Summary of presentations and discussions by session

Opening session

The meeting was opened by José Antonio Prado, Director Forest Management Division, Forestry Department, FAO.

Opening Remarks (Jan Heino, ADG Forestry Department, FAO)
Forest degradation is a serious problem. The total area of degraded forests and forest lands in tropical countries has been estimated to be as high as 800 million hectares, or 20 % of the global forest area. Severe forest degradation can have serious negative impacts on the livelihoods of the rural poor, on biological diversity and on soil erosion and it can contribute to climate change by reducing the ability of forests to sequester carbon.

For this reason a reduction in forest degradation forms part of the first of the four global objectives on forests as agreed by the members of the United Nations Forum on Forests; it is linked to the 2010 target on Biodiversity; and it is given prominence in the discussions on climate change mitigation and adaptation.

Estimates of the rate or level of forest degradation are few and vary widely. Only a handful of countries are able to report on the area of degraded forest or the level of forest degradation – and they use different definitions and assessment methodologies to do so. Given the severity of the problem and this lack of comparable information, the CPF initiative on Forest Degradation aims to strengthen the capacities of countries and organizations to assess, monitor and report on forest degradation. The ultimate aim is to provide better information on the scale and causes of forest degradation in order to garner support at all levels to effectively address this problem.

Background (Mette Wilkie, FAO)
Countries need to know where forest degradation is taking place, what causes it and how serious the impacts are in order to prioritize the allocation of resources to the prevention of degradation and to the restoration and rehabilitation of degraded forests. For countries to report on forest degradation and demonstrate efforts to tackle the problem and meet global objectives and targets, common definitions and agreed methodologies for the assessment and monitoring of forest degradation are needed.

The CPF initiative hopes in particular to:

- Highlight the different aspects of forest degradation;
- Review assessment methodologies;
- Facilitate access to new tools, especially in developing countries;
- With the ultimate aim of leading to action to reduce current rates of forest degradation.

Process of the Study (Victoria Heymell, FAO)
This work builds on some existing processes that are already established. These include:

- Nine eco-regional processes on criteria and indicators for SFM that have been operational since 1992;
- Three past expert meetings on harmonizing forest related definitions including one in 2002 that made a recommendation for a core definition of forest degradation;
- Experiences in other sectors, both within FAO and through the CPF.

The key components of the study have included:

a. Questionnaires to National Forest Correspondents and a survey of existing country practices to establish what is being measured;
b. The preparation of an annotated bibliography and an analytical study on definitions which provides a framework for the process;
c. A series of case studies describing proven or promising methodologies and tools for assessing different aspects of forest degradation.

Other activities have included:

- An ongoing in-depth review of existing and promising new methodologies and tools to generate scientifically sound estimates of historical rates of levels of forest degradation in developing countries;
- Outreach activities, including presentations at COFO in March and at UNFCCC-SBSTA in June; development of a brochure in English, French and Spanish and a webpage dedicated to forest degradation on the CPF site.

Annotated Bibliography (Evisa Abolina, Intern UNFF)

During the process of the Forest Degradation study, a long list of studies had been collected through internet searches, as well as others that were provided by Guide Lund. These were collated into an annotated bibliography. The main goals in preparing the annotated bibliography were to:

- List studies on Forest Degradation under the themes of Sustainable Forest Management;
- Indicate which forest degradation assessment methodologies and indicators were used in each study;
- Identify any definitions used in assessing forest degradation in each of the studies;
- Evaluate studies to determine the most promising ones for future work;
- Determine areas that are poorly covered with few studies.

The most poorly represented elements of SFM to have been assessed were the Protective and Productive functions of forests. This might be explained by the indicators used under each element and its specifics. Regarding protective functions of forests from the point of view of forest degradation, it may be that forest degradation studies rarely look at forest areas designated for protective purposes. Regarding productive functions of forests, these are seen primarily from a commercial or market perspective. It would be useful to incorporate ecosystem services here.

Many of the studies did incorporate several elements of SFM and associated indicators. Several studies suggested that remote-sensing imagery (using indicators of biomass, forest canopy cover and density and vegetation cover) supported by ground observations (including indicators such as species composition, tree height, volume, quality of timber) are the most reliable way to estimate locations and rates of deforestation and forest degradation.

