Annex D

Montréal Process Criteria and Indicators for the

Conservation and Sustainable Management of Temperate and Boreal Forests

TECHNICAL NOTES ON IMPLEMENTATION OF THE MONTRÉAL PROCESS CRITERIA AND INDICATORS

Criteria 1-6

Second Edition

December 2007

I. Introduction

In November 2007, the Montréal Process Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests[1] agreed on a revised set of 64 indicators for the seven Montréal Process criteria[2].

The Second Edition of the Technical Notes on Implementation of the Montréal Process Criteria and Indicators is intended to assist forest practitioners in collecting data and reporting on the 2007 Montréal Process criteria and indicators (C&I). They will also help policy-makers, stakeholders and wider society understand the scope and application of C&I.

The Technical Notes are based on the work of the Montréal Process Technical Advisory Committee (TAC) and reflect the best scientific and technical knowledge of member countries based on lessons learned in developing national reports based on C&I adopted in 1995.

[1] The Montréal Process Working Group has twelve member countries: Argentina, Australia, Canada, Chile, China, Japan, Korea, Mexico, New Zealand, the Russian Federation, the United States of America and Uruguay.
[2] Indicators for Criteria 1-6 have been revised, Indicators for Criterion 7 remain unchanged

Section II of the Technical Notes provides rationale statements describing the intent of each of the Montréal Process indicators, as well as suggested approaches to collecting data or "measuring" each indicator. **Section III** provides a glossary of selected terms used in Section II, as well as other information intended to facilitate a common understanding of the rationale statements and approaches to measurement. The **Annex** contains a list of the revised Montréal Process criteria and indicators approved in 2007.

A. Conceptual basis of Montréal Process Criteria and Indicators

If managed sustainably, forest ecosystems can provide multiple social, economic and environmental benefits for current and future generations and may contribute significantly to sustainable development.

Together, the Montréal Process C&I provide a common framework for member countries to monitor, assess and report on trends in forest conditions with respect to the full range of forest values and, in turn, on national progress toward sustainable forest management. They represent a holistic approach to forest management.

The seven Montréal Process criteria characterise the essential components of sustainable forest management. The 64 indicators provide a way to measure those essential components. No single criterion or indicator alone is an indication of sustainability.

While the C&I are not performance standards, they provide useful information for forest policy makers. A number of countries also see criteria and indicators as providing a useful framework for developing sub-national policies, management plans, and inventories.

Given the wide differences in natural and social conditions among Montréal Process countries, the capacity to apply C&I varies based on national circumstances. The C&I are designed to allow for national flexibility in their application. This flexibility is reflected in the Technical Notes, as noted below.

B. General guidance for using/applying the Technical Notes

The following general guidelines should be taken into account when using the Technical Notes.

- The approaches to measurement outlined in Section II are intended to be descriptive, not prescriptive. The appropriateness of specific measurement techniques will vary from country to country based on national conditions.

- Many of the quantitative indicators can be readily measured, such as the percentage of a country's forest cover. Other indicators may require the collection of new data, the establishment of systematic sampling or even basic research. Even minimal data on an indicator will help identify conditions and trends.

- A number of the indicators are qualitative or descriptive, such as those related to public policies or the attitudes of people toward forests. Where possible, assessment of these indicators should include aspects or "measurements" that can indicate changes or trends over time.

- Relative indicator terms, such as "significant" or "low", should be interpreted based on national forest conditions. Where these terms are used, such as for indicators related to soil and water resources, baselines should be established to help understand conditions and trends. Plots and information gathering for national forest inventories offer opportunities to obtain baseline and updated information on such ecological aspects, although sampling may be less intensive.

- National level data may not be available for a number of indicators. For some indicators, it may be possible to generate nation-wide data by aggregating data available at the forest management unit level, assuming the information is collected consistently across management units. Random sampling of management unit data is an alternative approach.

- Government sources of information and statistics are usually the most reliable and comprehensive. However, other sources of information, such as publications by international organisations, non-government organisations and industry associations, may be useful to supplement official sources.

- Spatial approaches to presenting information may be useful in addition to tables, charts and narrative text. For example, maps may be helpful in conveying information with a geographic aspect. Pie charts and other graphic material may be helpful illustrating the relative weight of data or percentage information.

C. Learn more about the Montréal Process

For further information of the Montréal Process, including the reports of recent meetings and a list of publications including country reports, please contact the Montréal Process Liaison Office hosted by Japan, via www.mpci.org.

II. Rationale Statements and Approaches to Measurement for Indicators

CRITERION 1 – CONSERVATION OF BIOLOGICAL DIVERSITY

Forests, and particularly native forests, support a substantial proportion of the planet's biological diversity and terrestrial species. Biological diversity enables an ecosystem to respond to external influences, to recover after disturbance, and to maintain essential ecological processes.

Human activities and natural processes can impact adversely on biological diversity by altering and fragmenting habitats, introducing invasive species, or reducing the population or ranges of species. Conserving the diversity of organisms and their habitats supports forest ecosystems and their ability to function, reproduce, and remain productive.

1.1 ECOSYSTEM DIVERSITY

Maintenance of the variety and quality of forest ecosystems is necessary for the conservation of species. Without sufficient habitat size, adequate connectivity, necessary structural diversity and appropriate protection and management measures, species may decline and become vulnerable to extinction.

These indicators provide information on the area and extent of ecosystem types, forest area under formal protection and the affects of fragmentation.

INDICATOR 1.1.a Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure

Rationale

This indicator provides information on the area and extent of forest ecosystem types, including successional stage, age class and the nature of tenure or ownership. The sustainability and stability of forest ecosystems may depend on their size and diversity. If these are not maintained, forests may become vulnerable habitat degradation and loss. Tenures or ownership types may have a variety of management regimes associated with them - each with a different impact on biological diversity.

Approaches to measurement

Data should include the total area and percentages of forest by type, successional stage and age class. Both the total area and percentage of Information should be available from forest inventories and management plans.

Remote sensing, multi-spectral imaging and photographic data combined with statistical plot measurement and boundary surveys provide useful information including data on forest type, age or successional stage. Forest types may be categorised or aggregated by each country as appropriate to their circumstances and reporting processes. Each country should have records relating to forest ownership and tenure.

Useful data may be obtained from government, universities, research organisations and industry sources. The Ministerial Council for the Protection of Forests in Europe (MCPFE) with the European Environment Agency of the European Union (EEA), International Union for Conservation of Nature (IUCN), United Nations Economic Commission for Europe and the United Nations Food and Agriculture Organisation (UNECE/FAO) have developed international forest classification systems that may be useful for reporting purposes.

INDICATOR 1.1.b Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage

Rationale

This indicator provides information on the area and extent of forest by ecosystem type, age class or successional stage protected to safeguard biological diversity and representative examples of forest ecosystem types. This indicator will also help identify forest types of conservation value that are in need of protection. The level of formal protection given to forests is a reflection of the importance society places on their conservation.

Approaches to measurement

Protected forest areas are those safeguarded by legal or policy instruments where there is a clear intention to protect them for all time. This may include forests on public or private land protected for multiple values and uses and not just for the forests themselves. This indicator does not include either public or private forests safeguarded or set aside over short time frames where there is no certainty of protection inter-generationally.

Forest inventories in protected areas are often not as comprehensive as inventories in areas used for commercial forest activities. In addition, protected forest areas within a country may be managed by different levels of government that often have different inventory requirements. Co-operation between all levels of government is important to establishing a comprehensive assessment of this indicator.

Where sufficiently detailed forest inventories are not available, estimates of the area protected can be accomplished by identifying the legal boundaries of protected areas and classifying the lands they contain to identify types. Additional care should be taken to distinguish the proportion of forest in protected areas from non-forest lands (ice-covered regions, deserts, grasslands, water bodies). The IUCN World Conservation Union has developed a set of categories of protected areas. These may be useful for reporting purposes.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 1.1.c Fragmentation of forests

Rationale

This indicator provides information on the extent to which forests are being fragmented over time by human activities and natural processes. Fragmentation may lead to the isolation and loss of species and gene pools, degraded habitat quality and a reduction in the forest's ability to sustain the natural processes necessary to maintain ecosystem health.

Approaches to measurement

This indicator is concerned with the increase or decrease in fragmentation as a result of human intervention. Natural processes such as fire and storm damage may further exaggerate the impacts of human induced fragmentation.

The sensitivity of biological diversity to the effects of fragmentation is not fully understood due to the complexity of the process. There is no single method to measure fragmentation. However, the precautionary principle suggests that the potential impacts attributed to fragmentation be carefully monitored and considered.

Reporting may describe the effects of fragmentation including the loss of species and genetic diversity and habitat degradation. The extent of fragmentation may be reflected in the number and size of remaining fragments. The distance between forest patches, the presence or absence of linkages and corridors, and the impacts of edge effects on forest condition should also be monitored. The sensitivity of keystone, foundation, flagship or other indicator species including species guilds, to degrees and types of fragmentation, may also be value. Reporting should seek to illustrate the extent and affects of the process of fragmentation over time where possible.

The effects of fragmentation may be illustrated by impacts on representative or keystone species or species associations including guilds. Fragment size, the distance between forest fragments and forest edge affects have different impacts on individual species. In countries with extensive areas of forest, road and highway density may act as a surrogate measure of fragmentation. Remote sensing, aerial photography and field verification and computer-based spatial analysis may be used to measure forest fragmentation and generate comparative statistics.

Useful data may be obtained from government, university, research organisation and industry sources.

1.2 SPECIES DIVERSITY

The greatest and most readily recognisable aspect of biological diversity is the variety of species and their population levels. A key objective for the conservation of biological diversity is slowing down the rate of population decline, and species depletion and extinction due to human factors[3]. Changes in species population levels and distribution may also provide an early warning of changes in ecosystem stability and resilience, as will increases in the number of invasive, exotic forest-associated species.

[3] The Millennium Ecosystem Assessment and the Red List of Threatened Species™ indicate that a large and increasing number of populations and species globally are threatened or being lost due to the loss and degradation of forest habitats.

INDICATOR 1.2a Number of native forest-associated species

Rationale

This indicator provides information on the health of forest ecosystems through the number of native forest-associated species. Knowledge of the number of native forest-associated species highlights the importance of certain forest types in meeting conservation objectives and in understanding the relationships species have within ecosystems. The loss or addition of species in an ecosystem can provide valuable insights into the overall health and productivity of that system.

Approaches to measurement

The simplest way to express this indicator is through tables, inventories or baseline data relating to the number of native and endemic forest-associated species by appropriate categories. Countries may wish to express this number by forest ecosystem type.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 1.2.b Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment

Rationale

This indicator provides information on the number and status of forest-associated species at risk or in serious decline. As a result, these species may require specific action or intervention to ensure their survival. The number of species at risk and their status is a measure of the health of forest ecosystems and their ability to support species diversity.

