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Extended Abstracts of accepted papers not presented at conference

IUFRO Division 1 Conference

Meeting the challenge: Silvicultural Research in a Changing World

Hotel Mercure, La Grande Motte, Montpellier, France
June 14-18, 2004

PROGRAM

Monday, 14 June

9:00-10:30 **Opening session**
- Jacques Valeix (Director, Département Forêts, Cirad)
- Eric Teissier du Cros (IUFRO Vice-President, Science)
- John Parrotta (Coordinator, IUFRO Division 1)

10:30-11:00 Coffee break

11:00-12:30 **Opening session** (***continued***)
- Alain Franc (France – Coordinator, IUFRO Division 8): "Heterogeneous stands – Between silviculture and ecology, between empirical and scientific knowledge" [coauthored with Robert Jandl and Sophie Zechmeister (Austria)]
- Mark Hunt (Australia) – Special presentation on IUFRO World Congress 2005, Brisbane, Australia.

12:30-14:00 Lunch

14:00-16:00 **Technical Session 1.** ***Landscape-level management***
Moderator: Björn Hånell (Sweden)

- "Close-to-nature silviculture: an example from Italy's eastern Alps." G. Grassi, G. Minotta, R. Giannini & U. Bagnaresi (*Lead Paper*)
- "Landscape based forest management - a real world case". Martin Mendoza, Juan José Fajardo & Jesús Zepeta
- "Water management in "La Antigua" (Veracruz): a multiproduct model approach in Mexican Forestry." Ana-Rita Román-Jiménez; Martín Mendoza; Mario Martínez; Alejandro Velázquez; Juan-Manuel Torres; & Hugo Ramírez.

16:00-16:30 Coffee break

16:30-18:30 **Technical Session 2.** ***Management for non-timber values and forest health***
Moderator: Paul Vantomme (FAO/Rome)

- "Managing forests for non-wood forest products: opportunities and constraints" Paul Vantomme (*Lead Paper*)
- "Should planting of broad-leaved species be encouraged at the expense of spruce? An economic approach to a current southern Swedish forestry issue." Per Holgén & Göran Bostedt

- "Silvicultural strategies in forest ecosystems affected by exotic pests." Kristen M. Waring and Kevin L. O'Hara
- "Gestion des produits forestiers non-ligneux par les populations en Afrique centrale : réalités et perspectives. " Mathurin Tchatat & Ousseynou Ndoye
- "Silvicultural lessons about stand dynamics and forest health from a study of oak decline in southern Missouri." W. Keith Moser, Kathy Kromroy, Mark Hansen, Chris Woodall, Linda Haugen & Manfred Mielke

Tuesday 15 June

08:30-10:30 Technical Session 3. ***Tropical forest management***
Moderator: Henri-Felix Maître (France)

- "Research, community forests, and CITES favor sustainable silviculture of mahogany (*Swietenia macrophylla* King) in natural tropical forests". Laura K. Snook (*Lead Paper*)
- "A new approach to silvicultural research in the Brazilian Amazon – Dendrogene." Romy B. Sato, Ian S. Thompson, Jorge A. G. Yared, José do C. A. Lopes, Márcia Maués, Regina C.V.M Silva, Denis R. do Valle, Bernd Degen, Milton Kanashiro
- "Using models for predicting recovery and assess tree species vulnerability in logged tropical forests." Sylvie Gourlet-Fleury, Guillaume Cornu, Sébastien Jésel, Hélène Dessard, Jean-Gaël Jourget, Lilian Blanc, Nicolas Picard
- "Connaître le tempérament des espèces pour prévoir l'évolution de la composition des forêts exploitées." Eric Forni
- "Phytosociologie appliquée à l'aménagement des forêts : cas de la forêt de Toffo au sud-Bénin." Jean Cossi Ganglo

10:30-11:00 Coffee break

11:00-12:30 Technical Session 4. ***Social forestry and traditional management***
Moderator: Laura Snook (CIFOR/Indonesia)

- "Constraints and opportunities for better silviculture practice in tropical forestry: an interdisciplinary approach". Bradley B. Walters, Cesar Sabogal, Laura K. Snook & Everaldo de Almeida (*Lead Paper*)
- "Community-Based Forest Management in Northern Thailand." Minna Hares
- "Traditional natural resource management in the Tanimbar (South East Moluccas)." Yves Laumonier, Yohanes Purwanto, Bayuni Shantiko & Yan Persulessy
- "Sustainable development of forest resources in Sri Lanka: a village-based approach" Mangala de Zoysa

