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Integrating global and local values

A review of biodiversity assessment

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6. Making a killing or making a living: wildlife trade, trade controls and rural livelihoods
7. Lesson learnt: Mamiraua Sustainable Development Reserve, Brazil

Executive summary

As a resource, biodiversity is managed at local levels, but subject to wider claims and influences. An important aspect of biodiversity management is assessment: measuring biological variety and variability, as well as the impacts on and outcomes of this diversity. Biodiversity assessment is of interest to many groups, and regularly carried out at local, national and international scales by direct users and managers of biological resources, government departments, research organisations, international bodies and the private sector.

Demand is now growing for more exchange and integration among different approaches to biodiversity assessment. The fundamental drive behind this is decision-makers' realisation that effective management of land and natural resources depends more and more on interacting constructively with other interest groups. More immediate drivers for biodiversity assessment include the Convention on Biodiversity (CBD), which advocates the Ecosystem Approach as a framework for putting decisions into practice – a framework that specifies the need for pluralist, negotiated, adaptive management based at local levels. Approaches like these need shifts in governance towards greater direct democracy. They also need good information. Biodiversity assessments, at best, deliver the sort of information that helps different interest groups to communicate and negotiate shared and divergent biodiversity values. As such, they might not only serve decision-making, but catalyse better governance.

Biodiversity is complex, too complex to be evaluated thoroughly. In practice this has implications for all the many kinds of biodiversity assessments, so that they have common features such as being relative rather than absolute, framed in time and usually also in space, and dependent on measuring more obvious features to estimate the less discernible. The complexity of biodiversity also means that we are not sure exactly what we gain from it. Benefits of biodiversity include direct use of a range of biological resources, indirect benefits such as stability of ecosystems and prevention of diseases, and non-use values, of which the most important is the option to use biological resources in the future. However, more biodiversity is not always better, and, as with any resource, management has to find a compromise among outcomes that fulfill different values.

Of course, different interest groups identify and prioritise biodiversity values differently. One contrast is between "global values" – the indirect use values (environmental services) and non-use values (future options and intrinsic existence values) that accrue to all humanity – and "local values" held by the day-to-day managers of biological diversity, whose concerns often prioritise direct use of the goods that biodiversity provides. Assessments are based on values. Many of the current approaches to biodiversity assessment advocated by governments and advisory bodies emphasise global over local values, a bias which is seldom made explicit and is often not intended.

For organisations seeking to improve the techniques they use to assess biodiversity, and particularly to find ways of integrating global and local values, guidance is now beginning to emerge. An overview of some of the scientific and other research tools shows many potentially useful techniques for combining different perceptions of biodiversity into shared assessments. Some of these have been pilot-tested successfully. Scientific tools have been applied mainly to assessing taxonomic diversity in terms of global non-use values, but there is considerable potential to apply the same techniques to evaluate biodiversity in terms of local priorities. The most important limitations to the use of these tools are their expense in terms of skills, time and equipment, and their dependence on a shared quantitative understanding of biological phenomena (or at least a trust in results presented by scientists).

Economic and social science research have developed some rather different tools, which offer ways to communicate local biodiversity values to wider audiences. Approaches such as Participatory Rural Appraisal, ethnobotany and economic valuations have done much to enhance outsiders' appreciation of local biodiversity values, but have not been widely adapted or adopted to fit into prescribed methods for evaluating biodiversity. Assessments done by local managers for their own purposes have received much less attention in the wider world, as they are often not documented at all, or are difficult to adapt or extrapolate above the local level.

Official procedures for assessing biodiversity, as carried out or condoned by international agencies and national governments, have largely failed to incorporate local concerns. They tend to focus on indicators that represent non-use biodiversity values and conservation priorities, while remaining vague about the exact purpose of the assessment and the justifications for chosen methodologies. The private sector too is showing an increasing interest in biodiversity assessment, using methods that are sometimes ad hoc, but have promise as the types of information bases that could assist negotiations over biodiversity among stakeholders with different viewpoints.

Although biodiversity assessments do not always need to be done jointly, or for that matter to be done at all, the demand for collaborative natural resource management – and hence for appropriate information to service that management – is growing. One obvious but not widely applied lesson from the examples reviewed here is that assessments are most useful if their aims are clear, and the components of the assessment designed to meet those aims. Greater clarity about the purpose of assessment is helped by disaggregating the different relevant values of biodiversity, identifying where there might be trade-offs, and trying where possible to assess the benefits derived from biodiversity rather than a surrogate biological indicator. Composite expressions of multiple biodiversity values are certainly possible – there are several simple techniques available – and might be useful tools for joint management in some circumstances. Principles-based approaches could be appropriate frameworks for assessments that strive to integrate local and global biodiversity values, as they offer means of evaluating process as well as content, combining multiple perspectives, and providing plenty of local flexibility.