Approaches to measurement

At a national level, countries should have clearly defined listing procedures based on scientific assessment and legislation for threatened, rare, vulnerable, endangered and extinct species. In reporting, countries should highlight those species that are wholly or partially dependent on forests for their survival. Countries may also wish to report on the number of species at risk and their relationship with a particular forest type. In reporting, reference should also be made to the IUCN framework for categorising species at risk. In the absence or quantifiable data, modelling of species habitat from satellite data or aerial photography and displaying results in map form may provide data.

Useful data may be obtained from government, university, research organisation, industry, and other non-governmental organization sources.

INDICATOR 1.2.c Status of on site and off site efforts focused on conservation of species diversity

Rationale

This indicator provides information that describes on site (or *in situ)* and off site *(*or *ex situ)* efforts to conserve species diversity. Some forest species and habitats may have declined to such an extent that intervention is required to safeguard them for the future.

Approaches to measurement

On site conservation refers to actions taken within the forest to conserve species diversity. This indicator does not include general designations of land for conservation purposes. It does include specific actions taken at a species level to ensure their survival in their natural habitat. Examples may include the provision of artificial *refugia* (nest boxes, hibernacula), predator or pest control measures, and monitoring species using remote technologies (satellite tagging and sensors). On site conservation also addresses habitat restoration or creation linked to species action plans and strategies, for example, the provision of corridors for migrating species.

Off site conservation is a usually a measure of last resort. Species may be taken from their natural habitat or range and moved to new sites such as specially protected areas (for example islands or reserves) or, in extreme circumstances, placed in captivity as part of breeding programmes or collections. Genetic material may be safeguarded in seed banks or gene stores.

Countries should describe the number and type of on site and off site programmes in place. In reporting, countries may also wish to focus on species under threat of extinction or in serious decline.

Useful data may be obtained from government, university, research organisation and industry sources.

1.3 GENETIC DIVERSITY

Genetic diversity, or the variation of genes within populations and species, is the ultimate source of Biological Diversity at all levels and is important for the functioning of healthy forest ecosystems. Threats to gene pools come from climate change, catastrophic events and , human activities and pressures.

Loss of genetic variation reduces the ability of species to adapt to environmental change and for society to maximise the potential benefits available from forest species for example, for medicines and other bio-resources. High levels of genetic diversity within populations are usually a measure of their greater potential for survival. The loss of genetic variation within species also makes forest ecosystems less resilient to change.

INDICATOR 1.3.a Number and geographic distribution of forest-associated species at risk of losing genetic variation and locally adapted genotypes

Rationale

This indicator provides information on the number and distribution of forest-associated species at risk of losing genetic variation across their population. This erosion in genetic variation makes species less able to adapt to environmental change and more vulnerable to extinction. Some local populations with unique gene pools may also risk being swamped by larger populations introduced intentionally, by accident, or by natural processes.

Approaches to measurement

Countries should provide information relating to the number and distribution of forest-associated species with locally adapted populations or subspecies that are declining or under threat. Reporting should highlight the conservation status of the species concerned and its subspecies, local populations and genotypes as appropriate. Selected species may be a subset of those species reported under 1.2.b.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 1.3.b Population levels of selected representative forest-associated species to describe genetic diversity

Rationale

This indicator provides information on the population status of selected forest-associated species that are considered to reflect the genetic diversity present in forest ecosystems. Some forest species support or rely heavily on particular forest structures, patterns, associations and processes and can therefore be used to describe the status of genetic diversity in forests as a whole.

Approaches to measurement

Representative species are those that can be used as a surrogate measure of genetic diversity and may include keystone, foundation, flagship or other indicator species. Species guilds may also be a useful approach to describe genetic diversity. Countries may wish to select representative species to illustrate diversity between forest ecosystem types or within forests themselves. Selected species may be a subset of those species reported under 1.2.b.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 1.3.c Status of on site and off site efforts focused on conservation of genetic diversity

Rationale

This indicator provides information that describes on site (or *in situ)* and off site (or *ex situ*) efforts to conserve genetic diversity within species. Some species have suffered from a loss of genetic variability due to population decline and a reduction in their former range and distribution. Continued loss of genetic variability will threaten the viability of these species and may accelerate a decline that may lead ultimately to extinction.

Approaches to measurement

On site efforts to protect genetic diversity of individual species may be similar to those developed for individual species themselves and may include predator or pest control measures; monitoring of the genetic health of populations, and habitat restoration or creation linked to action plans and strategies. In situ efforts may also include research and explorative programmes to find new individuals to enrich the genetic population of threatened species.

Off site conservation of genetic diversity may include the removal of individuals from their natural habitat or range to be located to new sites such as specially protected areas, for example islands or reserves. In extreme circumstances, individuals may be placed in captivity or collections or genetic material collected and held in seed banks or other gene stores.

Countries should describe the number and type of on site and off site programmes in place. In reporting, countries may also wish to focus on the measures being taken to safeguard the genetic diversity of species under threat of extinction or in serious decline.

Useful data may be obtained from government, university, research organisation and industry sources.

CRITERION 2 – MAINTENANCE OF PRODUCTIVE CAPACITY OF FOREST ECOSYSTEMS

Many communities depend on forests directly or indirectly for a wide range of forest-based goods and services. The sustainable provision of these services is clearly linked to the productive capacity of the forest. If this capacity is exceeded there is the risk of ecosystem decline and collapse.

For forests to be sustainable it is necessary to understand the levels at which goods and services may be extracted or used without undermining the functioning of forest ecosystems and processes. The nature of goods and services provided by forest's change over time due to social and economic trends, and technological developments. Change in the productive capacity of forests may be a signal of unsound forest management practices or other agents that are affecting forest ecosystems in some way.

INDICATOR 2.a Area and percent of forest land and net area of forest land available for wood production

Rationale

This indicator measures the availability of forest land for wood production compared with the total forest area of a country. It provides information that will help assess the capacity of forests to produce wood to meet society's needs.

Approaches to measurement

Data should be collected across all land tenures and forest types. This should include the total area of forest land, the area of forest land available for wood production and the area in plantation forest.

Countries may wish to present information on plantation forests separately. Where possible, countries should report the area of forest land and the net area available for wood production by productivity class.

In reporting, countries may wish to explain the causes of change in data over time and interpret them against national policies and management plans where appropriate. If there have been both gains and losses over a reporting period, then they should be included in the interpretation. The difference between total area and net area demonstrates that some forests are not going to be harvested for a variety of reasons.

Data for this indicator should be consistent with Criterion 1 (Conservation of Biological Diversity). Countries may also choose to comment on the inclusion or otherwise of environmental plantings and links with Indicator 1.1a (Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure).

INDICATOR 2.b Total growing stock and annual increment of both merchantable and non-merchantable tree species in forests available for wood production

Rationale

This indicator measures the growing stock and annual increment of forest area available for wood production to meet society's needs. The annual increment and growing stock can be related to the volume harvested each year to provide a means to demonstrate the sustainable management of forest resources.

Approaches to measurement

Reporting should include information relating to the growing stock of merchantable and non-merchantable species forests available for wood production. Market fluctuations and trends may affect what are considered to be merchantable or non-merchantable species over time. When commenting on data, countries should consider merchantable and non-merchantable stocks separately and as a total sum. Countries should consider whether or not they are reporting against the net or gross annual increment.

An increase or decrease in growing stock may be correlated with changes in the net area of forest, in the productive capacity of the forest, or in forest management strategies. When reporting, countries may need to refer to management plans and other factors that may have influenced both actual growing stock levels and data quality.

This indicator may help interpret other indicators in this criterion for example Indicator 2.d (Annual harvest of wood products by volume and as a percentage of net growth or sustained yield) and Criterion 3 (Forest ecosystem health and vitality).

Useful data may be obtained from government, research organisation and industry sources.

INDICATOR 2.c Area, percent, and growing stock of plantations of native and exotic species

Rationale

This indicator provides information on the nature and extent of plantation forests. Changes in the area of plantation reflect society's present and future needs or the impact of competing land uses on forest cover. The use of both native and exotic plantation species may enhance the range and quantity of goods and services available.

Approaches to measurement

In reporting countries should show by forest species type, the net area as a percentage of the total forest area, age classes of plantations, the value of plantations, growing stock or projected yields over time, and maps of plantation distribution.

Countries may wish to comment on the reasons for any increase or decrease in the area of plantation over time or between reporting periods. Trends in yield show plantation productivity over time for different species. When interpreting this indicator, countries may distinguish between changes due to increases in the plantation estate and changes due to improvements in silvicultural techniques and genetic stock.

Not all plantations are established for wood production, some are created for environmental reasons such as erosion control, riparian management or landscape enhancement. Reporting on new plantations should reflect the intent behind forest establishment and be categorised accordingly.

Useful data may be obtained from government, research organisation and industry sources.

INDICATOR 2.d Annual harvest of wood products by volume and as a percentage of net growth or sustained yield

Rationale

This indicator compares actual harvest levels against what is deemed to be sustainable. The purpose is to assess whether forests are being harvested beyond their ability to renew themselves or are being under-utilised for wood products.

Approaches to measurement

Data for this indicator should include the volume of harvest by product type, calculated biological sustained yield and the approved harvest rate by product type. Countries may wish to discuss the basis upon which sustained yield is calculated in management plans. In reporting, it may be useful to distinguish between public and private forests, forest ownership type and tenure arrangements and plantations and natural forests.

Countries may wish to explain rationales, protocols and assumptions behind approved harvest rates. For forests that do not have management plans, average growth or biological potential could be used as a surrogate measure of sustainability.

The level of production deemed to be sustainable might not always be a calculation of tree growth versus cut, it may take into consideration other resource values, such as watershed protection and the maintenance of forest ecosystem conditions.

In reporting, concepts of biological potential and sustained yield should be considered together with forest sensitivity to harvesting and silviculture. The sustained yield from forests may be determined in the context of extraction rates. An assessment of the state of sustainability of yield may be made if data allows.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 2.e Annual harvest of non-wood forest products

Rationale

This indicator reports on the sustainability of the harvest of non-wood forest products. The well being of indigenous and other communities dependent on non-wood forest products may be closely allied to the forest's ability to maintain its productive capacity over time.

Approaches to measurement

Data for this indicator may include the type, amount and annual permitted or sustainable harvest levels of non-wood forest products determined in management plans or by scientific assessment.

In the absence of a rigorous assessment of harvest sustainability, countries may wish to report on individual case studies where they are considered to be of national or sub-national importance to the economy or to the well being of individual communities. This indicator is linked to Indicator 6.1e.

Useful data may be obtained from government, university, research organisation and industry sources.

