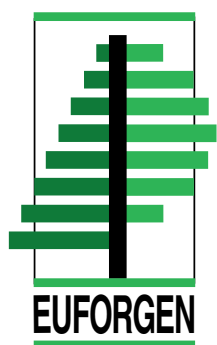




# Conifers Network

Report of the second (20–22 September 2001, Valsaín, Spain)  
and third (17–19 October 2002, Kostrzyca, Poland) meetings

**K. Vančura, B. Fady, J. Koskela and Cs. Mátyás,  
compilers**



European Forest Genetic Resources Programme (EUFORGEN)



FUTURE  
HARVEST

<[www.futureharvest.org](http://www.futureharvest.org)>

IPGRI is  
a Future Harvest Centre  
supported by the  
Consultative Group on  
International Agricultural  
Research (CGIAR)

**The International Plant Genetic Resources Institute (IPGRI)** is an independent international scientific organization that seeks to advance the conservation and use of plant genetic diversity for the well-being of present and future generations. It is one of 16 Future Harvest Centres supported by the Consultative Group on International Agricultural Research (CGIAR), an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. IPGRI has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute 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 2003, had been signed 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 IPGRI's research is provided by more than 150 donors, including governments, private foundations and international organizations. For details of donors and research activities please see IPGRI's Annual Reports, which are available in printed form on request from [ipgri-publications@cgiar.org](mailto:ipgri-publications@cgiar.org) or from IPGRI's Web site ([www.ipgri.cgiar.org](http://www.ipgri.cgiar.org)).

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 for 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 analyse 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. Further information on EUFORGEN can be found from its Web site ([www.euforgen.org](http://www.euforgen.org)).

The geographical designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of IPGRI or the CGIAR concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. Similarly, the views expressed are those of the authors and do not necessarily reflect the views of these organizations.

Mention of a proprietary name does not constitute endorsement of the product and is given only for information.

**Citation:**

Vančura K., B. Fady, J. Koskela and Cs. Mátyás, compilers. 2004. Conifers Network, Report of the second (20–22 September 2001, Valsaín, Spain) and third (17–19 October 2002, Kostrzyca, Poland) meetings. International Plant Genetic Resources Institute. Rome, Italy.

ISBN 92-9043-625-5

IPGRI

Via dei Tre Denari, 472/a

00057 Maccarese

Rome, Italy

© International Plant Genetic Resources Institute, 2004

---

 Contents

<b>Summaries</b>	<b>1</b>
Second EUFORGEN Conifers Network meeting (Valsaín, Spain)	1
Third EUFORGEN Conifers Network meeting (Kostrzyca, Poland)	9
<b>Conservation of conifer genetic resources</b>	<b>21</b>
Selection of <i>in situ</i> gene conservation units (gene reserves) of conifers <i>Csaba Mátyás</i>	21
Common yew ( <i>Taxus baccata</i> L.) and its genetic diversity in the Czech Republic <i>Vladimir Zatloukal and Karel Vančura</i>	25
Conservation of common yew ( <i>Taxus baccata</i> L.) in Poland <i>Małgorzata Falencka-Jablońska</i>	31
The Forest Gene Bank in Kostrzyca <i>Zbigniew Sobierajski</i>	35
<b>Genetic conservation and restoration in areas affected by industrial pollution</b>	<b>39</b>
Forest restoration in the Western Sudetes <i>Andrzej Potyralski</i>	39
Rehabilitation of silver fir ( <i>Abies alba</i> Mill.) populations in the Sudetes <i>Władysław Barzdajn</i>	45
Seed source for reforestation and gene conservation in the Sudetes <i>Jan Matras</i>	52
Evacuation strategy in air-polluted regions of the Czech Republic <i>Karel Vančura and František Beran</i>	59
<b>Programmes</b>	<b>62</b>
Second EUFORGEN Conifers Network meeting, 20–22 September 2001, Valsaín, Spain	62
Third EUFORGEN Conifers Network meeting, 17–19 October 2002, Kostrzyca, Poland	64
<b>List of Participants</b>	<b>66</b>



## Second EUFORGEN Conifers Network Meeting

### **Opening**

Csaba Mátyás, Chair of the Network, welcomed the participants to Valsaín and to the second EUFORGEN Conifers Network Meeting. Mr Manuel de Tuero y Reina, Director of the Breeding Service of Dirección General para la Conservación de la Naturaleza (DGCN) attended the opening session as a representative of the Ministry of Environment.

Ricardo Alía gave a brief presentation on the venue of the meeting, on the diversity of tree species in Spain in general and on the species that are found around Valsaín. He described the Valsaín complex, which includes a breeding centre and a sawmill that processes most of the Scots pine timber from the Valsaín forest. He also provided an overview of the logistic arrangements for the meeting and for the field trip, and introduced Ms Sonia Martin of the DGCN.

Csaba Mátyás gave a brief introduction on the importance of conifers in Europe. He pointed out that in many countries these species are now considered less important than broadleaves. An objective of the Network should be to highlight the role of conifer species and their ecological and economic importance. He also encouraged EUFORGEN members to become more active and open in respect of the environment protection community.

Jozef Turok welcomed the participants on behalf of IPGRI and underlined how the presence of so many countries shows the importance of conifers in Europe. He gave a brief overview of the latest developments in the preparatory process for the next Ministerial Conference on the Protection of Forests in Europe (MCPFE) to be held in April 2003. Some of the main items that will be discussed include sustainable forestry, national forest programmes, climate change and criteria and indicators. He also announced that the next EUFORGEN Steering Committee meeting would be held in June 2002, following the kind invitation from Sweden. It will be very important to emphasize the links between gene conservation and the issues listed above. He touched on the subject of research, pointing out that the Networks have been instrumental in providing opportunities to discuss needs and priorities for research, and a platform to develop research proposals and to facilitate dissemination of research results. He thanked the host country and all the local organizers for the excellent arrangements.

The agenda was presented and was adopted by the Network.

### **Reports on the status of conservation**

Twenty-seven countries (Armenia, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, The former Yugoslav Republic of Macedonia, Malta, Norway, Poland, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and the United Kingdom) were represented at the meeting.

In order to streamline the discussion on the progress made, it was proposed to divide the participants into four groups loosely representing major ecogeographic areas of Europe: western Europe, Mediterranean, northern Europe, and central and eastern Europe. Each group had the task of summarizing the important elements from the national reports and presenting them in a concise form in plenary.

### **Western Europe**

Armin König presented the results of the group. The group realized that opinions on *in situ* conservation differ from country to country and are therefore difficult to generalize. In Germany, for example, even the different states have different approaches to conservation. The group felt that the standard country reports fulfil the requirements of reporting.

Monitoring should be used for evaluating changes between meetings or at least on a regular basis, on both the technical and the political aspects at country level. Reference was made to the Helsinki H2 Resolution, Natura 2000 (EU-wide) and the Birds Directive (EU-wide) as possible additional tools for conserving biodiversity. However, as in many countries protected areas cannot be used for collection of reproductive material, the inclusion of these areas in statistics might create confusion.

### **Mediterranean**

Bruno Fady presented the results of the group discussion. It was felt that regional grouping was effective for comprehensive overviews, but that the country reports should also be accessible. The choice of species was limiting, as some countries did not have any of the four that were selected. It was proposed to include the *Pinus brutia/halepensis* complex. Common threats (transfer of plant material and global change) and breeding and research activities were identified. In general, the intensity of conservation activities is linked to the economic importance of species, which raises the issue of how to achieve conservation of non-commercial species, to bridge the gap between genetic diversity and biodiversity issues. The first measures taken were usually protected areas, followed in some cases by *in situ* conservation networks. For the three main species, research data are available on range-wide genetic diversity, but not on adaptive structures. Little information is available for *Taxus*. More research is needed for rare and endangered species. It was also felt that current conservation methods should be analysed for effectiveness, and on the basis of this evaluation the Network could provide indications for future directions.

### **Northern Europe**

Tore Skrøppa reported that only two of the selected species were present in the subregion (*Picea abies* and *Taxus baccata*). The distribution of *Taxus* is rather scattered. It is not used as a commercial species, but is of interest for many countries. There are many conservation areas, but little research has been done. Norway spruce is highly important in the region and is not at all neglected. The main threat to *P. abies* is fragmentation, particularly in the Baltic countries. At present, a significant proportion (up to 50%) of seed used for plantation originates from seed orchards. Research is under way in Norway and Sweden to quantify the implications of the Norway spruce plantations of central and eastern European origin for the degree of adaptation and diversity of the local provenances.

### **Central and eastern Europe**

Karel Vančura presented the results. The status of the selected species varies between countries. Depending on the geographic location and/or climatic conditions, a species can be either widely occurring or rare and endangered. Several threats to forests were identified: dieback, pollution, browsing, illegal cutting and fragmentation. There is a lack of information on *Taxus*. Research activities are under way in most countries, but as yet not much information is available. Legislation is at different stages of development in the different countries, and adoption of EU regulations is also influencing its formulation. Priorities identified were capacity-building, halting illegal cutting, sustainable forest management, control of reproductive material, genetic response to climate change, improvement of collaboration between foresters and environmentalists, creation of genetic reserves, formulation of national strategies and legislation. It was suggested that more comprehensive reports should be prepared for the MCPFE, but it would also be useful to have some strong arguments, including economic considerations, to promote the agenda of forest genetic resources.

### **Summary**

The Chair summarized the main points of the discussion. It is clear from all subregional reports that the quantification of conservation measures can be interpreted only if definitions for all categories of *in situ* and *ex situ* conservation measures are formulated very clearly in advance. Country progress reports were regarded as essential to the monitoring task, and

should focus on describing the progress achieved. In addition, important data may be submitted in tabular form. To facilitate monitoring and reporting, national databases on gene conservation should be established in each country (see section on Documentation below, pages 6–7). Range-wide species status reports are considered very useful as well, and their compilation should be made upon decision of the Network by elected rapporteurs.

Species priorities cannot be set uniformly across Europe as the status of the individual species may vary between low priority/abundance and serious levels of threat, according to local ecological and socio-economic conditions.

The need for harmonization of nature conservation and forest management elements of genetic conservation is considered as an essential issue in most European countries, particularly with regard to the various categories of nature protected areas.

The incorporation of genetic principles into the use of appropriate forest reproductive material should be encouraged. The creation of an adequate legal basis for conservation and use of forest genetic resources has to be regarded as high priority, particularly in view of the emerging concept of shared responsibility for gene conservation (see section below).

The importance of public awareness activities was also underlined. An interesting initiative is the establishment of 'promotional forest complexes' in Poland. Forest gene conservation units should also be considered as important demonstration areas.

### **Case studies**

Francesco Spada presented an overview of the status of yew (*Taxus baccata*) in Italy, pointing out that the traditional phytosociological approach is insufficient to prove an understanding of the ecological behaviour of the species. Too much weight is put on arbitrary links between species (e.g. yew and beech), and the effects of more important factors, both ecological and anthropogenic, are underestimated. An interesting aspect of genetic regulation is the sexual reversal observed in individual trees, which seems to be associated with environmental conditions.

Karen Ter-Ghazaryan presented a case study on *Taxus baccata* in Armenia. The presentation included a general overview of Armenian forests, some details on the distribution of yew, its forestry importance, current research activities, ongoing and future projects, conservation status and activities, relevant policies and legislation, and *in situ* and *ex situ* conservation measures.

It was agreed that the Report of the meeting should include synthesis reports from the four ecogeographic subregions (outcome of working group discussions), as well as case studies. Additional case studies will be selected by the compilers and included in the Report of the meeting on the basis of the country reports submitted to the Secretariat. Network members concerned should send contributions to the Secretariat no later than 31 October 2001 (in electronic format). The country progress reports will be made available to subregional rapporteurs. The rapporteurs will compile and circulate the synthesis reports by 31 December 2001.

### **Criteria and indicators for monitoring progress**

Jozef Turok briefly recalled the overall objectives of EUFORGEN. The need to monitor progress at both the Network and the country level (third objective of Strasbourg Resolution S2) was discussed. The results from the survey on the progress made in national programmes and in Europe during the last Steering Committee meeting (November 1998) were also presented.

The genetic indicators currently adopted at the MCPFE level appear to be rather vague ("proportion of forest areas managed for the conservation of genetic resources ..."). It is important to incorporate better monitoring procedures for the conservation of forest genetic resources.

In order to identify the best milestones for assessing progress it was proposed to create an Inter-Network task force. On the basis of the Steering Committee survey, this task force will review the qualitative milestones already available and separate them into two groups:

- Milestones for measuring progress reached within the national programme in general (policy, legal frameworks, institutional capacities, etc.). These milestones will be the responsibility of the National Coordinators.
- Milestones for measuring progress in the conservation of individual species (*in situ*, *ex situ* conservation measures etc.). These milestones will be the responsibility of the Network members.

Milestones should be realistic and achievable. The task force will also propose which milestones would be suitable for reporting at the broader level of the MCPFE process. The issue of genetic criteria and indicators will be discussed at the next Steering Committee meeting, in June 2002. The task force will be contacted by the Secretariat before 31 October 2001. Tore Skrøppa and Thomas Geburek were invited to represent the Conifers Network on this task force.

### **Research**

Giovanni Vendramin presented a research proposal on Mediterranean conifers, to be submitted to the EU in mid-October 2001, which is being jointly developed by Italy, France and Spain. The proposal is still at a preliminary stage and is open for other participants to join. It is expected that Mediterranean conifer forests will be strongly affected by climate change. The project will address their reaction in terms of adaptation and migration to be included in a prediction model. Neutral and adaptive molecular markers will be used for assessment. An emphasis will be placed on interspecific hybrids expected to occur following migration. Five work packages were identified and were briefly described.

Ladislav Paule presented an INTAS proposal (see [www.intas.be](http://www.intas.be)) on gene conservation of yew in the Carpathians, Crimea and the Caucasus. He provided some background information on the history and the current distribution of yew. There is limited information on genetic diversity and differentiation, and no gene conservation strategies have been elaborated. The project will update the knowledge of present distribution in the three mountain regions, carry out a comparative phytosociological study with modern methodologies and analyse biotic factors that are threatening yew. Sexual reproduction will be studied, and finally genetic diversity will be studied with isoenzymes and cpDNA markers. All the results will be used for the development of *in situ* and *ex situ* gene conservation measures and the design of a gene conservation strategy. Six partners will participate in the project (Slovakia, Italy, Russia, Armenia, Georgia, Ukraine).

### **Seminar: Emerging facts and issues related to gene conservation of conifers in Europe**

Tore Skrøppa presented a paper on epigenetic effects (changes in gene expression without changes in DNA sequence) and their consequence for gene conservation. This is a widely occurring phenomenon, in both plants and animals. Experiments conducted on *Picea abies* have shown that seedlings of identical genetic background, produced under different environmental conditions, performed differently. A project funded by the EU is currently further evaluating the genetic basis of these effects and attempting to understand the links between environmental conditions and gene expression.

The implication of these effects on conservation and breeding strategies were discussed. It was agreed that although epigenetic effects play a role in maintaining genetic diversity, it is still premature to draw conclusions for conservation strategies because neither the general validity of the effects at species level nor the group of species displaying epigenetic effects has been clarified.

Weber Amaral presented a paper on climate change and forest genetic resources. He provided a brief overview of IPGRI's activities in this area and gave information on the



general effects of climate change on agriculture, forestry and natural environments. He emphasized the need to scale down from the global to the local level and develop species-specific models. Several possible mitigation options that were discussed in the framework of the Kyoto Protocol were presented. A practical geographical information system (GIS) application developed for crops was presented.

### **Sharing of gene conservation responsibilities**

The conclusions of the Inter-Network Meeting held in Antalya, Turkey in October 2000 were briefly presented. The idea of a Europe-wide system of *in situ* conservation units was agreed to be a vision for future activities of the EUFORGEN programme. The role of EUFORGEN would be to analyse gaps in conservation, to develop minimum conservation standards and to raise public awareness. The *in situ* networks would be designated through a multilateral agreement or master plan to which countries would adhere on a voluntary basis. In each country, some of the conservation areas would be designated to become part of the networks, or countries could decide to create new reserves to complete the coverage of the distribution range.

The proposal was agreed in principle, but some concerns were raised, particularly relating to the legal status of the units and the cost associated with the management of these networks.

In order to assess the feasibility of the system, it was agreed that a pilot study would be initiated with *Picea abies*, for which standards for conservation units have already been developed. Therefore, as a first step, all countries will provide information on existing gene conservation units for Norway spruce. Each country will be responsible for deciding which areas should be included in the European network.

The Secretariat will provide the existing minimum requirements (definitions and criteria) for the gene conservation units to be included and the form to be completed for each unit before 31 October 2001. Countries will provide information to be converted to map format and made available over the Internet by 31 March 2002.

### **Distribution maps**

It was agreed that the Secretariat, in collaboration with Teijo Nikkanen, will follow up the contacts made with the *Atlas Florae Europaeae* (based in Helsinki, Finland) and verify the possibility of collaborating on the production of distribution maps at suitable scale to help identify gaps for gene conservation. The Secretariat will inform the Network about the progress made before 31 October 2001.

### **Technical guidelines**

The relevant outcomes of the first Inter-Network meeting of Chairs of the EUFORGEN Networks were presented and discussed. The role of the Inter-Network Group is to harmonize priorities and coordinate activities among the five Networks, in order to share experience and avoid duplication of efforts. With regard to the technical guidelines, the Inter-Network Group agreed that a general document on the objectives, principles and methods of forest genetic conservation should be prepared, as a basis for the species-specific guidelines that could be developed as separate modules. This general document is being prepared on the basis of a training manual used for the course in Austria in May 2001.

The modules will be developed with similar format for a first set of identified species (see below). It was agreed that five draft guidelines should be produced before the next Network meeting:

- *Abies alba* (H. Wolf)
- *Picea abies* (T. Skrøppa)—on the basis of the existing document produced by the *Picea abies* Network in 1997
- *Pinus halepensis/brutia* complex (B. Fady)
- *Pinus pinaster* (R. Alia)
- *Taxus baccata* (L. Paule)

Each module should be no longer than four printed pages, including illustrations, etc. The final text should be limited to 1200 words. Each module will comprise the following components: standard introduction paragraph, distribution map (native and naturalized distribution will be highlighted in different colours), biology and ecology of the species, threats to genetic diversity, genetic knowledge, importance and use, and guidelines for genetic conservation and use. These guidelines will consist of a sequence of actions, or steps, ordered according to their technical and economic feasibility, which are required to ensure the conservation and sustainable use of genetic resources within the species' distribution areas in Europe.

The target audience, as agreed at previous Network meetings, includes forest officers and agencies responsible for applied forest genetic conservation in each country. The sheets will be produced first in English, but the template of each will be made available to Network members, who will be responsible for their translation and adaptation to national conditions. The modules will include relevant graphs, figures and illustrations. References for further reading will be included at the end of each module.

Similar species modules currently being developed for noble hardwoods and other species will be circulated through the EUFORGEN listserv before the end of the year. The authors may seek inputs or review of the draft modules from other Network members and other specialists as appropriate.

The Secretariat will send the Table of Contents of the general document (see above) to the authors before 31 October 2001.

A draft of the five species guidelines will be circulated 2 months before the next meeting.

### **Research needs**

The Chair summarized the research needs of continued high interest for conifer species, as follows:

- 1 Mating systems of species, intensity and effects of gene flow: more knowledge in both areas is essential for formulating gene conservation strategies.
- 2 The role of phenotypic plasticity and epigenetic effects in maintaining genetic diversity and counteracting local adaptation require to be clarified.
- 3 Velocity of adaptation processes and the realistic assessment of adaptation to local ecological conditions are needed to refine the traditional view on autochthonous origin and value of local populations.
- 4 Species migration potentials, possible effects of introgression and response to predicted environmental (climatic) changes should be investigated at both molecular and quantitative levels.
- 5 Links between neutral molecular markers and adaptively important traits need to be identified to assist the selection of areas and populations of high value for forest genetic resources conservation.
- 6 Evaluation is required, at the ecological, economic and genetic levels, of the efficiency of the different gene conservation strategies implemented over Europe.

In line with the statements of the Inter-Network Group meeting, it was proposed that multinetwork seminars on the above questions would be useful. Representatives of relevant scientific disciplines (such as ecology) could be invited to attend such seminars.

It was felt that special, increased attention should be given to practical implementation. Because of the nature of information on genetic diversity, it is of the utmost importance for the forest genetic resources community to find suitable ways of demonstrating links to forestry practice, such as management regimes in commercial and protected forests, the use and control of reproductive material, mitigating effects of climate change, etc.

### **Documentation**

Simone Borelli explained the idea of providing a gateway to information on plant genetic resources in Europe through the IPGRI website, in particular by facilitating access to

information on national programmes. The page also provides direct access to the ECP/GR and EUFORGEN Networks. He also briefly presented the existing EUFORGEN databases to demonstrate the ease of access to information.

He then presented the EUFORGEN bibliography, which was developed on the basis of the existing bibliographies from the different networks. The bibliography currently contains around 1700 references, mostly to grey literature on conservation and use of forest genetic resources. This online database is being used quite extensively and in fact is the most frequently visited page of the entire IPGRI site. However, in order to maintain the effectiveness of this tool, it must be continuously updated. Network members were encouraged to provide additional references from their respective countries whenever they have the opportunity, in Microsoft Access database format. To facilitate this task, the Secretariat will send the format for contributions by 30 September 2001, together with the electronic version of this report.

### ***Conifers in Spain***

Sonia Martin gave an overview of the distribution of conifers and conservation activities in Spain.

### ***Public awareness***

#### ***Slide collection***

Bruno Fady reported that few slides have been received so far, but quite a number were delivered during the meeting. He presented an outline of the possible contents of the slide collection for reference. Network members were reminded to send their slides by 15 October 2001.

As a follow-up to this task, it was proposed to produce a PowerPoint presentation on gene conservation of conifers.

#### ***Other public awareness activities***

The need for more comprehensive publications to disseminate the activities of the EUFORGEN networks was raised.

There was a preliminary proposal to prepare a publication on conservation and management of forest genetic resources in Europe to be compiled from existing EUFORGEN material (i.e. reports, technical guidelines). The objective of the publication would be to reach policy makers and scientists. The contents could include:

- current situation of forest genetic resources in Europe
- the MCPFE: implications for genetic conservation in Europe
- the Strasbourg Resolution S2 and EUFORGEN
- technical guidelines and other practical tools
- country case studies
- thematic issues:
  - use of reproductive material
  - sustainable forest management
  - climate change
  - biodiversity

The idea of articles in newspapers at a national level was also raised as a possible means for raising awareness of the public at large. Websites for children were also mentioned as a possible means for raising awareness.

### ***Adoption of the report***

The report of the meeting was adopted.

***Date and place of the next meeting***

Poland invited the Network to meet at the Kostrzyca Forest Gene Bank facility during the last week of September 2002.

***Any other business***

Jozef Turok officially announced that Simone Borelli would be leaving the EUFORGEN Secretariat at the end of October 2001. He thanked him for his contribution and wished him luck in his new position in FAO.

Csaba Mátyás announced that Alphonse Nanson will officially retire at the end of September 2001 and thanked him for his valuable contribution to the activities of the Network.

***Closure***

The Chair thanked all participants for their contribution and commitment and encouraged them to continue providing their valuable contribution to the activities of the Network. He once more thanked the local organizers for the excellent arrangements and declared the meeting officially closed.

## Third EUFORGEN Conifers Network Meeting

### **Introduction**

Jan Matras welcomed the participants on behalf of the local organizers. He introduced his colleagues from the Forestry Research Institute, and representatives from the State Forest Service and other institutions who attended the meeting as observers.

Csaba Mátyás, Chair of the Network, welcomed the participants from 25 countries and thanked the local organizers for the arrangements. The Chair reiterated the importance of producing visible and useful output, which not only supports conservation activities in the participating countries, but at the same time serves as awareness-raising material for wider professional circles, for decision-makers and for the public in general.

Jozef Turok, EUFORGEN Coordinator, presented the agenda and summarized the progress made in implementing the joint tasks of the Network since the last meeting. He introduced Michele Bozzano, Temporary Scientific Assistant working with the EUFORGEN Secretariat. He also announced the arrival of the new EUFORGEN Coordinator, Jarkko Koskela, who will take up his responsibilities as of 1 January 2003.

