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## ASSESSMENT OF BIOLOGICAL DIVERSITY AND METHODOLOGIES FOR FUTURE ASSESSMENTS

Note by the Secretariat

## 1. BACKGROUND

1. 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.

2. The first meeting of the SBSTTA proposed a medium-term programme of work in recommendation I/2. Item 1.1.1 of this proposed medium-term programme of work was:

> "Review of the assessment of biological diversity made in 1995, and methodologies for future assessments, as well as the minimum standard data required, as appropriate, to be applied in accordance with national priorities and programmes".

3. Decision II/1 of the COP requested the SBSTTA to ensure, in considering its programme of work for 1996, 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 generally acknowledged the importance of assessments in providing the necessary factual basis for implementing the Convention. The COP specifically recognised the importance of the SBSTTA reviewing assessments and will consider the recommendations of the SBSTTA on this matter under item 8.2 of its provisional agenda.

4. Assessments of biological diversity are central to many of the provisions of the Convention. Implementation of Articles 6, 7, 8, 9, 10 and 14 are all dependant upon using existing assessments effectively and generating further assessments where more information is required.

5. The work of the SBSTTA has already recognised the central importance of assessments of biological diversity in undertaking the work of the SBSTTA. For example, recommendation I/6 of the SBSTTA, adopted by the COP in decision II/1, paragraph 4, requested the Secretariat to prepare, under the guidance of the Bureau of the Conference of the Parties and the SBSTTA, a periodic report on biological diversity, which may include, *inter alia*, a brief summary of the status and trends of biological diversity at global and regional levels.

6. Recommendation I/3 of the SBSTTA on "Alternative ways and means in which the Conference of the Parties could start the process of considering the components of biological diversity particularly those under threat and the identification of action which could be taken under the Convention" 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.

7. In particular, the recommendation noted in paragraphs 2, 4 and 5 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 the 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 I 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. The Conference of the Parties should organise international co-operation:

(i) To respond to the needs formulated under paragraphs 1 to 4 above and, more specifically, to compile and assess the above-mentioned methodologies, taking into account existing data, processes and reference materials;

...

(iii) To make these studies available through the clearing-house mechanism established by the Convention to promote technical and scientifical co-operation, and to promote a regional approach to further enhance the collection and analysis of relevant information.

8. This Note has been prepared by the Secretariat to assist the second meeting of the SBSTTA in preparing its recommendations on the modalities of the assessments required to support the work of the Convention. It reviews existing assessments of biological diversity, chiefly those made in 1995, and concludes that while many are extremely valuable, none fully meets the requirements of the Convention. It also draws attention to some thematic areas for which there are major gaps in assessment and emphasises the pervasive need to make better and more co-ordinated use of existing information. Established methodologies for biological-diversity assessment are briefly described and some of the common problems that they face are discussed. Major recommendations include support for national-level actions, improved co-ordination at the international level and the need to review existing methodologies, particularly with regard to GIS (geographic information systems) and indicators.

9. A consequence of the central importance of assessments in implementing the Convention is that the consideration of this item by the SBSTTA cannot be considered in isolation from the consideration of other items on the agenda of either this meeting of the SBSTTA or of future meetings. Similarly, this Note is of direct relevance to many of the other items on the provisional agenda of this meeting of the SBSTTA. In particular, as is evident from the observations of the SBSTTA in recommendation I/3, there is a large degree of overlap between the issues raised by this item of the provisional agenda and item 3.2 on the identification, monitoring and assessment of components and biological diversity and processes that have adverse impacts, and item 3.3 on the review and promotion of indicators. In order to avoid repetition, the Secretariat has had to allocate issues for the notes for these items. However, the subject matter itself does not naturally or easily separate into the topics of this agenda; thus determining what should be included in this Note and what should support the discussion of other items is a somewhat arbitrary exercise. Consequently, the Secretariat advises that this Note be considered in conjunction with the other notes prepared by the Secretariat and in particular the notes prepared primarily to assist the SBSTTA in their consideration of items 3.2 (document UNEP/CBD/SBSTTA/2/3) and 3.3 (document UNEP/CBD/SBSTTA/2/4) of the provisional agenda.