CRITERION 3 – MAINTENANCE OF FOREST ECOSYSTEM HEALTH AND VITALITY

The maintenance of forest health and vitality is dependent upon the ability of the ecosystem's functions and processes to recover from or adapt to disturbances. While many disturbance and stress events are natural components of forest ecosystems, some may overwhelm ecosystem functions, fundamentally altering their patterns and processes and reducing ecological function.

Decline in forest ecosystem health and vitality may have significant economic and ecological consequences for society including a loss of forest benefits and the degradation of environmental quality.

Information gained on the impacts of biotic and abiotic processes and agents may inform management strategies to minimise and mitigate risk. The maintenance of forest ecosystem health and vitality is the foundation of sustainable forest management.

INDICATOR 3.a Area and percent of forest affected by biotic processes and agents (e.g. disease, insects, invasive species) beyond reference conditions

Rationale

This indicator identifies the impact that biotic processes and agents have on forests. Where change due to these agents and processes occurs beyond a critical threshold, forest ecosystem health and vitality may be significantly altered and a forest's ability to recover could be reduced or lost. Monitoring and measuring the effects of these processes provides information helpful in the formulation of management strategies to mitigate risk.

Approaches to measurement

Forests are affected at all times by agents (e.g. insects, invasive species) or processes (e.g. disease, nutrient cycling, reproduction, pollination). However, under certain conditions, some may become a serious concern. In addition, the decline or absence of certain agents and processes that were once part of forest ecosystems may also have an impact on forest health and vitality (e.g. pollinators and seed dispersal agents).

Reference conditions may be based on historic variation, baselines, targets or thresholds. Where data to support reference conditions are not available, trends may be used as a substitute.

Countries should begin by identifying changes in forest conditions by agents in their forests. Data may include the area affected by biotic processes and agents in the most recent year compared to the area affected in the reference condition, and the presence, abundance and impact of exotic biota, including recent outbreaks and the areas affected. Remote sensing may reveal the prevalence and extent of actual impacts of biotic threats, as well as areas at risk, and enable plant health surveillance over large areas. Site specific records and reference sites for key pathogens can also be used to measure the occurrence and impacts. Awareness of known relationships between processes and agents may also be used. Important trends may be discerned from time series information.

Qualitative assessment against management objectives may be possible in many cases and appropriate adaptive management responses adopted.

Useful data may be obtained from government, university, research organisation and industry sources.

INDICATOR 3.b Area and percent of forest affected by abiotic agents (e.g. fire, storm, land clearance) beyond reference conditions

Rationale

This indicator identifies the impact that abiotic agents, both natural and human-induced, have on forests. Where change occurs due to these agents and processes beyond a critical threshold, forest ecosystem health and vitality may be significantly altered and a forest's ability to recover from disturbance could be reduced or lost. Monitoring and measuring the extent of forest affected by physical agents provides information to guide the formulation of management strategies to mitigate risk.

Approaches to measurement

Useful information relating to the frequency, extent and duration of changes due to abiotic disturbances in forests may be obtained from analysis of reports, time series air photographs, soil carbon analysis, forest inventories and other historic records, dendrochronology (tree-ring dating) and remote sensing. It is possible to measure the effects and extent of some forms of air pollution through indicator species. Comparisons should be made between polluted and unpolluted areas and relevant air quality standards, where available.

Reference conditions may be based on historic variation, baselines, targets or thresholds. Where data to support reference conditions are not available, trends may be used as a substitute. Modelling may help to reconstruct a picture of past events or conditions and establish the reference conditions necessary to interpret the indicator

Useful data may be obtained from government, university, research organisation and industry sources.

CRITERION 4 – CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES

Soil and water underpin forest ecosystem productivity and functions. Forest ecosystems play an important role in the regulation of surface and groundwater flow and, together with associated aquatic ecosystems and clean water, they are essential to the quality of human life.

The interaction of soil, water and topography influence the character and health of streams and rivers flowing through and from forests. Monitoring change in the chemical, physical, and biological characteristics of soil, water and aquatic systems provides valuable information to support sustainable forest management.

Forest management activities can significantly alter forest soils, water quality and associated aquatic habitats. Inappropriate management may result in soil compaction, the loss of the soil A horizon, loss of riparian buffering capacity, increased sediment loads in streams, degradation and destruction of aquatic habitats and altered flow regimes. Change in water flow can also create an increased risk of flooding or the complete desiccation of streams. Both have harmful implications for human safety, property and economies.

Soil and water resources may be protected through the allocation of land for that purpose or through appropriate management regimes and best management practices.

4.1 PROTECTIVE FUNCTION

Healthy and productive forests depend on the maintenance of the soil and water resource. Forests also regulate these resources by moderating the flow of water, controlling erosion and preventing catastrophic events such as flooding, avalanches and mudslides.

INDICATOR 4.1.a Area and percent of forest whose designation or land management focus is the protection of soil or water resources

Rationale

The area and percent of forest designated or managed primarily for the protection and regulation of soil and water reflects the importance of these resources to society, including the trade-offs made between other uses.

Approaches to measurement

When reporting, countries may wish to categorise the areas designated or managed for soil and water protection. Categories may include important catchments or designated watersheds, areas set aside due to sensitive or erosion prone soils, stream buffers, riparian zones, steep slopes and areas prone to avalanches and mudslides.

Data may be obtained from watercourse hierarchy inventories, topographic maps, designated avalanche risk-zones and areas identified as vulnerable to erosion. Data might be available from sub-national stream and soil resource assessments and protection standards. Lands managed for multiple uses but where the primary management goal is to conserve soil and water values should also be included.

Useful data may be obtained from government, university and research organisation sources.

4.2 SOIL

Forest soils support forest productivity and other ecological and hydrological functions through their ability to hold and supply water and nutrients, store organic matter and provide habitats for plant roots and for a wide range of soil organisms. Not maintaining the soil resource may result in a decline and degradation in forest health and the provision of other environmental services.

INDICATOR 4.2.a Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources

Rationale

This indicator provides information about the extent to which soil resource protection, legislation and best management practices have been identified and integrated into forest management activities. Inappropriate activity may result in the loss of soil nutrients, forest productivity and other ecosystem services that soils provide.

Approaches to measurement

Data sources may include harvest administration data and enforcement agency records. Random sampling of forest management activities and operators may provide useful information. Statistical soil sampling of forests under active management (e.g. site preparation and harvesting) may reveal data about soil change over time and the causes of that change.

Reporting should be expressed as the percentage of management activities, operators and forest area that conform to best management practices and legislation. Different jurisdictions within countries are likely to have different standards and approaches to measure compliance. A method of normalising regional differences may also be required.

Interpretation of this indicator may be supported by a brief summary of relevant best management practices and legislation, including efforts and measures taken to monitor compliance.

Useful data may be obtained from government, university, industry and research organisation sources.

INDICATOR 4.2.b Area and percent of forest land with significant soil degradation

Rationale

This indicator provides information on the extent of significant soil degradation in forests likely to affect productivity, hydrology, ecosystem processes or social and cultural benefits. This indicator is primarily concerned with degradation caused directly or indirectly by human activity.

Approaches to measurement

It is recognised that most countries do not have comprehensive national reporting systems in place to monitor change in soil quality as a result of human activity. Sub-national data relating to soil degradation may be obtained by comparing undisturbed sites with sites that have a known intensity and frequency of human use. Countries may wish to report using case studies to highlight current experience of soil degradation in forests. It may also be possible to establish random national soil test plots to collect statistically relevant data.

Degradation includes the processes of soil compaction, erosion and contamination by chemicals, heavy metals and radioactive substances.

Useful data may be obtained from government, university, industry and research organisation sources.

4.3 WATER

Water is one of the most valuable of forest ecosystem services. Forests and how they are managed, influence the quantity, quality and timing of surface and ground water flows. Changes to water quality and flow can have a severe impact on forest resources as well as human wellbeing. In addition, associated forest aquatic and riparian habitats are some of the most biologically diverse and productive forest ecosystems.

The quality and quantity of water flowing from forested areas is commonly regarded as an indicator of the quality of forest management. Water quality is widely understood to be a measure that captures many potential impacts on forest sustainability and a good indicator of overall ecosystem health.

INDICATOR 4.3.a Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water related resources

Rationale

This indicator provides information about the extent to which water resources have been identified and safeguarded during forest management. This indicator is primarily concerned with activities that may affect riparian zones, water quality, quantity and flow rather than the designation of land for water-related conservation. The protection of the water resources and associated forest and aquatic ecosystems is vital for the human populations dependent on them.

Approaches to measurement

Management standards commonly address road design standards, watershed or catchment disturbance limits, recreational site design, in-stream management and livestock grazing regimes.

Reporting should be expressed as the percentage of management activities, operators and forest area that conform to best management practices and legislation. Different jurisdictions within countries are likely to have different standards and approaches to measure compliance. A method of normalising regional differences may also be required.

A low percentage of compliance or an absence of water-related best management practices and legislation indicates that management may be having, or will have, serious impacts on water and aquatic resources. A high level of compliance should suggest that the effects of management practices are being considered and minimised.

Interpretation of this indicator may be supported by a brief summary of relevant best management practices and legislation, including efforts and measures taken to monitor compliance.

Useful data may be obtained from government, industry, university and research organisation sources.

INDICATOR 4.3.b Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical or biological properties from reference conditions

Rationale

This indicator provides information relating to water quality in forests. Significant changes in the physical, chemical or biological properties of water in forest lakes, rivers and streams may reveal the extent to which management activities or natural events are affecting water quality. Maintaining water quality is important for human use and consumption and to support healthy forest and aquatic ecosystems. Where water quality is being adversely affected by human activity, forest management practices may be adapted to protect water values.

Approaches to measurement

Water quality data may be available from national and sub-national government bodies and other sources including wildlife and fish management agencies. Other data may be obtained from monitoring stations for stream volume, flow rates and timing, historic and current water quality data for disturbed and undisturbed watersheds and the reconstruction of historic data for water storage facilities. Reporting should comment on the area and percentage of water bodies and watercourses in forests where significant change has occurred.

Water quality may be adversely affected by turbidity (cloudiness), changes in chemical composition including dissolved oxygen and nutrient enrichment, temperature, pH values and by harmful algae and other organisms. When reporting, countries may wish to categorise the agents of change in water quality and their causes. Reference conditions may be based on historic variation, baselines, targets or thresholds. Where data to support reference conditions are not available, trends may be used as a substitute.

Countries may wish to highlight specific case studies in which water quality is affected by changes in its physical, chemical and biological properties and the implications for forest management.

Useful data may be obtained from government, university, industry and research organisation sources.

CRITERION 5 – MAINTENANCE OF FOREST CONTRIBUTION TO GLOBAL CARBON CYCLES

Forests are renewable and one of the largest terrestrial reservoirs of biomass and soil carbon. They have an important role in global carbon cycles as sinks and sources of carbon. Carbon stocks in forests include above ground biomass, below ground biomass, dead and decaying organic matter and soil carbon. Carbon is also stored in wood products.