The agenda of the meeting was adopted. All participants then briefly introduced themselves. Jan Matras, Giovanni Vendramin, Bruno Fady and Csaba Mátyás agreed to chair sessions during the meeting. Tore Skrøppa, Giovanni Vendramin, Armin König and Jan Matras agreed to act as discussion leaders for the four ecogeographic working groups. The following rapporteurs were nominated: Tore Skrøppa, Giovanni Vendramin, Sam Samuel, John Fennessy and Michele Bozzano.

### **Country reports: status and progress made in gene conservation of conifers**

Network members were divided into four working groups to discuss progress made in the four ecogeographic subregions of Europe. A representative of each working group gave a presentation summarizing the status and progress in the following plenary session (see working group summaries below). Updates from each country concerning conservation and use, inventories, relevant policies and legislation, research, tree improvement, public awareness and perspectives will be posted on the IPGRI Information Platform ([www.ipgri.cgiar.org/networks/euforgen/default.asp](http://www.ipgri.cgiar.org/networks/euforgen/default.asp)) (see the section on 'Documentation, information and public awareness', page 16).

The importance of the participation and involvement of all European countries in the EUFORGEN Network was stressed by all working groups. This is particularly important as the Network moves towards common systems for sharing information and making it available to researchers, scientists and policy-makers.

The working groups strongly supported the concept of combining information on ecological importance and genetic diversity of target species with all available conservation strategies (e.g. habitat-oriented) at a European level.

All participants will provide the Secretariat with an electronic version of their country report or country update, in the agreed format, by 31 October 2002. Each update should carry a date of completion.

### **Northern Europe working group**

#### **Participants: Estonia, Finland, Lithuania, Norway, Sweden**

The group regrets that Latvia is missing from EUFORGEN and encourages Latvia to actively participate in the activities of this Network.

Politicians in the Nordic countries have recently focused on genetic resources in agriculture and forestry. The Nordic Council of Ministers has developed a Nordic gene resource strategy. A proposal for a strategy on genetic resources of forest trees has been completed and will be discussed in the near future. Public awareness about the value of genetic resources and their management has been given high priority in the Nordic

countries, and an annual publication combining three sectors (animal husbandry, agricultural plant production and forestry) has been launched.

The percentage of seeds used from seed orchards is increasing in several countries. In Finland, 70% of Norway spruce seeds and 60% of Scots pine seeds are produced in seed orchards, and in Lithuania and Estonia the proportion is about 50% for both species.

In Lithuania, fragmentation of formerly continuous conifer forests is a major problem. Electronic maps (GIS system) of all forests and genetic reserves are available. Three new laws have been passed by the government; one on protected landscapes, one on plant genetic resources, and one amending the forest act. Common definitions are used in all laws, and the regulations for forest trees are according to the EC Directive on forest reproductive material. The number of gene reserves for Norway spruce has been reduced, resulting in larger-sized areas.

In Estonia, 1.5-generation seed orchards have been established for both Norway spruce and Scots pine. A working group has been established to develop a strategy for the seed requirements for the next 30 years. Provenance trials with Scots pine show that the local provenances generally have the best performance.

In Norway, combined seedling seed orchards and gene conservation stands of Norway spruce have been established for the northern areas, based on large numbers (200–400 per zone) of half-sib families from natural stands. The family identity of individual seedlings has been kept, and thinning can be done on the basis of information from progeny tests planted at the same time.

### ***Mediterranean working group***

#### **Participants: Bulgaria, Cyprus, France, Italy, Spain, Turkey**

The discussion focused on the five target species: *Abies alba*, *Picea abies*, *Pinus pinaster*, *Taxus baccata* and the *Pinus halepensis/brutia* species complex. The importance of these species is very different in each country: for example, *Picea abies* is economically important in Bulgaria, France and Italy but *Pinus brutia* is the most relevant species for Turkey and is the only conifer of importance in Cyprus.

Other conifer species that are not represented on this list are also of economic and ecological interest in this subregion: various *Abies* species, *Cupressus* species, *Pinus sylvestris*, the *Pinus nigra* species complex, *Pinus leucodermis/heldreichii* and *Pinus pinea*. The Mediterranean is well known to have a high overall level of biological diversity, which deserves conservation efforts. In some countries, the genetic resources of some of these species are already conserved or some conservation plans are being developed.

The discussion focused on two main points: new research knowledge and new activities in sustainable management of conifer genetic resources.

For species of major ecological and/or forestry importance, the amount of scientific knowledge relevant for gene conservation is quite impressive. Recently, knowledge of the genetics of the less economically important species of the Mediterranean has increased, but this knowledge may not be exploitable for practical conservation. Neutral and adaptive diversity must be used together for a truly integrated approach to conservation. Recent projects have concentrated on the characterization of genetic resources using combined approaches involving neutral and adaptive molecular markers (e.g. *Pinus pinaster* and *P. halepensis*). Although each country has some level of conservation activity, conservation of widely distributed species needs to be addressed on an international scale as well.

Genetic information based on molecular markers is now available for *Picea abies* and *Pinus pinaster*, and soon will be for *Pinus halepensis*. Other important scientific results have recently been obtained on colonization dynamics, gene flow and hybridization processes for these species as well as *Abies alba*. Methods for provenances and seed lot identification were developed for *Pinus pinaster* and can be applied to other species.

New provenance trials and progeny tests for *Pinus brutia*, *Pinus halepensis* and *Pinus pinea* have been established jointly during the past few years in several Mediterranean countries.

Results from research activities were used to design or expand already existing conservation networks.

- *In situ* conservation:
  - In Spain, conservation areas were identified for *Pinus pinaster*, *Pinus halepensis* and *Abies alba*.
  - In France, additional units were chosen for the *Abies alba* conservation network.
  - In Cyprus, a new inventory of the distribution of *Pinus brutia* populations was carried out.
  - In Turkey, 50 *Pinus brutia* gene conservation units were identified and the number of *Pinus brutia* selected seed stands was increased.
  - In Bulgaria, the number and size of *Picea abies* and *Abies alba* selected seed stands was increased.

*Ex situ* conservation :

- Clone banks: In Spain, 50 *Taxus baccata* clones were selected and in Turkey there are now approximately 2500 *Pinus brutia* clones in four different clone banks.
- Seed banks: In Spain and Italy, the number of populations stored increased for *Pinus pinaster* and *Pinus halepensis*.
- DNA banks: In France, Italy and Spain, DNA fragments isolated from populations of *Abies alba*, *Pinus halepensis*, *Pinus pinaster*, *Pinus brutia* and *Picea abies*, stored at  $-80^{\circ}\text{C}$ , are available.
- Additional initiatives:
  - Several databases including molecular genetic and ecological data were created at national and international levels for target species.
  - Spain organized a course dealing with conservation of forest genetic resources for forestry practice managers.
  - In Cyprus, legislative measures were taken to prevent the introduction of insects and pathogens from other countries.
  - The new EC Directive 1999/105/EC enters into force on 1 January 2003. France and Spain have already transposed it into national legislation with some enhancements (*Taxus baccata* was included in Spain).

### **Western Europe working group**

#### **Participants: Austria, Belgium, Germany, Ireland, Switzerland, United Kingdom**

In terms of forests and forestry, there is a big contrast between the north-west European countries and those in the south-west of the subregion. The forest area in Ireland and the UK amounts to 9% and 11% respectively, whereas it is 30% in Switzerland and 47% in Austria. In Ireland and the UK the main coniferous species, *Picea sitchensis* and *Pseudotsuga menziesii*, originate from Pacific North America. In Belgium the main coniferous species is *Picea abies*, far ahead of *Pinus sylvestris*, *Pseudotsuga menziesii* and *Larix* sp.; all of these are exotics. In these western European countries only *Juniperus* sp. and *Taxus baccata* occur naturally. Additionally *Pinus sylvestris* is native in northern parts of Scotland, and by some is also considered to be so in Ireland. Seed collection sources are approved in the UK as a basis for extension of existing areas and creation of new woodland of this type. Ireland, the UK and Belgium aim to increase their forest areas. This increasingly favours native species.

In Austria, Germany and Switzerland several conifers have a high economic importance, especially *Picea abies*, *Pinus sylvestris* and *Larix decidua*. *Abies alba*, which has suffered heavily from air pollution, seems to be recovering slightly. In past years there has been a trend to transform non-natural pure conifer stands into stands closer to nature, in which broadleaved species are favoured. Where natural regeneration is practised, the consequence is a reduced collection in seed stands and a reduced artificial plant production.

The member states of the EU are completing the harmonization of their national legislation on forest reproductive material with EC Directive 1999/105/EC. The regulations have an impact on forest genetic resources.

In Ireland and the UK, no formal policy of gene conservation has been formulated but the process has started in both countries. Sitka spruce and Douglas fir are the subjects of breeding programmes but not of any real active genetic conservation programme.

In Belgium, no active long-term management of forest genetic resources has been initiated so far, but conservation of these resources is indirectly made through the breeding programme (seed stands, field tests, seed orchards).

Germany has established a concept for the 'conservation and sustainable use of forest genetic resources'; this concept has been revised in recent years and a new version (in German and in English) was published in 2000 (available at [www.genres.de/fgrdeu/](http://www.genres.de/fgrdeu/)). A working group comprising members from each state as well as from federal organizations is responsible for implementing the programme. The latest working plan was established for the period 2001–2004.

Ireland and the UK do not have gene conservation units other than for Scots pine in the UK, which remains to be collated.

Belgium does not have any either, but there is an intention to make two of the *Picea abies* selected seed stands representative for the 'Ardenne' landrace.

In Germany, gene conservation stands have been delineated mainly in regions where the respective species is endangered. In regions where a species occurs frequently, such as *Abies alba* in southern Germany, integration of conservation into forest management is considered to be the best concept. Seed stands are also conservation stands. Protection is secured by self-regulation of the forest administration.

Switzerland is creating a network of *in situ* gene conservation units for the main coniferous species.

Austria has established a network of gene conservation units since 1986, considering stands in all ecoregions. In total 7000 ha (net coniferous area) has been declared explicitly for conservation purposes.

### **Central and Eastern Europe working group**

**Participants: Azerbaijan, Czech Republic, Georgia, Hungary, Poland, Slovakia, Slovenia, Yugoslavia F.R.<sup>1</sup>**

The discussion concentrated on five main topics: species priorities, progress made in *in situ* and *ex situ* conservation measures, changes in legal background and new research activities in each country. The newly participating countries—in particular Azerbaijan and Georgia—proposed to incorporate additional species to be considered within the priorities of the Conifers Network (especially *Abies nordmanniana*, *Picea orientalis*, *Pinus eldarica*, *Pinus kochiana* and various *Juniperus* species).

There were great differences among countries in the progress reported for *in situ* and *ex situ* gene conservation during last two years. New gene reserves specifically selected for gene conservation purposes were created in Hungary, Poland, Slovakia, Slovenia and Yugoslavia. In Azerbaijan and Georgia, new nature reserves were designated, which also fulfil *in situ* gene conservation objectives. Considerable progress with regard to *ex situ* conservation was reported by Poland, Slovakia, Slovenia and Yugoslavia.

Nearly all the countries of this subregion mentioned the ongoing process of adapting national regulations on forest reproductive material to harmonize with the new EC Directive. Additional legal documents with relevance to the subject were highlighted: for gene reserves in Slovakia, biodiversity in Slovenia, the forest act in Georgia and biodiversity protection in Azerbaijan.

Relevant inventory and research activities were mentioned: a recently completed inventory of *Taxus baccata* in the Czech Republic; an ongoing forest management project in Georgia; an inventory of lowland occurrences of *Taxus baccata* in Hungary; DNA analyses of spruce and pine variability in Poland; a mountain forest project in Slovakia; molecular and

---

<sup>1</sup> Since February 2003 the Former Republic of Yugoslavia has been known as Serbia and Montenegro.



biochemical databases in forestry in Slovenia; and identification of genetic bases for forest seed and seedling production in Yugoslavia.

### ***Visit to the Kostrzyca Forest Gene Bank***

The Kostrzyca Forest Gene Bank is one of the most recently built, state-of-the-art facilities for long-term storage of forest tree seeds in Europe. It is located in one of the forest areas that has been most damaged by industrial air pollution. This emphasizes the importance of the role and activities of the gene bank.

The laboratories of the gene bank are fitted with equipment from suppliers around Europe for the entire seed preparation process and long-term storage. The gene bank is authorized to issue seed quality certificates, according to both national and international standards (more information is available at [www.lbg.jgora.pl](http://www.lbg.jgora.pl)). Facilities include a nursery for the production of container plants and nursery stock, as well as a 4.32-ha arboretum. New laboratories are planned for molecular research, including isoenzyme and DNA analyses.

This Network meeting, some of the sessions of which took place at the gene bank, was an excellent opportunity for discussing the collaborative work on conifers in Europe, including the particular role and challenges of gene conservation in forest tree gene banks. The participants visited the facilities and had the opportunity to discuss the work of the gene bank on the first day of the meeting.

### ***Implementation of genetic conservation strategies and guidelines***

Jozef Turok introduced the policy context for discussion about future steps in implementing the common conservation strategies and guidelines for selected conifers in Europe. He presented the structure, history, current developments and perspectives of the process of Ministerial Conferences on the Protection of Forests in Europe (MCPFE). The next Ministerial Conference will be held in April 2003, in Vienna. A draft 'Vienna Declaration', four 'Special Items' and a number of annexes are currently being developed for the Conference.

The EUFORGEN Steering Committee prepared a brief statement for the attention of the Conference. The statement refers to the follow-up work made at international level with regard to Strasbourg Resolution S2 and outlines the perspectives for future collaboration in Europe, with the overall objective "... to tie the island of gene conservation to the continent of sustainable forest management. . ." This statement was brought to the attention of the last MCPFE expert level (preparatory) meeting held in October 2002. It was noted, however, that the MCPFE Liaison Unit did not incorporate the statement into new draft commitments. The Network meeting therefore proposed that this statement should be brought to the attention of national representatives in the MCPFE process, especially those of the lead countries (Poland, Austria, Norway and Portugal).

The meeting also expressed the need to inform the environment process, the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), about the importance of genetic diversity in forest conservation in Europe. Network members were encouraged to contact the country representatives in this process.

Jozef Turok also presented the main outcomes of the last EUFORGEN Steering Committee meeting, held in Jönköping on 30 June–1 July 2002. The Steering Committee evaluated the progress made during the first part of Phase II and provided recommendations for the remaining period, as well as an outlook for future collaboration. The Steering Committee highlighted the need to focus current activity in the Networks on finalizing species-specific technical guidelines.

### ***Technical guidelines for selected conifer species***

Four species modules were developed following the purpose, target audience, structure and format, which were agreed at the previous Network meeting in Spain. These draft modules were introduced during the meeting:

- *Picea abies* (Norway)
- *Pinus pinaster* (Spain)
- *Pinus brutia/halepensis* (France and Italy)
- *Taxus baccata* (Slovakia).

The authors were commended for the excellent work done on the four modules since the last meeting.

Michele Bozzano presented the edited technical guidelines on *Fraxinus excelsior* produced by the Noble Hardwoods Network for illustration and reference.

It was agreed that the authors will incorporate the comments and suggestions received during the meeting or shortly after (comments can be sent to authors until 31 October 2002), and will circulate advanced versions, through the Secretariat, no later than 30 November 2002. The Secretariat will ensure that introductions, distribution maps and terminology are harmonized throughout the modules developed by the different Networks (it was agreed that authors need not include an introduction in their modules). The authors were encouraged to use figures and images to illustrate text. They were reminded about the text limit of 1200 words (excluding introduction and references). The bibliography should consist of no more than five important references that are widely available. The first set of technical guidelines in the form of species modules will be produced before the MCPFE in April 2003.

The module on *Abies alba* will be added to the first set of species, according to the original agreement. The module on *Taxus baccata* will incorporate relevant outcomes of the research work done recently on the species (see pages 26–35).

It was proposed that five new species modules will be developed and presented at the next Network meeting:

- *Pinus sylvestris* (Hungary, UK and Sweden)
- *Pinus nigra* (Yugoslavia, France and Turkey)
- *Pinus cembra* (Switzerland and Slovenia)
- *Larix decidua* (Poland)
- *Juniperus communis* (UK, Caucasus countries)

Interest was expressed in developing additional species modules, which was appreciated by the Network members. Network members will confirm the availability of their countries to contribute to additional modules before 31 December 2002.

### **Sharing of conservation responsibilities—case study on *Picea abies***

Following the workplan made during the last Network meeting in Spain, the Secretariat has devoted resources to compiling distribution maps with georeferenced *in situ* gene conservation units<sup>2</sup> for *Picea abies* as the selected pilot species. Five countries provided information on their *in situ* gene conservation units.<sup>3</sup> The results of this work were presented by Michele Bozzano. He explained the compilation of distribution maps using different sources of data and introduced the different software packages and information available to date. An additional source of good maps (<http://dendrome.ucdavis.edu/Image/Rangemap/index.html>) was mentioned.

---

<sup>2</sup> **Gene conservation unit:** A common term for all units in which genetic resources are maintained, including gene reserves, *in situ* and *ex situ* gene conservation stands or populations, seed lots stored in genebanks, clone collections, seed orchards and arboreta.

<sup>3</sup> ***In situ* conservation:** conservation of genetic resources ‘on site’, in the natural and original population, on the site formerly occupied by that population, or on the site where genetic resources of a particular population developed their distinctive properties. Although usually applied to stands regenerated naturally, *in situ* conservation may include artificial regeneration whenever planting or sowing is done without conscious selection and in the same area where the reproductive material was collected.

The discussion highlighted the importance of this work for coordinating, harmonizing and sharing conservation responsibilities in Europe. The minimum common information standards were discussed.

All countries were requested to provide feedback on the distribution map and to send information on designated gene conservation units for the pilot species. In consultation with the Chair, the Secretariat will circulate a note specifying criteria and format, and requesting input from all countries before 31 October 2002. The input will be provided by all countries before 30 November 2002. Representatives from countries not present at the meeting will also be contacted by the Secretariat.

It was emphasized that the identification of *in situ* gene conservation units for inclusion in a pan-European network will be jointly discussed by the Network on the basis of the information supplied by each country. The public-awareness value of updated distribution maps with cross-border networks of gene conservation units was stressed.

### ***'Best practice' in genetically sustainable silvicultural management***

Csaba Mátyás, Chair of the Network, outlined the concept of a publication that would describe genetic aspects of sustainable silviculture. The document should cover genetic considerations relevant for the use of reproductive material, silvicultural treatment and regeneration of forest stands. It should include principles of monitoring genetic sustainability and a chapter on balancing forest management, nature and specific gene conservation. Such a document has recently been published in Hungary. Csaba Mátyás offered to produce an English version, which will be circulated for comments to the Network. The document, approximately 10 pages long, could be proposed for adoption either as a Conifer Network publication or as a more general EUFORGEN publication.

### ***Technical support for policies on use of forest genetic resources***

It was felt that in order to keep genetic considerations in focus, linking gene conservation to sustainable forest management is essential. Csaba Mátyás proposed that EUFORGEN Networks could offer advice and technical support to European forest policy in the area of use of forest genetic resources. First steps in this direction have already been taken by producing technical guidelines. The expertise and the available information (at both national and common level) would enable EUFORGEN to play an advisory role in facilitating the appropriate use and maintenance of forest genetic resources. It was felt that further elaboration of this idea would be needed and Csaba Mátyás agreed to produce a proposal that will be discussed at the next meeting.

### ***Research***

Tore Skrøppa gave a brief report on the EU-supported Adaptability project, which studied the effects of the female reproductive environment on the phenotypes of Norway spruce offspring. DNA methylation may be the epigenetic regulatory mechanism that explains why identical genotypes produced under different environmental conditions have different phenotypes under the same environmental conditions.

Giovanni Vendramin reviewed recent studies of genetic variability based on neutral molecular markers and discussed their implications for gene conservation. He presented as an example some results from the EU-funded CYTOFOR project, in which 22 forest tree and shrub species were studied using molecular markers and fossil pollen. This project demonstrated the usefulness of phylogeographic studies in understanding the importance of migration patterns in shaping current genetic and geographic diversity. This is a relevant approach to designing conservation strategies but is of little value in understanding adaptability patterns. This is why new types of molecular markers are being developed for Norway spruce as well as *Pinus pinaster* and *Pinus halepensis* (for example, single nucleotide polymorphisms [SNPs] in the expressed region of the genome). They have a great potential in the study of adaptive traits.

Csaba Mátyás questioned the use of neutral genetic markers for the conservation of genetic resources. These markers have been useful for characterizing common origins of populations and their postglacial migration routes, and for studies of mating systems. They have less potential for characterizing genetic diversity in adaptive traits and the adaptive potential of populations. He stressed the need to bring the two approaches together so that genetic markers can also be used to study the adaptability of populations and effects of selection. The new type of markers may be a first step in this direction.

Bruno Fady highlighted the necessity to use both neutral and adaptive approaches. In the face of environmental changes, populations will migrate or adapt, or both. Knowledge of both mechanisms is necessary for gene conservation.

Jozef Turok mentioned the Conference on the Dynamics and Conservation of Genetic Diversity in Forest Ecosystems (DYGEN) (see [www.pierroton.inra.fr/genetics/Dygen/](http://www.pierroton.inra.fr/genetics/Dygen/)), which will be held in Strasbourg, France on 2–5 December 2002. It will bring together approximately 300 scientists in the field of population genetics and conservation of forest genetic resources. Introductory review presentations will be given by leading scientists and major achievements of the different projects dealing with forest genetic resources financed by the EU will be presented. EUFORGEN has been involved in the preparation of the conference, and the coordinator and Network chairs are members of the scientific committee. Network activities and strategies will be presented at poster sessions.

Csaba Mátyás presented the outline of a poster to be produced by the Conifers Network. It would focus on the target species of the Conifers Network. Ideas, pictures or maps should be sent to him before 31 October 2002. It was suggested that a EUFORGEN poster could be made to present the common goals of all Networks.

Jozef Turok gave a short presentation on the EU Sixth Framework Programme for research 2002–2006 ([www.cordis.lu/rtd2002](http://www.cordis.lu/rtd2002)). It contains seven thematic priorities. The research on forest genetic diversity fits into the priority ‘Sustainable development, global change and ecosystems’. The most relevant activity for the Network is ‘global change and ecosystems’, in which genetic resources are specifically mentioned.

Two instruments are available to implement these priorities:

- Integrated projects (IP), which are large in scale and scope. Only highly integrated projects will be funded and multidisciplinary approaches are needed. Their goal is to produce new scientific knowledge.
- Networks of excellence (NoE); large networks of research centres. Their goal is to structure the European research community more efficiently.

Expressions of interest were submitted in the summer of 2002, and EUFORGEN was involved in the preparation of two of them: Diversity of European Forest Trees (EVOLTREE), a NoE led by A. Kremer, INRA, France; and Genetic Resources and Changing Ecosystems (GRACE), an IP led by N. Maxted, University of Birmingham, UK.

The programme will be launched in November 2002, and first calls will most likely be published in early 2003. Participation will be from a larger number of countries than in earlier programmes. EUFORGEN Networks were invited to act as a catalyst to bring together scientists and end-users to prepare projects in the field of forest genetic resources.

### **Documentation, information and public awareness**

Michele Bozzano presented the recently updated EUFORGEN Information Platform ([www.ipgri.cgiar.org/networks/euforgen/default.asp](http://www.ipgri.cgiar.org/networks/euforgen/default.asp)), through which the documentation produced by EUFORGEN Networks is now accessible. Country reports and updates are maintained in a database-driven system that facilitates searching through the information.

Information on the current status and progress made in the conservation of genetic resources (*in situ* and *ex situ*), which has been available as tables, will be stored in the database in order to provide a complete picture of forest gene conservation in Europe.

Michele Bozzano briefly presented the EUFORGEN bibliographic database on grey literature. The database has been frequently used online from the web page. An improved

Access form will be circulated to Network members to avoid the problem of duplicate references. It was noted that contact information for the author (or contributor of the reference when author not available) should be provided for all references.

Bruno Fady updated Network members on the progress made on the image collection database and stressed the importance of providing more slides, particularly on the items listed in Table 1.

