variance may be more competitive in a specific environment than a heterogeneous one. The additive variance might be regarded as a genetic load in the short term. When the environmental conditions are expected to change dramatically, extra concern for the vegetatively or asexually propagated species with limited additive variance is justified as regards priorities in gene conservation. This may be relevant for some tree species belonging to the Rosaceae family.

Adaptive traits may be positively or negatively correlated with each other. If the correlations are negative, progress in one trait results in recession in the other trait. Therefore, in such a case the ability to respond genetically in both adaptive traits is considerably constrained (Fig. 4). The stronger the positive correlation is between two adaptive traits, the greater the possibility for genetic response.

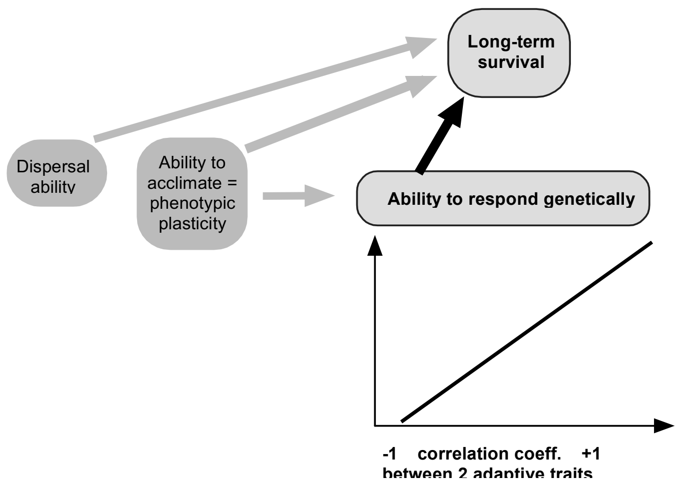


Fig. 4. Schematic illustration of the abilities needed for survival under global warming with special emphasis on genetic correlations between adaptive traits.

From the above discussion it is obvious that either the dispersal ability or the ability to respond genetically has to be larger than the speed of the environmental change in order to guarantee the survival of a species (see Fig. 5). The ability to respond genetically depends largely on the presence of additive variance. The ability to acclimate is mainly of importance in the short-term perspective. It is also evident that a long-generation species must contain more additive variance than an annual species to cope with the change genetically.

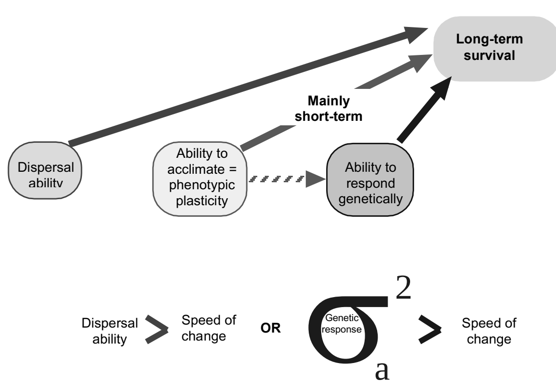
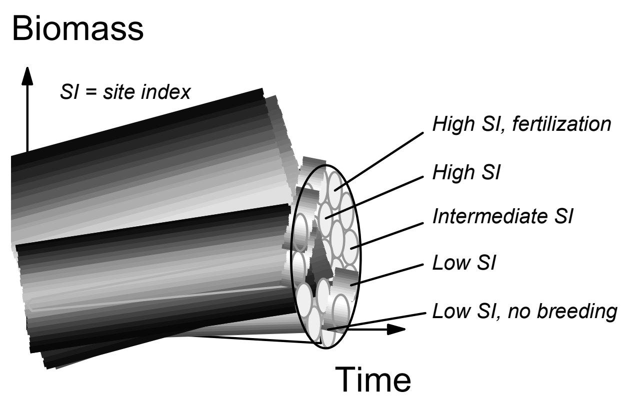


Fig. 5. Summarized schematic illustration of the abilities needed for survival under global warming.

Methods of gene conservation

One way of classifying gene conservation methods is to distinguish between static and dynamic methods. Above I have strongly emphasized the need for species to be able to respond to the expected changes in the environment. This means that any static method for preservation of the present genetic structure is not useful. Seed banks are excluded. More than 20 years ago the North American scientist Gene Namkoong developed the concept of multiple populations in tree breeding to cope with changes in trait values and environmental changes. Later on he extended the concept of *Multiple Population Breeding System (MPBS)* to encompass both breeding and gene conservation. Some 15 years ago he showed that breeding, if carried out according to this concept, takes care of gene conservation. The essence of MPBS is that the combined breeding and gene conservation population is subdivided into approximately 20 subpopulations. These subpopulations are distributed over a broad array of site conditions and during the course of the development of the subpopulations their genetic structure may be changed by natural selection, i.e. adaptation has taken place in the subpopulations. One schematic example of the principles and merits of the MPBS is given in Figure 6.

Besides the advantage of being dynamic, the MPBS method increases the among-subpopulation additive variance over generations while keeping the within-population additive variance at a satisfactory level. The speed of response to selection may also be faster in several small populations than in one large population. If the sampling of the subpopulations incorporates the span of site conditions existing over the distribution area of a species, then it is a guarantee for capturing low-frequency genes.



Multiple **P**opulation **B**reeding **S**ystem, MPBS

- Subdivision of the gene resource population to ≈ 20 subpopulations
- Each subpopulation ≈ 50 genetic entries
- Subpopulations distributed over a broad array of site conditions

Merits of **MPBS**
- Dynamic
- Increasing among-pop σ_a^2
- Keeping within-pop σ_a^2
- Fast speed of response

Fig. 6. Illustration of the meaning and merits of the *Multiple Population Breeding System* concept developed by Gene Namkoong.

In Figure 7 one difference between dynamic and static gene conservation is illustrated. Static gene conservation is widely accepted as regards agricultural crops. The objective of gene conservation in crop plant species is mostly to have a material ready for breeders who want to transfer a desired gene into a high-yielding variety. This can be accomplished by 7-8 generations of back crossings, a technique that is beyond the possibility for long-lived forest trees. If the forest tree breeder's objective is preservation of the present genetic constitution as a reference for future comparisons, then *ex situ* storage of seeds or other propagules is the most efficient method.

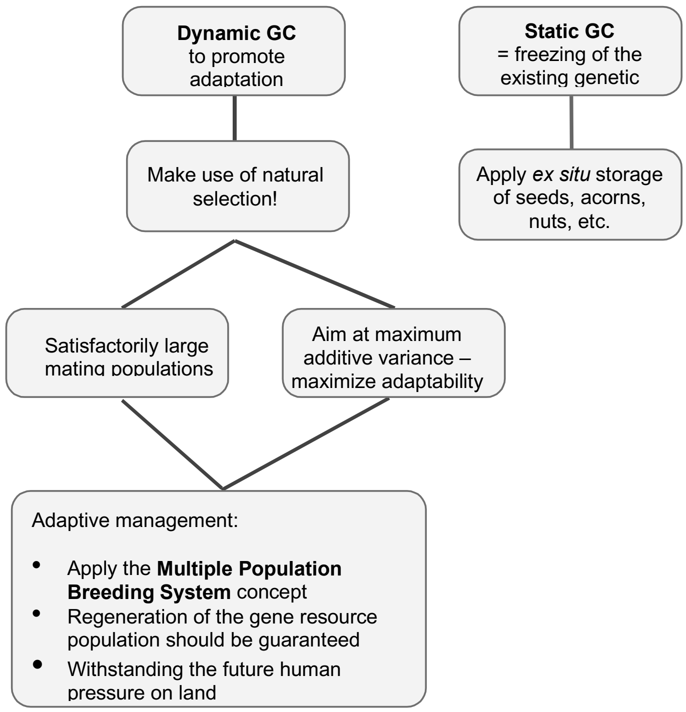


Fig. 7. Schematic illustration of dynamic and static gene conservation (see text).

The essence of dynamic gene conservation is to promote adaptation by exposing the gene resource population to natural selection. It should be noted that this might be obtained both by *ex situ* and *in situ* methods. Educated guesses about future environmental conditions can help to prepare the gene resource populations for adaptation under the new conditions. A prerequisite for natural selection to be operative is that the gene resource population is large enough to avoid genetic drift. Since additive variance is another prerequisite for natural selection, the sampling should be carried out such that maximum additive variance is captured. To achieve sampling without any genetic knowledge, educated guesses about existing genetic variation must guide the sampling. If successful we shall be close to the maximum of the genetic part of the adaptability.

A fulfilment of these requirements is part of adaptive genetic management. As regards natural populations that have been designated as gene resource populations, it is obvious that dynamic gene conservation requires that the gene resource population is regenerated. We have seen too many cases where a gene resource population is being replaced by a population of another species owing to a *don't touch* attitude to gene resource populations. Such an attitude means that the designated gene resource population is a dead end. Thus, active measures should be taken whenever there is a need for maintenance of the gene resource population over generations. It is expected that there will be a strong pressure on forest land in future. Therefore, it is important to evaluate whether or not a potential gene resource population has its long-term existence threatened before it is designated as a gene resource population.

The multiple population breeding system (MPBS) is the best method for a dynamic forest tree gene conservation.

Conclusions

Either the dispersal ability or the ability to respond genetically has to be larger than the speed of change for a species to survive under environmental changes. As regards the genetic part there is no principle difference in the processes going on under more "normal" environmental conditions than under global warming; it is rather a question of degree. Under rapid environmental change dynamic gene conservation becomes more important than ever before. The *Multiple Population Breeding System* is a good system to apply. It should be emphasized that measures should be taken to guarantee regeneration of the gene resource populations.

Acknowledgement

Thanks are due to David Clapham for revision of the English text.

References

Eriksson, G. 1998. Global warming and gene conservation of Noble Hardwoods. Pp. 98-112 *in* Noble Hardwoods Network. Report of the third meeting, 13-16 June 1998, Sagadi, Estonia. (J. Turok, J. Jensen, Ch. Palmberg-Lerche, M. Rusanen, K. Russell, S. de Vries and E. Lipman, compilers). International Plant Genetic Resources Institute, Rome.

Eriksson, G., G. Namkoong and J.M. Roberds. 1993. Dynamic gene conservation for uncertain futures. For. Ecol. Manage. 62:15-37.

Lande, R. 1995. Mutation and conservation. Conserv. Biol. 9(4):782-791.

Namkoong, G. 1984. Strategies for gene conservation in tree breeding. Pp. 93-109 *in* Plant genetic resources: a conservation imperative (C.W. Yeatman, D. Kafton and G. Wilkes, eds.). AAAs selected symposium 87, Westview Press, Boulder, CO.

Soulé, M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pp. 151-170 *in* Conservation biology: an evolutionary-ecological perspective. (M.E. Soulé and B.A. Wilcox, eds.). Sinnauer Ass., Sunderland, Mass.

Riding on a wave of anxious concern: genetic implications of expected climate instability at the southern forest limits

Csaba Mátyás

Department of Environmental Sciences, Sopron University, Sopron, Hungary

Introduction

There are numerous reasons for concern with regard to the future of global forest resources. The general public perceives three main problem areas:

- The destruction and degradation of forest cover in developing countries both in the arid and humid tropical/subtropical zones
- The loss of biological diversity due to non-sustainable forest management practices
- Consequences of expected environmental changes, especially climate change on forest ecosystems.

Stability of forests and natural diversity

The possible effect of environmental changes on forest ecosystems is treated by many authors as a problem of stability, determined by the diversity of the communities. It is widely believed that in natural conditions diversity (mostly understood as species diversity) is ecologically balanced and optimized. Accordingly, natural processes of selection and succession follow and buffer environmental changes even in worst-case scenarios, such as elevated temperatures and increasing aridity at medium latitudes. Mediterranean-type vegetation is forecast in large parts of western Europe as well as the northward advance of deciduous and boreal forest zone limits.

The underlying concept is that these processes function best in natural-state communities where the genetic diversity of natural species contains an optimum of adaptive potential to effectively counterbalance unforeseeable changes. The restoration of natural diversity conditions, of natural plant communities appears to be a logical and sound measure to take. In this respect, however, questions to be addressed are:

- Is diversity *per se* a goal, which warrants stability and adaptability? In addition, are all elements of diversity equally important?
- Should human interference in forest ecosystems (e.g. change of dominant tree species composition, artificial regeneration, selection through intermediate cutting) be regarded as necessarily destructive?

Presuming an effective functioning of ecological optimization (i.e. adaptation), ecotypic variation has to be anticipated at the within-species level, which means in genetic terms:

- Small effective population sizes
- Relative reproductive isolation
- Existence of site-specific alleles.

Genetic adaptation

In case of relatively fast environmental changes, locally adapted population structure would lead to acclimation problems, causing irreparable loss of certain alleles and adaptation stress. If this holds true, a need for immediate action arises in areas where significant climate changes are anticipated. On the other hand, genetic research results from the last decades show that:

- Much of the observed genetic variation pattern is adaptively not interpretable
- Effective population sizes are unexpectedly large
- Geneflow between populations is strong
- Acclimation of introduced species or of transferred populations is fast

- Most of the genetic variation is found at the within-population level
- Epigenetic effects seem to provide a yet unknown potential for plasticity
- Few cases of environment-specific allelic distribution could be verified.

The above facts support the opinion that there is a significant genetic buffering capacity in the investigated forest tree species, which means at the same time that precise adaptation to local site conditions is improbable due to constraints of the genetic system. From the point of view of gene conservation, this picture implies that in general, changes in environmental conditions do not cause an immediate emergency situation, such as irreparable losses of unique vital alleles.

Then, what triggers mass mortality phenomena observed in the last years for a number of tree species? The genetic and ecological causes have to be investigated thoroughly because the results contribute significantly to our perception of the response of natural ecosystems to changing conditions. Valuable information can be gathered from:

- Common garden experiments, i.e. provenance tests
- Time series on mortality with regard to climate extremes.

When investigating causes for ecosystem or population-level adaptation constraints, the following main effects should be pointed out:

- Limitations in migration
- Exhausted buffering capacity
- Distribution pattern of the species
- Human interference.

Implications of climate instability in Central Europe

Migration speed of forest tree species, in terms of expanding distribution limits, has been explored from paleobotanical data. In general, the average advance velocity, following large-scale interglacial warmings, seems to fall between 100 and 400 m per year for most species. In a worst-case scenario for Central Europe, i.e. a warming of 2.5°C in 35 years, the northward switch of isotherms would be much faster. The south-north horizontal movement might be 1.5 to 3.5 km per year. This is a magnitude faster than indicated by paleobotanical data. In vertical direction, the increase in temperature requires a much slower pace, i.e. around 15 m in altitude per year.

The given figures refer to the migration of species in form of seeds. No data are available about the velocity of geneflow by pollen, i.e. how fast alleles migrate within the distribution area of the species. Given the high intensity of geneflow, the speed must probably exceed seed migration by 2 magnitudes.

The above speculations imply that with changing conditions the allelic frequencies of populations might be adjusted relatively fast, however it has been also shown that this has only limited importance.

On the southern limits of the deciduous forest belt, on the edge of the continental steppe zone, the situation is different. It has to be said clearly that in these areas the problem is first of all that there are no alternative tree species that might take over the successional positions of species which have reached the limits of their tolerance and disappear from the ecosystem.

Even in less threatened positions migration by natural means is hampered by human interference. Climate change scenarios calculate with unconstrained natural succession; in reality forests in Central Europe are under intense silvicultural management, where artificial regeneration leaves little space for natural processes. Even if this were the case, the fragmentation of the forest cover limits the migration of species.

Mass mortality phenomena have been experienced in Central Europe in connection with a series of drought years, stressing especially the populations planted outside of their original area of distribution. A good example is the fate of Norway spruce in West Hungary. But even within natural distribution areas, "*Waldsterben*" was proven to be triggered first of all by low rainfall and high summer temperatures, such as in the case of oaks.

Fragmentation and regulated forest management affects nearly all the forest cover in Central Europe. This leads not only to restriction of species migration, but in case of "minor" species to reproductive isolation and interception of geneflow, even to local extinctions.

For widely distributed, economically important species these threats are not relevant except for the populations at the southern/low elevation limits of the distribution area. As species occurrence in these areas is restricted by the genetically limited tolerance of the species, any significant unfavourable shift of environmental conditions triggers first a productivity loss, followed by increased mortality.

Even before the appearance of "*Waldsterben*" symptoms, sexual reproduction and regeneration are increasingly hindered. Vitality loss and mortality affects the older age classes first, resulting in fructification decline and loss of seed viability. Regeneration conditions become increasingly difficult not only because of more infrequent and low-vitality seed crop, but also due to microclimate change on the ground (decreasing topsoil moisture, weed and shrub competition due to canopy gaps).

Conclusions and need for action

Expected climate instability threatens first of all the southern, low elevation, and continental climate peripheries of the distribution area of the main forest tree species. To a lesser extent, populations growing in smaller mountain ranges, where no "reserve altitude" is available to migrate into, are also endangered. Species with scattered or restricted distribution, as well as those with low-density occurrence are more threatened than the main tree species.

In view of expected climate stress conditions, gene conservation programmes should consider for economically important species the northward relocation of breeding populations and the evacuation of valuable, threatened outlier populations on the southern fringes of distribution.

For species with restricted distribution and low density, evacuation into archives or new habitat is necessary. Admixed species occurring in stands of economically important tree species should be included into the gene conservation efforts.

It should be made clear that in areas threatened by unfavourable climate changes, human interference is indispensable. The policy to lower management intensity and to leave adjustment of forest communities to natural forces will generally not be applicable. The interference of foresters to maintain forest cover and to keep adaptable populations is an important contribution to the stability of forest ecosystems.

Targets of conservation and evacuation measures should be populations with high phenotypic plasticity, growing on favourable, sufficiently variable sites. Priority should be given to stability over autochthonous origin, both on genetic (population) and community (species) level. This implies that the maintenance of adaptively less important diversity within and between populations is of secondary importance.

Forest management in the threatened zones should be understood as the stewardship of a stable forest cover in the interest of maintaining the vital ecological functions of the forest in the human environment. In most countries, however, society is not readily acknowledging the obvious need for supporting these activities by external funding.

The maintenance of biological diversity has become an important element of sustained forest management. The aggressive realization of this basically correct policy provokes, however, certain questions especially in Central Europe, where human interference in forest ecosystems shaped the genetic resources of present stands and plant communities, and where ecological consequences of civil engineering measures of the past (first of all changes in hydrological conditions), as well as expected climate changes, threaten the future of the forest resources.

Developing criteria and indicators for genetically sustainable forestry

Outi Savolainen

Department of Biology, University of Oulu, Oulu, Finland

Introduction

The development of criteria and indicators for assessing the sustainability of forestry practices is an international process, where several organizations are at work either for temperate and boreal or for tropical forests. The criteria span biological, economical, sociological and legal issues.

The purpose of this presentation is to discuss the population genetics foundations behind genetic criteria and indicators. I will first review some basic relevant aspects in population genetics, then I consider the application of these principles for tropical forestry (Namkoong *et al.* 1996; Namkoong *et al.* submitted), and last I will discuss the relevance of these criteria for temperate and boreal forests.

Basics of population genetics

We first consider the evolutionary forces that govern the genetic variability in populations. These are mutation, the mating system and recombination, genetic drift, migration, and selection. We know quite well the basic principles of population genetics which determine how these forces influence variability and its distribution in populations (Kimura and Crow 1970, Gillespie 1998). It is always necessary to consider the balance of evolutionary forces. In the simplest case (with no selection), mutation and drift will determine the level of variability. The expected heterozygosity at some locus, H, will be $4N\mu/(1+4N\mu)$, where N is the effective population size and μ the mutation rate. The commonly used genetic markers are often considered to be only weakly if at all influenced by selection, and thus governed by this equation. As an example, we know that the North American red pine (*Pinus resinosa*) has very low variability at marker genes (Fowler and Morris 1977), whereas Scots pine (*Pinus sylvestris*) is one of the most variable organisms; for review, see e.g. Muona (1990). Since there is no reason to suspect that these two species would have very different mutation rates, the conclusion is that red pine has a much smaller (maybe two orders of magnitude) effective population size. Noting that the current distribution range of red pine is large, what counts here is a bottleneck in an earlier time, the effects of which are still being seen. This also illustrates that historical effects can have large influence on genetic variability (Nei *et al.* 1975, Fowler and Morris 1977). Further, this shows that we cannot point to some level of variability at marker genes that pine trees would need to survive. For a long time, red pine has been a successful species, despite lack of variation (but not favourite of tree breeders!). Genetic variability in Australian Acacias (measured as expected heterozygosity at the same set of loci in different species) ranged from about 0.02 to more than 0.30 (Moran *et al.* 1989). Again, historical effects are likely to account for these differences between species with rather similar life histories.

Many of the factors listed, genetic drift, migration and mating system will affect, on average, all loci in the genome in a similar way. An important exception is selection, where the effects are highly locus-specific. To illustrate this principle again with Scots pine, the autumn frosts in northern Europe will certainly distinguish the genotypes which are dormant and frost-resistant from those which continue growth too late. However, all genotypes at a marker locus might have equal probabilities of survival in the face of such frost. The effects of the selection depend on the balance between migration and selection. If selection is strong, relative to migration, the populations will differentiate, as is found with respect to frost tolerance in Scots pine in Finland (Hurme *et al.* 1997). If migration is extensive relative to selection (Koski 1970), then no differentiation is expected to occur, as is found at marker loci, also in Scots pine (Karhu *et al.* 1996).

From basic population genetics theory, we also understand how changes in the evolutionary factors will influence genetic variability. For instance, increased genetic drift will reduce variability within a population, and increase variation between populations. Or increased directional selection would alter the gene frequencies, as well as reduce variation. Increased migration will render populations more homogeneous (at least if selection is not considered). Many population genetics textbooks describe these principles (Gillespie 1998).

Application to tropical forestry

There are about 100 000 species of trees, of which nearly 10 000 species are threatened. Forestry is one of the causes threatening these species. Forestry is often combined with other threats to the species as well: changes in climate, altering patterns of land use. Sustainable forestry does not only refer to the forest tree species, but the health of the whole ecosystem must be addressed.

Gene Namkoong led a process aimed at developing criteria and indicators for mainly tropical forestry, under the auspices of CIFOR, the Center for International Forestry Research based in Indonesia (Namkoong *et al.* 1996; Namkoong *et al.* submitted). A set of criteria was developed in a workshop held in Indonesia in 1996, and these were later tested in Cameroon.

Genetic sustainability could be construed as maintaining current genetic variability. However, there is no possibility to obtain such baseline data on all relevant species. Also, as discussed above, there is no minimum level of genetic variability that can be designated as necessary for the genetic health of the species, even among species with similar life histories. Thus, the criterion for genetic sustainability of forestry was chosen to be *"Conservation of the processes that maintain genetic variation"*.

It is evident that we cannot directly see the processes, but they are reflected in various ways in the genetic composition of the populations. Observing changes in such processes is even more difficult. The effects of the changes in processes become visible over long time spans. A further constraint is that current population genetics is a high-tech labour-intensive effort, the criteria developed for practical silviculture must be easy to assess, by people who are not fully trained geneticists, but more likely forest technicians in tropical countries.

The use of forest resources can take several forms: logging, grazing, harvesting of non-timber forest products. Rather than trying to directly relate their consequences on genetic variability, we need to consider the effects on the evolutionary factors. For instance, if a population of 1000 trees is thinned to one tenth of its density, how will genetic variability be affected? If we assume that there are no other effects besides the density reduction, then the change would be through an increase in genetic drift. Drift depletes genetic variation at the rate of $1/(2N)$ per generation. Instead of losing 1/2000 of variability per generation, the rate of loss of genetic variation would be 1/200 per generation, one half of one percent, a difference so small in one generation as not to be detectable, nor worth the concern to try to detect it.

Silvicultural measures can be classified with respect to what kinds of changes they are likely to cause in the evolutionary processes. In most cases the effects will not be as simple as above, because many silvicultural measures could have effects on many factors, e.g. a reduction in the density of trees could also influence behaviour of pollinators, and thus cause a change in the mating system. Such complex interactions are perhaps especially likely in tropical ecosystems where animal pollination is frequent, rather than in wind-pollinated conifer forests. The proposal by Namkoong *et al.* (1996) tabulates various silvicultural measures with respect to their effects on evolutionary factors.

We then developed five indicators of the genetic processes for assessing the effects of forestry management. These are: level of genetic variation, directional changes in gene or genotypic frequencies, gene migration between populations, mating system, and as a fifth indicator, feasibility of preventive of restorative actions (Namkoong *et al.* submitted).

All of these indicators are accompanied by verifiers, which are actually measured in the forests. For most of the genetic indicators, there are two levels of verifiers. Demographic verifiers are easy and cheap to measure, and we hope have predictive power for the real genetic verifiers. For instance, the demographic verifiers for level of genetic variability are: number of sexually mature individuals (N>50), the number of reproducing individuals (N>30), and the phenotypic coefficient of variation. If there are enough reproducing individuals, we would not worry about the effects of genetic drift. The phenotypic variation could suggest that there is also genetic variation. If these verifiers were to fail, then it would be necessary to go to the genetic verifiers, and measure numbers of alleles or gene diversity at marker loci, or measure additive genetic variation for quantitative traits. We also tried to include critical levels for the different verifiers (above in parentheses). Likewise, demographic and genetic verifiers were developed for all indicators.