The biosphere has a significant influence on the chemical composition of the atmosphere. Vegetation draws CO_2 from the atmosphere, through photosynthesis and returns it through respiration and the decay of organic matter. The interchange between the biosphere and atmosphere is large; approximately a seventh of total atmospheric CO_2 passes into vegetation each year.

Global climate change could have significant impacts on the structure, distribution, productivity, and health of temperate and boreal forests as well as impacts on forest carbon stocks and fluxes, and the prevalence of forest fires, disease and insect outbreaks, and storm damages.

Forest management practices also affect the carbon cycle and fluxes. Deforestation has a negative impact, but management activities that maintain and enhance the carbon stored in forests and forest products over the medium to long term can make a positive contribution to mitigating atmospheric carbon dioxide levels. In addition, biomass from forests can be used as a substitute for fossil fuels thereby reducing greenhouse gas emissions.

Change in the global carbon cycle and associated climate change will have major impacts on human wellbeing, especially rural communities and indigenous peoples dependent directly on the natural environment.

INDICATOR 5.a Total forest ecosystem carbon pools and fluxes

Rationale

This indicator provides information about the total amount of carbon stored in forest ecosystems. It also describes changes, fluxes or flows in carbon between forests and the atmosphere. A better understanding of these processes will aid the development of appropriate responses to the effects of climate change.

Approaches to measurement

International and national panels and processes on climate change will provide information and approaches that may be used when reporting against this indicator. This indicator is primarily concerned with the contribution of each country's forests to the global carbon cycle.

The International Panel on Climate Change (IPCC) offers information relevant to the assessment of scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

The United Nations Framework Convention on Climate Change (UNFCCC) and national greenhouse gas accounting inventories will also provide data that may be used in reporting against this indicator.

Useful data may be obtained from government, university, industry, and research organisation sources.

INDICATOR 5.b Total forest product carbon pools and fluxes

Rationale

This indicator provides information on the role that forest products play in storing, cycling and releasing carbon. Forest products delay the release of carbon into the atmosphere and are more sustainable than products with manufacturing processes that have significant carbon footprints.

Approaches to measurement

“Forest product” refers primarily to carbon stocks contained in lumber, plywood, furniture and paper. The International Panel on Climate Change technical guidelines (2006) include approaches to estimating carbon pools and fluxes in harvested wood products. Life cycle analysis (LCA) may be used to assess the effect of substituting wood products for products with significant environmental and carbon footprints, such as steel, concrete, and plastics.

Useful data may be obtained from government, university, industry, and research organisation sources.

INDICATOR 5.c Avoided fossil fuel carbon emissions by using forest biomass for energy

Rationale

This indicator provides information about the amount of energy produced from forest biomass and the extent to which it offsets the need to burn fossil fuels, thereby benefiting the global carbon budget and lowering carbon emissions.

Approaches to measurement

Energy production from forest biomass may include burning wood waste and residues or producing bio-ethanol from forests. Energy production values may be converted to fossil fuel carbon emission equivalents using standard conversion factors.

Changes in the use of biomass over time may show energy supplied by biomass and its share of total energy used at a national level and by sectors. Estimates should be consistent with information and methods (e.g. emission factors) used by each country in national greenhouse gas inventory reports and with International Panel on Climate Change (IPCC) guidelines.

Useful data may be obtained from government, university, industry, and research organisation sources.

CRITERION 6 – MAINTENANCE AND ENHANCEMENT OF LONG TERM MULTIPLE SOCIO-ECONOMIC BENEFITS TO MEET THE NEEDS OF SOCIETY

Forests provide a wide variety of social, cultural and economic goods, services and other benefits that contribute to meeting the needs of society. Many people and communities, including indigenous peoples, are dependent on forests for their livelihood and well being. Information on the production and consumption of forest products, investment and employment in the forest sector, forest-based recreation and tourism, and other social and cultural forest values illustrate the many benefits forests provide.

6.1 PRODUCTION AND CONSUMPTION

These indicators provide information on the contribution of wood and non-wood products and environmental services to national economies. The value, volume and revenues associated with domestic production and consumption of forest products and services, including through international trade, demonstrates the type and magnitude of the contribution of forests to domestic economies. They also provide information about market conditions relevant to forest management and the forest sector.

INDICATOR 6.1.a Value and volume of production of wood and wood products production, including primary and secondary processing

Rationale

This indicator provides information on the value and volume of wood and wood products at various stages of processing. The value and volume of wood and wood products reflects one aspect of the importance of forests and the wood processing sector to domestic economies.

Approaches to Measurement

Value may be expressed as the market value at various stages in production from harvesting to finishing. It does not include value beyond the completion of secondary processing. Primary processing of wood products includes pulp and paper, dimension lumber and panel products. Secondary processing includes coated papers, cardboard boxes, mouldings and joinery, and wooden furniture and other products. Countries may wish to highlight products and types of processing that may be of particular importance to their own experience. Measurement units may vary between products. The conversion of product volumes to round wood equivalent will allow comparisons to be made with harvest volumes (Indicator 6.1).

Production data could be obtained from government and industry associations. Value data may be obtained from price reports or marketing sources and should be expressed in a consistent way for example, as manufacturer's prices or free-on-board (FOB) or at the mill.

INDICATOR 6.1.b Value of non-wood forest products produced or collected

Rationale

This indicator provides information on the value of non-wood forest products. The collection, processing and use of non-wood forest products are important dimensions of the economic value of forests. In some countries, non-wood forest products are vital to the livelihoods and lifestyles of indigenous and other rural communities.

Approaches to Measurement

Relevant data includes the harvest and market value of non-wood forest products. Countries may wish to describe and categorise non-wood forest products according to their own experience.

Some products will be collected, used and consumed by indigenous and local communities without ever entering a formal market system. These may play an important role in sustaining local economies by replacing commodities usually bought from shops and markets. Countries may wish to highlight examples through case studies, if appropriate. Where possible, comment should be made on whether the levels of extraction and use of non-wood forest products are deemed to be sustainable.

Data may be available from government and other sources including co-operatives, collectives, producer organisations and local and indigenous communities.

INDICATOR 6.1.c Revenue from forest-based environmental services

Rationale

This indicator provides information about forest-based environmental services for which markets and revenues are emerging or currently exist. Revenues from forest-based environmental services can be an important component of the economic value of forests.

Approaches to Measurement

Environmental services of forests, often referred to as ecosystem services or functions, include the provision of clean air, the mitigation of air pollution and salinity, erosion control, the quantity and quality of water supplies, carbon storage, scenic value, eco-tourism and wildlife conservation. Countries may wish to describe and categorise forest-based services according to their own experience.

Where possible, estimated totals of actual revenues received should be reported. Examples may include income generated from the sale of carbon certificates, payments by water utilities to obtain clean water, payments received by forest landowners for the sale of conservation easements, and concessions for campsites and eco-tourism activities. Cost savings from the existing value of environmental services should also be included. For example, the reduction in operating costs for water users who can rely on clean water from forested watersheds compared to what they would otherwise pay to use the best available alternative water supply.

Data may be available from government and other sources.

INDICATOR 6.1.d Total and *per capita* consumption of wood and wood products in round wood equivalents

Rationale

This indicator provides information on consumption, including consumption *per capita*, of wood and wood products. The quantity of wood and wood products consumed illustrates one aspect of society's dependence on forests as a source of raw materials.

Approaches to Measurement

Information reported should include the volume of wood and wood products consumed, estimated as total domestic production including imports and minus the amount exported overseas. Fuel wood should be included in calculating domestic consumption. Converting all products into round wood equivalents will aid interpretation and allow comparisons to be made with indicators that measure the productive capacity of forests (Indicators 2.b, 2.d and 6.1a). *Per capita* consumption is the ratio of the volume of wood and wood products consumed against total population. Interpretation of this indicator will be aided by reference to 6.1f.

Data may be available from government, industry and other sources.

INDICATOR 6.1.e Total and *per capita* consumption of non-wood forest products

Rationale

This indicator provides information on the consumption of non-wood forest products. The quantity of non-wood products consumed illustrates society's dependence on forests as a source of these products.

Approaches to Measurement

Relevant data includes the volume of non-wood forest products consumed, estimated as domestic production plus imports and minus exports. *Per capita* consumption is the ratio of the volume consumed compared with the total population.

Countries may wish to comment on the ability of forests to meet demands for non-wood forest products from the domestic economy, and on implications for sustainable forest management.

Data may be available from government and other sources including co-operatives, collectives, producer organisations and local and indigenous communities.

INDICATOR 6.1.f Value and volume in round wood equivalents of exports and imports of wood products

Rationale

This indicator provides information about the value and volume of a country's exports and imports in wood products and their contribution to the domestic economy. International trade in wood products may be a significant factor in the management, commercial use and economic value of forests.

Approaches to Measurement

Data should include the total market value of exports and imports of wood products reported by appropriate categories to each country's experience. Trade data is available from government and industry sources. Converting product volumes into round wood equivalents will aid interpretation and allow comparisons to be made between indicators (indicator 6.1a). The reporting basis for estimating values, for example, customs basis, free-on-board or cost, insurance and freight, should be the same for all products.

Countries may chose to align reporting against this indicator (and indicator 6.1a) with data requirements from other international bodies for example, the United Nations Economic Commission for Europe (ECE), United Nations Food and Agricultural Organisation (FAO), International Tropical Timber Organisation (ITTO) Joint Forest Products Questionnaire. Past analyses of international trade information show that the volumes exported and imported are sensitive to fluctuations in global prices and the margins between global and domestic prices for products. This may make it difficult to interpret trends in exports and imports.

Information from this indicator is needed to report on indicator 6.1.d.

Data may be available from government, industry and other sources.

INDICATOR 6.1.g Value of exports and imports of non-wood forest products

Rationale

This indicator provides information about the value of a country's exports and imports of non-wood products and their contribution to the domestic economy. International trade in non-wood products may be a significant factor in the management, commercial use and economic value of forests.

Approaches to Measurement

Reporting should include the total market value of non-wood forest product exports and imports, reported for selected products. To aid interpretation, the same non-wood forest products selected in indicator 6.1b should be used, unless total production is consumed domestically.

Countries may wish to report using case studies to highlight examples where consumption may be based entirely on imports or where domestic production is exported. Comment should also be made on levels of extraction and use that are deemed to be sustainable.

Trade data is available from government and industry association sources.

INDICATOR 6.1.h Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption

Rationale

This indicator provides information on the relative importance of international trade in wood and wood products to domestic production and consumption. Wood and wood product exports can be a significant source of revenue for domestic economies. Imports may supplement or substitute for production from domestic forest sources.

Approaches to Measurement

Reporting should include estimates of the total market value of a nation's exports and imports of wood and wood products, separated by product categories and expressed as a percentage of total national production. Reporting should be on the basis of common volume units and as market value.