Table 1. Slides required

Code topic	Number of slides needed
100 General data on the species	30–35
110 Natural range map	
Mixed forests	
Stands of different countries	
120 Morphological aspects	
Leaf	
Flower	
Seed	
Bud	
Bark	
Seedlings	
Plant	
Flushing	
130 Taxonomy	
140 Pests	
200 Conservation aspects	30–35
210 <i>In situ</i> conservation	
220 <i>Ex situ</i> conservation	
240 Outstanding trees or stands	
250 Public awareness activities	
300 Genetics and breeding	10–15
310 Within-species variability	
320 Material selected	
400 Silviculture	10–15
410 Regeneration	
420 Thinning	
430 Stand growth	
500 Utilization	10

The importance of producing a regular publication after every meeting was highlighted. It was agreed to change the scope and style of published reports. The new Network reports will be devoted to a specific theme, which will be addressed during the preparatory phase leading to the meeting and during the meeting itself. The theme will be associated with the location or country in which the meeting takes place.

It was agreed that the Report of the Third Conifers Network Meeting should focus on the role of gene conservation in areas affected by industrial air pollution. The Report will contain contributions from the meeting as well as any relevant contributions from the previous meeting. Karel Vančura and Bruno Fady agreed to be the guest editors for this Report. They will be responsible for the contents of the Report. The Secretariat will support their work by facilitating communication with Network members and by providing publication services.

It was agreed that country reports and updates will only be published on the website (Information Platform). The thematic reports may, however, include summary information

on the current status of conservation of genetic resources for selected species in Europe, for example in a tabular form (with details for all countries).

### **Seminar: 'Genetic conservation and restoration programmes in areas affected by industrial air pollution'**

Opening the programme, Mr Wojciech Fonder, Chief of the Silviculture Department of the General State Forest Service, welcomed EUFORGEN participants to the Forest Gene Bank and gave an overview of Polish forestry and the programme to preserve Poland's forest genetic resources.

Forests cover more than 28% of Poland and it is planned to increase this to 30% by 2025. Approximately 78% of the forests are managed by the State Forest Service. The most abundant species is Scots pine (70.5%) followed by oak (6.7%), Norway spruce (5.6%), birch (5.6%), beech (4.6%), alder (4.3%), Douglas fir and other firs (2.0%) and other broadleaves (0.7%).

Mr Fonder then went on to outline the programme to preserve Poland's forest genetic resources in this region. The present programme (1990–2010) is a continuation of a programme originally started in 1975. The objectives of the programme are:

- to preserve forest genetic resources
- to create a seed base to preserve this forest genetic resource
- to select seed trees to maintain a parent base for this programme.

In the Wrocław region approximately 4000 ha are planted annually, which is close to 10% of the total planting for Poland. To satisfy the demand for forest reproductive material, seed is obtained from a number of sources. These include material from:

- permanent seed stands
- temporary seed stands
- selected plus trees for the establishment of seed orchards.

The programme will run for a further 8 years, but many of the objectives have already been achieved, including over 1000 ha of seed orchards. In this region state forests predominate and conifers represent 77% of forest cover. The next phase of the programme is now well advanced. An important aim is to increase the level of natural regeneration from the current 3–5% to a level of 10–15%.

### **Genetic conservation and reforestation of the areas destroyed by air pollution in the Polish Sudetes**

Mr Kazimierz Harcich, Regional Director of the State Forest Service in Wrocław, presented a paper giving information on the forests of Lower Silesia. He presented a range of statistics showing changes in the period 1988–99 in the Sudetes mountain areas affected by air pollution. The region has 33 forest districts, one fishery and two forest service units—roads and wood transportation—under its control. In 1988, 27.8% of the land in this region was under forest cover. By 1999 this had increased to 28.2% and it is envisaged that by 2030 the forest area will have increased to 33%.

Details for all main species by age structure, distribution by forest habitat type, production and standing volume were given. Annual planting stock requirements are supplied from local nurseries in each forest district, which produce 6.5 million plants.

Increasing numbers of deer and wild boar necessitate increased levels of culling and fencing. Of the 4000–6000 ha planted annually, one quarter is fenced. Although a high level of industrial pollution remains, the immediate threat has declined. Today only 9% of the area is no longer under industrial pollution threat; 56% is in zone 1, 33% is in zone 2 and 2% is in zone 3.

### **Forest restoration in the Western Sudetes**

The third paper, presented by Mr Andrzej Potyralski, Director of the Forest Gene Bank, focused on the restoration of destroyed forests in the Western Sudetes.

This area remained in a natural state until the 14th or 15th century. There followed a period of transformation of forests into spruce stands, lasting from the 16th to the 20th century. From 1880 until 1914, regeneration by sowing was gradually superseded by planting. After that, clear cutting became the only method of forest management in the Sudetes mountains. This was followed by a transformation into mixed forests, which began in the second half of the last century and has continued to date. This period is characterized by natural disasters which have led to large-scale forest dieback. More recently, damage from air pollution emitted by power plants in Poland, Germany and the Czech Republic led to the identification of this region as the 'black triangle'. This pollution resulted in a great ecological disaster which led to the removal of over 4.6 million m<sup>3</sup> of timber in an area of 14 000 ha. Between 1978 and 1998 reforestation of the area has resulted in a major change in species because of forest decline due to the effects of industrial air pollution.

There is concern over the decline in area of *Abies alba* during this period, and efforts are being made to redress this balance. The soils in the Sudetes mountains are seriously chemically and biologically damaged as a result of long-term emissions of harmful substances in the form of dust and acid rain.

### **The Forest Gene Bank in Kostrzyca**

Mr Zbigniew Sobierajski, deputy director of the Forest Gene Bank, explained that construction works started in 1994 and the gene bank began its activities in 1996. He outlined the goals set for the gene bank as follows:

- maintenance of all forest genetic resources through storage, for a maximum period of time based on current knowledge, of representative seed samples collected from the selected seed stands and plus trees from the territory of Poland
- control of seed collection and identification of seed origin in organizational units of state forests
- inventory of forest ecosystems for the conservation of their resources
- development of activities aimed at the conservation of endangered populations and the implementation of a programme for the conservation of species of trees, shrubs and forest floor vegetation.

The Gene Bank carries out its activities in accordance with the 'Programme for the conservation of forest genetic resources of forest tree species in Poland 1991–2010' within the framework of binding legal regulations and international agreements. An extensive tour of the facilities was made on the previous evening.

### **Rehabilitation of silver fir populations (*Abies alba* Mill.) in the Sudetes**

Władysław Barzdajn, Agricultural Academy, Forest Faculty Poznan, presented a programme aimed at the preservation of one of the most endangered tree species in the region—silver fir. Inventories have shown a decline from a high of 8% in the middle of the 18th century to 4% in 1988, with a further decline to only 2% today. The age structure of stands with silver fir is poor, with most of the stands being in the 81–140 years age category. The silver fir in this area is very homogeneous, and quite different from that species in other regions. Mr Barzdajn outlined a strategy for gene resource conservation of silver fir in the region with the aim of preserving local populations. The programme aims to eventually increase the share of silver fir in the Sudeten forests to 18%.

### **Conservation of common yew (*Taxus baccata* L.) in Poland**

The presentation by Małgorzata Falenca-Jablonska of the Ecology and Environmental Protection Department, Forest Research Institute, Warsaw, focused on the conservation programme for common yew. This is a rare species in Poland, and one of the earliest protected species in the country. An inventory carried out in the forest districts of the state forests in 1999–2000 has shown that naturally occurring or artificially regenerated yew is recorded in 129 forest districts. Yew most frequently occurs in broadleaved and mixed forest habitats, and rarely in riparian habitats, and it usually represents the shrub layer or

understorey. Even if conditions are favourable, it does not form pure stands. One of the limiting factors for yew occurrence is the type of parent rock material and the slope of the terrain. It grows best on calcareous, deep, moist soils.

### **Seed source for reforestation and gene conservation in the Sudetes**

Jan Matras' paper dealt with the requirements of a permanent and reliable seed sources and the difficulties in developing this under the conditions prevailing in the Sudetes. The paper outlined the impact of industrial emissions and the resulting destruction of the forests and its effect on an increased demand for planting stock and a subsequent increase in quantities of seed required.

### **Common yew (*Taxus baccata* L.) and its genetic diversity in the Czech Republic**

Karel Vančura presented an overview of a survey of the common yew and its genetic diversity in protected areas of the Czech Republic. This survey was undertaken by Vladimír Zatloukal and his colleagues at the Sumava National Park in the Czech Republic.

In the Czech Republic, yew is declared to be a highly endangered species. It is no longer seen as a forest timber species, and over the centuries it has practically disappeared from the forests where it was once found. The aim of this project was to obtain important missing information about common yew in the Czech Republic. Information sought included key elements such as frequency of occurrence, current state, ecological requirements and genetic characteristics of individual populations. In the course of the project, 532 individual yews from 21 populations have been subjected to isoenzyme analysis. The survey found that the entire gene pool of yews in the Czech Republic probably comes from a single glacial refugium from which one large primal superpopulation emerged. The differences in the genetic structure of the individual populations are probably the result of long-term isolated development of the remains of this population. Recommendations for preservation and strengthening of the yew population in the Czech Republic are in three key areas:

- theoretical: continuing research into the yew gene pool
- administrative and legislative: increasing the effectiveness of legal protection in areas where yews occur and improve the method of management while controlling the number of browsing animals
- implementation policy: support for natural regeneration and planting of yews where necessary using suitable reproductive material.

### **Miscellaneous**

Alexander Alexandrov outlined his proposal for the role and potential collaborative activities on Mediterranean conifers, and called for more attention to be devoted to the numerous conifer species of the Mediterranean. The Network recognized the need for strengthening its focus on Mediterranean species. It was agreed that the gene conservation in these species could be addressed specifically during one of the future Network meetings. It was also emphasized that setting priorities within EUFORGEN is a continuous process under the oversight of the Steering Committee. Alexander Alexandrov offered to prepare a document for Steering Committee discussion.

### **Date, venue and theme of next meeting**

The next Network meeting will be held in United Kingdom, in Scotland, in September 2003. Further details will be provided in due course. It was proposed that the theme of the meeting should focus on the issues associated with gene conservation of introduced/exotic conifer species.

### **Conclusion**

Csaba Mátyás concluded by thanking the local host and organizers for their excellent work and hospitality during the meeting. He also expressed his thanks to Jozef Turok and the EUFORGEN Secretariat for their contribution.



## Conservation of conifer genetic resources

**Selection of *in situ* gene conservation units (gene reserves) of conifers**

Csaba Mátyás

Institute of Environmental Science, University of West Hungary, Sopron, Hungary

**General introduction: aims and principles**

Genetic resources are elements of genetic variability which are (or might be) used to meet human needs and objectives. In forestry, the term covers naturally occurring populations and individuals, as well artificial plantations and collections, which carry actually or potentially valuable genetic information. Their protection is considered necessary from the point of view of economics, ecology, conservation, and/or even human culture or aesthetics.

Gene conservation forms part of the strategy of conservation of biodiversity, and more generally of nature conservation. The general aim of conserving the genetic resources of forest trees is to safeguard adaptability, and in the long run their evolutionary ability, which requires the conservation of genetic diversity.

A basic concept for conservation is the *minimum viable population* (MVP), the total number of reproducing individuals necessary for the long-term survival of a population. It has to be large enough to conserve genetic diversity and to safeguard evolutionary ability. Assessing the probability of loss of low-frequency alleles is the most appropriate way to estimate the MVP (Table 1).

Table 1. Estimation of minimum viable population size (MVP) based on probabilities of allele loss ( $P$ ) (from Krusche and Geburek, in Mátyás 2004)

$P$	$q$	Population size			
		$M=1$	$M=10$	$M=100$	$M=1000$
0.01	0.05	90	135	180	225
	0.01	459	687	916	1 146
	0.005	919	1 378	1 837	2 296
0.005	0.05	104	149	193	238
	0.01	528	757	986	1 243
	0.005	1 058	1 516	1 976	2 435

The table gives estimates for three allele frequencies ( $q$ ) and different numbers of rare alleles ( $M$ ). The calculation is based on the assumption that all genotypes are homozygotes. If the population is in Hardy–Weinberg equilibrium, the numbers should be halved.

Table 1 shows that MVP should include at least 100 or so individuals, if there is only one rare allele. The numbers refer to effective population sizes, so in reality MVP has to be at least one order of magnitude larger; i.e. for one allele at least 1000 individuals for outcrossing widely occurring wind-pollinated species, such as most conifers. The size of MVP may vary widely according to species, depending on diversity and mating conditions, dispersion, density and evolutionary status (natural population sizes).

**Why specific forest gene conservation strategy is needed**

Although nature conservation areas protect valuable genetic resources, they are not sufficient because:

- the areas do not necessarily represent ecological conditions typical and important for silviculture
- there may be legal obstacles to interventions in protected areas (regeneration, seed collection, etc.)

A strategy of forest gene conservation and the selection of conservation units should be based on some knowledge of past and present human influence, mating conditions, and the size of *MVP* and of adaptively homogenous areas (AHAs; Mátyás 2004).

### **Methods of gene resource conservation**

Dynamic *in situ* conservation of natural or naturalized populations is the optimal solution. Although natural forest dynamics should be preferred in most cases, unavoidable human intervention to regulate succession or density, and even to artificially regenerate (with authentic material) is acceptable. The species-oriented protection of evolutionary potential is best served by a network of gene reserves, covering the area of distribution of the species.

In *ex situ* conservation, reproductive material is brought to units outside the natural habitat. Gene banks include seed, pollen and tissue banks, as well as field collections (clonal archives, stool beds, etc.). *Ex situ* conservation stands (progeny stands) may be established with evacuated populations where the original site is threatened, or with plantations of valuable selected populations or exotic species. In what follows, only *in situ* gene reserves are considered.

### **General requirements for gene reserves**

Gene reserves represent forest areas specifically selected, registered and managed in order to maintain and promote genetic diversity. The following requirements apply:

- There has to be a legal basis for conserving the genetic resource.
- The area must have identifiable, defined boundaries and must be properly registered and marked in the field.
- The forest owner and/or manager is required to maintain the area and density of the population, or to extend it.
- The introduction of reproductive material of the target species from outside the gene reserve is not acceptable.

Both unmanaged and managed forests qualify for *in situ* conservation, but active gene conservation is mainly implemented in managed forests by adopting specific silvicultural measures to safeguard gene conservation. Genetic conservation is theoretically possible also in national and nature parks, nature reserves and wilderness areas. The prerequisite is the accessibility of the genetic material (e.g. seed harvesting, sampling for genetic analysis) and the fulfilment of all further requirements described below. A nature conservation area is unsuitable for genetic conservation in the strict sense if interventions that are potentially necessary for active conservation (e.g. regulating succession processes) cannot be carried out. Seed stands *per se* do not qualify either, as their perpetuation and proper regeneration with the same material is generally not prescribed.

### **Ownership**

Preference should be given to publicly owned forests, where long-term integrity of populations and access to genetic resources is most easily safeguarded. No potential change of land use should threaten the long-term existence of the population.

### **Size and stand characteristics**

The minimum area for a suitable management unit should be greater than 10 ha (net area) or 2000 sexually mature individuals in a contiguous unit of larger size. The stand may include various admixed species as long as proper mating conditions for the target species are maintained. The optimum (although seldom reached) size would be 100 ha, with a minimum diameter of 300–400 m.

### **Selection of locations and number of sites**

Selected locations should adequately represent the spatial genetic and ecological variation pattern of the species, but the consideration of adaptive variation pattern should have priority. Knowledge (or an educated guess) of within-species genetic patterns arising from

within-species gene flow and genetic adaptation is therefore essential for the decision on *in situ* gene conservation units.

The balance of gene flow and adaptation forms AHAs within the species, which should serve as a basis for conservation planning. Within an AHA, adaptive behaviour and diversity of populations are roughly similar. As a result of gene flow, AHAs are considerably larger than selective environments where fitness value of genotypes is roughly uniform. If detailed genetic information is lacking, at least distribution data should be checked in detail.

Usually biogeographical regions, such as forest regions, may be taken as convenient units for selection of at least one, preferably two representative reserves per region (if ecological variability, e.g. by altitude, is low). Spatial and temporal site variability (heterogeneity) promotes genetic diversity and should be therefore considered when selecting conservation areas. Locations extending over variable site conditions (water regime, altitude) are preferable to uniform sites.

### **Autochthonous populations**

The conservation of autochthonous populations (those of local origin) should have priority. Special care must be taken to include populations outside the contiguous range, where selective forces might maintain specific alleles. The same applies to threatened occurrences (if conservation may be solved *in situ*, without expatriation or evacuation).

Nevertheless, the conservation of well-adapted allochthonous populations (landraces) can be also of interest, and should not be excluded. Information indicating the origin of the basic material should be recorded (e.g. historical evidence, genetic data, etc.). The unit may be formed from adjacent stands (subcompartments) of varying age and composition, but of uniform origin.

### **Isolation from undesired gene flow**

Gene flow from stands of unknown or undesirable origin should be minimized through selection and establishment of large conservation areas and/or selection of relatively sheltered locations (e.g. valleys), or through the design of a buffer zone around a smaller central zone. The distance from undesired populations should be kept at 500 m or more.

### **Registration**

For the registration of the gene reservation the following are required:

- The permanent status of the reserve must be safeguarded by an entry in the management plan and the local land register, or by any other suitable means, e.g. a contract.
- The responsible national authorities must keep a register of forest genetic conservation units.
- The units must be described according to a standard format.

### **Silvicultural requirements**

All activities must be in line with conservation requirements. There are, however, no specific prescriptions regarding silvicultural treatment and utilization if they are in accordance with the general aim of the gene reserve; i.e. gene reserves need not be excluded from the production forest area.

General principles of management are described by Koski *et al.* (1997) and are not repeated in detail here. Special care has to be taken for (natural) regeneration, however. Ideally, good seed years over a longer regeneration period should be used for regeneration. Treatment should provide optimum conditions for widest possible mating (creation of regeneration in gaps). If necessary, site preparation, game regulation or protection (e.g. fencing) should be provided in order to guarantee regeneration success.

Artificial regeneration with reproductive material from the gene reserve itself should be applied only as an exception. Sowing is preferable to planting, if possible. Regardless of the method applied, it is important that the number of plantlets constituting the new stand be as high as possible.

**References and further reading**

- Bonfils, P., A. Alexandrov and J. Gracan. 2001. In situ conservation of oaks. Pp. 43-47 in Report of the Third EUFORGEN Meeting on Social Broadleaves, 22-24 June 2000, Borovets, Bulgaria (S. Borelli, A. Kremer, T. Geburek, L. Paule, E. Lipman, compilers). International Plant Genetic Resources Institute, Rome, Italy.
- Koski, V., T. Skrøppa, L. Paule, H. Wolf and J. Turok. 1997. Technical guidelines for genetic conservation of Norway spruce (*Picea abies* (L.) Karst.). International Plant Genetic Resources Institute, Rome, Italy.
- Mátyás, Cs. 2004. Population, conservation and ecological genetics. *In*: Encyclopedia of Forest Sciences (J. Burley, J. Evans, J. Youngquist, editors), Elsevier Major Reference Works, Oxford (in press).

## Common yew (*Taxus baccata* L.) and its genetic diversity in the Czech Republic

Vladimír Zatloukal<sup>1</sup> and Karel Vančura<sup>2</sup>

<sup>1</sup>Sumava National Park, Vimperk, Czech Republic

<sup>2</sup>Ministry of Agriculture, Forestry Development Department, Prague, Czech Republic

Common yew (*Taxus baccata* L.) is a small, deep-rooted tree, often only 2–3 m tall with a bushy aspect. It can grow up to 10–20 m tall under favourable conditions and without damage caused by cattle, game animals or decorative cutting. Common yew has an extremely slow height growth rate, 2–3 cm per year up to the age of 6 years and then somewhat faster. It does not reach a height of 10 m until it is approximately 100–110 years old. Growth in diameter or girth is also slow: 0.6–1.2 mm per year.

Common yew is a primarily dioecious tree species (i.e. the male and female gametes are formed in different trees) and monoecious individuals are rare. This makes it difficult for individuals to exchange genetic information if the population is fragmented and pollination occurs between within a very small group of individuals.

Common yew begins to flower at the age of 10–12 years, or even later in shady growing conditions. In the Czech Republic, the usual flowering period is from March to April, depending on altitude and weather conditions in a given year. The reddish fruits ripen between July and October. The seeds are 6 mm long and 4 mm wide, and they remain dormant for 1–3 years. On average the 1000-seed weight is 58.7 g.

Common yew has often multiple stems and the frequency of individuals with multiple stems differs among populations. The growth properties of yew clearly mark it out from the usual timber species. The wood has no resin and it has very narrow, sharply defined annual rings. The wood is also highly resistant to rot and insect attack and it can be worked, polished and stained excellently. Yew wood suffers from relatively few diseases or pests. Seedlings may be attacked by weevils (*Otiorhynchus* spp.), midges (*Taxomyia taxi*) and mites (*Cecidophyes psilapsis*). A 'blight'-type fungal illness causing defoliation has also been observed on mature trees to a varying extent.

The wood and other parts of the tree are poisonous, except the follicles of the fruits. Yew contains substances which are used for cancer treatment (taxins) and this has increased interest in using the species for pharmacological purposes. However, from the point of view of genetic conservation, it also increases a risk of over-exploitation (possibly illegal) of the existing common yew resources.

Common yew is highly adapted to shaded growing conditions under the upper tree canopy, as well as surviving under a wide range of ecological conditions. This is probably why fragmented yew populations have survived under the commonly applied forest management practices, which do not favour it.

Common yew has a relatively large distribution area, from the Mediterranean to southern Scandinavia, and from the British Isles in the west to the Carpathian arch and the Baltic republics in the east. Although the distribution area is large, occurrence of the species is scattered and minimum temperatures regularly below  $-20^{\circ}\text{C}$  may be one of the limiting factors for its distribution. Common yew is found over the entire edaphic range, with the exception of highly acidic, poor and peat soils. Its occurrence is also limited on soils heavily affected by water.

Human influence is a major reason that has caused a decline of yew resources and the disappearance of the species from extensive areas. The sensitivity of common yew to anthropogenic disturbances is primarily due to its very slow growth and inability to compete with other tree species. The primary causes for the decline in yew resources can be listed as follows:

- selective logging caused by demand for yew timber
- grazing by cattle (some animals, such as goats and sheep, feed on yew although it is poisonous)
- extermination as a poisonous species threatening some farm herbivores (especially horses)
- extermination as a 'weed' tree taking up space that could be used by more profitable timber species
- extermination of most large predators which naturally regulated population sizes of large herbivores (especially cervids) browsing yew
- landscape fragmentation
- use of clear-cutting in forest management, creating unfavourable light and temperature conditions for common yew
- replacement of natural mixed forests by spruce monocultures.

### ***Yew survey project in the Czech Republic***

Lack of comprehensive information on the amount and distribution of common yew populations was a major constraint for improving the management of the species and its genetic resources in the Czech Republic. To improve the situation, several Czech institutions and organizations collaborated in the development and implementation of a survey project over a period of two years (2001–2002). In addition to extensive literature searches, the aims of the project were:

- to assess the occurrence and condition of common yew resources in the Czech Republic, with a particular focus on the protected area of Sumava
- to develop a distribution map for common yew in the Czech Republic
- to analyse genetic diversity and relationships between significant common yew populations, with a focus on developing *ex situ* conservation measures
- to develop appropriate conservation measures, including possible reintroductions
- to increase public awareness on yew as part of natural forest ecosystems.

As well as field surveys, the project also used questionnaires to find out common yew populations outside the protected areas that may have been overlooked during past surveys. In the course of the project, the overall condition of the surveyed populations (state of health, damage, natural regeneration, age, etc.) was assessed as well. Information was also collected from a database of historically important trees, from the Internet and hiking maps, for example. The questionnaire project was also aimed at increasing interest in common yew among owners and users of forests. Extensive photographic material was also acquired during the survey, and samples were collected for laboratory analyses.

Isozyme studies were used as a primary tool to provide data on the genetic diversity of the common yew in the Czech Republic. The Electrophoretic Laboratory of the Sumava National Park in the town of Kasperske hory carried out the isoenzyme analyses. For selected individuals and populations, the isoenzyme analyses were supported by DNA analyses carried out in the laboratories of the Agricultural Faculty of the South Bohemian University in Ceské Budejovice.

