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BIOLOGICAL DIVERSITY IN FORESTS

Note by the Secretariat

Summary

The Conference of the Parties, in its decision II/9, requested the Executive Secretary to prepare a background document on the links between forests and biological diversity in order to consider, at its third meeting, whether further input to the Intergovernmental Panel on Forests is required. The Secretariat has prepared a draft background document for review by the Subsidiary Body on Scientific, Technical and Technological Advice prior to the preparation of the final draft to be submitted to the Conference of the Parties at its third meeting.

Forests are the most biologically diverse terrestrial ecosystems. Forests are of major importance globally, occupying around a third of the world's ice-free land surface; they are diverse, reflecting the combined influences of evolution, biology, the physical environment, and people. The tropical rainforests are recognised as the most complex and species-rich terrestrial ecosystems, but even the simplest forest communities comprise genetically diverse populations of trees and a wealth of associated plants and animals. Human societies have caused great impacts on forest biological diversity throughout history. Whilst the net effect of these impacts has been overwhelmingly negative, not all have been adverse - particularly in the case of forest-dwelling or -dependent peoples. The unprecedented scale and accelerating rate of recent human impacts on forests threaten forest biological diversity through the erosion and loss of ecosystems, of species, of populations within species, and of genetic diversity within populations. Relatively few forest tree species have been domesticated for industrial use, but indigenous and local forest-dwelling communities have both domesticated and conserved many species important in farming or livelihood systems. There are few

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established national reserve systems likely to conserve forest biological diversity comprehensively or adequately in situ, and only a tiny proportion of forest species are conserved satisfactorily ex situ. Consequently, conservation of forests, trees and genepools in managed ecosystems is fundamental to the conservation and sustainable use of forest biological diversity. The benefits of forest biological diversity accrue to individuals, communities, enterprises and societies in and ex situ. Benefits range from direct to indirect, and material to spiritual. There are presently few mechanisms which capture or direct the benefits of forest biological diversity to those who have conserved or developed it in situ.

Having reviewed this draft background document, and in the light of the Statement from the Conference of the Parties to the Intergovernmental Panel on Forests, the Medium-term Programme of Work of the Conference of the Parties, and the work of the first and second sessions of the Intergovernmental Panel on Forests, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to consider recommendations to the Conference of the Parties on the scientific, technical and technological aspects of any further input to the Intergovernmental Panel on Forests. It may also wish to consider the need for and modalities of future work under the Convention on forests and biological diversity.

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I. BACKGROUND

1. At its first meeting, the Subsidiary Body on Scientific, Technical and Technological Advice noted the establishment by the Commission on Sustainable Development of an Intergovernmental Panel on Forests, recognised the importance of forests for the conservation and sustainable use of biological diversity, and recommended that the Conference of the Parties consider whether an input into that process would be desirable (Recommendation I/3).

2. At its second meeting, the Conference of the Parties requested the Executive Secretary "to commission and carry out work on forests and biological diversity, with a view to producing a background document on the links between forests and biological diversity in order to consider, at its third meeting, whether further input to the Intergovernmental Panel on Forests is required, and to transmit this document to the Intergovernmental Panel on Forests for information." (decision II/9, para.2(b)).

3. Part II of the present Note by the Secretariat constitutes a draft of the background document referred to in decision II/9, para.2(b) and is submitted to the Subsidiary Body on Scientific, Technical and Technological Advice for its further scientific, technical and technological advice prior to the preparation of the final draft of the document for the third meeting of the Conference of the Parties.

4. This document also draws upon the guidance provided in the Annex to decision II/9 ('Statement on Biological Diversity and Forests from the Convention on Biological Diversity to the Intergovernmental Panel on Forests). In this Statement, the Conference of the Parties:

(a) identified provisions of the Convention of particular relevance to forest biological diversity and to the programme of work of the Intergovernmental Panel on Forests;

(b) requested the Intergovernmental Panel on Forests to acknowledge and consider issues identified in the Statement,

(c) identified issues not explicitly addressed in the terms of reference of the Panel; and

(d) identified issues of forest biological diversity requiring further action and informed the Panel of its intention to explore these issues in its Medium-term Programme of Work.

5. The Subsidiary Body on Scientific, Technical and Technological Advice may also wish to consider possible recommendations to the Conference of the Parties about further work on forests and biological diversity.

II. FORESTS AND BIOLOGICAL DIVERSITY

2.1 Introduction

6. The Convention defines biological diversity as '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 part; this includes diversity within species, between species and of ecosystems' (Article 2). In its Statement to the Intergovernmental Panel on Forests, the Conference of the Parties noted that forests play a 'crucial role [..] in maintaining global biological diversity' and that

'together, tropical, temperate and boreal forests provide the most diverse sets of habitats for plants, animals and micro-organisms, holding the vast majority of the world's terrestrial species'.

7. Forests occupy around a third of the world's ice-free land surface. Their diversity reflects the combined influences of evolution, biology, the physical environment, and people. The tropical rainforests are recognised as the most complex and species-rich terrestrial ecosystems, but even the simplest forest communities comprise genetically diverse populations of trees and associated plants, animals and micro-organisms.

8. In addition to the direct use of forest products in the subsistence activities of forest-dwellers or as goods traded on local, national or international markets, the ecological services provided by forests are crucial to the maintenance of biological diversity far beyond forest boundaries. Such services include climate regulation, carbon sequestration, watershed protection, soil conservation, storage and recycling of organic matter and mineral nutrients, and the provision of migratory, nursery and feeding habitats. The maintenance of ecological processes and the resilience of individual forest ecosystems depend upon the maintenance of biological diversity.

9. Methods for valuing the multiple benefits derived from forests need to take into account the economic benefits (monetarized and non-monetarized), the environmental services provided by forest ecosystems, and intangible or non-consumptive values. These include the important cultural, religious and recreational values of forests.

10. Human societies have had important impacts on forest biological diversity throughout history. Whilst the net effect of these impacts has been overwhelmingly negative, not all human impact has been adverse - particularly in the case of indigenous and local forest-dwelling communities.[1] The unprecedented scale and accelerating rate of recent human impacts on forests threaten forest biological diversity through the erosion and loss of ecosystems, of species, of populations within species, and of genetic diversity within populations.

11. Of the world's estimated 3.4 billion hectares of forests in 1990, tropical forests accounted for 1.76 billion hectares, boreal and temperate forests in industrialised countries for 1.43 billion hectares and temperate forests in developing countries for 0.2 billion hectares. During the period 1981-90 it is estimated that tropical forests were lost at an annual rate of 0.8 percent (15.4 million hectares).[2]

12. A net increase in forest biomass and area in the temperate zone occurred over the same decade. However there are substantial concerns about forest quality. Forest degradation caused by air pollutants, pests, drought and nutrient loss is occurring in some areas. Little of the old-growth forests in temperate regions is fully protected, and continues to be replaced by plantations or by new regrowth following clearfelling. Most plantations and heavily managed forests provide fewer environmental benefits and contain less biological diversity than primary forests.

13. Until recently forest quality was considered in terms of criteria related to the production of timber, such as sustainable yield, and measurements of pollution-related forest degradation. Whilst relevant, such approaches are insufficient to construct a concept of forest quality that takes into account the full range of benefits derived from forests. More holistic indicators of forest quality have been proposed, based on criteria of authenticity, forest health, environmental benefits, and social and economic values.[3]

14. Appreciation of the links between forests and biological diversity in the context of the objectives of the Convention on Biological Diversity requires a synopsis of forest biological diversity, the processes and forces that have shaped it, and those to which it is now subject.

2.2. Forest biological diversity: an overview

15. The biological diversity of forests is apparent at all levels of biological organisation. Forest biological diversity can be catalogued at each of these levels, in terms of ecosystem, species and genomic richness; but what is more important is the appreciation that - even in its poorly-known state - forest biological diversity is high relative to that of other terrestrial ecosystems. Contemporary forest biological reflects the combined influence over evolutionary time of:

(a) the abiotic physical factors of climate, soil, water, fire, geological and geochemical processes;

(b) diverse biotic factors, including competition and complementarity between coexisting organisms, host-pathogen interactions; pollination and predation; ecological succession, genetic mutation and other mechanisms;

(c) the reproductive, habitat, feeding and other patterns of individual species; and

(d) human modifications of each of these factors.