It is evident that this process is not finished. The applicability of the system has been tested in Cameroon, after which the details were further defined, but more tests will be necessary. Research into the relationships between the demographic and genetic verifiers is needed. There are solid theoretical predictions, the accuracy of which needs to be tested in field situations.

Application to boreal and temperate ecosystems

The population genetic principles governing genetic variability hold equally in tropical and temperate or boreal forests. There are still many important differences between the ecosystems and forestry practices that need to be considered. The relatively low numbers of tree species in the boreal and temperate forests are largely wind-pollinated. For some species, human influence has lasted for thousands of years, such that hardly any natural populations are left. Other species, at least in some areas, are just entering the phase of intensive domestication and improvement. Thus, "forestry" in a broad sense does not just concern logging operations. We also need to consider gene reserve populations, breeding populations, multiplication populations, and actual production populations. For many such species, there are large amounts of data available.

We have suggested that at least boreal conifers are, from the population genetic aspects, rather robust in the face of forestry (Savolainen and Kärkkäinen 1992). The forestry practices and their consequences are rather well understood. There is, however, an important limitation. Most of the work is based on marker genes, and quantitative variation has not been directly studied.

Within the framework of EUFORGEN the emphasis is on genetic variation in forest trees. However, forestry has its most significant effects elsewhere. For instance in Finland, forestry practices endanger many other plant species and animals, as old forests become rare. Many of these species will also face genetic consequences of losing their habitat.

The European temperate and boreal forests provide excellent opportunities for studying and understanding the relationships between forestry practices and genetic variation in the widely used species. This understanding can then be applied to Europe's less studied species, and for species in other biogeographical areas.

References

Fowler, D.P. and R.W. Morris. 1977. Genetic diversity in red pine: evidence for low genic heterozygosity. Can. J. For. Res. 7:343-347.

Gillespie, J.H. 1998. Population Genetics. A Concise Guide. Johns Hopkins University Press, Baltimore.

Hurme, P., T. Repo, T. Pääkkönen and O. Savolainen. 1997. Climatic adaptation of bud set and frost hardiness in Scots pine (*Pinus sylvestris* L.). Can. J. For. Res. 27:716-523.

Karhu, A., P. Hurme, M. Karjalainen, P. Karvonen, K. Kärkkäinen, D.B. Neale and O. Savolainen. 1996. Do molecular markers reflect patterns of differentiation in adaptive traits of conifers? Theor. Appl. Genet. 93:215-221.

Kimura, M. and J.F. Crow. 1970. An Introduction to Population Genetics Theory. Harper and Row.

Koski, V. 1970. A study of pollen dispersal as a mechanism of geneflow in conifers. Comm. Inst. For. Renn. 75:1-30.

Moran, G.F., O. Muona and J.C. Bell. 1989. *Acacia mangium*: a tropical forest tree of the coastal lowlands with low genetic diversity. Evolution 43:231-235.

Muona, O. 1990. Population genetics in forest tree improvement. Pp. 282-298 *in* Plant Population Genetics, Breeding and Genetic Resources. (A.H.D. Brown, M.T. Clegg, A.L. Kahler and B.S. Weir, eds.). Sinauer Ass., Sunderland Mass.

Namkoong, G., T. Boyle, Y. El-Kassaby, G. Eriksson, H.-R. Gregorius, H. Joly, A. Kremer, O. Savolainen, R. Wickneswari, A. Young, M. Zeh-Nlo and R. Prabhu. Criteria and indicators for assessing the sustainability of forest management: conservation of genetic diversity. Ambio (*submitted*).

Namkoong, G., T. Boyle, H.-R. Gregorius, H. Joly, O. Savolainen, W. Ratnam and A. Young. 1996. Testing criteria and indicators for assessing the sustainability of forest management: genetic criteria and indicators. Center for International Forestry Research:1-12.

Nei, M., T. Maruyama and R. Charaborty. 1975. The bottleneck effect and genetic variability in populations. Evolution 29:1-10.

Savolainen, O. and K. Kärkkäinen. 1992. Effects of forest management on gene pools. New Forests 6:329-345.

Collaborative efforts on the conservation of forest genetic resources in the Trans-Caucasus

Karen Ter-Ghazaryan

Forest Research and Experimental Centre, Ministry of Nature Protection, Yerevan, Armenia

General characteristics

The Trans-Caucasus sub-region is situated in the southern part of the former Soviet Union (FSU), covering an area of 186 340 km^2 between 38°26' and 43°34' of the northern longitude, and 40º00′ and 50º20′ of the eastern latitude.

There are three former Soviet Union countries located in the sub-region: Armenia, Azerbaijan and Georgia.

Agriculture, environment and forestry

In **Armenia,** the agricultural sector (which included forestry up to 1995) accounted for 38% of GDP in 1996, and employed about 25% of the active labour force. The land reform in 1991 has resulted in the privatization of most agricultural land (tilled land, not grazing areas) and livestock, resulting in an estimated 325 000 new landholders (1997), most of whom lack experience or skills in modern agriculture and sustainable land-use practices.

Soil erosion is a major problem, affecting 60% of the agricultural land. This is due mainly to poor agricultural practices, such as the use of livestock manure as household fuel, and the uncontrolled overgrazing of pasture lands. Grazing also takes place on forest lands, and is a major impediment to natural forest regeneration in some areas.

The possibilities for effective nature protection are good, as the nature in the country is exceptionally rich and diverse. There are still areas practically undisturbed by man in the remote mountains. The advance of illegal forest harvesting is endangering the existence of the old-growth forests, especially indigenous coniferous (pine, juniper) forests.

Due to its position at the meeting point of three diverse biogeographic regions and the mountainous nature of its landscape, the country sustains high biological diversity and a number of endemic species of the Caucasus. Approximately 11% of the territory is covered by forests, at altitudes from 500 to 2700 m asl, characterized by more than 200 species of trees and shrubs (Ter-Ghazaryan 1998).

One fundamental problem in Armenia's forestry is that environmental impact analysis has not been carried out for methods used in logging and forest regeneration. For instance, new methods were used without any prior knowledge of their effects on the environment. Well-known examples of this are soil scarification by means of ploughing and harrowing, or use of chemicals. Non-native tree species and provenances have been introduced without first establishing what the environmental consequences would be.

Natural forest ecosystems are increasingly being replaced by artificial forests, thus endangering forest genetic resources. Deciduous forests are in general replaced by conifers and marginal agricultural land is planted with fast-growing hybrid exotic poplars. Planted pines replace natural mountain oak forests. The area occupied with mixed forests is slowly declining. Virgin old-growth forest is decreasing, upon which many species of plants and animals depend.

Forest roads are built without permits or adequate planning, which often results in fragmented forest landscapes. This may threaten certain species of plants and animals sensitive to such disturbance.

As a result of the economic collapse, which severely affected wood processing industries, the reported contribution of the forestry sub-sector to the national economy has shrunk to less than 0.5% of GDP. In reality, forests are a source of timber, fuelwood, non-wood forest products (NWFP), game meat and recreation for a large number of people whose salary levels are inadequate for household requirements. Particularly in rural areas have forests been of great importance for people's survival and well-being during recent years. The forests represent also other environmental utilities, like greenhouse gases sequestration and carbon storage. These forest services are not included in the GDP calculations.

Table 1. Forest characteristics in the Trans-Caucasus countries (as of 1996)

Country Fore	**st area (ha)**	**Growing stock (million m^3)**	**Increment (m^3/year)**
Armenia 33	4 100	48	360 000
Azerbaijan	989 300	125	1 000 000
Georgia	2 752 000	430	4 000 000
Total	**4 075 400**	**603**	**5 360 000**

Azerbaijan is predominantly a mountainous country. Yet, along with high mountain ridges, there are vast plains and lowlands. Eighteen per cent of the country's territory is situated below the sea level. The climate varies from subtropical and dry in central and eastern Azerbaijan to subtropical and humid in the southeast, temperate along the shores of the Caspian Sea, and cold at the higher mountain zone. Most of country receives scant rainfall (152 to 254 mm annually).

A key aspect of the government's reform programme is land reform and farm restructuring. The Land Reform Law from July 1996 aimed to transfer land to private ownership.

The country is rich in biodiversity. The flora is represented by 4300 species of which 240 are endemic. The fauna encountered more than 600 species of vertebrates.

Fourteen state reserves with a total area of 191 200 hectares which comprise 2.2% of the total area of the Republic are in place in Azerbaijan. They include all major natural landscapes and contribute to the preservation of the biodiversity of the Caucasus. The total forest area is 1 213 700 ha, of which 989 300 ha are covered with forest. Ten percent of the forests are considered as primarily water protective, 70% as soil protective, sanitation belts 12%, and 8% as special forests.

During the last six years quite large forest areas were damaged by illegal cutting. It is reported unofficially that the quantity of the trees felled is as high as 20% of the total amount of trees. Roads were built through pristine areas.

Air and water pollution are widespread and pose great challenges to economic development. Major sources of pollution include oil refineries and chemical and metallurgical industries.

During the Soviet era, **Georgia** was an important exporter of wine, tea, fruits and vegetables. Land use favoured the production of citrus, grapes, tobacco or tea in large plantations, and agroindustry accounted for about two-fifths of total industry output in Georgia.

Political events and disruption of trade have seriously disturbed the balance. Agricultural production in 1995 was about half of its 1990 level. About 80% of the required food grain are imported.

Despite that the energy crisis has reduced overall air pollution during the last few years, it has also made some other environmental problems more acute.

In Georgia the soil erosion is one of the most serious problems. Deforestation and improper agricultural practices, in addition to its detrimental results, negatively affect the fertile soil layer. According to the last available information, about 1 million hectares (33% of total agricultural land area) were eroded during last decades. During the last seven years the amount of arable lands has been reduced by 11 000 ha due to this erosion.

Saline soils are another serious problem, specifically in the eastern lowlands.

Local sources of water contamination, such as the sewage system in Tbilisi, Batumi and some other main cities, many of which pour untreated into water, also cause concern. Other main pollutants of water and soil are normally agricultural activities, but due to reduction in the use of chemicals and mineral fertilizers, the situation is relatively better than before the economic crisis.

The forests cover 38% of the territory of Georgia, from 500 to 2300-2500 m asl. Beech, oak, hornbeam, chestnut, ash and maple are predominant broadleaved species. Georgia's forests are rich also with coniferous species: Nordman fir, Eastern spruce and Caucasian pine. Almost all forests are located on mountainous sites.

About 500 000–600 000 ha of forests are considered as not accessible, and thus completely undisturbed by man. Mean growing stock is 300 m^3/ha.

In Georgia 14 state reserves covering 168 000 ha were established with the forest as a main landscape type. Many endangered tree species are under special protection, in particular native oak species, junipers, and yew.

Georgia supports a rich biodiversity that includes about 4500 species of vascular plants. Endemic plant species constitute about 9% of the total flora. Georgia is characterized by a wide variety of plant communities, with examples of almost all of the main habitat types found elsewhere in Europe.

No reliable information as to the amount or distribution of illegal felling is available, although the situation can improve as the German Development Agency (GTZ) currently undertakes independent aerial observations. It is reported that the amount of registered illegal cuttings reached 50 000 m^3 in 1995, but in reality this figure could be much higher.

Table 2. Flora and vegetation types of the Caucasus

Species total	**over 6000**
Most widely occurring plant families (species)	Asteraceae (636 spp.), Poaceae (444), Fabaceae (409), Apiaceae (247), Rosaceae (209), Lamiacae (195), Cyperaceae (113)
Flora elements (%)	
Ancient Tertiary	12
Boreal 21	
Mediterranean 17	
Front Asian	27
Caucasian 15	
Steppe European	6
Central Asian	2
Endemic plant species	1600
Main vegetation types	dry steppe, steppe, forest-steppe, broadleaved forest, subtropical deciduous forest, arid open woodlands, coniferous forest, subalpine and alpine meadows

International cooperation

The World Bank (WB) represents a largest donor in the entire sub-region. Its lending to **Armenia** is designed to help the government to accelerate the transition to the market economy and to alleviate the large pockets of poverty that have emerged over the last years. The emphasis so far was on the promotion of the private sector development and the establishment of a targeted system of social security.

The WB's assistance programme aims to support **Azerbaijan** in its transition by providing policy advice with supporting economic and sectoral work, through adjustment and investment lending, and through aid coordination.

The objective of WB's assistance to **Georgia** is to help reverse the economic decline of the past few years, assist the transition to a market economy, and help alleviate poverty. In addition to promoting private sector development and supporting infrastructure, the WB’s assistance will also improve public management, develop human resources and institutional capacities, strengthen the social safety net, and promote regional environmental initiatives.

Stemming environmental degradation in the newly independent states remains a difficult task in view of limited domestic resources. The World Bank has supported efforts to tackle this issue by helping governments to develop national environmental action plans (NEAP), which emphasize sustainable policy changes and further institution building.

The financial assistance targeted to halt the degradation of the environment and forest resources in the sub-region should still be raised. At present the level of the financial support for these areas does not exceed 1% of the total WB lending. Moreover, in 1997 there were no allocations made for these areas. This hardly can coincide with the strategy of the WB, which basically should balance economic, social and environmental needs of the countries. The issue of effectiveness also must receive greater attention in terms of the focusing on the greater success areas. Partnerships should be developed with the players in areas where they have a comparative advantage.

The concept of forest policy adopted at the workshop that took place in Yerevan, Armenia (May 1995) is one that aims to satisfy objectives related to environmental protection, economic and rural development, and land use. The principles upon which forest policy is based are conservation, afforestation and regeneration, sustainable and multiple use of forest resources, and maximum participation of private and non-governmental organizations in the forestry development. The last two principles represent major departures from past policy, which did not address timber production use of forests as well as non-governmental participation in forest activities.

Cooperation with the UN Agencies in Azerbaijan enabled a number of international organizations to cooperate in the field of environmental protection. Negotiations have been held with UNDP, UNEP, UNESCO, the World Bank, and environmental organizations from USA, UK, Germany, Turkey, Iran and the Commonwealth of Independent States. The "Agreement on cooperation in the field of ecology and environmental protection" was signed between Azerbaijan and Turkey. A "Protocol on Cooperation between the Environmental Protection Ministry of the UK and the State Committee for the Environment" and an "Agreement on cooperation between the British Petroleum Company and State Committee for the Environment in the field of Ecology and Environmental Protection" are also in effect.

A National Environmental Action Plan supported by the UNDP and World Bank is under preparation.

The Government of **Georgia** prepared the National Environmental Action Plan (NEAP), which will identify priorities and set goals for environmental management, regulatory policy and related institutional development. Forestry is one of the components in this national planning activity.

Regional and sub-regional cooperation to date

The reforms in the fields of forest policy and legislation are more important than ever before. The overall economic and social changes together with the increasing need for sustainable forestry development urged the countries to develop their own forest policies and legislation to meet the requirements of the market economy in a pluralistic political system.

Before independence the international cooperation in the forestry sector of Armenia was planned and implemented by central institutions of the FSU. Rather strong links were maintained between Armenian and Russian forestry institutions. The Trans-Caucasus regional workshops were promoted on a periodical basis. The proceedings of such research workshops and seminars are available in Russian. Armenian foresters participated also in all-Russian symposia and conferences. On the other hand, the linkages with western partners and institutions were incomparably weak.

Since 1998 the Forest Research and Experimental Centre is operating under the supervision of the Ministry of Nature Protection. The Centre coordinates activities related to the promotion of foreign cooperation and assistance, and is involved in donor relations and screening process as well as mobilization of financial support. A similar agency was established also in Georgia.

Although workshops and seminars were considered as the most important means of transferring knowledge and information, the donor and recipient countries expressed concerns regarding insufficient follow-up actions.

As it became evident during the transition period, the existing capacities are not able to address all problems under the new circumstances, not even those institutions which were very efficient in the previous system. Especially the institutional framework of forest management, the forestry extension service, and the statistical and information systems need to be strengthened. There is an urgent need also to design and implement the national strategy for the conservation and sustainable use of the forest and agroforestry genetic resources.

Major donors and projects in the sub-region

The environmental and forestry development issues are one of the main elements in the entire framework of the projected development assistance to the countries in transition, and particularly to Trans-Caucasus countries. Nevertheless, multilateral agencies keep their differences while addressing the issues mentioned. In particular the WB, the Organization for Economic Cooperation and Development (OECD), the European Bank for Reconstruction and Development, and the Economic Commission for Europe (ECE) are stressing the introduction of environmentally sound approaches in the overall economic and sectoral development policies over the transitional period. The United Nations Development Programme (UNDP) following its global mandate is emphasizing the capacity building programmes. The United Nations Environment Programme, the European Union/Technical Assistance to the Commonwealth of Independent States (EU/TACIS), the United Nations Education, Science and Culture Organization (UNESCO), and the Food and Agriculture Organization of the United Nations (FAO) are mainly dealing with conservation and sustainable use of natural resources including forests. The International Fund for Agriculture Development (IFAD) major policy being to eradicate rural poverty and hunger at a global scale and to ensure food security, is addressing the environmental/forestry policies indirectly.

The largest donor NGOs (WWF, IUCN, Ford Foundation, and Soros Foundation) are mainly stressing the objectives of nature conservation, larger involvement of communities, and sustainable and equitable use of resources.

Just a few of the multilateral and bilateral donor agencies are mentioning forest development issues as their priority field of intervention. Among these are:

- WB - Forest management
- UNEP - Forest Ecosystems Protection
- FAO - Technologies and Methodologies for the Conservation and Use of Trees and Forests; Global Forest Resources Statistics; Forestry Institutional Strengthening
- FINNIDA (Finland) - National Forest Programmes Development; Criteria and Indicators for Sustainable Forest Development
- Austria - Forestry Institutional Support
- WWF - Forest Conservation
- IUCN - Ecosystem Conservation and Networking of Forest Conservationists.

Many funding agencies are dealing with forestry development issues indirectly, through more generalized programmes, like natural resources sustainable use, biodiversity protection, transfer of technology and know-how, etc. It is evident that the resources earmarked for the forestry development projects in this case will be considerably small.

Conclusion

Given the considerable extent of the forest resources in the Trans-Caucasus and its potential as a contributor to the socioeconomic development in the region, and taking into consideration the vastly changed economic situation compared with FSU times, there is an urgent need for a broadly based both national and regional debate on the development of the forestry sector, leading to the formulation of national forest programmes. The latter would, *inter alia*, be necessary as a basis for attracting foreign participation and assistance. It would also lead to proposals for the most critical issue of the conservation and sustainable use of the forest genetic resources.

References

Anonymous. 1984. Bolshoy Kavkaz. Nauka Publishing House, Moscow.

Anonymous. 1990. Zapovedniki Kavkaza. Mysl Publishing House, Moscow.

Gigauri, G.N. 1997. Forests and forestry in Georgia. EFI Manuscript. Joensuu, Finland.

Ter-Ghazaryan, K., V. Karapetian and M. Barseghian. 1995. Forests and forest products. Country Profile, Republic of Armenia. Geneva Timber and Forest Study Papers (ECE) No. 8. Joint ECE/FAO Agriculture and Timber Div., Geneva, Switzerland. Timber Section. United Nations, New York, USA.

Ter-Ghazaryan, K. 1998. Conservation and use of forest genetic resources in Armenia. IPGRI Newsletter for Europe 14:5.

Forest genetic resources in Uzbekistan and in Central Asia

Abdihalil K. Kayimov and Evsey S. Alexandrovsky
Uzbek Forestry Research Institute, Cont. Darkhan, Tashkent region, Uzbekistan

According to the State Committee on Forests of the Republic of Uzbekistan, the total forest area was 8 285 300 ha ("forest fund" as of 1 January 1995) or approximately 19% of the country's territory. The area covered by forests was 1 945 600 ha (5%).

Owing to the variety of natural conditions, several forest types are distinguished: mountain forest, desert forest, valley forest and riparian forest (called "tugay"). The major part of the area designated as forest fund is concentrated in deserts (6 971 300 ha) and mountains (1 185 100 ha), whilst valleys (171 100 ha) and the tugay zone (57 800 ha) harbour a smaller proportion of forests in Uzbekistan.

Insufficient forest protection in the past, as well as the current absence of economic use of many forest areas, unlimited pasture and fires have led to a decrease of forest resources. Consequently, forests do not cover a significant proportion of the territory, are scattered in small areas far from settlements and mainly found in almost inaccessible places. Thus, the weakening of forest ecosystems through the loss of species or at least through the impoverishment of the genepool of their populations occur under the influence of anthropogenic factors. The situation is alarming. An urgent action is required in order to conserve the genetic potential of remnant forests in Central Asia.

Priority species in the plan for conservation of biodiversity and genetic resources in the mountain forest zone are: junipers (*Juniperus* sp.), Persian walnut (*Juglans regia*), pistachio (*Pistacia vera*), almond (*Amygdalis* sp.), apple (*Malus sieversii*), local species of hawthorn (*Crataegus* sp.), maple (*Acer* sp.), ash (*Fraxinus* sp.), pear (*Pyrus* sp.), plum (*Prunus* sp.), apricot (*Armeniaca vulgaris*) and shrubs: barberry (*Berberis* sp.), rose (*Rosa* sp.) and commonsea buckthorn (*Hippophaë rhamnoides*). Juniper stands formed by three species are the basis of mountain forests.

The desert forest is formed basically with two species of saxaul: white saxaul (*Haloxylon persicum*) and black saxaul (*H. aphyllum*). Other priorities for the conservation of forest genetic resources in the desert are saltworts (*Salsola richteri* and *S. paletzkiana*), calligonum (*Calligonum* sp.) and tamarix (*Tamarix* sp.).

The wild white poplar (*Populus alba*) does not occur as native species but is widely cultivated on the territory of Uzbekistan. Black poplar (*P. nigra*), which is found in Central Asia at the border of its natural distribution area, is widespread. Priorities for the conservation of genetic resources in the tugay zone are *Populus pruinosa* and *P. diversifolia*. These are known under the common name "turanga", which forms thickets on islands and along the banks of Central Asia's rivers, penetrating deep into valleys where they grow together with psammophytes.

Biological diversity and genetic variation are effectively preserved in areas specifically aimed at the conservation of genetic resources (genetic reserves), but these have not yet been designated in Uzbekistan. The total area set aside for nature protection is 2 052 000 ha or approximately 4.6% of the whole territory of the Republic and is concentrated in nine forest reserves, two national parks and a number of nature monuments.

However, only 822 500 ha (1.8% of the territory) are set aside with strict or permanent type of protection attributed to IUCN categories I and II. The most strictly protected type of territory are forest reserves, which occupy 227 400 ha (nearly 0.55% of the country's territory). In Uzbekistan, which is notable for its broad range of natural conditions, the network of specifically protected areas requires expansion and completion. For instance, although the area of wild pistachio is more than 27 000 ha, no forest reserves aimed specifically at the protection of this species have been declared yet.

An important role in the conservation and rational use of genetic resources is assigned to botanical gardens, which alongside with multidisciplinary studies, provide collections of native and introduced species and varieties, accumulate and save their genetic diversity. Only small part of the species' genepool, which obviously cannot represent the entire genetic variation found in the natural range of a species, is present in botanical gardens. In spite of that, botanical gardens are considered to provide good potential for the search of valuable genetic forms and varieties.

At present, work on the conservation of forest genetic resources and tree improvement have been conducted basically through species introduction, plus tree selection and seed supply. Many introduced tree species are intensively used in forestry, landscape gardening and in the amenities.

The tree improvement work, started in 1945, has included genetic and breeding evaluation of more than 20 tree species. These activities are carried out by the Uzbek Research Institute of Forestry, the Institute of Horticulture and Viticulture, the Tashkent Botanical Garden and the Agrarian University in Tashkent.

Efforts to create and use permanent forest 'seed-breeding plots' (for the production of selected basic material) are also an important part of the conservation and use of forest genetic resources.

The establishment of field trials with reproductive material derived from selected populations of different geographic origin is seen as a highly effective way to conserve and use genetic diversity of the species concerned. By observing growth performance under different site conditions, the phenotypic plasticity can be assessed, useful climatypes, ecotypes and populations most productive under local conditions identified, and the genetic collections conserved. In Uzbekistan, provenance research has started but has not been sufficiently developed because of a number of reasons. The first experiments gave promising results (e.g. the identification of Jondor form of saxaul in the Bukhara region).

Genetic reserves are the most important way of conservation of forest genetic resources. Their designation has not been carried out yet in Uzbekistan, but some plans have been developed. At one time a 'breeding reserve' of *Juniper zeravshanica* was designated (1260 ha). There are also plus trees, plantations of their progeny (550 ha), field trials and clonal archives with genetic resources of this important species in Central Asia.

Future needs and perspectives of the conservation and use of forest genetic resources are presented in the following plan:

1. To develop a status report and a plan on the designation, conservation and sustainable use of the forest genetic resources in Uzbekistan, in conjunction with the other four countries of Central Asia.
2. To develop methodological guidelines on the selection of existing plantations and assess their potential as gene reserves in order to provide suitable varieties and provenances for the entire range of natural conditions.
3. To organize field inventories, focusing on the specifically protected areas in mountain and desert forests and in the tugay, in order to prepare proposals for the designation of forest genetic reserves of the relevant tree species.
4. To revise the dendroflora in order to identify rare and threatened species, subspecies and distinct populations of forest tree species, and to reveal new provenances and unique genotypes. To develop recommendations and establish arboreta (species collections) for their conservation and use.
5. To continue genetic and breeding evaluation of native and perspective introduced forest tree species. To develop early testing for genetic characters. To develop recommendations and establish clonal archives and field collections, including provenance trials.
6. To develop methods of long-term conservation of seeds (if needed of other reproductive material) and create a seed bank to conserve valuable genotypes of forest tree species.