Information will be available from government and industry sources.

INDICATOR 6.1.i Recovery or recycling of forest products as a percent of total forest products consumption

Rationale

This indicator provides information on the extent to which forest products are recycled or recovered. Recycled and recovered products are an important source of wood fibre for many industries and may compete with or substitute for harvested wood. Such products can help meet the demand for forest products without increasing harvest levels.

Approaches to Measurement

Data required include the volume of paper, solid wood and wood fibre recovered from the post-consumer waste stream and used as a raw material by a producer or end user. Recycled wood fibre is used inside and outside the forest sector, in paper production, to strengthen wood-plastic composites and as landscaping mulch and bedding for farm animals. Reporting should also include the volume of recovered solid wood products, for example timber recovered from buildings and also the volume of recovered forest products used to produce energy through incineration. The conversion of wood fibre into methanol or ethanol should be reported in indicator 5.c. Volume should be reported as a percentage of the amount recycled or recovered against total consumption of forest products.

Data may be obtained from government sources and industry associations.

6.2 INVESTMENT IN THE FOREST SECTOR

These indicators provide information on long-term and annual expenditures to enhance forest management, forest-based enterprises, and the knowledge and skills of people who are engaged in the forest sector. Maintaining and enhancing the long-term multiple socio-economic benefits derived from forests depends in part on investment in the forest sector, including both long-term capital investments and annual operating expenditures.

INDICATOR 6.2.a Value of capital investment and annual expenditure in forest management, wood and non-wood forest product industries, forest-based environmental services and recreation and tourism

Rationale

This indicator quantifies investment and expenditure in developing, maintaining and obtaining goods and services from forests. Maintaining and enhancing forests and their benefits often depends on regular investments in restoration, protection and management, as well as in operations, forest industries and forest-based environmental services. When the capacity to protect, manage and use forests is eroded through lack of funding, the benefits that forests provide may decline or be lost.

Approaches to Measurement

This indicator addresses the value of capital investment and annual expenditure, including operating costs, by both public and private agencies. Capital investment and expenditure should be reported as an annual total. It may also be expressed as a rolling average annual value calculated over a number of years. A moving average annual value is the sum of investments and expenditure for the preceding years divided by the time period selected. Average values help to illustrate trends, reduce anomalies and recognise that investment expenditure may not be made every year.

Examples of investment and expenditure include the cost of new plants and equipment, forest infrastructure, investments by tourism operators, acquisition of forest, conservation areas, parks and easements, and expenditure by public and private agencies management, protection and operating costs.

Information on annual investment and expenditure should be consistent with the categories of goods and services identified in indicator 6.1. Information should be tabulated according to each country's experience and reported on separately and as an aggregate.

Data may be obtained from government, private sector, industry association, university and non-governmental organisation sources. Countries may wish to report domestic and foreign sources of investment separately.

INDICATOR 6.2.b Annual investment and expenditure in forest-related research, extension and development, and education

Rationale

This indicator provides information on annual investment and expenditure in forest-related research, extension and development, and education. Research underpins scientific understanding, including the ability to practice improved forest management and to develop and apply new technologies. Education, including extension activities, increases public awareness of the multiple benefits provided by forests.

Approaches to Measurement

Information required includes the total annual investment and expenditure by both public and private agencies in forest research, development, extension, and education activities. The total should include operating expenses and grants. Data should be reported separately for each category. It may be expressed as an annual total or as a rolling average annual value of investment to sustain or expand activity. A moving average annual value is the total investment and expenditure for the preceding three to five years divided by the time period selected. Average values help to illustrate trends and to reduce anomalies.

Reporting should address the level of investment in capital assets including the cost of new laboratories, buildings, infrastructure and land for research purposes, equipment, interpretation and educational facilities. Annual operating expenses should be estimated from the budgets of relevant public and private agencies.

Data sources include government agencies, universities, industry organisations and non-governmental organisations.

6.3 EMPLOYMENT AND COMMUNITY NEEDS

Forest-based and forest-related employment is a useful measure of the social and economic importance of forests at the national and local level. Wage and income rates and injury rates are indicators of employment quality. Communities whose economies are concentrated in forest industries, or who rely on forests for subsistence purposes, may be vulnerable to the short or long-term affects of economic or policy changes in the forest sector. These indicators provide information on levels and quality of forest employment, community resilience to change, use of forests for subsistence purposes, and the distribution of revenues from forests.

INDICATOR 6.3.a Employment in the forest sector

Rationale

This indicator provides information on the level of direct and indirect employment in the forest sector. Employment is a widely understood measure of economic, social and community wellbeing.

Approaches to Measurement

Data required includes total direct and indirect employment in the forest sector and forest-related activities for the categories for which production and investment data were reported in sub-sections 6.1 and 6.2. Examples of forest sector and forest-related employment include all aspects of forest management, wood processing and the use of non-wood forest products. It should also include forest-related research, education and support activities for recreation and tourism. Employment in the production and marketing of environmental services may also be included.

Data may be obtained from government agencies and relevant sector associations.

INDICATOR 6.3.b Average wage rates, annual average income and annual injury rates in major forest employment categories

Rationale

This indicator provides information on average wage, income and injury rates. These are important aspects of employment quality and the economic value of forests and forest related employment to communities.

Approaches to Measurement

Reporting should include average wage and annual income rates in major forest employment categories. These categories may reflect production and investment data reported in sub-sections 6.1 and 6.2.

Injury rates should be standardised (e.g. injuries per 100,000 employees or per million working-hours) and reported by major employment categories, such as loggers and mill workers. Countries may wish to report injury rates associated with high-risk employment categories separately (e.g. fire fighting, harvesting, etc.).

Wage and income rates can influence the ability of the forest sector to recruit and retain its workforce.

Data sources include government, unions, industry associations and non-governmental organisations.

INDICATOR 6.3c Resilience of forest-dependent communities

Rationale

This indicator provides information on the extent to which communities dependent on forests for their wellbeing, livelihoods, subsistence, quality of life or cultural identity are able to respond and adapt to social and economic change.

Approaches to Measurement

When reporting, countries should explain their definition of forest dependency and select approaches to measurement that best reflect their national experiences.

Some communities respond better than others to changes in economic, social and environmental conditions. Declining communities are often characterised by poor performance against a range of indicators of social and economic wellbeing (e.g. low educational achievement, high crime rates, high unemployment, high levels of outward migration and ageing populations). Using a combination of appropriate measures, countries should report the health of forest-dependent communities and trends over time.

Using case studies, countries may wish to explore the characteristics of resilient communities. Resilience may be related to the nature of those communities (e.g. values, attitudes, leadership), their processes (e.g. participation, collaboration), their resources and organisation. The characteristics of community resilience may be used to support community planning and sustainable development initiatives.

Sources of information may include national and sub-national government reports, research providers, indigenous peoples groups and organisations, forest managers, non-governmental organisations and community groups.

INDICATOR 6.3.d Area and percent of forests used for subsistence purposes

Rationale

This indicator provides information on the extent to which indigenous and other communities rely on forests as a source of basic commodities, such as food, fuel, shelter and medicinal plants. The practice of forest-based subsistence reflects the dependence of rural communities and individuals on forests for essential resources and may be closely linked to cultural identity and quality of life.

Approaches to Measurement

The measure desired is a description of the land areas and locations where subsistence is an important component of forest use.

Useful data includes the area of forest protected, allocated or used by indigenous groups or local communities for subsistence activities. Some communities may have legal or treaty rights and agreements for resource use and collection. Information may be obtained from permits issued to allow access or harvesting rights. Countries may wish to include specific case studies to illustrate the importance of forests for subsistence purposes and implications for sustainable forest management.

Sources of information may include national and sub-national government reports, research providers, indigenous peoples groups and organisations, forest managers, non-governmental organisations and community groups.

INDICATOR 6.3.e Distribution of revenues derived from forest management

Rationale

This indicator provides information about the flow and distribution of revenues derived from forest services, management and use; back into forest-based communities, wider society and the forest sector. The distribution of those revenues provides information on the extent to which forest-based communities, the forest sector, and the wider society share in the economic benefits generated by forests.

Approaches to Measurement

Relevant data should include the source and distribution of revenue received from forest management activities, including the sale of forest products, licenses and fees, and receipts from the sale or provision of environmental services. Reporting may include income received by forest workers, revenues collected by government agencies (e.g. through taxes and deposits to governmental agencies) or other parties (e.g. private forest owners, collectives, communities, firms, concession and leaseholders) and reported in categories appropriate to national experience. When reporting, countries may wish to refer to indicators 6.1a, 6.1b and 6.1c.

Government sources may provide information on the collection of revenue generated by publicly owned forests. Information on revenues received from privately owned forests might be available from industry sources or estimates. For publicly owned forests, it may be helpful to report the share (percentage) of revenues collected that are retained by and/or allocated to national, regional, or local governments, landowners, communities, and/or the forest management unit that generated the revenue.

Other sources of information may include research providers, indigenous peoples groups and organisations, non-governmental organisations and community groups.

6.4 RECREATION AND TOURISM

Forests have long been used as a place for recreation and other leisure activities. The location and accessibility of forests and the availability of recreation facilities are important to forest-based recreation and tourism. Levels of use are an indication of the extent to which forests are valued by society for these uses.

INDICATOR 6.4.a Area and percent of forests available and/or managed for public recreation and tourism

Rationale

This indicator provides information on the area and extent of forests available and/or managed for recreation and tourism activities. The availability and management of forests for these activities is a reflection of society's recognition of the value of forests for recreation and tourism.

Approaches to Measurement

Data should include the total area of public and private forest available and/or managed for recreation and tourism activity. This should be expressed as a percentage of the total forest estate and includes forest leased to groups or concessions, even though access may be limited to members. Countries may wish to report on the basis that total forest area excludes land where public use is prohibited. This may include private land and public land closed to public entry (e.g. military bases or other specially protected areas).

Countries may also wish to differentiate between forest ownership and management objectives, for example, wilderness areas with open access and urban forests managed intensively for recreational uses.

Data may be obtained from national forest inventories, government agencies, non-governmental organisations, the forest industry, and recreation and tourism associations.

INDICATOR 6.4.b Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available

Rationale

This indicator provides a measure of the level and type of recreation and tourism use in forests. The number and geographic distribution of visits and the facilities available reflect the extent to which people participate in forest-based leisure activities and the importance of forests for recreation and tourism.

Approaches to Measurement

Information required includes the number of recreational visits to forests by appropriate categories and location. Data should be standardised where possible (e.g. as visitor days). Other relevant information includes the number and distribution of forest recreational facilities, actual visitor numbers and estimates of their carrying capacity. Countries may wish to highlight (using maps or spatial representations) the proximity of recreational facilities to major centres of population and comment on whether or not recreational facilities are meeting demand or are under significant visitor pressure. Comment may also be made on the geographic distribution of visitors, the types of recreational activity undertaken, levels of use and accessibility from major centres of population. Implications for future forest management from increasing use and pressure, especially close to urban areas, may be considered. Examples of forest recreation facilities include campgrounds and picnic areas and facilities for walking, cycling, horse riding, cycling, skiing, water-based activities and other uses.