16. Whilst the abiotic factors are essentially location-specific, each of the other factors varies spatially and temporally. These dynamic, heterogeneous, interacting and variously interdependent factors characterise forest biological diversity in similar terms. Thus, no single parameter can adequately characterise forest biological diversity in all its manifestations, because:

(a) forest ecosystems are diverse and complex, in terms of composition, function and process;

(b) forests vary at all scales of organisation, from the molecular to that of landscape;

(c) the ecological and genetic processes which both maintain and change forests are dynamic, on time scales varying from minutes to millennia;

(d) populations of constituent species are similarly diverse and dynamic.

17. The resultant complexity of forest biological diversity defies simple description or measurement, and is more realistically represented in terms of the biological, spatial and temporal dimensions which jointly define this wealth of diversity, and the human influences which modify it. For practical purposes, though, we have to approximate such complexity with simpler frameworks that are both biologically meaningful and practically useful.

18. Such a framework comprises three principal foci, two of which are those of the forest community and its constituent populations of species. These two foci - those of ecology and genetics - respectively represent different but complementary perspectives on biological diversity. An ecological perspective emphasises the role of environment and species biology in shaping forest communities; a genetic perspective emphasises the genetic forces that shape populations of a species. Thus, these perspectives inform different levels of biological organisation, with ecology most relevant to ecosystems and habitats, and genetics to the species, population and genome levels. The third perspective essential to appreciating contemporary forest biological diversity and to considering its future is that of human intervention, emphasising how human societies have affected it over time, and are doing so now.

2.2.1 Scientific knowledge

2.2.1.1 Ecological perspectives

19. An ecological perspective emphasises the complexity and interdependencies of biological communities, and the role of environmental variation in shaping forest communities. We use the concept of ecosystems to describe these communities in a landscape. Ecosystems are necessarily defined loosely, and usually at a coarse rather than a fine scale, because forest communities are dynamic and spatially heterogeneous. The vegetation of any given area of forest is a point sample of a continuum of species assemblages grading into each other, reflecting the differential responses of constituent species to variation along environmental gradients, and to disturbance patterns and histories. These gradients may be subtle or strong, and perturbations widespread or very local, defining patterns of community variation on different spatial and temporal scales. As the composition and structure of the forest flora vary, so too do the habitats available for animals - and thus the forest community as a whole. Similarly, as abiotic factors vary, so too do the conditions available for soil micro-organisms, which in turn influence other trophic levels in the ecological web.

20. An ecological perspective stresses the fundamental importance to forest biological diversity of self-regulating natural communities, with their complex co-adaptive balance, and the resulting impact on forest biological diversity caused when these communities are disrupted by human intervention. Our imperfect understanding of forest ecosystems suggests that the converse is also true: maintenance of plant and animal diversity is essential in sustaining structure and function of forest communities. An ecological perspective recognises that forest ecosystems are not merely serendipitous assemblages of independent species and individuals; rather, the diversity of ecosystems and the species which comprise them are shaped, maintained and changed by the complex interactions of organisms and their differential responses to both natural and human influences. In turn, the characteristics of organisms are an expression of their genes and of genetic processes, identifying the need for a genetic perspective. An ecological perspective stresses the need to develop and implement ecosystem management regimes, employing adaptive management principles, designed to maintain in perpetuity the basic ecological integrity of the system.

2.2.1.2 Genetic perspectives

21. Within forest ecosystems, populations of individual species fluctuate according to ecosystem and genetic processes. Each species exists as a series of populations, genetically linked by varying degrees of gene flow. Although our knowledge for forest species is sparse and biased towards those of the temperate ecosystems, there is some consistency emerging from the recent proliferation of studies based on assaying variation in the enzymes or DNA of organisms. This information describes levels and patterns of genetic diversity, which together characterise the biological diversity within a species - that is, in more utilitarian terms, its genetic resources.

22. Tree species, the most characteristic life form of forest ecosystems, are with few exceptions much more genetically diverse than other plant species, a consequence of their mating systems, life histories, relatively extensive geographic distributions and typically limited history of domestication. In contrast to many non-woody plant species, and particularly those which have been domesticated as crops, tree populations maintain these high levels of genetic diversity through strongly outbreeding reproductive strategies, through extensive gene flow within and between sub-populations, and through the longevity and fecundity of individuals. Their reproductive biology also implies that geographically

isolated trees in agroecosystems, and those in remnant forest fragments, may not be reproductively isolated, and indeed may play a critical role in maintaining gene flow within and between populations.

23. These mating system and life history differences also determine that the spatial patterns of genetic diversity in tree populations differ greatly from those of most non-woody plants. In general, most genes found in a tree species are present in most of the populations across a species range, a testament to the effectiveness of gene flow between populations and the biological mechanisms which maintain genetic diversity within populations. Other forest plants with similar mating systems will exhibit similar patterns of genetic diversity, in marked contrast to those of inbreeding plants, for which there is strong genetic divergence between populations. Although the magnitude of genetic differences between populations of trees is small relative to that of inbreeding plant species, it is nevertheless responsible for variation of major consequence in traits of value to people and production systems.

24. Knowledge of the population biology of other forest species is variable but, overwhelmingly, limited. Whilst that of some forest animals and birds is relatively good, most species of forest invertebrates, fungi and micro-organisms are probably not yet known to science: there is no site on earth - even in the relatively simple and intensively-studied temperate forests - for which a full inventory of these forest species has been completed. The enormity of current gaps in cataloguing species and in fully understanding their roles in maintaining critical ecosystem processes and functions calls for a precautionary approach to their conservation. Few generalisations are possible from those species of which we have some knowledge, in part because of the profound but particular influence on them of human activities.

25. A genetic perspective on forest biological diversity emphasises the fundamental role of the population, and of genetic processes at the population level. It describes the rich and diverse genetic resources of forests, and stresses the importance of maintaining viable populations of individual species. There is concordance with the ecological perspective on two fundamental points: first, because most forest species differ greatly in their genetic composition and population structure, generalisations are helpful only at a coarse level; second, the genetic divergence evident between populations highlights the role of environmental variation in shaping and sustaining genetic diversity.

2.2.2 Traditional knowledge

26. Forest biological diversity is paralleled by a diversity of indigenous or traditional societies, who have inhabited and manipulated forests - sometimes for millennia, sometimes only recently or transiently. The knowledge of these societies includes a wealth of traditional ecological knowledge, relating to management and conservation of the environment; it includes systems of classification, sets of empirical observations about the local environment, and local management systems governing resource use. In the case of forest biological diversity, such traditional knowledge also describes that of rural communities with respect to the management and use of forest genetic resources - especially those of trees - in farming systems. Traditional knowledge of forest biological diversity both contributes to and complements modern scientific knowledge. Indigenous knowledge of forest ecology and forest biological diversity is increasingly being used to define sustainable management regimes and identify genetic resources of value to other societies. However the conversion and degradation of forests world-wide has led to a dramatic loss of cultural diversity, and with it a corresponding loss of traditional forest-related knowledge. An appreciation of the importance of traditional knowledge emphasises both the history and importance of human influences on forest

biological diversity, and the critical role of indigenous and rural peoples in its conservation and sustainable use.[4]

2.2.3 Human impacts on forest biological diversity

2.2.3.1 Human impacts throughout history

27. The history of humankind is one of modification of the forested environment: by the degradation, conversion and fragmentation of forest ecosystems; by their alteration through the harvesting of forest products, use of fire, or more general environmental alteration; by the introduction of pests, pathogens and exotic species; and by the domestication of plant and animal species. These processes have exerted profound but poorly quantified impacts on forest biological diversity, demonstrated most spectacularly by examples of species extinction, but more commonly resulting in the erosion of biological diversity, that is to say, in the impoverishment of ecosystems and gene pools. However, it is important to recognise that not all human intervention has impacted adversely on forest biological diversity, and that many traditional forest management and farming systems were consciously designed to sustain or enhance diversity, especially that which was beneficial to people. Examples of such systems can be found world-wide, and include the home and forest gardens of Asia, the forest patches of the Brazilian and Guinean Savannah, and the Leucaena agroforestry systems of Mexico.

28. The conversion of forests to other land uses results in the loss of locally-adapted forest ecosystems and their constituent populations. The resultant fragmentation of ecosystems and populations is likely to reduce species richness and densities within remaining forests, as fewer species are represented in fragments of smaller size than in those of larger area. Depending on the barriers that fragmentation imposes on migration between residual populations, and population size and structure within fragments, within-population genetic diversity may also be eroded. Consequently, fragmentation may also lead, ultimately, to the extinction of locally-adapted populations. Specific effects will depend on the scale and pattern of forest conversion, the dynamics of particular ecosystems, and the population structure and reproductive biology of particular species.