The status and collaborative efforts on forest genetic resources in sub-Saharan Africa

Oscar Eyog Matig

Centre de Recherches Agronomiques d'Ekona, Station Polyvalente de Kribi, Edea, Cameroon
Present address: IPGRI Sub-regional Office for West and Central Africa, Cotonou, Benin

Introduction

Geographically, sub-Saharan Africa extends from the Tropic of Cancer to the Cape in South Africa. This zone can be subdivided into three main floristic regions:

- The Sudano-Zambezian region with three zones
- The Congo-Guinean region with two zones
- The Afro-Alpine region.

Little work has been done to cover these floristic regions with systematic inventories. Few inventories have been carried out and allowed each country to conduct a broad assessment of its forestry resources.

Area (source: FAO 1995)

Zone	Area (million km²)
Guinean zone	≈ 1.8
Sudan zone	1.6
Zambian zone	3.9
Sahelian zone	3.55
Hills and mountains (Afro-Alpine zone)	≈ 1.6

Diversity of the vegetation

The floristic abundance is only partially known. New plant species continue to be discovered and classified.

For the Sahelian zone, more than 1200 species have been described up to now; 40 of these species are strictly endemic to the zone. In the Sudan zone, 2800 species have been identified. For Eastern Africa, it is the region of prevalence of endemic species with 1300 out of 2500 species endemic to the region.

If inventories are easy in the dry regions, they become more difficult in the humid zone owing to the abundance of plant species, resulting in the closure of the forest cover. Data available on total plant species are approximate and should be analyzed with care. Nevertheless, timber tree species are better known. In the Guinean and Congo zones of Cameroon, 600 timber tree species can be counted, while Gabon counts on its territory more than 200 timber tree species.

The Sahelian zone is characterized by an abundance of spiny plant species of the genus *Acacia*. Many Combretaceae can also be found (*Combretum* spp., *Guierea senegalensis* and *Piliostigma reticulatum).*

The Sudan zone is a woody savannah. Less homogeneous plant communities composed of Combretaceae (*Anogeissus leiocarpus*), Sapotaceae (*Butyrospermum parkii*) and Meliaceae (*Khaya senegalensis*) replace *Acacia*.

The Zambezian zone is an open forest dominated by the genera *Brachysteria, Isoberlinia, Baikiaea, Burkea* and *Crytosepalum.*

The Congo zone is a semi-deciduous dense forest, dominated *by Entandrophragma* spp., *Khaya ivorensis, Triplochiton scleroxylon* (Ayous), *Terminalia superba* (Frake).

The Guinean zone is a humid evergreen dense forest rich in Cesalpiniaceae, (Mimosaceae, Fabaceae) and Ochnaceae. The most frequent genera are *Afzelia, Berlinia, Gilbertiodendron, Lophira* and *Pycnanthus.*

In the Afro-Alpine zone, up to 2000 m altitude, the flora is similar to that of the neighbouring plain. Above 2000 m the vegetation is composed of many Gymnosperm species such as *Podocarpus* and *Juniperus*.

Utilization

Forest products have multipurpose uses including firewood, timber, food products, medicinal products and fodder products. Some species serve a great number of purposes; others have a very specific utilization.

Firewood

With a few exceptions most of the species are used as firewood. In Africa, firewood satisfies 80% of energy requirements. The quantity of wood needed as energy source is estimated at 1 m^3/person/year. This represents an annual consumption of about 472 million m^3 of wood.

Timber

Although the volume of logged trees remains lower than what has been observed in Asia, Latin America and the Caribbean, there is an increasing trend not only of the area, but also of the volume exploited, even more so after the devaluation of the CFA Franc in 1994. In fact, this volume (FAO 1995) was still below 20 million cubic meters between 1986 and 1990 with an increasing rate around 1 million cubic meters/ha/year.

We should note the particularity of logging practices used in Africa. It consists of the selection in a given country of less than 100 commercialized tree species according to the international market. The choice of the tree species to be felled on the list of 100 depends on the market demand. All exploitation of timber tree species can be based on a very low number of tree species, which are sometimes exploited right to extinction.

Construction wood

Wood is also used as material for construction. Even though the exploited volume is low, the logs selected are those with a diameter comprised between 10-40 cm. This could represent a handicap for the regeneration of the selected species.

Food products

The forest provides not only directly consumable products for the population, but it is also a reserve of land for agriculture (food crop and cash crop cultivation).

Fruit consumption could be a threat for regeneration of some species such as *Irvingia gabonensis, Baillonella toxisperma, Tamarindus indica, Balanites aegyptiaca* and *Annona senegalensis*. The fruits of these species are consumed and commercialized.

Livestock products

Distinction should be made between herbaceous and woody forage. The daily need to feed a Tropical Animal Unit (cow 250 kg in weight) is around 6.25 kg dry matter. The pastoral area in Sudan and Sahelian zones of Cameroon with 7 million ha was supporting 160 000 cattle in 1974 (USAID 1974). We have noticed that the animals appreciate more than 60 tree species, such as *Stereospernum kuntianum*, *Combretum aculeatum*, *Ficus* spp. The impact of animals on the flora is double: the consumption of flowers, fruits, leaves and tree bark but also destruction of the herbaceous cover.

Pharmaceutical products

The economic crisis and above all the devaluation of the CFA franc have doubled the price of pharmaceutical products. This has brought about a desertion of chemist shops and an increase in the market of traditional medicines from plants. Unfortunately, this exploitation is not carried out according to the regulations. There is no control; the trees are victims of mutilations, which can lead to their death. This is the case with *Garcinia lucida, Khaya senegalensis,* etc.

Threats

We can distinguish two important threats: climatic disturbances and human practices.

Climatic disturbances

The interannual variation curve for rainfall (Catinot 1988) shows that the zone faced dry periods during the beginning of the 1970s and mainly in the 1980s. A consequence of these droughts was the modification of the Poaceae composition. The perennial species (*Andropogon gayanus*) were replaced with a vegetation of mixed composition with occurrence of annual species such as *Cenchrus biflorus* and *Sida cordifolia.* As for tree species, their resistance to these successive drought periods varied from one species to another. Chad has observed considerable losses due to the dry spell on its *Acacia senegalensis, Anogeissus leiocarpus* and *Khaya senegalensis* populations. But it is above all the combined effect of drought and human practices which is the principal cause of the high mortality either of some individuals of a given species or of entire populations. Sometimes the entire ecosystem is lost. It was estimated that in countries like Cameroon and Senegal the annual rate of disappearance of the dry savannah is 100 000 ha. The species concerned are *Acacia nilotica, Acacia senegalensis, Pterocarpus lucens, Sclerocarya birrea, Prosopis africana, Lannea microcarpa* and *Dalbergia melanoxylon*. Edaphic dryness adds to the effect of climatic drought, due to the increase of salt concentration in the soil. This is the case with "*tannes*" or salty soils in Senegal and also with "*hardés*" sterile soils in Cameroon. The combination of dryness and saltiness of the soil has brought about the disappearance in Senegal of the Cayor *Hyphaene thebaica* plantation and of some oil palm plantations in Casamance.

Logging

FAO (1995) estimated that between 1981 and 1990 all the concerned regions in Africa lost 4.1 million ha of their forest area. This represents an annual regression estimated at 0.7%. The loss of forest area has induced a loss of 2% timber species.

Agriculture

It has been estimated that 480 000 out of 1.8 million km^2 of the Guinean area are composed of fallow lands more or less covered with forests (FAO 1995). Around 40% of the forest area have been converted into agricultural lands between 1981 and 1990.

Overgrazing

In 1974 Cameroon had 160 000 cattle with 7 million ha of pasture lands. Today the number of cattle has been multiplied by 8, with around the same grazing area (6.5 million ha) (Donfack 1998). We can easily imagine the impact on the species.

Bush fires

Experimental observations on the semi-deciduous forest of Côte d'Ivoire have shown that the number of species decreased from 117 to 20 after 50 years of yearly burning of the forest during the dry season.

Exploitation of plant parts

This practice can have a direct and indirect impact on the species concerned:

- Direct impact with extraction of reproductive parts (flowers, fruits and seeds). It concerns mostly *Acacia* species of which the flowers and fruits are eaten by animals. The seeds of *Khaya senegalensis, Parkia biglobosa, Vitellaria parkii* and *Baillonnella toxisperma* are used for oil production for various purposes. Fruits of *Sclerocarya birrea,*

Ximenia americana, Coula edulis are consumed by humans. The fruits of *Acacia nilotica* are used as tannin for leather.
- Indirect impact concerns the extraction of non-reproductive parts (leaves, roots, cambium), which has an impact on the flowering and/or fructification of the individual tree.

Conservation and management strategies: genetic resources integration in forest management plans

In situ conservation

The first step in a conservation strategy adopted by most countries was to designate forest lands as permanent forests. The majority of the states adopted that 30% of the national territory should be classified as permanent forests. There are several types of classified forests; the two main types are (i) protected areas for wildlife and (ii) forest reserves.

FAO (1995) mentions that at the end of 1990, African countries had designated 84.2 million ha as permanent forests (for logging and protected forests). This represents 3.8% of the land area.

The second step has consisted of enhancement through planting of some forest reserves impoverished by logging activities. These plantations have brought out the development of a seed production and conservation technology.

Ex situ conservation

The third step in the strategy developed by African countries concerns tree plantations, gene conservation as seeds or *in vitro* conservation. In 1990, the rate of tree plantations in African countries was 90 000 ha per year (FAO 1995).

The conservation plots and arboreta established concerned mainly exotic species. The same situation is found with genetic improvement programmes focusing on *Eucalyptus* and *Pinus* species, for which many provenance trials have been conducted.

Except for a few inventory activities, very little research work has been carried out on intraspecific diversity. The few existing studies concern *Parkia biglobosa* and *Acacia albida*. The cost of molecular and isoenzyme analyses is a limiting factor.

Elaboration of management plans

The International Tropical Timber Organization (ITTO) guidelines provide that by the year 2000, all commercialized timber from member countries should come from managed forests.

If we should praise the fact that forest management plans, mostly for productive forests, ensure sustainable forest production at a certain level, it should be underlined that this framework could be improved by integrating considerations for the conservation of intraspecific variability, such as the critical threshold (minimum number of individuals for a given population of tree species). Such notions should be taken into consideration, if the data are available at least for a certain number of important tree species. A good knowledge of the forest genetic diversity is indispensable.

Collaboration among African countries

The collaboration among African countries should start with the harmonization of forestry laws. All countries have not yet formulated their laws so that they take into account treaties or international conventions, whereas these treaties and conventions have not yet been ratified by all African countries.

Regional and sub-regional cooperation is carried out through a number of projects, organizations and institutions. The cooperative mechanisms mostly group the countries situated in the same geographical region. The Organization of African Unity regroups all African countries.

Sub-regional mechanisms include:

- CAO – mostly east African countries
- CORAF - a technical network for agronomic research in west and central African countries
- CDEAO – west African countries
- UDEAC – central African countries
- LCBC - Cameroon, Chad, Niger and Nigeria.

Apart from these organizations at the policy level, there are also technical networks. For example IGAD for East Africa, CILSS for the Sahelian countries, the Sahara and Sahel Observatory, the Neem (*Azadirachta indica*) Network, the Fallow Network for west African countries. The sub-Saharan Africa Forest Genetic Resources Programme (SAFORGEN) networks are under establishment.

Forest genetic resources meetings

Many meetings of the specialists responsible for forest resources have been held in the past. They mainly concern forest management in general rather than forest genetic resources in particular. Two meetings on forest genetic resources took place in Ouagadougou in March and September 1998.

The objective of the workshop held in March 1998, organized by IPGRI in collaboration with FAO, the Danida Forest Seed Centre and CIRAD-Forêt, was to provide training for participants from west and central African countries and Madagascar on forest genetic resources. This workshop brought together 54 participants from 19 countries and 3 sub-regional and international organizations. The main conclusions of this meeting were:

- To continue the joint efforts for increasing opportunities to train African scientists in the area of forest genetic resources. Training courses should be organized on the basis of modules with practical sessions
- To make operational the SAFORGEN Programme which should play an important role for the collaboration among African countries
- The participants recommended that SAFORGEN start with three networks: forest fruit species, fodder species, timber species and non-timber forest species. A list of priority species has been established (Ouédraogo and Boffa 1999).

The meeting held in September 1998 was organized by FAO in collaboration with IPGRI and ICRAF. It brought together 35 participants representing 15 countries and 6 international agencies for regional and bilateral cooperation. The objective of the meeting was to elaborate under FAO aegis a Sub-regional Plan of Action for conservation, management, sustainable use and enhancement of forest genetic resources in the Sahelian and North Sudan zones.

It was agreed to define priorities and to undertake collaborative actions within the countries on the basis of the priorities established. IPGRI in general and the new SAFORGEN Programme in particular were requested to ensure the follow-up of these recommendations and also to serve as a platform for overall coordination of activities in order to achieve the objectives.

Collaboration between Europe and Africa

Europe can bring its support to the development of sustainable management practices for genetic resources of African forests. The top priority areas of collaboration are as follows:

- Training of researchers and technicians: group training (seminars and workshops) as well as individual training (schools and laboratories)
- Technical assistance: this can be done within joint projects where transfer of technology is a major component

- Financial assistance: it consists in helping African countries to acquire knowledge on the potential of their forest genetic resources. Financial support is necessary for obtaining the equipment and the running costs of laboratories.

References

Catinot, R. 1988. Projet national des semences forestières. Document du Cameroun. Draft, IUFRO et FAO. 38pp.

Donfack, P. 1998. Végétation des jachères du Nord-Cameroun. Thèse Doct. d'Etat. Univ. Yaoundé I. 225pp.

FAO. 1995. Evaluation des ressources forestières 1990. Pays tropicaux. Etude FAO Forêts 112. 42pp.

Ouédraogo, A.S. and J.-M. Boffa, editors. 1999. Vers une approche régionale des ressources génétiques forestières en Afrique sub-saharienne. Actes du premier atelier régional de formation sur la conservation et l'utilisation durable des ressources génétiques forestières en Afrique de l'Ouest, Afrique Centrale et Madagascar, 16-27 mars 1998, Centre National de Semences Forestières, Ouagadougou, Burkina Faso. Institut international des ressources phytogénétiques (IPGRI), Rome, Italie.

USAID. 1974. Inventaire des ressources naturelles au Cameroun. USAID.

Forest genetic resources in North America: status, conservation and opportunities for collaboration with European countries

Deborah L. Rogers

Genetic Resources Conservation Program, University of California, Davis, California, USA

Introduction

The breadth of the topic, scarcity and clumped distribution of available information, and subjectivity of both the terms 'status' and 'collaboration' combine to make this paper a challenge. In the absence of complete and objective information, the author attempts to:

1. Offer some information on the conditions (e.g. biological, social, political) that underlie the genetic diversity and status of forest tree species in Canada, Mexico, and the United States.
2. Comment on some of the issues concerning genetic diversity and provide a few case studies to illuminate linkages between genetic conservation and political/biological conditions.
3. Offer possibilities for collaboration with EUFORGEN and European countries in general, on a country-by-country (within North America) basis.
4. Review some of the (most relevant to EUFORGEN) recommendations from a North American workshop held in 1995 that focused on the genetic status of North American temperate forest tree species.

This is not a comprehensive report on the status of forest genetic resources in North America. Much of the information for this report, unless otherwise referenced, is drawn from a report based on a workshop with a similar theme - The Status of North American Temperate Forest Genetic Resources - held in Berkeley, California in 1995 (Rogers and Ledig 1996). Note that for both that publication and this report, there is a disproportionate amount of information available for Canada and the USA.

Canada

Conditions

Containing over 416 million hectares of forest land - 10% of the world's forests - Canada has considerable forest genetic resources. The socioeconomic impacts of these resources are significant: over 120 million hectares are currently managed for timber production. Conservation is a concern, with over 50 million hectares (12%) protected from harvesting by policy or legislation (Mosseler 1995). Of the 135 native forest tree species, 31 are coniferous and 104 deciduous. In general there are few boreal species (24), but these tend to be widespread. Towards the south, the number of species (temperate) increases. Forest regions in Canada are generally organized as boreal, subalpine, montane, temperate, and grassland (Rowe 1972).

The historical patterns of settlement were generally south to north, and east to west, with colonization in the 17th century beginning on the east coast and quickly extending into Quebec and Ontario, accessible through the Great Lakes - St. Lawrence system. Most forest land is owned by provincial governments (71%) and recently many provincial governments have been reducing their staff, in some cases dramatically. Federal and territorial ownership covers 23% of the forest land, with only 6% in private ownership (Natural Resources Canada 1998). These patterns of forest land ownership are not consistent from province to province. For example, there is no private forest in the Yukon or Northwest Territories and the eastern (Maritime) provinces have the highest concentration of private forests (where 'private forests' refer both to company and individual holdings).

Status, issues and consequences

In terms of species endangerment (i.e., listed as threatened, vulnerable, or endangered), the country's forest genetic resources are not in crisis: as of 1995, only six species were listed (Table 1). All are temperate-zone species. The reason for their listing status varies from hybridization with exotics to the Canadian populations being the northern limits of the species' range, but mostly due to loss of habitat or fragmentation.

Table 1. Temperate forest tree species in Canada that have been designated at risk. Source: Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa, Ontario (reprinted from Rogers and Ledig 1996).

Species[1]	Status[2]	Date[3]	Comments
Fraxinus quadrangulata	Threatened	1983	Very small populations. Uncommon outside Canada; *F. quadrangulata* is dioecious and some populations in Canada include trees of only one sex. No significant seedling regeneration.
Morus rubra	Threatened	1987	Only six populations known; only one of these has evident reproduction and success is low. The species hybridizes with introduced *M. alba*, and is, therefore, subject to genetic swamping.
Magnolia acuminata	Endangered	1984	Only three populations known; all endangered.
Castanea dentata	Threatened	1987	Although 49 sites are known, most trees have blight canker and viable seed is produced at only nine sites. Trees are still being lost through cutting and urban expansion.
Ptelea trifoliata	Vulnerable	1984	Very limited distribution. Reproducing populations exist in low numbers.
Quercus shumardii	Vulnerable	1984	Very limited distribution, but is reproducing well.
Gymnocladus dioica	Threatened	1983	Only one sexually reproducing population in Canada; *G. dioica* is dioecious and most Canadian populations contain only male or female trees, not both.
Salix planifolia subsp. *tyrrellii*	Threatened	1981	Subspecies has a restricted and sparse distribution on sand dunes in northern Saskatchewan. Current and projected human activity, accelerated by road construction, threatens its habitat.
Celtis tenuifolia	Vulnerable	1985	Only three populations are known in Canada, all in southern Ontario.

[1] The list includes all woody species. The last two species on the list are often considered to be shrubs.
[2] Endangered = a species facing imminent extirpation or extinction. Threatened = a species likely to become endangered if limiting factors are not reversed. Vulnerable = a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events. It includes any indigenous species of fauna or flora that is particularly at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not a threatened species. (This category includes species that had previously been designated as rare. The rare designation was abolished by COSEWIC in 1990).
[3] Date of designation by COSEWIC.

However, loss of the entire species is at the extreme end of the spectrum of genetic depletion. Other lesser but significant genetic consequences for these species are not well known. For example, the widely occurring boreal gymnosperms are seemingly well buffered from consequences due to their expansive ranges and northern distributions (i.e., in relatively undeveloped areas). However, many of these species have been under forest management for some time so the genetic consequences from forest practices - including harvesting and replanting practices - while not well understood, may be substantial.

Southern deciduous species may be more at risk due to settlement patterns. Early agricultural settlement and more recent urban and industrial development have led to loss of habitat and most likely accompanying loss of genetic diversity. Examples of species that have suffered large habitat losses are sugar maple (*Acer saccharum* - the national symbol) and black walnut (*Juglans nigra*).

In recognition of the possible genetic impacts on even widely distributed forest tree species, in view of the scarcity of data, and in consideration of the need to set priorities for genetic conservation due to limited financial and human resources, forest genetic professionals in the province of British Columbia set out to establish a ranking system to identify their forest tree species of greatest genetic conservation concern. Their criteria include natural distribution of the species (e.g. widespread versus narrow), capacity of the species for natural regeneration, status of provenance testing, representation in *ex situ* and *in situ* reserves, etc. (Yanchuk and Lester 1996).

In Ontario, the Ontario Ministry of Natural Resources (OMNR) - the government agency charged with managing much of that province's public forest land - was taken to court by a coalition of environmental groups, charged with mismanagement of forest resources. The environmental coalition won the case and the OMNR has been instructed to prepare a new plan for managing natural resources. However, dramatic downsizing of public employees over recent years has left the agency with a little flexibility to rise to these new challenges. Thus, forest genetic resources in Ontario and elsewhere are susceptible to threats from loss of appropriate professionals to plan for their conservation, from discontinuity in political administrations, and to changing priorities.

Aboriginal issues may play an increasing role in the management of Canada's forests. Recently, the Supreme Court of Canada ruled on an historic Aboriginal land claim in British Columbia, where it found that Aboriginal title to land exists where a First Nation occupied lands before the Crown (federal government) asserted sovereignty (Natural Resources Canada 1998). Most of the forest land of British Columbia is subject to similar claims, leaving much uncertainty about the future responsibility for and actions towards genetic conservation of forest tree species in that province.

Canadian forestry professionals are proud of their commitment to sustainable forests that predates the Rio Earth Summit in 1992. Since then, the Canadian Council of Forest Ministries has accepted a criteria and indicators framework - including six criteria, one of which is conservation of biological diversity of which genetic diversity is one element (Fig. 1).

Summary and opportunity for collaboration with European countries

1. Genetic status of forest tree species is strongly influenced by the east-to-west, and south-to-north pattern of settlement, resulting in loss of habitat and fragmentation effects for many of the southern and eastern angiosperms, and as yet unknown or poorly understood forest management effects on the more northern and widely occurring boreal species.

2. Strong influence of land ownership on opportunities for collaboration in genetic conservation:
   a) Federal government (e.g. Canadian Forest Service of Natural Resources Canada) owns and manages relatively little forest land. It plays mainly roles of research, coordination of national strategies among the provinces, trying to encourage national standards and collaboration through funding and other incentives and some direct seed inventory and *ex situ* conservation activities (e.g. National Tree Seed Centers). Thus, European countries can request seed from nationally-controlled collections. There are some forested areas in nationally administered parks (Parks Canada).
   b) Although strong provincial ownership of forest genetic resources makes it difficult to have national-level standards or conservation plans, ironically this situation may lead to a strength in conservation planning. The reasoning here is that, for example, a widely occurring species would experience different environmental and management

impacts across its range (i.e., differences in ownership and management may result in a diversified conservation approach, lower risk.). And the dominance of (provincial) government ownership should facilitate development of genetic conservation plans at provincial level (i.e., relative to a situation with more diverse and private ownership).

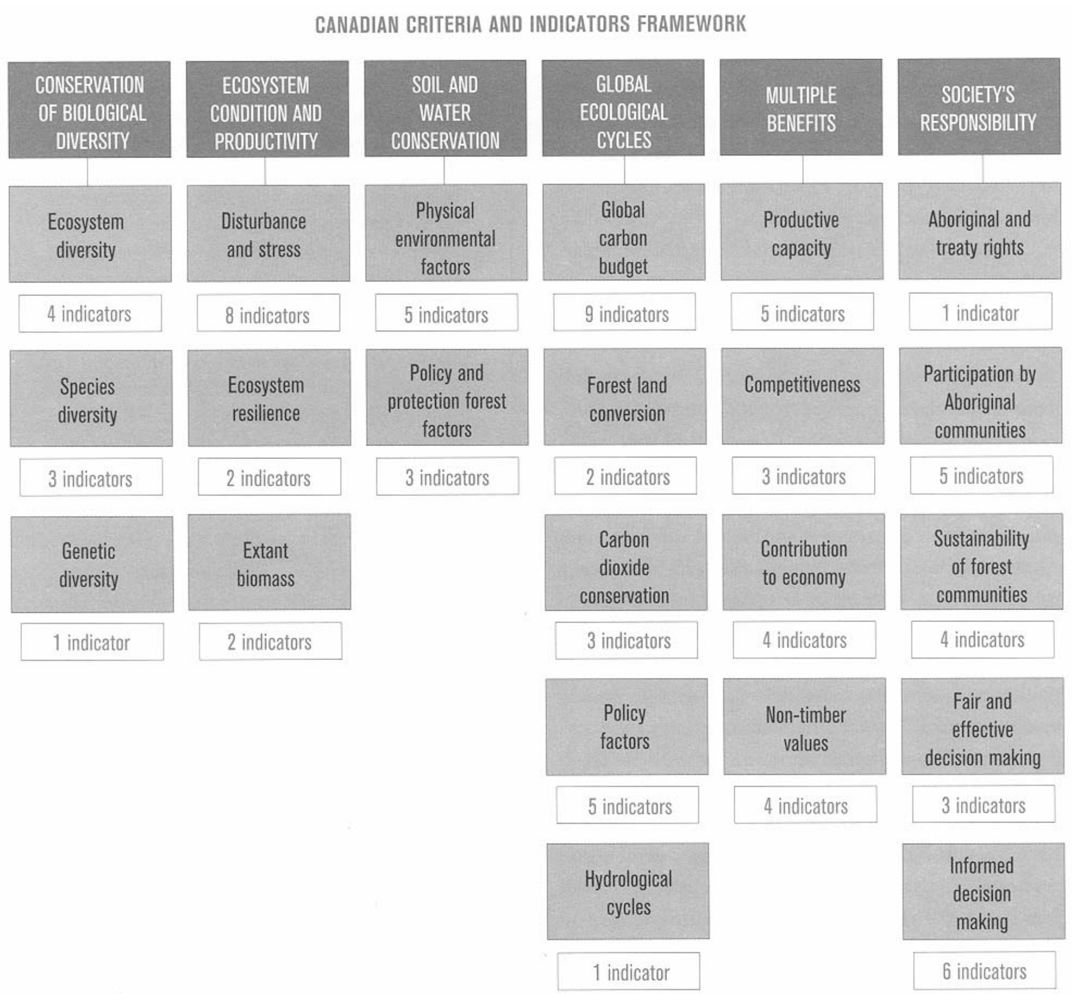


Fig. 1. The second cycle of Canada's National Forest Strategy (1998–2003) adopts a 'criteria and indicators' framework for sustainable management of forests. Shown here is this framework consisting of 6 criteria, 22 elements, and 83 indicators (Natural Resources Canada 1998).