Defining Forest Degradation

Towards Defining Forest Degradation: Comparative Analysis of Existing Definitions (Markku Simula, FAO Consultant)

The paper reviews the existing international and national definitions of forest degradation, analyses their elements and parameters and identifies their commonalities and differences. The generic definition of forest degradation (*the reduction of the capacity of a forest to provide goods and services*) provides a common framework for all the international definitions however it may be difficult to operationalise. The most comprehensive international definitions have been developed by ITTO and CBD, covering change in forest structure and dynamics, forest functions, human induced causes and a reference state.

Few countries have developed a national definition of forest degradation. Typical indicators in these definitions are stocking level, productivity, biomass density and species composition. The analysis indicates that the elements of sustainable forest management may offer a suitable framework for assessing forest degradation as well as its causes and impacts.

In general, the review of existing definitions shows that many definitions are either very general or their focus is on reduction of productivity, biomass or biodiversity. There may then be a need to combine the holistic approach and specific-purpose definitions. A particular issue is the definition of thresholds between non-degraded, degraded and non-forest. For degradation definitions the temporal scale is crucial, with the need for a long term approach, while the purpose of the definition is linked with the level of assessment.

The various international definitions currently in use, leave several issues open which need to be addressed, and any operational definitions of forest degradation for specific purposes should provide: (i) identification of forest goods and services; (ii) a spatial context of assessment; (iii) a reference point; (iv) coverage of both process and state (degradation/degraded forest); (v) relevant threshold values; (vi) specification of reasons for degradation (human induced/natural) (when required by the use of definition); (vii) an agreed set of variables; and (viii) indicators to measure the change of a forest. Additional elements could be added or singled out, depending on the particular interests related to the use of definition.

It was suggested that possible core elements could be measured by 3 proxies:
- Reduction in biomass for the growing stock or the carbon stored which can be associated with the reduction of canopy cover and or number of trees per unit area;
- Reduction in the loss of biological diversity which can be associated with the occurrence of species (dominant and non-dominant) and habitats;
- Reduction in soil as indicated by soil cover, depth and fertility.

Key points raised in the discussion included the following:

- There was overall agreement that the generic definition is sufficiently broad;
- The time and scale may depend on the objectives of management;
- Degradation could be considered as both a state and a process;
- "One person's degraded forest is another person's livelihood". [There needs to be a definition and framework that can function pragmatically to ensure that the 800 million ha of degraded forests and forest lands can be incorporated into REDD. A process may be needed to measure and track degradation that meets both the aims of UNFCCC and the aims of the CBD.] Degradation cannot be measured only in terms of Carbon stocks,

as proposed by UNFCCC and SBSTA, therefore a proxy is needed at global and landscape levels that can describe the decline in capacity to provide goods and services;
- Trade-offs exist in all management decisions and tools to deal with trade-offs exist (multi-purpose forestry). Levels of tolerance, safeguards and thresholds can be used when addressing trade offs;
- If forest degradation is related to the specific objective or parameter, it may be possible to say that a forest is degraded in terms of carbon, or wood species (loss of this amount). In regard to a specific duration of degradation, it may be related to how long it might take to restore it;
- Reference data could be considered as the recovery function according to the management objective that is being set.

Potential Indicators Related to Degradation by SFM Element

SFM element	Potential indicators (examples)
Extent of forest resources	Forest cover, crown cover, growing stock, stand density, degree of fragmentation, trees outside forests (TOF).
Biological diversity	Ecosystem diversity, species composition/diversity, genetic diversity, degree of fragmentation, connectivity, naturalness, crown cover, forest structure.
Forest health and vitality	Area affected by pests, diseases, fire, storm damage, area subject to air pollution damage, area with diminished biological components.
Productive functions of forest resources	Stocking level, Mean Annual Increment (MAI), age structure, NTFP yield, wood quality.
Protective functions of forest resources	Soil erosion, water quality and runoff, managed watershed area, flood protection areas, protective plantation area
Socio-economic functions of forests	Value of forest products, recreation and tourism; cultural and community values; employment; income; area available for recreation, area available to indigenous people/social services.
Contribution to the carbon cycle/climate change by forests	Carbon stock in pools (above/below ground biomass, deadwood, litter, soil), stocking density, removals, TOF

Extent of Forest Resources

<u>Measuring and Monitoring Forest Degradation through National Forest Assessments (Mohamed Saket, FAO)</u>

The presentation demonstrated how the NFMA programme addresses key criteria of forest degradation linked to the thematic elements of sustainable forest management (SFM) in its methodology. Each SFM thematic element is examined in the context of the NFMA country experience and how it has facilitated delivery of data on status and extent of forest degradation. Country-level proxies and parameters are provided for each theme in order to demonstrate how the NFMA approach can enable countries to assess and monitor degradation of forest resources. In this work, remote sensing together with field level measurements and household interviews are used.