29. The effects of the harvesting of forest products will also vary with ecosystem, species and harvesting regime. Where harvesting of forest products is regulated effectively, either by the state, by communities or jointly, sustainable use regimes will be based on modern and/or traditional understanding of ecosystem processes. Thus, for example, foresters will apply timber harvesting regimes which vary with ecosystem type and the species extracted; similarly, indigenous peoples' knowledge is manifested in management practices which, for example, favour the regeneration and development of particular species. The effects of harvesting on forest biological diversity are greatest where forest harvesting been little regulated according to scientific or traditional knowledge, and has been most rapid and extensive. Because such harvesting is likely to have major adverse impact on ecosystem function and process, or on the population size of particular species, forest biological diversity is likely to suffer at all levels of organisation, with consequences similar to those of fragmentation. Where the impacts of harvesting are below this poorly-defined threshold, there may still be effects on species genepools, though these may be transient and relatively ephemeral. However, our empirical knowledge of the genetic effects of ecologically-appropriate harvesting regimes remains poor, with inconsistent results from the few studies so far reported. What is apparent is the fundamental importance of management regimes which recognise the reproductive ecology of

the species harvested, so that viable populations are maintained over time, and of the need to include measures to minimise adverse impacts on non-harvested species.

30. Fire regimes are among the most pervasive human influences on forest ecosystems, with major implications for ecosystem structure, composition, function and distribution. As well as being a natural phenomenon, fire is one of the technologically-simplest management tools, used with discrimination by almost all forest-dwelling and dependent peoples, and - sometimes with less discrimination or as a means of protecting timber resources without taking into account impacts on biological diversity - by agriculturalists, foresters, and land managers. The modification of Australian and North American forest ecosystems by altered fire regimes following both Native and European occupation are two relatively well-documented examples. The consequences of forest fire for forest biological diversity are substantial but variable, with ecosystems and populations responding differentially according to their adaptation to particular fire regimes. Similarly general but imprecise conclusions apply to the consequences of more general environmental modification, such as those resulting from industrial pollution or climate change.

31. Another major impact of humans on forest biological diversity is that realised through the translocation to exotic environments of plants, animals and micro-organisms. Species introduced by humans may affect indigenous communities and populations by displacing native species and genotypes, or by becoming pests or pathogens of species with which they did not co-evolve. Within species groups, the anthropogenically-expanded range of economically important or useful species has both reduced genetic diversity by contamination of local gene pools and homogenisation of population structure, and expanded it through exposure to new environmental pressures and intra- and inter-specific hybridisation.

32. The processes of domestication, frequently but not invariably associated with translocation, typically reduce within-population genetic diversity, although total diversity within a species may be sustained through the maintenance of divergent populations. Although relatively few forest tree species have been domesticated for industrial use, indigenous communities have both domesticated and conserved species important in farming systems. The domesticated crop plants and animals of high-input agricultural systems illustrate the ultimate consequence of lengthy and intensive domestication, exhibiting low levels of genetic diversity; in contrast, most forest trees, even those most domesticated, still retain high levels of genetic diversity.

2.2.3.2 Contemporary human impacts

33. This century has seen enormous human impact on forest biological diversity, at a rate which continues to accelerate. For example, half the world's croplands were forested 90 years ago; in the tropics, change of this magnitude has been effected in only 50 years. Whilst the recent effects of humans on forest ecosystems have been greatest in the tropics, with rates of forest loss and degradation continuing to rise by between 4-9% annually, industrialised societies are also impacting adversely on temperate and boreal forest ecosystems. Although the current rate of forest loss appears unprecedented in human history, its scale is reminiscent of that of European settlement on the forest ecosystems of the New World, and of earlier civilisations on the forests of Europe and the Middle East.

34. The major agents of the loss and erosion of forest biological diversity are relatively easily identified. The principal agent of forest ecosystem loss and fragmentation is the conversion of forests to agricultural systems. Among other important agents, albeit on more localised scales, are the expansion of human settlements, extractive industries, and associated infrastructure. Individual agents

of conversion and fragmentation range from large scale agricultural enterprises, including those establishing industrial plantation forests on forest sites, to the small-scale farmers whose individual impact may be tiny, but whose cumulative impact is not. Other important agents of forest biodiversity loss include:

(a) forest ecosystem degradation (for example, through industrial pollution);

(b) introduction of pests, pathogens and exotic species (by agriculturalists, plantation foresters or horticulturalists)

(c) unsustainable levels of harvesting forest products - wood and non-timber forest products, including wildlife and plants, of commercial or subsistence value. Such harvesting regimes can have adverse impacts on genepool diversity, population viability, the ecological balance of natural communities, and ecosystem processes and functions. The scale and purpose of harvesting activities vary from industrial to subsistence, and their impacts are similarly variable.

35. The underlying causes of the loss and erosion of forest ecosystems, populations and genepools are less easily generalised. Many analyses have been made of the underlying causes and studies have identified as factors, inter alia:

(a) the inequitable distribution and allocation of resources in human societies, at scales varying from global to local;

(b) the operation of both market and subsistence economies, and the interactions between these systems;

(c) accounting mechanisms which do not accord appropriate value to natural capital, and the resultant misvaluation of both market and non-market goods and services;

(d) public policies which, perhaps as a consequence of the above, recognise little value in forest ecosystems or the biological diversity they represent;

(e) inappropriate policies and programmes of international financial institutions and aid donors;

(f) unsustainable patterns of consumption, production and trade;

(g) demographic pressures;

(h) cultural mores and social attitudes;

(i) lack of integration of the conservation and sustainable use of forest biological diversity into relevant sectoral or cross- sectoral plans, programmes and policies;

(j) ignorance of or disdain for the long-term consequences of our actions.

36. The comprehensive and effective implementation of the Convention will require Parties to identify and address the underlying causes of the loss and erosion of forest biological diversity. This entails consideration of the social, economic, ethical and political dimensions, in addition to the scientific, technical and managerial issues.

2.2.3.2.1 New technologies

37. The new biotechnologies have been employed in forest science, as in plant and animal science more generally. Those of most relevance to the conservation and sustainable use of forest biological

diversity in the foreseeable future are molecular markers, genetic engineering, and technologies for in vitro storage and micropropagation. Their major impacts to date have been to inform us of genetic diversity at the molecular level, and to offer propagation options which themselves represent the gateway to the application of many biotechnologies. Genetic engineering of forest species remains at the early experimental stage. With the exception of a very few advanced conservation or domestication programmes, the new biotechnologies have yet to impact substantially on either the conservation or sustainable use of forest biological diversity; the most profound impacts would arise from advances in genetic engineering and storage technologies.

2.2.4 Synthesis

38. Although we have quantitative data for only a tiny proportion of the complement of forest biological diversity, there is widespread agreement - based on our understanding of history, ecology and genetics - that the overall impact of human societies on forest biological diversity has been adverse, with rates of loss and erosion varying from rapid to slight, depending on circumstance. In the worst cases, the effects have been overwhelming and enduring, as the now depauperate state of many island flora and fauna demonstrate most strikingly. Although abundant biological diversity remains in many forest ecosystems and their constituent populations, the accelerating rate and scale of human impacts demand urgent action, including identifying and correcting the underlying causes of forest biodiversity loss, including identifying and removing the underlying causes, if the objectives of the Convention on Biological Diversity are to be realised.

39. The complexity, heterogeneity and dynamism of forest biological diversity, and of the forces that have shaped and are changing it, define the context of the Convention on Biological Diversity in relation to forests. We are required to draw upon our admittedly imperfect understanding of ecological, genetic and human perspectives on forest biological diversity in order to implement the objectives and specific provisions of the Convention.

2.3 Forest biological diversity and the objectives of the Convention on Biological Diversity

40. The characteristics of forest biological diversity define the way in which the threefold objectives of the Convention on Biological Diversity can be applied to forests. Broadly, in the context of forest biological diversity:

(a) conservation of biological diversity implies that the communities represented by forest ecosystems, their constituent populations of species, and the genetic diversity of those species, be maintained at levels and in conditions sufficient to preclude their loss or erosion - whilst recognising the dynamic state of each of these levels of organisation;

(b) sustainable use of the components of biological diversity implies that harvesting regimes must operate within the constraints defined by conservation goals;

(c) fair and equitable sharing of the benefits arising out of the utilisation of genetic resources implies both a recognition of the roles of people - individuals, communities and societies - in sustaining, shaping and harnessing forest biological diversity, and a distribution of benefits consistent with such recognition. Benefit sharing regimes must acknowledge the spectrum of benefits and variety of roles which, together, conserve forest biological diversity and make its components available for use.