United States of America

Conditions

There are approximately 800 forest tree species in the United States. The forest landbase falls under a diverse range of ownership (many federal and state agencies - e.g. the National Park Service and the National Forest Service; non-profit organizations - e.g. The Nature Conservancy; industrial - e.g. Weyerhaeuser Corporation; and private ownership). The diversity in ownership and management underlies the difficulty in compiling similarly structured statistics to comprehensively present the status of forest genetic resources.

Geographic distribution of the forest resources at the species level is well known: genetic diversity of the resources is imperfectly known. Amounts and patterns of genetic variation have been outlined for many species; nevertheless, genetic diversity of most taxa is imperfectly known and the impacts of anthropogenic influences are not well understood (Rogers and Ledig 1996).

As in Canada, the east-to-west historical settlement pattern in the United States has consequences for the status of forest tree species. For example, National Forests and Parks cover much more land in the western than in the eastern United States (Fig. 2). Thus, species with western distributions are more likely to be represented on federal lands with some conservation conditions than are eastern species. Not only were forested areas converted to agriculture and other types of development early in the country's history, lessening the opportunity for such forest reserves, but also this intensive and early impact is now reflected in other threats to remaining forests. The threats that are particularly evident in the east include decline due to exotic insects and diseases (e.g. chestnut blight affecting American chestnut, blister rust affecting white pine, gypsy moth affecting many hardwood species, Dutch elm disease affecting elms, and more recently, the Asian long-horned beetle affecting maples and other hardwoods); direct loss of habitat and potential genetic consequences from fragmented populations; changes in disturbance patterns (e.g. impacts on natural drainage systems and natural fire disturbance); and cumulative impacts from many human-caused and natural threats (e.g. 'northern hardwood decline' in the Southern Appalachian Mountains where beech/birch/maple forests are suffering mortality that may be linked to demographic factors, Armillaria root disease, pollution, drought stress, etc.) (US Department of Agriculture, Forest Service, Web site information).

In the west, exotic invasions are also a serious problem for forest tree species. For example, *Miconia (Miconia calvenscens*) is an invasive tree species now found on four of the five main Hawaiian Islands. Estimates of its coverage suggest it now dominates two-thirds of the forest canopy on these islands, competing with native species (USDA Forest Service, Web site information).

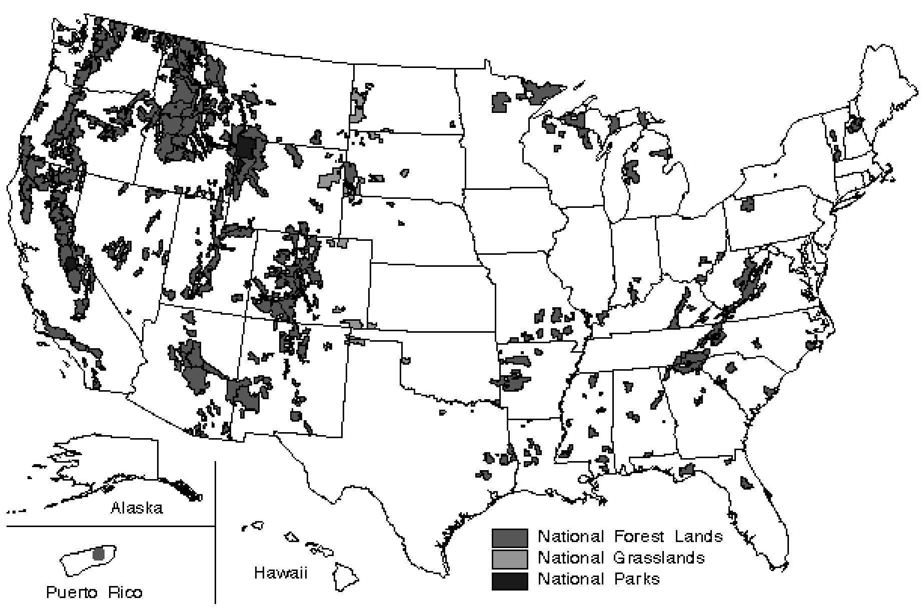


Fig. 2. The distribution of National Forest Lands, National Grasslands, and National Parks in the United States (United States Department of Agriculture, Forest Service Web site: <http://www.fs.fed.us/database/lar/nfsmap.htm> (February 1999).

Status, issues and consequences

As in Canada, there are few forest tree species that are in danger of extinction in the near future: seven species are listed (federally, according to the Endangered Species Act). Consistent with the earlier statements about historical patterns of development, most of these species are located in the east (Table 2).

Table 2. Tree species on the federal 'Endangered Species' list for the United States. Source: Web site directory of endangered species <http://www.fws.gov>, U.S. Fish and Wildlife Service, Division of Endangered Species, Sacramento, California (reprinted from Rogers and Ledig 1996).

Species	Common name	Date first listed	Status[1]
Gymnosperms			
Cupressus abramsiana	Santa Cruz cypress	1987	E
Torreya taxifolia	Florida torreya	1984	E
Angiosperms			
Betula uber	Virginia round-leaf birch	1978	T
Chionanthus pygmaeus	Pygmy fringe tree	1987	E
Prunus geniculata	Scrub plum	1987	E
Quercus hinckleyi	Hinckley's oak	1988	T
Rhus michauxii	Michaux's sumac	1989	E

[1] T = threatened, E = endangered. "The term Endangered species means any species which is in danger of extinction throughout all or a significant portion of its range ...". "The term Threatened species means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." "The term species includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (Endangered Species Act of 1973).

We do not know the genetic status of most species, but there are reasons for concern, even in what might be considered the 'less affected' species in the western part of the country. Three case studies presented below give examples of the types of issues that are arising with western US species.

Giant Sequoia (*Sequoiadendron giganteum*): traditionally an important timber species, giant Sequoia is increasingly valued for non-consumptive purposes - recreation, aesthetic purposes, and spiritual rejuvenation. Approximately 90% of the current natural distribution of the species is under public ownership and approximately 53% of the current giant sequoia area has been continuously protected from logging and has been managed within a policy context of fire suppression for the last century (Stephenson 1996). Due at least in part to the fire suppression policy, these groves now have an unnatural age structure, with lower natural regeneration and fewer trees in the 1-100 year category, than expected under natural conditions. A recent pilot study of genetic diversity and structure within two groves shows a correlation between age class (as represented by diameter class) and genetic structure, suggesting that this practice of fire suppression may indeed have had genetic consequences regardless of the attempt to 'protect' the habitat (Rogers 1999, unpublished report for the USDA Forest Service). This is one example of how management policies and management of natural disturbances, in particular, can be manifest as genetic consequences.

Whitebark pine (*Pinus albicaulis*): this subalpine coniferous species has a wide-ranging and sometimes disjunct occurrence in the western United States and Canada. Fire disturbance is a natural component in many parts of its range, and this species, too, may be negatively affected by fire-suppression policies as well as decline from mountain pine beetle (*Dendroctonus ponderosae*) and introduced white pine blister rust (*Cronartium ribicola*) (Tomback *et al.* 1993). However, fire suppression and other management practices may have as yet undocumented genetic impacts. In particular, we know little about fine-scale genetic structure in many western conifers that have been studied at regional levels and hence have not fully explored management impacts at this level. In a recent study, the fine-scale genetic structure of whitebark pine was investigated at nested geographic levels from watershed to adjacent stems in the eastern Sierra Nevada Range of California (Rogers *et al.* 1999). Characteristics of whitebark pine that may be related to its fine-scale genetic structure include wingless, bird-dispersed seeds; having the reputed capacity to reproduce vegetatively; and forming distinct growth morphologies at different elevations in this part of its natural range. Genetic differentiation, as measured with 21 allozyme loci, between upper-elevation prostrate krummholz thickets and lower-elevation upright tree clump growth forms was modest (F_{st}=0.051). Much stronger differentiation was measured among the individual thickets and clumps within their sample sites (F_{st}=0.334). Genetic structure is apparently profoundly influenced by the seed-caching behaviour of Clark's nutcracker (*Nucifraga columbiana*). Western (US) pine species typically show little among-population differentiation and high levels of within-population genetic variation. In whitebark pine in the eastern Sierra Nevada of California, genetic variation is highly structured, especially within the natural groupings - krummholz thickets and upright tree clumps. Management impacts on this level of genetic structure - for this or other forest tree species - are not yet understood.

Monterey pine (*Pinus radiata*): highly valued in other countries as a commercial species, growing on over 4 million hectares of plantations worldwide, Monterey pine is not, nevertheless, grown domestically for commercial purposes except, for example, to a modest extent in Christmas tree plantations. This species has a very restricted natural range along the central coast of California and on two small Mexican islands. It is valued domestically more in terms of its aesthetic and symbolic value, enhancing expensive real estate along the central California coast and defining small remaining forested areas in a region with high levels of development, high per-capita incomes, and high levels of environmental activism.

This pine has suffered from recent and dramatic impacts from pitch canker disease, a fungal (*Fusarium subglutinans* f. sp. *pini*) disease vectored by an insect that was introduced to California over a decade ago. This disease has triggered local concern, not only because it may potentially impact the more widely occurring native pines, but also because the mortality is in rather scenic and wealthy areas of California. The disease and subsequent mortality in Monterey pine have also triggered international concern because of the threat to native Monterey pine genepools. A pitch canker task force - involving state and federal government agencies, non-profit environmental groups, researchers and others - was organized to help determine strategies to control the disease and deal with related issues. Internationally, the concern over native genepools and potential impacts for exotic plantations of the species has resulted in a major international workshop (November, 1998 in Monterey, California). It was hosted and organized by research and industry collaborators (Australia, New Zealand, Chile, United States) to discuss the current understanding of the disease and to develop a broad-scale initiative to establish Monterey pine field trial in California to provide a means of selecting resistant genotypes and further studying the disease.

There is no genetic conservation plan for Monterey pine at present. However, funds associated with a State Senate Bill that was shepherded by the California Department of Forestry and Fire Protection (among others) to fight the disease, have been earmarked for the development of such a plan. The genetic conservation plan will be coordinated by the Genetic Resources Program of the University of California and will receive input from university scholars (genetics, paleohistory, ecology, etc.), state and federal agencies, non-profit organizations, related industry researchers and others. Thus, although there is no genetic conservation plan in place for this (or any other) California forest tree species, the combination of a threatening introduced disease and the species' various social and ecosystem values have provided the will and means by which to prepare one in the near future. Unfortunately, reactionary plans may have fewer opportunities for genetic conservation than proactive plans.

One additional concern related to the status (and future health) of forest genetic resources in the US is erosion of the infrastructure for educating forest geneticists. For example, at the University of California at Berkeley – once one of the top forestry schools in the country – there is no longer a forest geneticist on faculty and forest genetics courses are no longer taught (and have not been for the past five years). Increasingly, 'forest genetics' is disappearing from university curricula. Other disciplines and degree programmes, including conservation biology and restoration ecology, may provide some of the education needed for conservation management of forest genetic resources but are not likely to provide all of the insight and educated foresight needed to wisely manage these resources in the long term.

Summary and opportunities for collaboration with European countries

1. Unlike Canada, there are significant forest lands and forest reserves under federal ownership and management here (e.g. National Park Service and National Forest Service) so direct collaboration on a national level is possible.

2. For many of the forest tree species, there is little or no genetic information. Genetic information is concentrated on the commercial species and the rare/endangered species. Effects of forest management activities are presumed but not well understood, and impacts at the level of fine-scale genetic structure are even less well known. Species-based and range-wide genetic conservation plans are virtually unknown.

3. Reduced budgets for research and reduced educational opportunities in forest genetics specifically may have impacts on how genetic diversity is recognized, valued, and managed in the long term.

Mexico

Conditions
Mexico is rich in forest tree species diversity - with perhaps 2000 to 3000 species in temperate and tropical zones - and in intraspecific genetic variation. For example, nearly half of the extant species of pine are native to Mexico. Little genetic information is available for these species: in most cases even distribution maps are incomplete. Most genetic reserves are maintained by federal or state agencies and by universities and research institutions.

Status, issues and consequences
Approximately 160 forest tree species are considered rare and endangered. Some species and populations have become increasingly threatened in recent decades from population growth and economic pressures that involve land conversion, habitat degradation, population fragmentation, and dysgenic selection. In natural areas, there is evidence of fragmentation and reduction in population sizes of several endemic forest species such as spruce species, Gregg pine (*Pinus greggii*), Chihuahua pine (*Pinus leiophylla*), Maximino pine (*Pinus maximinoi*) Chiapas white pine (*Pinus chiapensis*), Mexican weeping pine (*Pinus patula*), Apache pine (*Pinus engelmannii*), etc. Loss of habitat is a severe threat - particularly for Chihuahua pine, *Pseudotsuga* species, and Chiapas white pine. In 1995, it was estimated that approximately 0.65% of the temperate forest area was converted to some other land use annually. Other threats to genetic integrity, in increasing order of importance, are pathogens, insects, and selective removal of trees. Recently, a problem has emerged with an introduced pest (wood borer) in exotic poplars which may spread to Mexico's native poplars.

National parks and other large reserves at present cover most of the major forest ecosystems throughout Mexico, and there are policies on protection of native, endemic forest species in natural forests, particularly for those at high risk of loss. These policies are established at both the federal and state level. Several thousand hectares are designated as 'conservation areas', in addition to the traditional national parks or other large reserves (i.e., Biosphere Reserves). Conservation areas are scattered throughout natural forests to protect rare, threatened, or endangered species and some unique populations. Harvesting is forbidden in these conservation areas, but seed collections are permitted for valid research or *ex situ* conservation activities. However, most of these areas are still vulnerable to natural (destructive) disturbances as well as human encroachment and may not be large enough to maintain viable populations in the long term (Rogers and Ledig 1996).

Anthropogenic pressures, leading to habitat loss and population fragmentation and degradation, are large and increasing. The delineation of conservation areas is recent, and it is unknown whether the current areas are adequate to protect the genetic integrity of populations or whether they can be enforced. Political unrest and insufficient funding for conservation and research activities further undermine the infrastructure for genetic research and conservation. The lack of information - even species level diversity is not well studied - is of particular concern, leading to a recommendation at the (1995) workshop to give research priority to Mexico (see recommendation number 5, below).

Some information on the status of forest genetic resources in the tropical states of Campeche, Veracruz, and Yucatan is available from the FAO.

Recommendations

The following is a list of consensus recommendations developed by the participants in the Workshop on North American Temperate Forest Genetic Resources, Berkeley, California 12-14 June, 1995 (Rogers and Ledig 1996). These address both the genetic status of forest genetic resources as well as, in some cases, the opportunities for and interests in collaboration with other countries outside of North America.

1. We recommend the development of national programmes to address issues in the conservation of forest genetic resources. Due to the complexity of land ownership patterns and land management objectives within and among Canada, Mexico, and the United States of America, coordination on the national level is necessary. All of those directly involved with forest land ownership and/or management should be actively involved with the national programme - contributing to databases, participating in conservation planning, and implementing action plans for conservation of forest genetic resources. These programmes should include the exploration, inventory, documentation, and monitoring of forest genetic resources, both *in situ* and *ex situ*. Both exotic forest tree species growing in North America and native North American species growing elsewhere should be considered in national programmes. Furthermore, because species cross national borders, coordination and cooperation among nations will be required.

2. We recommend that conservation of forest genetic resources be addressed by multiple approaches, and that, whenever possible, they should include ecosystem reserves. We recognize, that for non-commercial species, ecosystem reserves may be the only economically practical method of conservation. We recognize that while biotechnology can be useful in many ways, it is not a substitute for an adequately funded, field-oriented genetic conservation programme.

3. Recognizing that many North American temperate forest tree species are important plantation species on this and other continents, and that it may be necessary to draw upon these forest genetic resources in the future, we recommend that Canada, Mexico, and the United States conserve these resources *in situ*. We assume that other countries outside North America will reciprocate with regard to their native genetic resources.

4. We recommend an increase in funding for research on conservation of forest genetic resources. This research should involve, when appropriate, interdisciplinary, interagency, and international collaboration.
   Some (non-prioritized) examples of research needs are:
   a) Exploration and inventory of species' distributions and patterns of spatial genetic structure within species.
   b) Development of more efficient methods of evaluating genetic variation for adaptive traits.
   c) Evaluation of the relative utility of various types of genetic data in the development of sampling strategies for conservation.
   d) Analysis of the impacts of sociopolitical structures on the effectiveness of programmes for the conservation of genetic resources.
   e) Analysis of factors influencing population viability.
   f) Analysis of the effects of habitat fragmentation, forest management practices, and environmental change on genetic resources.

5. Recognizing the high level of species and genetic diversity in Mexico and the extreme lack of information on this resource, we recommend that research on Mexican tree species should receive special attention.

6. Recognizing that forest management practices may have positive or negative impacts on genetic diversity and population viability and, in fact, that some form of management will be necessary to maintain genetic resources, we recommend a research emphasis on the consequences of forest management practices. We encourage the use of reference populations within long-term ecological research sites, 'model forests', and research natural areas for studies on the effects of forest management.

7. We recommend that the FAO encourage the development of a centralized metadatabase of genetic resources. We see this as composed of local databases, coordinated through a network and designed to facilitate exchange within the international community.

8. We recommend that member countries request FAO, through their Regional Forestry Commissions, to promote and coordinate national forest genetic resource conservation programmes, and their integration into forestry practices.

9. Recognizing that private sector owners and managers play an important role in *in situ* conservation of forest genetic resources, we recommend that the FAO and conservation agencies explore a range of incentives and agreements (e.g. tax incentives, easements, and land trusts) to foster conservation of forest genetic resources by the private sector.

10. Recognizing that effective genetic conservation programmes are very long-term in nature, we recommend that the FAO encourage and assist in the education of natural resource professionals and the lay public to foster a conservation ethic.

11. Recognizing that species introductions affect native ecosystems and local cultures and economies, we recommend the development of guidelines for the introduction of species. These guidelines should include general procedures for conducting risk analyses for biological, social, and economic factors as well as general procedures for monitoring the species after introduction.

12. Recognizing the importance of the Convention on Biological Diversity, the benefits of unrestricted exchange of germplasm, and the distinction between forest genetic resources and those of domesticated crops, we recommend that the forest genetic community provide leadership in addressing the emerging issues of intellectual property rights, indigenous peoples' rights, and plant breeders' rights as they pertain to forest genetic resources.

Conclusion

In summary:

- We do not have comprehensive genetic information for most of the forest tree species in North America. This information is disproportionately available for commercial species, often conifers.
- In Canada and USA, the threat - for the majority of forest tree species - is not of extinction, but genetic consequences from continuing and accumulative impacts from forest management activities and other human land-use activities that fragment or potentially degrade the genepool.
- Also of concern in these two countries is loss of infrastructure and funding for forest genetics education and research.
- In Mexico, the threat of extinction is greater. There is not even basic information on all species and their distribution. Other significant genetic effects can be anticipated due to continued large-scale loss of habitat.
- The opportunities for collaboration with Europe differ among these three countries, due to differences in political structures and forest ownership, for example. Funding for research and conservation activities is needed in Mexico. Opportunities for collaboration with North American countries are perhaps most obvious for species that are native here and grown as exotics in Europe (e.g. *Pinus radiata, Robinia pseudoacacia, Pseudotsuga menziesii*) or vice versa (e.g. *Pinus sylvestris, Juglans regia, Populus nigra*). Here, the mutual concerns over genetic conservation are obvious. Other opportunities for collaboration, already well demonstrated by much experience, include sabbaticals across the Atlantic, training and development in genetic conservation, and collaborative research.

References

Mosseler, A. 1995. Country Report for Canada to the International Conference and Programme for Plant Genetic Resources, Part two: Forestry. 26pp.

Natural Resources Canada. 1998. The State of Canada's Forests, The People's Forests 1997-1998. Canadian Forest Service, Natural Resources Canada, Ottawa, Ontario, Canada. 108pp.

Rogers, D.L. and F.T. Ledig, editors. 1996. The Status of Temperate North American Forest Genetic Resources. Report No. 16. University of California Genetic Resources Conservation Program, Davis, CA.

Rogers, D.L., C.I. Millar and R.D. Westfall. 1999. Fine-scale genetic structure of whitebark pine (*Pinus albicaulis*): Associations with watershed and growth form. Evolution 53(1):74-90.

Rowe, J.S. 1972. Forest Regions of Canada. Canadian Forest Service Publication No. 1300.

Stephenson, N.L. 1996 Giant sequoia management issues: protection, restoration, and conservation. Pp. 1431–1467 *in* Sierra Nevada Ecosystem Project, Final Report to Congress. Vol. II. Assessments and Scientific Basis for Management Options, Chapter 55. University of California, Davis, CA.

Tomback, D.F., S.K. Sund and L.A. Hoffman. 1993. Post-fire regeneration of *Pinus albicaulis*: height-age relationships, age structure, and microsite characteristics. Can. J. For. Res. 23:113–119.

Yanchuk, A.D. and D.T. Lester. 1996. Setting priorities for conservation of the conifer genetic resources of British Columbia. Forestry Chronicle 72(4):406–415.

Annex I. Strasbourg Resolution S2 (Conservation of Forest Genetic Resources): International Follow-up Report

Jozef Turok
International Plant Genetic Resources Institute (IPGRI), Rome, Italy

Summary[1]

Genetic resources have been given high attention in the Pan-European Process on Forests, in view of the increasing threats to the genetic diversity of forest stands and its potential for meeting human needs. Strasbourg Resolution S2 called for the development of a functional but voluntary instrument of international cooperation, in order to promote and coordinate *in situ* and *ex situ* conservation of genetic diversity, exchange of reproductive materials and to monitor progress in these areas. The European Forest Genetic Resources Programme (EUFORGEN) was established in October 1994 as the implementation mechanism of Resolution S2. EUFORGEN is financed by its participating countries (currently 28) and is coordinated by the International Plant Genetic Resources Institute in collaboration with the Food and Agriculture Organization of the UN. The Programme operates through five networks. Network members from participating countries carry out an agreed workplan, with their own resources, as inputs in kind to the Programme. The collaborative tasks typically include regular exchange of data and information, development of technical guidelines, common descriptors and databases, preparation of joint project proposals, exchange of genetic materials, literature overviews and public awareness activities. A large number of practical outputs have been provided by the networks to date. EUFORGEN is overseen by a Steering Committee of National Coordinators nominated by the participating countries. Main opportunities for further work include strengthening the links with non-European countries and increasing the various contributions in kind of countries towards this multilateral framework. Effective coordination and harmonization of efforts related to genetic resources among the different Ministerial Resolutions should be ensured and links with other ongoing initiatives facilitated.

Objectives of the Resolution

The need to strengthen efforts on the conservation of forest genetic resources[2] in European countries was recognized during the late 1980s, when a number of countries developed and started to implement national strategies to specifically address these issues as part of their forest management programmes. The principal concern requiring a better conservation of the genetic resources of forest tree species within their distribution areas has been the forest decline attributed to rapid environmental changes. Threats leading to the loss of genetic diversity in European forests have been identified as transboundary atmospheric pollution and intensive forest management, including the replacement of mixed forest stands with monocultures, fragmentation, loss of local ecotypes, artificial selection and uncontrolled movement of reproductive material. Despite that the risk of the actual loss of species is low, these threats to genetic diversity within species became very urgent. Conservation and sustainable use of genetic resources has also gained attention due to the genetic potential of forests to meet the increasing demands for high-quality timber and other forest products and

[1] Report submitted to the Third Ministerial Conference on the Protection of Forests in Europe, Lisbon, Portugal, 2-4 June 1998. This Report was published in the Follow-up Reports Volume I (Liaison Unit in Lisbon, pp. 14-27).

