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INDICATORS OF FOREST BIODIVERSITY

Working document prepared for the meeting of the liaison group on forest biological diversity

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INDICATORS OF FOREST BIODIVERSITY

Note by the Secretariat

1. To facilitate the discussion and the identification of priorities of the liaison group on forest biological diversity with respect to criteria and indicators for forest biological diversity, the Secretariat submits the attached document for consideration.

2. The third Conference of the Parties in, *inter alia* decisions III/9, III/10 and III/12 recognised the need to develop biodiversity indicators in general, and criteria and indicators for forest biological diversity in particular, suitable for use in national reports to the Convention on Biological Diversity. This proves to be difficult as indicators must be sensitive enough to give reliable information, they should be applicable at national level and should be capable of regular updating, all without posing unreasonable demands on governments and supporting institutions.

3. In the forest sector, some of the practical difficulties of assessing biodiversity are magnified by frequent lack of data and by a particularly diverse range of ecosystems. However, there is already a vast amount of information and techniques from a range of existing initiatives, many of which have been developed as a result of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro.

4. The current paper has been developed to fulfill four functions: to suggest some general principles for the development of criteria and indicators of forest biodiversity; to discuss different levels of biodiversity assessment, including their strengths and weaknesses and applicability to CBD national reports; to summarise information on existing initiatives that might provide techniques and data that could be utilised or adapted by the CBD; and to make preliminary suggestions regarding indicators of forest biodiversity.

5. Out of necessity, some of the information contained in this paper is drawn from drafts of documents that are yet to be finalised, and from personal communications and unpublished material. It should therefore be confined to members of the expert group at the present time. Development of biodiversity indicators draws on expertise from a wide range of disciplines, and as a result some of the material and ideas will already be familiar with some of the readers.

I General Principles for the Development of Criteria and Indicators of Forest Biological Diversity

6. Drawing on previous research on biodiversity assessment[1] and experience with criteria of forest quality[2], this paper suggests some principles for developing forest biodiversity indicators:

7. It is important to place biodiversity assessment within a broader framework of forest quality. Biodiversity is influenced by a wide range of factors including, cultural practices, air pollution and forest management. As an example, criteria and indicators of *forest quality* has been drawn up - i.e. a list of the goods and services that forests provide, including biological, social and economic elements. These are summarised below and may provide a basis for consideration under the CBD. Placing biodiversity within a broader framework of forest quality is important both because biodiversity is itself influenced by many of these other elements and because biodiversity is already often being assessed alongside other forest quality elements by other institutions.

ELEMENTS OF FOREST QUALITY

Authenticity:

* composition - composition of trees etc.;
* pattern - spatial variation of trees with respect to age, size etc.;
* function - continuity of forest, proportion and type of dead timber etc.;
* process - natural disturbance patterns and regeneration strategies;
* management practices - mimicking natural processes, landscape approaches etc.

Forest health:

* health of trees;
* health of other forest flora and of fauna; and
* robustness to changing environmental conditions.

*Environmental benefit*s

* biodiversity and genetic resource conservation;
* soil and watershed protection;
* impacts on other natural or semi-natural habitats; and
* climatic stabilisation.

Social and economic values:

* wood products;
* non-timber forest products;
* employment, indirect employment and subsistence activities
* recreational values;
* forest as homeland for people;
* historical value;
* educational value, including the role of forests in scientific research;
* cultural and aesthetic values;
* spiritual and religious values; and
* local distinctiveness

8. Biodiversity is influenced by more than just area under trees: Analysis of forest cover and deforestation rates may give some useful information, but will not provide a total picture of forest

biodiversity. For example, New Zealand and Scotland have a roughly equivalent proportion of their land under trees (approximately 25 per cent and 16 per cent respectively). However, New Zealand has around 85 per cent native forest and 15 per cent *Pinus radiata* plantations, while Scotland has less than 10 per cent native woodland and over 90 per cent plantations mainly of spruce (*Picea* spp)[3]. The biodiversity value of these two forest estates is very different.