41. The interaction of ecological, genetic and anthropogenic forces which have shaped, and which will continue to shape, forest biological diversity determines that the conservation and sustainable use of biological diversity, and the fair and equitable sharing of benefits arising from its use, are not separable activities; rather, they represent complementary, interdependent and associated perspectives on the spectrum of possible outcomes of human intervention in biological systems. This principle, of the mutually reinforcing roles of the Convention on Biological Diversity's objectives in relation to forest biological diversity, underpins the discussion which follows.

2.4. Realising the objectives of the Convention on Biological Diversity for forest biological diversity

42. Our understanding of forest biological diversity, and of prevailing institutional structures and functions relevant to it, suggest issues and priorities relevant to realisation of the Convention on Biological Diversity's objectives for the particular case of forests. The following discussion considers such issues and priorities, and notes their correspondence with the provisions of the Convention.

2.4.1 Institutional structures and functions

43. The Articles of the Convention on Biological Diversity which restate the principle of sovereignty and responsibilities of nation states (Articles 3 and 4) reinforce the institutional framework long-established for the stewardship of forests. A brief synopsis of the history and scope of forest policies illustrates both this concordance and the limitations of traditional forest-related policy frameworks in terms of the objectives of the Convention on Biological Diversity.

2.4.1.1 A brief history of policies about forests

44. Most nations or their constituent administrative regions (eg states or provinces) have formally declared forest policies to express the principles by which the forests under their control - at least those in public ownership - should be managed. Such formal forest policies have a long history, originating in the 18th century in Europe and in the next century in India, and they have almost universally been founded on the dual principles of the sustainable harvesting of forest products and management for multiple products and benefits. Thus, whilst principles of conservation and sustainable use have formed the basis for forest policies since their inception, these objectives have usually been expressed in terms of a relatively limited range of forest products and services, typically with a focus on those with a direct or commercial value. More recent forest policy statements have recognised explicitly the broader range of forest values, including biological diversity, and some have recognised the principles of benefit sharing with local communities and of co-management. Correspondingly, forest policy formulation has acknowledged that many other public policies affect forests, and may be of more consequence for the conservation and sustainable use of forests than are forest policies per se. Furthermore, with so much of the overall forest estate in private ownership, there is a growing recognition that more attention needs to be paid to policies promoting the sustainable management of forest biological diversity by private owners.

45. The substantial, often overwhelming, influences of policies directed at non-forest issues (eg those concerned with agriculture, land tenure, regional or industrial development, or trade) have been long acknowledged as of fundamental importance to the success or otherwise of "forest" policies. However, public policy priorities which have favoured conversion rather than conservation of forests, and associated institutional constraints, have frequently restricted this acknowledgement to the level

of rhetoric. As the rate of forest ecosystem loss and genetic erosion has accelerated over the past few decades, the obvious limitations of "forest policies" isolated from "policies about forests" are shifting the terms of discussion and action to the latter. This will thus entail identifying ways to address the underlying causes of the loss of forest biological diversity.

46. As the objectives of the Convention on Biological Diversity are broadly consistent with those already declared by governments for forests under their control, the Convention offers a compatible, integrating and holistic framework, within which hitherto disparate policies can be co-ordinated to better realise the objectives of the Convention (Article 6). Two of the policy arenas for which closer integration with "forest policies" would be of immediate and enduring value to the achievement of the objectives of the Convention on Biological Diversity are first, those concerned with conservation through reserves and second, those which affect the management of forests in private ownership. Other aspects of public policy likely to be important in the formulation of the national strategies called for in Article 6 are those identified in 2.2.3.2 (above).

47. Policies directed at the conservation of forests through the establishment of reserve systems have usually been formulated and implemented by agencies other than those responsible for conserving and managing forests for production. Typically, conservation strategies have focused on establishment and maintenance of a reserve system to fulfil ecosystem, species or landscape conservation objectives. Allocation of forests to meet these conservation objectives has been competitive with, and often subsidiary to, allocation to other uses. In the absence of policies integrating conservation strategies across forests managed by different agencies, there has often been poor co-ordination in the realisation of conservation objectives inside and outside reserves, and consequent sub-optimal achievement of conservation objectives. Such integration is called for in Article 6 of the Convention.

48. A limitation of major consequence to the scope of most public policies about forests is their restricted jurisdiction over forests under private ownership or control, with consequences for the conservation of forest biological diversity similar to those described above. Although a range of incentives and regulations may be employed to promote conservation and sustainable use, the effectiveness of these measures varies widely and to date relatively few countries have put in place effective measures. Indeed, some have acted as perverse incentives for the conversion or unsustainable management of forests. National strategies which recognised that forest ecosystems and populations transcend tenurial boundaries would advance considerably the cause of the conservation of forest biological diversity. Articles 8(l) and 11 of the Convention provide the basis for effective regulations and incentive measures to promote the conservation and sustainable use of forest biological diversity on land in private ownership. There are, however, encouraging examples of initiatives within the private sector, and of partnerships between the private, government and non-governmental sectors, which illustrate the potential of private ownership and enterprise to contribute to the conservation and sustainable use of forest biological diversity.

2.4.1.2 Institutional structures for co-operation in research, training, education and the exchange of information

49. The history of national (and sub-national) responsibility for forest management and forest genetic resources has fostered the development of various institutional structures to promote co-operation and information exchange between agencies and individuals, in support of national programmes. These structures comprise both institutions and co-operative mechanisms, which operate on bilateral and multilateral bases, within and without governments. Some are mandated with specific

responsibilities in relation to forest biological diversity, whereas for others this role is more implicit within a broader charter. An indicative but not exhaustive classification of these institutional structures for the case of forest biological diversity might be:

Mode of operation	Example [5]
Multilateral government	CIFOR, FAO, ICRAF, IPGRI, ITTO
Multilateral non-government	IUCN, TNC, WWF, FSC
Multilateral informal	IUFRO
Multilateral indigenous	IATIPTF, IPBN
Bilateral government	National ODA agencies
Global centres	WCMC
National institutions with assumed international responsibilities	CSIRO ATSC, DANIDA TSC, OFI

50. These institutional structures already promote, facilitate and support co-operation in research, training, education and the exchange of information relevant to forest biological diversity (Articles 12, 13, 17 and 18). However, the low status historically accorded forest genetic resources relative to that of crop plants has placed much of the onus for strategic development, co-ordination and action on those national institutions which have been able to assume international responsibilities, on informal collaborative structures, and more recently on non-governmental organisations. Few of these are well-resourced. While some countries do still lack the necessary institutional structures, generally it is not a lack of structures, but of adequate and effective support for those which already exist, which most limits co-operation in research, training, education and the exchange of information relevant to the conservation and sustainable use of forest biological diversity.

2.4.1.3 Identification and monitoring

51. Given the complexity and dynamism of forest biological diversity, the identification of those components important for its conservation and sustainable use, and the monitoring of both these components and the effects of interventions (Article 7) (in terms which are both biologically meaningful and operationally feasible) are far from simple tasks. Because complete inventories of biological diversity are impractical, we are forced to approximate the totality of forest biological diversity with a series of surrogate measures, each of which has its own utility, but none of which is adequate in its own right. Such surrogate measures are useful for measuring quantitative and qualitative progress towards specific objectives and for assessing the effectiveness of specific interventions.

52. At the landscape level, three categories of surrogate are feasible - a subset of species or taxa, ecological assemblages, and environmental parameters:

(a) *Subsets of species* Although some species or species groups appear to act, at some sites, as indicators or predictors of overall biological diversity, there is little evidence that any such subset can reasonably represent biological diversity in toto with any generality.

Nevertheless, in ecosystems where many species are unknown or undescribed, as is the case for many tropical forest systems, the comparatively well-known and easily assessed tree flora may provide useful indicators for monitoring the biodiversity of forest ecosystems. Keystone species may also constitute useful indicators.

(b) *Ecological assemblages* Ecological assemblages, inevitably defined more loosely than a species, incorporate a level of ecological complexity which species cannot, but correspondingly mask finer-scale variation. At this ecosystem level, ecological measures of community characteristics (eg indices of species richness, endemism and abundance) are most relevant, but nevertheless still individually weak. In this case, and that of environmental parameter surrogates, multivariate methods of characterisation are the most promising.