[2] Genetic resources are characterized as the biological material containing useful genetic information of actual or potential value.

to provide environmental and social benefits. European forests share the influence of similar traditions in silviculture and overall forest management. These provide a common basis for jointly incorporating genetic resources concerns into forestry practice.

The call for increased international collaboration and coordination of efforts in this area was realized through the adoption of Resolution S2. The representatives of 31 signatory countries made a commitment towards further development and implementation of their national strategies. They also decided to follow a concerted policy for the conservation of genetic resources and to establish an international monitoring structure.

From Strasbourg Resolution S2[3]

"…a functional but voluntary instrument of international cooperation should be found among existing relevant organizations, in order to promote and coordinate (i) *in situ* and *ex situ* methods to conserve the genetic diversity, (ii) exchange of reproductive materials and (iii) monitoring of progress in those fields…"

This international commitment was reconfirmed at the Second Ministerial Conference (Helsinki, 1993) where four further Resolutions with components relevant to genetic resources and their conservation were agreed. Within the follow-up to Resolution H1[4] it was, for example, proposed that one of the Indicators of sustainable forest management be the proportion of stands managed for the conservation and use of genetic resources. Resolution H4 focuses partly on research into the genetic effects of global climatic change on forest tree populations.

Follow-up

Establishment of the European Forest Genetic Resources Programme

The European Forest Genetic Resources Programme (EUFORGEN) was endorsed at the Second Ministerial Conference in Helsinki as the instrument of international cooperation for implementing Resolution S2 (Arbez 1994[5]). Its development and overall management has been undertaken by IPGRI[6] in collaboration with the FAO Forestry Department[7]. The Programme aims at ensuring the conservation and the sustainable use of forest genetic resources in Europe. It became fully operational in October 1994.

---

[3] Anonymous. 1990. Resolution 2 of the Ministerial Conference on the Protection of Forests in Europe, 18 December 1990, Strasbourg. Ministère de l'Agriculture et des Forêts, Paris.

[4] Helsinki Resolutions:
H1 - General Guidelines for the Sustainable Management of Forests in Europe
H2 - General Guidelines for the Conservation of the Biodiversity of European Forests
H3 - Forestry Cooperation with Countries with Economies in Transition
H4 - Strategies for a Process of Long-Term Adaptation of Forests in Europe to Climate Change

[5] Arbez, M. 1994. Fondement et organisation des réseaux européens de conservation des ressources génétiques forestières. Genet. Sel. Evol. 26: 301-314.

[6] IPGRI: International Plant Genetic Resources Institute, established in 1974 and operating as one of 16 international agricultural research centers of the Consultative Group on International Agricultural Research.

[7] Food and Agriculture Organization as the United Nations agency entrusted by the world community to deal with issues on food and agriculture including and forestry and forest resources.

Priority-setting process

Prior to establishing EUFORGEN, the S2 Follow-up Committee (composed of France, Finland, Poland and Portugal) conducted an international survey on the status of forest genetic resources in Europe and prepared the basis for collaboration in networks. Following the results of the survey (Arbez 1994), four 'pilot' networks were established to focus on a selected set of species. These not only reflected national priorities for the conservation of the most threatened genetic diversity (Fig. 1) and its actual or potential use, but it also covered different types of ecogeographic and genetic distribution patterns. The networks initially selected were: *Picea abies* (Norway spruce - a wind-pollinated, widely distributed and intensively managed conifer), *Quercus suber* (cork oak - a valuable species in southern Europe, with diversity under threat), *Populus nigra* (black poplar – a characteristic riparian species with spontaneous interspecific hybridization) and Noble Hardwoods, a group of 'overlooked' species with scattered distribution patterns and high-quality timber.

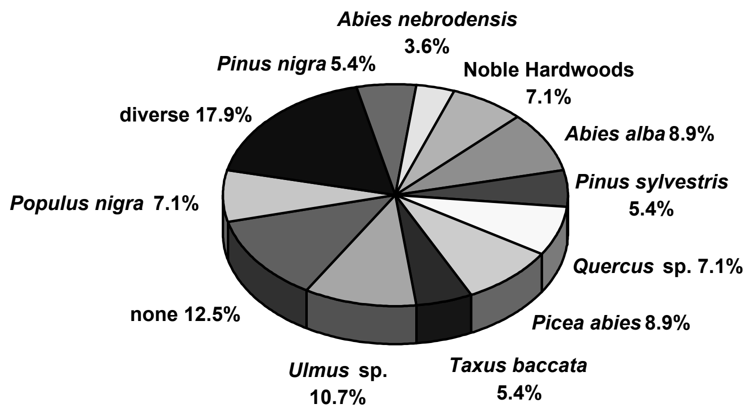


Fig 1. Overview of species with the most threatened genetic diversity of populations in Europe, as revealed by a questionnaire of the S2 Follow-up Committee, in % of respondents (after Arbez 1994).

Structure and mode of operation

EUFORGEN is financed by participating countries and the coordinating secretariat is hosted by IPGRI. The Programme is operated as a multilateral trust fund which functions through individual Letters of Agreement with participating countries. Most countries which signed Resolution S2 are participating in the Programme (Table 1). Individual countries formally join the Programme by signing a Letter of Agreement, specifying the financial contribution to be made and nominating a National Coordinator. Contributions to the trust fund are made on an annual basis and cover the cost of meetings, publications and overall coordination. The financial contributions are based on the UN assessment rating of countries. Letters of Agreement are signed for the current phase which lasts five years.

Table 1. List of European countries which signed Resolution S2 and their participation in the European Forest Genetic Resources Programme (as of January 1998)

List of European Countries	Signatories of Resolution S2	Countries participating in EUFORGEN since	Annual contribution in US$
Albania X			
Armenia*** X			
Austria X		July 1995	10,000
Azerbaijan*** X			
Belarus***		May 1995	5,000
Belgium X		January 1995	10,000
Bulgaria X			
Croatia* X		November 1994	5,000
Cyprus			
Czech Republic**	X	December 1993	5,000
Denmark X		May 1994	10,000
Estonia***	X	intended in 1998	
European Community	X		
Finland X		June 1994	10,000
France X		December 1993	30,000
Georgia***	X	intended in 1998	
Germany X		January 1998	30,000
Greece	X	intended in 1998	
Hungary		September 1995	5,000
Iceland X			
Ireland X			
Italy X		October 1995	30,000
Latvia*** X		October 1994	5,000
Liechtenstein X			
Lithuania*** X		October 1994	5,000
Luxembourg X		September 1997	5,000
Macedonia, FYR*	X		
Malta X		April 1995	2,000
Moldova*** X		May 1995	5,000
Monaco X		December 1993	2,000
Netherlands X		April 1994	10,000
Norway X		June 1994	5,000
Poland X		February 1995	5,000
Portugal X		March 1994	5,000
Romania	X	intended in 1998	
Russian Federation***	X	May 1995	30,000
Slovakia** X		November 1995	5,000
Slovenia* X		December 1997	5,000
Spain X		September 1995	10,000
Sweden X		May 1995	10,000
Switzerland X		March 1994	10,000
Turkey	X	intended in 1998	
Ukraine*** X		September 1994	10,000
United Kingdom	X		
FR Yugoslavia (Serbia & Montenegro)*	X		

* known at time of signing Resolution S2 as Yugoslavia
** known then as Czechoslovakia
*** known then as USSR. The contributions of Belarus, Moldova, Ukraine and partly Russian Federation are covered by the International Association for the promotion of cooperation with scientists from the New Independent States of the former Soviet Union (INTAS).

The Programme is overseen by a Steering Committee composed of National Coordinators from all participating countries. As formal representatives of their countries, the National Coordinators act as a link between the coordinating secretariat and national institutions involved in the activities on forest genetic resources. They seek to commit all relevant institutions within their country to carry out the agreed tasks and liaise between them (Fig. 2).

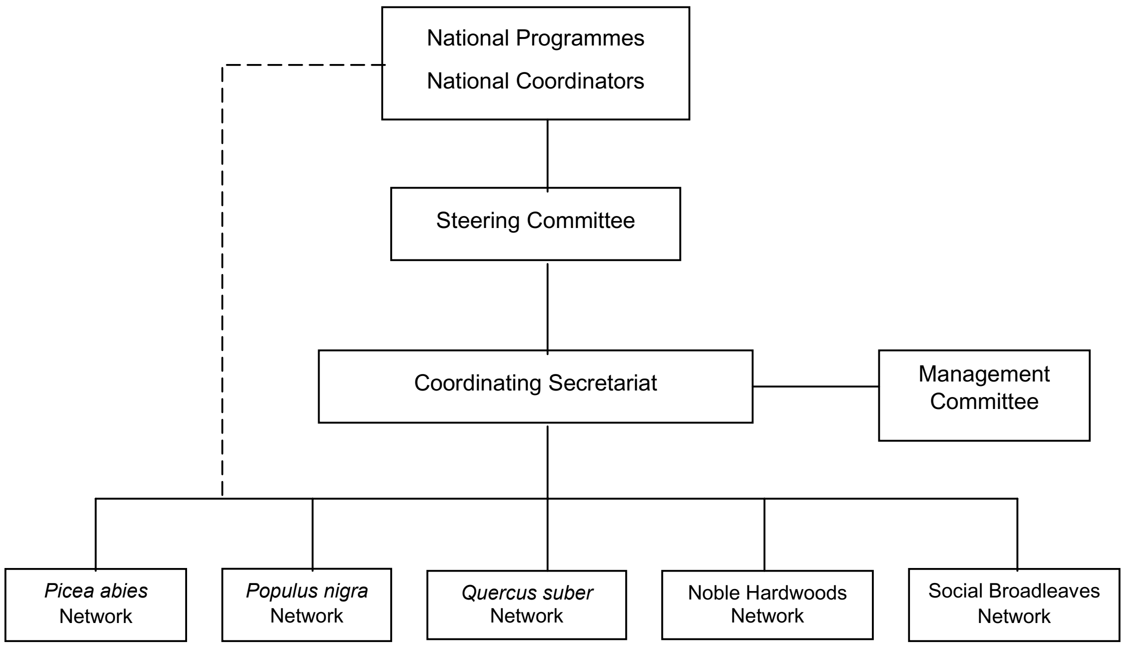


Fig. 2. Organizational structure of EUFORGEN.

The Steering Committee meets every three years to review the progress made, discuss issues relevant to gene conservation in Europe, make recommendations for the future of the Programme including new networks and to approve the budget. The first meeting, attended by representatives of 27 countries was held in November 1995 (in Sopron, Hungary). While the objectives and the overall structure of the Programme were confirmed, the meeting recommended further development of activities on the conservation of forest genetic resources in addition to networking. EUFORGEN thus aims at providing a contribution to various international collaborative initiatives, raising public awareness and facilitating information flow among countries[8]. The species-based approach was considered to best accomplish the overall role. A new network on Social Broadleaves (temperate oak and beech) was initiated. The National Coordinators emphasized the continuing interest of their countries in this type of international collaboration. Providing guidance for the development of national policies and encouraging long-term national strategies and activities on forest genetic resources continue to be the most important impact areas of the Programme.

[8] Report of the first Steering Committee meeting. 1996 (see Annex V, List of publications).

European Forest Genetic Resources Workshop

Attended by National Coordinators and resource persons from three European countries and Canada, the European Forest Genetic Resources Workshop, which was held concurrently with the Steering Committee meeting in 1995, also provided several technical recommendations with regard to the conservation of forest genetic resources in Europe. For example, it was recommended that the activities on genetic resources and their conservation be increasingly integrated into applied silviculture and forest management systems. Recognizing the basic link between conservation, tree improvement and managed use of forests, the Workshop also recommended that a balance be sought between *in situ* conservation and sustainable forest management on the one hand, and management of protected areas on the other, and that conservation and management of genetic resources *in situ* and *ex situ*, and tree improvement activities be considered complementary strategies (IPGRI/FAO 1996)[9].

The EUFORGEN Management Committee composed of two representatives of FAO and two representatives of IPGRI was set up and meets twice a year to provide technical and scientific advice to the secretariat. The coordinating secretariat (EUFORGEN Coordinator and part-time assistant) acts as a facilitator of the activities, ensures the implementation of the Programme in accordance with the mandate given by the Steering Committee, provides logistic support to networks and ensures that the agreed workplans are carried out, reports on the activities, prepares financial reports, maintains contacts with the National Coordinators and assists with the search for donors to support tasks of the workplans.

International gene conservation networks

EUFORGEN operates through networks in which forest geneticists and other forestry specialists work together to analyze needs, exchange experiences and develop conservation strategies and methods for selected species (*Picea abies*, *Populus nigra*, *Quercus suber*, Noble Hardwoods and Social Broadleaves). The networks also contribute to the development of conservation strategies for the ecosystems to which these species belong.

Two different levels of involvement in the networks are distinguished: attending members, who participate in the meetings and corresponding members, who exchange information but do not attend the meetings. Both attending and corresponding members receive all related information and are expected to facilitate the implementation of tasks given in the workplans. This arrangement contributes towards maintaining network meetings reasonably small and dynamic, and ensures that each country is represented in the networks according to its needs. All network members are nominated by the respective National Coordinator. This structure is flexible and allows for modifications whenever additional networks are established.

Network meetings are held at regular intervals (Table 2). They review the progress made, set priorities, establish and update workplans and plan further collaborative activities accordingly. A chairperson is elected within each network.

[9] IPGRI/FAO. 1996. International Technical Conference on Plant Genetic Resources. Preparatory process for Europe. IPGRI/FAO, Rome, Italy.

Table 2. List of network meetings held so far and numbers of countries represented

Network Me	eting date/place	No. of countries
Picea abies	First meeting, 16-18 March 1995, Stara Lesna, Slovakia	10
	Second meeting, 5-7 September 1996, Hyytiälä, Finland	17
	Third meeting, 26-29 April 1998, Opocno, Czech Republic	est. 20
Populus nigra	First meeting, 3-5 October 1994, Izmit, Turkey	12
	Second meeting, 10-12 September 1995, Casale Monferrato, Italy	13
	Third meeting, 5-7 October 1996, Sárvár, Hungary	13
	Fourth meeting, 3-5 October 1997, Geraardsbergen, Belgium	16
Quercus suber	First meeting, 1-3 December 1994, Rome, Italy	5
	Second meeting, 26-27 February 1995, Rome, Italy	5
	Third meeting, 9-12 June 1996, Sassari, Italy	8
	Fourth meeting, 20-22 February 1997, Almoraima, Spain	8
	Fifth meeting, 3-5 April 1998, Le Lavandou, France	est. 12
Noble Hardwoods	First meeting, 24-27 March 1996, Escherode, Germany	18
	Second meeting 23-25 March 1997, Lourizán, Spain	20
Social Broadleaves	First meeting, 23-25 October 1997, Bordeaux-Cestas, France	23

Despite differences between the networks' focus and needs, their members chose a similar approach to solving common tasks. The collaborative activities of the networks typically include regular exchange of information, development of conservation strategies and technical guidelines, common descriptors and databases, identification of common research needs and preparation of joint project proposals, exchange of genetic materials, literature overviews, public awareness activities, etc. Network members, in collaboration with other scientists and forest officers from participating countries, carry out the tasks of agreed workplans with their own resources as inputs in kind to the Programme. Many practical outputs have been produced by the networks to date (Table 3).

Table 3. Overview of the main activities carried out by EUFORGEN networks and their outputs

Tasks of the workplans	*Picea abies*	*Populus nigra*	*Quercus suber*	Noble Hardwoods	Social Broadleaves
Regular exchange of information/overviews	+ + +			+	+
Long term conservation strategies and methodologies	+			+	+
Technical guidelines	+ + +			+	
Descriptors	+ + +			+	
Databases	+ + +			+	
Successful project proposals		+	+	+	+
Exchange of genetic material		+	+	+	
Field trials and collections		+	+		
Literature overviews		+	+	+	+
Public awareness		+		+	+

Exchange of information

Members of all the networks exchange information about the status of genetic resources, conservation, breeding and research activities, methods, legislation, constraints, needs and priorities. This is considered very helpful for developing the national strategies. Country reports were presented during the first network meetings and brief updates were then provided and discussed at the subsequent meetings. They are published after the meetings (see Annex V, List of publications). The information obtained on individual species enables to produce overviews and analyses of data and to monitor the progress made. An important role of the networks is also to disseminate information about the use of advanced methods and technologies in genetic conservation.

Development of conservation strategies

Long-term European gene conservation strategies are developed for the individual species or groups of species. The Noble Hardwoods network identified species which need attention according to the priorities given by all participating countries.

The main objective of the strategy for Noble Hardwoods is to create good conditions for future evolution. The steps suggested for better conserving the diversity within entire distribution areas of elms, maples, mountain ash and wild fruit trees include ecogeographic and genetic surveys, preservation and enhancement of variation in small local populations, improvement of methods, creation of a European network of gene conservation stands and regulations on the transfer of reproductive material. When suggesting a network of stands, it is important to take into consideration many factors such as the occurrence of genetic diversity under marginal environmental conditions, representativeness for certain areas and minimum population sizes. According to the strategies, *in situ* and *ex situ* conservation measures should be integrated. For example, the conservation approach to rare wild fruit trees requires the establishment of breeding populations as essential part of the strategy.

The network emphasizes that existing activities should be better linked to each other and that joint European strategies serve as orientation and support for the implementation of national or regional programmes. The development of these strategies also illustrates the consensus building role of the networks.

Technical guidelines

The need for practical guidelines on the management of gene conservation stands in particular, and on genetically sustainable forestry in general, has been recognized since the establishment of EUFORGEN. A first booklet with technical guidelines was produced by the Norway spruce network[10], followed by cork oak and Noble Hardwoods networks (in preparation). They aim at providing advice to forest officers and authorities responsible for gene conservation. The guidelines for Norway spruce are divided into chapters on *in situ* conservation and *ex situ* conservation in populations, collections and in genebanks. The black poplar network produced a set of guidelines which focus on the management of different types of genetic collections.

Descriptors and databases

Data about genetic resources, including gene conservation stands and clone collections, are stored in databases that vary in format, structure and information level. In order to ensure better access to this information, as well as comparability of data, attention has been given to standardization of databases. The first step towards harmonizing data from different countries and on the various species was to develop lists of descriptors. Simple lists of descriptors have been agreed so far by the four networks (Table 3). In addition to the common minimum descriptors (geographic position, responsible institution and ownership, type and function of gene conservation unit, genetic evaluations, etc.) each country or institute registers a number of complementary data for various purposes (e.g. threats, detailed ecological site descriptors).

The next step undertaken by networks, where relevant, is to link the existing data in joint databases. A database of black poplar clones available in European countries was established. There are currently more than 2000 entries and the database has been used

---

[10] Koski *et al.* 1997 (see Annex V, List of publications).

successfully for the identification of duplications in national collections. It is maintained as an input in kind by a voluntary institute and has been made available on the internet through the coordinating secretariat.

Preparation and facilitation of research projects

Regular meetings of the networks provide an opportunity to plan and develop joint project proposals. Network members often work together with, or as partners involved in different ongoing research projects, discuss the application of results and complement the approach taken. The cork oak network, for example, developed an EU-funded FAIR project for the evaluation of genetic resources in this species. Provenance tests in seven countries have been established within this effort. Close collaboration exists between the black poplar network and another EU/FAIR project on genetic diversity in riparian ecosystem. Members of the Noble Hardwoods network work together with a genetic resources project on elms[11]. A collaborative project on genetic resources of broadleaved species in southeastern Europe was developed with contribution of the Noble Hardwoods and the Social Broadleaves networks. These examples illustrate the role of the EUFORGEN Programme for mobilizing funds for tasks carried out by the networks and for gene conservation activities in general.

Exchange of genetic material

The conservation and use of locally adapted genetic resources is considered very important for forest tree species in general. The networks have frequently pointed at the risks associated with the transfer of reproductive material with unknown properties or from unknown sources. Nevertheless, small quantities of genetic material have been exchanged among the members of the cork oak and black poplar networks for experimental purposes.

Reference clones were exchanged and a core collection of clones established by the black poplar network. The core collection includes representative clones from the entire distribution area[12]. It aims at providing a tool for standardized evaluation of national collections. The collection is propagated and sent to any interested institute on request. The origin and other data for all clones are given according to the common descriptor list developed previously by the network.

Public awareness

During the first years of the existence of the Programme, it was realized that the tasks of conservation of genetic resources are insufficiently known and often unclear to the general public. Therefore, the networks devote time to discussing and developing tools for raising public awareness. Besides presentations and publications on this subject by the network members in their countries, joint outputs of the networks, which contribute to the task, are leaflets, slide collections, posters etc. The organization of network meetings itself (see Table 2) is also a contribution to raising awareness in the respective countries. An internet site was launched which describes the objectives of Resolution S2, informs about activities of the EUFORGEN Programme and makes the outputs of the networks available (<http://www.cgiar.org/ipgri/euforgen>). The EUFORGEN logo became part of the public awareness role played by the networks (Fig. 3).

---

[11] Collin, E. 1998. European gene conservation strategy on elms (*Ulmus* spp.). *in* Report of the second Noble Hardwoods Network meeting (see Annex V, List of publications).

[12] Cagelli, L. 1997. Passport data for *Populus nigra* database. *in* Report of the fourth *Populus nigra* Network meeting (see Annex V, List of publications).

Fig. 3. The EUFORGEN logo

Literature overviews

Overviews of literature with regard to genetic resources of species are a regular task of the networks. They are reviewed during meetings and subsequently completed and published in the reports of network meetings. Particular attention is paid to unknown manuscripts and 'grey literature' with limited diffusion.

Collaboration with other regional programmes

EUFORGEN collaborates with other regional initiatives and organizations involved in the conservation of genetic resources. In particular IUFRO[13] working groups on research into conservation, genetic resources and breeding provide a basis for complementary activities. The networks have established informal links with the relevant working groups.

Exchange of information takes place with the secretariat of the Pan-European Strategy on Biological and Landscape Diversity. EUFORGEN activities as such contribute toward its implementation.

The first meetings of the cork oak network were organized jointly with FAO's programme "*Silva Mediterranea*", which also helped to involve Morocco and Tunisia in the network later on. The black poplar network benefited from the meetings and activities of the International Poplar Commission of FAO.

These two networks developed their strategies (see above) in collaboration with non-European countries in the distribution area of the species and equally concerned with their genetic conservation and use. Links have been sought between all the networks and adjacent regions, particularly with countries in North Africa, West and Central Asia and North America.

Most countries from the European part of the former Soviet Union participate actively in the EUFORGEN networks. Special efforts are being undertaken to assist the newly independent states, through international collaboration, in strengthening their programmes on forest genetic resources in light of the political and economic changes.

Workshop on Sustainable Forest Genetic Resources Programmes in the former USSR

A workshop was convened in Belarus (in September 1996), to provide an overview of the current activities, to reassess needs and priorities, and to emphasize the interest and capacities of these countries to be proactive in international collaboration. A number of possible collaborative projects were proposed and further developed later. They led to the establishment of collaborative mechanisms in Central Asia and the Caucasus, regions which are home to genetic resources of importance to many tree species occurring in Europe.

[13] International Union of Forestry Research Organizations

One of the key problem areas identified by east and central European countries within the follow-up to Helsinki Resolution H3 ('Forestry cooperation with countries with economies in transition') was forest genetic resources and conservation. The activities described within the framework of EUFORGEN provide an opportunity for links with that Resolution.

Constraints and perspectives

Since its establishment in 1994 EUFORGEN has become fully operational and has received the practical endorsement of participating countries. A major contribution of this networking Programme towards implementing Resolution S2 is the technical and political impact it has on the development of national programmes and strategies in the long term, fully recognizing that the responsibility for decisions on the management of genetic resources and their financing lies entirely with each country.

It is hoped that all signatory countries of Resolution S2 join EUFORGEN in the future. The mode of operation through several species oriented networks reinforces the basic role of individual countries and their national genetic conservation programmes. The participating countries determine priorities for common tasks in the networks according to their needs. The five networks for 'pilot species' have been developed taking into consideration the priorities of countries and the actual possibilities of the Programme. It is often requested that new networks be established or additional species be included under the scope of the existing networks. Any changes regarding the scope of the networks and other important decisions lie with the Steering Committee of National Coordinators as the officially nominated representatives of their countries.

The networks bring together partners with different interests and priorities but their outputs provide a stimulus for activities in all participating countries. This requires networks to maintain a flexible organization and that the effectiveness in accomplishing the common tasks is higher than if members had tried to reach them individually. The actual implementation of network tasks relies on the willingness to provide various contributions in kind of individual countries to the networks. In order to increase these contributions, and thus to strengthen their impact on national activities, it is desirable to involve decision makers further. Further attention to the follow-up work by European agencies and organizations would be beneficial. The 'multiplier effect' of network activities for stimulating development of national and various international projects has been shown.

EUFORGEN as a specialized programme could provide a linkage and increasingly harmonize efforts related to genetic resources and conservation among the different Ministerial Resolutions. It is essential to avoid any duplication of efforts in this area. The Programme should also continue to act as a contribution towards implementing the Pan-European Strategy on Biological and Landscape Diversity and the Convention on Biological Diversity (COB) in general.

Collaboration with other regions outside of Europe is also very important and should further be strengthened, considering the necessity to conserve and sustainably use the genetic diversity of forest tree species in their entire distribution areas.