### ***Project results***

#### **Distribution of common yew**

From the literature, the number of yew trees in the Czech Republic was estimated to be approximately 10 000 mature individuals. By November 2001, the survey had found 11 242 individuals. In many locations the occurrence of common yew was confirmed for the first time, and in some places the number of individuals was found to be much higher than originally expected. In many cases, early stages of natural regeneration were also found to be more frequent than expected. The search for hitherto unknown individuals and the verification of their occurrence will continue after the project has been concluded.

Common yew is found from the low-altitude oak forests to the high-altitude spruce-beech forests. It is also occasionally found in pine forests. In terms of altitude, its occurrence ranges from 235 m above sea level (a.s.l.) in Brezinske (a protected countryside area in Ceske stredohori in the central Bohemian highlands) to approximately 900 m a.s.l. in Sumava, Jeseniky and the Beskydy mountains. The survey results indicate that common yew is mainly found just above 500 m a.s.l., which corresponds to the upper zone of oak-beech forests.

Common yew was also found on a wide range of soil categories in the Czech Republic. Although sites on basic rocks seem to suit this species well enough, yew populations commonly do better on acidic subsoils. Yew is most widespread on humus-enriched and fertile soils, and it is less frequent on rich, loamy, compacted soils. It has a marginal incidence on water-influenced (hydromorphic) soils, in which it generally grows on stony slopes with flowing water. On pseudogley soils yew occurs only exceptionally and under relatively favourable conditions. It is not found on acidic and very poor soils of the 'blueberry' or floodplain category, on poor and medium rich pseudogley soils or on peat soils.

The upper canopy story of the forest seems to have an important effect on the distribution of yew and, in particular, its condition in particular sites. Mixed coniferous-deciduous forests, especially if there is no full canopy closure, are favourable for yew. It can also survive under deciduous stands with a closed canopy, probably because it can take advantage of the periods before the leaves flush in spring and after they fall in autumn.

Even healthy populations with good potential for regeneration are affected by browsing. Game animals are an extremely serious threat to the natural regeneration of yew in otherwise promising locations. In many places where yew was found growing, the density of the yew population has fallen below the critical limit. Without active intervention, the local extinction of such populations is merely a matter of time.

### ***Genetic diversity***

For the overall evaluation of the genetic structure of the common yew populations, a total of 21 populations and 532 trees were analysed. The results indicate a high level of within- and among-population variation. However, genetic similarities were also discovered between remote populations. The results of isoenzyme analysis provided evidence of a genetic relationship between yew populations in southern Bohemia and southern Moravia (Podyji) and possibly central Moravia (Moravsky kras), rather than between populations in southern Bohemia and central Bohemia. Surprisingly, there are great differences among populations in various localities of the central Bohemian highlands.

A lack of polymorphism was observed in the yew populations of the Bavorsky les (Bavarian) forest and Chrobolske. This type of reduction in genetic variability may occur as a result of generations of constant adaptation to highly specific microclimatic conditions. Another, totally opposite, explanation is that the populations have been artificially created by human activity, using material from only a few mother trees. Molecular genetics cannot answer this question, but historical research may provide some insight. In any case, a low level of genetic variability is likely to reduce adaptability, especially in small populations, and make them more vulnerable to pests and climate change, for example.

However, the overall genetic diversity of common yew populations in the Czech Republic is still considerable. From the overall dendrogram of genetic similarity of the analysed populations, it is possible to observe, with a certain exaggeration, a total of six population clusters which are more distant from one another. These genetic similarities do not reflect geographical distribution; different geographical areas were clustered together, such as the Bavorsky les and Jeseniky. The only relatively compact and genetically well-defined area in the Czech Republic seems to consist of populations from Ktisska, Podyji and Moravsky kras.

Of all the monitored populations, the best genetically defined yews appear to be from the Slapy region. The Babakov population from the Zelezne hory mountains also appears to be

highly genetically specific, and cannot be compared with any of the other populations assessed by the project. The Podyji and Moravsky kras populations are also highly specific, and are practically genetically identical. Despite the large total number of trees analysed within the project, the number of individuals analysed was low in certain populations. In these cases, the results are only tentative and further work is needed.

### ***Recommendations for the conservation of common yew in the Czech Republic***

It is essential to increase public awareness of common yew as a native tree, because the species is sometimes considered to be 'foreign'. Also, forest owners are concerned about possible conservation measures hindering forest management. The following activities would increase public awareness on common yew:

- regular publication of articles about the species in periodicals read by the general public
- publication of research results and recommendations for management of common yew in professional journals
- publication of a monograph based on the results of the present project
- encouragement of academic dissertations and continuing research on the species
- more attention to areas where common yew is growing when mapping out areas for the NATURA 2000 programme and other conservation efforts.

In addition to increasing public awareness, it is also necessary to increase the level of management of the existing common yew resources. A general strategy would be to reduce risks and threats, especially to limit damage caused by game. Sudden clear cutting of shelterwood should be avoided in areas where common yew is present. It is also necessary to negotiate with landowners and try to find a way to manage forests without onerous strict conservation measures. Better coordination is also needed in state administration dealing with nature conservation and forest management.

In areas where the density of common yew is low, or where the species has disappeared, it is suitable to plant new trees using reproductive material from local sources. Knowledge of the gender of trees is important in vegetative reproduction, as using seedlings from known clones enables some manipulation of the sex ratio in new populations. This can be done using a mixture of vegetatively and generatively produced seedlings. Fewer male individuals are required than females, and they should be located either evenly within a stand or in a more clustered manner taking into account the direction of the prevailing winds. If possible, the tree planting efforts should contribute to reducing fragmentation of the yew populations.

*Ex situ* conservation should focus on gene pools of yew populations with fewer than 100 adult individuals, or larger populations if the trees are highly dispersed. *Ex situ* conservation can be implemented in several ways, through long-term storage of seeds or other tissue, or tissue culture, for example. Threatened populations can also be conserved as clone archives. These can then be used for vegetative propagation or as seed stands.

The state of common yew populations needs to be monitored regularly, in 5–10-year cycles. It is also necessary to monitor the health of the trees, the frequency of harmful factors, and changes in land ownership and forest management practices.

### ***Cultivation of reproductive material***

Yew seeds ripen between the end of July and October. Early seed collections are recommended because fully ripe fruits drop very quickly, especially in heavy rain or wind, or are taken by birds. When collecting seeds it is always necessary to gather them from as many seed-bearing individuals as possible of the given population or fragment of the population which is to be reproduced (with the exception of special breeding or cultivation intentions). Proper documentation of seed collection and keeping records of collect seed lots is essential for later planting purposes and targeted transfers of reproductive material between geographically separated populations.



Acquiring reproductive material by collection of seedlings is a special case. It is suitable when seedlings grow in places where they have no hope of long-term survival and in areas of abundant natural regeneration. Early spring or the period before the autumn phase of root growth (around August) is appropriate for the uprooting of seedlings.

Propagation by cuttings is a suitable and practical technique for the vegetative propagation of common yew; grafting is used primarily for the reproduction of garden varieties. Tissue culture is suitable for the production of a large number of genetically identical individuals from a limited number of clones. The method can be used particularly for the vegetative reproduction of poorly rooting yews. The advantage is that plagiotrophic growth does not occur in individuals reproduced in this manner. Layering can also be used in propagating common yew. The species is capable of rooting even from older branches if they are in contact with the ground for a long time. In practice this method is not very productive and it has a destructive aspect—if a large number of seedlings are produced, this will obviously have an undesirable impact on the tree.

Direct sowing is used only rarely as a regeneration method but it is commonly used for raising nursery stock. It is essentially possible to sow yew seeds without follicles even without pre-sowing treatment soon after seed collection. When common yew is cultivated intensively in nurseries, the seeds are generally stratified.

In vegetative propagation, a mixture of peat and sand (in a ratio of 1:1) is usually used as the reproduction substrate. The temperature of the substrate should not exceed 10–12°C, as higher temperatures promote the growth of calluses at the expense of rooting. The best time is considered to be from September to November (later in greenhouses).

## Conclusions

Common yew resources in the Czech Republic are fragmented. The state of the populations is highly diverse; some of them are in rather stable conditions while others are deteriorating. Conservation measures need to be strengthened to maintain the existing gene pools and reduce the threats to them. Damage by game animals is a major threat and their population sizes should be controlled. Otherwise only good fencing can provide the long-term protection (at least 20 years) that is needed to ensure natural regeneration. The risks arising from unfavourable forest management practices are also significant, but are far less than the long-term threat from game.

In order to maintain or increase common yew resources in the Czech Republic, it is necessary to implement measures in three areas:

- **research:** continue monitoring and assessing yew populations and their gene pools
- **administrative and legislative:** increase the effectiveness of legal protection of localities where yew is present; unify the database of historically important trees; find resources to develop an acceptable method for game management
- **implementation:** rehabilitate fragmented and degraded populations; make backups of the gene pools of threatened populations as seed stands or clone archives; reintroduce yew at suitable areas; provide long-term protection against game.

Areas for reintroduction of common yew should be selected using the following criteria:

- **Suitability of growth conditions.** The optimum areas are oak–beech, fir–beech and beech forest in respective altitudinal zones. In the lower altitudes (oak and beech–oak forests), the most appropriate locations for reintroduction are cold closed valleys—especially at the base of slopes and damp, shaded slopes with north or northwest exposure.
- **Restricted intensity of forest management.** In production forests, common yew will always face increased risks as a result of its slow growth and specific demands on the environment. For the reintroduction of yew, it is appropriate to choose forests in which the management intensity is already restricted for some other reason. Protected forests and certain types of special-purpose forests fall into this category.

The findings of the project regarding the genetic structure of common yew populations in the Czech Republic can be summarized as follows:

- The yew gene pool is highly heterogeneous.
- It is possible that the yew populations originate from one glacial refugium.
- The differences between individual populations probably reflect adaptation of these populations to specific local conditions.
- Genetically, the best defined or otherwise specific populations in the country are in Ktišsko in Sumava, the Podyji National Park and Babakov in the Zelezne hory Mountains. The yews in the area of the Slapy reservoir appear to be totally different from other populations.
- Other populations, such as those of Netreb and the Luzicke hory (Lusatia) mountains display peculiarities resulting from the occurrence of certain alleles.
- The populations from the Bavarian forest and Chroboly have a significantly lower variability. In contrast, high variability was noted in populations from Ktišsko, Slapy and Podyji.
- For certain alleles, there may be some relationship between genetic structure and geographic location. Differences in the north–south and west–east directions were detected, but in order to confirm this it will be necessary to work in a pan-European context.

## Conservation of common yew (*Taxus baccata* L.) in Poland

*Małgorzata Falencka-Jabłońska*

*Ecology and Environmental Protection Department, Forest Research Institute, Warsaw, Poland*

Common yew (*Taxus baccata* L.) is one of 11 indigenous species of conifers in Poland. It can reach a height of 10–15 m, but most commonly occurs as a shrub. Common yew has a characteristic brownish-red or greyish-brown flaking bark and sheds its needles every 6–8 years. The wood does not contain resin.

Common yew is dioecious. Ball-like single male flowers are set in the angles of the needles, similar to female flowers, which appear on the underside of twigs in March and bloom in April–May. On female trees, the fruits (i.e. seeds surrounded by red fleshy cups) mature in October–November and are a favourite food of birds. Yew trees reproduce from seed, and the shrub form is reproduced vegetatively.

The whole plant is poisonous, except for the red cups surrounding the seeds, which are edible. Even smelling the twigs can cause poisoning, and eating the fruits can kill a horse. The poisonous properties of yew have been known since ancient times, when wine was served in a jar made of yew wood to get rid of an inconvenient person. Julius Caesar recalls the defeat of the Eburons, a tribe in Gallia whose chief died of yew poisoning. Dioscorides, the 1st century authority on pharmacology, also warned against yew.

Common yew is a rare species in Poland. It grows in clumps in reserves and is often protected as a monument tree. Its height growth rate is the lowest of all conifers. Before the age of 6 years yew grows by 20–30 mm per year; at the age of 10 years it reaches a height of 2 m, and at the age of 20 years 2.5 m. On average, 30-year-old yews are 3–4.5 m tall. Yew has two height growth culminations, at 30–40 years and 150–160 years of age (Namvar and Spethmann 1986). The diameter growth is also slow and in successive years it can range from 0.2 to 2.9 mm (Gumińska and Marecka 1991).

In the Tatra mountains, common yew occurs at elevations up to 1380 m (Myczkowski 1961). Numerous natural stands of yew are found in the lowlands, uplands and mountains. The oldest specimen of common yew—in fact the oldest tree in Poland—grows in Henryków near Lubań (Lower Silesia). Its age is 1250 years, girth 5.12 m and height 13 m (Pacyniak 1992).

Common yew was the first protected species in Poland. In 1424, Władysław Jagiełło issued the first legal document forbidding people to enter yew forests. In modern-day Poland, yew is protected by the Ordinance of the Minister of Environment Protection, Natural Resources and Forestry of 6 April 1995. Pursuant to the ordinance, all natural stands of yew are protected and large populations (currently 29 sites) are declared as nature reserves.

The yew inventory carried out in the forest districts of the State Forests in 1999–2000 revealed that naturally or artificially regenerated common yew occurs in 129 forest districts. Most of the yew sites (83) were found in the Szczecin Regional Directorate of State Forests. The Toruń Regional Directorate inventoried 47 yew sites, Krosno 44 and Wrocław 39. Overall, 448 yew stands with 6057 yew trees were inventoried (Figure 1).

The most numerous sites with naturally regenerated yew are situated in the south of Poland in the natural forest regions V-Śląska, VII-Sudecka, VIII-Karpacka, the western part of VI-Małopolska and less numerous in I-Bałtycka, II-Mazowiecko-Pomorska and III-Wielkopolsko-Pomorska. The only natural forest region in which yew does not occur is IV-Mazowiecko-Podlaska (Figure 2). In the Bałtycka and Mazowiecko-Pomorska natural forest regions yew stands from artificial regeneration prevail, but there are many places where yew has regenerated naturally from seeds transported by birds or from old fruiting trees. The recruitment in such a group can amount to 7000 seedlings, as in the Rokita forest district in the Goleniowska old-growth forest.

**Figure 1.** Number of common yew sites (*Taxus baccata* L.) in Polish forests. The boundaries are those of forest directorates. Dark circles denote the number of naturally regenerated sites, light circles artificially regenerated sites.



Fungal diseases of common yew are poorly understood. Little research has been undertaken in this area, as yew is a healthy, decay-resistant and strictly protected species. Damping off, dieback of needles and shoots injured by late frosts, and wood rots of old trees are the most common form of damage.

One of the limiting factors for the occurrence of yew is the type of parent rock and the slope of the terrain. In contrast to beech, yew grows successfully on marl soils. The extreme limiting factors are soil moisture and competition for light. Yew grows best on calcareous, moist, deep soils, and worst on dry, boggy and acidic soils.

Common yew occurs most frequently in broadleaved and mixed forest habitats, and rarely in riparian habitats (Gieruszyński 1961). It often forms the shrub layer or understorey, and rarely occurs in the upper storey of a stand (Habibi and Lessani 1986), as it grows better in shaded environments. Even if conditions are most favourable it does not form pure stands (Zaręba 1984). Yew is often found in beech forests on calcareous soils and in oak-hornbeam forests, less frequently in oak forests on acidic soils.

Many researchers have pointed out the relationship between the height growth of yew and light regimes. The growth rate of yew is better in shaded environments (up to 60% of full light); when it receives more light, its growth slows down. Open terrain does not facilitate the growth of yew.

Recent measures have focused on passive protection of yew, as the species is of no economic importance (Czartoryski 1975). In recent decades, the interest in yew has greatly increased as a result of its medicinal properties; it may become a species of higher economic importance.

The main effort to conserve yew in Poland should focus on maintaining the species where it presently grows and introducing it where the growth conditions are optimal. The optimum ecological conditions for yew are moist broadleaved forest and alder swamp forest habitats. Studies have demonstrated that it can also grow in drier habitats, especially on calcareous soils. Seedlings used for artificial regeneration should come from plant communities growing in similar habitats.

Natural regeneration of yew does not require soil preparation, because of its shade tolerance and the ability of seedlings to emerge under poor light conditions. The studies of Giertych (2000), conducted in the arboretum in Kórnik, have demonstrated the natural regeneration potential of yew under crowns and its absence in open terrain.

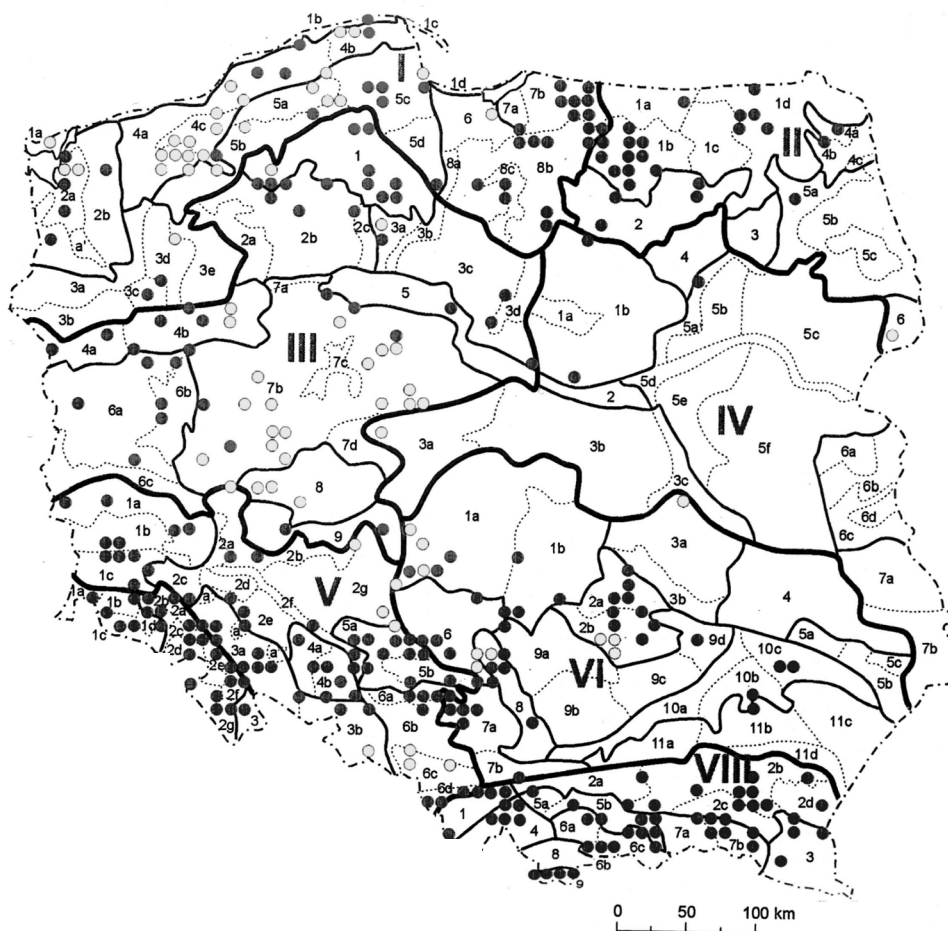


Figure 2. Location of common yew sites in Poland. Black circles denote naturally regenerated sites, light circles artificially regenerated sites; I, II, etc. natural forest regions; 1, 2, 3, etc. natural forest subregions; a, b, c, etc. mesoregions.

Generative reproduction of yew is the most efficient and least expensive way to produce planting material. About 150–200 g of seeds can be obtained from 1 kg of fruits after cleaning. If the demand for reproductive material is high, it is reasonable to establish seed stands of local origin. Yew plantations should be established in a shaded place to obtain the largest possible amount of seeds in female trees.

On the basis of recent studies and the inventory of yew in Poland, the following recommendations can be formulated for forest management and conservation of yew:

- Cultivation of yew in Poland should focus on the maintenance of the species in locations of its natural occurrence and on its reintroduction as an admixture species (5–10%) in habitats with optimal growth conditions in Forest Regions I–III, V–VIII and IV (northwest part of the country). Calcareous soils are preferable.
- Stable light and microclimatic conditions (moderate crown closure of the upper storey) are needed to maintain yew.
- Artificial regeneration of yew should consist of planting under the canopy of light-demanding species in the stands of age classes II–IV or underplanting in mixed stands before the regeneration phase.
- Adequate measures should be taken to suppress the competition of herbaceous plants and seedlings of other tree species. The woody form of yew requires careful thinning of the upper and lower storeys of a stand. (Sokołowski *et al.* 2000).

**References**

- Czartoryski, A. 1975. Opieka nad cisem i jego ochrona. W: Cis pospolity (*Taxus baccata* L.) [Yew protection and preservation]. Pp. 141–166 in Common yew (*Taxus baccata* L.). PWN, Warszawa–Poznań.
- Giertych, P. 2000. Factors determining natural regeneration of yew (*Taxus baccata* L.) in the Kórnik Arboretum. *Dendrology* 45:31–40.
- Gieruszyński, T. 1961. Struktura i dynamika rozwojowa drzewostanów rezerwatu cisowego w Wierzchlesie [Structure and developmental dynamic of sylva in 'Wierzchlas' yew reserve]. *Ochrona Przyr.* 27: 41–90.
- Gumińska, B. and H. Marecka. 1991. Cis (*Taxus baccata* L.) w rezerwacie 'Cisy w Malinówce' (województwo krośnieńskie) [Yew (*Taxus baccata* L.) in 'Ywes in Milowka' reserve (krośnieńskie province)]. *Ochrona Przyr.* 48: 105–119.
- Habibi, H. and M.R. Lessani. 1986. A study of soil condition and tree quality in yew (*Taxus baccata* L.) stands of Iran. *Iranian Journal of Natural Resources* 39: 13–28.
- Myczkowski, S. 1961. Zespoły leśne rezerwatu cisowego 'Wierzchlas' [Forest groups in the 'Wierzchlas' yew reserve]. *Ochrona Przyr.* 27.
- Namvar, K. and W. Spethmann. 1986. Die Eibe (*Taxus baccata* L.) [The yew(*Taxus baccata* L.)]. *Allg. Forst. Zeitsch.* 23:568–571.
- Pacyniak, C. 1992. Najstarsze drzewa w Polsce [The oldest trees in Poland]. Wydawnictwo PTTK 'Kraj', Warszawa.
- Sokołowski, A.W., A. Grzywacz, J. Gutowski, M.Falencka-Jabłońska *et al.* 2000. Ekspertyza ochrony cisa oraz opracowanie założeń krajowej strategii ochrony tego gatunku.[The expertise in preservation of yew and study premises for domestic protection strategy of this species].
- Zaręba, R. 1984. Możliwości reintrodukcji w lasach i utrzymanie w rezerwach cisa pospolitego (*Taxus baccata* L.) [Possibility of reintroducing the common yew (*Taxus baccata* L.) in reserves]. *Sylvan* 128(11):31–34.

## The Forest Gene Bank in Kostrzyca

*Zbigniew Sobierajski*

*Forest Gene Bank in Kostrzyca, Miłków, Poland*

The establishment of the Forest Gene Bank is a result of the commitments made by the Polish Government to implement Resolution 2 (Conservation of forest genetic resources) adopted at the Strasbourg Ministerial Conference in December 1990 and the Convention on Biological Diversity adopted in June 1992. The Forest Gene Bank Project was financed by the Forest Fund of the State Forests Holding, with additional funding from the World Bank through its Global Environment Facility (GEF) programme, the National and Provincial Funds of Environment Protection and Water Management, the EcoFund Foundation and the Polish Forest Research Institute. In 1996, the PHARE Fund joined the group of donors to finance the construction of adjacent hotel and social facilities.

The construction work started on 1 March 1994, and the Forest Gene Bank began its activities on 1 January 1996. Details of the site and buildings of the complex are shown in Table 1.