(c) *Environmental parameters* Given the seminal influence of environmental variation in defining forest biological diversity, there is a strong theoretical basis for the use of environments as surrogates for biological diversity. Examples of classification systems which characterise variation in the physical environment at this landscape scale are the Australian "environmental domain analysis" and Canadian "ecological land classification"; each has been used as "coarse filter" to identify patterns on a broad (national and regional) scale. They have the advantage of drawing on environmental data (which tend to be more widely available and reliable) than biological data, but suffer similar limitations as do ecological assemblages with respect to fine-scale variation in forest biological diversity.[6]

53. At the level of variation within species and populations, various measures of allelic richness and evenness derived from assessment of the proteins or DNA of individuals inform us of levels and patterns of diversity. The different characteristics of these systems, and the different levels of technology, costs, and information associated with each, lends them to different purposes. For example, isozyme and RAPD markers are relatively simple and cheap to use, suggesting a primary role in extensive screening and characterisation of broad patterns of variation; the differential inheritance of organellar DNA, variation in which can be assessed using (currently) more laborious and expensive RFLP [7] technology, suggest a role for this information in the identification of distinctive populations meriting priority for conservation.

54. Consequently, various combination of surrogates representing the different levels of biological organisation will be required to inform the conservation and sustainable use of forest biological diversity. The obvious limitations of our current knowledge should not restrain us from acting upon it,[8] but do emphasise the importance of directing resources to the development of better measures for identification and monitoring of forest biological diversity. Support for the continuing development of technologies for the assessment of genetic diversity (eg molecular markers) and the manipulation and interpretation of information (eg Geographical Information, Database, and decision Support Systems) would promote realisation of Articles 7(a) to (d). Similarly, further development of methodologies of population viability analyses, and of those for assessing potential impacts and levels of risk and uncertainty associated with both human interventions and conservation strategies, would contribute greatly to decision-making more informed in terms of Articles 7(b) and 7(c). The direction of support for such work, in fulfilment of Articles 7(a), 7(b) and 14, to those institutions engaged in co-operative research and training (2.4.1.2 above) would be consistent with Articles 12, 16, 17 and 18.

55. Subject to the caveats above, we are already aware in general terms of the processes and categories of activities with significant adverse impacts on the conservation and sustainable use of forest biological diversity (2.2.3 above). The identification of these processes and activities, and the

monitoring of their effects (Article 7(c)) is simplest for those which impact at the landscape scale, i.e. conversion and fragmentation; national, regional and global data sets describing these impacts already exist from remotely sensed images, and are held by national conservation agencies and centres such as WCMC. Advances in information technology are increasing the accessibility and value of such data. Where impacts on ecosystems and populations are more specific, eg the effects of extractive use or of translocation, existing knowledge and technologies to acquire it in sufficient quantity are poorer. Here, we are likely to continue to rely on extrapolation from detailed studies. Therefore, resources should be used to support studies designed to provide results of general applicability on issues of highest priority, for a range of ecosystems and interventions.

2.4.2 The conservation of forest biological diversity

56. The conservation of forest biological diversity entails conservation in and ex situ (Articles 8 and 9), demands effective identification and monitoring (Article 7), incentive measures (Article 11), research and training (Article 12) and public education and awareness (Article 13), and is supported by both the sustainable use of forest biological diversity (see 2.4.3 below) and the fair and equitable sharing of benefits arising from the utilisation of forest genetic resources (see 2.4.4 below).

2.4.2.1 Conservation in situ

57. The complexity of forest ecosystems, the dominant role of tree species in them, the environmental and economic value of forests and trees, and the poor conservation status of most tree populations ex situ, have all led to forest trees being regarded as a paradigm of the need for in situ conservation. The provisions of the Convention entail a comprehensive approach to in situ conservation going beyond simply creating protected areas. Effective in situ conservation (Article 8) demands that both ecosystem functions and processes, and intra-specific population genetic processes, are maintained in a network of sites which are comprehensive and representative in terms of all levels of genetic organisation.

58. Traditional conservation strategies have envisaged a reserve system of protected areas, the ultimate expression and focus of in situ conservation, buffered by land uses which operate in support of in situ conservation objectives. Reserve models based on population genetic principles, using various measures of population viability, imply that very large areas may be required for the conservation in situ of many forest tree and animal species. For example, some tree species occur at densities of less than one per hectare, or have reproductive systems which promote mating between geographically disparate individuals, implying minimum area estimates for viable populations in the hundreds of hectares; estimates on the same basis for predatory forest animal species can be in the millions of hectares. These ideal reserve models pose two major problems for in situ conservation of forest biological diversity. The first relates to the location of reserves, and the second to their size.

59. The provisions of the Convention entail a more holistic, ecosystem approach to protected areas than has generally been the case. The history of establishment of protected areas, typically on sites less favoured for agriculture or production forestry, reveals i) that choice of sites has been made on criteria other than the maintenance of biodiversity, and ii) that national reserve systems almost invariably represent a biased and inadequate sample of ecosystems and populations, with an over-representation of uplands and slopes, sites of lower fertility, and stands of lesser economic value. Similarly, because few have been established or managed according to population genetic principles, they do not necessarily comprise viable populations of forest species.

60. While ideal reserve models emphasise the importance of large contiguous areas for in situ conservation, they also demonstrate the limits of the role of fully protected areas in the conservation of forest biological diversity. The mobility of many forest animal species, the extensive geographic distribution of most tree species, the reproductive biology of tree species and the high levels of gene flow between populations, and the large areas associated with minimum viable populations of many tree and animal species, emphasise the essential contribution of forests outside reserves to the conservation of populations within protected forest ecosystems. In reality, it is through the sustainable management of forests and trees outside reserves that most in situ conservation of forest biological diversity will be realised, though the likelihood of achieving this is greater when protected areas themselves are also well-managed.[9]

61. This conclusion highlights the roles of indigenous and local communities, and those of the managers of forests and trees outside reserves, in the conservation and sustainable use of forest biological diversity (Articles 8(j)and 10(c)). It similarly emphasises the importance of the rehabilitation and restoration of degraded ecosystems and the recovery of threatened species (Article 8(f)) in the conservation of forest biological diversity, and suggests the use of metapopulation models of population structure and function to design and implement in situ conservation strategies.

62. A metapopulation perspective on the demographic and genetic dynamics of individual species recognises that populations of a species wax and wane over time, within and across forest ecosystems or reserve boundaries; individuals and populations, variously linked by gene flow to form the overall metapopulation, play a dynamic role in the conservation of genetic diversity. Whilst the fate of specific populations depends on their particular population biology, the decline or demise of individual populations does not threaten the stability of metapopulation or conservation of its genepool, so long as other populations arise. A metapopulation perspective also emphasises the challenges inherent in the identification and monitoring of those components of forest biological diversity important for its conservation and sustainable use.

2.4.2.2 Conservation ex situ

63. The ex situ conservation status (Article 9) of forest species is generally correlated with the extent of their domestication, and is therefore either poor or non-existent for most. Only a tiny proportion of forest species (eg around 100 tree species) are conserved adequately ex situ. These species are almost exclusively those whose genetic resources have been assembled for domestication programmes, with which almost all substantive ex situ forest conservation activities are associated.

64. In the case of forest trees, national and sub-national seed centres or forestry agencies, and a few institutions with international mandate, hold the majority of forest genetic resources in store or in field trials. Consistent with Article 9(e), support for these activities has focused increasingly on the country of origin of the genetic resources. The majority of ex situ resources, though, are represented by trees established in the forest or farm production systems. The majority of these trees represent a limited and poorly known sample of species gene pools, of limited value to ex situ conservation. For forest species, the value of ex situ seed storage is further limited by the relatively large number of species, many of economic importance, whose seed is not amenable to storage. Some progress has been made with other storage technologies, consequent to that with crop species, but none is currently operationally feasible for trees. Whilst research to develop these technologies has merit, their technical limitations and cost will continue to preclude their use in other than exceptional cases - emphasising the primary and overwhelming importance of conservation in situ.

65. Although crop plants of economic importance and a few animal species have been subject to more concerted ex situ conservation programmes than have most tree species, the general conclusions which apply to trees are also relevant to the vast majority of other forest species - the majority of which are not yet described by science.

2.4.2.4 Introductions of species and genetically-modified organisms

66. The potentially adverse consequences for forest biological diversity of introductions of exotic species have historically received little attention from those associated with their translocation. The introduction of exotic species (including micro-organisms, fungi, insects as well as higher orders of animals and plants) have given rise to adverse impacts in the form of pests, pathogens, parasites and displacers of native species, often leading to the disruption of ecological processes and relationships. The risks associated with such introductions, and those potentially associated with the use or release of genetically modified organisms, have now generated sufficient concern to prompt the formulation of guidelines. In the case of species or germplasm introductions, though, these remain voluntary and untested. A strategy which addressed all aspects of the introduction and management of species, germplasm or modified organisms originating from or which could disrupt forest ecosystems, including protocols for testing and control, would support the conservation of forest biological diversity (Articles 8(g) and (h)).[10]

2.4.2.4 The conservation of forest biological diversity: summary

67. In situ conservation will continue to play a pre-eminent role in the conservation of forest biological diversity, implying priority to those activities which support it. These may be classified into research issues and those measures which act as incentives for conservation. Although incentive measure for conservation do exist, most investigation of incentive structures has been conducted in the context of sustainable use, and this is discussed below (2.4.3).