9. Biodiversity is not made up of units of equal significance: biodiversity value varies between species and ecosystems according to a range of factors, including the degree of genetic variation within species, the degree of difference between the various species in an ecosystem, complexity of lifestyle, the number of other species associated with a particular species, endemism, etc.[4]. Other variations relate to risk factors, particularly with respect to vulnerability to extirpation or extinction. Some conventional measures of biodiversity - such as numbers of species present - only give a very partial picture. For example, species numbers can increase after clearcutting a forest, but the newcomers usually consist of generalised or invader species, thus disguising losses of site-specific species[5]. Ranking may be necessary, for example by rarity or vulnerability.

10. Most forests have already been modified by people: Complete ecological integrity is already an historical concept in most forests. Many forests that have developed since the last ice age have *never* existed without human disturbance. Even supposedly "virgin" forests - such as those in the Amazon - are now known to have been profoundly influenced by indigenous people, often to the extent of introducing species, changing dominance and altering the canopy. The distinction between "natural" and "disturbed" forests is less important than the *degree* and *type* of disturbance. WWF uses the concept of *authenticity* to focus on current ecosystem function, regardless of the forest's history[6], thus creating a definition with relevance to both natural and disturbed forests.

11. Biodiversity can be significant in very non-natural forests. Even artificially created forests can sometimes develop or attract relatively high levels of diversity; in degraded landscapes these can assume critical importance. For example, the *tembawang* fruit forests established by the Dayak people of West Kalimantan are essentially planted forest fragments, maintained for food crops, but now contain the highest levels of biodiversity remaining in a heavily modified landscape[7]. Many of the swamp forests of Latvia were planted less than a hundred years ago but now have a key role in preserving biodiversity at both ecosystem and species level[8]. Measurements of "naturalness" do not give a comprehensive picture of status or importance to biodiversity.

12. When choosing indicators it is clear that no single indicator will be adequate to summarise information on all aspects of national forest biodiversity. Instead, a picture will have to be built up from a range or *portfolio* of different indicators which together provide an approximate picture of national biodiversity status. Each indicator should be chosen to "capture" as much information as possible.

13. The section below outlines some key points to consider when choosing forest biodiversity indicators:

(a) <u>Breadth of issues</u> addressed by biodiversity indicators: As outlined above, biodiversity can be influenced by a wide range of factors. Not all of these will be within the scope of the Convention or national reports. A balance will have to be struck between keeping the field of research wide enough to present an accurate picture and avoiding the risk of duplicating other processes and developing an unwieldy system of information collection. Many of these wider issues will, inevitably, have to be omitted from the CBD National Reports. A

decision on how wide a range of issues are to be addressed must be made *before* looking in detail at types of indicators.

(b) Simplicity should be a major consideration in choosing forest indicators: Before finalising the choice of indicators, consideration should be given to whether a simpler alternative exists. Use of highly expensive techniques such as satellite images and detailed biodiversity surveys should be confined to situations in which no alternative is available.

(c) Quantitative and descriptive indicators. Some aspects of forest biodiversity may not be suitable for quantitative description at the present, due to lack of techniques, data or money. In these cases, a descriptive approach may be justifiable. The alternative often means omitting the particular issue altogether or adopting "quantitative" measures of unproved accuracy. Insisting on only quantitative measures can, paradoxically, reduce the accuracy of the overall assessment.

(d) Limited resources and expertise. Many countries are severely limited by lack of money and trained personnel; there is also a global lack of expertise in many aspects of biodiversity measurement. Resources will have a large influence on the *level* of assessment undertaken, as examined below in section 2.

(e) Changes over time. All indicators should be tracked over time to show progress in biodiversity conservation; if possible indicators should also be linked to specific targets.

(f) Regional differences between indicators. Choice of indicators will also to some extent be driven by the extent of resources and expertise in a country or region. Accordingly, some regional differences may be inevitable, at least in the first few National Reports. This issue is examined in section 4.

(g) Social aspects. Although the biological information supplied by indicators is important, these also have important social values, particularly if they are used as the basis for reporting to the public. Choice of indicators should therefore also be made partly on their ease of comprehension, social values and on the impression that indicators make on the public.