**Table 1.** Site and buildings of the Forest Gene Bank complex (see also [www.lbg.jgora.pl](http://www.lbg.jgora.pl))

Site area:	5.78 ha
buildings, roads and car parks	13 800 m <sup>2</sup>
sanitary protection zones and green areas	28 400 m <sup>2</sup>
Building structure area	
built-up area	4029.5 m <sup>2</sup>
total area	3629.5 m <sup>2</sup>
usable area	3417.8 m <sup>2</sup>
Total building volume	20 366 m <sup>3</sup>
hall and corridors	1954 m <sup>3</sup>
administrative and laboratory unit	3141 m <sup>3</sup>
Gene Bank unit	2101 m <sup>3</sup>
seed collection and biopreparation production units	5946 m <sup>3</sup>
hotel and social building	2484 m <sup>3</sup>
Other technical infrastructure units	4740 m <sup>3</sup>
boiler room	536 m <sup>3</sup>
transformer station and engine-room unit	36 m <sup>3</sup>
sewage treatment plant	1250 m <sup>2</sup>

The activities of the Forest Gene Bank focus on the conservation of genetic resources in a broad sense, in accordance with the 'Programme for the conservation of forest genetic resources and the breeding of forest tree species in Poland in the years 1991–2010' within the frame of binding national legislation and international agreements, including:

- Act on Forests of 28 September 1991
- Act on Nature Protection of 16 October 1991 as amended by the Act of 9 December 2000
- Order No. 42 of the Director General of State Forests of 15 July 1998
- Resolution S2 'Conservation of forest genetic resources', adopted at the European Ministerial Conference in Strasbourg on 18 December 1990.

The primary goals of the Forest Gene Bank are:

- Storage for a maximum period of time, based on the current state of knowledge, of representative seed samples collected from the valuable selected seed stands and plus trees from the territory of Poland.

- Control of seed collection and identification of seed origin in organizational units of the State Forests.
- Inventory of forest ecosystems and vegetation zones to assist with the conservation of their genetic resources.
- Activities aimed at the conservation of endangered populations and their restitution, and implementation of the national programme on the conservation of trees, shrubs and other species.

In addition to the task of *ex situ* conservation in which the Forest Gene Bank actively participates, the national programme includes selecting new plantations for gene resources, establishing progeny plantations and gene conservation areas, and initiating natural regeneration methods.

Nearly 500 new areas for breeding and gene conservation are established every year, totalling 10 000–15 000 areas after the completion of the programme.

During the first 6 years of its activity the Forest Gene Bank stored seeds of 16 tree species from a total of 2521 stands (Table 2). Of these, 455 are stands of the highest genetic quality, 1977 stands with most valuable plus trees from which seeds were collected, as well as 27 seed orchards, 62 progeny plantations and other valuable sources of forest genetic resources.

Table 2. Genetic material stored in the Forest Gene Bank (2002)

Species	Selected seed stands	Selected plus trees	Seed orchards	Gene reserves
<i>Pinus silvestris</i>	260	1143	22	
<i>Pinus nigra</i>	8	71		
<i>Pinus rigida</i>	1			
<i>Pinus strobus</i>	3	27		
<i>Picea abies</i>	56	233	1	6
<i>Picea sitchensis</i>	1			
<i>Abies alba</i>	51	60		1
<i>Larix deciduas</i>	9	174	2	1
<i>Pseudotsuga menziesii</i>	8	131		
<i>Fagus sylvatica</i>	44	119		4
<i>Betula pubescens</i>	2	6	2	
<i>Prunus avium</i>		3		4
<i>Alnus glutinosa</i>	6	10		
<i>Fraxinus excelsior</i>	6			1
<i>Sorbus aucuparia</i>				1
<i>Prunus domestica</i>				1
Total	455	1977	27	62

Regional gene banks closely cooperating with the Forest Gene Bank are being established to implement tasks connected with the conservation of genetic resources important for different regions. The first regional gene bank of this type is the Regional Bank for Istebna Spruce established in the Wisła forest district in 2000.

The seed processing technologies used in the Forest Gene Bank differ from those commonly used in typical extractories. The plant material is handled in a more careful manner, as seed processing should not negatively affect physiological or biochemical processes in seeds that may influence the duration of their storage. Mechanical seed processing, thermotherapy, seed extraction, seed dewinging and various techniques of seed separation are closely integrated and processes are constantly controlled by various seed viability testing methods. All the equipment needed to screen seeds is available, such as pneumatic screen separators, gravity separators, air and vibration separators, water separators, and pressure–vacuum (Prevac) subpressure separators. Incubating, dry and



separation (IDS) technology is used to separate germinating from non-germinating seeds. The final testing of seed viability, using the seed dyeing method, germination test or vigour tests is of particular importance. The basic principle is to preserve a complete gene pool of the stored seed collection, so the 'discarded' seedlot is checked to see that it does not contain too many seeds capable of germinating.

Seed drying is an important process, as it determines seed survival at low temperatures. Different temperature ranges and seed moisture content for different species are essential for successful seed storage at low temperatures. No less important is the material of the container in which seeds are stored, which should comply with the appropriate standard, i.e. it should be certified for storage of lipid products. In long-term storage this can determine seed viability and survival.

The main seed reserve created from the collected seeds contains a minimum of 50 000 seeds, sufficient to restock 15 000 ha of stands. Depending on the quantity of seeds, auxiliary reserves are created, including tested seed reserves, research seed reserves and control seed reserves which each contain 1000–2000 seeds, to provide for seed viability testing during storage.

The Forest Gene Bank stores seeds of many forest tree and shrub species of strategic and economic importance for the needs of Polish forest districts and national parks.

Genetic material is submitted to the Seed Collection Unit. This unit cooperates with other basic units of the Forest Gene Bank, receives genetic material (fragments of plants, fruits, cones, seeds) for preliminary storage, collects genetic resources and prepares seeds for low-temperature storage.

The Laboratory Unit of the Forest Gene Bank serves as a scientific base for the technological processes and stratification of seeds, as well as for the assessment of qualitative changes in the stored genetic resources. The laboratory issues certificates of seed quality using the normal equipment for seed testing stations including radiography equipment and computer-based image registration of samples. The laboratory is also equipped with different types of germination beds and chambers for vegetative propagation.

In autumn 2001, a laboratory for biopreparation with the mycorrhizal fungus *Hebeloma crustuliniforme* was established in the Forest Gene Bank. The biopreparation was produced using Polish expertise at the Agricultural University in Cracow. Within the framework of the programme for the years 2003–2010, the biopreparation will enable mycorrhization of 10 million seedlings per year.

Cryogenics is one of the technological challenges that the Forest Gene Bank faces, in relation to novel methods of storing seeds and plant tissues in liquid nitrogen, and plant propagation using *in vitro* cultures. Cryopreservation has been successfully applied in storage of the genetic material of more than 500 plus trees of pedunculate oak, sessile oak and sycamore.

The Scientific Council of the Forest Gene Bank ensures regular contact with recent scientific findings that can be adapted to the needs of forest management. The members of the Council are outstanding researchers and practitioners representing all forest scientific centres in Poland, including universities and the Board of Polish National Parks.

The broadening of the work of the Forest Gene Bank in Kostrzyca provides a new challenge for its programme and educational activities. The programme for the conservation of genetic resources is continuing, and its implementation should be completed as planned by the end of 2010. However, the assumptions drawn up for the old programme are insufficient in the present changing circumstances. The health condition of our forests and the factors that threaten them are changing. It is reasonable to develop a new, parallel programme with an extended range of activities and with the participation of the Forest Gene Bank in which special attention should be drawn to:

- execution and coordination of the progeny testing programme
- establishment of new population seed collections of forest tree species in accordance with other rules of seed collection and control

- execution or coordination of actions connected with conservation and rehabilitation of forests
- participation of the Forest Gene Bank in the implementation of the Act on forest management
- coordination of programmes and technologies of the regional gene banks in connection with *in situ* conservation
- initiation of scientific research and introduction of novel technologies in the field of seed and nursery production, including mycorrhization
- creation of the basis for preparing the output material for establishing seed orchards and clone archives
- establishment and maintenance of mycorrhizal fungi archives.

From the very beginning the Forest Gene Bank anticipated the need for ecological education. All visitors to the facility were given a basic knowledge of forestry, conservation of genetic resources, and protection of the environment. The great interest in the Forest Gene Bank has led to the establishment of the Forest Ecological Education Centre. This is aimed at schoolchildren and university students, as well as territorial administrative units and economic organizations at different levels of management. The most important activities, however, are meetings with foresters to present not only the aims and tasks of the Forest Gene Bank, but also the most recent scientific achievements and novel technologies.

## Genetic conservation and restoration in areas affected by industrial pollution

### Forest restoration in the Western Sudetes

*Andrzej Potyralski*

*Forestry Management Section, Regional Directorate of State Forests, Wrocław, Poland*

#### **Historical development of the Sudeten forests**

The Western Sudetes is a mountain range composed of the Izera, Karkonosze (the Giant mountains), Rudawy Janowickie and Kaczawskie mountains. It is under the administration of the forest districts of Swieradów, Szklarska Poręba, Śnieżka and Kamienna Góra, and covers an overall forest area of 56 754 ha.

From the end of the last Ice Age until about 1000 years ago, undisturbed natural forests were a predominant plant formation in the Sudetes. The development of human civilization, manifested by the expansion of human settlements in this region, is documented by archaeological findings. These have shown that Kotlina Jeleniogórska was already populated at the beginning of the 13th century. The development of sheep-farming, mining and metallurgical industry, along with population growth in the 14th and 15th centuries, led to excessive exploitation and devastation of forests in the Sudetes.

In the 18th century there was a transition from the excessive, uncontrolled large-scale exploitation of forests to planned forest management, i.e. human intervention in species composition and forest structure. Mixed stands were removed and replaced by pure Norway spruce (*Picea abies*) established by sowing or planting, and natural regeneration was abandoned. An act passed in 1750 brought an end to the despoliation of mountain forests in the Sudetes.

European larch (*Larix decidua*) was introduced to the Karkonosze forests from Moravia as late as 1776. At that time forests were managed in a strip cutting system, with strips 15–20 m wide. Norway spruce, beech (*Fagus sylvatica*), silver fir (*Abies alba*) and common ash (*Fraxinus excelsior*) were left as seed trees on the logged-over areas, but forests could not naturally regenerate under this forest management system, mainly because of strong winds. The spruce seeds were purchased through a number of European trading companies, and seeds from different countries were sown on the logged-over areas. Foreign populations unsuitable for mountain conditions replaced the indigenous populations adapted to local conditions. Between 1880 and 1914, regeneration by sowing was gradually superseded by planting. After 1914, clear cutting became the only method of forest management in the Sudetes. The clear-cut areas were regenerated by planting, and Norway spruce was still the main tree species used for this purpose. However, planting Norway spruce of foreign or unknown origin was not permitted. The transformation of the Sudeten forests into increasingly even-aged spruce stands continued, in order to maximize profits from land rent.

From the point of view of species composition of the Sudeten forests, the following historical periods can be distinguished:

- **Period of natural forests:** From ancient times until the 14th–15th century, the Sudetes were covered by mixed forests with the share of spruce amounting to 30% and high proportions of silver fir, beech, sycamore (*Acer pseudoplatanus*), common ash, elm (*Ulmus* spp.), birch (*Betula* spp.) and rowan (*Sorbus* spp.). The forests were characterized by a relatively stable species composition and healthy condition; they regenerated naturally without human intervention.
- **Period of transformation of forests into spruce stands:** This continued from the beginning of the 16th century until the middle of the 20th century. Increasing human intervention resulted in an increase in the proportion of spruce in stand composition from

around 30% to more than 90%. The forest health condition and resistance to external factors were poor. Artificial regeneration of Norway spruce from seeds of unknown origin imported from all over Europe resulted in the establishment of poorly adapted spruce stands. Natural disasters were more and more frequent and intensive; the greatest damage to stands was caused by wind throws, snowfalls and secondary pests. Forest soils underwent degradation.

- **Period of transformation of pure spruce stands to mixed forests:** This began in the second half of the 20th century (more than 50 years ago) and is still continuing. The characteristics of this period are natural disasters and diseases of forest ecosystems, leading to large-scale forest dieback.

### ***Ecological disaster and regeneration***

'Ecological disaster in the Sudetes' is a phrase we often hear. A disturbed species composition resulting from unsuitable silvicultural management practices in the previous historical period caused the forests to become susceptible to industrial emissions, the intensity of which exceeded the level that can be tolerated by plant communities. The most dramatic situation was recorded in the Western Sudetes, where south-westerly winds transporting industrial pollutants from Czechoslovakia and southwest Germany caused an avalanche dieback of Norway spruce forests.

Moreover, in the years 1950–1990, these stands were affected by the extensive development of coal-based power plants located in the area where the Polish, German and Czech borders meet. This area was called the 'black triangle of Europe' because of the noxious pollution generated by this industry.

Regional forest decline in the years 1986–1992 occurred as a result of high concentrations of several pollutants, mostly sulfur dioxide and oxides of nitrogen, and a rapid decrease in soil pH (as low as 2.7). During these years, the declining spruce forests were removed in an area of 14 000 ha (1672 ha in Kamienna Góra, 1939 ha in Śnieżka, 3897 ha in Świeradów and 3667 ha in Szklarska Poręba). The rate of deterioration was so high that although forest workers from all over the country were involved in the removal of dying trees, the process could not be stopped (in total of 4.6 million m<sup>3</sup> of wood was harvested). Although the uncontrolled spread of ecological disaster had been prevented, foresters and environmentalists fully realized that the threat of ecological disaster was not yet overcome, and that an incidental development of one of the precipitating factors could cause a rapid development of others.

Reforestation was carried out at the same time as removals. At first plantations with a greater share of more resistant broadleaved species in their composition appeared to be a failure, mainly because of very strong soil acidification (pH dropped locally as low as 2.5) and a rapid increase in animal populations such as roe deer, red deer and rodents, especially field voles and mice, which fed on the bark of seedlings under the snow cover. It was agreed that the composition of a stand should include tree species that had demonstrated a high survival rate (rowan, birch, larch and spruce), although they were not to be the target species. When the stands reached the stage of forming a thicket, they were thinned and underplanted with beech, sycamore, ash, alder and fir. The present state of plantations and young stands up to an elevation of 800 m above sea level (a.s.l.) is considered to be good. Problems arise, however, when we try to restock and maintain the main forest species at higher altitudes, especially on the flat, boggy plateaus and areas close to the timberline which play a role in soil protection.

The instantaneous regeneration of large deforested areas aimed to protect soil against erosion, degradation and weed invasion, but the first effect was to hasten stand conversion into mixed stands by increasing the share of broadleaved species and larch. In the period 1981–1997, more than 17 000 ha of the deforested area were restocked.

The changes in the proportion of tree species in the forests of the Western Sudetes before and after the reforestation efforts are illustrated in Table 1.

**Table 1.** Proportion of tree species in the forests of the Western Sudetes in 1978 and 1998

Species	Proportion (%)	
	1978	1998
<i>Pinus sylvestris</i> and <i>Larix decidua</i>	4.1	9.0
<i>Picea abies</i>	83.4	64.5
<i>Abies alba</i>	0.4	0.2
<i>Fagus sylvatica</i>	5.1	5.9
<i>Quercus</i> , <i>Acer</i> , <i>Fraxinus</i>	3.6	11.2
<i>Betula</i>	2.6	7.2
<i>Alnus</i>	0.5	1.3
<i>Populus tremula</i>	0.3	0.7
Total	100	100

Several basic conditions had to be fulfilled to regenerate the deforested areas, reintroduce forest species adapted to local conditions and maintain them until the main threats were over.

The first condition was the supply of seedlings of high quality and known origin raised in polyethylene greenhouses under controlled humidity and temperature conditions. The container nursery in Kostrzyca (Śnieżka forest district), established especially for the production of seedlings for areas of ecological disaster, meets the requirements. It provides seedlings of all main forest tree species, including seedlings inoculated with mycorrhizal fungi, for all Sudeten forest districts. Nevertheless, each forest district should have a nursery that can raise seedlings for local needs.

Especially in the 'black triangle' region of the Western Sudetes, soils are seriously chemically and biologically degraded as a result of long-term industrial emissions of harmful substances in the form of dust and acid rain. Until 1996, soil pH in some extreme cases was as low as 2.5–2.7. The acidification of soils has markedly decreased in recent years as a result of decline in industrial production, greater attention to environmental protection by large industrial plants in the countries of the 'black triangle', and higher precipitation. It is observable that life has returned to the soil which is very encouraging, especially as some researchers anticipated that this phenomenon would take at least 400 years. Magnesium and calcium affect nutrient cycling in the acid soils and adding these elements can speed up the restoration of life processes in the soil. In 1996, a total of 1132 tonnes of a fertilizer containing around 55% of magnesium and 10% of calcium was applied to 2265 ha of forest in Kamienna Góra forest district, 171 ha in Śnieżka, 209 ha in Świeradów and 1600 ha in Szklarska Poręba. The total cost of the treatment, including the application of the fertilizer, purchase of wire netting and fencing of fertilized areas, was covered by the PHARE Fund. It is too early to assess the effects of the fertilization treatment, but examples of its use in other heavily disturbed areas lead us to believe that this treatment may have a positive and long-term effect.

Cervids (roe deer and red deer) are a great threat to seedlings and young trees. Several protective measures are taken to limit the extent of damage, such as the use of repellents, aluminium foil to protect terminal shoots, plastic thorns, sheep's wool, plastic tubes, wire netting, etc.

The effectiveness of all these protection methods is variable and depends to a great extent on other factors such as forest penetration by visitors, management of hunting grounds, and types of mixture of broadleaves in plantations. However, fencing is the only efficient method of protecting plantations against game. To avoid fencing off large forest areas, mixed

broadleaved species or silver fir are planted in clumps and only these clumps, which make up about 20% of the regenerated area, are fenced off.

Repellents are commonly used to protect young trees against browsing and peeling. As red deer need conifer bark in their diet, thinning operations are usually carried out in the winter when demand for bark by game is highest, so they readily consume bark from the fallen trees.

To protect plantations against mice and voles, tall wooden perching poles have been set up for birds of prey to increase their hunting efficiency.

One of the most serious threats is the occurrence of pests, which can cause unpredictable damage in a biologically unbalanced ecosystem such as the forests of the Western Sudetes. Natural and pheromone traps have been set up in the threatened areas in order to monitor the state of insect populations and partially control them. In the case of mass occurrence of any insect species, the inspection of traps allows us to decide whether chemical control should be used. Spruce bark beetle is the most dangerous pest of spruce stands. An outbreak of this insect can destroy hundreds of hectares of forests without a chance of efficient intervention.

### **Stand transformation**

Stand transformation in the Sudetes consists of adjusting species composition to habitat conditions by artificial introduction of new tree species. This will increase resistance of ecosystems, and enhance biological diversity and wood production. Transformation of stands in younger age classes is connected with initial reduction of stand density and introduction of shade-tolerant (beech, sycamore) or shade-loving species (fir) under the canopy. Furthermore, existing gaps are regenerated by planting or sowing light-demanding species (larch, oak). In older age classes, reduction of stand density is not required; this operation is carried out after early thinning. Species introduced after stand transformation need special protection, because they are attractive food for cervids.

The reduced species diversity in the Sudeten stands was a consequence of the excessive harvesting of timber and errors made in regenerating large deforested areas. Combined with industrial pollution, this led to almost complete elimination of silver fir which was the main tree species of the Sudetes in the past.

The fir ecotype in Sudetes differs from that of the Carpathians. In 1995, the decision was taken to set up a programme for conservation of silver fir gene pool in this ecotype. In 1996, the Regional Directorate of State Forests in Wrocław asked the Silvicultural Department at the Agricultural Academy in Poznań and the Institute of Dendrology of the Polish Academy of Sciences in Kórnik to develop a conservation programme for silver fir in the Sudetes, including both *ex situ* and *in situ* conservation. The programme was implemented in two phases. The first phase began in 1996 with an inventory of all pure fir stands, mixed fir stands and single fir trees. The inventory was based on data from the forest management instructions and materials obtained from a questionnaire sent to forest districts. In the second stage, the data was verified and evaluated in the field for fir health status, number of old fir trees, regeneration rate of young fir stands, and the suitability of firs for vegetative propagation and seed production.

The inventory data were used in selecting firs for special protection. These were mainly very old trees that displayed a high tolerance to stress factors, indicating that these individuals were of local origin. Such individuals were regarded as gene reserve trees. They were measured, marked in the field and their position indicated on the forest maps. These trees are the source of seeds for nursery production and scions for grafting.

Fir trees were selected in this way in the whole region of the Sudetes and the foothills (Pogórze Sudeckie). Two elevation zones for fir were identified, at elevations of 401–600 m and 601–800 m a.s.l. Fir seed orchards for gene conservation have been established separately for each elevation zone. Silver fir rarely occurs above 800 m a.s.l. in the Sudetes, and the number of firs at this elevation is insufficient to establish seed orchards for gene

conservation. It is recommended that seed orchards should be established by vegetative propagation from gene reserve trees using no less than 150 clones.

In the spring of 1998, scions were collected for grafting from 160 silver firs identified as gene reserve trees. Grafting was carried out in the nursery of the Forest Arboretum in the Syców forest district.

The first seed orchard for gene conservation of silver fir was established in 1999 on a 9.16-ha site at an elevation of 750–790 m a.s.l. in the Kamienna Góra forest district in the Western Sudetes. Grafted firs were outplanted under the canopy of a spruce–pine stand. A preliminary evaluation of grafts carried out 5 months after planting showed that the survival and growth were satisfactory.

In 2000 and 2001, silver fir plantations were subsequently established in the forest districts of Kamienna Góra, Szklarska Poręba and Śnieżka at an elevation of 401–600 m a.s.l. It is noteworthy that an insect (*Epinotia nigricana*) was observed to be present on buds during the harvesting of cuttings from gene reserve trees. This pest damages buds and deforms the top part of fir crowns in all age classes. Bud colonization by the pest on cuttings was 27–100%.

The method adopted for silver fir conservation, by establishing fir plantations from vegetative propagation, is very expensive. The Regional Directorate of State Forests in Wrocław implements the fir conservation programme thanks to the financial assistance of the EcoFunds, the National Fund of Environment Protection and Water Management and its own funds.

### **Conservation of wildlife**

Many rare bird species were recorded in the forests inventoried during the project, such as capercaillie (*Tetrao urogallus*), black grouse (*Tetrao tetrix*), eagle owl (*Bubo bubo*), pygmy owl (*Glaucidium passerinum*) and Tengmalm's owl (*Aegolius funereus*). Except for black grouse, all these are listed as endangered species in the Polish Red Data Book. Measures have been taken to ensure the protection of the existing habitats of these species and to create conditions likely to increase their population size.

The Karkonosze Foundation (Fundacja Karkonoska) has a project on active protection of black grouse and capercaillie, implemented in the territory of Karkonosze and Izera mountains. After consultations with the project coordinator, we found it advisable to support this undertaking by supplying rowan seedlings and establishing several dozen feeding grounds.

The protection of owls will be preceded by an inventory. Protection zones for eagle owl will be established and hollow trees will be marked and protected. Nesting boxes for pygmy owl and Tengmalm's owl will also be set up.

In addition to artificially established forest communities, a number of forest complexes with autogenic vegetation and rich fauna can be still found in the Western Sudetes. Examples are protected insect species such as hermit beetle (*Osmoderma eremita*), longicorn (*Osmoderma eremita*) and many carabid species (*Carabus* spp.), which are found in the Sudeten ecosystems. These areas are a reservoir of natural soil fauna responsible for very important decomposition processes of organic matter. Dead fallen and standing trees are left in stands for the benefit of these insect species, which require decaying wood of broadleaved species for their survival.

Non-forest communities such as fields, meadows, pastures, orchards, lanes with ancient trees having a positive effect on the maintenance of biodiversity, are also subject to protection. Many rare species of plants and insects can be found in these communities, which should therefore be the subject to active protection and not included in the afforestation programme. The succession of common species observed in these communities frequently limits the occurrence of species that are under legal protection. As far as the available financial resources allow, seedlings of birch and aspen will be removed in such areas by sheep and cattle grazing.

**Further reading**

Bednarek, T. Restitution of silver fir (*Abies alba* Mill.) in the Western Sudetes. Forest Gene Bank in Kostrzyca. Information materials.

Lenart, J. 1998. Threats to mountain forests in the Western Sudetes—the history and the status quo. Szklarska Poręba.