Analysis of the Normalized Differential Vegetation Index (NDVI) for the detection of Degradation of Forest Coverage in Mexico2007 – 2008 (Carmen Lourdes Meneses Tovar, Mexico)
The study described relationships between forest usage and the Normalized Differential Vegetation Index (NDVI) estimated from satellite imagery. Some of the indicators of forest usage that were related to the euclidean space of the satellite images are: type of vegetation, number of live trees, number of species, crown diameter, total height, trunk diameter, and estimates of wood volume and biomass. Other supporting variables used included precipitation, temperature, number of days of rain per year, evaporation, a digital elevation model, ecological regions of the country, as well as variables related to anthropogenic effects.

Forest Degradation in Nepal: review of data and methods (Resham Bahadur Dangi, Nepal)
In Nepal various different methods have been use to assess forest resources since the 1960s. The presentation looked at the various drivers of degradation, their level of significance and the key degradation element linked to each of those drivers. Detectability of each of those key degradation elements was rated from low to high for 3 methods of detection that included field surveys, aerial photos and satellite image analysis.

An example could be fuel wood removal as a driver of degradation. The key degradation element measured is biomass and understorey. Detectability was considered as high, medium to low for each of: field surveys, aerial photos and satellite images respectively.

Overall the work concluded that the use of satellite imagery supported by ground based inventory could provide a suitable approach for assessing forest degradation as it would combine the strengths of both methods.

Extrait de l'inventaire forestier des forêts classées autour de Bamako (Nianti Ousmane Tangara, Mali)
The case study from Mali describes a dramatic degradation process as documented by forest inventories carried out 8 years apart. The gazetted forests studied exist close to Bamako where they are used for the production of wood products. The study used forest inventory to describe the forest structure and volume of timber. Hence changes over time and forest degradation could be quantified. The study focuses particularly on wood production and provides an example of a traditional approach at the local level.

Biological Diversity

Assessing forest degradation due to fragmentation – developing biodiversity-relevant measures (Val Kapos, UNEP-WCMC)
In assessing forest degradation due to fragmentation, biodiversity-relevant measures were developed. The focus is about understanding differences in composition rather than assessing species richness. Another possibility is to investigate processes and factors known to cause biological diversity to deviate from that of undisturbed forest. These include area loss, which is known to affect the abilities of some species to survive – especially animals with large home ranges and rare species (some trees) that lose options for reproduction as areas decline. Changes in forest structure as discussed elsewhere here have implications not only for carbon, but also for the suitability of the forest as a habitat for some species. Changes in composition can themselves lead to other changes as the occurrence of predators and the availability of food species changes. Finally, it is known from many studies that forest fragmentation has implications for biological diversity that are greater than those simply relating to area loss.

Occupation des sols des forêts classes du Niger et l'analyse des dynamiques du changement (Ibro Adamou, Niger)

The case study from Niger made a comparative analysis of the situation of classified forests between 1975 and 1999. It described the forests in terms of degradation, no change or improvement. It was noted that the majority of forests were affected by advancing agricultural land use. Local communities noted changes in the structure and composition of the forests, the disappearance of some species and the general reduction in biological diversity. It is an example of what can be done in Sahelian conditions and an example of what can be done at the national level. It looks at changes in vegetation types in a sample of 20 gazetted forests covering some 230,000 hectares spread over the country from Tillabery to Diffa. Over a period of 25 years it was noted that 22.7% was degraded, 68.5% had not changed and 8.8% had improved.

Defaunation and forest degradation: how to measure the impacts of hunting? Congo Basin (Robert Nasi, CIFOR)

The work reviewed methods used for assessing defaunation, as a forest degradation component, linked to logging and logging concessions with an emphasis on mammals in the Central African Rainforests. A discussion on the usefulness and weaknesses of various methods was provided. Logging is recognized as having different types of impacts on wildlife that can be classified as direct (usually visible shortly after logging) and indirect (concerning the longer term). Direct impacts can be presence of heavy machinery and logging teams, disturbance and modification of the structure and composition of the habitat. Logging increases access to remote forests by opening roads into previously inaccessible areas. Given the limitations of the different methods discussed, a well designed survey protocol might imply the use of a combination of approaches with both measures of mammal abundance and measures of hunting and trading activities within the logging concession. Priority for the coming years should be to develop more standardized protocols that would allow comparisons among sites.