(h) Susceptibility to human influence. Indicators need to be chosen with care to avoid those that may be changing anyway due to natural fluctuations. The main *cause* of changes in indicators should be apparent.

(i) Assessment. Even indicators that provide good information may become less useful over time, either because the pressures on them change or, in the case of species indicators, they can sometimes adapt to hanging conditions. For example, in Wales the merlin (*Falco columbarius*), a small bird of prey, has long been an indicator of loss of semi-natural moorland, but now has apparently adapted to breeding in dense conifer plantations.

(j) New approaches. New information and techniques are becoming available, but there are still large areas of uncertainty. At present choice of indicators is still driven mainly by current data availability and by particular interests amongst taxonomists. Knowledge tends to be concentrated on larger plants and animals, although there is no proof that these are actually

the best indicators of biodiversity. For example, birds are often fairly poor indicators of disturbance in forests, with no clear trends appearing between forest ecosystems.

(k) At the same time, some old measures are becoming obsolete or are changing. For example, the development of new categories of protected areas by the World Commission on Protected Areas implies that many country statistics are having to be revised.

14. It is important to bear in mind that national reporting to the CBD will inevitably take place against a background of developing expertise, and therefore care should be taken to plan for revisions in technique and data sources in the future.

15. For the moment, experience with other initiatives, described below, suggests that partial information is usually better than no information.

II Levels of biodiversity assessment

16. Biodiversity can be measured at a number of different levels, depending on the time, resources and expertise available. For simple surveys to determine forest management practices, conservation strategies and areas requiring further study, very broad-scale survey techniques are probably adequate. At the other end of the scale, detailed surveys of local provenance and genetic variation may be needed for studies of genetic biodiversity.

17. Five general levels of assessment can be identified [9].

(i) National survey: a survey to monitor such issues as compliance with international agreements, provide data for global surveys etc. This relies on very general data, often in the form of questionnaires from international agencies, national-level studies etc.

Methods include:

- division of forests into status broad classes, such as *natural forest*, *semi-natural forest* and *plantation*;
- use of age-class to identify old forest; and
- use of Red Lists of endangered species.

(ii) Landscape survey: an initial survey to identify areas worthy of further study. This uses techniques that are either very simple to apply and thus can be used over a wide area in a fairly short time, or more specialised methods such as interpretation of satellite imagery that cover large areas in a single examination.

Methods include:

- use of satellite images to identify unfragmented, primary or old-growth forest;
- use of aerial and/or video surveys of forest cover, with the option of including computer simulated mapping from video images; and
- ground-level surveys of canopy structure on or from elevated land to identify old-growth characteristics in forest or particular indicator tree species.

(iii) Structural survey - forest authenticity: a ground-level survey of structural characteristics of forests, to identify the *potential* for authentic population levels and composition of biodiversity.

Methods include:

- identification of underlying geology and soil type;
- survey of species mix, age composition and stand structure; and
- identification and classification of snags and downed logs.

Structural surveys can identify forests that have a natural pattern and process, and can indicate areas that have the potential for high biodiversity by virtue of possessing a wide range of suitable habitats. However, structural characteristics do not offer proof that a forest has high biodiversity. A forest can look natural but if, for example, it has been cleared at some time in the past and later regrown, or if certain components have been removed at some period (such as people collecting dead wood for fuel) then the biodiversity may have been substantially altered. To gain more knowledge about whether the potential for high biodiversity is realised, more detailed surveys are needed, such as those using indicators.

(iv) Indicators survey: a survey using specialised indicator species to identify rare habitats and microhabitat continuity. Indicators must be chosen carefully to "capture" as large a proportion of biodiversity as possible. Ideally, a "portfolio" of indicators will be used to identify different aspects of ecological authenticity. For example, some fungi grow on downed logs while others are confined to snags; using examples of both will give a more complete picture of forest function than one or the other. However, this method is only an *indication* of biodiversity rather than a complete survey and a balance must be struck between detail and limitations of time and resources. Indicators also need to be continually re-assessed to check whether they are supplying valid information.