Annex II. Report on the progress made in EUFORGEN: Update on the activities carried out during 1998

Comprehensive information on the progress made in EUFORGEN since its establishment was provided in the "International Follow-up Report on the Implementation of Strasbourg Resolution S2 (Conservation of Forest Genetic Resources)"[14], which was submitted to the Third Ministerial Conference in Lisbon in June 1998) and was also circulated beforehand to all National Coordinators and Network members (in March 1998). An update on the activities carried out between April and November 1998 is given below.

Networks

The following Network meetings were held during 1998:

Network	Meeting date/Place	No. of countries
Quercus suber	Fifth meeting, 3-5 April 1998, Le Lavandou, France	11
Picea abies	Third meeting, 26-29 April 1998, Opocno, Czech Republic	12
Noble Hardwoods	Third meeting, 13-16 June 1998, Sagadi, Estonia	24

Activities

A meeting on ***Quercus suber* and other Mediterranean oaks** was held in Le Lavandou, France, 3-5 April 1998. It was organized jointly by the EUFORGEN Network and the Concerted Action EU/FAIR 1-CT 95-0202 ("European network for the evaluation of genetic resources of cork oak for appropriate use in breeding and gene conservation strategies"). Besides France, Italy, Morocco, Portugal and Spain, as well as Germany and Sweden, which attended the previous meetings, representatives of a wider range of countries from the entire Mediterranean region participated (Cyprus, Greece, Malta and Turkey). This reflected the previously agreed opening of the scope of the Network to include related evergreen oaks.

The participants reviewed the progress made in the EU/FAIR-funded provenance experiment and planned a joint evaluation of the trials and databases. Research on the adaptation of cork oak under different conditions is essential for developing regulations on the transfer and use of reproductive material in this species.

During the meeting, each country also introduced the status of genetic resources of evergreen oaks and the activities towards their conservation and use. As agreed during the previous two meetings (held in June 1996 and February 1997), *Quercus ilex* (hom oak), *Q. coccifera* and *Q. alnifolia* should also be concerned when dealing with the genetic resources of *Q. suber*. They represent a complex of closely related evergreen oaks with natural hybridization occurring between them. The Mediterranean region is very important for genetic resources of evergreen oaks because of the rich diversity they represent. Following the discussion about the genetic resources of evergreen oaks, it was concluded that (1) more knowledge should be obtained through research on these species and (2) minimum standards (technical recommendations) for their gene conservation in the long term should be developed. National reports on the genetic resources of evergreen oaks will be published as part of the Report of the meeting (in preparation). The discussion among participants suggested that all Mediterranean oaks (evergreen and deciduous) be given attention in the future. The main arguments for including all Mediterranean oaks under the scope of the Network are: occurrence in the same ecosystems; similarity of threats, problems and constraints of gene conservation; natural hybridization between species; shared institutional responsibilities and others. Broadening the scope of the *Q. suber* Network to all

[14] see Annex I

Mediterranean oaks would enable the Social Broadleaves Network to concentrate its efforts on temperate species.

Almost all field trials within the provenance experiment have now been planted. Most countries reported severe difficulties with finding suitable, sufficiently homogeneous and available land. It was stressed that experience obtained from establishing the trials must be well documented. It will be essential not only for the further management of these trials but also useful for setting up similar experiments in the future. A handbook will, therefore, be developed for this purpose in the framework of the EU/FAIR project.

To complement the approach taken in the handbook, concise Technical Guidelines on the conservation and management of cork oak genetic resources are currently being developed by the Network. These will aim at forest officers and national agencies responsible for genetic resources and will consist of 4 chapters. The first draft will be presented and discussed at the next Network meeting in 1999.

Several documents were exchanged among Network members after the meeting, including the assessment of needs and priorities for gene conservation of Mediterranean oaks throughout the region. An updated version of the Bibliography on cork oak genetic resources (first published in 1997) has been uploaded on the Internet.

The third ***Picea abies*** **Network** meeting was held in Opocno, Czech Republic, 26-29 April 1998. The participants discussed the progress made in the implementation of national strategies and focused on the role of genetic resources in view of the global changes of the environment and air pollution. It was recognized that each country had a national strategy on Norway spruce genetic resources either in preparation, or already in place. The main purpose was to outline gene conservation as part of the overall national forestry policy. No serious constraints or difficulties in developing the national strategies were reported. It was stated that further exchange of experience and the support from the Network would be needed for their practical implementation.

It was noted that gene conservation of Norway spruce in the different regions of Europe has different objectives and subsequently requires different approach and methods. For instance, the main argument for gene conservation in central and eastern Europe is the threat to genetic diversity posed by air pollution. Genetic resources of Norway spruce in areas affected by air pollution were discussed in detail during the meeting. The economic importance of Norway spruce and its wide use in afforestations was mentioned as the main argument for gene conservation in Belgium, Finland, Lithuania, Norway, Sweden and other countries. The main task is to ensure sufficient genetic diversity in the managed Norway spruce stands for their dynamic development.

The participants stressed that a common information source/database of Norway spruce genetic resources is essential to monitor the progress made in each country and to provide up-to-date information about the coverage of the genetic variation in the species' distribution area by gene conservation measures. Using the Network's common minimum descriptors, summary information sheets were compiled after the meeting. Links to the national databases will be provided through the Network's Internet home page. The Report of the meeting (including brief progress reports) has been published on the Internet and printed copies are available on request. It was also agreed to regularly update the Technical Guidelines that were produced by the Network in 1997. A list of items to be added or updated was agreed upon.

In addition to Norway spruce, it was suggested that Scots pine (*Pinus sylvestris*) serve as a model species with continuous distribution, since the gene conservation measures for both species are often very similar. It was agreed that the scope (and name) of the Network should be changed to Spruce and Pine Network.

The Bibliography on genetics, breeding and genetic resources of Norway spruce is currently being prepared in close collaboration with the IUFRO Working Party 2.02.11. As a first step, search runs were conducted in existing literature databases and several files were sent to the contact persons identified previously in each country. The lists of references already available were also established on the Internet in order to facilitate the process of collecting and compiling references by the national contact persons. Format and outputs/file types were specified. It was agreed that files should be sent by each contact person to IPGRI before 1 December 1998. The Bibliography will be published electronically as an on-line searchable database in 1999. It will be accessible from the home pages of both the IUFRO Working Party and the Network.

Members of the **Noble Hardwoods Network** met in Sagadi, Estonia, 13-16 June 1998. Participants reviewed the progress made in their countries since the last meeting (March 1997) and agreed on the further development of a number of practically oriented activities: long-term European gene conservation strategies, technical guidelines, bibliography, documentation of genetic resources and research. Several outputs resulting from these activities are included in the Report of the meeting which has been compiled and will be available in early 1999. The Report of the second Network meeting and a leaflet about their gene conservation in Europe were produced during the year. The need to raise awareness of policy makers, foresters and the general public of the role and potential of the often overlooked species covered by the Network, was re-emphasized.

Discussions during the Network meeting focused on the strategies and methodologies for the genetic conservation of the species covered. The strategies, previously developed for maples (*Acer*), elms (*Ulmus*), rowan (*Sorbus*) and the wild fruit trees, are concerned with a number of issues from inventories of occurrence and abundance, genetic variation and variation patterns, breeding and reproductive systems, to regeneration, silviculture and sustainable use of the species. It was confirmed that "rareness" of species, a term often associated with Noble Hardwoods, was a relative concept because most, if not all, species become "rare" at the extremes of their distribution range.

Strategy documents on ash (*Fraxinus*), chestnut (*Castanea*) and lime (*Tilia*), prepared and circulated by Network members to all participants in advance before the meeting, were adopted and will be published in the Report. With regard to chestnut, it was stressed that appropriate institutional and professional links need to be forged between horticulturists and foresters to ensure the mutual support and collaboration of both groups.

The core of any conservation strategy for Noble Hardwoods is their silvicultural management and sustainable use, carried out with due attention to genetic principles. An overview paper on this topic was presented. Technical Guidelines, aimed at forest officers responsible for genetic conservation in European countries, will be produced by the Network and their outline was agreed upon during the meeting. The basis for concern related to global climate change must lie in ensuring availability of genetic variation in tree populations which will allow them to adapt to changing environments. A special paper was prepared and discussed at the meeting.

The Network also discussed information management on Noble Hardwoods genetic resources in Europe. The common descriptors, previously proposed by the Network, should be kept to the very minimum. If countries wish and are able to record additional variables, this would be an advantage but should not necessarily be coordinated at an international level. While the development of national databases was encouraged, the issue of a common, centralized information system on Noble Hardwoods would need to be further discussed. In the meantime, a link page will be set up on the Network's Internet site, which will include a list of the agreed common descriptors and electronic links to existing national databases as requested by the countries concerned.

The Network decided to regularly update the overview of ongoing national and international research projects. The possibilities of securing additional EU funding for some of the Network activities were noted, including shared cost projects (EU Framework Programme V, INCO-Copernicus etc.). The participants also expressed their wish to strengthen the links between EU-funded research projects and scientists in non-EU countries. It was stressed that priority should be given to research on reproductive biology of the Noble Hardwood species, as a basis for the development and implementation of long-term genetic conservation strategies. A meeting to discuss the possible submission of a project proposal was held in Sweden at the end of October.

Following the meeting in Sagadi, countries participating in the Network updated and added new information to the table of priorities concerning species considered important for gene conservation. This information, so far contributed to by 27 countries, has been made available on the Internet.

The EUFORGEN ***Populus nigra*** and **Social Broadleaves Networks** did not hold a meeting during the period (April to November 1998), but progress in their activities was made through correspondence and exchange of data and information. The Reports of the previous Network meetings were published and distributed to almost 800 addresses in the case of the Report of the fourth *Populus nigra* Network meeting and 500 in the case of the Report of the first meeting on Social Broadleaves. Network members also represented the Networks at a number of international meetings (Black poplar meeting in Germany in May 1998; IUFRO Division 2 Conference in China in August 1998).

Third Ministerial Conference on the Protection of Forests in Europe

The Third Ministerial Conference on the Protection of Forests in Europe was held in Lisbon, 2-4 June 1998. The ministers responsible for forestry adopted two resolutions concerning socio-economic aspects and the pan-European criteria, indicators and operational level guidelines for sustainable forest management. EUFORGEN reported on the implementation of Strasbourg Resolution S2.

The Conference was attended by 37 Signatory States, the European Union, 5 observer countries and a number of international governmental and non-governmental organizations. The General Declaration and two "Lisbon Resolutions" adopted by the Conference emphasized the need to strengthen the links between the forestry sector and society, increasing dialogue and mutual understanding, and further enhancing the participation of all relevant stakeholders in the sustainable management of forests.

Within Resolution L1, the Signatory States committed themselves, *inter alia*, to maintaining and developing frameworks conducive to enabling and motivating all forest owners to practice sustainable forest management; to adapt education and training systems for the development of a highly skilled, multidisciplinary workforce; to promote the improvement and application of appropriate safety and health standards and practices, professionalism of forest owners, workers and contractors, and skills certification.

The 'Pan-European Criteria and Indicators for Sustainable Forest Management', previously developed by expert level follow-up meetings to the Second Ministerial Conference, were endorsed in Lisbon (Resolution L2). These represent a basis for the development of national criteria and indicators and for international reporting in six areas: forest resources, health and vitality, productive functions of forests, biological diversity in forest ecosystems, protective functions and other socio-economic functions and conditions. Criteria and indicators will be used as a tool for policy analysis and formulation at the national level. Regular reporting will give the possibility of detecting trends and changes at an early date, thus providing valuable information on future developments in each Signatory State. As part of Resolution L2, 'Operational Level Guidelines for Sustainable Forest Management' were also endorsed, a rather general framework of recommendations for use on a voluntary basis.

Several indicators are relevant to forest genetic resources and one of them ('Changes in the proportions of stands managed for the conservation and utilization of forest genetic resources') directly concerns the assessment of gene reserve forests, seed collection stands etc. While it is widely recognized that management of forests should also be genetically sustainable, the genetic criteria and indicators will require further development and concrete application by European countries during the coming years. The main challenge for our Programme within this process is to harmonize efforts related to genetic diversity among the different resolutions and initiatives.

Review of IPGRI's Programme in Europe

An in-depth internally-commissioned external review of IPGRI's activities in Europe was carried out in September 1998. The review panel consisted of Dr Eva Thörn, Director of the Nordic Gene Bank, Sweden; Dr Michel Arbez, Director of Forest Research Station INRA, Bordeaux-Cestas France; and Prof. Ivan Nielsen, Department of Systematic Botany, University of Aarhus, Denmark. The review, conducted every four years, covered IPGRI's work in both forest and crop genetic resources areas, in eastern and western Europe. The work of IPGRI on forest genetic resources in Europe is largely carried out through EUFORGEN. The review provided a critical analysis of the adequacy, quality and effectiveness of activities in addressing overall institutional objectives and strategy; achievements and impact; complementarity and linkages with partners; constraints and priorities for future work. Several National Coordinators were contacted by the review panel members.

The review panel developed several recommendations with relevance to EUFORGEN. The main outcomes, applicable to EUFORGEN, are as listed below.

- The need for an increased autonomy of the activities carried out within the individual Networks was expressed by the panel. The number of participating countries is high and is expected to increase further, which means an additional workload for the coordination of EUFORGEN.
- The review panel recommended that close attention be paid to the need for building strong national programmes in the eastern but also western European countries (mainly by improving public awareness about the importance of creating national programmes).
- IPGRI's Regional Office for Europe has a responsibility for mobilizing expertise and funds in Europe for the benefit of other regions. It was recommended that the level of fundraising activities for collaboration with other regions be increased in Europe, and that IPGRI involves National Coordinators in the process.
- The self-sustainability of EUFORGEN in terms of its financing from the participating countries is rather unique within IPGRI's system of operations. With a stronger commitment from the countries, increased participation and activities in the Networks, there will be a need for increased funding for plant genetic resources in the region. It was noted that the possibilities for receiving funds from the EU programmes have not yet been fully exhausted. The review panel recommended that IPGRI make further efforts to investigate the potential sources of funding within the EU programmes, in particular INTAS, INCO, PHARE and TACIS.
- During the take-off phase of EUFORGEN (1994-1998), the number of species of concern, as well as the number of participating countries has increased, but the amount of staff time available for the coordination of the Programme has not increased. It will be necessary to stabilize the number of Networks and/or reduce the frequency of meetings, or even leave some Networks after they become sufficiently autonomous, in order to be able to transfer some time to new activities proposed by the participating countries. The review panel suggested not to embark on many new species (Networks), but to pay attention to the issues associated with the continuity of gene reserves and regeneration.
- It was recommended that more community ecology expertise be included in the EUFORGEN Networks.
- The panel recommended that the proposed training course on forest genetic resources be organized in the near future.
- The review panel recommended that contacts with developing countries, especially those of the Central, West Asia and North Africa region be further strengthened, for example by

inviting institutions and students to participate in the relevant activities of the European Networks. Collaboration with the countries of this region should be increased for both scientific and development reasons.

- EUFORGEN should develop collaboration with institutions working with long-term regional effects of climate change on European forests as well as its consequences for long-term gene conservation. The role of the European Forest Institute (EFI) was emphasized in this regard.
- The review panel recommended that particular efforts be made to promote plant genetic resources programmes in the countries of the former Soviet Union and to mobilize funding for these activities.

Eastern Europe

During 1997, IPGRI initiated a three-year project on Broadleaved Forest Genetic Resources in Southeast Europe (Bulgaria, Moldova and Romania). The activities undertaken with financial assistance of Luxembourg include the development of maps of distribution areas, the compilation of databases of seed stands and *in situ* gene conservation units, as well as the development and application of advanced micropropagation techniques for priority species. Experiments on *in vitro* rooting of oaks (*Quercus* spp.) and *Sorbus domestica* were prepared and conducted jointly by scientists from the Forest Research Institute in Sofia, Bulgaria and the Centre de Recherche Public-Centre Universitaire in Luxembourg. Scientists from Luxembourg and Romania focused on developing techniques for somatic embryogenesis of *Quercus robur*. The results obtained, to be published in scientific journals, will contribute to making *ex situ* conservation and use of the genetic resources in the region more effective. An inventory, carried out in three neighbouring southeast European countries during the past year, led to the establishment of comprehensive electronic databases and the construction of maps of distribution areas for *Quercus robur*, *Q. petraea* and *Fagus sylvatica*. Several practical recommendations on the genetic principles of sustainable forest management, partly resulting from this inventory, were provided to the respective state forest services. The second meeting of partners was held at the end of September 1998 in Chisinau, Moldova. They discussed the progress made and agreed on the activities to be carried out during the second year. More attention will be given to studying the adaptation processes of populations. Among other outputs, a monograph on beech (*Fagus* spp.) genetic resources in the region will be published. A scientific workshop is also planned in Bulgaria in May 2000.

A database on *in situ* forest genetic resources in the Russian Federation has been initiated by the Russian Tree Breeding Centre (CENTRLESSEM) with technical and financial support from IPGRI. Currently, the considerable amount of information resulting from the work of forestry research institutions in identifying valuable *in situ* forest genetic resources in the Russian Federation is not readily accessible to other scientists and forest officers responsible for gene conservation. This includes, for *in situ* conservation activities, information on designated gene reserves and gene conservation stands, plus trees, seed stands, valuable provenances, populations, seed orchards, clonal archives etc. The establishment of a computerized database will allow efficient storage, retrieval and dissemination of this information, which will thus be made available to the national and international scientific community. At national level, it will also improve the monitoring of the forest genepool and its appropriate conservation, and will facilitate the use of forest genetic resources. It includes a training component and will result in the establishment of the database structure, purchase of the necessary equipment (computer, software) and starting data entries by the end of 1998.

Annex III. Progress, potential and perspectives of the EUFORGEN Networks from the Chairpersons' point of view

Populus nigra Network

François Lefèvre[1] and Sven de Vries[2]

[1] *Unité de Recherches Forestières Méditerranéenes INRA, Avignon, France*

[2] *Institute for Forestry and Nature Research IBN/DLO "de Dorschkamp", Wageningen, The Netherlands*

Introduction

The EUFORGEN *Populus nigra* Network results from a convergence between the objectives of Resolution 2 and the recommendations of the International Poplar Commission (IPC/FAO). During its 19th Session in Zaragoza (1992), the IPC recommended to work actively on the genetic conservation of *Populus* species. In 1993, *P. nigra* was chosen as a pilot species for one of the EUFORGEN Networks. There were *a priori* many reasons for creating the *P. nigra* Network:

- Poplar is a highly domesticated forest tree of economic importance all over the world, and poplar breeders, using advanced strategies based on recurrent selection and clonal varieties, are concerned with the long-term preservation of genetic resources
- The survey carried out by Resolution 2 confirmed the status of *P. nigra* as a threatened species mainly due to the alteration of the riparian ecosystem under human activities, and to the interactions between wild and cultivated genepools
- *P. nigra* may also be considered as a model species for biological reasons: dioecy, pioneer behaviour, sexual *versus* vegetative propagation.

Progress

The fact that *ex situ* conservation of *P. nigra* had already started in many countries with support from poplar breeding programmes facilitated the Network from the outset. Indeed, at least 15 of the 19 countries, which have so far participated in the Network, are represented by research organizations also involved in breeding. Four of them are even specialized "poplar institutes".

A general framework for the conservation of *P. nigra* in Europe, based on the very diverse situations and strategies developed at national level, could be established from a synthesis of 17 national reports (Lefèvre *et al.* 1998). The first priority was to ensure the coordination of ongoing *ex situ* conservation activities. Agreement among all participating Network members was easily obtained, probably due to their previous involvement in collaborative activities. Guidelines and lists of descriptors were developed; reference material exchanged among Network members and a core collection of clones established. The database of European clone collections was set up which now contains entries from 18 national collections. Available on the Internet and updated regularly, it is a tool of major interest for poplar breeding purposes worldwide. Of course, the exchange of poplar germplasm for breeding already occurred before EUFORGEN, but this database should make it more efficient, by providing up-to-date information on the material available throughout Europe, and allowing to easily detect duplicates among different collections. Recently, even Chinese and North American colleagues contacted Network members, asking for *P. nigra* pollen for their breeding programmes.

The difficulty sometimes lies in achieving the implementation of the agreed tasks, for example, many more accessions could be entered in the database, but compilation and collection of data are time consuming and costly. We have reached a fair level of coordination of *ex situ* activities over Europe, but a final implementation in all participating countries would require additional financial and technical input.

Concerning the *in situ* strategy, a synthesis of ongoing activities has so far been provided. The identification of *P. nigra* in the wild was identified as a key concern for conservation activities and a practical leaflet for non-specialists was published (now translated in 8 languages); a list of stand descriptors was also prepared. In comparison with the *ex situ* activities, *in situ* conservation has been looked upon from a methodological point of view rather than applied. This is because we generally lack inventories of riparian forests and of *P. nigra* in particular. Also, the riparian area may have different (specific) ownership patterns and forest services are not the only organizations involved in their management. Finally, the biology of a pioneer species makes it difficult to define concrete operational conservation action, because the management does not only concern the species itself but also, and probably mainly, the whole ecosystem. The dynamics of *P. nigra* is highly dependent on the water regime, but its conservation is obviously not the first priority in the management of river systems.

A joint research proposal came out of the Network discussions and was accepted for funding by the EU in 1997 (EUROPOP: Genetic diversity in river populations of European black poplar for evaluation of biodiversity, conservation strategies, nature development and genetic improvement). This project will provide a standardized evaluation of the genetic diversity within participating countries (both natural populations and *ex situ* collections).

Public awareness was also identified as a key task for the Network, probably because of the particular status of the species: with regard to poplars, the question of clonal forestry, interspecific hybridization, exotic germplasm and ecology of riparian sites is raised. We are convinced that sustainable management of the resource is possible, but it requires people with different interests (wood production, gene conservation, ecology, landscape etc.) to discuss on a reliable scientific basis.

Potential and perspectives

Objectives

This Network should continue its activity on *P. nigra,* with 2 objectives in the short term:

- To ensure the further coordination of *ex situ* conservation activities at the European level in the long term
- To facilitate the *in situ* conservation activities at the European level.

The first objective deals with the conservation of the diversity and its use. This will be useful not only for Europe. The strategy is well defined and its implementation has already begun in most countries. The first point is to complete the European database. In any case, it will be necessary to clarify the responsibilities for the maintenance and updating of this database. *Ex situ* conservation is "easy" with black poplar as it allows for an immediate use of germplasm (in breeding or restoration of riparian sites), but it cannot alone ensure the long-term genetic conservation. Dynamic strategies are needed: *in situ* or breeding populations.

The second objective is increasingly demanded by countries participating in the Network, which have already started *in situ* conservation or plan to do so. This area is particularly interesting for managers of riparian sites who want to monitor the consequences of their activities. Beyond methodological questions, the Network is also an opportunity to set up an applied *in situ* programme at the European level: EUFORGEN as such is an important motivation for many countries and, considering the situation of black poplar, motivation is deeply needed to support the existing plans and projects.

Activities

Concerning *ex situ* conservation, the Network should focus on the evaluation of genetic diversity and facilitate germplasm exchange when needed, either for poplar breeding or non-commercial plantations. For *P. nigra*, the diversity has prevailingly been assessed at the individual (clonal) level. This is probably a sound approach since we do not know exactly what is a provenance in this pioneer species (structure of diversity for adaptive traits, small linear "populations", decay of riparian sites). As a first step, the EUROPOP project will give an evaluation of the genetic diversity maintained in national clone collections compared with the diversity found in wild populations in Europe, after which decisions will be made about the need for further collecting. In fact, EUROPOP was initiated within the Network and the Network will benefit from its scientific results. The Network and the EUROPOP participants will join in a large panel of experts to define appropriate strategies for *in situ* conservation and re-introduction. The challenge is then to extend the work carried out also to non-EU member countries participating in the Network. Close links are certainly needed; the Network should help non-EU countries to achieve the evaluation of their collections following common standards. The Network should extend the current European database of passport data to characterization. The inclusion of more material from outside Europe should also be given attention.

To develop the *in situ* strategy, we will first have to identify a network of conservation sites over Europe, and then define management rules within and among the sites. Initially, the Network could at least identify a list of riparian areas considered by each country as essential for the genetic conservation of *P. nigra* and define their status (ownership, management, protection). A database of *in situ* conservation units should be organized after joint discussions between EUROPOP and the Network.

Some of the Network countries have a long-term breeding strategy for poplars, which includes breeding population. This can be considered as a dynamic approach to conservation, and a certain level of coordination among European breeding programmes might be useful. Concerning the selection of Euramerican hybrid clones (*P. deltoides* × *P. nigra*), the Network should actively promote the diversification of the genetic base used in the different poplar breeding institutes.

Finally, an evaluation of the costs of *ex situ*, *in situ* and breeding populations would be of great interest for the submission of research or applied conservation projects.

The Network is involved in the coordination of practical conservation activities but scientific discussions are also needed. One task for the Network is to submit joint project proposals, and therefore scientific discussions are needed prior to submission. Moreover, when a research project is accepted, a close link should be maintained with the Network, as is the case with EUROPOP, in order to enlarge the audience for both groups and exchange more ideas effectively in both directions. The Network will also benefit from the outcomes of the research projects.