Data may be obtained from government, industry association and commercial sources as well as scientific and research publications.

6.5 CULTURAL, SOCIAL AND SPIRITUAL NEEDS AND VALUES

People and communities, in both rural and urban areas, have a variety of social, cultural, and spiritual connections to forests based on traditions, experiences, beliefs, and other factors. Among them, the spiritual and cultural connections of indigenous people to forests often form part of their identity and livelihood. These values may be deeply held and influence people's attitudes and perspectives towards forests and how they are managed. These indicators provide information on the extent to which social, cultural, and spiritual needs and values exist and are recognized by society.

INDICATOR 6.5.a Area and percent of forests managed primarily to protect the range of cultural, social and spiritual needs and values

Rationale

This indicator measures the extent of forests managed primarily for their cultural, social and spiritual values to people and communities, including indigenous communities and others with strong ties to forests. The protection of forests to meet such needs and values is a reflection of the extent to which they are recognised by society.

Approaches to Measurement

Relevant information includes the area of forest where cultural, social, or spiritual needs and values receive formal protection in legislation, policy or management plans. Countries should categorise these values and needs according to their experience. Where appropriate, countries may wish to comment on the uniqueness of values held by their indigenous and other communities. Small sites may have very strong significance and this should also be captured in reporting.

Protected areas may include sites safeguarded for food and the collection of resources, spiritual values, cultural associations (e.g. iconic trees, art and literary linkages), archaeology, historic events and religious needs.

Reference may be made to indicators 2.a and 6.3d in reporting against this indicator.

Sources of information may include national and sub-national government reports, research providers, indigenous peoples groups and organisations, forest managers, non-governmental organisations and community groups.

INDICATOR 6.5.b The importance of forests to people

Rationale

This indicator provides information on the range of values that communities and individuals hold for forests. These values shape the way people view forests, including their behaviours and attitudes to all aspects of forest management.

Approaches to Measurement

Reporting should include a description of the full range of values, reasons, and feelings as to why forests are important. These may vary according to a variety of factors, including age, ethnicity, social and economic profiles, and geographic location.

People may consider forests to be important for many reasons including spiritual or intrinsic values, physical and psychological health benefits, quality of life, aesthetics, tranquillity, watching and enjoying wildlife, wilderness experiences and relaxation. Forests may also be valued just because they are there or appreciated distantly through a variety of media including films, television or other technologies.

Sources of information may include national and sub-national government reports, research providers, indigenous peoples groups and organisations, forest managers, non-governmental organisations and community groups.

III GLOSSARY OF TERMS

The Montréal Process countries have accepted the definitions provided below. Countries may interpret the definitions in their own national reports according to their own national experience.

Abiotic
Pertaining to nonliving components of the environment (e.g., climate, ice, soil, and water).

Above-ground biomass
All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage.

Abundance
The number of organisms in a population, combining density within inhabited areas with number and size of inhabited areas.

Adaptive management
A process of responding positively to change. The term adaptive management is used to describe an approach to managing complex natural systems that builds on common sense and learning from experience, experimenting, monitoring, and adjusting practices based on what was learned. (From Bernard T. Bormann, et al, in Adaptive Management: Common Ground Where Managers, Scientists, and Citizens Can Accelerate Learning to Achieve Ecosystem Sustainability. Prepared for the Ecological Stewardship Workshop in December 1995 in the USA.).

Age class
A category into which the average age or age range of trees or other vegetation is divided for classification or use. Age class is usually used in reference to even-aged stands of trees. It represents the dominant age of the main body of trees in a stand. In some mixed-aged stands, age class can be used to describe the average age of specific cohorts of trees.

Alien species
A species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities. Also known as introduced species.

Below-ground biomass
All living biomass of live roots. Fine roots of less than (suggested) 2mm diameter are sometimes excluded because these often cannot be distinguished empirically from soil organic matter or litter.

Best Management Practice (BMP)
Best practice is a management idea which asserts that there is a technique, method, process, activity, incentive or reward that is more effective at delivering a particular outcome than any other technique, method, process, etc. The idea is that with proper processes, checks, and testing, a project can be rolled out and completed with fewer problems and unforeseen complications. BMP, in the SFM domain, would be characterised by scientific rigour, comprehensiveness, and be, at least, under periodic improvement.

Biological Diversity / Biodiversity
The variability among living organisms from all sources, including *inter alia* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part: this includes diversity within species, between species, and of ecosystems. (Convention on Biological Diversity, Article 2, UNEP 1992)

Biomass (woody)
The mass of the woody parts (wood, bark, branches, twigs, stumps, and roots) of trees alive or dead and shrubs and bushes, measured to a specified minimum diameter. Includes above-stump woody biomass, and stumps and roots. Excludes foliage.

Biotic
Pertaining to living components of the environment (e.g. animals, plants, insects, microbes, fungi)

Compaction
A reduction in soil volume leading to poor soil aeration, reduced drainage, and root deformation.

Connectivity
The structural links between habitat patches in a landscape.

Critically Endangered Species (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for the Critically Endangered category of the IUCN

Red list and is therefore considered to be facing an extremely high risk of extinction in the wild.

(For details see the IUCN website: http://www.iucn.org/themes/ssc/RedList2003/English/backgroundEn.htm)

Criterion
A category of conditions or processes by which sustainable forest management may be assessed. A criterion is characterised by a set of related indicators that are monitored periodically to assess change.

Dead wood biomass
All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.

Disturbance
A significant change in the structure and/or composition of ecosystems, communities, or populations through natural or human-induced events.

Direct employment
The number of jobs created by public and private firms in the process of producing a good or service. However, in the process of producing the good or service, the primary firm also generates secondary economic activity in other sectors of the economy. The jobs created by this secondary economic activity are referred to as indirect employment.

(see also indirect employment)

Ecosystem
A dynamic system of plants, animals, and other organisms, together with the nonliving components of the environment, functioning as an interdependent unit

Ecosystem approach
See paper on sustainable forest management and the Ecosystem approach. http://www.fao.org/forestry/site/24447/en/

Ecosystem-based management

Management systems that attempt to simulate ecological processes with the goal of maintaining a satisfactory level of diversity in natural landscapes and their pattern of distribution in order to ensure the sustainability of forest ecosystem processes.

Ecosystem diversity

The variety and relative abundance of ecosystems and their plant and animal communities.

or

Describes the variety of different ecosystems found in a region. A categorisation of the combination of animals, plants, and micro-organisms, and the physical environment with which they are associated is the basis for recognising ecosystems.

Endangered species

A taxon is endangered when the best available evidence indicates that it meets any of the criteria A to E specified for the Endangered category of the IUCN Red list and it is therefore considered to be facing a very high risk of extinction in the wild.

See also Critically Endangered species and Vulnerable Species

(For details see the IUCN website: http://www.iucn.org/themes/ssc/RedList2003/English/backgroundEn.htm)

Endemic Species

Species is endemic when found only in a certain strictly limited geographical region, i.e. restricted to a specified region or locality.

Erosion

The wearing away of the land surface by running water, wind, ice, or gravity.

or

The wearing away of the land surface by running water, waves, or moving ice and wind, or by such processes as mass wasting and corrosion (solution and other chemical processes).

Exotic species

A species which is not native to the region in which it occurs. See also alien species and introduced species.

Extinct species
A species for which there is no reasonable doubt that the last individual has died or when exhaustive surveys in known or expected habitat throughout its historic range have failed to record an individual.

***Ex-situ* conservation & *ex situ* gene conservation**
The conservation of components of biological diversity outside their natural habitats.

Forest dependent human communities
Forest dependent human communities are considered to be communities with a significant level of the base income earned or, alternatively, proportion of their employment, coming from forest products or forest use. Forest dependency may also refer to circumstances where the communities hunt, gather, collect or grow, in forests, goods equal to a significant proportion of their total needs. The determination of a significant level should be conducted on a national basis. There is some difficulty in making general statements about what constitutes a forest dependent human community because a wide range of factors may affect the future viability of a community.

Flagship species
A flagship species is a species chosen to represent an environmental cause, such as an ecosystem in need of conservation. These species are chosen for their vulnerability, attractiveness or distinctiveness in order to engender support and acknowledgement from the public at large. Thus, the concept of a flagship species holds that by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems and all species contained therein. Examples of flagship species include the giant panda of China, the golden lion tamarin of Brazil's Atlantic coastal forest, the Indian tiger, the African elephant, the mountain gorilla of Central Africa, the orang-utan of Southeast Asia, and the leatherback sea turtle.

Forest
The definition of Forest is country specific, but many countries may wish to use information provided to FAO. The following definition is from the Forest Resource Assessment. Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds

in situ. It does not include land that is predominantly under agricultural or urban land use.

Explanatory notes:

- Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 meters in situ. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10 percent and a tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate.
- Includes areas with bamboo and palms provided that height and canopy cover criteria are met.
- Includes forest roads, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest.
- Includes windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 ha and width of more than 20 m.
- Includes plantations primarily used for forestry or protection purposes, such as rubber-wood plantations and cork oak stands.
- Excludes tree stands in agricultural production systems, for example in fruit plantations and agroforestry systems. The term also excludes trees in urban parks and gardens.

Forest-associated species
Species for which the forest is important to their survival, or parts of their life cycle, or for components of their daily existence. Example functions can include refuge, transit, reproduction, food sources, shelter etc. It is a superset of forest dependant species.

Forest-dependent community
A community or census subdivision that derives at least 50% of employment income from the forest sector.

Forest dependent species (flora and fauna)
Any species that needs forest ecosystems and their conditions for all or part of its requirements of food, shelter, or reproduction. That is, any species that could not survive or reproduce in the absence of forest ecosystems is forest dependent.

Migratory species that use the forest during migration, and forest species dependent on them will also be considered as forest dependent.

Forest land

Land with existing forest (as in indicator 1.1.a). In addition, some countries report "potential forest" and "non-forest" land as forest land but it is important that these elements be reported separately in order to prevent confusion in interpreting many indicators.

Land with existing forest (as in indicator 1.1.a) plus area of potential forest cover (Argentina, Chile, Mexico).

Potential forest land - land currently without trees that is formally designated as having the potential to grow trees to produce timber

Land with existing forest (as in indicator 1.1a) plus non-forest area that falls within legally designated forest land (Russian Federation).

or

Land with a specified minimum tree crown cover and generally more than a specified minimum area, including land that formerly had such tree cover and that will be naturally or artificially regenerated. The trees should generally be able to reach a minimum specified tree height at maturity in situ. It may consist either of closed forest formations in which trees of various stories and undergrowth cover a high proportion of the ground, or of open forest formations with continuous vegetation cover in which tree crown cover exceeds the minimum percent. Young natural stands and all plantations established for forestry purposes, which have yet to reach the minimum crown density or tree height, are included under forest, as are areas normally forming part of the forest area that is temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.

