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APPRAISAL OF THE SBSTTA REVIEW OF ASSESSMENTS OF BIOLOGICAL DIVERSIT AND ADVICE ON METHODOLOGIES FOR FUTURE ASSESSMENTS

Note by the Executive Secretary

1. INTRODUCTION

1. In its decision II/18, the COP decided that it ay, at its third meeting, consider appraisal of th SBSTTA review of assessment of biological diversity for the implementation of Article 25, paragraph 2(a), and advice on methodologies for future assessment.

2. Article 25, paragraph 2(a), calls upon the SBSTTA to provide scientific and technical assessments of the status of biological diversity.

3. At its first meeting, the SBSTTA considered "Alternative ways and means in which the Conferenc of the Parties could start the process of considering the co ponents of biological diversity particularly those under threat and the identification of action which could be taken under the Convention". Its recommendation I/3 made several general observations about the importance of assessments in implementing the provisions of the Convention. The observations were endorsed by the COP in paragraph 2 of decision II/8.

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4. In particular, the recommendation noted in paragraphs 2 and 4 that:

> "2. Assessment of the status and trends of components of biological diversity and causes of biodiversity losses provides baseline data which can assist countries to formulate their biodiversity strategies, plans and programmes to implement the provisions of the Convention.... There is, however, a need to identify, evaluate, develop and share methods needed for th assessment and conservation and sustainable use of biological diversity. Specifically there is a need to:
>
> > (i) Further describe the categories of components of biological diversity set down in Annex of the Convention;
> >
> > (ii) Evaluate methodologies for identification, characterisation and classification of biological diversity and their components so as to identify methods suitable for different conditions of data availability and how their effectiveness can be enhanced;
> >
> > (iii) Identify methodologies for detecting national and international negative trends in biological diversity;
> >
> > (iv) Promote exchange of information on existing methodologies through various information systems including electronic mail;
> >
> > ...
>
> 4. There is a need for each Party to start assessing the effectiveness of measures taken under the Convention. However, methods for assessing the effectiveness of measures to conserve or sustainably use biological diversity should be reviewed. The use of indicators of biological diversity and the status of its components is particularly time- and cost-effective. Several indicators are currently being used and developed. They should be reviewed and their use promoted".

5. At its second meeting, the SBSTTA addressed the agenda item "Review of the assessment of biological diversity made in 1995, and methodologies for future assessments, as well as the minimu standard data required, as appropriate, to be applied in accordance with national priorities and programmes".

6. To assist it in its consideration of this item, the SBSTTA had before it document UNEP/CBD/ SBSTTA/2/2, entitled "Assessment of biological diversity and methodologies for future assessments". Th SBSTTA, in discussing the issue, made observations on th document and concluded, as noted in its recommendation II/1, that the document contained useful approaches to the subject.

7. This Note has been prepared by the Executive Secretary to assist the third meeting of th COP in its consideration of this matter. It is based on the SBSTTA's appraisal of and observations on assessments of biological diversity and draws on document UNEP/CBD/SBSTTA/2/2.

8. The second meeting of the SBSTTA reasserted the vital importance of monitoring and assessing

biological diversity, particularly with respect to Article 7, but also to other Articles such as 6, 8, 16, 25 and 26. Major recommendations made by the SBSTTA include a two-track approach to assessment and indicator development; support for national-level actions, particularly through capacity-building and th development of guidelines; improved coordination at the international level; and the need to review existing methodologies, particularly with regard to indicators.

9. In its review, the SBSTTA identified a number of thematic areas in which biological diversity had not been adequately assessed to date, and for which there was consequently a priority need for further assessment.

10. The SBSTTA additionally observed that there was a distinction between assessing the state of biological diversity and assessing the state of knowledge of biological diversity. It considered that th former was relevant principally at the national level, the latter principally at regional and global levels.

11. In its advice on methodologies for future assessments, the SBSTTA identified, in its recommendation II/1, the need for a review of existing methodologies along the lines of a review included as an annex to document UNEP/CBD/SBSTTA/2/2. This review is therefore included as Annex I to th present document. In addition, the SBSTTA stressed the central importance of indicators of biological diversity in assessments. It generally supported the discussion of indicators contained in document UNEP/CBD/SBSTTA/2/4 and r -emphasised several of the recommendations on indicator development made in that document, which is therefore included as Annex II to the present document.

12. In considering this issue, the COP may wish to be mindful of the report of the second meeting of the SBSTTA (document UNEP/CBD/COP/3/3), which contains in its recommendation II/1 general advice, priority tasks and proposed specific recommendations concerning indicators, and monitoring and assessing biological diversity. The COP may wish to be mindful of the advice giv n by the SBSTTA in its recommendation II/1 that the issues of indicators and of monitoring and assessing biological diversity ar inextricably interlinked and should therefore be considered together.

2. THE SBSTTA'S REVIEW OF ASSESSMENT OF BIOLOGICAL DIVERSIT

13. The SBSTTA's analysis and review of the assessments of biological diversity reveals that there remains a large gap between the basic requirements of the Convention and its Parties and th information that exists. For example, despite considerable attention being devoted to national environmental assessment, many countries have not undertaken the necessary assessment of the status of their biological diversity. This is beginning to be addressed under the Convention by the financial mechanism supporting projects known as "enabling activities". These projects are essentially intended to assist developing countries in preparing to fulfil their commitments under the Convention, mainly by supporting them in the preparation of their first national biodiversity strategies and action plans, which entails making an assessment of the status of biological diversity. As of the end of June 1996, there were 41 Parties that had received financial support to undertake enabling activities, with a further five approved (see document UNEP/CBD/COP/3/5).

14. The SBSTTA concurred that at the international level there remain many important natural ecosystems or biomes that have been inadequately assessed. These include:

(a) non-coastal marine;

(b) freshwater systems (lakes and rivers);

(c) tropical dry forests and woodlands;

(d) montane systems; and

(e) rangelands, arid and semi-arid lands.

15. There also remain large gaps in knowledge for other ecosystems and biomes that have received a great deal of attention, such as coral reefs and tropical moist forests. The SBSTTA noted in its Recommendation II/1 that other forest types, wetlands, grasslands (particularly temperate grasslands and agricultural ecosystems were also in need of assessment.

3. EXISTING METHODOLOGIES FOR ASSESSMENTS OF BIOLOGICAL DIVERSIT

16. The SBSTTA r -emphasised that the Convention recognises that the primary focus of assessments of biological diversity should be at the country level. Such assessments are required by the Parties to set a baseline for the development of national strategies and action plans that will be the primary mechanism by which adverse human impacts on biological diversity may be mitigated. They should also serve as the basis for regional a global assessments although, of themselves, they will be insufficient to provide a complete picture at regional a global levels. This is because the distribution of biological diversity does not adher to geopolitical boundaries and, in the case of marine biological diversity, a significant proportion of it lies outside national jurisdictions. Some analysis at the supranational level will therefore always be required.

17. In response to the need for national assessments, UNEP established an Expert Advisory Team for Country Studies on the "costs, benefits and unmet needs for conservation and sustainable use of biological diversity". They prepared a document, *Guidelines for Country Studies on Biological Diversit* , designed to assist countries undertaking such studies. The technical annexes to the *Guidelines* identify four categories of information as necessary: socio-economic factors affecting biodiversity; biological data; the assessment of benefits, costs and net monetary values of biodiversity; and the current capacit for conserving and sustainably using biodiversity. Possible pathways for managing this information in the context of the Convention ar discussed in some detail in the data -flow model prepared by WCMC for the UNEP/GEF Biodiversity Data Management Project (1995).

18. Empirical studies have shown that, institutional issues aside, the collection of a significant proportion of the data covered by the *Guidelines* is much too demanding; it is thus critical to define a minimum set of data in relation to specific goals of a biodiversity strategy. Where funds and staff are limited, the importance of the need to select the most critical data for compilation or collection cannot be over-emphasised. Each country should, of course, decide on its own minimum data set to meet its specific requirements.

19. Defining a minimum data set raises two separate but nevertheless interconnected issues: the setting of priorities and the choice of methodologies. Priorities are important because our knowledge of biodiversity is very incomplete. First, we lack information on the distribution and status of elements of biodiversity. Such gaps ar theoretically possible to fill, although in practice it is often time-consuming and expensive to do so. Second, we

lack a full, and in some cases even a partial, understanding of the processes that create and maintain biologica diversity: those of ecology -- particularly at the large scale -- and of evolution. Our ignorance of these is a far more intractable problem. With limited resources, the choice of the most efficient and reliable methodologies is self-evidently also of great importance. This question of methodology is the principal subject of the present Note.

20. While some problems of monitoring and assessment have technical solutions, there is also a challenging but fundamental requirement to address the sustainability of staff and institutions -- particularly in terms of funding support -- in order to make use of these techniques.

21. In all cases, efforts should first be made to identify existing data and studies that might serve as partial baselines. Sources of existing information may cover biodiversity at the local, national, regiona or global level; may be published or unpublished (reports, databases or digital files); and may be held in-country or externally. In-country sources of information may include national museums, universities, agricultural development agencies, government departments (particularly forestry and wildlife), non-governmental organisations (NGOs) and the private sector. Although quantified time-series data are preferable, less rigorous or sometimes even anecdotal evidence can be valuable.

22. Within the broad framework of the UNEP guidelines, a number of techniques for making assessments of the status of biological diversity have been developed over the last decade. These have been applied at bot national and sub-national levels in various efforts to identify priority areas, in particular those of high diversity or possessing large numbers of restricted-range or threatened species.

23. Some of the more prominent biodiversity assessment techniques are:

(a) Gap Analysis, developed by the U.S. Fish and Wildlife Service;

(b) Rapid Ecological Assessment, developed by The Nature Conservancy (TNC);

(c) Conservation Biodiversity Workshops (CBWs), developed by Conservation International (CI);

(d) The Conservation Needs Assessment (CNA) was implemented for Papua New Guinea by the Biodiversity Support Program (a USAID-funded consortium of the World Wildlif Fund-US, The Nature Conservancy and the World Resources Institute);

(e) National Conservation Review (using Gradsect sampling), developed for Sri Lanka;

(f) Biodiversity Information Management System (BIMS), developed by the Asian Bureau for Conservation;

(g) Guidelines for the Rapid Assessment of Biodiversity Priority Areas (RAP), developed by the World Bank, the GEF and CSIRO;

(h) All Taxa Biodiversity Inventory (ATBI), developed by the University of Pennsylvania in conjunction with INBio (Costa Rica);

(i) Rapid Biodiversity Assessment, developed by MacQuarie University (Australia); and

(j) RAP: Rapid Assessment Programme, developed by Conservation International (CI).

24. These techniques are described and assessed in Annex I. Most use species as the basic unit of biologica diversity and rely on the compilation of existing data, the collection of new data, or, as in the majority of cases, both. The SBSTTA recommended a further review of these methodologies along the lines set out in Annex I.

3.1 Principles and Problems in the Assessment of Biological Diversity

25. The variety of techniques points to the fact that there is no universal methodology that will suit all the different needs of the Convention or its Parties, as is demonstrated in the assessment of techniques in Annex I t this Note. Different techniques have different strengths and weaknesses. Which technique is the most suitable for which purpose will be determined by the existing information, the aims of the assessment, and the needs of the audience. This was explicitly recognised by the SBSTTA in its recommendation II/1, which noted the need for flexibility in the approach to assessment, national reporting and indicator development in response to widely varying ecological conditions and national capacities. Regional or ecosystem approaches to the development of guidelines and indicators were stressed and their development considered an important task. Nevertheless, ther are a number of general observations that can be made about t e existing methodologies that will help guide decision-makers as to which is the most appropriate technique for them or whether a new technique altogether needs to be developed.

26. All of the techniques for making assessments of biological diversity suffer to some extent from a number of methodological problems, of either a biological or socio-economic nature. The biological problems stem from difficulties in the classification and description of the elements of biological diversity and the impracticability of assessing all these elements. The social and economic problems essentially derive from the weakness of methodologies for identifying and quantifying human impacts on biological diversity and a consequent inability to meaningfully incorporate human impacts into assessments of biological diversity. This issue is further addressed in document UNEP/CBD/COP/3/12.

27. The following paragraphs outline some principles and problems in the assessment of biological diversit at the levels of ecosystems, habita ts, species and genes. The consideration of ecosystems and habitats is particularly important, as the COP reaffirmed in its decision II/8, which stated that the ecosystems approach should be the primary framework of actions to be taken under the Convention. This presents a major challenge in that satisfactory systems for classifying ecosystems and habitats have to be developed so that the natura environment and changes to it can be mapped.

3.2 Identifying Ecosystems and Habitats

28. The classification of the natural environment is far more problematic than the classification of organisms, and few of the terms so far developed to this end (e.g., *community, habitat, ecosystem, biome*) have a satisfactory or universally accepted definition. Indeed, there are good theoretical grounds for questioning the basis of most such classifications because they are ultimately based on an assumption that the natural environment ca

be divided into a series of discrete, discontinuous units rather than representing differ ent parts of a highly variable natural continuum; in reality the latter model is undoubtedly a more accurate description of the real world.

29. Many attempts to classify ecological units are based on identifying the species that occur in them, along with a description of the physical characteristics of the area. Terrestrial ecosystems, for example, are often identified on the basis of plant communities -- that is, areas with similar plant species composition and structure -- on the assumption that differen t species may habitually be closely associated with each other over a wide geographical range. The extent to which this is the case is controversial. It can reasonably be argued that the distribution of plant species is dependent on the physical environment and historical accident rather than on the occurrence or otherwise of other plant species, although within a particular geographical region species wit similar ecological requirements may, of course, be expected to have similar distributions. Even if t e concept of communities is accepted, then the more rigidly a community is defined, the more site-specific it becomes and hence the more limited its use in analysis and planning.