12:30-14:00 Lunch

14:00-16:00 Technical Session 5. ***Uneven-aged management for multiple uses.***
Moderator: Kevin O'Hara (USA)

- "A new silviculture: loosening the grip". K. J. Puettmann, K. D. Coates & C. Messier (*Lead Paper*)
- "Application of free selection in mixed forests of the inland northwestern United States." Russell T. Graham & T.B. Jain

- "Effects of strip cutting and single-tree selection cutting on birds and their habitat in a SW Quebec extensive northern hardwood forest" Frédérik Doyon, Daniel Gagnon & Jean-François Giroux
- "Ecological and economic reasons for retaining white birch in interior spruce plantations." Chris Hawkins & Thomas W Steele
- "Uneven aged management experimentation in eastern Canadian boreal forest." Hervé Bescond, Yves Bergeron, J. Morasse & K. Harper
- "30-year response of white pine to release after partial harvesting in pine mixedwoods" Darwin Burgess, Craig Robinson & Suzanne Wetzel

16:00-16:30 Coffee break

16:30-18:30 **Technical Session 6.** ***Forest structure and biodiversity***
Moderator: John Stanturf (USA)

- "Effects of forest management on biodiversity of ground vegetation in Canadian and European conifer forests." Andreas Schmiedinger, Jürgen Kreyling, S. Ellen Macdonald & Carl Beierkuhnlein (*Lead Paper*)
- "Silviculture of beech – present and future challenges?" Palle Madsen, Khosro Sagheb Talebi, Kazuhiko Terazawa, Robert Rogers & Katrine Hahn
- "Effects of topography on regeneration pattern of sub-alpine forests in Western Sichuan of China." Shirong Liu, Yuandong Zhang, Changming Zhao, Zuomin Shi and Xingliang Liu
- "Characterisation of forest structure of Scots pine stands across a 120-year rotation." Fernando Montes & Isabel Cañellas

Wednesday 16 June: Field excursion

Thursday 17 June

8:30-10:30 **Technical Session 7.** ***Quantifying silviculture***
Moderator: Daniel Auclair (France)

- "Modelling as a forest management decision tool in response to climate change: regional impacts of climate change on wood production and carbon storage in temperate forests." Denis Loustau et al. (*Lead Paper*)
- "Assessing effects of forest management on selected public forest goods and services: a case study." Daniel Köchli & Peter Brang
- "Quantifier les objectifs de la silvaculture à l'aide du concept de peuplement cible". Philippe Nolet, Frédérik Doyon & Éric Forget
- "Silvicultural systems for non-traditional and multiple objectives: exploring alternatives." James N. Long & Scott D. Roberts
- "A light-capture based stand dynamics model for forecasting response to silvicultural practices." Arthur Groot & Jean-Pierre Saucier

10:30-11:00 Coffee break

11:00-12:30 Technical Session 7 (continued). *Quantifying silviculture*
Moderator: Daniel Auclair (France)

- "Productivity relationships in managed forest stands." Kevin L. O'Hara (*Lead Paper*)
- "Modelling response to midrotation thinning and fertilization in loblolly pine plantations." Ralph L. Amateis
- "Wood production, litter fall and humus accumulation in thinning experiment in Norway Spruce CZ 13 – Vitkov." Marian Slodicak & Jiri Novak
- "Investigating scale-dependent stand heterogeneity with structure-area-curves". Eric Zenner

12:30-14:00 Lunch

14:00-16:00 Technical Session 8: *Forest restoration and conservation.*
Moderator: Palle Madsen (Denmark)

- "Silviculture for restoration of degraded temperate and boreal forests". John A Stanturf, Palle Madsen, & Emile S. Gardiner (*Lead Paper*)
- "Restoring bottomland hardwood forests: a comparison of four techniques" John A Stanturf, Emile S. Gardiner, James P. Shepard, Callie J. Schweitzer, C. Jeffrey Portwood, & Lamar Dorris
- "The theoretical basis of mining-quaries land recultivation in taiga zone in Russian north-west". Evgeniy V. Abakumov, Olga V. Lisitsina, & Elvira I. Gagarina
- "Silvicultural measures for conservation of dune landscapes in Russia." Anton V. Doroshin & Anatoliy V. Zhigunov
- "Les unites pilotes d'amenagement, de reboisement et d'agroforesterie : nouvelle approche de gestion durable des forets Congolaises" Antoine Mountanda, Pierre Taty & Jean Albert Placide Kaya