68. In terms of research, our currently inadequate knowledge of forest metapopulation attributes and processes, and of associated issues (particularly the effects of ecosystem and population fragmentation) demand urgent attention. Without such information, the knowledge base necessary to integrate conservation inside and outside reserves will remain limiting. However, our current understanding of both forest metapopulations and surrogate approximations of forest biological diversity is sufficient for us to review the adequacy of existing reserve systems and, where feasible, enhance them.

69. A fuller appreciation of indigenous and local peoples' knowledge would complement that of metapopulation dynamics. It would better inform us of the consequences for forest biological diversity conservation of both traditional and modern forest and agro- ecosystem management practices, enabling more appropriate management for conservation both within and outside reserves. Research on both these fronts is underway, but remains on a tiny scale relative to both the apparent level of traditional knowledge, on the one hand, and the evident limits of scientific knowledge, on the other. However, the limits of current knowledge do not preclude action now; because of the profound, pervasive and accelerating impacts of contemporary societies on forest biological diversity, the effective in situ conservation of forest biological diversity depends more fundamentally on political choices about resource use, allocation, ownership and benefit sharing than on the refinement of such knowledge as we do have.

2.4.3 Sustainable use of the components of forest biological diversity

70. As is apparent from the preceding discussion, issues of the sustainable use of the components of forest biological diversity (Article 10) are embedded within and inseparable from those relevant to its conservation. Thus, the discussion here focuses on those issues which, whilst of importance to both objectives, are priorities for the sustainable use of the components of forest biological diversity: the products and services of forest ecosystems, and the genetic resources represented by forest populations and organisms.

71. Both traditional and modern management regimes for forests have been based on the principle of sustainable use, manifested by regulation of the level of harvest to within the productive capacity of the forest. Whilst "scientific forestry" since the 18th century has focused principally on the "sustained yield" of wood products, traditional management regimes have applied to a much broader range of (primarily) non-timber forest products. More recently, modern forestry has acknowledged explicitly the importance of maintaining ecosystem function and process to maintaining productivity, and has sought to develop a more holistic approach to ecosystem management, a philosophy encapsulated by the so-called "new forestry". Ecological perspectives, and therefore ecological principles, have been dominant in the formulation of these management regimes. Information on levels and patterns of genetic variation within species has been only sparsely available, and therefore little used to date. The major challenge to sustainable use of the components of forest biological diversity is the incorporation into these ecologically-based management regimes of the principles and practices arising from our emerging knowledge of the genetic structure and dynamics of forest populations. This conclusion applies equally to the scope of methodologies used to assess the impact of proposed projects on forest ecosystems (Article 14), for which the assessment of associated risk and uncertainty (2.4.1.3 above) is similarly relevant.

72. In the case of forests managed for both conservation and production, there are examples from Scandinavia, the Americas and Asia which demonstrate how forest managers have incorporated genetic criteria into forest management strategies and regimes. Experience with forest harvesting operations more generally suggests that, although some income may be foregone in the short term as a result of implementing conservation criteria, such opportunity costs are relatively small: in the short term, because they promote better planning and management of harvesting operations, and in the longer term, because of the magnitude of benefits realised or maintained. The major technical obstacle to the more widespread application of conservation genetic principles to forest management is the difficulty of defining criteria and indicators for the conservation and sustainable use of forest biological diversity which satisfy the dual criteria of conservation merit and operational feasibility. This conclusion emphasises the importance and urgency of advancing our knowledge of those components of forest biological diversity important for its conservation and sustainable use (Article 7), i.e. those surrogate measures which will act as criteria for and indicators of forest biological diversity in toto.

73. In the interim, a precautionary approach based on current knowledge of forest ecology and forest genetics favours harvesting regimes whose impact at both landscape and local scales is the minimum consistent with the reproductive ecology of the species and the maintenance of ecosystem structure, function and process. This implies that appropriate harvesting regimes will vary with both the ecosystem and the species harvested; for many of these, a precautionary approach is likely to imply harvesting operations more conservative of ecosystem structure than those to which large-scale industrial forestry has become accustomed. Article 10(c) calls for Parties to encourage co-operation

between its governmental authorities and its private sector in developing methods for sustainable use of biological resources

74. Our embryonic knowledge of the metapopulation structure and dynamics of forest species also suggests that we accord priority to gaining a better understanding of how farmers' and other land managers' practices affect the genetic resources of forest species. Their practices of forest and tree retention, establishment, management and regeneration, including the processes by which they acquire and distribute germplasm of forest species, will affect the sustainability of use of those components of forest biological diversity represented in agroecosystems. Such information will allow us to realise sustainable use by embedding production within a conservation context.

75. Improving the knowledge base of forest population dynamics, of surrogate measures of forest biological diversity, and of the impacts on forest biological diversity of traditional and modern farming and forest management practices, will promote the development of sustainable use regimes. Such regimes need to recognise and correctly value inter alia timber and non-timber forest products, subsistence uses of forest products and non-consumptive uses of forest ecosystems. However, their implementation will depend more on the economic, political and cultural regimes which determine the balance between the conservation and conversion of forest ecosystems, reservation and production within retained forests, and forest and farm management practices within production systems. The forest policy literature is rich in both theory and example of regulatory frameworks, incentive mechanisms and institutional structures intended to promote the conservation and sustainable use of forests (Article 11). Synthesis of this literature, and of contemporary political thought, suggest an increasing emphasis on market-mediated and innovative institutional mechanisms acting as incentives for sustainable use, partly in response to the obvious limitations and perceived failures of approaches based on the regulatory mechanisms and institutional structures which have typified forest management and conservation agencies in the past.

76. For forest products entering the market place, the prospect of independent certification of the quality of management of the forests from which they originate has emerged as a promising incentive mechanism. Such certification relies upon the definition and implementation of forest management standards consistent with the conservation and sustainable use of forest biological diversity. This prospect reinforces the critical importance of identifying criteria for and indicators of sustainable forest management consistent with both ecological and genetic principles.

77. The advantages of institutional structures which recognise traditional resource rights, and which accommodate and promote participatory modes of forest management, emerge from theory and experience as a second principle of management likely to sustain the benefits and values of forests. Participatory processes are as diverse as the societies and environments in which they have been developed, though emphasis on local knowledge, custom and benefits is a common theme to those which have achieved some measure of success. Resource allocation mechanisms which acknowledge local as well as more distant demands, and direct benefits accordingly, and which recognise the long time horizons inherent in the management of forest ecosystems, are a third principle of policies which foster the sustainable use of forests and, with appropriate management in ecological and genetic terms, that of the components of forest biological diversity. The promotion of policies which incorporate and build from these principles is a priority in advancing the objective of sustainable use of the components of forest biological diversity.

2.4.4 Fair and equitable sharing of the benefits arising out of the utilisation of genetic resources

78. The genetic resources of forests are rich and diverse, comprising the genes and gene complexes of forest trees, plants and animals. Historically, we have exploited these genetic resources at the level of populations or individual organisms; new biotechnologies have the potential to make these resources available at the level of the gene or gene complex. The benefits arising from the utilisation of forest genetic resources accrue variously to individuals, communities, enterprises and societies both in and ex situ, but there are as yet few mechanisms which capture or direct these benefits to those who have conserved or developed forest biological diversity.

2.4.4.1 Access to and benefit-sharing from forest genetic resources

79. Typically, forest genetic resources have been sampled and tested for research and development purposes without restriction, and at nominal or no charge to the collector (Article 15). Where forest genetic resources have been assembled on a large scale, for example the collection of tree seed for operational establishment or of plant material for pharmaceutical screening, some market price reflecting primarily short-run supply and demand has prevailed. The income generated has typically accrued principally to the collecting enterprise, variously a state agency or individual entrepreneur. In the latter case, some level of fee is usually levied by the state or the forest owner. In neither case has it been common for benefits to be shared with indigenous or local communities, except where their resource or property rights have been recognised explicitly.