30. At the other extreme, very general habitat classifications (wetlands, grasslands, deserts) are based on the physical characteristics and appearance of an area, independent of species composition. They generally cover such a wide range of possible conditions that they have very limited heuristic use. The term "forest" applies both to highly diverse lowland tropical rain forests and to coniferous monocultures, two systems that have virtually no species in common. Moreover, defining boundaries for even these very general systems is difficult. It is, for example, impossible to determine for how long, how regularly and how intensely an area must be flooded befor it should be classified as a wetland rather than a terrestrial ecosystem.

31. In reality, most systems for classifying terrestrial habitats combine the two approaches and use a range of descriptive criteria, of which the major ones are:

(a) physiognomic: features of height, growth form and coverage of vegetation;

(b) bioclimatic: the prevailing climate regime;

(c) edaphic: soil type and geology;

(d) phenological: leaf-retaining characteristics (i.e., whether vegetation is deciduous or evergreen);

(e) floristic: occurrence of certain principal plant taxa; a

(f) functional: management use (e.g., fuelwood production)

32. Classifications may indicate the actual vegetation present or indicate the "potential" vegetation that would be expected to occur in the absence of human activity.

3.3 Monitoring Ecosystems and Habitats

33. The need to monitor change over time in ecosystems and habitats, as essential components of biologica diversity, is implicit in Article 7 of the Convention and forms an integral part of any assessment of biological diversity. Only by monitoring change in the natural environment over time can the effects of humankind be assessed, both in ter s of negative influences on biological diversity and on the success or otherwise of efforts to mitigate such influences, which is one of the main aims of the Convention. As with efforts to classify and map the natural environment, there are both practical and theoretical impediments t carrying this out. The principal theoretical problem is that natural environments are not static entities, but ar dynamic and thus constantly changing at all geographical and temporal scales. Some changes (especially diel a nd seasonal ones) are cyclical and highly predictable, many others are not. Establishing baselines from which to measure change is therefore essentially an arbitrary exercise. This applies equally, for example, to the designation of potential vegetation cover in terrestrial ecosystems and to the species composition and biomass of fish stocks in particular regions.

34. Changes in terrestrial environments can usefully be categorised as either complete conversion (i.e., destruction) or modification. Assessing the former is essentially a matter of setting mor -or-less arbitrar boundaries. Thus FAO's tropical forests assessment defines forests as: "ecological systems with a minimum of 10% crown cover of trees and/or bamboos, generally associated with wild flora and fauna and natural soil conditions and not subject to agricultural practices"; while deforestation was defined as: "change of land use or depletion of crown cover to less than 10%".

35. Environmental modification, that is, change in habitat condition or quality, is much more difficult t measure. In large part, this is because notions of condition or quality are functionally dependent, so that there ca be no single measure for these attributes. From an ecological point of view, it can be argued that habitat modification can only be assessed with respect to effects on particular species. This is because any change in a area, other than complete destruction, will affect different species in that area in different ways. Some species may decrease in abu ance, others may increase, while others may remain apparently unaffected. This applies as much to natural changes as to those induced by humans. Indeed, the role of periodic disturbance in maintaining high diversity in, for example, tropical moist forests and coral reefs, is an area of considerable debate within ecology.

3.4 Identifying, Monitoring and Assessing Species

36. Problems of identifying and classifying species are rather different from those of identifying habitats a ecosystems. Although there are many exceptions and the concept of a species is by no means a fixed or consistent one, species are in general more discrete and easily identifiable entities than habitats. Some groups of organisms (chiefly higher vertebrates and some plant groups) are well known globally and there are usable, if imperfect, standard taxonomies.

37. The major problem with species is that there is a very large number of them, a high proportion of which, particularly invertebrates, are as yet undescribed. Moreover, the identification of described species often requires a high level of expertise. Identifying all species in even a limited area is thus a very onerous task.

38. Further, monitoring changes in biological diversity at the species level essentially entails monitoring changes in the distribution and abundance of species. This implies that populations of species should b inventoried on a systematic and regular basis. Many techniques have been developed for doing this, but they ar almost invariably labour-intensive and, with finite resources, can only realistically be applied to a small number of species and circumscribed geographical areas. Even if changes in distribution or abundance can be tracked, interpreting them may often be problematic because, as with ecosystems, population sizes of individual species are very rarely if ever static -- that is, maintained at some unvarying equilibrium level -- but are constantly changing, both through stochastic perturbations and in response to environmental variation on many different time-scales. Disentangling the effects of humankind (e.g., different la -use practices and harvest and management regimes) from these natural variations is difficult and, for many species, is likely to need detailed monitoring and population modelling over decades.

3.5 Identifying, Monitoring and Assessing Genes

39. Genetic diversity is impossible to quantify as a general property, but key parameters such as karyotypic variation, mitochondrial DNA divergence or protein polymorphism can b measured using techniques such as protein electrophoresis, DNA fingerprinting, the polymerase chain reaction (PCR), restriction site mapping and DNA sequencing. Some of these methods can be applied to both coding and non-coding sections of DNA, allowing for the investigation of the entire genome, and some can also allow for the inference of evolutionary relationships. Such methods for measuring genetic diversity within or between populations require many samples as well as analysis by trained personnel usi ng sophisticated laboratory techniques.

40. Because these techniques are expensive and labour-intensive, and because it is not always obvious how to interpret findings or make practical use of them, genetic diversity is not the normal scale on which biodiversity is measured. UNEP recommends that biological data on biodiversity be collected primarily at the species level, and that subspecies, populations and genetic diversity *per se* be considered only wher they have some significant economic value or indigenous use, for example, as sources of genetic material useful in crop or breed improvement. The assessment of genetic erosion is made difficult because of the requirement of a baseline against which to measure it. Because these techniques

are generally very new, baselines have yet to be established. Again, because of the expense of applying these techniques, it is highly unlikely that such baselines will be established other than in a few exceptional cases.

4. ADVICE ON METHODOLOGIES FOR FUTURE ASSESSME TS OF BIOLOGICAL DIVERSITY

41. As outlined above and discussed in more detail in the Annex, much valuable work has been carried out to date in developing methodologies for assessing biological diversity at various scales. Nevertheless, there is a clear need for further development, which should involve both a better and a more coordinated use of existing resources and techniques as well as the implementation of more innovative techniques.

42. In its recommendation II/1, the SBSTTA advised that assessments should be: transparent; based on scientific principles; based initially on existing knowledge; focused; pragmatic; cost -effective; within a socio-economic context; and management- or policy-oriented.

43. Two important areas that are used to some extent in most of the methodologies listed above, but that merit further development, are the use of Geographic Information Systems (GIS) and the use of indicators for extrapolation.

4.1 Using GIS

44. GIS may present one of the most productive avenues for the development of biodiversity assessment. Because representations of different, measurable attributes of the environment can be stored in separate layers within a GIS, their planned use of may obviate the need to develop the complex habitat and ecosystem classifications that are, as discussed above, currently a major problem. Examples of such attributes are: soil characteristics; altitude; rainfall; percent canopy cover; mean height of dominant vegetation; and distributions of individual species. The baselin maps used may be generated from satellit data, aerial survey and existing maps, or created by field survey and expert advice. Different combinations of these disaggregated data sets can be chosen to generate maps according to need, without having to choose a predetermined classification system. Further, these systems can be extended to include land-tenure and land-use categories and can thus be of great value in conservation planning on the ground. Such systems also lend themselves to extrapolation in that, for example, species distributions can be predicted in unsurveyed areas on the basis of congruence in environmental characteristics with areas known to contain the species.

45. However, the use of GIS implies an advanced and highly technical approach; this will not always be preferred, particularly where the capacity of the personnel involved is not appropriate and where staff continuity cannot be secured.

4.2. Using Indicators

46. As noted above, the variety of living species in even a small area is so great that identifying all of the species present is generally impracticable. Certain taxa can therefore be chosen as "indicator groups" that act as surrogates for the whole of biological diversity. Other parameters may also be used as indicators. As noted in the introduction to this paper, the SBSTTA advised in its recommendation II/1 that indicators were a vital part of assessment and considered that the background document prepared by the Executive Secretary on indicators of

biological diversity for consideration at the second meeting of the SBSTTA (document UNEP/CBD/SBSTTA/2/4) provided useful approaches to the subject. The latter paper is therefore appended as Annex II to the present Note.

4.3 Coordinating International and Regional Initiatives

47. There is a growing number of international processes that are calling for assessments of biological diversity in one form or another. Of immediate relevance to ensuring greater coordination, and of particular importance to the Convention itself, are the instruments related to biological diversity. Several of thes instruments have also called for global assessments of the state and trends of some aspects of biological diversity of importance to their conventions. For example, the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (the Ramsar Convention) has called for a global assessment of wetlands, and the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, has called for a global assessment of desertification. The SBSTTA concurred that the production of such assessments should b coordinated with the work of the Convention. The COP, in decision II/13, requested the Executiv Secretary to explore ways and means of improving the exchange of information and experience and to harmonise the reporting requirements of Parties under those instruments and conventions. This is th subject of discussion und r item 18 of the provisional agenda to this meeting.

48. There is also a large overlap with regard to critical sites and components for the various biodiversity-related conventions and instruments. The critical sites and components for the purposes of this Convention are described in Annex I to the Convention. The development of a common set of indicators would go a long way to ensuring that information, data and predictive models could be shared usefully among the biodiversity-related conventions. The synergies that Annex I has with the critical sites and components of other biodiversity-related instruments and the modalities of coordination between th processes is discussed in more detail in the Note to assist the COP in their consideration of the previous item on the provisional agenda (document UNEP/CBD/COP/3/12).

49. The harmonisation of methods and terminologies for assessment is not only important for ensuring quality control of the data produced for assessments, but also to ease the reporting burden on the Parties under this and other conventions and instruments. It is important that work begin on this soon, as a number of the other conventions have established definitions for several of the key terms of Annex I. The Ramsar Convention, for example, has an approved global definition of wetlands that rests in part on vegetation. The extent to which this accords with the intended meaning of the term as used in Annex I of the Convention and adheres to the principles of the Convention needs to be considered. In general, th adoption of existing standards, for example, the checklists of various taxa already in use by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), would not only promot harmonisation, but would also likely assist the Parties in their national assessments as it would obviate th need for a time-consuming review of different classification systems in order to choose a preferred one.

50. A more centralised system of data collection for all of th se conventions would significantly encourage the greater coordination of information, ease reporting burdens on Parties, and make managing the data easier. The degree of management required to make the most of various assessments is beyond th envisaged capacity of the clearing-house mechanism, the Secretariat of the Convention, or the institutions of the other biodiversity-related instruments. In general, the secretariats lack the proper

facilities to manage, analyse and interpret the data that are supplied to them by their Parties and have expressed a desire for guidance on this issue. In light of the general need to cooperate and coordinate, what is required is the design of a common data-management programme that all th secretariats and Parties could use.

51. Similarly, the secretariats generally recognise the importance of data that presents information in a spatially referenced manner. Such maps can easily be used by both management and scientific field staff for practical work, make excellent tools for training, and help in promoting public awareness of th purposes and work of the Conventions. The secretariats do not have the capacity to undertake this type of geographical information system work. Such work will need to be carried out by national GIS facilities or outside GIS specialists (e.g., GRID or WCMC).

52. The coordination of information being generated for international processes is vital. This means harmonising and centralising the presentation of data or national reporting requirements with these international processes. A greater coordination of national reporting requirements will provide benefits to both the international processes and the countries themselves. For countries, it would, for example:

(a) increase the ease and efficiency of building national biodiversity information systems that would facilitate strategy and policy development;

(b) improve the initiation of country-driven actions in support of international commitments;

(c) reduce the cost of meeting international reporting requirements;

(d) improve feedback from secretariats and comparability with other countries; and

(e) increase ability to develop and use integrated indicators of sustainability.

53. From the international institutions' perspective it would:

(a) improve the efficiency of information management and the flexibility to adjust to changing situations;

(b) reduce the cost of information-systems development;

(c) facilitate the preparation of global and regional assessments, including in consideration of other international instruments;

(d) improve information quality, consistency and transparency; and

(e) improve links with international environmental monitoring agencies, major data custodians, and regional treaties.

54. The coordination of international reporting requirements requires an overarching information infrastructure that adheres to the following principles:

(a) synchronised reporting schedules;

(b) agreed-upon information interchange and sharing modalities;

(c) compatible technology for information management; and

(d) standards and guidelines for the scientific and technical data content of reports.

55. The COP may wish to consider the practical steps required to begin to establish such a harmonised infrastructure and may wish to consider such documents as th *Guidelines for Country Studies* and the *Data Flow Model in the Context of the Convention on Biological Diversity.* The data-organisation structures of The Nature Conservancy, of CORINE (the European Commission's system for coordina ting information on the environment) and of the Australian Nature Conservation Agency, referenced in the Not by the Secretariat on Agenda Item 5.5.1 of SBSTTA I (UNEP/CBD/SBSTTA/ 1/4), may also be of interest.

5. CONCLUSION

56. This Note has illustrated a number of priority needs with regard to undertaking assessments to meet the requirements of the Parties and ultimately those of the Convention as well. On the basis of these needs, the COP may wish to consider the following suggestions, based largely on recommendations made by the second meeting of the SBSTTA.

57 In its recommendation II/1, the SBSTTA advocated a two-track approach to assessment and indicator development. In the short term, actual assessment should be made of sectors and components of biological diversity that are already reasonably well-known and understood. In particular, use should b made of indicators known to be operational. Longer-term programmes involving research and capacity-building should be developed in areas needing advances in knowledge.

5.1 Support for National Assessments

58. All assessments and reviews of assessments have pointed to a need for capacity-building at all levels, most particularly at the national level. The SBSTTA, in its recommendation II/1, considered that the enhancement of capacity-building, and the strengthening of institutions and funding in developing countries to carry out identification, monitoring and assessment within the remit of the Convention wer high-priority tasks.

59. The two most important components of capacity-building are better coordination of information gathering and improved training at the national and local level. Both these components require additional resources. The Convention's financial mechanism has already begun to provide financial support for national assessment through its programme of enabling activities for developing countries as described in document UNEP/CBD/COP/3/5.