16:00-16:30: Coffee Break

16:30-18:00: IUFRO Division 1 Business Session

<u>Friday 18 June</u>

08:30-10:30 Technical Session 9: *Plantation management*
Moderator: Chris Hawkins (Canada)

- "Implications of legal and policy regulations on rural development: the challenge of agroforestry". Christian Dupraz et al. (*Lead Paper*)
- "Growth and species interactions in a mixed plantations of *Eucalyptus globulus* and *Acacia mearnsii.*" David Forrester, Jürgen Bauhus & Annette Cowie
- "The potential of using wood ash and peat ash as forest fertilizer on peat soils in Sweden" Björn Hånell
- "Potential for legume introduction in short rotation plantation forests as a means to increase productivity and maintain site fertility? – the need for coordinated research" Jean-Pierre Bouillet, Jose Leonardo M. Gonçalves, Jacques Ranger, Antoine Galiana, Jean de Dieu Nzila, Philippe Deleporte & Jean-Paul Laclau
- "Rationale for developing teak clonal plantations". O. Monteuuis, D.K.S. Goh & H.F. Maître

- "Taxon-specific responses of subtropical *Pinus* to site preparation technique on very wet sites in the southeast Queensland coastal lowlands." Mark A. Hunt, David O. Osborne, Ken Bubb & Marks R. Nester
- "Industrial coniferous plantations in Russia." Igor V. Shutov & Anatoliy V. Zhigunov

10:30-11:00 Coffee Break

11:00-12:30 **Technical Session 10.** ***Silviculture and biodiversity conservation.***
Moderator: Sylvie Gourlet-Fleury (France)

- "Impact of selective logging on mating system and gene flow of a tropical rain forest species." Mathieu Lourmas & Marie-Hélène Chevallier (*Lead Paper*)
- "On the genetic diversity of nursery stock as influenced by culling practices: the case of *Pinus cembra* L." Raphael Th. Klumpp
- "Studies on the endangered pondberry (*Lindera melissifolia* [Walt] Blume)." Margaret Devall, Nathan Schiff, Tracy Hawkins, Kristina Connor, Craig Echt, Emile Gardiner, Paul Hamel, Ted Leininger & Dan Wilson.
- "Plantation technology and field performance of selected tree species of multiple end uses indigenous to Indian Peninsula". KKN Nair, C Mohanan & George Mathew

12:30-14:00 Lunch

14:00-15:30 **Closing Session:** Summing up and discussion of future directions.
Moderators: John Parrotta & Henri-Felix Maître

Introduction and Meeting Report

The present volume of the IUFRO World Series contains extended abstracts of the nearly 60 papers presented during the technical sessions of the IUFRO All-Division 1 (Silviculture) Conference held at the Hotel Mercure-La Grande Motte, in Montpellier, France from June 14th-18th June 2004. This conference, entitled "Meeting the Challenge: Silvicultural Research in a Changing World", was convened to explore the changing role and expectations of silviculture to meet new challenges and societal needs around the world. Through their presentations of current research and subsequent discussions, conference participants considered how silvicultural research findings and new research initiatives can be best applied to solve emerging forest management issues.

The event was jointly sponsored by our hosts in Montpellier, CIRAD-Forêt and the Institut National de la Recherche Agronomique (INRA), and the USDA Forest Service. Conference participants included over 70 forest scientists from 23 countries in the Americas, Europe, Africa, Asia and Australia, representing a significant proportion of Division 1's Research Groups and Working Parties. A superb in-conference field trip, organized by our hosts in Montpellier, introduced participants to the rich history, culture, cuisine, and natural beauty of the Camargue region.

The conference was opened by Jacques Valeix (Director, CIRAD-Forêt) who welcomed participant on behalf of the local organizers and hosts, and IUFRO Vice-President (Science) Eric Teissier du Cros, who provided an overview of IUFRO, its activities and programs. In his opening talk Division 8 coordinator Alain Franc challenged participants to develop more effective theoretical and practical models to link silvicultural and ecological research as an approach to multidisciplinary issues related to biodiversity conservation, multifunctional forestry and sustainable forest management. Mark Hunt, on behalf of the 2005 IUFRO Congress Organizing Committee, followed with a special presentation on the IUFRO World Congress to be held in Brsibane, Australia.