## Rehabilitation of silver fir (*Abies alba* Mill.) populations in the Sudetes<sup>1</sup>

Władysław Barzdajn

August Cieszkowski Agricultural University, Poznań, Poland

The expansion of human settlement in the Sudetes and the resultant development of sheep-farming, mining and metallurgical industries (glass and metals) led to an excessive exploitation of forests and deforestation which started in the 14th century and was most intense in the 16th and 17th centuries (Staffa 1985, Korta 1986, Ciężkowski *et al.* 1996). Forest management, which began in the Sudetes in the 18th century, has not stopped the process of destruction of silver fir (*Abies alba* Mill.) forests. Derelict land, pastures and clear-cut areas (common until 1914) were restocked mainly with Norway spruce (*Picea abies* (L.) Karst.) (Koehler 1927, Zoll 1958, 1963, Wilczkiewicz 1976, 1982, Bernadzki 1983). Air pollution and subsequent soil contamination caused major damage, as silver fir appeared to be relatively susceptible to this disturbance (Feliksik 1991). During the period of the greatest damage to forest ecosystems in the Sudetes (1981–1989) several proposals for developing forest plantations were made, but silver fir was not included in any of them. In the 'Principles of forest cultivation' (1988), silver fir was not among the tree species foreseen for regeneration of forests adversely affected by industrial pollution, nor was it mentioned in the 'Instructions for forest management in Sudety' (1983), dating from the period of increasing forest dieback. The 'Programme for forest management ...' (1988) treats the species more kindly; it anticipates a limited share of silver fir in plantations established in the mountain mixed coniferous forest, mountain mixed broadleaved forest and mountain broadleaved forest habitats, away from the areas affected by industrial pollution. Silver fir appeared in the species composition of plantations for the first time in the instructions developed by Szymański *et al.* (1991).

Changes in the vegetation cover of the Sudetes that have occurred over hundreds of years do not provide an explanation of the role that silver fir played in the past. The available data are scarce and imprecise. According to Zoll (1958), in 1747 the share of silver fir in the Śnieżnik massif was 9.3%. In 1936, the share of fir in individual regions of Sudetes was as follows: Góry Złote and Śnieżnik massif 3%, Międzylesie forest district 6%, Góry Bystrzyckie 2.88%, Góry Łomnickie 1.7%, Góry Orlickie 1.5%, Góry Stołowe 5.7%, Góry Sowie 3% and Góry Izerskie 0.05% (Wilczkiewicz 1976). The share of fir in Sudetes as of 1 October 1965 amounted to 0.7% according to Wilczkiewicz (1976) and only 0.3% according to Jaworski (1996).

Recent knowledge encourages us to use native tree species which are adapted to local conditions. Silver fir is no exception; like many tree species, it has a high among and within-provenance genetic variation (Gunia *et al.* 1972, Kramer 1980, Korpel' and Paule 1984, Larsen and Mekic 1991, Mejnartowicz *et al.* 1994, Skrzyszewska 1998). Because of the specificity of Sudeten fir populations it is sometimes classified as a separate Lusatian variety (*Abies alba* var. *lusatica*) belonging to the climatic type '*A. alba* var. *hercynica*' (Svoboda 1953).

### Silver fir resources in the Sudetes

The available materials from the so-called 'second revision' of the forest survey enabled us to locate stands with fir in their species composition. The survey was carried out in the forest districts of the VII-Sudecka Natural Forest Region, in which, according to 'Forest regionalization of seeds and seedlings in Poland' (1994) seed microregions<sup>2</sup> 701, 702, 703, 751 and 752 are located. The share of silver fir appeared to be exceptionally low. Table 1 presents

<sup>1</sup> Lecture delivered at the SITLiD conference 'Forest restitution in Sudetes'. 1–2 October 2001, Szklarska Poręba—Świeradów Zdrój.

<sup>2</sup> A seed microregion is an area within which the transfer of seeds and seedlings of forest trees is permitted.

the proportion of silver fir by seed microregions and forest management units. The share of fir is highest (over 1%) in microregion 703, encompassing the forest districts of Stronie Ślaskie and Międzylesie. The highest shares of fir are found in stands in the forest management units of Międzygórze and Bystrzyca. The share of fir in species composition of stands in the seed microregions of Pogórze Izerskie (751) and Pogórze Kaczawskie (752) is almost negligible. In seed microregion 701, covering Góry Izerskie and Karkonosze, the share of fir is 0.36%.

Table 1. Presence of silver fir in the natural forests of region VII–Sudecka, by seed microregion and forest subdistrict

Micro-region	Forest subdistrict	Forest subdistrict area (ha)	Area of stands with fir (ha)	Net area of fir stands (ha)	Share of fir (%)
701	Kamienna Góra	7 051.1	32.5	3.5	0.1
	Lubawka	7 210.6	178.2	21.2	0.3
	Śnieżka	5 736.9	9.2	1.3	> 0.1
	Kowary	6 706.1	34.1	3.9	0.1
	Świeradów	8 087.3	84.5	8.9	0.1
	Szkl. Poręba	6 703.8	11.4	1.1	> 0.1
	Piechowice	6 738.7	12.1	1.3	0.0
	Wałbrzych	6 551.1	31.1	3.9	0.1
	Głuszyca	7 399.6	14.6	1.8	> 0.1
	Total	62 185.1	407.5	47.0	0.1
702	Bardo Śl.	5 842.7	365.1	61.7	1.1
	Kamieniec Ząbk.	6 184.9	410.7	66.3	1.1
	Bystrzyca	6 778.3	711.8	110.6	1.6
	Pokrzywno	5 173.7	241.6	29.9	0.6
	Duszniki	8 065.0	163.0	24.8	0.3
	Polanica	6 875.3	56.4	7.7	0.1
	Jugów	5 417.0	105.2	15.7	0.3
	Kłodzko	2 840.5	93.5	20.6	0.7
	Total	47 177.5	2 147.3	337.2	0.7
703	Strachocin	8 148.0	533.6	83.3	1.0
	Stronie Śl.	7 428.7	302.1	46.7	0.6
	Międzylesie	5 236.0	290.4	70.1	1.3
	Międzygórze	4 559.8	469.5	75.3	1.7
	Total	25 372.6	1 595.6	275.4	1.1
751	Lwówek	10 030.7	16.5	3.4	> 0.1
	Wleń	7 050.6	12.9	1.4	> 0.1
	Zgorzelec	6 893.3	0.0	0.0	> 0.1
	Lubań	6 337.3	7.7	1.1	> 0.1
	Total	30 311.9	37.2	5.9	> 0.1
752	Jawor	7 386.3	31.4	4.1	0.1
	Bolków	5 885.3	25.1	2.9	> 0.1
	Świerzawa	9 246.8	46.7	6.2	0.1
	Total	22 518.4	102.9	13.2	0.1
Grand total in Sudetes		187 756.5	4 290.5	678.7	0.4

Individual seed microregions differ in their habitat type structure and in stand area with fir in individual habitat types. Fir was found in 11 out of 22 habitat types in the Sudetes. Most stands with a share of fir were found in the mountain mixed broadleaved forest habitat, in seed microregions 702 and 703.

The age structure of stands including silver fir is not optimal (Table 2; data updated 1997). The stand area was calculated as the ratio of the share of fir in a stand to the area occupied by fir alone. Most stands are in the sixth age class. More than 75% of the area calculated in

this way is occupied by stands aged 81–140 years. The calculated net area of fir stands in the entire territory of Sudetes is 679 ha, of which areas of stands in the early developmental phase (age class I) make up only 53 ha. This age structure will lead to a further reduction in the share of fir in the Sudeten forests.

Table 2. Age structure of stands with a share of silver fir in the Sudetes

Age class	Stand area with share of fir (ha)	Net area of fir (ha)
0–20	431.7	53.1
21–40	126.0	16.2
41–60	85.2	11.8
61–80	342.8	50.3
81–100	1008.5	147.3
101–120	1406.6	222.6
121–140	686.4	142.3
141–160	176.4	28.8
161–180	23.5	5.9
181–200	3.4	0.3
Total	4290.5	678.7

### Scale of rehabilitation

The scale of rehabilitation is difficult to determine, and suggestions can only be provisional. It can be based on the potential natural plant communities, forest habitat types, economic preferences or the environmental services that forests provide. Silver fir is an inherent component of the following plant communities established for the Sudetes (Matuszkiewicz 1993):

- The community of oak–hornbeam forests and submontane acidophilus oak forests with associations *Galio–Carpinetum*, *Aceri–Tilietum* and *Molinio arundinaceae–Quercetum*.
- The community of oak–hornbeam forests and montane beech forests with associations *Dentario enneaphyllidis–Fagetum* and *Galio–Carpinetum*.
- The community of subalpine beech forests with associations *Abieti–Piceetum montanum*, *Dentario enneaphyllidis–Fagetum*, *Luzulo–Fagetum* and *Acerenion*.

Data from forest surveys and selected instructions from the 'Principles of forest cultivation' (1988) are more practical for quantitative elaborations. In this paper estimates are based on data concerning forest habitat structure in the Sudetes and the work of Bernadzki (1964), as well as postulated management stand types and species composition of plantations. If silver fir was assumed to be one of two main species the desired fir share was set at 50%; if there were more species the share was 30%. If silver fir was only an admixture species the desired fir share was set at 20%, and if there were more species the share was 10% (Table 3). The proposed share of fir was then calculated as the area occupied by each type of forest habitat compared with the actual net area occupied by fir. This indicates the area in which fir should be introduced to obtain the desired share of fir by habitat types. Determining species composition in accordance with the 'Principles of forest cultivation' will result in an increase of fir share in the forests of the region from 0.36% to 18%. Such a large increase means that fir has to be introduced in an area of 33 000 ha. This is the net area of plantations that has to be occupied only by fir. To attain the desired share of fir, 264–330 million seedlings will have to be planted, depending on spacing. Approximately 79 200–99 000 kg of seed will be needed to produce such a large number of seedlings.

Currently, the area of fir seed stands in the Sudetes (6.77 ha) is sufficient to satisfy the seed demand of forest districts. The minimal area of seed stands was estimated at 2.6–4.1 ha, which is a very small area in view of the scope of the fir rehabilitation programme. For the programme to be successful, the new seed base has to be created from scratch.

### **Requirements for rehabilitation**

Rehabilitation of silver fir forests should be based on local seed sources, i.e. indigenous populations that survived the worst impact of industrial pollution during the period 1981–89. Indigenousness and vitality are also priority criteria in selecting silver fir stands for gene conservation.

Gene reserve stands should be regenerated naturally and artificially, using their own seed. The seeds collected should also serve as reproductive material for establishing registered plantations. Gene reserve trees selected in fir stands and elsewhere should be the source of seeds and grafts. In certain cases, seedling seed orchards targeted for gene conservation should be established from the generative progenies of silver fir. Clonal seed orchards for gene conservation should be established from vegetative propagation. This can be done by grafting scions, or when the number of scions is insufficient they can be taken from clone archives. The seed orchards can serve the establishment of progeny plantations.

Such a seed base has to comply with the principles for seed regionalization and the principles for establishing plantations. Presumably, two or three elevation zones will have to be considered for the mountain microregions and each of them should have its own seed source. This means the establishment of eight seed orchards for the whole Sudetes, each of which will produce seeds for its own microregion and elevation zone. The number of families or clones in the seed orchards should be as high as possible, but not less than 100.

### **Silviculture**

The purpose of seed orchards for gene conservation and gene conservation areas is to reintroduce or increase the share of fir in a stand, not to form pure fir stands. An in-depth habitat and silvicultural analysis should be carried out before the share of fir in a stand is determined. The insufficiency of the planting material should encourage us to establish seed orchards for gene conservation or gene conservation areas as larger uniform forest areas, instead of scattered forest areas which have no records of seed origin or locations of outplanting.

Each silvicultural operation, from seed collection to seedling outplanting, should be well documented. The habitat and biosocial requirements of silver fir should be taken into consideration when choosing sites for seed orchards. Fir grows well in open terrain (Ring 1950; Magnuski 1975), but under the canopy of shelter trees it is better protected against frost, heat and lack of water vapour, and in effect shows higher vitality in the long term (Bernadzki 1983). The use of shelter tree species is therefore advisable. Silver fir can be planted in regenerated stands of beech and Norway spruce. Silver firs should be planted in larger groups (4–10) as they grow more slowly than beech, Norway spruce and other tree species. In the transformed stands, silver fir should be planted several years before beech and spruce are regenerated. Stands with prevailing silver fir should be regenerated over long periods of time, and the most common system of shelterwood cutting in the Sudetes should be replaced by irregular shelterwood cutting and selection cutting.

Changes in the forest management system are essential in stands where silver fir is the main species. The data mentioned show that no stands in the Sudetes have a shelterwood structure that is optimal for silver fir. The most suitable for transformation are stands under special management, because the shelterwood cutting system suits all forest functions.

### **Forest protection**

Fir is attractive to game animals, and suffers a lot from browsing. It therefore should not be planted where it cannot be successfully protected. Nor should it be introduced in areas of high frost hazard, except under the shelter of nurse crops or in areas where there is a locally high impact of industrial emissions.

Table 3. Forest habitat types with silver fir in the Sudetes.

Forest habitat type	Area (ha)	Net area of fir (ha)	Real share of fir (%)	Proposed share of fir (%)	Proposed net area (ha)	Area foreseen for fir introduction (ha)
Mountain coniferous*	9 262.0	6.6	> 0.1	10	926.2	919.6
Mixed cool coniferous	3 193.8	0.1	> 0.1	10	319.4	319.3
Upland mixed coniferous	3 014.1	0.4	> 0.1	10	301.4	301.00
Mountain mixed coniferous	40 301.5	82.3	0.2	10	4 030.2	3 947.8
Cool mixed broadleaved	4 251.2	0.4	> 0.1	10	425.1	424.7
Upland mixed broadleaved	28 012.2	24.3	0.1	20	5 602.4	5 578.2
Mountain mixed broadleaved	69 073.5	386.8	0.6	20	13 073.5	12 686.7
Cool broadleaved	933.0	0.3	> 0.1	10	93.3	93.00
Upland broadleaved	10 469.4	10.5	0.1	50	5 234.7	5 224.2
Mountain broadleaved	11 994.9	166.6	1.4	30	3 598.4	3 431.9
Mountain riparian*	80.4	0.4	0.5	10	8.0	7.7
Mixed moist coniferous**	260.2	0.00	> 0.1	10	26.0	26.0
Total	180 845.8	678.7	–	–	33 638.6	32 960.0
For the region	187 565.4	–	0.4	17.9	–	–

\* Habitat types in which according to the 'Principles of forest cultivation' (1988) a share of fir is not anticipated, although fir does occur in these habitats.

\*\* Habitat types with anticipated fir share, although fir does not occur in these habitats.

## Conclusion

The range of tasks involved in silver fir rehabilitation is perhaps surprisingly wide. The minimum programme should at least ensure the sustainability of the existing resources. Only stands with a high share of silver fir can be sustained by applying proper forest management and silviculture. The maximum programme assumes an increase in the share of silver fir in the Sudeten forests to 18%, which requires creation of a new seed base capable of producing 100 tonnes of seeds for five seed microregions and 2–3 altitudinal zones within each.

## References

- Baza nasienna podstawowych gatunków drzew leśnych w terenach skażonych imisjami przemysłowymi w Sudetach. 1995 [Seed sources of the most important forest trees in the polluted territories in the Sudetes]. Dyrekcja Generalna Lasów Państwowych, Instytut Badawczy Leśnictwa, Warszawa.
- Bernadzki, E. 1964. VII. Kraina Sudecka [Sudetes mountains]. Pp. 419–425 in *Typy siedliskowe lasu w Polsce* [Types of forest sites in Poland]. (L. Mroczkiewicz and T. Tramplera). Prace IBL nr 250.
- Bernadzki, E. 1983. Zamieranie jodły w granicach naturalnego zasięgu [Decline of silver fir in the natural range]. Pp. 483–501 in *Jodła pospolita *Abies alba* Mill.* (S. Białobok, editor). PWN, Warszawa–Poznań.
- Ciężkowski, W., W. Irmiński, S. Kozłowski, S. Mikulski, S. Przeniosło and H. Sylwestrzak. 1996. Zmiany w litosferze wywołane eksploatacją surowców mineralnych [Changes in the lithosphere caused by exploitation of mineral resources]. Pp. 85–119 in: *Masyw Śnieżnika*.

- Zmiany w środowisku przyrodniczym [Massif of Śnieżnik. Changes in the environment] (A. Jahn, S. Kozłowski and M. Pulina, editors). Polska Agencja Ekologiczna SA.
- Feliksik, E. 1991. Badania wrażliwości ważniejszych gatunków drzew leśnych na zanieczyszczenia przemysłowe [Studies on sensitivity of the more important forest trees to industrial pollution.] Zesz. nauk. AR w Krakowie, Leśnictwo 20: 353–374.
- Gunia S., J.E. Due and W.Kramer. 1972. Die Weißtanne (*Abies alba* Mill.) im Nordosten ihres natürlichen Verbreitungsgebietes. Ergebnisse von Beobachtungen in der Volksrepublik Polen [Silver fir (*Abies alba* Mill.) in the North-eastern limit of the range. The results of observations in Poland]. Forstarchiv 43 (4/5): 84–91.
- Jaworski, A. 1996. Stan i znaczenie lasów górskich [State and importance of mountain forests]. Pp. 120–128 in Ochrona i zrównoważone użytkowanie lasów w Polsce [Protection and sustainable exploitation of forests in Poland]. (B. Łonkiewicz, editor). Fundacja IUCN Poland, Warszawa.
- Koehler. 1927. Die forstlichen Verhältnisse der Herrschaft Schaffgotsch im Riesen- und Isergebirge [Forest studies in the Karkonosze and Izerskie Mts]. Jahrb. des Schlesischen Forstvereins für 1927: 23–62.
- Korpel', Š. and L.Paule. 1984. Ergebnisse eines Provenienzversuches mit tschechoslowakischen und polnischen Herkünften der Weißtanne (*Abies alba* Mill.) [The results of provenance experiments with Czechoslovak and Polish provenances of silver fir (*Abies alba* Mill.)]. Silvae Gen. 33 (6): 177–182.
- Korta, W. 1986. Życie gospodarcze Śląska w okresie feudalizmu [Economy of Silesia in the feudal period]. Studia Śl. 44: 11–41.
- Kramer, W. 1980. Osteuropäische Herkünfte von Weißtanne (*Abies alba* Mill.). [East European provenances of silver fir (*Abies alba* Mill.)]. Forstarchiv 51 (9): 165–169.
- Larsen, J.B. and F. Mekic. 1991. The geographic variation in European silver fir (*Abies alba* Mill.). Silvae Gen. 40 (5/6): 188–198.
- Leśna regionalizacja dla nasion i sadzonek w Polsce [Forest regionalization of seeds and seedlings in Poland]. 1994. Dyrekcja Generalna lasów Państwowych i Instytut badawczy Leśnictwa, Warszawa.
- Magnuski, K. 1975. Wzrost upraw jodłowych w warunkach rębni zupełnej, częściowej i gniazdowej [Growth of silver fir cultures under the conditions of clear cutting, shelterwood and group cutting]. Sylwan 119 (10):
- Matuszkiewicz, J.M. 1993. Krajobrazy roślinne i regiony geobotaniczne Polski. [Vegetation, landscape and geobotanical regions of Poland]. Polska Akademia Nauk, Instytut Geografii i Przestrzennego Zagospodarowania, Prace Geograficzne nr 158.
- Mejnartowicz, L.E., A. Lewandowski and F. Bergmann. 1994. Genetic structure and variation of the european silver-fir populations at man-made range disjunction. Pp. 118–126 in Ergebnisse des 7. IUFRO–Tannensymposiums der WPS. 1.01–08 'Ökologie und Waldbau der Weißtanne'.
- Program gospodarki leśnej na terenach objętych klęską ekologiczną w Sudetach [Programme for forest management . . .]. 1988. Dokumentacja IBL, Warszawa.
- Ring, K. 1950. Poznajmy lepiej jodłę i zmierzmy metodę jej odnawiania [Increasing our knowledge of the silver fir and changing its method of regeneration]. Las Polski 24 (9): 8–12.
- Skrzyszewska, K. 1998. Analiza zmienności wewnątrzgatunkowej i wartości genetyczno–hodowlanej jodły pospolitej (*Abies alba* Mill.) pochodzeń Ogólnopolskiego Doświadczenia Proweniencyjnego Jd PL 86/90. [Analysis of intraspecific variation and genetic value of silver fir in Polish provenance trials]. Rozpr. dokt. AR Kraków.
- Staffa, M. 1985. Rozwój osadnictwa [Populating]. Pp. 453–470 in Karkonosze polskie (A. Jahn, editor). Zakład Narodowy im. Ossolińskich, Wrocław.
- Svoboda, P. 1953. Lesní dřeviny a jejich porosty [Forest trees and their stands]. Část 1. SZN, Praha.
- Szymański, S., J. Ceitel and J.Zientarski. 1991. Wytyczne dla praktyki w sprawie składów gatunkowych upraw leśnych w Sudetach (ustalone na podstawie zachowanych fragmentów

- lasów zbliżonych do naturalnych) [Indications for the forest practice concerning the species composition of the cultures in the Sudetes mountains]. Dokumentacja IBL, Warszawa.
- Wilczkiewicz, M. 1976. Jodła pospolita (*Abies alba* Mill.) w Sudetach [Silver fir(*Abies alba* Mill.) in the Sudetes nountains]. Sylwan 120 (1): 69–80.
- Wilczkiewicz, M. 1982. Rys historyczny gospodarki w lasach sudeckich [Outline of forestry in the Sudeten forests]. Sylwan 126 (6): 49–54.
- Zasady hodowli lasu 1988. [Principles of forest cultivation].
- Zoll, T. 1958. Podstawowe zagadnienia zagospodarowania lasów górskich w Sudetach [Fundamental problems of forestry in the Sudeten mountain forests]. Sylwan 102 (5–6): 9–33.
- Zoll, T. 1963. Analiza stanu lasu w Sudetach [Analysis of forest state in the Sudetes mountains]. Zesz. probl. Post. nauk roln. 37: 123–144.

## Seed source for reforestation and gene conservation in the Sudetes

Jan Matras

Forest Research Institute, Warsaw, Poland

Successful forest management requires long-term, good-quality seed sources for the main tree species. This requirement is particularly important when, as in the Sudetes, specific local conditions make the large-scale use of external seed sources practically impossible. In the Sudetes, however, there are several problems that make it difficult to create seed sources that produce adequate quantities of seed. These problems are:

- biotic, abiotic and anthropogenic factors
- unsuitable species composition of stands
- specific ecological conditions.

Among the anthropogenic factors adversely affecting stand development and seed production, industrial pollution is most harmful to forest ecosystems. The negative impact of air pollution depends not only on high concentrations of toxic substances but also on topographic features, climatic conditions and location of the main emission sources. The oldest stands, which under normal conditions would produce seeds, are most affected by air pollution, as manifested by the reduction in stand increment including stand decline and seed production.

Systematic forest management, i.e. human intervention in species composition and stand structure, began in the 18th century. Mixed stands were removed and replaced by pure Norway spruce stands artificially established from imported seeds, which were not adapted to specific mountain conditions. The share of Norway spruce increased, especially at an elevation of 850–1100 m above sea level (a.s.l.), and the share of such species as beech and silver fir significantly decreased. According to Zoll (1963), during the past 200 years the share of beech has dropped from 21.9% to 2.6% and that of silver fir from 9.3% to 0.7%.

### **Aim and scope**

In the regions affected by industrial emissions, there is a need to regenerate areas deforested by the ecological disaster and to convert the Norway spruce stands at higher elevations back into mixed forests. This requires large quantities of high-quality seed. Choice of seed sources becomes the main prerequisite for establishing stable and multifunctional stands, as well as conserving their genetic variability for the future. Indigenous populations threatened by extinction should be conserved using *in situ* and *ex situ* methods in a complementary way.

### **Seed demand in the threatened areas of the Sudetes**

Seed demand for reforestation in various forest districts (Świeradów, Szklarska Poręba, Śnieżka, Kamienna Góra, Wałbrzych, Jugów, Zdroje, Bardo, Bystrzyca, Łądek, Międzylesie) was based on estimates of the area planned for regeneration and of the amounts of seeds of individual species required for this purpose.

Estimates were based on data from 1994–2003. Areas planned for reforestation, by species and altitude class, are shown in Table 1. The seed demand of various tree species is in accordance with the regeneration plan shown in Table 2. The average annual demand for seeds of the tree species is listed in Table 3. The average annual demand for seeds amounts to about 3400 kg for the 10 main tree species and over 1000 kg for other species, including pedunculate oak and sessile oak at the lowest elevations.