60. Further international support can, however, be provided by the Convention to these national efforts. In particular, the COP may wish to consider the following measures:

(a) Capacity building within Parties could be supported by a greater sharing of experience, practices and assessments. The COP may wish, therefore, to recommend that the first national reports be made available, *as they are completed,* through the clearing-house mechanism in order to allow other countries still engaged in the process to benefit from the experience of earlier reports.

(b) To provide further support in this regard, the COP may wish to consider the ways and means by which the clearing-house mechanism can develop the capacity to provide technical support at the national level to help in the process, such as providing better access to GIS systems. The SBSTTA identified the development of the clearing-house mechanism as a high priority task in this regard in its recommendation II/1.

(c) A large amount of information on biological diversity, particularly that in less-developed countries, exists outside the countries concerned, in a range of institutions (universities, museums, herbaria, botanical gardens, international NGOs). Reporting burdens on Parties would be greatly eased if they had greater access to this information. The COP may like to make recommendations for improving the flow of information to the Parties, particularly less-developed countries, from these sources. The possible role of the clearing-house mechanism should be examined. The central importance of taxonomic information in meeting the needs of the Convention, the need for increased access to taxonomic information and possibl mechanisms to achieve this are detailed in the SBSTTA recommendation II/2 on practical approaches for capacity-building for taxonomy, which the COP may wish to consider endorsing.

(d) The COP may wish to consider recommending a critical review of particular methodologies for assessment that would assist countries in developing their own methodologies by providing them with a better understanding of the strengths and weaknesses of existing methodologies. Annex I to this Note provides an indication of what such a review might look like. The SBSTTA considered in its recommendation II/1 that such a task should be accorded high priority, and advised that the annex provided a suitable starting point. In addition, the SBSTT identified as important a review of methods for monitoring activities that have or may have advers impacts on biological diversity and specifically recommended the production of a listing of current approaches to indicator development along with a preliminary core set of indicators of biological diversity, particularly related to threats. The SBSTTA suggested that th Secretariat might be charged with the responsibility of producing such a listing and core set of indicators.

(e) At present, UNEP's *Guidelines for Country Studies on Biological Diversity* is the basis for providing guidance for coordinating the generation of the data needed for assessments. Th collection of a significant proportion of the data cover d by the *Guidelines* is, however much too demanding; it is thus critical to define a minimum set of data in relation to specific goals of a biodiversity strategy. The COP may wish to consider endorsing that part of the SBSTTA's recommendation II/1 that noted that the development and refinement of national guidelines should be accorded high priority. Such guidelines should include: assessment and monitoring methodologies; indicators; thematic approaches; definition and clarification of terms; recommendations for harmonisation. The SBSTTA specifically suggested that the Secretariat might be charged with the responsibility of producing such guidelines.

(f) The assessment of biological diversity and human impacts on it is a multidisciplinary process. In many countries, increased capacity is required in a range of different disciplines, including taxonomy (as emphasised in the SBSTTA's recommendation II/2), ecology, natural-resource management, remote sensing, information-systems management, and sociology. Befor making specific recommendations for capacity-building through providing training or institutional support, the COP may like to initiate a review of the process of assessing biological diversity and compare identified needs with existing capacity to determine the critical limiting steps in th process. The COP may also like to initiate a review of past experience in capacity building in areas relevant to the assessment of biological diversity, particularly within the scope of the Convention, with a view to identifying the most cost-effective and successful forms of capacity-building. It may wish to be particularly mindful of the need to ensure institutional stability and continuity.

5.2 International Activities

61. The importance of improving international cooperation in assessing and reporting on biological diversity was emphasised by the second meeting of the SBSTTA, as expressed in its recommendation II/1.

62. The COP may wish also to consider initiating a review of existing standard or widely used classification systems, taxonomies and definitions of terms, with a view to developing those that may prov useful in national, regional and global assessments of biological diversity.

63. A more centralised system of data management would be useful. The degree of management required to make the most of various assessments is beyond the envisaged capacity of the clearing -house mechanism and the Secretariat. The COP may wish, therefore, to consider a review mechanism for assessing the extent to which this task can be fulfilled by some other organisation that does have th capacity. The COP may also wish to consider the preferred mechanism for centralising the reporting

requirements of the Parties. For example, it may wish to consider the nature of the institution that might b used to provide this support, such as whether it should be public or private.

64. Although the aim of improving the coordination of data management at the international level is ultimately to increase the efficiency of reporting procedures and should therefore lead to the saving of resources, investment will be required in the initial stages in order to develop harmonised systems. Th COP may wish to consider the appropriate levels and modes of investment.

65. This review of assessment has indicated that there exist some major needs in the assessment of biodiversity at the global level. In its recommendation II/1, the SBSTTA considered important the tas of developing an assessment of the knowledge and status of biological diversity in one or more of the following areas:

(a) freshwater systems;

(b) coastal and marine;

(c) forests and woodlands;

(d) montane systems;

(e) rangelands, arid and semi-arid lands;

(f) grasslands; and/or

(gi) wetlands.

66. The COP may wish to consider initiating an assessment of a particular area, which would simultaneously contribute to the general understanding of biodiversity, support the consideration of other issues before the COP, and begin the process of providing assessments for the specific n ds of the Convention. The COP may wish to be particularly mindful of the fact that, in its mediu -term programme of work of the Conference of the Parties 1996-1997 (annex to decision II/18), it may consider at its fourth meeting the following item: "To assess the status and trends of the biodiversity of inland water ecosystems and identify options for conservation and sustainable use". The SBSTTA noted, in its recommendation II/1, that a global assessment of freshwater ecosystems was urgently required.

67. The COP may wish to consider what information or analysis not contained in national assessments might be required for any global assessments, and particularly any assessment of marine biological diversity where a significant proportion lies outside national jurisdiction. In considering this issue, th SBSTTA noted in its recommendation II/1 that, when necessary, regional bodies should be called upon to provide information to facilitate the assessment of biological diversity beyond national jurisdiction.

68. The COP may also wish to consider, as suggested by SBSTTA in its recommendation II/1, ho best to ensure that assessments of biological diversity are included in resource assessments within relevant

economic sectors at regional and global level when these are undertaken by regional and global organisations, particularly the FAO.

Annex 1

DETAILS OF BIODIVERSITY ASSESSMENT TECHNIQUES

1. GAP ANALYSIS: US Fish and Wildlife Service and others

Source: Scott, J.M., et al. 1993.

1.1 Brief Summary o Technique

1. Gap Analysis is essentially a coars -filter approach to biodiversity conservation. It is used to identify gaps in the representation of biodiversity within areas managed solely or primarily for the purpos of biodiversity conservation (referred to below as reserves). Once identified, such gaps are filled through the creation of new reserves, changes in the designation of existing reserves, or changes in management practices in existing reserves. The goal is to ensure that all ecosystems and areas rich in species diversity are adequately represented in reserves.

2. Gaps in the protection of biodiversity are identified by superimposing three digital layers in a Geographical Information System (GIS), namely maps of vegetation types, species distributions and land management. A combination of all three layers can be used to identify individual species, species -rich areas and vegetation types that are either not represented at all or under-represented in existing reserves. In effect, vegetation, co mon terrestrial vertebrate species, and endangered species are used as surrogates to represent overall biodiversity.

1.2 Data needed

(a) Maps of existing vegetation types, which are prepared from satellite imagery and other sources. The smallest unit mapped is usually 100 ha, because the overall process covers entir states or regions. Vegetation maps are checked through ground-truthing and examination of aerial photographs. Landsat Thematic Mapper digital imagery is now the standard source for Gap Analysis vegetation maps.

(b) Predicted species distribution maps. These are based on existing range maps and other distributional data, extrapolated to include potential species ranges using data on known habitat preferences. Maps of a particular group or groups of species of political or biological interest can be synthesised from maps of individual species' distribution. Gap Analysis normally uses vertebrate and butterfly species (and/or other taxa, such as particular groups of vascular plants) as indicators of overall biodiversity.

(c) Land ownership and management status maps.

1.3 Assessment of Likely Availability of Data

3. Vertebrates (particularly birds, followed by mammals) are the best-studied groups of animals. If a national data set for any taxonomic group exists, it is most likely to be for birds.

1.4 Costs Involved

4. A GIS-supported Gap Analysis requires technical infrastructure, a great amount of baselin information, and highly trained personnel. It is likely to be an expensive undertaking. Projects identified so far have been carried out mainly in developed countries: e.g., the United States and Australia.

1.5 Human Resources Involved/Required

5. A high level of technical competence is necessary to interpret satellite images, prepare maps, and manipulate the complex GIS data layers involved.

1.6 Data Generated

6. Data generated by the Gap Analysis process include vegetation maps, maps of species' actual and potential distribution, and prioritisation of protected areas needs.

1.7 Time Frame

7. No indication of the time required from satellite image acquisition to publication of Gap Analysis results is available.

1.8 Examples of Implementatio

8. Scott et al. (1986) conducted a Gap Analysis on endangered forest birds in Hawaii. Gap Analysis is now also being used on a state by state basis in the U.S.A.; results and recommendations of one for Idaho were under review in 1993.

1.9 Points For and Against

9. For:

(a) Gap Analysis provides a quick and efficient assessment of the distribution of vegetation and associated species, and can be used at short notice to generate recommendations for th conservation of biodiversity in response to rapid rates of habitat loss.

(b) The data layers generated and the GIS framework in which they are stored can be used as the basis for monitoring and evaluating changes in biodiversity at both fine and coarse levels.

(c) Data generated during the Gap Analysis exercise can be combined with other geographic data sets (if available), such as road networks, urban development, etc.

(d) Many different questions in conservation biology and land-use planning can be addressed by Gap Analysis data, including potential impacts of human-induced changes.

10. Against:

(a) Mapping units have a minimum size, which may result in the omission of significant but small patches of habitat, for example, meadows and wetlands in a predominantly forest matrix.

(b) Vegetation maps often fail to distinguish between different successional (seral) or ag stages in the plant community, which may result in the under-representation of a particular stage of a particular community. For example, they can identify large areas of unfragmented forest, but not whether the habitat is regrowth following clear-cutting or a forest fire, or "old-growth" forest.

(c) Vegetation classes used in mapping must be distinguishable in remotely sensed images and identifiable in large- to medium-scale aerial photographs.

(d) Vegetation classes used must be compatible with those used to describe animal habitat preferences.

(e) Gap Analyses in the United States have shown about 70% accuracy in the prediction of species present in a given area. The presence of species of particular importance, such as rare or threatened ones, requires confirmation prior to sit -specific management activity.

(f) Gap Analyses tend to be focused on national or regional reserve systems. In developing countries, many highly biodiverse regions will lie outside the protected-areas network, and alternative strategies to the gazetting of new reserves may be required.

(g) Predicting species distributions on the basis of habitat types may ignore highly influential additional factors. For example, anthropogenic factors (e.g., pollution, hunting, disturbance) may greatly modify actual species distributions.

(h) For some groups, e.g., reptiles, species distributions predicted on the basis of vegetation types may show poor correlation with actual distributions unless climatic variables are included as data layers.

(i) Predicting distributions of aquatic (riparian and wetland) species generally requires the us of a separate data layer representing hydrological features.

(j) Gap Analysis predicts the presence or absence of a species, but does not indicate whether it is rare or common at a particular site. Field work is necessary to determine the abundance of a species at a given location.

(k) The choice of indicator species groups may greatly affect the results of Gap Analysis. In addition, the empirical relationship between biodiversity in vertebrate species and other groups of organisms (e.g., fungi, invertebrates, ferns, higher plants) has not yet been established.

(l) Gap Analysis requires a relatively high level of technical expertise (in GIS, satellite imag interpretation, etc.).

(m) Gap Analysis is not a substitute for field investigation. The establishment of new reserves or management changes to existing ones should only be attempted after careful on-the-ground studies.

1.10 Appraisal

11. Gap Analysis can be a useful tool for identifying areas worthy of further investigation for biological significance and conservation needs. Gap Analysis should be viewed as complementary to conserving individual threatened species. It potentially permits the identification of areas of high biodiversity that are most in need of additional protection. It is probably most suitable for relatively developed countries with a high degree of technical infrastructure and a well-established existing reserv system.

2. RAPID ECOLOGICAL ASSESSMENT (REA): T e Nature Conservancy
Source: Grossman, D.H. et al. 1992

2.1 Brief Summary of Technique

12. Rapid Ecological Assessment (REA) is a technique developed by The Nature Conservancy (TNC) as a tool to aid conservation planning in areas that are large, poorly studied, or exceptionally biodiverse. The REA process consists of a series of increasingly refined analyses, with each level further defining sites of high conservation interest. The levels involved are satellite observation; airborne remote sensing; aerial reconnaissance; and field inventory. The analysis of satellite images is used to produce maps of ecoregions, land cover and priority areas; while integration with data from airborne sensors and aerial reconnaissanc produces more detailed maps, extended to cover vegetation types and ecological communities. These ar used to direct the cost-effective acquisition of biological and ecological data through stratified field sampling. Such data are used to support the conservation planning process and to identify priority sites.

13. Spatially referenced information is managed by a Geographic Information System (GIS), allowing for easy data handling and map generation. Other conservation information is managed through manual files and a relational database called Biological and Conservation Data (BCD) developed by The Natur Conservancy.

2.2 Data Needed

(a) Maps, prepared from satellite data with aerial reconnaissance input and some "ground-truthing". The primary data need is for a vegetation map, but maps of the physical and social components of the landscape are necessary for identifying threats. In a recent REA of Jamaica, Landsat Thematic Mapper (TM) data were acquired and processed; digital terrain data wer obtained from existing GIS data sets and used to generate slope, aspect and altitudinal classes, and an existing 1:250,000-scale geology map was digitised and coded by TNC into GIS format.