Technical sessions included presentations and discussion of papers on a broad range of topics related to landscape-level forest management, tropical forest management, management for non-timber values and forest health, social forestry and traditional forest management, uneven-aged management for multiple uses, quantifying and modeling the effects of silvicultural treatments, plantation management, forest restoration, and silvicultural approaches to biodiversity conservation.

Technical Session 1 - "Landscape-level management" - was moderated by Björn Hånell (Sweden/SLU) and included three papers.

Grassi et al. examined the use of a traditional selection cutting system to achieve "close-to-nature", uneven-aged coniferous stands in Italy's eastern Alps, reporting that the "Cadarino" system tested resulted in desired irregular structures even at small scales, though at the cost of frequent, moderate cuttings. **Mendoza et al.** discussed the use of a landscape ecology approach to development of policies and silvicultural management practices for a mixed pine forest in western Mexico, where local residents and landholders support continued timber harvesting yet see a need for the modification of the current evenaged management system designed solely for timber production to a more refined set of practices designed to transform future forest structure and composition to a more natural state with a greater diversity of stand structures and lower degree of fragmentation while continuing to be managed for timber production. Finally, **Roman-Jiménez et al.** presented a multiproduct model approach to forest watershed management in Veracruz, Mexico; this case study highlighted the importance of public recognition of the non-timber products and environmental and social services provided by forests in the region, with particular attention to water quality.

Technical Session 2 - "Management for non-timber values and forest health", moderated by Paul Vantomme (Belgium/FAO), included 5 presentations.

Vantomme's opening paper discussed the large and globally increasing opportunities and societal demands for managing forests for non-timber values and for improving overall forest ecosystem health. He argued that despite the growing public recognition of the importance of non-timber forest values, forest management, legislation, and particularly silviculture continue to focus mainly on timber production. The paper by **Holgén & Bostedt** discussed issues related to valuation of forest recreation and biodiversity conservation in southern Sweden, where timber profitability of oak and beech are much lower then for spruce. They argued that methodologies to assess monetary values of the non-timber products and benefits of (mixed) broadleaved forests (assuming they have a higher biodiversity and landscape recreational value then pure spruce stands) need much to be improved, and that reliable measures of the Willingness to Pay (WTP) by the society needs further, more extensive, testing, and the need for research to evaluate the extent to which recreation forests can or should be managed for timber production, if at all, and on the associated silvicultural methods and systems are most cost-efficient for the society. **Waring & O'Hara** discussed the evolution of silvicultural strategies in forest ecosystems affected by exotic pests in the USA, from a primarily genetics focus towards a broader scope of understanding of both host and pest ecology within an integrated pest management approach.Research on Oak decline in Southern Missouri (USA), discussed by **Moser et al.**, shows that species mix and density influence forest mortality and growth rates. The authors pointed out that over-mature (mixed broadleaved) stands may have high biodiversity and recreational value, but are also prune to higher forest health problems. A paper by **Podshivaev** (not presented) discussed research related to the situation in the Leningrad region of Russia where decreasing mature coniferous (mainly spruce) stands and increasing areas of fresh clearcuts, burns and as well as young, mature and overmature deciduous (aspen) stands have resulted in higher biodiversity levels, including higher mammalian herbivore populations (mainly elk, beaver) but which are also having serious negative impacts on these forests.

Discussions during this session highlighted the fact that natural forests provide a large number of NTFPs and which are important to sustain the livelihoods of forest dependent people, such as for example demonstrated for the Central African region (**Tchatat & Ndoye**). However, despite their (local) importance and high frequency of NTFP species in the forest, these species are not covered by forest management plans and forest products legislation, which still focus mainly on the timber component. Opportunities for managing forests for non-timber products and services are manifold and already endorsed by many (inter-)national Conventions and related SFM initiatives. In addition, among the public at large, but particularly within environmental and donor agencies, there are high expectations for the possibility that the commercial use of NTFPs and forest services can contribute both to forest biodiversity conservation and income generation. However there is still a serious lack of reliable quantitative information, assessment methodologies and technical knowledge to manage forests for these resources. Key research challenges for silviculturalists raised during this session included: how to integrate non-timber products and values (higher biodiversity and recreational demands) into current timber stand management in ways that is technically feasible and economically cost-effective; development of reliable methodologies to assess the non-timber monetary values and society's willingness to pay for these or to forsake (part of) the timber revenue; and the impact of (changing) species composition of the stand on forest health, wildlife stocking and strategies for integrated pest management.