Examples of indicators include:

- lichens and fungi associated with different ages and conditions of trees;
- vascular plants associated with ancient woodland; and
- birds associated with old-growth forest.

(v) Genetic survey: detailed stand survey of genetic variation within a stand to identify local varieties, different provenance, etc. Knowledge of genetic surveys is still developing. Possible methods include:

- historical surveys to identify dates of planting and management, and sources of seed;
- identification of local variation in species where this can be identified by visible characteristics (such as some land snails, vascular plants and birds);
- detailed studies of genetic variation in particular species.

18. Note that the five levels require an increasing level of specialisation amongst professional staff. Techniques used for landscape surveys will be applicable in many areas; elements for structural surveys will be applicable over biomes; indicator species will be confined to regions; and studies of local provenance will rely on very site-specific data.

19. Biodiversity assessment can and should take place on a number of different levels, depending on the degree of detail needed. Assessing biodiversity at the national level poses a particular challenge. For national reporting, it will probably only be possible to record the more general information given by surveys at levels (i), (ii) and perhaps (iii). However, it should be noted that most of these, and particularly surveys using satellite images, geomorphology and structural characteristics of forests, can at best give information about the *likelihood* of high biodiversity. Forests that are old enough to have developed a natural structure may still have relatively low biodiversity, because of historical clearance, hunting pressure, atmospheric pollution, removal of dead timber or other causes. For example, field surveys found that woodlands planted 400 years ago in southern England still had on average 40 per cent fewer vascular plant species than more ancient woodlands in the same area[10].

20. Precise information on biodiversity involves use of more detailed surveys of the species that are present or at least of carefully chosen indicator species; this will often be impossible at the scale needed for national surveys. The techniques available are summarised in Table 1 below:

Level of survey	**Details of some survey techniques**	**Quality of information**
National	Status classes, age classes, use of Red Lists of endangered and vulnerable species	Potential biodiversity
Landscape	Satellite imagery, aerial video surveys, ground-level structural surveys	Potential biodiversity
Structural	Underlying geomorphology, stand structure, species mix, identification of dead timber etc.	Potential biodiversity
Indicators	Birds and vascular plants associated with old-growth forests, lichens associated with different microhabitats	Actual biodiversity
Genetic	Historical surveys, local variation in species, detailed genetic studies	Actual biodiversity

21. At present, most experience is in site level surveys of the type too detailed for the CBD's current needs (although it should be noted that a *total* biodiversity survey of a site has never been completed). Experience of satellite data sources is growing, but this may also still have limited value in terms of forest biodiversity assessment. A compromise between accessibility of data and accuracy is needed, including the further development of techniques of assessment.

III Existing initiatives

22. In considering forest biodiversity, the Convention on Biological Diversity has the advantage of being able to draw on expertise from a wide range of previous experience, including: experience gained from the preparation of national reports required by other UN conventions and treaties; forest resource assessments carried out by the UN FAO and UNECE; experience and techniques developed from various sustainable forest management criteria and indicator initiatives on a national level and by NGOs.

23. Virtually all existing UN conventions have some reporting requirements, and many require regular national reports of the type being developed by the CBD. An initial survey undertaken in the preparation of this paper suggests that, with some exceptions, other UN treaties offer relatively little in terms of data, but can provide good background experience about the process of reporting and data gathering.

24. An analysis undertaken for a non-governmental organisation suggests that: "the receipt of reports on time is a chronic problem for virtually all international treaties"[11]. For example, 28 per cent of CITES signatories submitted their 1991 report on time, and 50 per cent were still outstanding two years after the deadline. Similarly, only 10 per cent of Ramsar signatories had submitted reports on time in 1993, although 65 per cent submitted by the meeting in which they were discussed.

25. Countries have also encountered problems in recording changes to forest conditions. In general, reporting problems appear to be particularly acute in developing countries, mainly due to lack of resources and trained personnel.[12] The relatively high level of reporting under the Climate Change Convention, where most information is required from developed countries, appears to support this assumption. It should, however, be emphasized that there need be no insurmountable problem with reporting if resources are made available to countries as necessary.