(b) Site-specific inventories of species present, conducted through field sampling at sites identified during initial analyses. Although not stated in the Jamaican methodology, it is likely that certain taxonomic groups were concentrated on. Suggested taxa are birds, mammals, butterflies and vascular plants.

2.3 Assessment of Likely Availability of Data

14. The availability of satellite maps of vegetation and the physical and social components of th landscape is likely to vary by country. Field survey of specific sites is relatively straightforward, but it might prove difficult to access remote areas.

2.4 Costs Involved

15. No indication of costs is available. The preparation of vegetation maps from satellite data is presumably a costly exercise, and requires highly trained personnel.

2.5 Human Resources Involved/Required

16. A high level of technical competence is necessary to manipulate the complex GIS data layers involved, and to interpret satellite data and images. Field surveys will not require either very many or well-qualified personnel.

2.6 Data Generated

17. Phase 1 of the Jamaican REA produced an updated classification system of the vegetation types of the island, together with digital and hard-copy vegetation maps, and digital and hard-copy Landsat TM image data. Field surveys will provide sit -specific inventories of key "indicator" groups of species. Thes will be used to identify priority sites and conservation actions.

2.7 Time Frame

18. A recent REA of Jamaica completed the field work for phase 1, an island-wide survey of th natural communities and modified vegetation types of the entire country , in six months. Jamaica, however, is relatively small in area (c. 11,425 k ^{2}). In addition, many of the required GIS data sets and maps already existed in a national database, the Jamaica Geographic Information System (JAMGIS), developed fro 1982 onwards by the Rural and Physical Planning Unit (RPPU).

2.8 Examples of Implementatio

19. The Nature Conservancy has used REA on small barrier islands off Virginia, and to support conservation planning and inventory in Jamaica (Grossman et al. 1992), Mato Grosso (Brazil), South Carolina, Georgia and New Mexico (USA), and Venezuela.

2.9 Points For and Against

20. The points for and against associated with the mapping component of the Gap Analyses techniqu also apply here. In addition, the following points should be considered:

21. For:

(a) REA involves substantial data acquisition from field surveys to "ground truth" th impressions obtained from map preparation and analysis.

(b) REA is not restricted in scope to a protected-areas network.

22. Against:

(a) REA is not a particularly rapid technique, in spite of the name. Phase 1 of an area equivalent to Jamaica may take considerably longer than 6 months if existing GIS data sets are not available.

2.10 Appraisal

23. In effect, REA uses the same GIS data sets as a Gap Analysis, and then supports the analysis with subsequent ground-truthing. It is most appropriate for small countries (or defined regions of larg countries) without comprehensive protected-areas networks. It can be used to predict where high levels of biodiversity in need of protection exist.

3. CONSERVATION BIODIVERSITY WORKSHOPS: Conservation International
Source: Tangley, L. 1992.

3.1 Brief Summary of Technique

24. Conservation Biodiversity Workshops (CBWs) were developed by Conservation International as a means of setting conservation priorities in large geographic regions. The technique entails collating biological information, in particular, maps prepared by CI's geographic information system (CISIG), and using it as a focus for discussion at a Workshop of field scientists who are the world's leading experts on a region's species and ecosystems. In this way, the knowledge attained by biologists through decades of field work can be captured. Following this initial stage of the Workshop, the maps are used as catalysts to obtain a group consensus on biological priorities for conservation throughout the region. One key output of the Workshop is a Final Workshop Map that summarises the information available, synthesising and integrating the data and opinions of the experts who attended it. This provides a single coherent picture that decision-makers can readily understand. Maps continue to play a key role even after the Workshop is over

because -- as easily interpreted images reflecting a broad consensus among experts -- they can help governments, NGOs and funding agencies decide where to allocate resources.

3.2 Data needed

(a) GIS data layers including topography, hydrography, vegetation type, political boundaries, management categories (including protected areas and logging concessions), roads and population centres. The CBW process does not generate new data layers; rather it harmonises existing ones obtained from other institutions and government departments by formatting them to a standard scale (e.g., 1:1 million or 1:3 million) and projection.

(b) Basic species-distribution maps, representative of "keystone" groups. These can b obtained from published sources, or through the distribution of blank maps to acknowledged experts, who are asked to draw their impressions of species' ranges. These data are then digitised for consistency and to allow their superimposition on other data layers. Such maps may be th result of individual contributions, but more often experts in a particular discipline are appointed to a "project team" that is asked to submit a composite map providing a summary of their individual opinions.

3.3 Assessment of Likely Availability of Data

25. GIS data layers are likely to exist for all countries, but their availability may be a matter of political sensitivity in some areas. Experts able to contribute advice and impressions of species ranges ar probably available for most countries.

3.4 Costs Involved

26. A CBW is an expensive process, requiring $US100-500,000 (Silvieri, pers. comm.).

3.5 Human Resources Involved/Required

27. The preparation of GIS data layers and maps requires GIS and computing expertise. Th organisation of a CBW requires considerable input from a combination of international and national experts. The actual Workshop itself is a partnership between CI, government departments and (wher available) NGOs. Up to 200 representatives from as many as 50 institutions may attend.

3.6 Data Generated

28. The CBW process generates a number of useful products, including compatible GIS coverage of the entire country (or region); refined maps of many species' distributions; a Final Workshop Map delimiting priority areas for conservation; and a database of the biological data gathered.

3.7 Time Frame

29. The Workshop itself may only take 10 days to 2 weeks, but the process of preparing the maps and collecting biological data, together with the training of host nationals in GIS techniques and organising th Workshop and its constituent working groups, may take 1 to 2 years.

3.8 Examples of Implementatio

30. CI organised a CBW for the Amazon basin in Manaus, Brazil, in January 1990. The Final Workshop Map produced has been used by several Amazonian countries to guide conservation policy decisions. Th second CBW was held in Madang, Papua New Guinea (PNG), in April 1992. During this CBW process, a number of working groups were organised on a thematic basis (e.g., 5 faunal groups, 2 botanical, 1 socio-economic). Team leaders were appointed for each thematic group; they were responsibl for collecting data from their constituent members. Further CBWs are planned for the Atlantic Forest region of Brazil and the Central African Region.

3.9 Points For and Against

31. For:

(a) By using a consultative, workshop approach, a CBW produces a broad consensus of expert opinion on conservation priorities. This can be used to exert more influence on government opinion than a narrow, sectoral approach.

(b) Provides a visual synthesis of nationally important areas for biodiversity conservation in the form of a Final Workshop Map.

(c) The process is relatively fast.

(d) A CBW entails the technology transfer of databases and computers to the host country.

(e) Uses existing maps and reformats them into compatible GIS coverages.

32. Against

(a) Requires the availability of substantial data sets (particularly GIS data layers).

(b) A CBW is really only the first stage in the setting of national or regional biodiversity conservation priorities. It identifies areas in which field surveys/conservation measures may be necessary. Their implementation is an entirely separate process.

3.10 Appraisal

33. CBWs effectively summarise the existing biological knowledge of a region or country. They ar most appropriate for setting investigation priorities in large, relatively unknown areas. A subsequent phas is to despatch RAP teams to unknown areas thought to contain high biodiversity (see below for a

description
of RAP).

4. CONSERVATION NEEDS ASSESSMENT: Biodiversity Support Progra
Sources: Alcorn, J.B. (ed.) 1993. Beehler, B.M. (ed.) 1993.

4.1 Brief Summary of Technique

34. The Conservation Needs Assessment (CNA) was implemented for Papua New Guinea by th Biodiversity Support Program (a USAID-funded consortium of the World Wildlife Fund, The Natur Conservancy and the World Resources Institute). The process involved is outlined in the section above on Conservation Biodiversity Workshops. Conservation International was responsible for preparing the maps for participants at the Workshop, and concerned itself primarily with biodiversity information. It is important to note that in addition to biologically oriented project teams, several non-biological project teams were also appointed prior to the Workshop to examine conservation implementation. These were a social scientists' team, a legal team, an information-management team and an NGO/landowner team. Th CNA process is considered to be a starting point for participatory approaches to conservation and sustainable development, and takes account of social and political realities.

4.2 Data Needed

(a) "Base Maps" prepared at the same scale and on the same projection of a number of factors affecting biodiversity, i.e., political boundaries; coastlines; hydrogeographic features; roads; topography; vegetation type and cover; population centres; protected areas; and timber rights purchases.

(b) Biological maps of species distributions, which are prepared on the base maps by "project teams" of scientists with expertise in a particular area or taxonomic group. These maps are debated and refined at the Workshop.

4.3 Assessment of Likely Availability of Data

35. GIS data layers are likely to exist for all countries, but their availability may be a matter of political sensitivity in some areas. Experts able to contribute advice and impressions of species' ranges ar probably available for most countries.

4.4 Costs Involved

36. No indication of the costs of the exercise are currently available, but it is obviously an expensiv process.

4.5 Human Resources Involved/Required

37. A CNA coordinates a multidisciplinary team of international and national experts. Preparation of base maps requires GIS expertise.

4.6 Data Generated

38. The CNA process generates the same kinds of product as the CBW, namely compatible GIS coverage of the entire country (or region); refined maps of many species' distributions; a Final Workshop Map delimiting priority areas for conservation; and a database of biological data gathered during the whol exercise. In addition, in Papua New Guinea, Workshop proceedings were published as a two-volume series entitled "Papua New Guinea Conservation Needs Assessment".

4.8 Time Frame

39. The CNA process for Papua New Guinea took 15 months from start to the completion of the Workshop and preparation of the Final Workshop map.

4.9 Examples of Implementatio

40. To date, only one CNA has been implemented, in Papua New Guinea.

4.10 Points For and Against

41. For:

(a) CNAs adopt a truly multidisciplinary approach to the conservation of biodiversity, focusing on both the social dimensions of conservation and the geographic dimensions of biodiversity.

(b) A CNA involves cooperation between the state, government and customary landowners.

(c) The PNG CNA developed a process for information-sharing and consensus-decision-making.

(d) The PNG CNA covered both terrestrial and marine areas.

42. Against:

(a) Requires the availability of substantial data sets (particularly GIS data layers).

(b) A CNA is really only the first stage in the setting of national or regional biodiversity conservation priorities. It identifies areas in which field surveys/conservation measures may be necessary. Their implementation is an entirely separate process.

4.11 Appraisal

43. CNAs effectively summarise the existing biological knowledge of a region or country, but in addition provide an overview of the social and economic factors affecting biodiversity, and take these into account when setting conservation priorities. They are most appropriate for setting conservation priorities in large, relatively unknown areas. As is the case with Conservation Biodiversity Workshops, a CNA will also highlight areas where further field surveys are needed.

5. NATIONAL CONSERVATION REVIEW (using Gradsect sampling): Sri Lanka Forest Department Source: Green, M.J.B. and E.R.N. Gunawardena 1993.

5.1 Brief Summary of Technique

44. The aim of the National Conservation Review (NCR) is to identify an optimal or minimum set of sites which is representative of national biodiversity. This is achieved through the collection of data on species distributions and their subsequent analysis. Surveys are conducted to assess these distributions (s below). The sampling procedure involves the following steps:

(a) identifying sites;

(b) positioning of transects along environmental gradients; and

(c) inventorying flora and fauna within plots.

45. The NCR also has a hydrological and soil-conservation component. These attributes of forests ar measured concurrently by a separate survey team. An iterativ -complementarity procedure is being used to define a minimum set of sites necessary for conserving Sri Lanka's biodiversity. This procedure is fully explained in Green and Gunawardena (1993).

46. In Sri Lanka, the survey technique employed was Gradient-directed transect (Gradsect) sampling. Transects are selected deliberately to traverse the steepest environmental gradients present in an area, whil taking into account access routes. This technique is considered appropriate for rapidly assessing species diversity in natural forests while minimising costs, since gradsects capture more biological information than randomly placed transects of similar length. Altitude may be the most significant environment gradient, and was the one chosen in Sri Lanka. Others, for example, could be precipitation, temperature, or latitude.

5.2 Data Needed

(a) Sites for survey were identified based on a 1:500,000 forest map of Sri Lanka. An accurate topographic map is needed to locate the gradsects within the chosen site.

(b) The presence or absence of species in selected groups of fauna and flora was ascertained during the field survey. Faunal groups inventoried were mammals, birds, reptiles, amphibians, butterflies, molluscs, and mound-building termites, while fishes were identified opportunistically. Floral inventory was restricted to woody plants.

5.3 Assessment of Likely Availability of Data

47. Topographic maps are usually available for most countries. In extensive forests, Landsat TM images can be used to distinguish between different types of communities in order to ensure that each is representatively sampled.

5.4 Costs Involved

48. The Gradsect survey technique is a field-oriented process. It involves low technological input, and therefore costs are therefore likely to be low.

5.5 Human Resources Involved/Required

49. A competent zoologist and botanist are required, together with unskilled labour to assist in positioning and marking the transects.

5.6 Data Generated

50. The faunal part of the survey was restricted to identifying the presence of higher vertebrates and a few invertebrate groups (butterflies, molluscs, and mound-building termites). The floral survey was confined to woody species. Specimens were collected of species tha t could not be identified in the field, and were sent to museums for positive identification. Species lists were therefore generated for each forest surveyed. Sub-sequent analyses were based mainly on the woody plants data, because of the large number of biases in-volved in faunal survey, and the likelihood that faunal diversity was greatly underestimated du to the speed at which the survey had to be conducted.

5.7 Time Frame

51. The forests of the Southern Province of Sri Lanka, comprising 10% of the country, were surveyed in 1 year. To complete the process for the whole country would take an estimated further 4 years.

5.8 Examples of Implementatio

This technique has been carried out in Sri Lanka's forests under a UNDP/FAO/IUCN programme.

5.9 Points For and Against

53. For:

(a) An NCR using Gradsect sampling is based on real data, not hypothetical or modelled data.

(b) Gradsect sampling is relatively cheap.

54. Against:

(a) As employed in Sri Lanka, the method is only suitable for investigating pr -identified sites, not for selecting possible sites.