## 2. REVIEW OF ASSESSMENTS OF BIOLOGICAL DIVERSITY

### 2.1. Review of assessments made in 1995

10. A range of assessments of biological diversity were produced in 1995. These were global, regional, national or local in scale, and covered one or more different sectors or facets of biological diversity. Many of them represented several years' cumulative effort, so that they were carried out at least in part before 1995. Other assessments carried out mainly or wholly in 1995 were not published until 1996, and some have yet to be produced. What follows is a brief review of some of the more significant assessments made available during 1995. Most earlier assessments were reviewed in some detail in the Global Biodiversity Assessment and are therefore not dealt with in this Note.

#### 2.1.1 Global assessments

***Global Biodiversity Assessment* (UNEP, 1995)**

11. The most important global assessment of biological diversity made in 1995 was the Global Biodiversity Assessment (GBA), released at the second meeting of the COP. Its objective was to "provide an independent, critical, peer-reviewed scientific analysis of the current issues, theories and views regarding the main global aspects of biodiversity". The result was a massive volume (1,140 pages) that examines in detail the critical scientific issues and draws attention to gaps in knowledge and the issues where uncertainty has led to alternative viewpoints which will require further research to resolve. About 1,500 scientists participated in the preparation of the report, which was commissioned by UNEP and financed by the Global Environment Facility (GEF).

12. Despite the enormous contribution this assessment has made to our understanding of biological diversity, the GBA is essentially an assessment of the state of knowledge of biodiversity, rather than an assessment of the state of biodiversity itself. It provides few baseline statistics that may serve as a starting point for continued monitoring and assessment and is not organised to serve as a data source. Consequently, of itself, it does not meet the requirements of the Convention in this respect, and further consideration of the issue is not only warranted but needed for the purposes of the Convention. This is recognised by the GBA itself, which states "that much of the basic inventory of biodiversity has not yet been undertaken, even at the species level".

***Centres of Plant Diversity* (WWF & IUCN)**

13. Volume 2 of *Centres of Plant Diversity*, covering Asia, Australasia and the Pacific, was published in 1995. When complete, the three volumes will provide a global review of plant diversity and represent the cumulative results of over ten years' work. They provide much valuable information on the distribution of major areas of plants diversity (particularly those with large numbers of endemic species) and an assessment of their conservation status. However, because standardised selection criteria were not adhered to in the choice of sites, it is difficult to use the information contained in these volumes to obtain a coherent picture of the status of plant diversity.

***A Global Representative System of Marine Protected Areas***

14. Four volumes were jointly published in 1995 by the Great Barrier Reef Marine Park Authority, the World Bank and IUCN -- The World Conservation Union. These provide regional overviews of marine biodiversity and assess the extent to which important areas are included in protected areas. Many of the overviews of marine biodiversity are, however, somewhat cursory in nature and do not make full use of available existing information. They also deal almost entirely with coastal and inshore ecosystems, where the great majority of marine protected areas are found.

### 2.1.2 Regional assessments

15. *Europe's Environment: the Dob⊆P© Assessment* was published in 1995 by the European Environment Agency Task Force. This deals with all aspects of the environment although the assessment of biological diversity comprises a relatively limited part of the whole. Chapter 9 -- Nature and Wildlife -- assesses major ecosystems and reviews the region's fauna and flora. It also provides a representative ecosystem site list. Other sections deal with pressures on the environment and human activities that affect the environment. Data is presented in a range of different ways, with heavy emphasis on case studies and examples. Lists and maps of important sites and ecosystems are not exhaustive, and criteria for selection are generally not made explicit. Consequently, it may be problematic to use much of this information as it is presented as a baseline for future assessments.

16. *A Conservation Assessment of the Terrestrial Ecoregions of Latin America and the Caribbean* was published by the World Bank. This maps major ecoregions and attempts to assess their importance for biodiversity conservation using a number of criteria. The approach used in this assessment is problematic because it assumes that extensive geographic areas can be considered effectively as single units (ecoregions) based on biogeographical considerations and taking into account the dominant vegetation type. This does not adequately take into account the wide range of different ecosystems found in any reasonably large geographical area (e.g., wetlands, freshwater systems, montane systems and natural grasslands are all likely to be found in an area that is predominantly forest). Nevertheless, it could be useful for very generalised assessments and provide some framework for establishing regional priorities.

### 2.1.3 National assessments

17. Two major country-level assessments were published in 1995: the *Egypt Country Study on Biological Diversity*, produced by the Egypt National Biodiversity Unit; and the *Papua New Guinea Country Study on Biological Diversity*, produced by the Conservation Resource Centre of the PNG Department of Environment and Conservation.