26. The UN Food and Agriculture Organisation co-ordinates an international survey of forest resources, with the temperate and boreal component being run by the UN Economic Commission for Europe. The full Forest Resource Assessment (FRA) reports every ten years, although interim reports are starting to appear more regularly.

27. In the past, the FRA confined itself to traditional forest data, such as area under trees, volume of timber etc., in part drawing on annual FAO trade statistics and partly on data compiled through questionnaires to national governments. The 1990 FRA went further in that it included qualitative descriptions of wider forest values, including non-timber forest products etc.[13]. Under pressure from member governments, preparation for FRA-2000 has included considerable efforts to develop simple measures of *forest quality*, through a week-long expert consultation in Finland during the summer of 1996[14] and through smaller meetings of specialist working groups. The results of this work, which are still only in draft, are analysed alongside other initiatives below.

28. At a Ministerial Meeting organised jointly by Finland and Portugal in Helsinki in the summer of 1993 four basic resolutions on forests were adopted. This launched the ‘Helsinki Process’, with the mandate to develop and implement a set of criteria and indicators of sustainable forest management. The ‘Helsinki Process’ has been followed by several others aimed at different regional groups and at various stages of development.

These are summarised in Table 3.

TABLE 3.

Process	Organising body	State of development
Helsinki[15]	Council of Ministers in Europe, secretariat in Finland and Portugal	Criteria and indicators developed and agreed, first interim report prepared[16], stand management level guidelines developed
Montreal[17]	Originally the Committee for Security and Cooperation in Europe and Canadian government; secretariat now in Canada	Criteria and indicators developed and agreed[18], first interim report prepared.
Tarapoto[19]	Amazon Pact countries	Draft criteria and indicators prepared
Dry-Zone Africa[20]	FAO	Draft criteria and indicators prepared
North Africa and the Middle East	FAO	Draft criteria and indicators prepared
Central America	FAO	Draft criteria and indicators prepared

29. A related development is also taking place in Asia. In addition, criteria and indicator processes are under development within the International Tropical Timber Organization (ITTO)[21], the African Timber Organization[22] and the OECD[23], while some NGOs have also developed C&I frameworks, including a joint initiative by IUCN and the World Resources Institute[24]. Although some of these are not precisely equivalent, they have enough common features to allow comparisons to take place. As a result, there are at least ten sets of criteria and indicators that include an element of forest biodiversity in advanced state of development, along with information from the modification of the FRA.

30. In the preparation of this paper, a detailed analysis of these initiatives has been carried out, and some common generalised indicators identified[25]. These are presented in detail in Table 4 over the following four pages, and discussed thereafter.

31. Three generalised indicators are common to all the initiatives: forest cover and quality; protected areas; forest dependent species; with a fourth important in all temperate and boreal forest areas: forest health (note that this does not always appear under the biodiversity section of the various criteria and indicators).

32. Three other indicators appeared in several of the initiatives: conservation of genetic resources; impacts of human activity; and legal infrastructure.

33. There is surprisingly strong coherence between the various initiatives, although some concentrate on certain issues to the exclusion of others.

Generalised indicators	Helsinki Process	Montreal Process	Tarapoto Process	Dry-Zone Africa Process
CRITERION	4. Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems 2. Maintenance of forest ecosystem health and vitality	3.3 Criterion 1: Conservation of biological diversity 3.3 Criterion 3: Maintenance of forest ecosystem health and vitality	4. Conservation of forest cover and of biological diversity	2. Conservation and enhancement of biological diversity in forest ecosystems
Forest cover and quality				
Area		Extent of area by forest type relative to total forest area		Areas by types of vegetation (natural and man-made)
		Extent of area by forest type and by age class or successional stage		
Changes in area	Changes in the area of natural and ancient semi-natural forest types		Rate of conversion of forest cover to other uses	
Amount of regeneration	In relation to the total area regenerated, proportion of annual area of natural regeneration		Rate of natural regeneration, species composition and survival	
Fragmentation		Fragmentation of forest types		Fragmentation of forests
Management impacts	Changes in the proportion of mixed stands of 2-3 species			
Protected areas				
	Changes in the area of strictly protected forest reserves	Extent of area by forest type in protected area categories as defined by IUCN or other classification schemes	Area, by forest type, in categories of protected areas, in relation to total forest area.	Extent of protected areas
	Changes in the area of forests protected by special management regime	Extent of areas by forest type in protected areas defined by age class or successional stage		
	Changes in the proportion of stands managed for the conservation and utilisation of forest genetic resources (gene reserve forests, seed collection stands etc)			
Forest dependent species				
Numbers		The number of forest-dependent species		Number of forest dependent species
Status of forest dependent species	Changes in the number and percentage of threatened species in relation to total number of forest species (using reference lists e.g. IUCN, Habitat Directive...)	The status (threatened, rare, vulnerable, endangered or extinct) of forest dependent species at risk of not maintaining viable breeding populations...		Number of forest dependent species at risk
		Number of forest dependent species that occupy a small portion of their former range		Area cleared annually of forest ecosystems containing endemic species