(b) The technique records the presence or absence of a species, but gives no indication of its abundance.

(c) The time-frame is long, but could be shortened by training and deploying more survey teams.

(d) The identification of specimens by museums takes time and adds an element of delay.

5.10 Appraisal

55. This technique is suitable for the investigation of, and conservation priority setting between, pr - identified sites, but not for conducting a first-tranche assessment of biodiversity. Although it has only been used in forests, modifications to the methodology would enable its adaptation to other habitats as well. It would be suitable for small countries with a limited number of sites of conservation interest.

6. BIMS (BIODIVERSITY INFORMATION MANAGEMENT SYSTEM):
Asian Bureau for Conservatio
Source: MacKinnon, J. (pers comm.)

6.1 Brief Summary of Technique

56. The Asian Bureau for Conservation has developed and distributed a software package called BIMS (formerly MASS) that can be used for monitoring the conservation status of species, wildlife habitats and protected areas on a national basis. The underlying principle is that the distribution and occurrence of species whose habitat requirements are known is predictable. In other words, a good naturalist with knowledge of the condition of a certain site can usually predict whether a particular species will be found there. BIMS monitors the status of individual species by assessing the extent of, rate of loss of, and degr of protection afforded to their required habitats.

57. The technique uses empirical modelling to estimate distribution and abundance patterns of species from sparse primary data, stored in a relational database. It includes estimates of the threats to the species being modelled. BIMS is based on a mapped-habitat classification that uses a small fraction of th computer space that an equivalent approach to species mapping using GIS would.

6.2 Data Needed

58. BIMS requires a mapped-habitat classification (i.e., the best available vegetation map) with th following minimal layers:

(a) a physical base map;

(b) biogeographical divisions;

(c) habitat classification (original distribution);

(d) habitat classification (current distribution based on remote sensing); and

(e) a protecte -areas system

59. Topographic coverage, and knowledge of species habitat requirements (particularly habitat typ and altitudinal range) are also required. Data on threats such as hunting can be added optionally to increas the accuracy of computer-generated predictions.

6.3 Assessment of Likely Availability of Data

60. All countries are likely to have habitat classifications or vegetation maps available at some degr of resolution.

6.4 Costs Involved

61. Relatively low.

6.5 Human Resources Involved/Required

62. Competent computer operators and experienced biologists/naturalists are needed to input realistic data and model it correctly.

6.6 Data Generated

63. BIMS can be used to generate predictive maps of species distribution, estimate population sizes, and assign categories of threat on a national basis.

6.7 Time Frame

64. Can be very quick where data are available.

6.8 Examples of Implementatio

65. BIMS databases have been established in most Asian countries and have been used to determin conservation priorities in China, Thailand, Bhutan, Vietnam and Indonesia; for example, in the preparation of a forestry masterplan for Bhutan (MacKinnon 1991).

6.9 Points For and Against

66. For:

(a) Provides "maps" of species occurrence without using GIS technology.

(b) Fast.

(c) Cheap.

(d) Gives acceptably accurate predictions of species' actual occurrence.

(e) Can be used to estimate species' population sizes.

(f) Can be used to assign categories of threat to individual species on a national basis.

67. Against:

(a) Not suitable for species whose habitat requirements are not well known.

(b) Has so far only been used in Asia.

6.10 Appraisal

68. Suitable as a first-cut approach to examining the biodiversity of a country and selecting species/ habitats that are predicted to be threatened. Enables biodiversity managers to make sensible decisions about the relative value for biodiversity conservation of different areas, even in the absence of survey data. Predictions need to be validated by field survey before conservation measures are enacted on the ground.

7. GUIDELINES FOR THE RAPID ASSESSMENT OF BIODIVERSITY PRIORITY AREAS (RAP): CSIRO (and others)

7.1 Brief Summary of Technique

69. The World Bank and the GEF are currently funding CSIRO and other Australian institutions to develop a series of Guidelines for Rapid Assessment of Biodiversity Priority Areas (RAP). These will adapt RAP tools employed in Australia for use in developing countries. The basic principle is that priorities need to be set. The technique used will be to compile a suitable database containing maps of the spatial distribution of the biodiversity surrogate chosen, and then use it systematically to identify a network of areas that collectively represents that surrogate. A complementarity approach will be recommended, in which priority areas are added on the basis of the elements of biodiversity they contain that are different from thos
already covered.

70. The application of CSIRO guidelines will enable an assessment of the relative contribution of different areas to overall biodiversity protection. Conservation initiatives will then focus on areas that mak a high contribution.

7.2 Data Needed

71. Some combination of data on the distributions of species, habitat types and environments ar needed.

7.3 Assessment of Likely Availability of Data

72. Which data are chosen will depend heavily on the actual availability of data.

7.4 Costs Involved

73. Unknown, but expected to be low.

7.5 Human Resources Involved/Required

74. Unknown, but it is expected that the Guidelines will recommend the training of biodiversity technicians or "para-taxonomists" to assist with field surveys.

7.6 Data Generated

75. First-phase products will include DOS-compatible databases for collating information from field surveys and collections, mapping tools for identifying areas of conservation concern, guidelines, and a handbook for their application.

7.7 Time Frame

76. Unknown, but expected to be short.

7.8 Examples of Implementatio

77. The CSIRO Guidelines have not yet been fully developed or implemented.

7.9 Points For and Against

78. For:

(a) Will provide a manual for biodiversity managers interested in national biodiversity inventory.

(b) Will provide DOS-compatible databases for collating information

(c) Scientists from developing countries will review the preparation and development of th

CSIRO materials, ensuring that they are compatible with their aims

79. Against:

(a) Methodology not yet available.

7.10 Appraisal

80. The CSIRO guidelines will provide valuable overall approaches to conducting baseline biodiversity inventories on a national basis. It is expected that they will consist of an amalgam of the most appropriate techniques discussed in this paper.

**8. ALL TAXA BIODIVERSITY INVENTORY (ATBI):
University of Pennsylvania in conjunction with INBio, Costa Rica.
Source: Janzen, D.H. and W. Hallwachs 1994.**

8.1 Brief Summary of Technique

81. The aim of an All Taxa Biodiversity Inventory is to make a thorough inventory or description of all the species present in a particular area, using highly trained taxonomic specialists recruited internationally and nationally. The rationale behind this approach is that species have to be used (i.e., must have a utilitarian value to human societies) in order to be preserved, and have to be described and understood before appropriate uses can be found for them.

8.2 Data Needed

82. An All Taxa Biodiversity Inventory attempts to determine for all the taxa and a very large number of species in one area:

(a) what they are, i.e., recognise and describe species and assign stable scientific binomial names. The latter facilitates information exchange about particular species between researchers working in different languages in different parts of the world;

(b) where they are; determine where at least some of the members of each taxon or species liv and can be found; and

(c) what they do; through accumulating ecological and behavioural information, determin their role in the ecosystem.

8.3 Assessment of Likely Availability of Data

83. It is extremely unlikely that data are currently available anywhere in the world at the level of detail required for an ATBI. However, specialists who could generate the required data do exist internationally for many taxonomic groups.

8.4 Costs Involved

84. Hugely expensive. The proposed budget for a fiv -year programme in Guanacaste, Costa Rica, is US$88 million.

8.5 Human Resources Involved/Required

85. The ATBI proposal for Guanacaste calls for 279 staff annually, including 100 "para-taxonomists", trained locally by up to 40 visiting specialists.

8.6 Data Generated

86. An enormous amount of basic data would potentially be generated.

8.7 Time Frame

87. A thorough species-level inventory of a large and biodiverse area is impossible in less than 2 or 3 years. Two years of planning followed by five years of field activity is a more realistic estimate, and is th time scale proposed for the Guanacaste project.

8.8 Examples of Implementatio

88. To date, the ATBI approach has only been tried in the Guanacaste Conservation Area, a reserve of 110,000 ha containing three tropical forest ecosystems (dry forest, cloud forest and rain forest) in Northwest Costa Rica.

8.9 Points For and Against

89. For:

(a) Produces a thorough inventory of a particular site, which could potentially be used as a benchmark from which other site evaluation techniques could be calibrated.

(b) Mutually beneficial scientific advantages from having scientists representing all the major taxa conduct their biodiversity actions at one site.

(c) High levels of training are associated with an ATBI: large numbers of graduate students and trained para-taxonomists would be produced, most of them host nationals.

90. Against:

(a) An ATBI attempts to inventory all taxa from viruses to trees and large mammals, which is very time-consuming.

(b) ATBI is an experimental technique, started in 1993; representative results are not available.

(c) An ATBI is not an exercise in site choice for conservation planning, since it does not entail a comparison between sites.

(d) An ATBI is not directly applicable to marine environments.

(e) The technique involves a considerable input of specialist knowledge from invited expatriat systematists.

8.10 Appraisal

91. ATBI is not the right technique to apply to a number of sites for determining their conservation value. It is sit -specific, expensive, and time-consuming. It relies totally on the formal taxonomic identification of species, in complete contrast to a Rapid Biodiversity Assessment (see below).

9. RAPID BIODIVERSITY ASSESSMENT (RBA): MacQuarie University
Source: Beattie, A. J., et al. 1993.

9.1 Brief Summary of Technique

92. Rapid Biodiversity Assessment (RBA) is based on the premise that certain aspects of biological diversity can be quantified without knowing the scientific names of the species involved. The main characteristic of RBA is the minimisation of the formal taxonomic content in the classification and identification of organisms. There are two methods by which this can be achieved:

(a) "Ordinal" RBA. In this approach only those taxonomic levels needed to achieve the goals of the assessment in question are used. Ordinal RBA is frequently used in environmental monitoring. For example, if it is known from prior studies that the presence or absence of a particular family or genus indicates disturbance or pollution, it may only be necessary to resolv the species collected at a site to the level of family or genus to ascertain environmental quality.

(b) "Basic" RBA. If large numbers of specimens are obtained from a particular area during a biodiversity inventory their identification may be problematic. There may be a shortage of taxonomists familiar with the groups in question, or perhaps none available at all in the country in which the inventory is being carried out. An alternative to formal and correct species identification by expert taxonomists is the creation of locally functional schemes for class-ification and identification. Specimens can be distinguished by easily observable morphological criteria. For example, butterflies might be distinguished on the basis of wing colour, pattern and size, resulting in classifications such as "Small, red with white spots". The units of variety recorded by such a scheme may be called morphospecies, operational taxonomic units (OTUs), or recognisabl taxonomic units (RTUs). Depending on whether operational procedures have been standardised and calibrated by conventional taxonomic measures, these units may or may not be less representative of natural biological variation than species *per se*. Biodiversity technicians trained by taxonomists are used to separate specimens into RTUs. Studi s show that if properly trained, such personnel can be very effective.

9.2 Data Needed

93. Data are gathered on certain groups of organisms. Several groups, chosen as good "predictor sets" of biodiversity are needed at each location inventoried. Appropriate groups are ones that:

(a) are relatively abundant;

(b) have a high species richness;

(c) contain many specialist species;

(d) are easy to sample; and

(e) have taxonomic traits amenable to RBA methods.

94. In contrast to RAPs (see below), which tend to use vertebrate and higher plant taxa as indicator groups, RBAs focus on invertebrate groups, such as butterflies, ants, termites, certain beetle families, grasshoppers and spiders.

9.3 Assessment of Likely Availability of Data

95. Once the indicator groups of species have been chosen, RBA needs no further data.

9.4 Costs Involved

96. Since the RBA technique uses low levels of technology and expertise, it is relatively cheap.

9.5 Human Resources Involved/Required

97. Trained -- but relatively unskilled -- biodiversity technicians are needed to separate the organisms inventoried into recognisable taxonomic units. Identification to species level requires specialist taxonomists.

9.6 Data Generated

98. Data obtained are representative measures of the species diversity of the area for particular taxonomic groups.

9.7 Time Frame

99. RBAs are relatively quick.

9.8 Examples of Implementatio

100. RBA has been used extensively in recent years in Australia, where invertebrate groups (particularly ants) are increasingly used in environmental-audit programmes. For example, Cranston and Hillman (1992) conducted RBAs at Ryan's Billabong and Mitta Mitta Creek in Australia using Odonata (dragonflies), Ephemeroptera (mayflies) and Chironomidae (midges) as indicator groups.

9.9 Points For and Against

101. For:

(a) Quick and cheap.

(b) Requires a low input of highly skilled labour.

(c) Uses non-invasive sampling, eliminating the time spent in collecting and then identifying specimens.

102. Against:

(a) Data are only directly comparable with other sites assessed by precisely the same method. Since no standard method exists, comparing data from neighbouring countries or between RB programmes conducted by different organisations may prove difficult.

(b) RBAs focus on invertebrate groups. The relationships between biodiversity in different groups of invertebrates (and those with vertebrate diversity) are even less well understood than that between different groups of vertebrates and higher plants.

9.10 Appr isal

103. A very rapid, cheap and attractive way of assessing the relative biodiversity value of different sites, provided they are assessed using the same indicator groups of species. A type of national or regional overview is required, however, as a preliminary step for identifying areas meriting investigation by RBA.

10. RAPID ASSESSMENT PROGRAMME (RAP): Conservation International
Source: Parker, T.A.P. III. et al. 1993.

10.1 Brief Summary of Technique

104. Conservation International (CI) created the Rapid Assessment Program (RAP) in 1989 to fill th gaps in regional knowledge of the world's biodiversity "hot spots". These hot spots cover less than 4% of the Earth's surface, but remain inadequately inventoried.

105. The RAP process assembles teams of international experts and host-country scientists to conduct preliminary assessments of the biological value of poorly known areas. RAP teams usually consist of experts in taxonomically well-known groups such as higher vertebrates (e.g., birds and mammals) and

vascular plants, so that the ready identification of organisms to the species level is possible. The biological value of an area can be characterised by species richness, degree of species endemism (i.e., percentage of species that are found nowhere else), the uniqueness of the ecosystem, and the magnitude of the threat of extinction. A RAP is a precursor to prolonged scientific study.