Species

During its fourth meeting (October 1997), the *P. nigra* Network decided to extend its scope to *P. alba*. This matter will be further discussed during the next meeting. Not all countries are interested in this species and, initially, the activities will be limited to the application of the *ex situ* guidelines also for this white poplar. In the future, we can imagine two directions for the further extension of the Network: the first based on taxonomy (Salicaceae), the second based on ecology (riparian forest ecosystem).

Countries

The Network participants now represent a good coverage of the species distribution range. A closer involvement of Mediterranean countries, including North Africa, would be of great interest not only to the *P. nigra* Network, but probably also to other Networks.

Mode of operation

Two meetings of the Network were satellite to IPC Sessions (Izmit 1994 and Sarvar 1996); one followed the final meeting of an EU/FAIR project on poplars (Casale Monferrato 1995). This was a way to broaden the scientific scope of the meeting but, in fact, some countries still have difficulty in joining extra meetings. A joint meeting with the EUROPOP project is planned in 2000.

Communication

Internet is of great interest for most members and for the dissemination of results worldwide and much has already been done by the Network in that direction. This effort should continue (a more exhaustive database of Network participants, links with homepages of connected research projects etc.), bearing in mind that some partners still need other (non-Internet) access to this information. Concerning a forum of discussion, care should be taken not to overlap with other existing groups (Forestgen, Dendrome…).

Links with other Networks

Links with the other EUFORGEN Networks, but also networks dealing with wild relatives of cultivated crops, would be useful to enrich the discussion.

Scientific exchange among EUFORGEN Networks should be developed. Obviously, a joint meeting of Chairs and Vice-Chairs would be easy to organize, but a joint conference of a wider range of Network members could also offer a good opportunity to exchange new ideas, and particularly among people who are not all used to collaborating in the frame of EU research projects. Most of the Network members are poplar breeders and geneticists. The ecology and landscape management perspectives could be better represented. We should be able to invite these specialists to our meetings and facilitate a continued Network discussion.

Noble Hardwoods Network

Gösta Eriksson

Department of Forest Genetics, Swedish University of Agricultural Sciences, Uppsala, Sweden

Introduction

The Strasbourg Resolution S2 Follow-up Committee became interested in Noble Hardwoods partly owing to the reduction in the distribution area of these species due to silvicultural activities, mainly in central European countries. In contrast to the two first selected species, Norway spruce and cork oak, most of the species in our Network are characterized by scattered distribution patterns and some of them are rare.

Progress

At the first Network meeting (March 1996) a clear objective of the Network was stated: "Identification of minimum gene conservation activities in the long term from a European perspective". Tasks were given to different Network members and focused on developing strategies for the different Noble Hardwoods species and genera. These tasks will hopefully be completed in 1999. Many Network members have contributed in an excellent way to this work. A special paper on management of genetic resource populations was developed. A general presentation on evolutionary genetics as a basis for sound gene conservation was prepared, as well as on sampling in the absence of genetic knowledge. Another presentation dealt with consequences of global warming for the species.

A concise leaflet aimed at raising public awareness of the need for genetic conservation was published. A database of "grey" literature has been developed, as well as minimum standard descriptors for genetic resource populations. Classification of different developmental stages during bud burst and in-wintering has been documented. An EU-funded applied project on genetic resources of elm species has been actively working together with the Network.

Potential and perspectives

When the publication of technical guidelines for the conservation of the mandate species is ready, our main task will have been accomplished. Once this has been reached, it is important to follow-up the applied gene conservation activities in individual countries. Moreover, an effective gene conservation must rely on genetic knowledge, which is largely missing for most of the Noble Hardwoods. The Network could serve as a platform for the development of coordinated research. Initiatives in this direction have been taken on several occasions. The latest is to develop a joint proposal on mating patterns in some of our mandate species.

As regards the balance between theoretical and applied problems, it should be noted that a sound application must be based on solid evolutionary genetic knowledge and not emotionally motivated. Even if our task is purely applied, it must be based on scientific knowledge. Therefore, it is important that both the scientific and applied sides cooperate within the Network. In this regard, I see the technical guidelines as the primary task of the Network. Besides, it is important that the Network members communicate in their countries with the authorities in charge of applied genetic conservation.

Species

A table listing all species and the priorities assigned to them by individual countries was compiled. This was necessary in order to identify common priorities. Similarly, after the extension of the *Quercus suber* Network to other Mediterranean oaks, that Network has encountered problems common to those of our own Network.

Mode of operation and communication

With regard to the mode of operation, the meetings have been very constructive and most Network members delivered their reports on time. Meeting once a year might be regarded as a slow process and once every 6 months would certainly speed up the work. On the other hand, most of the Network members have many other duties, so once a year might be close to what is attainable. In my opinion the EUFORGEN Coordinating Secretariat has kept us very well informed about what is going on in the other Networks.

Links with other Networks

I do not see the need for every forest tree species that is growing in Europe to be considered. The principles for genetic conservation of Norway spruce are certainly valid for Scots pine as well. Perhaps more general issues such as the consequences of global warming for genetic conservation of tree species, the role of tree breeding in gene conservation and a thorough scrutiny of urgent research needs might be more relevant than species oriented work. Similarly, the role of forest tree gene conservation for the non-forest tree species dwelling in our ecosystems and dependent on our forest trees for their existence is important for EUFORGEN to address. Traditionally, these species were treated by ecologists with limited or no connection to forestry.

Tree breeders are poorly represented in the Network. Perhaps contacts with breeders would be more useful than meetings between Chairs and Vice Chairs of the Network.

Picea abies Network

Veikko Koski
Finnish Forest Research Institute, Vantaa, Finland

Introduction

When discussing the species to be taken as pilot cases for gene conservation networks in Europe, it was agreed that attention should not only be paid to rare and endangered trees. Widely distributed and commercially important species are, in fact, more significant from the viewpoint of genetic conservation in forest ecosystems, as well as tree breeding.

Pollution has caused considerable damage to Norway spruce forests in several countries. Extensive seed transfers also changed the natural structure of populations. On the other hand, simple and inexpensive *in situ* methods can be used in most cases for effective gene conservation.

Progress

Publication of the Technical Guidelines is perhaps the most concrete and useful accomplishment. Many countries have their own gene reserves, including nature protected areas, clonal banks or special gene conservation stands. The "handbook" will hopefully help national authorities to evaluate the gene reserves and offer practical advice to the forest officers responsible for their management. A common database of gene conservation units and a bibliography on Norway spruce genetics, breeding and genetic resources are underway.

Potential and perspectives

Due to various reasons, progress on conservation of forest genetic resources is not as rapid as we would like. Forest genetics and tree breeding are under heavy pressure in many countries. Without the active efforts of those concerned (forest geneticists), often short-sighted commercial policies may lead to genetic erosion. Commitment at a political level, actively supported by international collaboration, is necessary. In this regard, a time span of 10 years might be beneficial for EUFORGEN. If European countries can set a good example, hopefully other countries will accept gene conservation as a part of their national forestry policy. For the future I see the continuity and regeneration of various gene reserves as the crucial issue of genetic conservation. Most countries have their conservation populations, but perhaps no definite plans on how to regenerate them. A national plan on forest genetic resources and the commitment of the respective authority in collaboration with all key players would be the means to achieve them.

Some members would like to see a theoretical, purely scientific agenda during Network meetings. However, there are many other, more appropriate fora, such as IUFRO meetings, for scientific discussions. We have been supportive of the idea to occasionally invite a speaker presenting results of new and significant research. It should not be acceptable to say that practical operations can only be started after we have a complete genetic map and/or knowledge of the population structure at our disposal. There is wide support among colleagues for the fact that we must undertake actions with limited genetic knowledge.

Species

The original EUFORGEN *Picea abies* Network aimed to provide a "pilot case" for other conifer species with similar characteristics. To my mind, all such species with current, or at least potential value ought to be gradually included. There is a lot of work to be done. As agreed during the third *Picea abies* Network meeting (April 1998), we suggest broadening the scope to include other spruce and pine species. The Network will first accomplish the tasks it has started on Norway spruce.

Mode of operation

The number of countries participating in EUFORGEN has increased rapidly, and there is a particular interest if more species are included in a Network. This means that the active participation of all the Network members in meetings becomes difficult and the discussion tends to spread over miscellaneous issues. On the other hand, it is essential for each country to be present and to have an opportunity to contribute to the discussion. A possible solution would be to subdivide the Network into small groups (during meetings), with one or more participants who could then summarize the outcomes of the group discussions in the plenary sessions. Such smaller groups would be more efficient, but it would be difficult to select countries or people. This is also to some extent a political issue and we must not discriminate.

Communication

It may be a little disappointing that the activity of Network members decreases between meetings. Colleagues are quite active and critical in the meetings, but then deadlines for a number of agreed tasks are not maintained. The tasks given are usually not very time demanding, e.g. when updating the guidelines.

The distribution of information and encouraging a more active participation of the Network members is a challenge. There is a general consensus that the receipt of various kinds of advertisements, information leaflets, electronic messages etc. is time demanding and even counter-productive. We cannot compete with commercial firms in quantity and, therefore, high quality and well focused information effectively distributed to the persons involved or concerned is necessary. Internet is very useful, but we must not build too much on it. Not all members have access and the updating of homepages seems to be neglected by many organizations.

Links with other Networks

Links and cooperation among Networks are necessary. There are currently links through (a very few) persons who belong to more than one Network. General and/or scientific issues could be dealt with in joint meetings or workshops; these are usually not specifically related to only one species or a group of species. Furthermore, efforts to appeal to the decision makers would be more effective coming from EUFORGEN as a whole rather than through individual Networks.

Quercus suber Network

Maria Carolina Varela
Estacão Florestal Nacional, INIA, Oeiras, Portugal

Introduction

Cork oak is an important Mediterranean species with natural distribution range confined to the western part of the Mediterranean basin: Algeria, France, Italy, Morocco, Portugal, Spain and Tunisia.

Thanks to the joint efforts by various countries, FAO, IPGRI/EUFORGEN and EU financed projects, concerted activities on the management, genetic research and conservation of genetic resources in cork oak have been developed during the past few years. Several relevant initiatives should be mentioned:

- Séminaire méditerranéen sur la régénération des forêts de chêne liège dans les pays méditérranéens – held in Tunisia, in 1996
- G.R.A.M. - Groupe de Recherches Agronomiques Méditérranéennes/Ressources Génétiques Forestières – a French initiative for the enhancement of the scientific cooperation among Mediterranean countries. GRAM meetings provide opportunities for contacts, discussion and further cooperation
- Séminaire sur l'Amélioration, la Conservation et l'Utilisation des Ressources Génétiques Forestières Marocaines – held in Morocco, in 1997.

Progress

The following *Quercus suber* Network meetings were held so far:

1. December 1994, Rome, Italy.
2. February 1995, Rome, Italy.
3. June 1996, Sassari, Italy - Joint meeting with EU/FAIR 1 CT 95 0202 (participation of Morocco for the first time).
4. February 1997, Almoriama, Spain - Joint meeting with EU/FAIR 1 CT 95 0202 (participation of Morocco and Tunisia with support from FAO Silva Mediterranea).
5. April 1998, Le Lavandou, France - Joint meeting with EU/FAIR 1 CT 95 0202 and Microaction B7 4100 from EU DG IB/A.

The cork oak focal point of the S2 Follow-up Committee organized the first meeting on this species in Lisbon, in July 1993. The meeting discussed issues related to gene conservation of cork oak in Europe and produced a document "Recommendations of the scientific advisory group for the conservation of the genetic resources of *Quercus suber*".

Through the EUFORGEN Network, with the overall support of FAO Forestry Department, collaborative project proposals for the conservation of genetic resources of cork oak were jointly prepared and submitted for funding to the grant programmes of the European Union. A concerted action and a research proposal guided by the need of deeper genetic knowledge for sustained conservation of genetic resources of cork oak were submitted. The proposal for a concerted action was adopted for funding (FAIR 1 CT 95 0202).

The implementation of the concerted action and the collaborative tasks of the EUFORGEN Network, supported by the links with FAO, provided an excellent basis for work in synergy among all participating countries.

These include France, Italy, Portugal (coordinator) and Spain, as well as experts from Germany and Sweden. Three North African cork oak countries (Algeria, Morocco and Tunisia) also joined the project with complementary support from the European Union.

A strong commitment from the various teams led to a unique genetic collection representing the cork oak diversity throughout the Mediterranean basin, encompassing 34 provenances and 600 mother trees. From this collection Algeria, France, Italy, Morocco, Portugal, Spain and Tunisia obtained genetic material to establish a network of 10 provenance trials and 6 progeny trials. Studies on adaptation, evaluation of genetic parameters and further characterization of the species have been undertaken in a collaborative way.

A database of scientific publications and 'grey' literature was one of the first activities of the Network, accomplished through the joint efforts with the EU funded concerted action (see below). The database is available on the Internet.

Technical guidelines are being developed to provide the basis for a sound conservation of cork oak genetic resources and to encourage and promote gene conservation measures as part of normal forestry practice for the sustainable use of the species.

Potential and perspectives

Species

Enlargement of the Network to include additional species has been addressed since the second meeting. It was, however, felt that because of lacking gene conservation programmes and activities in the Mediterranean forestry in general, the Network should concentrate its efforts on one species and postpone the enlargement when sound work was achieved.

The Mediterranean basin is a region of extraordinary diversity. Human pressure, accompanied by the very low current economic interest in and use of a number of species, makes a number of tree species particularly threatened. This situation is obvious for the group of evergreen Mediterranean oaks.

Since the EUFORGEN *Quercus suber* Network has made a satisfactory progress towards achieving its objectives, time has come to propose the enlargement of the Network to include all evergreen Mediterranean Oaks.

Countries

The Network currently involves France, Italy, Portugal and Spain. Algeria, Morocco and Tunisia have also participated in a number of activities in the framework of this collaboration.

Owing to the complementarity and ongoing links between EUFORGEN and the EU project FAIR 1 CT 95 0202, the Network also benefited from the inputs of experts from Germany and Sweden.

Mode of operation

The first meetings of the Network have been possible thanks to national funding of each of the participants as well as IPGRI and FAO support.

Under EUFORGEN the issue of conservation of cork oak genetic resources can rely on the work conducted in a planned and organized way. Publications also provided a certain level of support for national activities, adding value to the regular meetings among the countries.

The joint meetings between the EUFORGEN Network and the EU/FAIR concerted action participants are an excellent basis for achieving synergies. Mutual benefits from the scientific discussion include publications, which have a much wider circulation than any of the activities could achieve separately.

Increased knowledge on the species should be used to facilitate the conservation of cork oak genetic resources on the basis of simple methodologies introduced on the normal management of the species and in breeding strategies.

Links with other Networks

No direct links have been established with the other EUFORGEN Networks. However, the fact that most European countries nominated a National Coordinator for forest genetic resources issues also facilitates the scientific flow among Networks.

Links with other activities

Silva Mediterranea is the FAO statutory body facilitating at present six networks:

FAO/Silva Mediterranea Network	International coordinator
Forest fire mangement	R. Velez, Spain
Silviculture of *Cedrus* sp.	M. Hirit, Morocco
Silviculture of *Pinus pinea*	G. Catalan, Spain
Selection of stands of Mediterranean conifers for the production of seed for reforestation programmes	M. Topac, Turkey
Silviculture of *Quercus suber*	M.C. Varela, Portugal
Multipurpose species	M. Zaafouri, Tunisia

The network on Silviculture of *Quercus suber* was joined by Algeria, Bulgaria, Cyprus, France, Italy, Jordan, Morocco, Portugal, Spain, Tunisia and Turkey.

Social Broadleaves Network

Antoine Kremer

INRA Station de recherches forestières, Pierroton, Gazinet, France

Introduction

Following recommendations by the National Coordinators, a fifth Network was created in EUFORGEN concerning Social Broadleaves. For the time being the Network addresses *Quercus petraea*, *Quercus robur*, *Fagus sylvatica* and *Fagus orientalis*. Other species may be added in the future.

The first meeting of the Social Broadleaves Network was held in Bordeaux, 23-25 October 1997. Participants were representing 23 countries at the first meeting. The meeting permitted to draw a general picture of the status of genetic resources available in Europe on oak and beech and to construct a joint workplan.

Progress

During the first meeting in Bordeaux, common needs and objectives were identified and tasks were discussed that should be addressed in the next future. Common needs concern particularly:

- To improve information flow among countries
- To harmonize research priorities and disseminate available research results
- To address legislation-related issues
- To develop joint, long-term, practically-oriented strategies and standardize or develop methodologies
- To raise awareness of decision-makers, the general public and forest owners about the necessity of conserving genetic resources of Social Broadleaves.

The participants developed a common workplan with shared responsibilities, which aims at strengthening collaboration among European countries by providing practical outputs such as technical guidelines for the sampling, design and management of gene conservation units, databases, information resources and public awareness tools.

Potential and perspectives

During the first meeting, the development of gene conservation strategies was identified as a fundamental task of the Network. As a first step, the current state of the art in the different countries has been assessed. Information about methodologies currently used for *in situ* and *ex situ* conservation in European countries will be gathered through a questionnaire. This basic information will lead to preparing a background document to be presented at the next Network meeting. The response to the questionnaire will help to identify topics where additional research is needed (e.g. spatial and genetic structure of diversity in gene conservation units, influence of silvicultural practices). The ultimate objective of the activity is to provide technical recommendations (guidelines) for the sampling, design and management of gene conservation units in beech and oak. It is expected that the research needs identified will be a basis for collaborative research projects to be submitted to different agencies. Strong interface and interaction between the Network and EU supported research projects will be tied, in order to promote dissemination of scientific results useful for promoting and implementing conservation strategies.

Information flow among countries on the genetic resources available throughout Europe, their evaluation in provenance tests and in genetic diversity surveys, will be improved by completing current databases.

Species

The Network agreed that the species covered by the activities should be *Quercus petraea*, *Quercus robur*, *Fagus sylvatica* and *Fagus orientalis*. However, concerns were raised about introducing other species (*Q. pubescens, Q. pyrenaica, Q. cerris…).* Future inclusion of the new species should be considered according to the needs expressed by the different countries.

Countries

Most west and east European countries participate in the Networks. However, some important geographic areas, where refugial zones have been described are missing: several countries from the Balkan Peninsula, and from the Caucasus.

Mode of operation and communication

Meetings every 18 to 24 months have been planned. The next meeting will take place in June 1999 in Birmensdorf (Switzerland). This meeting is planned as a joint meeting with the EU supported FAIR project entitled "Synthetic maps of gene diversity and provenance performance for utilization and conservation of oak genetic resources in Europe". The creation of an Internet Web site may be considered as an effective tool for exchanging information among participants.

Links with other Networks

In the long run links with the *Quercus suber* Network may be mutually beneficial, especially with regard to gene conservation of those south European oak species which can hybridize with temperate oaks. Generic meetings between the two Networks that include oaks may be beneficial for discussing common topics as practical conservation strategies. At one point, the need of a general technical meeting across all Networks may appear in order to share different opinions on conservation strategies, and to discuss common technical concerns related to the management of gene conservation units.

Annex IV. European Forest Genetic Resources Programme (EUFORGEN) - Proposal for a Phase II[15] (1 January 2000 - 31 December 2004)

Scope and objectives

The signatory states of Resolution S2 and participating international institutions at the First Ministerial Conference on the Protection of Forests in Europe (Strasbourg, 1990) committed themselves to implement in their own countries, using whatever methods seem most appropriate, a policy for the conservation of forest genetic resources.

Resolution S2 called for the development of an instrument for cooperation on conservation of genetic diversity of European forests:

"To facilitate and extend the efforts undertaken at national and international levels, a functional but voluntary instrument of international cooperation should be found without delay from among the existing relevant organizations to promote and coordinate:

1. in situ *and* ex situ *methods to conserve the genetic diversity of European forests;*
2. exchanges of reproductive materials;
3. the monitoring of progress in these fields."

The European Forest Genetic Resources Programme (EUFORGEN) was established in October 1994 as the implementation mechanism of Resolution S2 (Table 1). The overall goal of EUFORGEN is to ensure the effective conservation and the sustainable use of forest genetic resources in Europe.

Table 1. Implementation of the objectives of Strasbourg Resolution S2 through EUFORGEN activities during Phase I and proposed for Phase II

Resolution S2	Implementation through EUFORGEN	Phase I	Phase II
In situ and *ex situ* conservation of genetic diversity	• exchange of information	xxx (*)	xxx
	• long-term regional gene conservation strategies: development	xxx	xx
	• long-term regional gene conservation strategies: coordination and promotion	-	xxx
	• technical guidelines	xx	xxx
	• descriptors and databases	xxx	xx
	• raising public awareness	x	xxx
	• identification of common research needs	xx	xx
Exchanges of reproductive materials	• exchange of genetic materials for research and gene conservation purposes	xx	xx
	• monitoring of policy and legal developments that impact on the exchange of reproductive materials among European countries	xx	xxx
	• promote and facilitate the development of mechanisms for efficient exchange of reproductive materials	-	x
Monitoring of progress	• overviews of information	xx	xxx
	• state-of-the-art reports by countries presented at Steering Committee meetings	x	xx

(*) xxx - high attention received and many outputs provided
xx - attention received and outputs provided
x - low attention received and few outputs provided

[15] This document was discussed and endorsed at the Second EUFORGEN Steering Committee meeting, Vienna, Austria, 26-29 November 1998.

Genetic resources aspects have been included in the Pan-European Process on Forests (Second Ministerial Conference in Helsinki, 1993 and Third Ministerial Conference in Lisbon, 1998).

As a coordinated European effort, EUFORGEN promotes the establishment and implementation of national programmes on forest genetic resources and facilitates the development of common minimum standards and determination of mechanisms for priority setting.

EUFORGEN is financed by its participating countries and is coordinated by the International Plant Genetic Resources Institute (IPGRI) in collaboration with the Food and Agriculture Organization of the UN (FAO). The Programme is overseen by a Steering Committee of National Coordinators nominated by the participating countries.

EUFORGEN operates through a small number of Networks focused on species or groups of species; presently five Networks are operational. Network members from participating countries carry out agreed activities using their own resources, as inputs in kind to the Programme.

It was originally agreed that EUFORGEN be established for an initial phase of five years (October 1994 to October 1999).

The first Steering Committee meeting, held in Sopron, Hungary, 19-20 November 1995, endorsed the mode of operation for EUFORGEN. The second Steering Committee meeting, in Vienna, Austria, 26-29 November 1998, reviewed the progress made and recommended that a second Phase of five years be launched starting from 1 January 2000.

In this second Phase, EUFORGEN should be further developed in support of meeting the objectives outlined in Resolution S2. It was agreed that the main level for implementing the overall objectives remained the species oriented Networks.

Mode of operation proposed for Phase II

The EUFORGEN Programme operates as a multilateral trust fund. Individual countries formally join EUFORGEN by signing a Letter of Agreement with IPGRI, in which the financial contribution to be made to the Programme is specified.

The Agreement will be deemed invalid if the country does not meet its financial obligations for two years.

National Coordinators and Steering Committee

When joining EUFORGEN, each country is requested to nominate a National Coordinator as the official contact person between the Secretariat and the participating country for all matters relating to the Programme. A Steering Committee composed of the National Coordinators of all participating countries has the overall responsibility for the Programme and meets twice during a Phase to:

- review the progress made, discuss and decide upon further activities
- set priorities
- review the audited financial reports prepared by the Secretariat
- approve the budget of the Programme
- make recommendations and decisions regarding the future activities
- review the concurrence of Network activities with the objectives of EUFORGEN
- discuss issues relevant to the conservation of forest genetic resources in Europe.

If there is a strong need to convene in a time period shorter than three years, an additional *ad hoc* Steering Committee meeting will be organized.

Decisions at Steering Committee meetings are usually taken by consensus. If necessary in certain cases, the procedure of voting by Steering Committee members will be followed.

The role of the National Coordinators is to:

- participate in the Steering Committee meetings
- ensure that necessary resources are chanelled to the Programme
- liaise between the Secretariat and the sponsoring ministry(ies)
- liaise between the Secretariat and the national institutions involved in the EUFORGEN activities
- nominate attending and corresponding members to the Networks and maintain regular contacts with them
- assist national institutes in carrying out the activities of the Programme.

EUFORGEN Networks

EUFORGEN operates through Networks in which forest geneticists and other forestry specialists work together to analyze needs, exchange experiences and develop conservation objectives and methods for selected species. The Networks also contribute to the development of conservation strategies for the ecosystems to which these species belong. Network members and other scientists and forest managers from participating countries carry out agreed workplans with their own resources as inputs in kind to the Programme.

Five Networks are operational:

- Conifers (started as *Picea abies* Network)
- Mediterranean oaks (started as *Quercus suber* Network)
- *Populus nigra* (and *P. alba*)
- Noble Hardwoods
- Social Broadleaves

The concurrence of Network activities with the objectives of EUFORGEN is reviewed by the Steering Committee.

Two different levels of involvement of countries in the Networks are distinguished: attending members, whose participation in the Network meetings is financed by the Programme and corresponding members who provide and receive information to the Network but do not attend its meetings. Both attending and corresponding members of a Network receive the meeting's report and are expected to facilitate the implementation of workplans given therein. Attending and corresponding members are listed and their contributions published in the reports. This structure contributes towards maintaining Network meetings reasonably small and therefore dynamic and ensures that each country has its (attending or corresponding) representative for each species or group of species.