OECD	African Timber Org	ITTO	FRA-2000	WRI/IUCN
Core forest resource indicators	III. The main ecological functions of the forest are maintained: III.2 Negative impacts of various interventions on biodiversity are minimised.			
Area and volume distribution of forests			Area of forest by main forest types and ecofloristic zones (including trends)	
			Naturalness of forests defined by: natural; semi-natural/ancient; plantation	
Percentage of harvest area successfully regenerated (including natural regeneration)			Forest regeneration divided into: natural; natural with planting; coppice; planting or seeding (exotic/native)	
% of disturbed/deteriorated forest		Maintaining a mosaic of old-growth fragments		
		Rotation length, felling cycles, retention of dead trees etc		
Percentage of protected forest in total forest area	Zones of biological protection where no interference is authorised are created in the permanent forest estate	Existence of protected areas and buffer zones	Proportion of forest in: IUCN Categories I to IV; and IUCN Categories V to VI	Proportion of area in strictly protected areas.
	Size of biological reserves is adapted to suit the object of preservation	Existence of corridors between protected areas		Endemic species in protected areas
	Selection of biological preservation areas should take into account their potential for effective protection	Existence of small virgin forest reserves within managed forests		Threatened species in protected areas
			Total forest dependent species	Species richness/endemic species
			Total forest dependent species at risk or endangered [information divided into categories: mammals, birds etc]	Species threatened with extirpation or extinction.
	Rare or endangered species are protected			Endemic species threatened with extirpation or extinction

(Continued overleaf)

Generalised indicators	Helsinki Process	Montreal Process	Tarapoto Process	Dry-Zone Africa Process
				Number of forest dependent species with reduced range
		Population levels of representative species from diverse habitats monitored across their range		Population levels of key species across their range
Responses			Measures of *in situ* conservation of species in danger of extinction	
Forest health				
Area affected	Changes in serious defoliation of forests using the UN/ECE and EU defoliation classification	Area and % of forest affected by processes or agents beyond the range of historic variation, e.g. by insects, disease etc...	Area and % of forests affected by processes or other agents (insect attack, disease, fire, flooding etc)	
	Serious damage caused by biotic or abiotic factors [insects, diseases, fires, storms and game animals]	Area and % of forest land with diminished biological components indicative of changes in fundamental ecological processes...	Area and % of land with fundamental ecological change	
	Changes in nutrient balance and acidity over the past 10 years			
Levels of damaging agents	Total amount of and changes over the past 5 years in depositions of air pollutants	Area and % of forest subjected to levels of specific air pollutants or ultraviolet B that may cause negative impacts on the forest ecosystem		
Genetic resources				
	Differentiation between indigenous and introduced species		Measures for the conservation of genetic resources	Average number of provenance
				Management of genetic resources
Impacts of human activity				
			Impact of activities in other sectors on the conservation of forest resources (mining, ranching, energy, infrastructure etc)	Resource exploitation systems used
Legal infrastructure				
	Existence of regulatory framework to provide for national adherence to international instruments			
	Existence and capacity of an institutional framework to conserve biodiversity...			
	Existence of (appropriate) economic policy framework and financial instruments...			
	Existence of information means to implement the policy framework...			