### 2.1.4 Species and natural resource assessments

18. Three *Action Plans* were published in 1995 by the IUCN, all dealing with groups of birds. One assessed the status of and recommended plans for the conservation of partridges, quails, francolins, snowcocks and guineafowl; the second dealt with megapodes; the third with pheasants. These 3 join 27 other action plans published under the auspices of the IUCN SSC (Species Survival Commission) since 1986. Of the total, 24 deal with groups of mammals, the present three with birds, two with reptiles and only one with invertebrates (swallowtail butterflies, published in 1991). The action plans vary

considerably in their depth of coverage, but generally provide useful assessments of the status of particular groups of species. They are, however, from a taxonomic viewpoint, highly skewed and therefore provide an incomplete overview of species diversity as a whole.

19. The FAO published its Fisheries Yearbook and two global assessments of the world's fisheries: *The State of the World's Fisheries and Aquaculture*; and *Review of the state of world marine fishery resources*. They also published a global synthesis of the results of their 1990 Forest Resources Assessment. The latter deals essentially with natural-resource use and pays relatively little attention to biological diversity *per se*, or the need for its conservation. However, the global reviews of world fisheries do draw attention to this issue, discussing overfishing and the deterioration of marine ecosystems at some length.

## 2.2 An assessment of the assessments of biological diversity

20. A detailed 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 the 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 18 Parties that had received financial support to undertake enabling activities, and the same number again are expected to have projects approved in the next few months.

21. At the international level there remain many important natural ecosystems or biomes that have been inadequately assessed. These include:

(i) Non-coastal marine;

(ii) Freshwater systems (lakes and rivers);

(iii) Tropical dry forests and woodlands;

(iv) Montane systems; and

(v) Rangelands, arid and semi-arid lands.

22. There also remain large gaps in knowledge for other ecosystems and biomes that have received a great deal of attention, such as coral reefs (see document UNEP/CBD/SBSTTA/2/14) and tropical moist forests (see document UNEP/CBD/SBSTTA/2/11). In addition, the assessment of the biological diversity of agricultural systems deserves far greater attention than it has hitherto received (see UNEP/CBD/SBSTTA/2/10).

# 3. EXISTING METHODOLOGIES FOR ASSESSMENTS OF BIOLOGICAL DIVERSITY

23. 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 and global assessments although, of themselves, they will be insufficient to provide a complete picture at regional and global levels. This is because the distribution of biological diversity does not adhere 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.

24. 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 Diversity*, 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 current capacity for biodiversity conservation and sustainable use. Possible pathways for managing this information in the context of the CBD are discussed in some detail in the data-flow model prepared by WCMC for the UNEP/GEF Biodiversity Data Management Project (1995).

25. 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.

26. Defining a minimum data set poses two separate but interconnected questions: 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 are 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 biological diversity: those of ecology -- particularly at the large scale -- and of evolution. Our ignorance of these is a far more intractable problem. The issue of priorities within the context of the Convention is addressed in some detail in the Note prepared by the Secretariat addressing item 3.2 of the provisional agenda (document UNEP/CBD/SBSTTA/2/3). With limited resources, the choice of the most efficient and reliable methodologies is self-evidently also of great importance. This is the principal subject of the present Note.

27. 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.

28. 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, regional 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.

29. 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 both 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.

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

(i) Gap Analysis, developed by the US Fish and Wildlife Service;

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

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

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

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

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

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

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

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

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

31. These techniques are described and assessed in Annex 1. Most use species as the basic unit of biological diversity and rely on the compilation of existing data, the collection of new data, or, as in the majority of cases, both.

### 3.1 Principles and problems in the assessment of biological diversity

32. 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 the Annex to 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. Nevertheless, there are a number of general observations that can be made about the existing methodologies, which 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.

33. 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/SBSTTA/2/3.

34. The following paragraphs outline some principles and problems in the assessment of biological diversity at the levels of ecosystems, habitats, species and genes. The consideration of ecosystems and habitats is particularly important as the SBSTTA recommendation I/3 suggests developing the ecosystems approach for 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 natural environment and changes to it can be mapped.

### 3.2 Identifying ecosystems and habitats

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

36. 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 different 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 with similar ecological requirements may, of course, be expected to have similar distributions. Even if the 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.

37. 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 rainforests 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 before it should be classified as a wetland rather than a terrestrial ecosystem.