Impact of developmental projects in the humid evergreen broad-leaved forest: A case of Wasabi Pilot Project at Lamperi, Western Bhutan (Pema Wangda, Bhutan)

The case study from Bhutan describes what happened following a failed development project (a pilot Wasabi plantation project) on humid evergreen broadleaved forest. It suggests an example where following the initial removal of trees there were secondary effects of subsequent increased grazing. It appears questionable whether the forest will return to its original state, or whether the degradation has led to a permanent change in the forest composition (and structure). The measurements made were undertaken 3 years after the disturbance.

Productive Functions of Forests

Etude de cas sur la dégradation des forêts de la République Démocratique du Congo (Christophe Musampa, Democratic Republic of Congo presented by François Wencelius)

An example of what can be done at the national level, the case study looked at a comparison of changes in areas of land use classes, by comparing satellite imagery. The land use classes used were: primary forest, secondary forest, swamp forest, industrial agricultural plantations, agriculture/savannah mosaic, villages and water.

The methodology used (remote sensing + GIS):

- is operational to quantify changes in land use classes;
- is appropriate for the evaluation of DRC's large areas of forest resources;
- makes it possible to identify the main causes of deforestation and degradation.

However, most of the elements of the methodology date back to the 1990s, and considerable improvements could be achieved through updated hardware and software, and further ground truthing.

An Operational Approach to Forest Degradation - Forest Stock Measurement Chile (Carlos Bahamondez, Chile)
An operational approach to Chile's forest degradation from the productive perspective is tested by using relative density. The case study from Chile showed that a stocking chart provided a useful tool for helping to recognise degraded forest. As a tool used together with field observations there was improved identification of degraded forest. Data for building the stocking chart is provided by the National Forest Inventory data bases for one of the most common forest types in Chile, the Roble-Rauli-Coihue forest type *(Nothofagus oblique-Nothofagus alpine-Nothofagus dombeyii*). The resulting stocking chart constitutes a powerful tool for understanding and identifying degraded forest from the stock point of view. It also identified the needs for suitable data which must be provided under periodical bases, like large scale permanent forest inventories. The use of a stocking chart provides a feasible way to identify objectively the condition of forest degradation. It has become a potentially important tool for monitoring sustainable forest management practices or policies.

Measuring ecological impacts from logging in natural forests of the Eastern Amazônia as a tool to assess forest degradation (Marco Lentini, Brazil)Brazil
In Brazil reduced impact logging (RIL) was compared with conventional logging (CL) from an economic perspective. The work presents a simple method to assess forest degradation and ecological impacts caused by logging. Results showed a net income from RIL 19% higher than CL. Remote sensing techniques are able to identify coarse scale problems with logging however simple field methods are also needed to evaluate quality of forest management and use of resources.

Contribution to the Carbon Cycle

Monitoring and Reporting Forest Degradation under UNFCCC (Danilo Mollicone, FAO)
In the interests of REDD the objective is in measuring the reduction in carbon stocks. Under UNFCCC there is no definition of forest and no definition of forest degradation, with a land based reporting approach. Carbon stock changes in the five pools, above and below ground biomass, dead wood and litter (dead organic matter), soil (mineral organic); the change in carbon being the change in carbon in any one of these pools added together. The stock difference can be the change in carbon in any one of these pools between two times.

Integrating Forest Transects and Remote Sensing data to Quantify Carbon Loss due to Forest Degradation: A case study of the Brazilian Amazon (Carlos Souza, Brazil presented by Danilo Mollicone)
Work in Brazil using remote sensing and rapid forest transect surveys showed the main sources of C emissions to be deforestation, selective logging, forest fires, forest fragmentation. Remote sensing detection of forest disturbances can range from highly detectable to almost undetectable. In this work forest degradation has been defined as a type of "land modification", which means that the original "land cover structure and composition is temporarily or permanently changed", but it is not replaced by other types of land cover. This work provided a brief review of how remote sensing has been used to detect and map forest degradation and how carbon stocks of degraded forests can be characterized using rapid forest transect surveys. Field data of forest carbon stocks can be integrated with optical remotely sensed data to regionally characterize

forest degradation. The challenges to integrating field-derived carbon estimates with remotely sensed data were also discussed.