Attending and corresponding members are nominated by the National Coordinators. The Network members should be identified according to the concerns and interests of individual countries and from those institutions which are recognized as playing (or prepared to play) a major role with regard to the species concerned. It is understood that this structure is flexible. The Networks meet (attending members) and exchange information (attending and corresponding members) at regular intervals in order to:

- set priorities within the Network
- plan collaborative activities such as inventories of the situtation regarding the genetic resources of the species concerned, long-term conservation strategies and technical guidelines, European databases and lists of descriptors
- establish and implement workplans
- identify common research needs
- prepare joint project proposals
- agree on the sharing of responsibilities for individual tasks
- contribute to raising public awareness
- monitor progress made.

To determine the number of Network meetings to which a country can nominate attending members, a mechanism dependent on the country's yearly contribution was proposed. The following guideline should be used:

Yearly contribution (US$)	Number of Networks to which attending members can be nominated
2,000	2
5,000	3
10,000/12,500	4
30,000	5

It was agreed that the number of Network meetings organized per year be reviewed in the light of needs and availability of funds. The cost of the participation of attending Network members in Network meetings is included in the attached budget (Table 2).
Besides the species oriented Network activities, EUFORGEN facilitates the dissemination of information and the development of various collaborative activities on the conservation and use of forest genetic resources in Europe.

Making full use of the complementarity and information sharing between the five Networks, emphasis should be given to the possibilities for combined activities around specific themes.

Inter-Network Group

A Working Group consisting of the Chairs and Vice-Chairs of all Networks and two representatives of the EUFORGEN Management Committee will be established. The aim is to harmonize priorities for action among the Networks, to avoid duplication of effort and to exchange information and experiences of the Networks.

International Secretariat

The Secretariat is provided by IPGRI. A Management Committee composed of two representatives of FAO and two representatives of IPGRI meets twice a year to provide technical and scientific advice to the Coordinator.

The EUFORGEN Coordinator, provided with secretarial assistance, is appointed by IPGRI to serve the different Networks. Day-to-day supervision of the EUFORGEN Coordinator is provided by IPGRI in the framework of technical and scientific advice at the Management Committee level.

The Secretariat reports on the activities of the Programme and prepares a financial report to be submitted to National Coordinators at the end of each year and at each meeting of the Steering Committee. An audited financial report is sent to all members of the Steering Committee one month prior to each regular Steering Committee meeting.

The role of the Secretariat is to:

- ensure the implementation of the Programme in accordance with the mandate given by the Steering Committee
- be responsible for the financial management of the Programme
- liaise with the National Coordinators
- liaise with the Management Committee
- prepare and organize Network meetings
- provide logistic support to the Networks and ensure that the agreed workplans are carried out
- liaise between the different Networks and with the Inter-Network Group
- prepare reports of the Network meetings and other publications
- assist with the search for contributions in kind and financial for carrying out tasks of the workplans

- gather and disseminate relevant information
- contribute to raising public awareness.

The Secretariat facilitates collaboration with IUFRO and other relevant international organizations on the basis of complementarity of activities.

Budget proposed for Phase II

Table 2 provides an overview of the budget of the Programme for Phase II.

An estimated minimum budget of ca. US$300,000 will be needed for Phase II in order to maintain the level of the activities established or initiated during the first Phase. Overhead charges by IPGRI remain at 13% to cover the provision of space in IPGRI premises, the input and time of IPGRI professional staff, etc.

Contributions are made by the countries on an annual basis to the EUFORGEN trust fund established by IPGRI to cover the costs of coordination of the Programme. Calculation of the level of contribution for each country is based on the revised United Nations assessment rates which take into account the economic development and the financial situation of its member countries (UNGA Resolution 52/215/1998; see Table 3).

In addition to the financial contribution to cover the costs of coordination of the Programme, participating countries provide contributions in kind to the EUFORGEN Networks of their greatest concern and interest (e.g. staff time).

Additional financial resources to support specific activities of the Networks (such as facilities for maintaining databases or collections on behalf of a Network, publications in several languages, provision of training) can be sought.

Table 2. Estimated budget (*per annum* in US$) for EUFORGEN Phase II (2000-2004)

Details US$	
Staff (appointed by IPGRI):	
Coordinator 80	,000
Secretarial assistance	45,000
Network meetings	75,000
Steering Committee meetings	20,000
(estimated 2 meetings in Phase II)	
Travel (Secretariat)	13,000
Communication and office consumables	10,000
Publications, Internet, newsletter	25,000
Subtotal 26	8,000
Overhead 13%	34,840
Total 3	**02,840**

Table 3. Annual contributions of countries (in US$) for Phase II (2000-2004)

Country	UN rates	Category	Phase I	Phase II
Albania 0.0	03	A	2000	2000
Monaco[1]	0.004 A		2000	2000
Macedonia, FYR	0.004	A	2000	2000
Armenia[1] 0	.011	A	2000	2000
Malta[1] 0	.014	A	2000	2000
Estonia[1] 0	.015	B1	5000	5000
Moldova[1] 0	.018	B1	5000	5000
Bulgaria 0	.019	B1	5000	5000
Georgia 0.0	19	B1	5000	5000
Azerbaijan 0.0	22	B1	5000	5000
Lithuania[1] 0	.022	B1	5000	5000
Latvia[1] 0	.024	B1	5000	5000
Iceland 0.0	32	B1	2000	5000
Cyprus 0	.034	B1	2000	5000
Yugoslavia 0.0	34	B1	5000	5000
Croatia[1] 0	.036	B1	5000	5000
Slovakia[1] 0	.039	B1	5000	5000
Slovenia[1] 0	.061	B1	5000	5000
Romania 0	.067	B1	5000	5000
Luxembourg[1] 0	.068	B1	5000	5000
Belarus[1] 0	.082	B1	5000	5000
Hungary[1] 0	.120	B2	5000	5000
Czech Republic[1] 0	.121	B2	5000	5000
Poland[1] 0	.207	B2	5000	5000
Ireland[1] 0	.224	B2	5000	5000
Ukraine[1] 0	.302	B2	10000	5000
Greece 0.3	51	B2	5000	5000
Portugal[1] 0	.417	B2	5000	5000
Turkey 0.4	40	B2	5000	5000
Finland[1] 0.5	42	C	10000	10000
Norway[1] 0.6	10	C	5000	10000
Denmark[1] 0.6	91	C	10000	10000
Austria[1] 0.9	41	C	10000	10000
Sweden[1] 1.0	84	D	10000	12500
Belgium[1] 1.1	03	D	10000	12500
Switzerland[1] 1.2	15	D	10000	12500
Russia[1] 1.4	87	D	30000	12500
The Netherlands[1] 1.6	31	D	10000	12500
Spain[1] 2.5	89	D	10000	12500
United Kingdom[1] 5.0	90	E	30000	30000
Italy[1] 5.4	32	E	30000	30000
France[1] 6.5	40	E	30000	30000
Germany[1] 9.8	08	E	30000	30000

[1] - country has participated in Phase I of EUFORGEN

Notes:
UN Assessment Rates for 1999 as % of the re gular budget, UN General As sembly 2 0 J anuary 19 98, A/RES/52/215
Key to calculation of annual contributions to EUFORGEN (threshold):

A	x<0.015	B1	0.015<=x<0.1	B2	0.1<=x<0.5
C	0.5<=x<1.0	D	1.0<=x<5.0	E	5.0<x

Annex V. List of EUFORGEN publications

1995

***Populus nigra* Network.** Report of the first meeting, 3-5 October 1994, Izmit, Turkey. 52 pages. E. Frison, F. Lefèvre, S. de Vries and J. Turok (compilers). IPGRI, Rome, 1995.

***Picea abies* Network.** Report of the first meeting, 16-18 March 1995, Stará Lesná, Slovakia. 96 pages. J. Turok, V. Koski, L. Paule and E. Frison (compilers). IPGRI, Rome, 1995.

***Quercus suber* Network.** Report of the first two meetings, 1-3 December 1994 and 26-27 February 1995, Rome, Italy. 41 pages. E. Frison, M.C. Varela and J. Turok (compilers). IPGRI, Rome, 1995.

1996

Report of the Steering Committee. First Meeting, 19-20 November 1995, Sopron, Hungary. 27 pages. J. Turok, C. Palmberg-Lerche, Cs. Mátyás, M. Arbez and E. Frison (compilers). IPGRI, Rome, 1996.

***Populus nigra* Network.** Report of the second meeting. 10-12 September 1995, Casale Monferrato, Italy. 27 pages. Incl.: Identification Sheet. J. Turok, F. Lefèvre, L. Cagelli and S. de Vries (compilers). IPGRI, Rome, 1996.

Noble Hardwoods Network. Report of the first meeting, 24-27 March 1996, Escherode, Germany. 172 pages. J. Turok, G. Eriksson, J. Kleinschmit and S. Canger (compilers). IPGRI, Rome, 1996.

1997

***Populus nigra* Network.** Report of the third meeting, 5-7 October 1996, Sárvár, Hungary. 77 pages. J. Turok , F. Lefèvre, S. de Vries and B. Tóth (compilers). IPGRI, Rome, 1997.

***Picea abies* Network.** Report of the second meeting, 5-7 September 1996, Hyytiälä, Finland. 67 pages. J. Turok and V. Koski (compilers). IPGRI, Rome, 1997.

Technical guidelines for genetic conservation of Norway spruce (*Picea abies* (L.) Karst.). 42 pages. V. Koski, T. Skrøppa, L. Paule, H. Wolf and J. Turok. IPGRI, Rome, 1997.

***Quercus suber* Network.** Report of the third and fourth meetings, 9-12 June 1996, Sassari, Sardinia, Italy and 20-22 February 1997, Almoraima, Spain. 87 pages. J. Turok, M. C. Varela and C. Hansen (compilers). IPGRI, Rome, 1997.

1998

Noble Hardwoods Network. Report of the second meeting, 22-25 March 1997, Lourizán, Spain. 104 pages. Incl. leaflet: Conservation of genetic resources of Noble Hardwoods. J. Turok, E. Collin, B. Demesure, G. Eriksson, J. Kleinschmit, M. Rusanen and R. Stephan (compilers). IPGRI, Rome, 1998.

***Populus nigra* Network.** Report of the fourth meeting, 3-5 October 1997, Geraardsbergen, Belgium. 85 pages. J. Turok , F. Lefèvre, S. de Vries, N. Alba, B. Heinze and J. Van Slycken (compilers). IPGRI, Rome, 1998.

Report of the first EUFORGEN meeting on Social Broadleaves. 23-25 October 1997, Bordeaux, France. 176 pages. J. Turok, A. Kremer and S. de Vries (compilers). IPGRI, Rome, 1998.

Conservation of Forest Genetic Resources in Europe. Proceedings of the European Forest Genetic Resources Workshop, 21 November 1995, Sopron, Hungary. 60 pages. J. Turok, C. Palmberg-Lerche, T. Skrøppa and A.S. Ouédraogo (editors). IPGRI, Rome, 1998.

Noble Hardwoods Network. Report of the third meeting, 13-16 June 1998, Sagadi, Estonia. 104 pages. J. Turok, J. Jensen, Ch. Palmberg-Lerche, M. Rusanen, K. Russell, S. de Vries and E. Lipman (compilers). IPGRI, Rome, 1998.

1999

Sustainable Forest Genetic Resources Programmes in the Newly Independent States of the Former USSR. Proceedings of a workshop, 23-26 September 1996, Belovezha, Belarus. 108 pages. Russian/English edition. G.G. Goncharenko, J. Turok, T. Gass and L. Paule (editors). IPGRI, Rome, 1999.

Populus nigra **Network.** Report of the fifth meeting, 5-8 May 1999, Kyiv, Ukraine. 88 pages. J. Turok, F. Lefèvre, S. de Vries, B. Heinze, R. Volosyanchuk and E. Lipman (compilers). IPGRI, Rome, 1999.

Agenda

26 November 1998

1. Opening of the meeting
   - 1.1 Introductory remarks (IPGRI, FAO)
   - 1.2 Election of Chairpersons
   - 1.3 Adoption of the Agenda

2. Welcome address by host country

3. Technical Workshop
   - 3.1 Session I: Genetic resources in the pan-European Process on Forests
   - 3.2 Session II: Contribution of Europe to the global efforts on forest genetic resources
   - 3.3 General discussion and recommendations

27 November 1998

4. Coordinator's Report on EUFORGEN

5. Presentation of the EUFORGEN Networks by Chairs

6. Response by Steering Committee members; discussion and adoption of the Report

7. Statements by observers

28 November 1998

8. National programmes on forest genetic resources in Europe (status, needs and priorities)

9. Proposal for a second Phase of EUFORGEN

10. Review of EUFORGEN Document
    - 10.1 Scope and objectives
    - 10.2 Mode of operation; Networks
    - 10.3 Communications
    - 10.4 Budget
    - 10.5 Complementary programme modules (training; collaboration with EU-funded projects)

29 November 1998

11. Conclusions
12. Closure

Participants

Mr Konstandin Dano
Forest and Pastures Research Institute
Kutia postare 8367
Tirana
Albania
Tel: (355-42)71237
Fax: (355-42)71242

Mr Karen Ter-Ghazaryan
Forestry Research Centre
Ministry of Nature Protection
Grikor Lusarovich Street 15
375015 Yerevan
Armenia
Tel: (374-2)582172/583655
Fax: (374-2)151959
Email: ktg.arminco.com

Mr Thomas Geburek
Institute of Forest Genetics, FBVA
Federal Forest Research Centre
Hauptstrasse 7
1140 Wien
Austria
Tel: (43-1)87838 2223
Fax: (43-1)87838 2250
Email: thomas. bva.bmlf.gv.at

Mr Grigorij G. Goncharenko
Department for Forest Genetics and Molecular Biology
Institute of Forestry
Proletarskaja 71
246654 Gomel
Belarus
Tel: (375-232)537373
Fax: (375-232)535389
Email: abgen.gomel.by

Mr Jos Van Slycken
Institute for Forestry and Game Management
Gaverstraat 4
9500 Geraardsbergen
Belgium
Tel.: (32-54)437110
Fax: (32-54)410896
Email: jozef. in.vlaanderen.be

Mr Alexander H. Alexandrov
Forestry Research Institute
Kliment Ohridski Blvd. 132
1756 Sofia
Bulgaria
Tel: (359-2)622961
Fax: (359-2)622965

Mr Oscar Eyog Matig
Centre de Recherches Agronomiques d'Ekona, Station Polyvalente de Kribi
Bureau d'Edea
BP 223
Edea
Cameroon
Tel: (237)464137
Fax: (237)464788/461419
Email: compuserve.com

Mr Joso Gracan
Forest Research Institute
Cvjetno Naselje 41
10450 Jastrebarsko
Croatia
Tel: (385-1)6281022
Fax: (385-1)6281493
Email: gracan. sumins.hr

Mr Karel Vancura
Forestry Development Department
Ministry of Agriculture
Tesnov 17
117 05 Praha 1
Czech Republic
Tel: (420-2)21812357
Fax: (420-2)21812988
Email: mze.cz

Mr Bjerne Ditlevsen
Tree Improvement Station
National Forest and Nature Agency
Krogerupvej 21
3050 Humlebæk
Denmark
Tel: (45-49)190214
Fax: (45-49)160016
Email: sns.dk

Mr Ülo Tamm
Faculty of Forestry
Kreutzwaldi 5
2400 Tartu
Estonia
Tel: (372-7)422346
Fax: (372-7)421053
Email: ph.eau.ee

Mr Veikko Koski
Finnish Forest Research Institute
PO Box 18
01301 Vantaa
Finland
Tel: (358-9)857051
Fax: (358-9)85705711
Email: veikko. metla.fi

Ms Outi Savolainen
Department of Biology
University of Oulu
PO Box 333
90571 Oulu
Finland
Tel: (358-8)5531782
Fax: (358-8)5531061
Email: outi. oulu.fi

Mr Michel Arbez
Station de Recherches Forestières
INRA, Domaine de l'Hermitage
BP 45
Gazinet/Pierroton
33610 Cestas-Principal
France
Tel: (33)557979000
Fax: (33)557979088
Email: michel. zouk.pierroton.inra.fr

Mr François Lefèvre
Unité de Recherches Forestières Méditerranéenes, INRA
Avenue A. Vivaldi
84000 Avignon
France
Tel: (33)490135920
Fax: (33)490135959
Email: avignon.inra.fr

Mr Helmut Dörflinger
Forestry Division
Bundesministerium für Ernährung, Landwirtschaft und Forsten
Rochusstrasse 1
53107 Bonn
Germany
Tel: (49-228)5294334
Fax: (49-228)5294318/5294262

Mr Richard Stephan
Institute for Forest Genetics and Forest Tree Breeding, BFH
Sieker Landstrasse 2
22927 Grosshansdorf
Germany
Tel: (49-4102)696144
Fax: (49-4102)696200
Email: aixh0001.holz.uni-hamburg.de

Mr Csaba Mátyás
Department of Environmental Sciences
University of Sopron
Bajcsy-Zsilinszky u. 4
9401 Sopron
Hungary
Tel: (36-99)311100
Fax: (36-99)311103
Email: efe.hu

Mr David G. Thompson
Coillte Teoranta
The Irish Forestry Board
Coillte Research Laboratory
Newtownmountkennedy
Ireland
Tel: (353)12819493
Fax: (353)12810465
Email: ol.ie

Mr Stefano Allavena
Corpo Forestale dello Stato
Ministero per le Politiche Agricole
Via Giosue Carducci 5
00187 Roma
Italy
Tel: (39)064824765
Fax: (39)064820665

Mr Alfas Pliûra
Department of Forest Genetics and Reforestation
Forest Research Insitute
4312 Girionys (Kaunas)
Lithuania
Tel: (370-7)547245
Fax: (370-7)547446
Email: pub.osf.lt

Mr Alexandar Andonoski
Faculty of Forestry
University Ss. Cyril and Metodis
PO Box 235
91000 Skopje
Macedonia, FYR
Tel:(389-91)239033
Fax:(389-91)253940

Mr Joseph Borg
Research and Development Centre
Ministry of Agriculture and Fisheries
Ghammieri
Marsa
Malta
Tel: (356)248803
Fax: (356)236389
Email: joe.a. magnet.mt

Mr Gheorghe Postolache
Laboratory of Silviculture
Institute of Botany
Padurii 18
277018 Chisinau
Moldova
Tel: (373-2)523553
Fax: (373-2)223348
Email: asm.md

Mr Sven M.G. de Vries
ALTERRA Green World Research
PO Box 47
6700 AA Wageningen
The Netherlands
Tel: (31-317)477841
Fax: (31-317)424988
Email: s.m.g. alterra.wag-ur.nl

Mr Tore Skrøppa
Norwegian Forest Research Institute
Høgskoleveien 12
1432 Ås
Norway
Tel: (47-64)949000
Fax: (47-64)942980
Email: tore. nisk.no

Mr Jan Matras
Department of Genetics and Physiology of Woody Plants
Forestry Research Institute
Bitwy Warszawszkiej 1920r 3
00973 Warszawa
Poland
Tel: (48-22)8464660
Fax: (48-22)8462018
Email: las.ibles.waw.pl

Ms Maria Carolina Varela
Estacão Florestal Nacional, INIA
Quinta do Marques
Edificio do Procalfer
2780 Oeiras
Portugal
Tel: (351-1)4415763
Fax: (351-1)4415660

Mr Ioan Blada
Forest Research and Management Institute
Sos. Stefanesti 128, sector 2
72904 Bucharesti
Romania
Tel: (40-1)2406845
Fax: (40-1)2406845/2406095

Mr Andrey Prokazin
Russian Tree Breeding Centre
Nadsonovskaya 13
141200 Pushkino (Moscow)
Russian Federation
Tel: (7-095)5843407
Fax: (7-096)5326662
Email: lessem.msk.ru

Mr Ladislav Paule
Faculty of Forestry
Masarykova 24
960 53 Zvolen
Slovakia
Tel: (421-855)5334486
Fax: (421-855)5350608
Email: vsld.tuzvo.sk

Ms Hojka Kraigher
Department of Forest Biology and Ecology
Slovenian Forestry Institute
Vecna pot 2
1000 Ljubljana
Slovenia
Tel: (386-61)1231343
Fax: (386-61)273589
Email: hojka. gozdis.si

Ms Katarina Celic
Ministry of Agriculture, Forestry and Food
Dunajska 56-58
1000 Ljubljana
Slovenia
Tel: (386-61)1789085
Fax: (386-61)1789089
Email: katarina. gov.si

Mr Ricardo Alía
Dpto. de Mejora Genética y Biotecnología
CIFOR-INIA
Apd. 8111
28080 Madrid
Spain
Tel: (34-91)3476857
Fax: (34-91)3572293
Email: nia.es

Mr Martin Lindell
Silviculture Division
The National Board for Forestry
Vallgatan 8
551 83 Jönköping
Sweden
Tel: (46-36)155600
Fax: (46-36)166170
Email: martin. svo.se

Mr Gösta Eriksson
Department of Forest Genetics
Swedish University of Agricultural Sciences
PO Box 7027
750 07 Uppsala
Sweden
Tel: (46-18)671240
Fax: (46-18)672718
Email: gosta. gen.slu.se

Mr Hasan Özer
Ministry of Forestry
Orman Bakanligi
APK Ataturk Bulvari 153
Kizilay Ankara
Turkey
Tel: (90-312)4177723/4177724
Fax: (90-312)4179160
Email: yahoo.com

Mr Roman Volosyanchuk
Laboratory of Forest Tree Breeding
Ukrainian Research Institute of Forestry
Pushkinska 86
310024 Kharkiv
Ukraine
Tel: (380-572)431549
Fax: (380-572)432520
Email: u-fri.kharkov.com

Mr C.J.A. Samuel
Forestry Commission
Forest Research
Northern Research Station
Roslin, Midlothian EH25 9SY
United Kingdom
Tel: (44-131)4452176
Fax: (44-131)4455124
Email: c.j.a. orestry.gov.uk

Mr Richard Jinks
Forestry Commission
Alice Holt Lodge Station
Wrecclesham-Farnham
Surrey GU10 4LH
United Kingdom
Tel: (44-1420)222555
Fax: (44-1420)23653
Email: r. orestry.gov.uk

Ms Deborah L. Rogers
Intercampus Activity in Conservation Biology
Genetic Resources Conservation Program
University of California
One Shields Avenue
Davis, CA 95616
USA
Tel: (1-530)7548507
Fax: (1-530)7548505
Email: ucdavis.edu

Mr Abdihalil K. Kayimov
Research Institute of Forestry
Cont. Darkhan
702017 Tashkent region
Uzbekistan
Tel: (998-71)1257232
Fax: (998-71)1257180

Mr Vasilije Isajev
Faculty of Forestry
Kneza Viseslava 1
11030 Beograd
Yugoslavia, F.R.
Tel: (381-11)553122
Fax: (381-11)545485
Email: ezampro.yu

Ms Christel Palmberg-Lerche
Forest Resources Development Service
Forest Resources Division, Forestry Department
FAO
Viale delle Terme di Caracalla
00100 Rome
Italy
Tel: (39)0657053841
Fax: (39)0657055137
Email: christel. ao.org

Mr Geoff Hawtin
Director General
IPGRI
Via delle Sette Chiese 142
00145 Rome
Italy
Tel: (39)0651892247
Fax: (39)065750309
Email: g. cgiar.org

Mr Jozef Turok
EUFORGEN Coordinator
IPGRI
Via delle Sette Chiese 142
00145 Rome
Italy
Tel: (39-06)51892250
Fax: (39-06)5750309
Email: j. cgiar.org

Unable to attend

Mr Xenophon Hadjikyriacou
Forestry Department
Ministry of Agriculture, Natural Resources & Environment
1414 Nicosia
Cyprus
Tel: (357-2)303935
Fax: (357-2)781419
Email: ytanet.com.cy

Mr Adalsteinn Sigurgeirsson
Iceland Forest Research Station
Mógilsá
270 Mosfellsbær
Iceland
Tel: (354-1)666014
Fax: (354-1)667750

Mr Janis Birgelis
Department of Forest
State Forest Service
13. Janvara iela 15
1932 Riga
Latvia
Tel: (371-7)226603
Fax: (371-7)820377
Email: sfs.gov.lv

Mr Frank Wolter
Service de l'Aménagement des Bois
Administration des Eaux et Forêts
BP 411
2014 Luxembourg
Luxembourg
Tel: (352)496071
Fax: (352)407840
Email: frank. ef.etat.lu

Mr Jean-Luc van Klaveren
Service de l'Urbanisme et de la Construction
BP 512
98015 Monaco cedex
Monaco
Tel: (377-93)158549
Fax: (377-93)158802
Email: gouv.mc

Mr Hassan Sbay
Centre National de Recherches Forestières
Charia Omar Ibn Khattab
BP 763
Rabat Agdal
Morocco
Tel: (212-7)672547
Fax: (212-7)671151
Email: mailcity.com

Mr Markus Bolliger
Swiss Forest Agency
Federal Office of Environment, Forests and Landscape
3003 Berne
Switzerland
Tel: (41-31)3247787
Fax: (41-31)3247789
Email: Markus. buwal.admin.ch