38. 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:

(i) Physiognomic: features of height, growth form and coverage of vegetation;

(ii) Bioclimatic: the prevailing climate regime;

(iii) Edaphic: soil type and geology;

(iv) Phenological: leaf retaining characteristics (i.e., whether vegetation is deciduous or evergreen);

(v) Floristic: occurrence of certain principal plant taxa; and

(vi) Functional: management use (e.g., fuelwood production)

39. 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

40. The need to monitor change over time in ecosystems and habitats, as essential components of biological diversity, is implicit in Article 7 of the Convention and forms an essential part of any assessment of biological diversity. Only by monitoring change in the natural environment over time can the effects of mankind be assessed, both in terms 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 to carrying this out. The principal theoretical problem is that natural environments are not static entities, but are dynamic and thus constantly changing at all geographical and temporal scales. Some changes (especially diel and 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.

41. 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 more-or-less arbitrary 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%*".

42. Environmental modification, that is, change in habitat condition or quality, is much more difficult to measure. In large part, this is because notions of condition or quality are functionally dependent, so that there can 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 an area, other than complete destruction, will affect different species in that area in different ways. Some species may decrease in abundance, 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 Identification, monitoring and assessment of species

43. Problems of identifying and classifying species are rather different from those of identifying habitats and 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.

44. 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.

45. 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 be inventoried on a systematic and regular basis. Many techniques have been developed for doing this, but they are 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. This is 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 mankind (e.g., different land-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

46. Genetic diversity is impossible to quantify as a general property, but key parameters such as karyotypic variation, mitochondrial DNA divergence or protein polymorphism can be 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 using sophisticated laboratory techniques.

47. 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 currency in which biodiversity is measured. UNEP recommends that biological data on biodiversity are primarily collected at the species level, and that subspecies, populations and genetic diversity *per se* are only considered where 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. METHODOLOGIES FOR FUTURE ASSESSMENTS OF BIOLOGICAL DIVERSITY

48. 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 better and more co-ordinated use of existing resources and techniques and the implementation of more innovative techniques. 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 GIS systems and the use of indicators for extrapolation.

### 4.1 Use of GIS systems

49. Geographic information systems (GIS) may present one of the most productive avenues for the development of biodiversity assessment. Planned use of them may obviate the need to develop the complex habitat and ecosystem classifications that are, as discussed above, currently a major problem. This is because representations of different, measurable attributes of the environment can be stored in separate layers within a GIS. Examples of such attributes are: soil characteristics; altitude; rainfall; percent canopy cover; mean height of dominant vegetation; and distributions of individual species. The baseline maps used may be generated from satellite 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.

50. 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 Use of Indicator Groups

51. 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. However, no one organism or group of organisms can be expected to comprehensively reflect the patterns of distribution and abundance of all other taxa, so the choice of indicator groups has to be made carefully. The limitations of existing indicator techniques and their relative strengths are discussed in more detail in UNEP/CBD/SBSTTA/2/4.

### 4.3. Co-ordinating international and regional initiatives

52. 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 co-ordination, and of particular importance to the Convention itself, are the biodiversity-related instruments. Several of these instruments have also called for global assessments of the state and trends of some aspects of biodiversity of importance to their conventions. For example, the Ramsar Convention has called for a global assessment of wetlands and the Convention on Combating Desertification has called for a global assessment of desertification. Obviously, the production of such assessments should be co-ordinated with the work of the Convention. The COP, in decision II/13, requested the Executive 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. To this end, the Executive Secretary has already entered into agreement with CITES, Ramsar and CMS. Negotiations are under way with the World Heritage Convention (WHC) and the International Oceanographic Commission (IOC). Initial consultations have begun with the FAO, IUCN, Cartagena Convention, WCMC and the CSD.

53. 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 1 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 1 has with the critical sites and components of other biodiversity-related instruments and the modalities of co-ordination between the processes is discussed in more detail in the Note to assist the SBSTTA in their consideration of the following item on the provisional agenda (document UNEP/CBD/SBSTTA/2/3).

54. 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 1. Ramsar, 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 1 of the Convention and adheres to the principles of the Convention needs to be considered. In general, the adoption of existing standards, for example, the checklists of various taxa already in use by CITES, would not only promote harmonisation, but would also be likely to assist the Parties in their national assessments as it would obviate the need for a time-consuming review of different classification systems in order to choose a preferred one.

55. A more centralised system of data collection for all of these conventions would significantly encourage the greater co-ordination 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 the 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 co-ordinate, what is required is the design of a common data-management programme that all the secretariats and Parties could use.