Limiting measures for qualification as forest land may vary by country. Current minimum area, cover, and tree height needed to be classified as forest by country.

Forest type, forest ecosystem type

A category of forest defined by its vegetation, particularly composition, and/or locality, as categorised by each country in a system suitable to its situation. See Supplementary Notes—“The Use of Forest Type as a Means to Effectively Characterise Biodiversity at the Ecosystem Level”, in the appendix at the end of this glossary.

Foundation species
It is a dominant primary producer in an ecosystem both in terms of abundance and influence.

Fragmentation
Describes one aspect of habitat capacity. Refers generally to the reduction in size of forest patches with coincident decreases in forest connectivity and increases in patch isolation and amount of forest edge. The fragmentation of a forest into small pieces may disrupt ecological processes and reduce the availability of habitat.

Genetic diversity
The range of genetic characteristics found within a species and among different species.

or

The genetic variability of a species. It is one aspect of biological diversity. Genetic diversity can be assessed at three levels:

(a) diversity within breeding populations,

(b) (b) diversity between breeding populations; and

(c) (c) diversity within the species. (FAO)

Genetic resources
Genetic material of actual or potential value

Genetic variation
The occurrence of differences among individuals of the same species. Genetic variation is brought about by a change in genes, as distinct from differences due to environmental factors.

Genotype
The genetic constitution of an organism as distinguished from its appearance or phenotype.

Also the gene classification of this constitution expressed in a formula.

Growing stock
The living tree component of the standing volume. Standing volume is the volume above stump, of standing trees living or dead.

Gross Annual Increment
Average annual volume of increment over the reference period of all trees, measured to a minimum diameter breast height (d.b.h.) of 0 centimetres (cm). Includes: The increment on trees which have been felled or die during the reference period.

Gross Domestic Product (GDP)
A measure of country output composed of the market value of the goods and services produced by labour and property located in the country. Because the labour and property are located in the country, the suppliers (that is workers and, for property, the owners) may be either country residents or residents of the rest of the world. Gross product, or gross product originating (GPO), by industry is the contribution of each private industry and of government to the nation's output, or gross domestic product (GDP). An industry's GPO, often referred to as its "value added," is equal to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other industries or imported). The industrial origin of value added is determined by the International Standard Industrial

Classification (ISIC), rev. 2

Guilds
See species guilds.

Indicator
A measure (measurement) of an aspect of a criterion. A quantitative or qualitative variable that can be measured or described and that, when observed periodically, demonstrates trends.

Indicator species
A species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem. Species which flag changes in biotic or abiotic conditions.

They reflect the quality and changes in environmental conditions as well as aspects of community composition. *Source*: Heywood,V.H., Watson, R.T. Global Biodiversity Assessment. UNEP.

Indigenous communities
Communities of people descended from the first inhabitants of a nation or sub-national region.

Indigenous Species
See native species

Indirect employment
The result of two types of economic transaction. First, jobs are created in secondary firms that provide materials, supplies, goods and services to the primary firm. Second, employees of primary firms spend their wages and salaries in the local economy, which generates activities in the local retail and service sectors.

(see also Direct Employment)

Introduced species
A species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities. Also known as alien species.

or

An established species not native to the ecosystem, region or country.

***In-situ* conservation**
The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

Source: The Convention on Biological Diversity. Article 2. UNEP 1992

IUCN - The World Conservation Union protected area classifications
Shown below are examples (See Appendix 3).

Other classification systems are available.

Category 1. Strict nature reserve/wilderness area

Category 2. National park

Category 3. Natural monument

Category 4. Habitat/species management area

Category 5. Protected landscape/seascape

Category 6. Managed resource protected area

Invasive species
Any species not native to a particular ecosystem whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Keystone species.
A species whose loss from an ecosystem would cause a greater than average change in other species populations or ecosystems processes; Species that have a disproportionately large effect on other species in a community.

Source: Heywood,V.H., Watson, R.T. Global Biodiversity Assessment. UNEP.

Land area
An area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river food plains; streams, sloughs, estuaries, and canals within country specific widths; and lakes, reservoirs, and ponds less than country specific defined size.

Life Cycle Analysis/Assessment (LCA)
The assessment of the environmental impact of a given product or service throughout its lifespan.

Merchantable tree species
A species that has known commercial uses for wood products. Merchantability is usually judged with respect to the suitability of a species for pulp, paper, lumber, or speciality wood products. Both native and exotic tree species can be considered merchantable tree species. Countries can report separately on merchantable and non-merchantable material. Standards for each should be developed locally. Reporting trends in merchantable tree volume may become confusing if the definition of merchantability responds to changes in technology or market conditions.

Monitoring
The periodic and systematic measurement and assessment of change of an indicator.

Native species
A species known to have existed on a site before the influence of humans. It depends on the temporal and spatial context of analysis, since long-established exotic species are often considered to be native by default.

or

Plants, animals, fungi, and microorganisms that occur naturally in a given area or region.

Source: Glossary of Biodiversity Terms. UNEP-WCMC. WRI.

Net Annual Increment
Average annual volume over the given reference period of gross increment less that of natural losses on all trees to a minimum diameter of 0 cm (d.b.h.).

(see also Gross Annual Increment)

Net area of forest land available for timber production
The area of forest land, less the area that is forested but not available for timber production. Examples of areas that would be excluded include stream-side buffers; areas of water; small areas of non-forest land, such as shrubland or rocky land; land that is too steep to be harvested if safety, (soil stability), or economics are taken into account; and land that is set aside for the formal conservation reserve system.

Non-merchantable tree species
A species that has no known commercial uses for wood products. Merchantability is usually judged according to the suitability of a species for pulp, paper, lumber, or speciality wood products. Both native and exotic tree species can be considered merchantable tree species.

Non-wood forest products
- Products for human consumption: food, beverages, medicinal plants, and extracts (e.g. fruits, berries, nuts, honey, game meats, mushrooms, etc.). Fodder and forage (grazing , range). Other non-wood products (e.g. cork, resin, tannins, industrial extracts, wool and skins, hunting trophies, Christmas trees, decorative foliage, mosses and ferns, essential and cosmetic oils, etc.). (FAO)
- Consist of goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests.
- In this context, such products do not include services provided by forests such as water regulation, biodiversity conservation, recreational or spiritual values, carbon release offsets and products from mining, or oil /gas extraction.

Nuclear magnetic resonance (NMR)
A physical phenomenon based upon the quantum mechanical magnetic properties of an atom's nucleus. NMR also commonly refers to a family of scientific methods that exploit nuclear magnetic resonance to study molecules.

See: Preston, C.M. 1996. Applications of NMR to soil organic matter analysis: history and prospects. Soil Sci. 161:144-166.

Plantation
Forest stands established by planting, or deliberately sowing seed. Additional considerations in classifying a stand as a plantation may include, but are not necessarily limited to purpose of the planting or seeding, site preparation, intensity of management. Forests that fall outside this classification are not necessarily natural forests.

Population
- The number of organisms of the same species inhabiting the same area that potentially interbreed and share a common gene pool.
- The total number of organisms over a large cluster of areas, such as a physiographic region or a nation.

Precautionary principle
The Wingspread Statement's definition of the precautionary principle is:

> "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."In this context the proponent of an activity, rather than the public, should bear the burden of proof. "The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."

The precautionary principle suggests five actions:

- Set a goal (or goals);
- Examine all reasonable ways of achieving the goal, intending to choose the least-harmful way;
- Monitor results, heed early warnings, and make mid-course corrections as needed;
- Shift the burden of proof -- when consequences are uncertain, give the benefit of the doubt to nature, public health and community well-being. Expect responsible parties (not governments or the public) to bear the burden of producing needed information.

– Throughout the decision-making process, honour the knowledge of those who will be affected by the decisions, and give them a real "say" in the outcome. This approach naturally allows issues of ethics, right-and-wrong, and justice to become important in the decision. (Montague, P. 2005. The Precautionary Principle in a Nutshell. www.precaution.org.lib/pp_def.htm, Nov 2007))

Productive capacity
A classification of forest land in terms of potential annual cubic-measured volume growth of trees per unit area at culmination of mean annual increment in fully stocked forest stands.

Recovery
Identifying wood fibre and wood products as part of the post-consumer waste stream and effectively removing it from that waste stream. Recovery may be made more efficient and effective through regulations that require consumers to sort waste paper and wood products from other solid waste.

Recycling
Means that recovered wood fibre and wood products are used as raw materials for another manufacturing process (e.g., used cardboard remanufactured into new cardboard) or through transformation into a new product (e.g., shredded paper reused as landscape mulch or animal bedding).

Remote sensing
The science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object and that uses wavelengths from the ultraviolet to radio regions of the spectrum.

Reuse (Recycling)
Wood product is recovered after initial use and reused again for the same purpose without re-manufacturing or transformation.

Representative species
Species with habitat dependencies typical of a group of similar species and which are likely to respond to changes in availability of those habitats or resources. Examples include species dependent on mature forests, air quality sensitive species, wetland dependent species, hollow-tree dependent species, and thermo-regulation dependent species. Selected species are relatively ease to identify and monitor.

Resilience (ecological)
The capacity of a community or ecosystem to maintain or regain the desired condition of diversity, integrity, and ecological processes following disturbance

Riparian zone:
A strip of land of variable width adjacent to and influenced by a body of fresh water.

Per capita
Ratio of the parameter being measured against total population.

Soil A Horizon
A soil horizon is a specific layer in the soil, which parallels the land surface and possesses physical characteristics, which differ from the layers above and beneath. The A Horizon is the uppermost layer of the mineral soil.

Soil degradation
A process that describes human-induced phenomena which lowers the current and/or future capacity of the soil to support human life. (FAO)

Degradation includes the processes of soil compaction, erosion and contamination by chemicals, heavy metals and radioactive substances.

Soil erosion
The movement of soil materials from one place to another. The movement of soil due to natural processes should be distinguished from that related to forest harvesting, road construction or other human impacts.

Species
A population or series of populations of organisms that are capable of interbreeding freely with each other but not with members of other species.

Species diversity.
The number and variety of species in a given area.

Species guilds
Any group of species that exploit the same class of environmental resources in a similar way. e.g. nectar feeders, desert lizards, terrestrial salamanders, insectivorous birds. Furthermore, they do not have to group species together in terms taxonomic positions, but rather on their niche requirements.