**Table 1.** Area for artificial regeneration in the Sudeten region in 1994–2003 (ha)

Species	Altitude above sea level (m)					Total area (ha)
	400–600	600–800	800–1000	1000–1100	>1100	
<i>Pinus sylvestris</i>	127.0	177.0	247.0	60.0	8.0	619.0
<i>Picea abies</i>	633.0	1 123.0	608.0	387.0	10.0	2 761.0
<i>Larix decidua</i>	651.0	1 039.0	608.0	289.0	8.0	2 595.0
<i>Pseudotsuga taxifolia</i>	93.5	38.0	8.0	0.0	0.0	139.5
<i>Abies alba</i>	27.5	70.5	0.0	0.0	0.0	98.0
<i>Fagus sylvatica</i>	914.5	1 386.0	462.0	122.0	0.0	2 884.5
<i>Betula verrucosa</i>	0.0	33.0	149.0	80.0	11.0	273.0
<i>Tilia cordata</i>	50.0	47.0	18.0	0.0	0.0	115.0
<i>Acer pseudoplatanus</i>	277.0	529.0	180.0	25.0	0.0	1 011.0
<i>Fraxinus excelsior</i>	58.5	40.5	1.0	0.0	0.0	100.0
Other species	80.0	98.0	59.0	115.0	1.0	353.0
Total area	2 912.0	4 581.0	2 340.0	1 078.0	38.0	10 949.0

**Table 2.** Seed demand for artificial regeneration in 1994–2003 (kg)

Species	Year										Mean (kg)
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
<i>Pinus sylvestris</i>	24.5	19.5	23.6	19.6	21.5	21.5	20.5	20.5	20.5	20.9	21.2
<i>Picea abies</i>	68.6	71.6	63.2	68.2	67.8	71.8	63.7	69.7	64.8	70.3	68.0
<i>Larix decidua</i>	51.5	47.7	46.1	47.1	44.1	45.1	49.1	48.1	46.1	45.1	47.0
<i>Pseudotsuga taxifolia</i>	16.1	15.1	16.1	13.1	14.1	13.1	14.1	13.1	14.1	13.1	14.2
<i>Abies alba</i>	61.5	51.6	56.7	51.7	56.8	46.7	46.8	46.8	46.7	46.7	51.2
<i>Fagus sylvatica</i>	2 952.0	3 322.0	3 202.0	3 102.0	3 102.0	3 222.0	3 272.0	3 152.0	2 952.0	3 073.0	3 135.1
<i>Betula verrucosa</i>	57.1	57.1	60.6	58.1	57.1	58.1	61.6	57.1	57.1	58.1	58.2
<i>Tilia cordata</i>	23.5	29.5	24.5	30.5	24.5	30.5	24.5	30.5	24.5	24.5	26.7
<i>Acer pseudoplatanus</i>	458.0	394.0	448.0	469.0	399.0	384.0	384.0	454.0	414.0	411.0	421.5
<i>Fraxinus excelsior</i>	51.0	52.0	50.1	50.2	53.1	80.1	80.2	50.1	80.1	80.1	62.7
Other species	987.0	1 186.0	986.0	1 187.0	987.0	982.0	987.0	987.0	984.0	1 152.0	1 042.5
Total	4 750.8	5 246.1	4 976.9	5 096.5	4 827.0	4 954.9	5 003.5	4 928.9	4 703.9	4 994.8	4 948.3

**Table 3.** Average annual demand for seeds (kg a<sup>-1</sup>)

Species	Seeds (kg a <sup>-1</sup> )
<i>Pinus sylvestris</i>	21.3
<i>Picea abies</i>	68.0
<i>Larix decidua</i>	47.0
<i>Pseudotsuga taxifolia</i>	14.2
<i>Abies alba</i>	51.2
<i>Fagus sylvatica</i>	3 135.1
<i>Betula verrucosa</i>	58.2
<i>Tilia cordata</i>	26.7
<i>Acer pseudoplatanus</i>	421.5
<i>Fraxinus excelsior</i>	62.7
Other	1 042.5

### **Minimum seed stand areas**

The available literature does not provide detailed information on seed production. Suszka *et al.* (1994) and Załęski (1992) provide approximate data on the average mast years of individual species, but not on the amount of seed that can be harvested from a given seed stand. Thus, in this paper, the determination of areas for seed stands is based on the work of Kocięcki (1996), adopting the data as estimates, as well as on oral information from practitioners (in the case of beech, for example) (Table 4). Two options for of the minimum seed stand area were distinguished—the **pessimistic variant**, using the upper limit of mast periods and the minimum seed yield per hectare of a seed stand (as given by Kocięcki), and the **standard variant**, using the mean for the mast periods and the mean seed yield per hectare of a seed stand.

The minimum area of seed stands required to satisfy the seed demand of 11 Sudeten forest districts for the main tree species is 932.5 ha in the standard variant and 1474.5 ha in the pessimistic variant. These figures were determined on the basis of the defined mast periods, harvest yield per hectare of a seed stand and a conversion factor for a 30-year period (assuming the demand for seeds in the subsequent decades to be similar to that for 1994–2003).

In view of the threats to forest ecosystems, it is more realistic to consider the pessimistic variant when selecting seed stands. The classification of seed stands by species and elevation is presented in Table 5. The largest seed stand areas are needed for elevations 600–800 m a.s.l. (687.9 ha in the pessimistic variant and 441.0 ha in the standard variant) and 400–600 m a.s.l. (457.1 ha and 294.7 ha respectively). Beech requires the largest seed stand area: 862 ha in the standard variant and 1295 ha in the pessimistic variant.

### **Selection criteria and stand survey**

Several basic selection criteria for seed stands have been adopted. The most important are:

- indigenous origin
- health status
- quality and productivity
- area and age.

The stands were surveyed in 1993–94. All stands registered as seed stands of the Sudeten gene bank, and detailed descriptions, are presented in Matras (1995). Seed stand areas are specified by species and altitudinal dispersion in Table 6 and by forest district in Table 7.

A total of 1456.6 ha of stands with 13 species including 112 ha of European larch, 669.6 ha of Norway spruce, 404.3 ha of common beech, 54.3 ha of Scots pine, 55.3 ha of common birch, 26 ha of common ash, 31.1 ha of sycamore, 45.1 ha of lime, 42.9 ha of Douglas fir, 0.8 ha of mountain ash, 3.6 ha of black alder, 6.8 ha of silver fir and 4.3 ha of sessile oak were registered as seed stands.

The distribution of the selected seed stands by forest districts is illustrated in Figure 1, and by species and altitude in Table 8. Seed stands were selected at all elevations, and their areas are larger than the minimum areas originally assumed (Table 5). The exception is the seed areas selected for beech, which were much smaller (by a factor of 2 for the standard variant and a factor of 3 for the pessimistic variant) than the assumed minimum areas needed to satisfy the demand for seeds. The selection of larger areas for beech is not possible without a drastic lowering of the selection criteria.

In addition to the current seed demand, the seed sources should be considered as the basic element in the conservation of genetic variability of local tree populations in the Sudetes. Protective measures should be implemented, following the principles laid down in the 'Programme for the preservation of forest genetic resources and selective cultivation of forest species in Poland in the years 1991–2010' (Matras 1993).

**Table 4.** Minimum areas of seed stands and data used for estimating potential seed productivity

Species	Interval between good seed crop (a)	Interval used for estimation (a)	Possible collection of cones, fruits, etc. per ha (kg)	Used for estimation (kg)	Seeds obtained from 100 kg of cones, fruits, etc. (kg)	Seed collected per ha (kg)	Year coefficient	Possible seed collection from 1 ha in 30-year period (kg)	Seed requirement of forest districts in 30-year period (kg)	Minimum area of seed stand (ha)
<b>Standard variant</b>										
<i>Pinus sylvestris</i>	3-4	3	100-500	300	1-1.5	3.5-4.5	10	35-45	640	14-18
<i>Picea abies</i>	3-5	(5) 8	500-1500	1000	2-3	20-30	30/8	75-110	2 040	18-27
<i>Larix decidua</i>	2-4	3	200-500	350	5-8	17.5-28	10	175-280	1 410	5-8
<i>Pseudotsuga taxifolia</i>	2-3	3	-	300	1-3	3-9	10	30-90	430	5-15
<i>Fagus sylvatica</i>	5-8	7	30-50	40	60-70	24-28	30/7	100-120	94 050	784-940
<i>Betula verrucosa</i>	1-2	2	50-500	225	50-70	110-160	15	1 650-2400	1 750	1-1.2
<i>Tilia cordata</i>	1-2	2	25-100	60	60-70	36-42	15	540-630	800	1.3-1.5
<i>Acer pseudoplatanus</i>	1-2	2	50-200	125	80-90	100-115	15	1 500-1700	12 650	7.5-8.5
<i>Fraxinus excelsior</i>	2-3	3	50-150	100	80-90	80-90	10	800-900	1 880	2.1-2.4
<i>Sorbus aucuparia</i>	2-3	3	300-500	400	1-3	4-12	10	40-120	-	-
<i>Abies alba</i>	3-4	4	500-200	1000	5-8	50-80	30/4	375-600	1 540	2.6-4.1
<b>Pessimistic variant</b>										
<i>Pinus sylvestris</i>	3-4	4	100-500	100	1.0-1.5	1.0-1.5	7.5	7.5-11.25	640.0	57-85
<i>Picea abies</i>	3-4(8)	8	500-1500	500	2.0-3.0	10.0-15.0	3.75	37.5-56.25	2 040.0	36-54
<i>Larix decidua</i>	2-4	4	200-500	200	5.0-8.0	10.0-16.0	7.5	75.0-120.0	1 410.0	12-19
<i>Pseudotsuga taxifolia</i>	2-3	3	-	300	1.0-3.0	3.0-9.0	10.0	30.0-90.0	430.0	5-14
<i>Abies alba</i>	3-4	4	500-2000	500	5.0-8.0	25.0-40.0	7.5	187.5-300.0	1 540.0	5-8
<i>Fagus sylvatica</i>	5-8	8	30-50	30	60.0-70.0	18.0-21.0	3.75	67.5-78.7	94 050.0	1200-1390
<i>Betula verrucosa</i>	1-2	2	50-500	50	50.0-70.0	25.0-35.0	15.0	375.0-525.0	1 750.0	3-5
<i>Tilia cordata</i>	1-2	2	25-100	25	60.0-70.0	15.0-17.5	15.0	225.0-262.5	800.0	3-4
<i>Acer pseudoplatanus</i>	1-2	2	50-200	50	80.0-90.0	40.0-45.0	15.0	600.0-675.0	12 650.0	19-21
<i>Fraxinus excelsior</i>	2-3	3	50-150	50	80.0-90.0	40.0-45.0	10.0	400.0-450.0	1 880.0	4-5
<i>Sorbus aucuparia</i>	2-3	3	300-500	300	1.0-3.0	3.0-9.0	10.0	30.0-90.0	-	-

Table 5. Seed stand requirements at different altitudes for the main tree species

Species	Minimal area of seed stand in variant (ha)		Altitude (m a.s.l.)									
	Mean	Pessimistic	Mean variant					Pessimistic variant				
			400-600	600-800	800-1000	1000-1100	>1100	400-600	600-800	800-1000	1000-1100	>1100
<i>Pinus sylvestris</i>	16.0	71.0	3.3	4.6	6.4	1.6	0.1	14.6	20.3	28.3	6.9	0.9
<i>Picea abies</i>	22.5	45.0	5.2	9.2	4.9	3.1	0.1	10.3	18.3	9.9	6.3	0.2
<i>Larix decidua</i>	6.5	15.5	1.6	2.6	1.5	0.7	0.1	3.9	6.2	3.6	1.7	0.1
<i>Pseudotsuga taxifolia</i>	9.5	9.5	6.4	2.6	0.5	0.0	0.0	6.4	2.6	0.5	0.0	0.0
<i>Abies alba</i>	3.3	6.5	0.9	2.4	0.0	0.0	0.0	1.8	4.7	0.0	0.0	0.0
<i>Fagus sylvatica</i>	862.0	1295.0	273.3	413.8	137.9	37.0	0.0	410.5	621.6	207.2	55.7	0.0
<i>Betula verrucosa</i>	1.1	4.0	0.0	0.1	0.6	0.3	0.1	0.0	0.5	2.2	1.2	0.1
<i>Tilia cordata</i>	1.4	3.5	0.6	0.6	0.2	0.0	0.0	1.5	1.4	0.6	0.0	0.0
<i>Acer pseudoplatanus</i>	8.0	20.0	2.2	4.2	1.4	0.2	0.0	5.5	10.5	3.6	0.4	0.0
<i>Fraxinus excelsior</i>	2.2	4.5	1.2	0.9	0.1	0.0	0.0	2.6	1.8	0.1	0.0	0.0
Total	932.5	1474.5	294.7	441.0	153.5	42.9	0.4	457.1	687.9	256.0	72.2	1.3

Table 6. Area of artificial regeneration with respect to species and altitude

Species	Altitude (m a.s.l.)					Species coefficient
	400–600	600–800	800–1000	1000–1100	>1100	
<i>Pinus sylvestris</i>	20.5	28.6	39.9	9.7	1.3	5.6
<i>Picea abies</i>	22.9	40.7	22.0	14.0	0.4	25.2
<i>Larix decidua</i>	25.1	40.0	23.4	11.1	0.4	23.7
<i>Pseudotsuga taxifolia</i>	67.0	27.2	5.8	0.0	0.0	1.3
<i>Abies alba</i>	28.1	71.9	0.0	0.0	0.0	0.9
<i>Fagus sylvatica</i>	31.7	48.0	16.0	4.3	0.0	26.3
<i>Betula verrucosa</i>	0.0	12.1	54.6	29.3	4.0	2.5
<i>Tilia cordata</i>	43.5	40.9	15.6	0.0	0.0	1.0
<i>Acer pseudoplatanus</i>	27.4	52.3	17.8	2.5	0.0	9.2
<i>Fraxinus excelsior</i>	58.5	40.5	1.0	0.0	0.0	0.9
Other	22.7	27.8	16.7	32.6	0.2	3.4
Altitude coefficient	26.6	41.8	21.4	9.8	0.4	100.0

Table 7. Area of seed stands in forest districts with respect to species

Forest district	Species area (ha)													Total area (ha)
	<i>Larix decidua</i>	<i>Picea abies</i>	<i>Fagus sylvatica</i>	<i>Pinus sylvestris</i>	<i>Betula verrucosa</i>	<i>Fraxinus excelsior</i>	<i>Acer pseudoplatanus</i>	<i>Tilia cordata</i>	<i>Pseudotsuga taxifolia</i>	<i>Sorbus aucuparia</i>	<i>Alnus incana</i>	<i>Abies alba</i>	<i>Quercus robur</i>	
Bardo Śląskie	18.6	8.4	27.2	-	-	7.9	-	36.5	13.6	-	-	-	4.3	116.5
Bystrzyca Kłodzka	6.7	91.0	19.	15.2	7.4	3.2	-	-	7.2	-	-	4.3	-	154.0
Jugów	1.5	107.3	35.7	-	3.4	-	-	-	5.7	-	-	-	-	153.6
Kamienna Góra	2.8	47.1	24.6	-	2.2	-	-	-	2.3	-	1.8	-	-	80.8
Łądek	1.3	46.6	60.7	-	-	2.5	5.0	-	7.3	-	-	-	-	123.3
Międzyzlesie	3.6	151.6	33.1	4.3	-	6.0	5.5	-	-	-	-	2.5	-	206.5
Śnieżka	10.3	1.3	27.5	14.00	26.7	4.7	5.2	8.6	6.8	0.8	1.8	-	-	107.5
Świeradów	27.2	44.6	-	9.6	-	-	-	-	-	-	-	-	-	81.6
Szklarska Poręba	27.7	22.7	35.1	4.5	12.8	-	-	-	-	-	-	-	-	102.7
Wałbrzych	2.2	76.9	51.2	-	3.1	-	15.5	-	-	-	-	-	-	148.8
Zdroje	10.3	72.1	90.3	6.8	-	1.5	-	-	-	-	-	-	-	181.1
Total area (ha)	112.0	669.6	404.3	54.3	55.6	25.8	31.1	45.1	42.9	0.8	3.6	6.8	4.3	1 456.6

Table 8. Area of selected seed stands with respect to species and altitude

Altitude (m a.s.l.)	Area (ha)												
	<i>Tilia cordata</i>	<i>Larix decidua</i>	<i>Pseudotsuga taxifolia</i>	<i>Fraxinus excelsior</i>	<i>Fagus sylvatica</i>	<i>Abies alba</i>	<i>Pinus sylvestris</i>	<i>Betula verrucosa</i>	<i>Picea abies</i>	<i>Quercus robur</i>	<i>Alnus incana</i>	<i>Acer pseudoplatanus</i>	<i>Sorbus aucuparia</i>
<400	36.5	2.7	5.3	3.2	17.4	-	-	-	-	-	-	-	-
400-500	6.4	35.2	8.9	8.5	25.5	4.3	15.2	3.4	35.8	-	-	-	-
500-600	2.2	30.0	11.1	10.4	63.8	2.5	25.2	18.1	123.6	4.3	1.8	-	-
600-700	-	31.5	10.4	2.2	74.4	-	12.5	18.7	95.1	-	1.8	18.9	-
700-800	-	12.5	7.2	1.5	100.4	-	1.5	15.5	150.4	-	-	9.4	0.8
800-900	-	-	-	-	96.8	-	-	-	102.8	-	-	2.9	-
900-1000	-	-	-	-	20.0	-	-	-	64.0	-	-	-	-
1000-1100	-	-	-	-	6.1	-	-	-	57.1	-	-	-	-
>1100	-	-	-	-	-	-	-	-	40.8	-	-	-	-

## References

- Kocięcki, S. 1966. Terminarz nasiennictwa leśnego z atlasem do oznaczania nasion [Timetable of seed collection with anatomical atlas of seeds]. PWRiL, Warszawa.
- Matras, J. et al. 1993. Program zachowania leśnych zasobów genowych i hodowli selekcyjnej drzew leśnych w Polsce na lata 1991–2010 [Programme of gene conservation and breeding of forest tree species in state forests for the period 1991–2010]. Dyrekcja Generalna Lasów Państwowych, Instytut Badawczy Leśnictwa, Warszawa.
- Matras, J. et al. 1995. Baza nasienna podstawowych gatunków drzew leśnych w terenach skażonych imisjami przemysłowymi w Sudetach [Seed base for reforestation of the area damaged by air pollution in Sudety region]. Dyrekcja Generalna Lasów Państwowych, Instytut Badawczy Leśnictwa, Warszawa.
- Suszka, B., C. Muller and M. Bonnet Masimbert 1994. Nasiona leśnych drzew liściastych od zbioru do wysiewu [Seeds of forest deciduous trees from collection to sowing]. Wydawnictwo Naukowe PWN, Warszawa–Poznań.
- Załęski, A. 1992. Pozyskiwanie i przechowywanie nasion drzew i krzewów leśnych [Collection and storage of seeds of forest trees and shrubs]. Biblioteczka leśniczego, Zeszyt 13. Wydawnictwo 'Świat', Warszawa.
- Zoll, T. 1963. Analiza stanu lasów w Sudetach [Analysis of the condition of the Sudeten forests]. Zeszyty Problemowe Post. Nauk. Rol. nr 37.

## Evacuation strategy in air-polluted regions of the Czech Republic

Karel Vančura<sup>1</sup> and František Beran<sup>2</sup>

<sup>1</sup>Forestry Development Department, Ministry of Agriculture, Prague, Czech Republic

<sup>2</sup>Forestry and Game Management Research Institute, Jiloviště-Strnady, Czech Republic

The reasons for the poor condition of forests in the Czech Republic are widely known. Most of the problems are of anthropogenic origin. The mountain forests of the Czech Republic have been exposed to atmospheric pollution since the mid-twentieth century. The quality, quantity and dynamics of this pollution stress have been monitored over a long period of time, in order to analyse the damage to forest ecosystems. This has important consequences for the choice of tree species composition in areas to be rehabilitated. In developing forest management practices, the anticipated dynamics of damage to forest stands by air pollutants have been taken into account. The forests have been divided into four risk zones (A–D) according to the expected lifetime of mature Norway spruce stands, to simplify the expression of the complex effects of air pollution (Table 1).

Table 1. Risk zones and expected lifetime of mature Norway spruce stands

Zone	Expected lifetime (years)	Forest area (%)
A	<20	6.3 <sup>a</sup>
B	21–40	28.1
C	41–60	65.6
D	61–80	0

<sup>a</sup>For the most endangered mountain forests.

These zones are the areas where the shortening of life expectancy of mature Norway spruce forests shows a similar declining trend due to air pollutants and climatic, orographic, and site conditions. Forest losses due to industrial pollution have become notorious, particularly in the northern part of the country, which forms part of the so-called 'black triangle' of Europe. This includes the Krušné hory (Ore/Erzgebirge), Jizerske (Isera) hory and Krkonoše (Giant) mountains—and, according to the ICP Forests Programme, about 60% of the forests of the whole country are damaged to some extent.

The air-pollution load is relatively low in some other mountain areas, such as Sumava, Novohradské hory and Jeseníky. Atmospheric concentrations of oxides of nitrogen (NO<sub>x</sub>) have decreased slightly in recent years. Synergistic effects of NO<sub>x</sub> and sulfur dioxide (SO<sub>2</sub>) create a new stimulus for increased tree defoliation at medium altitudes (e.g. Hruby Jeseník). Recently, ozone damage to forest stands has increased in the mountainous regions of the country (particularly in Sumava, Slavkovský les, Krušné hory, Jizerske hory and Krkonoše). During the last decade, although the atmospheric concentrations of SO<sub>2</sub> and NO<sub>x</sub> have decreased significantly, acidification of soils has become a serious health hazard for the Czech mountain forests.

The total forest area of the country is continuously increasing (as has been the case since the beginning of the 20th century), but unfortunately the problems due to industrial pollution persist. In the mountain forests, particularly in the Krušné hory area, this catastrophic development took place in several stages and the severity of the damage made it imperative to adjust forest management objectives and practices to the evolving situation. The stages in which the damage occurred are as follows:

- The first stage followed the initial, sudden large-scale damage, which occurred in 1947. Scientists confirmed that the damage was a consequence of polluted air. The idea of solving the situation by normal silvicultural methods was based on the assumptions that the air pollution would not increase substantially, and that newly introduced technical measures would gradually reduce the pollution. The principle was to preserve all trees showing some signs of life. The proportion of broadleaved species increased considerably, and underplantings were used to rehabilitate the damaged stands.

- Huge thermal power plants were established in the late 1950s and early 1960s. The second stage was characterized by increasing damage to the stands due to these new sources of pollution. It was considered that silvicultural methods would not help to stabilize the stands, and the approach that was adopted included a rapid increase of salvage cuttings in areas affected by air pollution. The accelerated deterioration of older Norway spruce stands led to the loss of beech underplantings, and damage to young spruce stands was becoming more severe. Only a few regenerated stands from this period have survived.
- Since the early 1970s (since the mid-1960s in the Krušné hory area), there has been an obvious deterioration in the health of the mountain forests. This has had immense ecological and social consequences. The 'black triangle' is the worst-affected area in central Europe. The General Plan (elaborated in cooperation between the Regional Forest Offices and the Forestry Research Institute), adopted during this third stage, aimed to maintain the vegetation cover (forest production had to be ignored) using various tree species including introduced ones. Gradually so-called transitory (or substitute) stands replaced Norway spruce stands, and it was decided to improve forest soil conditions through adjustment of the water regime, liming and fertilization.
- Forest management decisions during the fourth (current) stage were based on an optimistic evaluation of the situation at the beginning of the 1990s. The intention was to substitute vast stands of birch, mountain ash and Colorado blue spruce with other species more appropriate to each site. However, development during the last decade has shown that decreasing concentrations of SO<sub>2</sub> cannot rapidly solve the deep disturbance of forest ecosystems caused by the long-lasting influence of air pollution.

### **Other problems for Czech forestry**

The number of cervids, particularly *Cervus elaphus* L., in the Czech forests is still too high. This is also considered an anthropogenic factor because the species is exotic. In spite of increasing hunting, the number of large game animals has risen over the last 5 years. As a consequence, significant damage to forest stands persists. The number of small game, which had declined considerably in recent decades, has stabilized within the last 3 years.