OECD	African Timber Org.	ITTO	FRA-2000	WRI/IUCN
	Special provision of sensitive areas should be defined in management plans			Species risk index
			Measures of *in situ* conservation of species in danger of extinction	
			Total area affected: annual average over 5 years and worst case over 10 years	
			Information on defoliation classes	
			Percentage of damage caused by different factors	
	Discouragement of single or exotic species' plantations		Provenance of genetic material used for planting	
	Enrichment planting should be of logged species			
	Conservation of non-timber forest products.	Existence of systems to assess biodiversity and existence of EIAs		
	Existence of a management plan	Existence of appropriate national legislation backed by sufficient resources		

34. The results are presented in summarised form in **Table 5** below.

Generalised indicators	**FRA-2000**	**Helsinki**	**Montreal**	**Tarapoto**	**Dry-Zone Africa**	**African Timber Organizat'n**	**OECD**	**ITTO**	**WRI/ IUCN**
Forest cover and quality									
Area	✓		✓		✓		✓		
Changes in area	✓	✓		✓					
Amount of regeneration	✓	✓		✓			✓		
Fragmentation			✓		✓		✓	✓	
Management impacts	✓	✓						✓	
Protected areas									
Extent	✓		✓	✓	✓	✓	✓	✓	✓
Changes	✓	✓							
Forest dependent species									
Numbers	✓		✓		✓				✓
Status of forest dependent species	✓	✓	✓		✓			✓	✓
Responses				✓		✓			
Forest health									
Area affected	✓	✓	✓	✓					
Levels of damaging agents		✓	✓						
Genetic resources									
Conservation of genetic resources	✓	✓		✓	✓	✓			
Impacts of human activity									
Management impacts				✓	✓	✓		✓	
Legal infrastructure									
Existence of legal infrastructure		✓				✓		✓	

4 Preliminary suggestions for indicators of forest biological diversity

35. It is clear from the preceding sections that developing a set of useful and realistic indicators of forest biodiversity is an extensive task. Key problems include:

- Lack of knowledge: techniques are still being developed, data are scarce in many countries and even concepts of biodiversity are still far from standardised;

- Lack of resources: in many countries, lack of money and trained personnel will put severe limitations on what can be achieved;

- Lack of reporting: experience with other similar reporting exercises suggests that a substantial proportion of countries will either not report or will at best report very late.

36. On the other hand, some countries have already developed sophisticated approaches towards biodiversity measurement. A balance has to be struck between keeping approaches simple enough to avoid disheartening the majority of countries and at the same time encouraging those that are prepared to go further. Aiming too low risks giving lead governments the excuse to reduce existing research and data collection. Experience with using existing data sets, such as the UN Forest Resources Assessment and the preliminary reports from the Helsinki and Montreal Processes suggests that some information is better than none, as long as the shortcomings are clearly admitted and identified. The following draft recommendations attempt to address the various problems outlined above and provide both a realistic and hopefully an optimistic strategy.

5 Recommendations

37. Capacity for data collection and reporting varies dramatically between Parties. One way of addressing this is to divide indicators into a series of categories; the following are suggested:

- international data: information that is available from international sources, which can provide at least partial cover for countries that do not complete National Reports;

- core set of data: information that should be available to any country attempting to complete a National Report (there may be some overlap with [1])

- advanced data: information that will probably only be collected by a limited number of countries, at least for the first National Report, but which other countries should be aiming to collect in the future;

- developing techniques: data that has been identified as being important in the future, but where collection techniques are still being developed or improved.

38. There is a general concern about duplication of effort in collection of data, particularly in the case of forest biodiversity, given the large number of other data collection systems already in existence or under development. Following the meeting of the liaison group on forest biological diversity in May, this problem could be addressed by convening a small meeting of key personnel involved in the various data collection processes to discuss if and where data sets could be shared.

39. There have already been some attempts to carry out such liaison by FAO[26], and a preliminary study by the World Resources Institute[27]. It should be noted that the proposal to amalgamate the various criteria and indicator processes was rejected at the Intergovernmental Seminar on Criteria and Indicators for Sustainable Forest Management in Helsinki in August 1996[28], so data sharing may have to be informal.