56. 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 the 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 facilitates or outside GIS specialists (e.g., GRID or WCMC).

57. The co-ordination of information that is being generated for international processes is vital. This means harmonising and centralising the presentation of data, or national reporting requirements to these international processes. Greater co-ordination of national reporting requirements will provide benefits to both the international processes and the countries themselves. For countries, it would, for example;

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

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

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

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

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

58. From the international institutions' perspective it would:

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

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

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

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

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

59. The co-ordination of international reporting requirements requires an overarching information infrastructure that adheres to the following principles:

(i) synchronised reporting schedules;

(ii) agreed information interchange and sharing modalities;

(iii) compatible technology for information management; and

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

60. The SBSTTA may wish to consider the practical steps required to begin to establish such a harmonised infrastructure and may wish to consider such documents as the *Guidelines for Country Studies* and the *Data Flow Model in the Context of the Convention on Biological Diversity* prepared by WCMC for the UNEP/GEF Biodiversity Data Management Project. The data-organisation structures of The Nature Conservancy, of CORINE (the European Commission's system for co-ordinating information on the environment) and of the Australian Nature Conservation Agency, referenced in the Note by the Secretariat on Agenda Item 5.5.1 of SBSTTA I (UNEP/CBD/SBSTTA/1/4), may also be of interest.

## 5. CONCLUSION

61. 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 SBSTTA may wish to consider the following suggestions.

### 5.1. Support for national assessments

62. All assessments and reviews of assessments have pointed to a need for capacity building at all levels, most particularly at the national level. The two most important components of this are better co-ordination 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. In light of the fact that none of the 18 Parties have so far completed their programme

of enabling activities, it is probably premature to consider a recommendation to the COP about the need for further financial support for these national assessments from the financial mechanism.

63. Further international support can, however, be provided by the SBSTTA and the Convention as a whole, to these national efforts. In particular, the SBSTTA may wish to consider the following measures:

(i) Capacity building within Parties could be supported by greater sharing of experience, practices and assessments. The SBSTTA 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.

(ii) To provide further support in this regard the SBSTTA 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.

(iii) 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 SBSTTA may like to make recommendations for improving the flow of information to Parties, particularly less-developed countries, from these sources. The possible role of the clearing-house mechanism should be examined. The need for increased access to taxonomic information and possible mechanisms to achieve this are discussed in document UNEP/CBD/SBSTTA/2/5, prepared by the Secretariat to assist SBSTTA in its discussion of item 3.4 of the provisional agenda (practical approaches for capacity building for taxonomy).

(iv) Providing a critical review of particular methodologies for assessment would assist countries in developing their own methodologies by providing them with a better understanding of the strengths and weaknesses of existing methodologies. The Annex to this Note provides an indication of what such a review might look like. The SBSTTA may therefore wish to review this Annex and make a recommendation to the COP. The SBSTTA may wish to consider initiating a more comprehensive review with a view to producing a report as soon as possible, and no later than the end of 1996, so as to enable Parties to draw on the review in time for the production of their national reports. The SBSTTA may wish to consider establishing a liaison group, an informal working group, or instructing the Secretariat to undertake a more comprehensive review.

(v) At present UNEP's *Guidelines for Country Studies on Biological Diversity* is the basis for providing guidance for co-ordinating the generation of the data needed for assessments. The collection of a significant proportion of the data covered 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 SBSTTA may wish to consider a review mechanism to refine these guidelines so that while they meet the needs of the Convention as much as possible, they are practical in the sense that they can be followed by the Parties.

In considering its recommendations, the SBSTTA may wish to be mindful of the fact that useful guidelines need to be adaptive and responsive. Consequently, the SBSTTA may wish to establish an informal working group that could develop more detailed guidelines and adapt them on an on-going basis. The SBSTTA may wish to consider the document *Assessing* *biodiversity status and sustainability* in its deliberations on this matter in order to determine whether it could serve as a basis for such guidelines.

(vi) 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 (discussed at some length in the Note to agenda item 3.4), ecology, natural-resource management, remote sensing, information-systems management and sociology. Before making specific recommendations for capacity building through providing training or institutional support, the SBSTTA may like to review the process of assessing biological diversity and compare identified needs with existing capacity to determine the critical limiting steps in the process. The SBSTTTA may also like to review 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

64. The importance of improving international co-operation in assessing and reporting on biological diversity has been described above, along with the initiatives undertaken to date by the Executive Secretary to this end. The SBSTTA may wish to provide further guidance to the Executive Secretary as to any particular processes and institutions that the Executive Secretary should approach. The SBSTTA may wish also to consider undertaking a comparative review of the various biodiversity-related instruments to determine more precisely the areas of overlap, and may then wish to provide specific guidance as to the types of provisions that would facilitate co-ordination.