Technical Session 3 - "Tropical forest management", moderated by Henri-Felix Maître (France/CIRAD-Forêt), included 5 presentations highlighting a number of trends and challenges in tropical silviculture.

Selective logging is not able to create openings in the canopy wide enough to assure the regeneration of many major commercial species, as discussed by **Snook** for mahogany in Quintana Roo (Mexico), and by **Forni** for light-demanding species in Cameroon. Without the help of an intensive silviculture

that creates large forest gaps, these species seem to be fated to a progressive decline. An alternative solution involving establishment of artificial plantings of indigenous species at sufficient densities in open forest areas (**Nair** – Session 10) is not always possible and may be questionable from the point of view of biodiversity conservation. Predictive models or these extremely complex ecosystems often show a long-term decline in important commercial species in selectively logged forests, where their long-term survival depends on the presence of large reproductive individuals and on the recruitment rate of young trees (**Gourlet-Fleury et al.**). However, **Lourmas & Chevallier** reported (in Session 10) that selective logging has a low impact in the genetic diversity of sapelli (*Entandrophragma cylindricum*: Meliaceae). It is therefore very difficult to make general predictions on logging impacts, and therefore research on a case-by-case basis is needed, optimally involving multidisciplinary teams and programmes. An innovative research approach is suggested and offered in Brazilian Amazon to overcome this kind of challenge (**Sato et al**.). To improve tropical silviculture and natural forest management, foresters and researchers must consider both the relationship of these practices to local traditional management (as discussed by **Hares**, **de Zoysa** , and **Laumonier *et al***. in Session 4) and the landscape management considerations (**Mendoza et al**. – session 1), which may include phytosociological studies (**Ganglo**).

There has been a renewed interest in the role of forest plantations and their significant impacts on the environment, social life, productivity, industry and the economy. The emerging trend in plantation forestry is towards short-term optimisation of returns on investment made on fewer and smaller areas of land. More intensive cultural and management practices include agroforestry systems consisting of trees in combination with other crops that generate earlier cash flow are progressively supplanting traditional extensively managed long rotation plantation systems (**Mountanda et al.** – Session 8). Such intensification requires superior quality planting stock and adapted silviculture methods. Depending on the species, special attention must therefore be given to proper provenance, progeny or clone selection in order to reach the highest yield and quality in the shortest time frame (**Monteuuis et al.** – Session 9).

Technical Session 4 - "Social forestry and traditional management", moderated by Laura Snook (Indonesia/CIFOR), included 4 presentations highlighting several issues.

In tropical countries from Indonesia and Thailand to Mexico, governments have become progressively more aware of the importance of integrating traditional villagers into decision making and management of local forests, to meet their own and the nations' needs for timber and nontimber products and conserve forest environmental services while reducing the potential for conflict between villagers and government forest management agencies. In some areas, international donors, NGO's and scholars have played an important role in this process, by introducing participatory research processes to help local communities articulate their needs, and interact more effectively with local governments. While respect for the importance and value of traditional systems of management is increasing, it is also clear that these systems need to be complemented by technical knowledge and support from government agencies and researchers so that local villagers and local forests can better meet the pressures of increasing demands and threats from inside and outside the system. However, translating technical knowledge of silvicultural management practices to sustain or enhance productivity into implementation of practices by forest managers, from traditional villagers to commercial timber producers, is a challenge. Discussions highlighted the enormous disparity in the level of silvicultural practice, and the opportunities to apply silviculture, between tropical and temperate settings. All the studies in this session were carried out in tropical settings where institutional issues, governance, and differences in availability of and approaches to knowledge create a framework within which the application of silviculture can be much more complicated than the technical aspects.

Walters et al. discussed factors favoring or impeding adoption of silvicultural practice by users in the Philippines, Amazonia, and Mexico. These include (a) learning by observation and imitation of motivated and successful individuals, and the importance of incentives including protection, tenure

and government programs; (b) constraints related to obtaining good planting material, lack of knowledge of management, poor technical support and lack of financial resources for both commercial logging firms and small scale farmers; and (c) support of dedicated foresters, secure tenure and interest in long term, government regulations/guidelines, external research support, in relation to silvicultural practices to regenerate mahogany in community forests Quintana Roo.