106. RAPs are undertaken by identifying potentially rich sites from satellite images/aerial reconnaissance, and th n sending in ground teams to conduct field-survey transects. Such field trips last from two to
eight weeks, depending on the remoteness of the terrain. Reports of RAP activities are made available to the widest possible audience. Subsequent research and conservation recommendations and actions are th responsibility of local scientists and conservationists.

10.2 Data Needed

(a) Satellite images are used where available, to determine the extent of forest cover and likely areas that would repay investigation.

(b) Aerial reconnaissance data are needed from surveys in small aircraft or helicopters to identify vegetation types and points for field transects.

(c) Field-survey transects, undertaken on foot, by car or boat. Species groups inventoried ar usually vascular plants and higher vertebrates (mammals, birds, reptiles and amphibians).

10.3 Assessment of Likely Availability of Data

107. By definition, RAPs are conducted in relatively unknown regions, where previous scientific studies are rare. At a minimum, survey overflights and field transects are needed to conduct a RAP.

10.4 Costs Involved

108. No indication of the costs involved is currently available.

10.5 Human Resources Involved/Required

109. Local experts are a central part of any RAP team, especially critical to understanding areas wher little exploration has been undertaken. However, one of the key elements is the participation of international experts, who are able to review the results obtained from a global or regional perspective.

10.6 Data Generated

110. Preliminary species lists for the groups inventoried: vascular plants and higher vertebrates.

10.7 Time Frame

111. Rapid Assessment is by its nature a very quick, first -cut attempt at inventorying the biodiversity of a region. CI conducted the fieldwork for one RAP of an area of 50,000 k ^{2} of forested eastern Andean slopes in Alto Madidi, Northwest Bolivia, in one month (Parker and Bailey 1990). It should be noted that field transects were restricted to small areas within this reg ion.

10.8 Examples of Implementatio

112. CI has carried out RAPs in various forested parts of South America. So far, the lowland and montane forests of Alto Madidi, in La Paz state, and the dry lowland forests of Santa Cruz (Bolivia); th Cordillera de la Costa (Ecuador); the Columbia River Forest Reserve (Belize); and the Kanuku Mountain region (Guyana) have been inventoried by RAP.

10.9 Points For and Against

113. For:

(a) Quick: RAPs to date have taken around one month of fieldwork.

(b) Uses non-invasive sampling, eliminating the time spent in collecting and then identifying specimens.

(c) Data gathered are fully comparable with those collected from other areas.

(d) Produces preliminary species inventories for major taxa, filling in gaps in scientific knowledge.

114. Against:

(a) In large areas, focuses (through necessity) on small, local, sample sites.

(b) Compared to an RBA, a RAP needs a higher level of technical input from experts.

10.10 Appraisal

115. RAPs are most suited for investigating the biological diversity of previously unexplored areas. In a comparison between relatively known sites, RBAs are probably cheaper and quicker.

REFERENCES FOR METHODOLOGIES

Alcorn, J.B. (ed.) 1993. Papua New Guinea Conservation Needs Assessment. Vol. 1. Biodiversity Support Program, Washington, D.C. and Department of Environment and Conservation, Boroko, Papua New Guinea. 216 pp.

Beattie, A. J., J.D. Majer, and I. Oliver. 1993. Rapid Biodiversity Assessment: A Review. Pp 4-14 in: *Rapid Biodiversity Assessment. Proceedings of the Biodiversity Assessment Workshop 3-4 May 1993, Macquarie University, Sydney, Australia.* Research Unit for Biodiversity & Bioresources, Macquarie University, Sydney, Australia.

Beehler, B.M. (ed.) 1993. *Papua New Guinea Conservation Needs Assessment. Vol. 2.* Biodiversity Support Program, Washington, D.C. and Department of Environment and Conservation, Boroko, Papua New Guinea. 433 pp.

Green, M.J.B. and E.R.N. Gunawardena. 1993. Conservation Evaluation of Some Natural Forest in Sri Lanka. UNDP, FAO and IUCN. Unpublished report. 163 pp.

Grossman, D.H., S. Iremonger, and D.M. Muchoney. 1992. *Jamaica: A Rapid Ecological Assessment*. The Nature Conservancy, Arlington, Virginia, USA.

Janzen, D.H. and W. Hallwachs. 1994. All Taxa Biodiversity Inventory (ATBI) of Terrestrial Systems: A generic protocol for preparing wildland biodiversity for non-damaging use. Draft report of an NSF Workshop, 16-18 April 1993, Philadelphia, Pennsylvania.

Parker, T.A.P. III., A.H. Gentry, R.B. Foster, L.H. Emmons, and J.V. Remsen, Jr. 1993. *The Lowland Dry Forests of Santa Cruz, Bolivia: A Global Conservation Priority*. Rapid Assessment Progra Working Papers No. 4. Conservation International, Washington D.C., U.S.A. / Fundación Amigos de la Naturaleza, La Paz, Bolivia. 104 pp.

Scott, J.M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T.C. Edwards, Jr., J. Ulliman, and R.G. Wright. 1993. Gap Analysis: A Geographic Approach to the Protection of Biological Diversity. *Wildlife Monographs*, 123: 1-41

Tangley, L. 1992. *Computers and Conservation Priorities. Mapping Biodiversity. Lessons from the Field I.* 28 pp. Conservation International, Washington D.C., U.S.A.

Annex II

INDICATORS FOR ASSESSING THE EFFECTIVENESS OF MEASURES TAKEN UNDER THE CONVENTION

BACKGROUND

Article 25, paragraph 2, calls upon the SBSTTA to provide scientific and technical assessments of the status of biological diversity and to prepare scientific and technical assessments of the effects of types of measures taken in accordance with the provisions of the Convention.

At its first meeting the SBSTTA proposed a mediu -term programme of work in recommendation I/2. Item 1.2.1 of this proposed medium-term programme of work was:

> "Review and promotion of indicators of biological diversity to be used for assessment of effectiveness of measures taken in accordance with the provisions of the Convention".

Decision II/1 of the COP took note of the proposed mediu -term programme of work and requested the SBSTTA in considering its programme of work for 1996 to ensure that the programme is based on the priorities set in the programme of work for the COP for 1996 and 1997. The second meeting of the COP acknowledged the importance of developing indicators of biological diversity in th development of the Convention. For example, the COP, in decision II/8, endorsed recommendation I/3, paragraph 4, which stated:

> "There is a need for each party to start assessing the effectiveness of measures taken under the Convention. However, methods for assessing the effectiveness of measures to conserv or sustainably use biological diversity should be reviewed. The use of indicators of biological diversity and the status of its components is particularly time- and cost-effective. Several indicators are currently being used and developed. They should be reviewed and their use promoted".

Furthermore, the COP, in its statement on biological diversity and forests to the Intergovernmental Panel on Forests, noted:

> "The Intergovernmental Panel on Forests is currently taking steps to create a dialogue and achiev a degree of harmony among the numerous national and regional efforts in developing criteria and indicators of sustainable forest management. The biological diversity aspects of these efforts should be examined to ensure compatibility with Convention goals and requirements for reporting".

Given the current understanding of biological div rsity the use of reliable indicators is essential to the development of measures designed to achieve the aims of the Convention. This is recognised in th Convention itself in several provisions. For example, Article 7 of the Convention calls on the Parties to identify, monitor and assess the components of biological diversity as well as the processes and categories of activities that have or are likely to have significant adverse impact on the conservation and sustainabl use of biological diversity. Cl arly it is not realistic for any Party to report on all components of its biological diversity. This is implicitly acknowledged in that Annex I gives indicative guidelines for th components of biological diversity to be considered. With finite resources and monitoring capabilities, indicators will play a vital part in allowing for the most effective and efficient monitoring of biological diversity. Indicators will also be essential if Parties are to be able to report on the effectiveness of measures taken in meeting the objectives of the Convention as required by Article 26.

This dependence on indicators is reflected in the other areas of the work programme of the COP and the SBSTTA. For example, the Secretariat observed in document UNEP/CBD/SBSTTA/2/2 that greater coordination at the international level, particularly between the various conventions concerned with biological diversity, would enhance the effectiveness of any assessments undertaken by the institutions of the Convention. An important avenu for increasing this coordination is the development and use of common key indicators for all these conventions.

The importance of developing indicators has also been raised frequently in the notes prepared by the Secretariat for many of the items of the provisional agenda of this meeting. The development of an effective response to the problems raised by the loss of biological diversity in agricultural systems, for example, is largely dependent on developing a set of indicators that will allow decision makers not only to assess the current status of and trends in agricultural biological diversity, but also to allow them to judg the effectiveness of the measures they adopt.

This Note reviews the current status of indicators of biological diversity that can be used for assessing the effectiveness of measures taken in accordance with the provisions of the Convention. It then suggests some ways and means that these may be promoted and highlights a number of issues of particular relevance to the SBSTTA which it may wish to consider.

1. INTRODUCTION

1. Indicators can provide policy-relevant performance measures for a wide range of policy issues, particularly in national reporting. They can be used to summarise quantitative information on the status and trends of elements of biological diversity, as well as relevant socio -economic, cultural and other data, so as to be comparable across time and space. Because they lend context to data, and simplify sometimes complex processes and conflicting trends, indicators are useful tools for conveying reporting information to policy makers and other audiences.

2. Indicators such as the national unemployment rate and indices like the gross national product (GNP) are well-established tools for measuring national economic performance. National and international institutions have only recently begun to look at measures that might capture the environmental and social dimensions of development, and the progress (or lack of progress) towards visions of a sustainable society. The Dutch government, for example, now uses indicators within its national reporting systems to assess progress towards achieving a series of environmental "sustainability" targets. The World Bank recently ranked countries according to indicators of human resources, natural capital and produced assets. This exercise demonstrated that, when other measures of wealth are considered, traditional economic measures account for only a fifth of global assets.

3. Agenda 21, the Climate Change Convention and the Conv ntion on Biological Diversity -- agreements that emerged from the 1992 United Nations Conference on the Environment and Development (UNCED) -- call on (in the case of the conventions, require) countries to monitor and assess progress towards environmental sustainability. As a result of these new information demands, there has been considerable work at both the national and international levels to define environmental indicators that ar useful for reporting. The Scientific Committee on the Problems in the Environment (SCOPE) is one such effort underway in support of the Commission on Sustainable Development (CSD).

1.1 Definitions

4. The term *indicator* is widely used both in ecology and in policy-making. The complexion put on it can understandably vary considerably with the perspective from which it is viewed. When ecologists, conservation biologists and natural resource managers use the ter *indicators* in the context of biological diversity, they generally mean environmental attributes -- often of species or groups of species -- that can be sampled and whose change either in space or in time is taken to reflect a change in biological diversity as a whole. In effect, therefore, indicators are measurable surrogates for larger measures of biological diversity. They are essentially monitoring tools used because it is simply not feasible to monitor the whol of biological diversity, even in a circumscribed area.

5. From a policy-making viewpoint, indicators are quantitative measures that "imply a metric (distance from a goal, target, threshold, benchmark, etc.) against which some aspects of public policy performance can be measured". As such, they differ from statistics (raw data) because they present

information in a context that gives them meaning for a broad audience, and not just for technical experts. For example, "there are 10,000 hectares of protected wetlands in country X" is a statistic, while "fiv percent of country X's wetlands are protected" is an indicator (because it references protected wetland area to a benchmark -- in this case total wetland area). This indicator is policy-relevant in a number of ways: it can be used to look at progress made in protecting wetlands over time, it can be used to assess th magnitude of change needed to meet a target, or goal (e.g., how much more wetland area country X must protect in order to reach the IUCN's goal for nations to protect at least 10% of all ecosystem types), and it can be used to compare how well country X protects its wetlands relative to other countries.

6. Indicators in this sense are essentially used to convey often complex data in a simplified form. As such, they should be viewed in the context of the entire information chain, which includes:

7. Data/Reports: (disaggregated statistics; integrated data bases; indicators; indices; and integrated reports) and;

8. Processes: (planning; surveys/inventories; data/information management; monitoring; evaluation [analysis and integration]; and reporting).

1.2. Indicator Objectives

9. As is evident from the above, indicators can serve a range of different purposes and different audiences, and it is important to distinguish between them. This distinction is related to the all-important question of scale. Indicators for managers need to be operational at fine scales, both temporal and geographical. They must also be thoroughly tested and reliable, but may be reasonably complex or technical. Indicators for policy-making and public education must be easily understood and applicable over much broader scales, but should always be based on sound scientific principles in order to be defensible. They must also ultimately be derived from real data collected under monitoring programmes of various types and are therefore a use of, not a substitute for, data gathering.

10. When used at a national level by governments, environmental indicators can serve many, often overlapping, purposes:

(a) Public awareness
Past trends, conditions and future outlooks are simplified using high-level indicators that help to communicate to the public whether the environment is getting better or worse.

(b) Environmental policy performanc
Environmental progress and/or achievements are measured against national objectives and international commitments.

(c) Sectoral policy development
Environmental indicators are applied in the context of a particular economic sector (e.g., forestry, fisheries, or agriculture).

(d) Environmental accounting
Integrating environmental and natural-resource accounts is the focus of indicator development.

(e) Sustainable development decision-making
Indicators that link environmental and socio-economic information permit decision-makers to assess policy options, alter national programmes and steer a course towards sustainability.

1.3 Indicator Criteria

12. Statistical data should meet certain criteria in order to be considered effective for indicator use. Good indicators should simplify information, be scientifically credible, relevant to policy or management, and be responsive to changes in ti e and/or space. In addition, indicators should be able to show changes against a target or threshold, and be comprehensible to the intended audience.

1.4 Indices

13. Indicator information can be further aggregated into indices by combining several indicators (or different statistical data sets). These measures provide "bottom line" information -- summarising sometimes conflicting conditions and trends (for example, summarising data for changes in vegetation for all cover types within a country). While us ful for painting broad-brush pictures of the status and changes in a particular environmental (or economic) sector, indices can be misleading because, through aggregation, they may mask or understate significant events.