65. The SBSTTA may wish also to consider reviewing existing standard or widely used classification systems, taxonomies and definitions of terms, with a view to making recommendations to the Conference of the Parties as to those that may prove useful in national, regional and global assessments of biological diversity.

66. 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 SBSTTA 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 the capacity. The SBSTTA may also wish to consider providing guidance on 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 be used to provide this support, such as whether it should be public or private.

67. Although the aim of improving the co-ordination 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. The SBSTTA may wish to consider providing guidance as to the appropriate levels and modes of investment.

68. This review of assessment has indicated that there exist some major thematic gaps in the assessment of biodiversity at the global level. On the basis of ecosystems and biomes they are:

(i) non-coastal marine;

(ii) freshwater systems (lakes and rivers);

(iii) tropical dry forests and woodlands;

(iv) montane systems; and

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

69. The SBSTTA 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 SBSTTA and/or the COP, and begin the process of providing assessments for the specific needs of the Convention. The SBSTTA may wish to be particularly mindful of the report by the Executive Secretary (document UNEP/CBD/SBSTTA/2/14) that sets out a proposed medium-term work programme for the conservation and sustainable use of coastal and marine biological diversity. This calls, *inter alia*, for a global assessment of marine and coastal biological diversity. It states (Annex 1, paragraph 2): "An extensive global assessment, conducted on a periodic basis, is widely regarded as a critical requirement in developing and implementing an effective, long-term programme of action to address marine and coastal biological diversity loss world-wide. Such an assessment (in effect, a global overview) would be essential to: (a) identifying and targeting priorities; (b) identifying and formulating necessary action; and (c) measuring progress in relation to specific objectives".

70. The SBSTTA may also wish to consider making recommendations for an assessment of biological diversity in agricultural systems. The SBSTTA may wish to be mindful of document UNEP/CBD/SBSTTA/2/10, which suggests, among other activities that the Conference of the Parties may wish to consider, "undertaking scientific, technical and technological assessments on the status of agricultural biological diversity, especially in the less-documented areas such as animal and microbial biological diversity".

71. The SBSTTA 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. The SBSTTA might wish to provide recommendations as to how such information might be acquired and managed.

72. The SBSTTA may also wish to consider how such an assessment might provide the basis for or at least support the preparation of the Global Biodiversity Outlook. Additionally, the SBSTTA may wish to consider how any assessment undertaken by the Convention might provide support for other processes and instruments.

73. In considering its recommendations under this agenda item, the SBSTTA might wish to be mindful of the interrelated nature of the first four items of the provisional agenda for this meeting and the strategic priorities of the SBSTTA. This means that the SBSTTA will need to be aware of the recommendations it wishes to make with regard to the other items on its provisional agenda, especially items 3.2, 3.3 and 3.4. As the level of resources available in no way matches the scale of needs, the SBSTTA may wish to consider some priorities, either in terms of time or resources, for items 3.1, 3.2, 3.3 and 3.4 of the provisional agenda for this meeting.

## Annex 1

## DETAILS OF BIODIVERSITY ASSESSMENT TECHNIQUES

GAP ANALYSIS: US Fish and Wildlife Service and others

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

### Brief summary of technique

Gap Analysis is essentially a coarse-filter approach to biodiversity conservation. It is used to identify gaps in the representation of biodiversity within areas managed solely or primarily for the purpose 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.

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, common terrestrial vertebrate species, and endangered species are used as surrogates to represent overall biodiversity.

### Data needed

(i) 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 entire 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.

(ii) 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.

(iii) Land ownership and management status maps.

### Assessment of likely availability of data

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.

## Costs involved

A GIS-supported Gap Analysis requires technical infrastructure, a great amount of baseline 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.

## Human resources involved/required

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

## Data generated

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

## Time frame

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

## Examples of implementation

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 USA; results and recommendations of one for Idaho were under review in 1993.

## Points for and against

### For

(i) 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 the conservation of biodiversity in response to rapid rates of habitat loss.

(ii) 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.