Community Measurement of Carbon Stock Change for REDD (Eliakimu Zahabu, Tanzania)
The work presented on community measurement of carbon stock change for REDD, show that there is an interest and willingness from communities to participate in carbon trading; that communities have the capacity to undertake forest inventory and carbon inventory; that community forestry entails higher social returns than just monetary gain. One solution to forest degradation lies in sustainable forest management by local communities. While reduced degradation is to be credited and rewarded under REDD policy, it may be more important to measure and reward increases in carbon stock due to the enhanced growth, than the decreases in emissions due to reducing the degradation.

Monitoring Degradation in the scope of REDD (Thomas Baldauf, Germany)
For methodologies to observe biomass and carbon stock change in the world's forest area to be cost effective, integrated methods, utilizing terrestrial surveys and remote sensing data are widely applied. Suitable methods are available for assessing deforestation. However, for detecting degradation, which in the context of REDD applies to the partial loss of biomass, even the adaption of existing methods encounter severe constraints. The work presents a comprehensive methodology, which is intended to provide figures on both deforestation and forest degradation in the scope of REDD. As field surveys are time consuming and expensive, particularly in remote areas, they are not conducted as full tallies, but undertaken by statistical sampling approaches.

Review of work on Historical Degradation (Martin Herold, GOFC-GOLD)
Work is being undertaken to identify and promote the use of effective and cost efficient methodologies and tools to monitor forest degradation in terms of changes in forest carbon stocks and sequestration rates in "forests remaining forests" in developing countries. In this respect a group of authors are undertaking an in-depth review of existing and promising new methodologies and tools to generate scientifically sound estimates of historical rates or levels of forest degradation in developing countries. They will contribute to collating and critically reviewing case studies, articles, guidelines, manuals and other documents describing methodologies for assessing historical rates or levels of forest degradation and will compare and contrast different methodologies.

Socio-economic functions/ Community level assessments

Forest Resources Degradation Accounting in Mongolia (Hijaba Ykhanbai, Mongolia)
A case study from Mongolia looked at the economic accounting of Forest Degradation. The case study outlined the results of forest resources degradation accounting, covering a period of 30 years (1976 – 2006), and measuring the dynamics of change of forest resources in the country. Forest Degradation accounting in that case was considered as a value of the changes of extent of forest resources and its adjustments with economic development indicators of the country. Measuring the forest as a renewable resource was dependent on annual growth and closing stock, and from stock changes due to factors of degradation.

Assessment of Forest Degradation by Local Communities – The Case Study of Ghana (Dominic Blay, Ghana)
In Ghana, the need to curb continuous degradation, led to the prioritisation of sites based on the level of degradation. Indicators for assessing degradation were developed in collaboration with the local communities. Work focussed on the state of flora resources (biodiversity), the state of

streams and rivers (protective functions) and the state of fire and soil fertility (forest health). The approach relied on skills that are locally available and indicators that are based mainly on visual assessments. It is an approach that could easily be applied at the local level elsewhere. The approach could be improved using statistical analyses.

Local Level field assessment of land degradation (Sally Bunning, FAO)LADA- FAO
Land Degradation Assessment in Drylands (LADA) looks at soil properties and soil erosion, water quality and quantity, and vegetation and land use and biodiversity. They define land degradation as "The reduction in the capacity of the land to perform ecosystem functions and services that support society and development". They use a multi-scale participatory process with an integrated analysis of human and environmental indicators.

Surveillance et Suivi de la Santé des Forêts au Maroc (Taoufiq Aadel, Morocco)
The use of permanent plots to determine and follow the state of forest health was described in a case study from Morocco. A systematic network of permanent plots (8 x 8 km) was established that uses indicators that provide a simple, rapid and reliable assessment of information on forest health. The operation was conducted in collaboration with the National Forest Inventory (NFI). The permanent plots have made it possible to report on the annual state of forest health, to monitor changes over time and to anticipate any potential phytosanitary imbalance.

Reversing Forest Degradation

Global Mapping and Monitoring of Forest Degradation: The Intact Forest Landscapes Method (Lars Laestadius, WRI)
The IFL Method uses high spatial resolution satellite images to identify and map large un-degraded areas called Intact Forest Landscapes (IFL), defined as unbroken expanses of natural ecosystems in the zone of forest growth without signs of significant human activity and at least 50,000 hectares in size. The method produces an IFL map which shows the boundary between unaltered forest landscapes (where most components, including species and site diversity, dynamics and ecological functions remain intact) and altered or fragmented forests (where some level of timber extraction, species composition change and alteration of ecosystems dynamic has taken place).