New problems arose during the transformation period of the 1990s. A large number of new forest owners with uneconomically small holdings had to deal with market realities such as low timber prices, and poor knowledge of the evaluation of other forest goods and services. Last but not least, movements of forestry professionals also unfortunately resulted in the loss of information, local experience and continuity of project management during the development of the market economy.

After the deteriorated stands were felled (47 300 ha since 1958, a total of around 2% of the total forest area of the country), problems arose with forest regeneration in these large clearings. The situation was also bad in protected mountain forests which were neglected for long periods for economic reasons.

The mountain forests were exposed to natural deterioration without sufficient regeneration, due to high stocks of game animals. The forests were also affected by ecological stresses resulting from air pollution. The ecological conditions of the deforested and polluted areas often showed characteristics of the dwarf-pine or alpine altitudinal zone.

It was obvious that no planting of Norway spruce could recover areas on critical sites, particularly in the so-called Zone A (survival 20 years maximum—see Table 1). Also, young trees died as a result of any anomaly in the weather, usually in the springtime. It is assumed that mixed autochthonous stands composed of local ecotypes of tree species (e.g. European beech, silver fir, Norway spruce, sycamore maple, European mountain ash, white birch, etc.) will survive much better than allochthonous Norway spruce stands. Thus, a long-term priority is to increase the proportion of broadleaved species, particularly European beech and sycamore.



### Evacuation strategy

The evacuation strategy is based on collecting reproductive material from remnant stands and trees surviving in polluted areas, and propagating more resistant seedling stock for reforestation purposes. Because of various technical difficulties the acquisition of this stock is costly, and it is also risky to plant seedlings in the polluted areas. For these reasons, the use of this strategy and development of *ex situ* procedures was restricted to research purposes. The strategy mainly applied to the establishment of seed orchards for Norway spruce, to conserve the most valuable gene pool from the Krušné hory mountains. It was also used in the Jizerske hory and Krkonoše mountains.

In the Krkonoše Mountains National Park, the evacuating strategy was implemented by developing an intraregional *ex situ* programme to conserve the endangered autochthonous populations of Norway spruce at the highest elevations—FVZ 8 and 9 (Table 2). Six plantations (established from cuttings of trees specifically grown for this purpose) are located at lower altitudes of the Krkonoše region, where the emission load is also lower. The long-term objective is to transfer these plantations into the clone archives. The aim is to have at least 100 clones with 25 individuals from every population which is endangered in its original site.

Table 2. Climatic characteristics of high elevation areas in the Krkonoše Mountains National Park (FVZ 8 and 9)

FVZ	Elevation	Average temperature	Annual precipitation	Growth period
	(m a.s.l.)	(°C)	(mm)	(days)
8	1050–1350	2.5–4.0	1200–1500	60–100
9	>1350	<2.5	>1500	<60

Trees are planted using relatively wide spacing. After some necessary silvicultural treatments, it is hoped that the whole clone spectrum can be conserved in future clone archives.

So-called first-class plantations were planted with seedlings obtained from seeds of selected trees and, to a smaller extent, also with cuttings. Current second-class plantations are created using cuttings from trees more than 180 years old.

The intention is to have each population represented by 90% of elite trees and the remaining 10% from various typically mountainous ecotypes of Norway spruce. Mother trees are carefully registered in order to keep a record of the populations and cultivated 'stress-tolerant' clones, as this material will be used later for reforestation purposes in heavily polluted areas.

There are still many problems that hinder the implementation of the evacuation strategy and subsequent reforestation efforts: populations of game animals are still too large, particularly in the mountain forests. Since the early 1980s the forests have been subject to *Neuartige Schäden* (so-called 'new types of damage'): chlorosis of older needle age classes, which is related to disorders in magnesium nutrition and low levels of calcium and zinc. In recent years there have also been extreme climatic conditions, e.g. floods in the mountain catchment areas (winter 1995–96), and extreme droughts (spring 2002 and summer 2003). Furthermore, changes in organizational structure and personnel have resulted in loss of documentation and interruptions in record-keeping and project management. The Forestry Research Institute has the respective information and records, but there is often a lack of feedback from practical foresters. Unfortunately, some sources of reproductive material used in the past have not been identified in an appropriate way. Finally, the greatest problem for Czech forestry and forest research is that they do not attract young people any more.

## Programmes

### **Second EUFORGEN Conifers Network meeting**

*Valsain, Spain, 20–22 September 2001*

**Wednesday 19 September**—arrival of participants

#### **Thursday 20 September**

Opening of the meeting

09:00 Welcome (Host country and Chair of the Network)

09:15 Introduction (IPGRI)

09:30 Adoption of the agenda and nomination of rapporteurs

Country reports on the status and practices of gene conservation in selected species

*(Abies alba, Picea abies, Pinus pinaster, Taxus baccata)*

09:45 Presentation of invited case studies

10:30 *Coffee break*

11:00 Invited case studies (continued)

12:30 Indicators of national gene conservation programmes (Secretariat)

13:00 Proposal for publication on current status of FGR in Europe (Csaba Mátyás)

13:30 Lunch

Research

15:00 Overview of ongoing research projects (All)

15:45 Presentation of project proposals (Project Coordinators)

16:30 *Coffee break*

17:00 Discussion on research needs and priorities (All)

Documentation

17:45 EUFORGEN Database/Information platform (Secretariat)

18:15 Bibliography (Secretariat)

20:00 Dinner

#### **Friday 21 September**

Seminar: Emerging facts and issues related to gene conservation of conifers in Europe—  
technical presentations and discussion

09:00 Research on epigenetic effects and their consequences for applied gene conservation  
(Tore Skrøppa)

09:30 Is genetic diversity and plasticity promoting evolution? (Csaba Mátyás)

10:00 Climate instability and gene conservation priorities (W. Amaral)

10:30 *Coffee break*

11:00 Discussion (All)

---

Sharing of gene conservation responsibilities

12:00 Results of the EUFORGEN Inter-Network meeting (Secretariat)

12:30 Selection of model ('flagship') species (All)

13:30 *Lunch*

15:00 Distribution maps and inventories (Secretariat)

16:00 *Coffee break*

16:30 Development of technical guidelines (All)

20:00 Dinner

**Saturday 22 September**

Field trip (half-day)

Public awareness

14:30 Follow-up, maintenance and use of image database (Bruno Fady)

15:00 Other public awareness initiatives – individual country or Network level (All)

15:30 Links between the Network and Ministerial Resolutions (Secretariat)

Adoption of the report

Date and place of next meeting

Conclusions

**Sunday 23 September** – departure of participants

### **Third EUFORGEN Conifers Network meeting**

*Kostrzyca, Poland, 17–19 October 2002*

**Wednesday 16 October**—Arrival of participants

#### **Thursday 17 October**

08.30 Opening of the meeting

Welcome by host (Jan Matras)

Welcome by Chair of the Network (Csaba Mátyás)

Introduction and organizational arrangements (Jozef Turok)

Adoption of the agenda and nomination of rapporteurs

09.00 Status and progress of genetic conservation in conifers: discussion on the progress made in countries (All participants)

*10.00 Break*

10.30 Status and progress of genetic conservation in conifers (continued—discussion and synthesis)

11.30 Common Action Plans for the practical implementation of genetic conservation strategies and guidelines for selected conifers in Europe:

Outcomes of the EUFORGEN Steering Committee meeting and the MCPFE process (Jozef Turok)

Draft technical guidelines for selected species (introduced by Bruno Fady, R.

Bruchanik, S. Martin, Tore Skrøppa, A. König)

Maps of distribution areas and information available on existing gene reserves (introduced by Michele Bozzano)

Discussion

*12.00 Lunch*

13.30 Common Action Plans (continued)

15.30 Break

16.00 Forest Gene Bank Kostrzyca: aims and tasks, process and equipment, container nursery arboretum (Dr Bogdan Szumowski)

*19.30 Dinner*

#### **Friday 18 October**

08.30 Research:

Overview of ongoing research projects (All participants)

Outcomes of the IUFRO Symposium on Population and Evolutionary Genetics of Forest Trees (Csaba Mátyás)

Conference on the Dynamics and Conservation of Genetic Diversity in Forest Ecosystems (DYGEN); arrangements for presentation of the Conifers Network (introduced by Csaba Mátyás)

EU Sixth Framework Programme for research (introduced by Jozef Turok)

Discussion on research needs and priorities, new proposals

*10.30 Break*

- 11.00 Documentation, information and public awareness:  
Database/ information platform (introduced by Michele Bozzano)  
Bibliographic database (introduced by Michele Bozzano)  
Collection of images (introduced by Bruno Fady)  
Discussion of communication and public awareness issues, publications

12.00 *Lunch*

- 13.30 Seminar: Genetic conservation and restoration programmes in areas affected by industrial air pollution (introductory presentations):  
Genetic conservation and reforestation of the areas destroyed by air pollution in Sudety mountains in Poland  
Ecological disaster: factors and results, studies and practical action in reforestation of destroyed forests (A. Potyralski, Head of Forest Department of Regional Directorate, State Forest Wrocław)  
Rehabilitation of silver of fir populations (*Abies alba* Mill.) in the Sudetes (W. Barzdajn, Agricultural Academy, Forest Faculty Poznań)  
Programme of yew (*Taxus baccata* L.) protection in Poland (M. Falecka-Jablonska, Department of Ecology, Forest Research Institute)  
Seed source for reforestation and gene reserves in Sudety region (Jan Matras, Department of Genetics and Physiology of Woody Plants, Forest Research Institute)  
Status of *ex situ* stands: experience with the evacuation of threatened populations in the Czech Republic

15.00 *Break*

- 15.30 Seminar (continued—discussion)  
16.30 Miscellaneous: Role and activities on Mediterranean conifers within the Network (introduced by A. Alexandrov)

Any other business

19.30 *Dinner*

### **Saturday 19 October**

- Field trip (half day)  
15.00 Draft report

Conclusions  
Closure of the meeting

19.30 *Farewell dinner*

**Sunday 20 October 2002**—Departure of participants

## Participants

Karen Ter-Ghazaryan (Valsaín only)  
Forest Research and Experimental Center  
Ministry of Nature Protection  
Lusavorich Street 15  
375002 Yerevan

### Armenia

Tel: +374 1 563081  
Fax: +374 1 562974  
Email: forester\_acc.am

Thomas Geburek (Valsaín only)  
Institute of Forest Genetics  
Federal Forest Research Centre  
Hauptstrasse 7  
1140 Vienna

### Austria

Tel: +43 1 87838 2109  
Fax: +43 1 87838 2250  
Email: thomas.geburek\_bfw.gv.at

Michael Mengl (Kostrzyca only)  
Institute of Forest Genetics, Federal Forests  
Research Centre  
Hauptstrasse 7  
1140 Vienna

### Austria

Tel: +43 1 87838 2224  
Fax: +43 1 87838 2250  
Email: michael.mengl\_bfw.gv.at

Vahid Hadjiyev (Kostrzyca only)  
Institute of Botany  
Azerbaijan National Academy of Sciences  
Potamdarskoye Shosse 40  
370073 Baku 73

### Azerbaijan

Tel: +994 12 393230  
Fax: +994 12 398608  
Email: valizadeh\_artel.net.az

Olivier Desteucq (Kostrzyca only)  
Centre de Recherche de la Nature, des Forêts et du  
Bois  
Avenue Maréchal Juin 23  
5030 Gembloux

### Belgium

Tel: +32 81 626452  
Fax: +32 81 615727  
Email: o.desteucq\_mrwallonie.be

Alphonse Nanson (Valsaín only)  
Centre de Recherche de la Nature, des Forêts et du  
Bois  
Avenue Maréchal Juin 23  
5030 Gembloux

### Belgium

Tel: +32 81 626453  
Fax: +32 81 615727  
Email: a.nanson\_mrwallonie.be

Alexander Alexandrov  
Forest Research Institute  
Kliment Ohridski Blvd 132  
1756 Sofia

### Bulgaria

Tel: +359 2 9620442  
Fax: +359 2 9620447  
Email: forestin\_bulnet.bg

Marilena Idžojtic (Valsaín only)  
Faculty of Forestry  
University of Zagreb  
Svetosimunska 25  
10 000 Zagreb

### Croatia

Tel: +385 1 2352541  
Fax: +385 1 2352505  
Email: marilena.idzajtichinet.hr

Xenophon Hadjikyriacou  
Forestry Department  
Ministry of Agriculture, Natural Resources and  
Environment  
1414 Nicosia

### Cyprus

Tel: +357 22805504  
Fax: +357 22781419  
Email: xenosh\_yahoo.com

Mr Karel Vančura  
Forestry Department  
Ministry of Agriculture  
Tesnov 17  
117 05 Prague

### Czech Republic

Tel: +420 221 812 357  
Fax: +420 221 812 988  
Email: vancura\_mze.cz

Ülo Tamm  
Forest Research Institute  
Estonian Agricultural University  
Kreutzwaldi 5  
51014 Tartu  
**Estonia**  
Tel: +372 7 313168  
Fax: +372 7 313153  
Email: ytamm\_eau.ee

Teijo Nikkanen  
Punkaharju Research Station  
Finlandiantie 18  
58450 Punkaharju  
**Finland**  
Tel: +358 10 2114226  
Fax: +358 10 2114201  
Email: teijo.nikkanen\_metla.fi

Bruno Fady  
INRA-URFM  
Avenue A. Vivaldi  
84000 Avignon  
**France**  
Tel: +33 4 90135910  
Fax: +33 4 90135959  
Email: fady\_avignon.inra.fr

Maia Akhalkatsi (Kostrzyca only)  
Institute of Botany  
Georgian Academy of Sciences  
Kojori Road 1  
380007 Tbilisi  
**Georgia**  
Tel +995 32 331320  
Fax: +995 32 001127  
Email: akhalkatsim\_netscape.net

Armin O. König  
Institute for Forest Genetics and Forest Tree  
Breeding, BFH  
Sieker Landstrasse 2  
22927 Grosshansdorf  
**Germany**  
Tel: (49-4102) 696147  
Fax: (49-4102) 696200  
Email: koenig\_holz.uni\_hamburg.de

Csaba Mátyás  
Institute of Environmental Sciences, Faculty of  
Forestry, University of West Hungary  
PO Box 132  
9401 Sopron  
**Hungary**  
Tel: +36-99 518395  
Fax: +36-99 329840  
Email: cm\_emk\_nyme.hu

John Fennessy (Kostrzyca only)  
COFORD  
UCD, Agriculture Building  
Belfield, Dublin 4  
**Ireland**  
Tel: +353-1716 7700  
Fax: +353-1716 1180  
Email: john.fennessy\_coford.ie

Giovanni G. Vendramin  
Istituto di Genetica Vegetale, CNR  
Polo Scientifico Sesto Fiorentino  
Via Madonna del Piano, Edificio D  
50019 Sesto Fiorentino, Firenze  
**Italy**  
Tel: +39 055 5225725  
Fax: +39 055 5225729  
Email: giovanni.vendramin\_i\_gv.cnr.it

Valmantas Kundrotas  
Lithuanian Forest Tree Breeding Centre  
Liepu 2  
4312 Girionys, Kaunas reg.  
**Lithuania**  
Tel: +370 7 547771  
Fax: +370 7 547771  
Email: lmssc\_post.sonexco.com

Vlatko Andonovski (Valsain only)  
Faculty of Forestry  
University Ss. Cyril and Methodius  
P.O.Box 235  
1000 Skopje  
**Macedonia FYR**  
Tel: +389 2 3135033  
Fax: +389 2 3079748  
Email: silva\_unet.com.mk

Eman Calleja (Valsain only)  
Ministry of Agriculture and Fisheries  
Department of Agriculture  
Notabile Road  
Attard  
**Malta**  
Tel: +356 415488  
Fax: +356 21493176  
Email: eman.calleja\_gov.mt

Tore Skrøppa  
Norwegian Forest Research Institute  
Høgskoleveien 8  
1432 Ås  
**Norway**  
Tel: +47 64 949067  
Fax: +47 64 942980  
Email: tore.skrøppa\_s\_kogforsk.no

Jan Matras  
 Forest Research Institute  
 Department of Genetic and Physiology of Woody  
 Plants  
 Bitwy Warszawskiej 1920 Roku 3  
 00 973 Warszawa  
**Poland**  
 Tel: +48 22 7150478  
 Fax: +48 22 7150313  
 Email: matrasj\_ibles.waw.pl

Andrey Prokazin (Valsaín only)  
 Russian Tree Breeding Centre CENTRLESSEM  
 Nadsonovskaya 13  
 141200 Pushkino (Moscow)  
**Russian Federation**  
 Tel: +7 095 5843407  
 Fax: +7 096 5326662  
 Email: centrles\_altercom.ru

Rudolf Bruchánik (Kostrzyca only)  
 State Forest of Slovak Republic  
 Lesy Sr, s.p.  
 Namestie SNP8  
 975 66 Banska Bystrica  
**Slovakia**  
 Tel: +421 48 4125903  
 Fax: +421 48 4125904  
 Email: bruchanik\_lesy. sk

Ladislav Paule (Valsaín only)  
 Faculty of Forestry  
 Technical University  
 Masarykova 24  
 96053 Zvolen  
**Slovakia**  
 Tel: +421 45 5206221  
 Fax: +421 45 5332654 or 5350608  
 Email: paule\_vs ld.tuzvo.sk

Gregor Bozic (Kostrzyca only)  
 Dept. of Forest Biology & Ecology  
 Slovenian Forestry Institute  
 Vecna pot 2  
 1000 Ljubljana  
**Slovenia**  
 Tel: +386 1 2007821  
 Fax: +386 1 3573589  
 Email: gregor.bozic\_gozdis.si

Robert Brus (Valsaín only)  
 Biotechnical Faculty  
 Department of Forestry and Renewable Forest  
 Resources  
 Vecna pot 83  
 1000 Ljubljana  
 Slovenia  
 Tel: +386 1 423 1161  
 Fax: +386 12571 169  
 Email: robert.brus\_bf.uni-lj.si

Ricardo Alía (Valsaín only)  
 Centro Investigaciones Forestales, INIA  
 Apdo. 8111  
 28080 Madrid  
**Spain**  
 Tel: +34 91 3476857  
 Fax: +34 91 3572293  
 Email: alia\_i nia.es

Sonia Martín Albertos (Kostrzyca only)\*  
 Dirección General de Conservación de la  
 Naturaleza  
 Servicio de Material Genético  
 Gran Vía de San Francisco 4  
 28005 Madrid  
**Spain**  
 Tel: +34 91 5964639  
 Fax: +34 91 5964905  
 Email: smartin@mma.es or  
 sonia.martin\_d gcn.mma.es

Lennart Ackzell  
 The National Board of Forestry  
 DG-Secretariat  
 Vallgatan 8  
 551 83 Jönköping  
**Sweden**  
 Tel: +46 36 155706  
 Fax: +46 36 166170  
 Email: lennart.ackzell\_s vo.se

Marcus Ulber\*  
 Forstliches Ingenieurwesen  
 ETH Zentrum, HG G 22.1  
 Rämistr. 101  
 8092 Zurich  
**Switzerland**  
 Tel: +41-1 7392493  
 Fax: +41-1 7392215  
 Email: marcus.ulber\_ws l.ch

---

\* Contact details at the time of the meeting



Hacer Semerci  
Forest Tree Seeds and Tree Breeding  
Research Directorate  
P.O.Box 11  
06560 Gazi – Ankara

**Turkey**

Tel: +90 312 2126519  
Fax: +90 312 2123960  
Email: hacersemerci\_ahoo.com or  
hacersemerci\_hotmail.com

Ihor Shvadchak (Valsain only)  
Ukrainian State University of Forestry and Wood  
Technology  
Gen. Chuprynyk, 103  
Lviv

**Ukraine**

Tel: +380 322 725792  
Fax: +380 322 271765  
Email: shvad\_orest.lviv.ua

Steve Lee (Valsain only)  
Tree Improvement Branch  
Northern Research Station  
Roslin, Midlothian  
EH25 9SY

**United Kingdom**

Tel: +44 131 4456926  
Fax: +44 131 4455124  
Email: steve.lee\_forestry.gsi.gov.uk

C.J.A.Sam Samuel (Kostrzyca only)

Forest Research  
Northern Research Station  
Roslin, Midlothian  
EH25 9SY

**United Kingdom**

Tel: +44 131 4456927  
Fax: +44 131 4455124  
Email: c.j.a.samuel\_ores try.gsi.gov.uk

## Observers

Bartolomeo Schirone (Valsaín only)

Dip. Sci. Ambiente For. e Risorse  
 Università degli Studi della Tuscia  
 Via S. Camillo de Lellis  
 011000 Viterbo

**Italy**

Tel: +39 0761 357391  
 Fax: +39 0761 357389  
 Email: schirone\_unitus.it

Francesco Spada (Valsaín only)

Department of Botany  
 Università Degli Studi di Roma  
 Piazzale Aldo Moro 5  
 00185 Rome

**Italy**

Tel: + 39 066833878  
 Email: francesco.spada\_v axtbio.uu.se

Weber N. Amaral (Valsaín only)

IPGRI  
 Via dei Tre Denari, 472/a  
 00057 Maccarese (Fiumicino)  
 Rome

**Italy**

Tel: +39 066118213  
 Fax: +39 0661979661  
 Email: w.amaral\_cgjar.org

Arancha Gomez (Valsaín only)

CIFOR-INIA  
 Carrera de la Coruña Km 7  
 28040 Madrid

**Spain**

Email: argomez\_nia.es

Sonia Martin (Valsaín only)

Servicio de Material Genetico  
 DGCN  
 Gran Via de San Francisco, 4  
 28005 Madrid

**Spain**

Tel: +34 91 5975439  
 Fax: +34 91 5975598  
 Email: sonia.martin\_d gcn.mma.es

## EUFORGEN Secretariat/IPGRI

Jozef Turok

IPGRI  
 Via dei Tre Denari, 472/a  
 00057 Maccarese (Fiumicino)  
 Rome

**Italy**

Tel: +39 066118250  
 Fax: +39 0661979661  
 Email: j.turok\_gjar.org

Michele Bozzano (Kostrzyca only)

IPGRI  
 Via dei Tre Denari, 472/a  
 00057 Maccarese (Fiumicino)  
 Rome

**Italy**

Tel: +39 066118221  
 Fax: +39 0661979661  
 Email: m.bozzano\_cgjar.org

Simone Borelli (Valsaín only)

IPGRI  
 Via dei Tre Denari, 472/a  
 00057 Maccarese (Fiumicino)  
 Rome

**Italy**

Tel: +39 066118221  
 Fax: +39 0661979661  
 Email: s.borelli\_cgjar.org

## Unable to attend

### **Second meeting (Valsain)**

Mr Kliti Starja  
IKPK  
Rruga "Halit.Bega" 23  
Tirana  
**Albania**  
Tel: +355 4 371237  
Fax: +355 4 371243  
Email: kstarja\_hotmai\_l.com

Ms Maia Akhalkatsi  
Institute of Botany  
Georgian Academy of Sciences  
Kojori road 1  
380007 Tblisi  
**Georgia**  
Tel: +995 32323429  
Fax: +995 32 001127  
Email: akhalkatsim\_netscape.net

Mr Heino Wolf  
Saechsiche Landesanstalt fuer  
Forsten  
Bonnewitzer Strasse 34  
01796 Pirna  
**Germany**  
Tel: +493501542220  
Fax: +493501542213  
Email: heino.wolf\_1\_af.sml.sachsen.de

Mr Mikhail V. Pridnya  
74 Str. Kurortnyi prospect  
354002 Sochi-2  
**Russian Federation**  
Tel: +8622 62 1842  
Fax: +8622 621842  
Email: niigorec\_sochi.ru

### **Third meeting (Kostrzycka)**

Mr Maxhun Dida  
Forest and Pasture Research Institute  
Rruga Halit Bega nr 23  
Tirana  
**Albania**  
Tel: +355 43 71237  
Fax: +355 43 71242  
Email: lkpk\_albaniaonline.net

Mr Vlatko Andonovski  
Faculty of Forestry  
P.O.Box 235  
1000 Skopje  
**Macedonia FYR**  
Tel: +389 70 332113  
Fax: +389 2 381813  
Email: silva\_mkinter.net

Mr Eman Calleja  
Ministry of Agriculture and Fisheries  
Department of Agriculture  
Notabile Road  
Attard  
**Malta**  
Tel: +356 415488/419125  
Fax: +356 493176/415488  
Email: emanc\_orbit.net.mt