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

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

**Against**

(i) 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.

(ii) Vegetation maps often fail to distinguish between different successional (seral) or age 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.

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

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

(v) 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 site-specific management activity.

(vi) 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.

(vii) 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.

(viii) 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.

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

(x) 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.

(xi) 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.

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

(xiii) 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.

## Appraisal

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 reserve system.

## RAPID ECOLOGICAL ASSESSMENT (REA): The Nature Conservancy

**Source: Grossman, D.H. et al. 1992**

## Brief summary of technique

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 reconnaissance produces more detailed maps, extended to cover vegetation types and ecological communities. These are used to direct the cost-effective acquisition of biological and ecological data through stratified field sampling. Such data is used to support the conservation planning process and to identify priority sites.

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 Nature Conservancy.

## Data needed

(i) 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 were obtained from existing GIS datasets 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.

(ii) 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.

### Assessment of likely availability of data

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

### Costs involved

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

### Human resources involved/required

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.

### Data generated

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 site-specific inventories of key "indicator" groups of species. These will be used to identify priority sites and conservation actions.

### Time frame

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

### Examples of implementation

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.

### Points for and against

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

**For**

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

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

**Against**

(i) 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 datasets are not available.

**Appraisal**

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

**CONSERVATION BIODIVERSITY WORKSHOPS: Conservation International**

**Source: Tangley, L. 1992.**

**Brief summary of technique**

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.

**Data needed**

(i) 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.

(ii) Basic species-distribution maps, representative of "keystone" groups. These can be 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 the 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.

**Assessment of likely availability of data**

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 are probably available for most countries.

**Costs involved**

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

**Human resources involved/required**

The preparation of GIS data layers and maps requires GIS and computing expertise. The 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 (where available) NGOs. Up to 200 representatives from as many as 50 institutions may attend.

**Data generated**

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.

**Time frame**

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 the Workshop and its constituent working groups, may take 1 to 2 years.

**Examples of implementation**

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. The 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 responsible for collecting data from their constituent members. Further CBWs are planned for the Atlantic Forest region of Brazil and the Central African Region.

**Points for and against**

**For**

(i) 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, sectorial approach.

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

(iii) The process is relatively fast.

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

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

**Against**

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

(ii) 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.

**Appraisal**

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

**CONSERVATION NEEDS ASSESSMENT: Biodiversity Support Program**

**Sources: Alcorn, J.B. (ed.) 1993. Beehler, B.M. (ed.) 1993.**

**Brief summary of technique**

The Conservation Needs Assessment (CNA) was implemented for Papua New Guinea by the Biodiversity Support Program (a USAID-funded consortium of the World Wildlife Fund, The Nature 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. The 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.

### Data needed

(i) "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.

(ii) 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.

### Assessment of likely availability of data

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 are probably available for most countries.

### Costs involved

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

### Human resources involved/required

A CNA co-ordinates a multidisciplinary team of international and national experts. Preparation of base maps requires GIS expertise.

### Data generated

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 whole exercise. In addition, in Papua New Guinea, Workshop proceedings were published as a two-volume series entitled "Papua New Guinea Conservation Needs Assessment".

### Time frame

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.

### Examples of implementation

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

### Points for and against

#### For

(i) 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.

(ii) A CNA involves co-operation between the state, government and customary landowners.

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

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

#### Against

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

(ii) 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.

### Appraisal

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.

## NATIONAL CONSERVATION REVIEW (using Gradsect sampling): Sri Lanka Forest Department

**Source: Green, M.J.B. and E.R.N. Gunawardena 1993.**

### Brief summary of technique

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 (see below). The sampling procedure involves the following steps:

(i) identification of sites;

(ii) positioning of transects along environmental gradients; and

(iii) inventorying flora and fauna within plots.

The NCR also has a hydrological and soil-conservation component. These attributes of forests are measured concurrently by a separate survey team. An iterative-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).

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, while 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.

**Data needed**

(i) 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.

(ii) 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.

**Assessment of likely availability of data**

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.

**Costs involved**

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

**Human resources involved/required**

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

**Data generated**

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 that could not be identified in the field, and were sent to museums for positive identification. Species lists were therefore generated for each forest surveyed. Subsequent analyses were based mainly on the woody plants data, because of the large number of biases involved in faunal survey, and the likelihood that faunal diversity was greatly underestimated due to the speed at which the survey had to be conducted.

### Time frame

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.