Hares utilized surveys in villages of several ethnic groups in a study of the impacts of the logging ban in northern Thailand and support to community-based forest management. Three categories of land use were identified: conservation forest (no logging, sometimes NTFP gathering), community forest (source of products), and agricultural areas; combination areas in this region are gazetted and defined by community. While villagers feel forest conservation is important to their livelihoods, national park gazetting was perceived by villagers as threat to livelihoods. Under village-based rules, permissions to cut trees based on need, and hunting now widely banned; reforestation and fire management are controlled from outside the villages. Government extension agents have taught villagers how to more effectively manage fires and provide seedlings for reforestation. It is likely that management will require mixture of traditional and introduced systems to meet needs of population.

Laumonier et al. discussed the strong traditional management systems in the isolated islands of Tanimbar in Indonesia, and the history of local resistance to exploitation of natural resources by outsiders. Current projects work with the new local government and population to develop land use plans based on participatory research, capacity building, and transparency. Traditional resource management systems (i.e., for shifting agriculture and copra, NTFP's, timber harvesting and sale, marine fishing) limit exploitation, but their effectiveness it not known, nor are they adapting to new challenges like fishing by outsiders. Additional research, including further silvicultural research, to support greater capacity to adapt, and to integrate traditional systems with official resource use system are needed.

Traditional village forests in Sri Lanka, discussed by **de Zoysa**, are disappearing due to elimination of common property rights. Demand for forest products exceed productive capacity of forest resources, benefits not equitably distributed. Multiple products are obtained through complex patterns of access and use. Villagers seldom integrated into government forest planning. The paper highlights the need to develop processes for decisionmaking and equitable allocation as well as stimulating tree planting to meet needs

Technical Session 5 - "Uneven-aged management for multiple uses", moderated by Kevin O'Hara (USA/UC-Berkeley), featured a series of closely related presentations on uneven-aged silviculture. These presentations display the ongoing evolution in uneven-aged silviculture from rigid systems to flexible systems that attempt to emulate natural disturbance regimes. These new systems are assumed to more closely represent natural structures and to enhance diversity and stand resistance to disturbance.

Püttmann presented a rationale for a new, more flexible approach to silvicultural management that recognizes the changing societal demands for forest goods and services and the better utilizes insights from modern ecological research regarding complexity, heterogeneity and stochasticity of forest ecosystems. In the interior northwest of North America, **Graham & Jain** described a "free-selection" system that maintains flexibility to favor healthy, fire resistant trees. **Burgess et al.** showed how basal area influences development of understory eastern white pine in Canada. Also in eastern Canada, **Bescond et al.** showed how partial cutting can be used to favor irregular stand structures and **Doyon et al.** examined the effects of partial cutting on bird species. Finally, in an even-aged application in western Canada, **Hawkins & Steele** showed how spruce-birch mixtures were more productive and healthier than pure spruce stands.

Technical Session 6 - "Forest structure and biodiversity", moderated by John Stanturf (USA/Forest Service), included 4 presentations that focused on forest management and its effects on biodiversity at the stand level.

Schmiedinger et al. reported on studies investigating the long-term effects of forest management practices on understory vegetation biodiversity in Canadian and European conifer forests and the development of standardized survey and analysis methods to detect areas with high biodiversity. **Madsen et al.** presented a broad, global, overview of challenges for silvicultural research on beech, highlighting the benefits of close collaboration between researchers, managers, and scientists in other disciplines in identifying and carrying our priority research. The presentation by **Liu et al.** reported results of an analysis of topographic influences on the distribution of old-growth, naturally regenerated and planted forests in the sub-alpine forest zone of Western Sichuan in China. Their analyses were useful for determining the potential and limitations of natural regeneration of these forests, and the most appropriate altitudinal ranges and aspects for artificial regeneration as a complementary measure where natural regeneration is inadequate. **Montes and Cañellas** presented a study of structural changes in managed even-aged Scots pine stands in the Central mountain range of Spain through an analysis of a chronosquence of stands up to 120 years of age. Their results indicates that while natural regeneration and stand structure exhibits great variability between stands of similar ages, the development of these stand leads to a normalization of stand structure at landscape level.

Technical Session 7 - "Quantifying silviculture", moderated by Daniel Auclair (France/INRA), included 9 presentations.