The paper presents the results of a global assessment of forest degradation and several examples of regional-level monitoring. Forest degradation was measured at the global, biome and national levels based on the distribution and proportion of IFL areas while the detailed boundary between 'intact' and 'non intact' forest landscapes was employed as a baseline for monitoring of forest degradation. The IFL method is a rapid and cost-effective practical solution for assessing forest degradation and intactness at the global and regional scales.

The method allows users essentially to define or identify the areas that can be considered not degraded, and thus eliminate them from the rest of the forest land that would potentially be included in any degradation survey.

Addressing Forest Degradation in the Context of Joint Forest Management in Udaipur, India (Michael Kleine, IUFRO)
Many rehabilitation projects define forest degradation through an indirect three-tiered approach at the local level, which covers the socio-economic situation, the reduction in goods and services from forests and the status of forest degradation through visual field inspections. Rehabilitation targets include: increased ground vegetation cover (improved grass production), reduced soil

erosion (controlled grazing; check dams), and increased tree biomass, including improved fire wood production (forest protection; planting of hedgerows).

Quantifying progress towards achieving the rehabilitation targets requires monitoring of indicators (biological, structural): data on "before and after scenarios" (on project-by project basis). Rehabilitation measures lead to higher forest biomass levels, in order to achieve improved productivity. This may or may not be in line with other goals (e.g. carbon, biodiversity).

Investments into forest rehabilitation may include field work (planting; fencing; check dam construction) and changes in the management of forests through policies and regulations, local institutions, capacities (including training of forestry staff), and employment and markets. Large portions of investments are needed to bring about a social transition to SFM. Otherwise rehabilitation results (e.g. improved production; reduced emissions) are only short-lived.

Global Partnership on Forest landscape Restoration (FLR) (Stewart Maginnis, IUCN)
Forest Landscape Restoration brings people together to identify, negotiate and implement practices that restore an agreed optimal balance of the ecological, social and economic benefits of forests and trees within a broader pattern of land uses
Aims:

- Support partners in effectively restoring degraded forest landscapes
- Establish and improve relationships among different interest groups involved in forest landscape restoration
- Encourage the development and use of innovative FLR approaches and methodologies

Underlying principles:

- Multi-functional
- Situation specific
- Participation
- Scale
- Adaptive Management

FLR provides a potential remedy to degradation as currently defined, and is a useful way of framing the enhancement of carbon stocks. However flexibility is required and several learning sites indicate that countries are not bound to follow the forest transition curve.

Forest Ecosystem Resistance and Resilience and Biodiversity (Ian Thompson, CBD)
Resilience is the capacity of an ecosystem to recover after disturbance. Disturbances may move the forest to a new state or age class. The stability of a forest state is a concept related to resilience. Most primary forest ecosystems are resistant and resilient to natural disturbances**.** Resilience of a forest is a function of biodiversity at many scales: genes, species, and regional diversity among ecosystems. Biological diversity also underpins the ecological goods and services from the forest. Loss of biodiversity may alter the forest resilience and will result in reduced goods and services. Loss of resilience means uncertainty about future forest condition. Most often, degraded forests are unstable because they lack diversity and functionality. Degraded forests always provide fewer ecosystem services. Diseases and disturbances do not affect all species equally, more diversity means less loss to these factors.

Ecological principles for restoring degraded forests to improve stability and resistance:

- biologically diverse systems tend to be more productive, stable, and produce more goods and services than simple ecosystems (e.g., monotypic plantations);

- re-forest by using native species and by using natural forests as models;
- maintain landscape connectivity;
- manage to maintain genetic diversity (e.g., reduce selective harvest of 'best' trees) and plant several seed stocks;
- protect primary forests and species at the edges of their ranges;
- plan to reduce invasive species.

Conclusions

- Evidence supports the concept that biodiversity confers resilience within a forest ecosystem at many scales;
- Mechanisms include redundancy, resistance to disease, increased productivity, genetic capacity to adapt to change;
- Loss of biodiversity can result in an ecosystem condition that is difficult to change or that provides an uncertain future condition;
- Biodiversity also provides most ecosystem goods and services;
- Degraded forests may be stable, although more often they are not, but they will provide reduced goods and services.