There are problems with the guild concept

- There is no objective criteria for assigning guild membership
- Limits on membership not clearly defined
- Causes of guild structure unresolved

See. Joern and Lawlor (1981; Oikos)

Streamflow
The movement of water in a natural channel, such as a river.

(http://ga.water.usgs.gov/edu/watercyclesummary.html#streamflow)

Subsistence
Subsistence is the hunting, gathering and collection of forest products to provide food, shelter or other items essential to life and the maintenance of personal or family livelihood or cultural heritage. Examples may include meat, fruit and nuts gathered for food; wood and other materials gathered for shelter, fuel, tools and crafts; trapping for fur and the collection of objects for ceremonial use. Subsistence implies a reliance on the forest as the major source of essential resources, rather than supplementary activity. Subsistence goods can be considered any goods that are substitutes for a market good.

Successional stage
A characteristic of many ecosystems that experience a change in structure and/or species on a given site in relation to time since major disturbance. Where they occur, seral stages include early successional vegetation through to later successional stages. In many cases, the successional stages reflect a shift from the dominance of shade intolerant species to that of shade tolerant species.

Sustainable Forest Management (SFM)
The stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality, and their potential to fulfil, now and in the future, relevant ecological, economic, and social functions at local, national, and global levels, and that does not cause damage to other ecosystems.

The criteria and indicators are intended to provide a common understanding of what is meant by sustainable forest management. Each is of equal importance. They

provide a framework for describing, assessing, and evaluating a country's progress toward sustainability at the national level and include measures of:

1. Conservation of biological diversity;

2. Maintenance of productive capacity;

3. Maintenance of forest ecosystem health;

4. Conservation and maintenance of soil and water resources;

5. Maintenance of forest contribution to global carbon cycles;

6. Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of society; and

7. Legal, institutional, and economic frameworks for forest conservation.

Tenure
The act of owning, using, or controlling land or the resources of that land under certain terms and conditions.

Threatened species
Plant or animal species likely to become endangered throughout all or a significant portion of their range within the foreseeable future.

Turbidity
A measure of water clarity, or the degree to which water is rendered opaque by the suspended silt or other sediments.

Vulnerable Species (VU)
A taxon is vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable category of IUCN Red list and is therefore considered to be facing a high risk of extinction in the wild.

IV SUPPLEMENTARY NOTES:

THE USE OF FOREST ECOSYSTEM TYPE AS A MEANS TO EFFECTIVELY CHARACTERISE BIODIVERSITY

Criterion 1 of the Montréal Process, 'Conservation of Biological Diversity', refers to the use of measures of change in the extent of forest ecosystem types as an indication of changes in ecosystem diversity. Forest ecosystem type is a term with a hierarchical set of meanings depending on the scale of the landscape being addressed. At a national level, countries must first distinguish forest ecosystems from non-forest ecosystems. Forest ecosystems can then be categorised at varying scales. Within areas defined as forested, aggregated forest ecosystem types can be used to broadly categorise vegetation, for example, as broad-leaved vs. mixed vs. evergreen, hardwood vs. softwood, or rainforest vs. wet schlerophyll vs. dry schlerophyll. In most countries forest ecosystem type refers to the categorisation of forest into tree species types such as hinoki, spruce-fir, or flooded gum. Descriptions of forest type often include the density and dominance of canopy and under story trees.

The elements of a forest ecosystem type category will vary from country to country. For example, forest ecosystem type can include the percentiles of major forest canopy tree species, tree canopy and understorey vegetation, or tree canopy and site productivity. Forest structure can be measured indirectly by the age of the forest since the last major disturbance, or the timber merchantability class such as seedling, poles, mature, or over mature, which is a measure of age.

The boundaries of a forest ecosystem type are usually defined by forest inventory specialists or by forest ecologists who quantify or judge the variation and determine when one forest ecosystem type has changed to another. Forest ecosystem types or groups of forest ecosystem types can cover an area from less than one hectare to thousands of hectares, depending on the nature of the forest and the variability of landform and terrain.

Many forest ecosystem type classification systems were initially established as part of a timber inventory mapping process. The types were often used as the basis for forest inventory, monitoring and projection of timber growth and yield. However, recent increases in public interest in non-timber values in forests has led to a broadening of the concept of forest ecosystem type and a broadening of the uses and interpretations placed on forest ecosystem types. At an optimum, forest

ecosystem type can be expanded beyond tree species groupings to a concept of forest ecosystem mapping. This type of change would be expected to take many years to unfold because of the magnitude and cost of full vegetation mapping processes. At the point at which ecosystems are mapped, the forest ecosystem type mapping becomes a highly effective tool for tracking the distribution and abundance of ecosystems and hence, their diversity. Changes in the diversity of ecosystems allow some ability to estimate the potential changes in availability of habitat for species and hence, to estimate potential changes in species diversity. Where there has been large scale habitat modification, or land use changes, for example, to agriculture, there is also the ability to recognise the risk or magnitude of reduced genetic diversity.

A total mapping of forest ecosystems has only been done in some countries. However, at present, most countries could use forest ecosystem type as a surrogate measure of forest ecosystems. As forest ecosystem type is generally a mapped feature, it does provide a continuing record of the distribution and abundance of tree species cover and other associated features, such as habitat. It is in this regard that forest ecosystem type can be used to monitor potential changes in ecosystem diversity. Systematic changes in the proportions of forest ecosystem types, such as late successional versus seral, or broad-leaved versus conifer, can indicate changes in the nature of the biodiversity of a country or region. While tracking ecosystem diversity via forest ecosystem type can overlook slight changes in vegetation communities and biota, it will signal changes that likely correlate with shifts in the pattern and character of biodiversity.

Using forest ecosystem type as a surrogate for ecosystem diversity, then, relies on the ability to track or predict changes in the nature, extent, and distribution of aggregated forest ecosystem types at the national or, in the case of larger countries, regional scale. Some benchmark or historical record of forest ecosystem type must be used against which to measure the degree of change, and repeated measures over time can then indicate expansion, contraction, loss, and creation of forest ecosystem types. Where specific forest ecosystem types are shown to be critical to the survival or well being of certain species, proportional changes in forest ecosystem type can provide insight into potential changes in dependent flora and fauna. Where there has been loss of forest ecosystem types at the edge of climatic or geographic ranges of species, there is likelihood that genetic diversity of species or populations may be compromised. It must also be recognised, however, that many

locally adapted populations (e.g., resistant to drought or salinity) are not found solely at the edge of overall species ranges.

In summary, forest ecosystem types (or groups of forest ecosystem types) are defined and used differently in different countries. Forest ecosystem type is presently considered to be the best available surrogate for the measurement of forest ecosystem diversity. The effectiveness of this approach, however, will be dependent on the degree of correlation actually found between forest ecosystem types and inter- and intra-specific diversity, the quality of the data, the amount of information used in the forest ecosystem type label, and the ability to assess trends in forest ecosystem type changes. Finally, the interpretation of changes in the distribution and abundance of forest ecosystem types can potentially be used cautiously as a signal that changes may be occurring in species and genetic diversity of forests.

The characterisation of forest ecosystem types in this manner will ensure the value of C&I as a direct contributor to the ecological conservation and assessment requirements of other global conventions (e.g., CBD, CITES, UNFF, IUCN) and to contribute to the information and reporting needs of NGO's and conservation-oriented stakeholders.

Definition from Glossary

Ecosystem -- A dynamic complex of living organisms (plant, animal, fungal and micro-organism communities) and the associated non-living environment with which they interact.

.

ANNEX List of Montréal Process Criteria and Indicators (Criteria 1-6) 2007 Version

Criterion 1: Conservation of biological diversity

1.1 ***Ecosystem diversity***

1.1.a Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure

1.1.b Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage

1.1.c Fragmentation of forests

1.2 ***Species diversity***

1.2.a Number of native forest-associated species

1.2.b Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment

1.2.c Status of on site and off site efforts focused on conservation of species diversity

1.3 ***Genetic diversity***

1.3.a Number and geographic distribution of forest-associated species at risk of losing genetic variation and locally adapted genotypes

1.3.b Population levels of selected representative forest-associated species to describe genetic diversity

1.3.c Status of on site and off site efforts focused on conservation of genetic diversity

Criterion 2: Maintenance of productive capacity of forest ecosystems

2.a Area and percent of forest land and net area of forest land available for wood production

2.b Total growing stock and annual increment of both merchantable and non-merchantable tree species in forests available for wood production

2.c Area, percent, and growing stock of plantations of native and exotic species

2.d Annual harvest of wood products by volume and as a percentage of net growth or sustained yield

2.e Annual harvest of non-wood forest products

Criterion 3: Maintenance of ecosystem health and vitality

3.a Area and percent of forest affected by biotic processes and agents (e.g. disease, insects, invasive species) beyond reference conditions

3.b Area and percent of forest affected by abiotic agents (e.g. fire, storm, land clearance) beyond reference conditions

Criterion 4: Conservation and maintenance of soil and water resources

4.1 ***Protective function***

4.1.a Area and percent of forest whose designation or land management focus is the protection of soil or water resources

4.2 ***Soil***

4.2.a Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources

4.2.b Area and percent of forest land with significant soil degradation

4.3 ***Water***

4.3.a Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water related resources.

4.3.b Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical or biological properties from reference conditions

Criterion 5: Maintenance of forest contribution to global carbon cycles

5.a Total forest ecosystem carbon pools and fluxes

5.b Total forest product carbon pools and fluxes

5.c Avoided fossil fuel carbon emissions by using forest biomass for energy

Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

6.1 ***Production and consumption***

6.1.a Value and volume of wood and wood products production, including primary and secondary processing

6.1.b Value of non-wood forest products produced or collected

6.1.c Revenue from forest based environmental services

6.1.d Total and *per capita* consumption of wood and wood products in round wood equivalents

6.1.e Total and *per capita* consumption of non-wood products

6.1.f Value and volume in round wood equivalents of exports and imports of wood products

6.1.g Value of exports and imports of non-wood forest products

6.1.h Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption

6.1.i Recovery or recycling of forest products as a percent of total forest products consumption

6.2 ***Investment in the forest sector***

6.2.a Value of capital investment and annual expenditure in forest management, wood and non-wood forest product industries, forest-based environmental services, recreation and tourism

6.2.b Annual investment and expenditure in forest-related research, extension and development, and education

6.3 ***Employment and community needs***

6.3.a Employment in the forest sector

6.3.b Average wage rates, annual average income and annual injury rates in major forest employment categories

6.3.c Resilience of forest-dependent communities

6.3.d Area and percent of forests used for subsistence purposes

6.3.e Distribution of revenues derived from forest management

6.4 Recreation and tourism

6.4.a Area and percent of forests available and/or managed for public recreation and tourism

6.4.b Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available

6.5 Cultural, social and spiritual needs and values

6.5.a Area and percent of forests managed primarily to protect the range of cultural, social and spiritual needs and values

6.5.b The importance of forests to people