The paper by **Loustau et al.** utilized a modeling approach to examine the regional impacts of climate change on wood production and carbon storage in northern northern broadleaved forests (*Fagus* and *Quercus*) and atlantic southern pine forest (*Pinus pinaster* Ait.) in France, and discussed the potential of forest management to adapt forests to climate scenarios. **O'Hara**, in his review of the state-or-knowledge on productivity relationships in managed forest stands, reexamined several classical relationships in silviculture, in particular concepts related to the efficiency of converting growing space to stem volume increment of trees and stands, the temporal dynamics of tree and stand respiration, and the relative productivity of forest stands with different structures. His analysis focused on the influence of variables that affect the amount and distribution of volume or biomass during stand development, specifically initial density and fertilization as well as subsequent control of density, species composition, stand structure, and age structure. **Long and Roberts** discussed a number of examples from the southeastern and western United States to illustrate how systematic development and careful evaluation of silvicultural alternatives can be an effective way to identify potentially conflicting goals and objectives, and to ultimately refine and refocus management objectives. The paper by

Köchli and Brang reported their use of a forest growth simulator and a GIS to assess the effects of three management strategies on selected goods and services in a peri-urban catchment in Switzerland over a 50-year period. **Zenner** examined the question of spatial scale in assessing structural complexity in old-growth forest stands, which concluded that understanding structural pathways and determining characteristic patterns of old-growth structure in natural stands are prerequisites for maintaining biological diversity, sustaining forest productivity, and enhancing and restoring old-growth ecosystems within managed ecosystems. The presentation by **Groot and Saucier** discussed progress in their on-going development of a stand dynamics model based on light capture by individuals trees as a means to provide robust, long-term forecasts of stand development in response to a wide variety of silvicultural treatments, as well as to natural disturbances. **Amateis** presented a summary of recent research in the southeastern United States aimed at development of response models appropriate for multiple treatments of thinning and fertilization of loblolly pine plantations applied at any point during a stand rotation.

Nolet et al. discussed their research in Quebec on the definition of quantifiable forest stand structural targets (and options), based on the social, economic, and ecological objectives of forest management,

and their utility for development of forest management plans and specific silvicultural treatments. **Slodiak and Novak** reported the results of long-term research conducted in the Czech Republic (part of IUFRO's international European Norway spruce thinning experiment), focusing on the effect of thinning treatments on wood production, wood quality, and the influence of these plantations on soil structural development.

Technical Session 8 - "Forest restoration and conservation", moderated by Palle Madsen (Denmark/KVL), included 5 presentations focusing on key issues and innovative silvicultural practices for forest restoration in boreal, temperate and tropical regions.

Stanturf et al. set the tone of the session a synthesis paper on silvicultural approaches for restoration of degraded temperate and boreal forests, pointing out that all forestlands have been altered or influenced by human activity and that the "natural state" (i.e. without human influence) is non-existent and impossible to restore. Forest restoration includes replacing other land uses with forest (e.g. through reconstruction, reclamation, replacement, afforestation) or rehabilitation of existing forests (e.g. through monoculture plantations) towards a more natural state with a desired species composition, stand structure and natural functions. The scientific challenge involves continued improvement and interpretation of the scattered knowledge of forest stand and ecosystem functions from a dynamic perspective – and to spread this paradigm not only among research colleagues but also among land managers and the general public. Case studies presented during the session illustrated and discussed very different aspects of forest restoration, such as afforestation with bottomland hardwoods on farmland in the lower Mississippi alluvial valley in the USA (**Stanturf et al**.), reclamation in mining quarries in the taiga zone of Russia's northwest region (**Abakumov et al**.), application of silvicultural practices for conservation of dune landscapes in Russia (**Doroshin & Zhigunov**), and new approaches to improve sustainability in forest management, with particular reference to reforestation and agroforestry development in Congo-Brazzaville (**Mountanda et al**.).

Technical Session 9 - "Plantation management", moderated by Chris Hawkins (Canada/UNBC), included discussion of 6 papers demonstrating that 'complex' systems have the potential to be more productive than simple systems. Overall the papers in this session highlighted the need for continued research and the importance of getting research incorporated into policy.