### Examples of implementation

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

### Points for and against

#### For

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

(ii) Gradsect sampling is relatively cheap.

#### Against

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

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

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

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

### Appraisal

This technique is suitable for the investigation of, and conservation priority setting between, pre-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.

## BIMS (BIODIVERSITY INFORMATION MANAGEMENT SYSTEM): Asian Bureau for Conservation

**Source: MacKinnon, J. pers comm.**

### Brief summary of technique

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 degree of protection afforded to their required habitats.

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 the computer space that an equivalent approach to species mapping using GIS would.

### Data needed

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

(i) a physical base map;

(ii) biogeographical divisions;

(iii) habitat classification (original distribution);

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

(v) a protected-areas system

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

### Assessment of likely availability of data

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

### Costs involved

Relatively low.

### Human resources involved/required

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

### Data generated

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

### Time frame

Can be very quick where data are available.

### Examples of implementation

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

### Points for and against

#### For

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

(ii) Fast

(iii) Cheap

(iv) Gives acceptably accurate predictions of species' actual occurrence

(v) Can be used to estimate species' population sizes

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

#### Against

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

(ii) Has so far only been used in Asia

### Appraisal

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.

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

## Brief summary of technique

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 those already covered.

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 make a high contribution.

## Data needed

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

## Assessment of likely availability of data

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

## Costs involved

Unknown, but expected to be low.

## Human resources involved/required

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

## Data generated

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.

## Time frame

Unknown, but expected to be short.

### Examples of implementation

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

### Points for and against

#### For

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

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

(iii) Scientists from developing countries will review the preparation and development of the CSIRO materials, ensuring that they are compatible with their aims

#### Against

(i) Methodology not yet available

### Appraisal

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.

## ALL TAXA BIODIVERSITY INVENTORY (ATBI):<br>University of Pennsylvania in conjunction with INBio, Costa Rica.

**Source: Janzen, D.H. and W. Hallwachs 1994.**

### Brief summary of technique

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.

### Data needed

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

(i) 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;

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

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

**Assessment of likely availability of data**

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.

**Costs involved**

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

**Human resources involved/required**

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

**Data generated**

An enormous amount of basic data would potentially be generated.

**Time frame**

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 the time scale proposed for the Guanacaste project.

**Examples of implementation**

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.

**Points for and against**

**For**

(i) 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.

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

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

### Against

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

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

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

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

(v) The technique involves a considerable input of specialist knowledge from invited expatriate systematists.

### Appraisal

ATBI is not the right technique to apply to a number of sites for determining their conservation value. It is site-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).

## RAPID BIODIVERSITY ASSESSMENT (RBA): MacQuarie University

**Source: Beattie, A. J., et al. 1993.**

### Brief summary of technique

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:

(i) "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 resolve the species collected at a site to the level of family or genus to ascertain environmental quality.

(ii) "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 classification 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 recognisable 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. Studies show that if properly trained, such personnel can be very effective.

**Data needed**

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:

(i) are relatively abundant;

(ii) have a high species richness;

(iii) contain many specialist species;

(iv) are easy to sample; and

(v) have taxonomic traits amenable to RBA methods.

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.

**Assessment of likely availability of data**

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

**Costs involved**

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

**Human resources involved/required**

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

**Data generated**

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

### Time frame

RBAs are relatively quick.

### Examples of implementation

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.

### Points for and against

#### For

(i) Quick and cheap.

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

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

#### Against

(i) 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 RBA programmes conducted by different organisations may prove difficult.

(ii) 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.

### Appraisal

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.

## RAPID ASSESSMENT PROGRAMME (RAP): Conservation International

### Source: Parker, T.A.P. III. et al. 1993.

### Brief summary of technique

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

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.

RAPs are undertaken by identifying potentially rich sites from satellite images/aerial reconnaissance, and then 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 the responsibility of local scientists and conservationists.

**Data needed**

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

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

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

**Assessment of likely availability of data**

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.

**Costs involved**

No indication of the costs involved is currently available.

**Human resources involved/required**

Local experts are a central part of any RAP team, especially critical to understanding areas where 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.

**Data generated**

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

### Time frame

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 $km^2$ 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 region.

### Examples of implementation

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); the Cordillera de la Costa (Ecuador); the Columbia River Forest Reserve (Belize); and the Kanuku Mountain region (Guyana) have been inventoried by RAP.

### Points for and against

#### For

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

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

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

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

#### Against

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

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

### Appraisal

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.

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