80. However, the entry into force of the Convention creates a new framework under which, as provided for by its Article 15, access to forest genetic resources will increasingly be subject to the negotiation of formal agreements with a range of stakeholders, offering a mechanism for more equitable benefit sharing. Similarly, it is only recently that, in a few cases, pricing mechanisms have acknowledged the potential future value of forest genetic resources, and sought to establish mechanisms to direct substantive benefits, in some form, to indigenous and local communities, in recognition of their roles as both contributors to and custodians of forest biological diversity. The "biodiversity prospecting" agreement between the pharmaceutical company Merck and the Costa Rican National Institute of Biological Diversity remains the best-known example.

81. A number of challenges present themselves in the development of regimes which better share benefits arising from the utilisation of forest biological diversity amongst those who have contributed to its development and conservation. These include:

(a) the diversity of interests at a sub-national level, with national and sub-national governments and management agencies, indigenous peoples and local communities, and individual owners of forest and agro-ecosystems variously responsible for ownership of and access to forest genetic resources (Article 15);

(b) the consequent difficulties, both practical and political, of obtaining prior informed consent to access forest genetic resources (Article 15);

(c) the limited acknowledgement of traditional resource rights by many modern societies, and the consequent difficulties experienced both by groups wishing to exercise such rights and those wishing to recognise them (Article 15);

(d) the divergence in intellectual property rights regimes between Western legal systems, which require individual and identifiable innovation, and most traditional cultures, which do not assign such rights (Article 16). In the case of forest biological diversity, issues of intellectual property assignment are further complicated by the dynamic nature and evolutionary timescale of biological diversity itself;

(e) divergent opinions as to the inherent value of forest genetic resources relative to that of the research and development activities which translate genetic resources into marketable products, particularly for the case of biotechnologies (Articles 16 and 19).

82. Overcoming the barriers these issues pose to the fair and equitable sharing of benefits arising from the utilisation of forest genetic resources will require the development of access agreements and property rights regimes which recognise the respective roles of individuals, communities (including indigenous peoples and farmers), and enterprises and agencies, in conserving and developing forest biological diversity. The emerging experience of collaborative resource management, which has its genesis in the rural communities of developing countries but growing applicability in industrialised countries, offers a platform for the development of benefit sharing regimes which are locally-appropriate.

2.4.4.2 Applications of biotechnologies

83. The potential of biotechnologies to exploit forest genetic resources has focused attention on the relative magnitudes of the inherent and developed values of forest genetic resources. The wild relatives of crop plants or of the few intensively-domesticated tree species have potential value as a source of genes for incorporation, whether by classical breeding or genetic engineering, into domesticated populations. Similarly, those forest organisms with potential pharmaceutical value are recognised as of sufficient potential value to justify substantial expenditure. In these cases, genetic engineering does offer the prospect of substantial financial returns, but its application is dependent on highly-domesticated populations, high levels of genetic information, and high levels of technology, all of which imply high costs.

84. In other, more typical, cases however, the financial benefits arising from the application of biotechnologies to forest genetic resources seem limited in the foreseeable future. This is because the biotechnologies of most application to the undomesticated populations which typify forest biological diversity are the molecular markers which, whilst of great value in assessing genetic diversity, deliver no financial gain in themselves. Their value lies instead in the provision of information to enable development of more effective strategies for the conservation and sustainable use of forest biological diversity. Existing co-operative institutional structures (2.4.1.2 above) have an important role in maximising the benefits derived from the application of these technologies.

2.4.4.3 Fair and equitable sharing of benefits: summary

85. As with the conservation of forest biological diversity and the sustainable use of its components, realising the objective of the fair and equitable sharing of the benefits arising out of the use of forest genetic resources depends fundamentally on political choice; in this case, about relative responsibilities, rights and values. The terms of discussion about these political choices reflect the diversity of opinions about:

(a) the relative responsibilities and rights of various stakeholder groups, in the development and conservation of forest biological diversity, and;

(b) the relative values of forest genetic resources, the products developed from them, and the technologies which effect that development.

2.5. Conclusions

86. Forest biological diversity is complex, heterogeneous and dynamic. Although still rich in both absolute and relative terms, it has been much diminished by the impacts of human societies. Those impacts are greater now than at any time in human history, and they are still accelerating. They are eroding contemporary forest biological diversity, and challenging the processes which maintain it in forest communities and their constituent populations.

87. Forest biological diversity is shaped by complex interactions between the physical environment, the biology of forest systems and populations, and the influences of individuals and societies. Our response to its loss must recognise these forces and their interdependencies. The Convention on Biological Diversity provides the framework for addressing the loss of forest biological diversity, the scale of which demands urgent action at all levels. Priority action on forest biological diversity includes:

(a) recognising that the three fold objectives of the Convention are inseparable and mutually supportive goals, and effectively integrating these into plans, programmes and policies at the international, regional, national and local levels;

(b) providing more effective support for those institutions already active in research, training, education and the exchange of information relevant to the conservation and sustainable use of forest biological diversity, and support for new institutions if required;

(c) undertaking policy, legal and other reforms and action that acknowledge the fundamental importance of forests and trees outside reserves to in situ conservation of forest biological diversity, and therefore of the roles of indigenous and local communities, and of the managers of forests and trees outside reserves, in the conservation and sustainable use of forest biological diversity;

(d) carrying out research to better define forest metapopulation structure and dynamics, useful surrogates of forest biological diversity, and the impacts of harvesting regimes;

(e) carrying out research to better understand the underlying causes of the loss of forest biological diversity and their impacts;

(f) developing innovative methods for achieving sustainable forest management, including appropriate financial mechanisms, and ways and means to transfer and develop appropriate technologies;

(g) carrying out research to better describe indigenous and local communities' knowledge of, and practices which impact on, forest biological diversity;

(h) effectively integrating modern and traditional knowledge of forest biological diversity into sectoral and cross-sectoral plans, programmes and policies;

(i) developing access agreements and property rights regimes which recognise the respective roles of diverse stakeholders in conserving and developing forest biological diversity.

III. POSSIBLE FUTURE ACTION

3.1 Further input to the Intergovernmental Panel on Forests

88. The second session of the Intergovernmental Panel on Forests was held in Geneva from 11 to 22 March 1996. As requested by the Conference of the Parties (decision II/9, para.2(a)), the Executive Secretary provided advice and information pertaining to the relationship between indigenous and local communities and forests. In consultation with the secretariat of the Ad Hoc Intergovernmental Panel on Forests in the Division for Sustainable Development of the Department for Policy Co-ordination and Sustainable Development of the United Nations Secretariat, the Secretariat prepared the document Programme element 1.3 - Traditional forest-related knowledge: Report of the Secretary-General (document E/CN.17/IPF/1996/9) for the initial discussion of Programme element 1.3 of the Panel's programme of work. A report of the second session of the Panel is contained in document E/CN.17/1996/24.

89. The third session of the Panel will be held in Geneva from 9 to 20 September 1996 and the substantive discussion of Programme element 1.3 'Traditional forest-related knowledge' will take place at this meeting. In accordance with decision II/9, paragraph 2(a), the Executive Secretary has prepared document UNEP/CBD/SBSTTA/2/Inf.3 as a contribution to the preparation of the Report of the Secretary-General for this substantive discussion.

90. In accordance with paragraph 4 of decision II/9, the Secretariat of the Intergovernmental Panel on Forests [has been][will be] invited to communicate progress on issues relevant to forests and biological diversity to the third meeting of the Conference of the Parties.

91. The Subsidiary Body on Scientific, Technical and Technological Advice will recall that at its first meeting it recommended (Recommendation I/3, para.8) that, when considering an input to the Intergovernmental Panel on Forests, the Conference of the Parties "[should consider] the following main elements ..:

> (i) There is an urgent need to identify the main causes that lead to the decline of forest biological diversity, develop and promote the use of methods for the management, conservation and sustainable use of forests, based on the identification and targeting of ecological processes and the multiple roles and functions of forest ecosystems, including ecological landscape planning and environmental impact assessment;
>
> (ii) Urgent development and application of ways and means to ensure fair and equitable sharing of benefits derived from the use of forest genetic resources would provide a major incentive for efforts to maintain forest biological diversity;
>
> (iii) The protection of the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles, and compensation through the equitable sharing of the benefits arising from the use of such knowledge, innovations and practices, in accordance with Article 8(j) of the Convention on Biological Diversity, should be promoted in order to improve conservation and sustainable use of forest biological diversity."