The session opened with an excellent overview and specific examples of agroforestry in Europe (**Dupraz et al.**), highlighting the role of current policies and laws in hindering adoption of agroforestry systems there. The authors pointed out that while grant or subsidy schemes exist for agriculture and forestry, they are lacking for agroforestry, and in some jurisdictions, agroforestry is illegal due to tax legislation. Agroforestry systems can exceed the productivity of agriculture or forest systems alone by 30 percent. Therefore there is a need to get the politicians to create laws that promote its practice. The paper by **Forester et al.** demonstrated that mixed plantations of *Eucalyptus globulus* and *Acacia mearnsii* in Australia produced more biomass than plantations of *E. globulus* or *A. mearnsii* growing alone. A paper by **Bouillet et al.**, presented by L. St. Andre, described a protocol for mixed species plantation experiments. They provided many cautions for doing research on complex stands. Often the results of mixed species' studies are better on poor sites, particularly when one of the species is a nitrogen fixer. The authors stress that soil properties must be monitored to understand the observed species' productivities.

The remaining papers looked at issues of plantation establishment and productivity in boreal, sub-tropical and tropical regions of the world. **Hånell** presented a convincing argument that productivity could be significantly increased on about 190,000 ha of peat soils in Swedish forests if they were fertilized with wood ash and pet ash at a rate of about 5 t per ha. This level of fertilization would require about 3 to 4 years of bio-ash production. The paper by **Monteuuis et al.** presented a case for establishing clonal teak plantations given the increased demand on natural teak resources, the *in situ* preservation of existing plantations for biodiversity, limitations of seed derived planting stock, and

pressure to intensify teak productivity. Clonal cultures have demonstrated good growth in plantations at 10 years (28 to 30 m and 40 cm in diameter). These plantations can be managed as monocultures or in an agroforestry system. **Hunt et al.** reported on the impact of five mechanical site preparation treatments on three year survival and growth of six pine stocktypes in southeastern Queensland, Australia. Survival was not influenced by site preparation but it was significantly affected by stocktype (73 to 98%). Site preparation significantly affected height (4.2 to 5.1 m) and diameter (7.2 to 9.1 cm) growth but the impact of stocktype was even greater for height (4.0 to 5.8 m) and diameter (7.0 to 9.8 cm).

Technical Session 10 - "Silviculture and biodiversity conservation", moderated by Sylvie Gourlet-Fleury (France/CIRAD-Forêt), featured 5 speakers presenting papers dealing with the long-term preservation of forests and tree populations across a wide range of ecological conditions in Europe, central Africa, southern Asia and North America.

Two papers focused on the impact of management practices on the genetic diversity of tree populations. **Lourmas et al.** examined the question of whether selective logging for timber in the tropical forests of Cameroon resulted in an increase of selfing and a decrease in gene flows in the timber species *Entandrophragma cylindricum* (Meliaceae), while **Klumpp** investigated how grading operations in nurseries, aiming at selecting the strongest plants for afforestation could result in genetic erosion in the species *Pinus cembra* (Pinaceae). In both cases, experiments lead by the authors, using microsatellites and isozymes technologies brought negative answers, but it is recognised that in this field of research, international results are contradictory, depending on the species studied, the experimental conditions and the efficiency of the markers used.

The three other papers presented in the session focused on the set of conditions needed to preserve, artificially regenerate and/or enhance the productivity of tree species. **Devall et al.** reported on various *in* and *ex-situ* observations and studies undertaken in the southern Mississipi Delta to determine the biological and ecological factors most influencing survival and development of *Lindera melissifolia* (Lauraceae), a species endangered by habitat destruction and alteration, with the aim is to help develop management plans for the species at the regional scale. **Nair et al.** discussed habitat destruction and over-exploitation, the main causes of the depletion of various man-used species populations in the monsoon forests of India, and reported on their *in-situ* and *ex-situ* studies used to assess the best technical ways of artificially regenerating five widely used species: *Calophyllum polyanthum* (Clusiaceae), *Dysoxylum malabaricum* (Meliaceae), *Garcinia gummi-gutta* (Clusiaceae), *Melia dubia* (Meliaceae) and *Vateria indica* (Dipterocarpaceae). Their work has resulted in technical prescriptions and user-friendly guides on the collection, storage and processing of seeds, as well as for nursery and plantation practices. Finally **Shutov & Zhigunov** reported on field trials conducted in the North West and Central European part of Russia, in order to determine the best set of conditions for the growth and yield of *Picea abies* and *Pinus sylvestris* (Pinaceae); their results demonstrate that plantations can be highly productive (more than natural ancient forests) and productive enough to supply the Russian forest market. The development of such plantations could help preserve the highly ecological value of the boreal forests.