1.5 Frameworks

14. Indicator frameworks organise indicators so as to present trends, processes and interrelationships in one coherent picture (for example, to provide an overview of the conditions of and trends in biological diversity within a particular country). Various framework appro aches have been developed for this purpose. For example, the media approach presents environmental information by broad sector (air, water, land, and living resources). The pressur -state-response (P-S-R) framework relates pressures on th environment to
the state of the resource or system in question, the impact these pressures have on the resource and/or system, and management and policy responses to these impacts. Because it highlights relationships between actions and responses, the P-S-R framework is a particularly useful way of presenting indicator information to decision-makers.

15. Other more complex frameworks are also advocated, for example, the process-patter -evaluation framework, which is based on systems analysis. This approach attempts to take into account th evolutionary and adaptive characteristics of natural systems that mean that such systems often do not respond to pressures or responses in straightforward or even predictable ways.

1.6 Presentation Formats

16. Indicators and indices can be presented through a variety of formats to depict changes over time and/or space: as tabular information (e.g., percentage of country X's vascular plant species that occur within publicly owned lands), as a graphic (e.g., as a bar chart depicting the percentage of vascular plant species occurring within publicly owned lands, by land use type), or as a map (e.g., a map depicting th location of public land, colour-coded to depict the percentage range of vascular plant species found within a given map unit).

1.7 Indicator Selection Process

17. In choosing indicators of biological diversity, information managers should:

1.7.1. Define the indicator audience, and its information needs.

18. The audience to be reached, its level of technical expertise, and its information needs determine not only what kinds of data should be presented through indicators, but also:

(a) the number of indicators that are to be presented, and the degree to which indicator information should be aggregated;

(b) the reporting units to be used. For example, managers generally require indicator results by management unit (by the watershed area, forest type, protected area they are working in). Policy analysts and policy makers, on the other hand, may prefer results by the administrative unit for which they are responsible (by state, or province, or country);

(c) the spatial and temporal scale of measurement;

(d) the thresholds, targets and benchmarks that are to be used in constructing indicators; and

(e) the presentation formats that can effectively communicate information to the target audience.

1.7.2 Articulate the criteria to be measured

19. Once the audiences and their general information needs have been defined, information managers should first work with these user groups to define the specific questions for which they need answers. Th managers should then articulate criteria -- textual descriptions of the phenomena to be measured -- that might answer these questions. For example, in answering the question "are wild fisheries being managed sustainably?", information managers should work with scientists to prepare a series of criteria describing what a sustainable fisheries would look like, then define indicators that can measure whether these criteria have been achieved.

1.7.3 Select appropriate indicators for these criteria

20. Not all criteria will be measurable by indicators, and of those that are so measurable, not all can b measured directly. For example, in defining criteria to assess forest condition, some of these criteria might best be answered qualitatively (e.g., whether forests are "pristine"), others can be captured directly through

indicators (e.g., plantations as a percent of total forest cover, as a measure of naturalness), and others can only be measured indirectly (percent of forest cover in large blocks of roadless areas, as an indirect measure of human disturbance).

1.7.4 Critically test the indicators

21. Most environmental indicators have only recently been developed and should be considered a s being in an experimental phase. It is important that indicators be tested against the wider phenomena they are intended to represent or summarise so that they can be relied upon. As with any such process, this testing can be expected to lead to modification, refinement, or even the abandoning of some indicators if they are found to be unreliable.

1.7.5 Establish appropriate targets, thresholds and/or benchmarks for these indicators

22. Indicators of use to policy makers provide context to data so they can be understood by non-technical audiences. Indicators do this by referencing targets, thresholds and/or benchmarks. Such references may include: change since a baseline year; benchmarks that describe a sub-component relative to the whole (e.g., the number of livestock breeds within a country relative to the total number of known extant plus extinct breeds); criterion benchmarks (e.g., the percentage of coral reef area threatened by pollution, where the criteria spell out ambient pollutant levels that might constitute a "threat"); and distanc to a policy target, or goal (e.g., the ambient water pollution relative to the ambient level desired by year X).

1.7.6 "Field test" the indicators

23. Once the indicators have been developed, information managers should vet these indicators with individuals representing a sample of the target audience(s). The objective of this step is to ensure that thes indicators effectively answer users' questions (and also that indicators are understood, that the reporting units are appropriate, that thresholds and benchmarks are intuitive, etc.).

2. ENVIRONMENTAL INDICATOR DEVELOPMENT AND USE

24. Research and operational programmes under the banner of "indicators" are being developed globally, nationally and sub-nationally. The goals, complexity and integration of indicator products in decision-making vary greatly among these activities. This should not be surprising, as indicator development is at a relatively young stage and the various research and operational methodolgies are being developed on a number of fronts.

25. While environmental-indicator research for some sectors (such as forestry) has made some progress, far less has been made in developing indicators for biological diversity. This is due, in part, to scientific uncertainty, such as a poor understanding of ecosystem processes and functions, and to the wid range of policy-relevant issues that fall under the rubric of biological diversity.

2.1 Global Indicator Initiatives

26. One of the earliest environmental indicator initiatives is that begun by the OECD in 1989. It has developed indicators in four sectors (energy, transport, forestry and agriculture). The OECD has also worked on environment accounts for forestry and water, linking environment to the economy. With respect

to reporting, a preliminary set of environmental indicators was published. Of the core set of 72 indicators, only 31 had adequate information, illustrating the need for the improved monitoring of primary data. This initiative also demonstrated how, where data are missing, surrogate indicators can be used to directly capture the phenomena to be measured. The OECD indicators included two biological-diversity measures.

27. A number of biological-diversity indicators of interest to policy-makers have been proposed. One summary list prepared by the World Resources Institute contains 22 indicators of the conservation of biological diversity *in situ*, *ex situ* and domesticated species diversity. Some indicators, such as one for species richness, measure the natural endowment (condition or state) of biological diversity, while others, such as that of the area protected, reflect policy responses to conservation. The coverage, completeness and quality of data were also ranked, demonstrating the gaps in the state of data supporting biological-diversity indicators. It should be noted, however, that the use of even secondary data can itself be useful to decision-makers in directing policies, research and monitoring activities to obtain the most desirabl information, thus gradually improving the core set of indicators.

28. In response to chapter 40 of Agenda 21, the CSD is leading an initiative to develop indicators of sustainable development. It is working closely with national governments, UN organisations, intergovernmental organisations and NGOs. It attempts to be complementary to national reporting on th state of the environment. The approach is to use the pressur -state-response framework, develop candidat indicators of issues identified in the Agenda 21 chapters and build consensus among the agencies involved. Two indicators of biological diversity addressed under Chapter 15 are included. However, other chapters -- such as oceans, freshwater, agriculture and forests -- also contain indicators relating to the sustainability of biological resources.

29. The process begun by the CSD might be one useful entry point to building the partnerships necessary to expand the suite of indicators of biological diversity to meet the requirements of this Convention.

30. A "bottom-up" approach to indicator development is being advanced through the UNEP's Global Environment Outlook, a programme designed to prepare integrated environmental assessments. The Dutch Ministry of Housing, Physical Planning and Environment, with the support of a feasibility study by th World Conservation Monitoring Centre (WCMC, 1996), has identified a preliminary core set of six indicators of biological diversity and its use. Indicators are proposed for ecosystem and species levels. These are intended to be applied at regional and global levels using Udvardy's biogeographical zones within which to develop common suites of indicators.

31. The World Resources Institute is approaching indicators with an emphasis on the threats to ecosystems. Pressure indicators are particularly useful for influencing action because they point to thos human activities that are detrimental to the condition of ecosystems and species. Those same pressur factors can be altered through changes in policy. In on xample, a GIS-based ecosystem-indicators model has been advanced and preliminarily applied to assess pressures on coastal ecosystems. The WRI model incorporates measures of ecosystem sensitivity (resilience) and data on human activities to generate an index of potential pressure on ecosystems. Map-based indicators, such as the WRI approach, can be used to help define priorities for conservation. The maps are also useful tools for communicating complex issues to decision-makers and the public.

2.2 National and Regional Indicator Initiatives

32. There is a growing number of national environmental indicator programmes that are providing tools and products to influence decision-making. The objective of Canada§s national indicator program is to develop a set of scientifically credible, understandable indicators relevant to decision-makers and th general public, that is representative of the state of Canada's environment and indicates trends towards sustainable development. The programme is also designed to provide an early warning and assist performance evaluation. Other strong national programmes are to be found in Australia, Denmark, Norway and the Netherlands.

33. The Centro Internacional de Agricultura Tropical (CIAT), based in Colombia, has embarked on an ambitious regional-indicator programme. The programme aims to develop a regional approach to environmental- and sustainability-indicator development and supporting information bases. The programme integrates indicators on a national basis and by eighteen life zones. The programme maintains ties with other global and national efforts with the aim of learning about and harmonising approaches as much as possible.

3. SECTORAL INDICATORS

34. Forests are currently the subject of numerous indicator efforts at various scales. Generally, the ai of these efforts is to develop and monitor measures of sustainability, although the concept often remains undefined or very loosely defined. Indicators of biological diversity are an important aspect to most of thes initiatives.

35. The OECD has identified and reported a national indicator relating productive capacity to annual harvest. Through the CSD process, several national indicators of pressure, state, and response have been identified to address chapter 11 of Agenda 21 of UNCED, which calls for the development of scientifically sound criteria and guidelines for the management, conservation and sustainable development of all types of forests.

36. Regional intergovernmental efforts such as ITTO (International Ti ber Trade Organisation) and the Helsinki, Montreal and Tarapoto Processes have developed national level criteria and suites of indicators for specific regional economic, ecological, social and cultural conditions. For example, through the Montreal process, countries sharing temperate forests have developed a series of six criteria, each with numerous proposed indicators of sustainability. The conservation of biological diversity is one criterion addressed through this process, although other criteria -- such as the maintenance of ecosystem health and vitalit -- are also critical to the conservation of biological diversity.

37. The concept of Forest Resource Accounting (FRA) is being advanced by the International Institut for Environment and Development (IIED) and the WCMC. FRA accounts will link policy and institutional changes at a national level with physical changes at a forest-site level. The FRA process requires indicators to track numerous environmental and socio-economic aspects of sustainability.

38. The Centre for International Forestry Research (CIFOR) has conducted research that demonstrates the importance of linking indicators developed at a local level with national policy-level indicators. Th purpose of the CIFOR programme is to identify and develop a minimum set of objective, cost-effectiv criteria and indicators applicable under different forest conditions. To accomplish this, the project is

developing a methodology for the objective evaluation of criteria, and developing a system for evaluating the sustainability of forest management as a whole, based on the recommended criteria and indicators. Th research is being undertaken in a number of countries with assorted forest conditions.

39. National efforts at forest indicators exist for many countries. In Canada, the Canadian Council of Forest Ministers has endorsed a comprehensive set of indicators of forest sustainability. The scheme proposes nine indicators related to ecosystem, species and genetic diversity, and many others that deal with other aspects of sustainability.

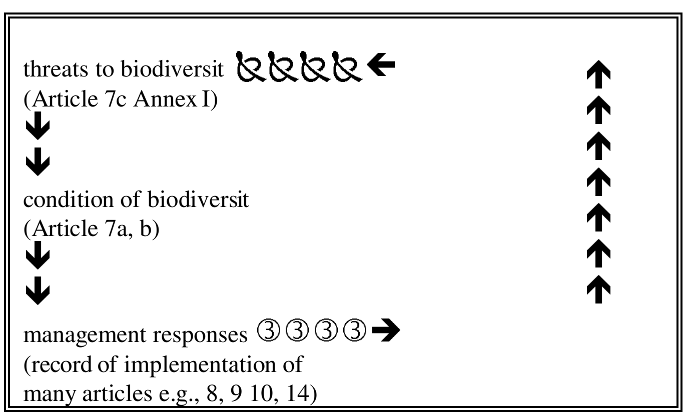
40. The WCMC is conducting research on habitat and biological-diversity indicator development, particularly for tropical forest countries. Attempts are being made to design and measure the effectiveness of indicators at different scales from global to forest-management unit.

41. There are also many other efforts under way to assess forest sustainability at the forest-management unit level in support of forest-certification schemes. The inclusion of biological-diversity criteria and indicators is an aspect of this work.

4. INDICATORS AND THE CONVENTION ON BIOLOGICAL DIVERSITY

42. The goals of the Convention are to ensure the conservation of biological diversity, the sustainabl use of biological resources and the equitable sharing of the benefits of genetic resources. Indicators contributing to all three objectives will be required in order to track progress effectively.

43. Using the widely accepted pressur -state-response framework for indicators, the Convention can be viewed in the following manner:



4.1 Indicators for the Condition of Biological Diversity

44. Within a pressure-state-response framework and in the context of the Convention, state indicators of biological diversity are ultimately of greatest importance. Only by assessing the state of biological diversity and how this changes through time will it be possible to assess the effectiveness of measures taken in accordance with the provisions of the Convention. Such indicators may be subsets of biodiversity, usually species or groups of species (indicator taxa), or may be other parameters. Biodiversity stat indicators may be essentially static, that is designed principally for geographical comparison (e.g., species richness or degree of endemism in a particular taxon), or may be dynamic, that is, intended to monitor change (e.g., percentage of species classified as threatened, area of habitat remaining). Indicators used for assessing the effectiveness of measures taken to maintain biological diversity must, of necessity, have a dynamic component.

45. It is appropriate to consider indicators at the three commonly perceived levels of organisation of biological diversity, as set out in Annex I to the Convention: ecosystems and habitats, species, and genes and genomes. B cause the three levels are interdependent, appropriate indicators for one level may actually be subsets of another level (e.g., species as indicators for assessing the state of ecosystems). Indicators of the state of habitats and ecosystems are of particular importance, as the SBSTT recommendation I/3 suggests developing the ecosystems-level approach for the primary framework of actions to be taken under the Convention.