92. In respect of sub-paragraph 8(i) of Recommendation I/3, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to note the substantive discussions at the second session of the Intergovernmental Panel on Forests on Programme element 1.2 ("..underlying causes of

deforestation..")[11], Programme element III.1(a) ("..assessment of multiple benefits..")[12], and Programme element III.1(b) ("..valuation of the multiple benefits..")[13] and note that the substantive discussions on Programme element I.1 ("..national strategies...")[14] and Programme element III.2 ("..criteria and indicators..")[15] will take place at the third session of the Panel. It may wish to offer scientific, technical and technological advice to the Conference of the Parties on i) the programme of work of the Panel and its relevance to the three-fold objectives of the Convention; ii) identifiable gaps in the Panel's work programme from the point of view of the Convention; and iii) the extent to which the work of the Panel might assist Parties in fulfilling the objectives of the Convention. It may thus wish to advise on the scientific, technical and technological aspects of any further input to the Panel in accordance with paragraph 2(b) of decision II/9.

93. In respect of sub-paragraph 8(ii) of Recommendation I/3, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to consider what further specific advice, if any, on the use of forest genetic resources it may wish to give to the Conference of the Parties in respect of the on-going consideration within the Medium-term Programme of Work of the Conference of the Parties of ways and means to ensure fair and equitable sharing of benefits.

94. In respect of sub-paragraph 8(iii) of Recommendation I/3, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to refer to Programme element I.3 ("..traditional forest-related knowledge..") of the Intergovernmental Panel on Forests and to take note of document UNEP/CBD/SBSTTA/2/7 ('Knowledge, innovations and practices of indigenous and local communities: implementation of Article 8(j)') prepared for item 3.6 of the provisional agenda of the present meeting.

95. In considering advice to the Conference of the Parties on further input to the Intergovernmental Panel on Forests, the Subsidiary Body on Scientific, Technical and Technological Advice will wish to bear in mind paragraph 17 of the "Statement on Biological Diversity and Forests from the Convention on Biological Diversity to the Intergovernmental Panel on Forests" (decision II/9, Annex). This states:

> "The Intergovernmental Panel on Forests may also receive substantive inputs from the Convention following the third meeting of the Conference of the Parties on, inter alia, the underlying causes of biological diversity loss in forest ecosystems, components and dynamics of biological diversity, and ways and means for the effective protection and use of traditional forest related knowledge, innovations and practices of forest dwellers, indigenous and local communities, as well as fair and equitable sharing of benefits arising from such knowledge, innovations and practices."

3.2 Possible Medium-term Programme of Work

96. In its "Statement on Biological Diversity and Forests from the Convention on Biological Diversity to the Intergovernmental Panel on Forests" the Conference of the Parties identified criteria for sustainable forest management as related to the Convention on Biological Diversity (paragraph 12). It also informed the Intergovernmental Panel on Forests that it "intends to explore how the conservation and sustainable use of forest biological diversity could be assisted by the establishment of specific environmental goals in the forest and other sectors" (paragraph 10). In addition to the aspects of forests and biological diversity referred to in paragraph 17 of the Statement, paragraphs 8 to 15 identify further links in terms of the specific provisions of the Convention.

97. The Subsidiary Body on Scientific, Technical and Technological Advice may wish to consider the advantages of establishing, in accordance with the provisions of its modus operandi, a process and programme of work to develop and implement methods for sustainable forest management which combine production goals, socio-economic goals of forest-dependent local communities, and environmental goals, particularly those related to biological diversity, and which take an ecosystem approach and are aimed at securing forest quality as related to the Convention (paragraph 12 of the Statement).

98. Such a programme might consist of those matters identified by the Conference of the Parties in the Statement to the Intergovernmental Panel on Forests, including:

(a) the underlying causes of the loss of forest biological diversity;

(b) specific environmental goals in the forest sector, including:
- (i) appropriate Environmental Impact Assessments;

(c) valuation of the multiple benefits derived from forests, including:
- (i) economic benefits
  - (1) monetarized
  - (2) non-monetarized
- (ii) environmental services
- (iii) non-consumptive values
  - (1) cultural, religious, recreational values
  - (2) existence, bequest, vicarious use values

(d) methods for sustainable forest management, including:
- (i) indicators of forest quality
- (ii) incentive measures
- (iii) methodologies and technologies
- (iv) criteria and indicators
- (v) impact of utilisation of components of biological diversity, particularly those under threat, on ecological processes
- (vi) remedial action in degraded forest areas
- (vii) co-operation between governmental authorities and its private sector

(e) in situ conservation, including:
- (i) establishment and management of protected areas
- (ii) conservation of primary/old growth and ecologically mature secondary forest ecosystems
- (iii) criteria and methodologies for participatory decision- making, planning and management processes

(f) access to forest genetic resources and equitable sharing of benefits, including:
- (i) prior informed consent

(ii) traditional forest-related knowledge, innovations and practices

(g) public education and awareness

(i) local communities

(ii) local and national policy-makers

(iii) forest managers

(iv) users of forests and forest products

(h.) research, training and capacity-building

(i) scientific and technical co-operation

(ii) transfer and development of technologies

(iii) financial resources

99. In its Statement, the Conference of the Parties informed the Intergovernmental Panel on Forests that it '[wished] to avoid duplication of efforts and co-ordinate with other relevant organisations on issues of biological diversity', '[stood] ready to contribute to the fulfilment of the mandate of the IPF' and '[wished] to establish a dialogue with the IPF on issues related to forests and biological diversity'.

100. In considering the need and options for a process and programme of work under the Convention on issues related to forests and biological diversity, the Subsidiary Body on Scientific, Technical and Technological Advice may wish to refer to i) the terms of reference, programme of work and reports of the substantive discussions of the Intergovernmental Panel on Forests, and ii) the topics to be considered at the third and fourth meetings of the Conference of the Parties as contained in its Medium-term Programme of Work (decision II/18, Annex), in order to identify the issues and to recommend ways and means to address them, while avoiding duplication.

Notes

1/ Some commentators argue, on the basis of research on specific historical cases, that human impact on forests in pre-industrial societies can best be described as cyclical, with periods of very heavy influence followed by periods of recovery. It may be that the net historical human impact, prior to the advent of industrial societies, was to increase forest biological diversity.

2/ See World Resources Institute/UNEP/UNDP World Resources 1994-95, chapters 7 and 19 and UNEP Global Biodiversity Assessment, section 11.2.2.2.5.

3/ See inter alia Dudley, N. (1992) Forests in Trouble: A Review of the Status of Temperate Forests Worldwide. World Wide Fund for Nature (Gland, Switzerland) and subsequent statements from WWF.

4/ See documents UNEP/CBD/SBSTTA/2/7 ('Knowledge, innovations and practices of indigenous and local communities: implementation of Article 8(j)') and UNEP/CBD/SBSTTA/2/Inf.3 ('Traditional forest-related knowledge').

5/ CIFOR - Center for International Forestry Research; CSIRO ATSC - CSIRO Australia, Australian Tree Seed Centre; DANIDA TSC - Danish International Development Agency, Tree Seed Centre; FAO - Food and Agriculture Organisation of the United Nations; FSC - Forest Stewardship Council; IATIPTF - International Alliance of Tribal and Indigenous Peoples of the Tropical Forests;

ICRAF - Centre for International Research in Agroforestry; IPBN - Indigenous Peoples Biodiversity Network; IPGRI - International Plant Genetic Resources Institute; ITTO - International Tropical Timber Organisation; IUCN - The World Conservation Union; IUFRO - International Union of Forest Research Organisations; ODA - Official Development Assistance; OFI - Oxford Forestry Institute; TNC - The Nature Conservancy; WCMC - World Conservation Monitoring Centre; WWF - World Wide Fund for Nature.

6/ See for example: World Conservation Monitoring Centre. 1996. Assessing Biodiversity and Sustainability. Groombridge, B. and Jenkins, M.D. (eds), World Conservation Press, Cambridge, UK, which contains an expanded list of biodiversity assessment techniques.

7/ Restriction fragment length polymorphism

8/ The Preamble of the Convention states that 'where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat'.

9/ This is not to imply that protected areas are not important, but rather that the conservation of forest biodiversity implies a wide range of different approaches, carried out by different management agencies - public, private and non-governmental. Protected areas are a critical element in this mix in virtually every country.

10/ In this context, see document UNEP/CBD/BSWG/1/3 (Elaboration of the Terms of Reference for the Open-ended *Ad hoc* Working Group on Biosafety, submitted to the meeting of the Open-ended Ad Hoc Working Group (Aarhus, Denmark, 22-26 July 1996))

11/ See document E/CN.17/IPF/1996/2

12/ See document E/CN.17/IPF/1996/6

13/ See document E/CN.17/IPF/1996/7

14/ See document E/CN.17/IPF/1996/8 prepared for the initial discussion

15/ See document E/CN.17/IPF/1996/10 prepared for the initial discussion

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