40. To facilitate the liaison group's discussion on options for forest biodiversity indicators the following suggestions, summarised in Table 6 below, are put forward. It should be noted that these are far from comprehensive and are presented to help stimulate further discussion. They draw on a

range of national experience including criteria and indicators developed by Finland, Malaysia[29], Switzerland[30], Canada[31], Germany[32], and experience from research by WWF, WRI, WCMC[33] and others. The table below only considers the first three levels of indicators: i.e. international, core set and advanced set.

Level	Indicator	Source(s) of information and notes	Quant've	Descr'tive
International				
	Forest cover	UN Forest Resource Assessment, satellite imagery, NASA project	!	
	Forest condition	Divided into natural, semi-natural and plantation. Data from UN-FRA	!	
	Protected areas	Analysis of *UN List of Protected Areas* (care needed to distinguish forest areas - inexact)	!	
Core set				
	Area of natural forest	National reports	!	
	Area of natural forest as a proportion of total forest	Definition of "natural forest" must be agreed	!	!
	Change in natural forest over 10 years		!	!
	Forest protected areas by IUCN Categories I-VI	Countries may need some time to re-categorise their PAs in line with the new definitions	!	
	Forest protected areas by ecoregion	Techniques such as gap analysis can help with this indicator	!	!
	Number of forest dependent species (divided into main taxa)	Red Lists	!	
	Proportion of forest-dependent species at risk	Red Lists	!	
	Area of forest managed to prioritise biodiversity conservation	For example, reference to certification of forests under the Forest Stewardship Council (currently collected by the World Conservation Monitoring Centre)	!	
	Air pollution levels exceeding forest critical loads	Only possible for areas with good data sets	!	
	Existence of legislation to protect biodiversity			!
	Existence of forest management codes to protect biodiversity			!

Level	Indicator	Source(s) of information and notes	Quant've	Descr'tive
Detailed nat'l infor-mation				
	Mapped details of forest types	All maps ideally based on satellite data	!	!
	Mapped details of old-growth/natural forest by types		!	!
	Mapped details of forest protected areas		!	!
	Mapped details of areas of forest under special management regimes		!	!
	Percentage and extent in area of forest types relative to historical condition and to total forest cover		!	
	Percentage and extent in area of forest types by age class		!	
	Levels of fragmentation and connectiveness	Need fragmentation index	!	
	Percentage of mixed stands		!	
	Area and representativeness of forest protected areas		!	
	Number of forest dependent species, categorised as: (i) indigenous (ii) non-indigenous (iii) endemic	Red Lists	!	
	Number of threatened forest dependent species, categorised as: (i) threatened (ii) endangered (iii) rare (iv) vulnerable	Careful choice needed	!	
	Population levels and changes over time of selected **indicator** species		!	
	Number of forest dependent species occupying a small proportion of their former range		!	
	Areas of forest cleared or degraded annually containing endemic species		!	
	Percentage of annual natural regeneration		!	
	Natural regeneration as a percentage of total regeneration		!	
	Percentage of stands managed for genetic resource conservation		!	
	Amount of *ex situ* genetic resource conservation			!

Level	Indicator	Source(s) of information and notes	Quant've	Descr'tive
	Proportion of trees suffering damage	UNECE data or national surveys	!	
	Area of land set aside into special management regimes		!	
	Area of land independently certified as being sustainably managed	From Forest Stewardship Council data and similar sources	!	
	Human disturbance index		!	!
	Main threats to forest biodiversity			!
	Area of forest annually affected by major threats		!	

41. Note that the distinction between *quantitative* and *descriptive* classification is an ideal; many of the indicators are open to a descriptive approach if quantitative data are not available.

42. Most collection systems require some kind of verification process. Except in cases where verification has already taken place (e.g. forest certification), two options could be considered:

- suggesting that Parties draw together working groups, made up of government officials, academics and NGOs, to assess data before submitting reports;

- develop a small group of experts, suggested by Parties themselves, to assess the whole of the data after submission of National Reports.

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