4.1.1 Habitat and ecosystem indicators

46. Indicators for habitats and ecosystems ay conveniently be divided into those of extent (or area) and those of condition. In general, the former are more easily developed than the latter, at least for terrestrial ecosystems. Indicators of ecosystem or habitat extent require that a definition of the ecosystem or habitat in terms of measurable parameters be settled. For example, a forest is generally defined in terms of percentage canopy cover, where the canopy is some minimum height. For the purposes of developing indicators, the exact definitions can be fairly arbitrary (indeed, as discussed in document UNEP/CBD/SBSTTA/2/1, they will generally *have* to be arbitrary) as long as they are applied consistently. The more easily and widely measurable the parameters are, the better. For this reason, parameters that are measurable by remote-sensing or aerial photography are to be preferred. Indicators can be developed in a straightforward manner from original data simply by calculating the percentage changes in extent of habitat from some baseline.

47. Indicators of extent provide valuable information with respect to one major pressure on biological diversity, namely, that of the complete conversion or destruction of habitats or ecosystems. However, adverse impacts on biological diversity often fall short of this and rather affect what may be loosely termed habitat or ecosystem quality. These impacts may be as far-reaching in their effects as conversion. A lak may be rendered virtually abiotic by pollutants, but still remain a lake, or a species -rich grassland may have its diversity drastically reduced by input of nitrogenous fertiliser, but still remain a grassland. Developing indicators for these situations is generally far more problematic, for both theoretical and practical reasons.

48. Because changes in habitat and ecosystem quality are essentially manifested in changes in th distribution and abundance of species, much attention has focused on developing the latter as indicators. Several sets of criteria have been established for indicator species, but very few such indicators have yet been made operational.

49. This is in large measure because the most basic attribute of indicators is that they must b correlated with some larger measure of biological diversity so that changes in the indicator over time or space mirror changes in biological diversity as a whole. Demonstrating this to be the case with species is problematic, for a range of theoretical and practical reasons. Although there is broad agreement that areas or ecosystems that are rich in one group of species are likely to be rich in others, this is by no means always the case and, indeed, at fine scales this relationship often breaks down, so that areas of richness in different taxonomic groups may be inversely correlated. Similarly, responses to environmental change, both natural and human-induced, may be very different in different subsets of biological diversity. For example, populations of generalist species, including many large mammals that would be widely considered as excellent indicators, often increase in logged -over or partially degraded forest, while populations of species dependent on undisturbed forest decrease.

50. A further assumption is that changes in chosen indicator species can be related directly to causes. Within a pressure-state-response framework this means that changes in state can be related directly to changes in pressures or responses. However, because natural ecosystems are highly dynamic at all spatial and temporal scales, this is often very difficult to demonstrate. The populations and ranges of all species vary for a number of reasons, including cyclical and non-cyclical environmental perturbations, through stochastic processes, and because of the impacts of humankind. Demonstrating that a change in the chosen indicator is the result of human actions, either beneficial (generally a response) or deleterious (a pressure), and not a product of other influences, is often not easy. Moreover, as noted above, because of the adaptiv nature of natural systems, the responses of these systems to human actions are often complex and sometimes counterintuitive.

51. Practical problems in developing species indicators for biological diversity lie in the paucity of base-line data sets in most parts of the world, and in the need for sustained monitoring programmes. Indicators of change by definition require monitoring through time, either continuously or periodically. Results obtained at different points in time have to be comparable, so methods for measuring or sampling must themselves remain consistent. However, in the vast majority of cases, monitoring the distribution and abundance of species is expensive and time-consuming, particularly if carried out over extensive areas, as is necessary if the indicators so developed are to have anything other than a very local application. As a result, few rigorous monitoring programmes have been sustained to date for any significant lengths of time.

52. Solutions to some of these methodological problems lie in: the use of sampling sites; the mobilising of large numbers of people, usually amateurs, as is done with annual wild bird counts in several countries; and the use of aerial surveys to count large species, generally mammals and some birds in open ecosystems such as grasslands.

4.1.2 Other measures of ecosystem and habitat quality

53. Although, as noted above, changes in habitat or ecosystem quality are essentially changes in th distribution and abundance of species, these changes may manifest themselves in structural changes,

particularly where species are structural components of the habitat, as in forests and coral reefs. Some of these may be easier to measure and develop indices for than direct measures of species abundance and distribution. Examples include fragmentation in forests, changes in density and height of vegetation cover in many terrestrial ecosystems and changes in plankton densities in aquatic ecosystems. Nevertheless, th challenge with these indicators remains one of linking them to the fate of species.

4.1.3 State indicators for species

54. Problems with monitoring and developing indicators for the state of species are discussed in general terms above. At national or global levels, however, species indicators do not necessarily have to b tied to particular habitats or ecosystems.

55. An important potential indicator of the state of species is the number or percentage of threatened species in a given area or country, as assessed under some standardised system such as that in use by th IUCN -- the World Conservation Union. However, assessing the threat status of species is very incomplet and very taxonomically skewed, so that only higher vertebrates (namely mammals and birds) and a few other smaller groups of organisms (e.g., conifers, cycads, swallowtail butterflies) have been at all completely assessed. It is only feasible to attempt to derive indicators for these few groups.

56. Such indicators may provide a useful static picture of the state of biological diversity; that is, they may be useful for geographic comparisons, but are at present of limited use in tracking trends in time. This is because changes in listings unconnected to species status -- mainly taxonomic changes, improved information and changing classification criteria -- generally swamp genuine changes in status. With th establishment of new, more objective, listing criteria and a growing tendency to adopt standard classifications, the situation may improve, but it will be several years before useful indicators of chang emerge.

4.1.4 State indicators for genes and genomes

57. Direct monitoring of the state of genes and genomes, particularly in wild populations, is generally not feasible at present. Presently, genetic diversity is of greatest importance in agricultural systems. Here, there are possibilities of developing indirect measures or indicators; for example, through assessing rates of loss of landraces or changes in the proportion of production from traditional as opposed to modern or improved varieties. The need for assessing biological diversity in agricultural systems is discussed in detail in UNEP/CBD/SBSTTA/2/10.

4.1.5 Pressure indicators

58. Pressure indicators are essentially indicators of the processes and categories of activities that hav or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity. These are discussed in document UNEP/CBD/SBSTTA/2/3. A number of pressure impacts can be measured, directly or indirectly, and can be used to generate indicators of threat. Of pa rticular importance in predictions of future pressures on biological diversity is the development of indicators for th major socio-economic factors that lead to adverse impacts on biological diversity, identified in document UNEP/CBD/SBSTTA/2/3 as land tenure, population change, cost-benefit imbalances, cultural factors and misdirected economic incentives.

59. Indicators of some aspects of pressure may be easier to develop than state indicators of biological diversity. Decreases or negative changes in pr ssure indicators will imply that measures taken to fulfil th aims of the Convention have, to some degree, been effective. Nevertheless, the crucial step will still be to link a decrease in pressure indicators to an amelioration in, or at least stabilisation of, the state of biological diversity. To achieve this, state indicators will ultimately have to be developed.

4.1.6 Response indicators

60. Responses to adverse impacts on biological diversity lie within the human domain and many of them are of a legal or formalised nature. The formal designation of protected areas is one obvious example. Such responses lend themselves well to the development of indicators because they are measurable and can be translated into terms understood by a wider audience. Within the context of the Convention, this suggests defining a minimum core set of indicators on the implementation of various articles of th Convention, in particular Articles 8,9 and 10. Such an exercise will feed into national reports and global summaries such as the *Global Biodiversity Outlook*.

61. More generalised responses, such as changes in public attitudes and behaviour, are more difficult to assess and develop indicators from. However, there are well-defined and tested methodologies for this outside the realm of biological diversity.

62. Again, as with pressure indicators, the challenge, and the principal subject of this Note, lies in relating such response indicators to state indicators, for it is only through this link that the effectiveness of these responses can be assessed.

4.2 Indicators of Sustainability

63. The Convention defines "sustainable use" as: "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations". This defines sustainability in terms of the effects of use on biological diversity. Indicators of sustainability can therefore effectively b seen as state indicators of biological diversity, discussed in detail above. Within a pressur -state-response framework, unregulated use is a pressure, while forms of regulation of use, including a wide range of traditional management systems, are responses.

64. Many of the sectoral indicator programmes, particularly those for forests outlined above, hav adopted wide interpretations of sustainability in which biological diversity is regarded as one component.

4.3 Indicators and Other Global Conventions

65. It is expected that several other global conventions will be able to contribute significantly to meeting the goals of the Convention on Biological Diversity. These include CITES, the Ramsar Convention and the World Heritage Convention, all of which have well-developed reporting procedures and supporting databases.

66. The information bases supporting these conventions produce reports on topics such as trade in species and progress in *in situ* conservation. Key indicators derived from some of these measures, perhaps used in conjunction with complementary data sets, might be useful indicators of the implementation of th Convention.

5. CONCLUSION

67. Indicators should be viewed as series of tools that can support a range of activities and processes under the Convention. The Convention contains numerous articles requiring action by the Parties. Progress in those actions, or "policy performance", will require indicators of not only the policy and programme initiatives taken by the Parties, but also of the per iodic assessments of the threats to and condition of bio-diversity as evidence of the effectiveness of measures taken in maintaining biological diversity. In addition to being used as measures of policy performance, indicators that provide an early warning role will b useful. Indicators that signal changes in the condition of biological diversity and sustainable use, along with those that measure pressures on these valued resources, can be powerful indicators for the Parties to use in order to revise policies or adopt new actions to address emerging threats to biological diversity.

68. The development and use of indicators can be a key focal point in capacity-building efforts, whereby the entire data and information infrastructure and decision-support mechanisms are energised to deliver policy-relevant information. Numerous indicator research and operational programmes will need to be mined for approaches and information required the by Parties in order to support the Convention. degree of consistency or harmony may be required.

69. The SBSTTA might like to consider reviewing existing indicator initiatives to determine which indicators discussed in these might be most appropriate for the purposes of the Convention. The SBSTT might like to be mindful of the fact that most indicators cited in these initiatives are proposed or hypothetical, and might like to identify specifically those indicators that have been made operational.

70. The SBSTTA may like to consider whether the pressur -state-response framework is the most appropriate for the purposes of the Convention. If the SBSTTA considers that this is a useful framework, the SBSTTA might like to consider structuring any review it may decide to undertake along these lines.

5.1 Pressure Indicators

71. The SBSTTA might like to examine these in light of the proposed framework of processes and categories of activities likely to have significant adverse impacts on biological diversity set out in document UNEP/CBD/SBSTTA/2/3. It might like to determine whether useful indicators already exist for th different processes and categories of activities and, if so, might recommend their consideration for inclusion in national reports and other products, such as global and regional assessments, of relevance to th Convention. Where indicators have not been developed, the SBSTTA might like to propose promising indicators.

5.2 State Indicators

72. The SBSTTA may like to identify which ecosystems and habitats might be usefully described using indicators of area, paying particular attention to those identified in Annex I to the Convention and discussed in some detail in document UNEP/CBD/SBSTTA/2/3. It may wish to assess the availability of data to derive such indicators. The SBSTTA might also like to be mindful of the limited success to date in identifying indicators of habitat quality, discussed at some length in this Note. It might wish to review current research efforts in this field, identifying the most promising approaches and proposing new ones in the form of a coherent research agenda.

5.3 Response Indicators

73. The SBSTTA might wish to review response indicators within the context of the Convention, and particularly Articles 8, 9 and 10, and recommend those which might be appropriate for inclusion in national reports, and in global and regional assessments.

74. As the most important use of indicators within the framework of the Convention is likely to be in national reports and assessments, the SBSTTA may wish to consider how indicators may best be usedin a national context. It may wish to assess the possibility of developing a minimum core set of national indicators of biological diversity and determining where indicators should be tailored to national economic, environmental, social and cultural conditions. The SBSTTA may also wish to consider how much harmonisation and standardisation is necessary or desirable in the development of national level indicators within the context of the Convention. It may also wish to assess the extent to which Parties will require additional capacity for collecting further data to support indicator development.

75. In cases where indicators are proposed, rather than operational, the SBSTTA might like to determine whether sufficient data already exist to allow for the development of the indicators. In cases

where sufficient data do not exist, the SBSTTA may wish to advise on cost-effective methodologies for gathering the data. The SBSTTA may wish to consider recommending priorities for the development of new indicators and may also wish to consider what the implications are in terms of capacity building and the increase in resources that might be required to establish and maintain monitoring programmes to gather the data to support such indicators.

76. The SBSTTA may also wish to assess the extent to which Parties can make use of the data and indicators they have developed (or will develop) for their other reporting requirements, such as through other conventions, in meeting needs under the Convention.

77. The SBSTTA might like to consider recommending use of the clearing-house mechanism to mak information on indicators more widely available. Such information could include, *inter alia,* a contact list of indicator programmes and initiatives, to assist Parties to draw on expertise in other countries; a review of current indicator use; a menu of currently available and proposed indicators; recommendations regarding scales of measurement, thresholds and benchmarks used, and presentation formats and other structural aspects of indicator development and use.

78. In view of the complexity of many of the issues surrounding indicator development and use, and the fact that much work on indicators is at present still at a preliminary stage, the SBSTTA might like to consider establishing an expert working group to carry out a detailed review of theory and practice in th use of indicators of biological diversity. Such a working group would report back to the next meeting of th SBSTTA with a view to making specific recommendations for COP IV.

79. The SBSTTA, or any working group which the SBSTTA might like to establish, may like to consider focusing its deliberations by considering indicator development specifically in one or other, or both of, two important thematic areas, namely agricultural biological diversity and coastal and marine biological diversity, both of which are to be discussed under the provisional agenda to this meeting (see documents UNEP/CBD/SBSTTA/2/10 and UNEP/CBD/SBSTTA/2/14).