Contents

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1 Introduction

Biodiversity is a good example of a resource that is managed locally, but is also subject to much wider claims as a public good – often a public good valued for the diffuse actual or potential value to all humanity around the world. As public concerns about biodiversity management grow, so there is increasing demand for communication between local and global approaches to valuing, and hence managing, biodiversity.

Intrinsic to managing a resource is tracking what's there: evaluating, or assessing, the resource. In the case of biodiversity though, there are no obvious means of assessing all the ways in which it is or might be valuable, because biological systems are more complex than we fully understand. Actual (and proposed) approaches to biodiversity assessment depend ultimately on underlying social values. Sometimes there are stark differences between the values that local people see to accrue locally, and what is valued for the public good. These differences are reflected in the ways that biological variety is described and evaluated.

> *"I do not feel comfortable in assigning "value" to different species and other biodiversity facets, but the fact is that conscious priorities have to be made, and these priorities are based on a "value". In the absence of an open and formal value system, priorities will still be made, but based on hidden value systems which are beyond critical examination."*
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> **Fredrik von Euler,** in e-mail conference hosted by Swedish Scientific Council on Biodiversity, 1999. http://www.gencat.es/mediamb/bioind/econfsum.htm

But biodiversity assessments are not merely an outcome of different sets of values and different ways of managing ecosystems. They are also a potentially a very useful tool for facilitating communication among these different approaches. In recent decades, central powers have moved towards agreeing with local opinions that management of natural resources is more efficient, sustainable and equitable when done locally. For national governments, biodiversity management is perhaps one of the most advanced in this trend, at least in intent. The primary framework for the implementation of the

Convention on Biological Diversity (CBD), which 179 countries have ratified, is the "ecosystem approach", which endorses principles of negotiated local governance and adaptive management (discussed further in Section 2.2).

Shared, adaptive decision-making over management of ecosystems requires better communication. For biodiversity assessment this means at best, joint evaluation, and at the least a mutual understanding and agreement about how the variety of life is measured. This review presents a small sub-set of the wide range of biodiversity assessment tools, with the purpose of evaluating how they do, and how they could, adapt to integrate multiple values attached to biodiversity.

Biodiversity assessment as a concept and a tool

2.1 What does biodiversity include?

Biodiversity, according to the widely accepted definition in the Convention on Biological Diversity, encompasses “the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (CBD 1992).

In common usage, biodiversity means the sum total of living things and the ecological processes associated with them – as such it can be, and is, used as a synonym for “nature” or “life on earth”. More strictly, though, the term refers specifically to the *variability* and *variety* within species, among species and among the ecological processes that connect them. Biodiversity is a combination of the living world’s capacity to change – variability – and the range of biological forms and processes that derive as a result – variety (Box 1). In this sense, what is important about biodiversity to humans is the *choice* that it offers, from the perspective of both present benefits of varied and variable life forms and the future options associated with variety and the capacity for organisms to mutate and adapt.

Box 1. Variety, variation and variability

Variety means the existence of differences.
Variation is the measure of variety, the extent or range of difference.
Variability means the ability to vary, or the capacity to change.

The scale of biological variety is difficult to imagine, and the very notion of variability hard to conceptualise. Neither is easy to describe in tangible terms or to measure. Yet societies all over the world use the concept of variation and variability in nature, albeit in very different ways. With an array of ways of conceptualising biodiversity comes as many approaches to assessing variation and variability – techniques tailored to measuring the facets of biodiversity of value to that individual or society.

2.2 Who and what are biodiversity assessments for?

The primary purpose of biodiversity assessments is to provide the sort of information to decision-makers that facilitates more effective management of biodiversity and associated resources. While we all depend on the variety of life, perhaps the most important of these decision-makers, in terms of how much they value and how much they influence biodiversity, are the most direct users and managers: farmers and other people whose livelihoods depend immediately on the variation and variability of biological resources. These natural resource managers have been assessing biodiversity for millennia, usually in ways that are not documented or accessible by outsiders.

As biological resources became scarcer relative to human populations, claims have been made for biodiversity as a global good. Over the past century, the perception that the benefits of biodiversity accrue globally has given rise to a strong international conservation lobby and a swathe of international processes and agreements that refer to biodiversity. Many of these agreements require signatories to conduct some form of biodiversity assessment. Signatories are national governments, who are pulled by both national and international interests. The rising interest in biodiversity assessment has not been confined to governments and campaigners. The private sector too has had to comply increasingly with environmental criteria that include standards for biodiversity, and companies have also been able to take advantage of new commercial opportunities for managing and monitoring biodiversity.

For all stakeholders, management of biodiversity is increasingly about interacting with other interest groups, in particular interest groups made up of local residents and resource users. The shift towards acknowledging the authority of local groups to analyse, plan, negotiate and act in the management of biodiversity is borne out by the "ecosystem approach" adopted by the Conference of Parties of the CBD. The operational guidelines of the ecosystem approach are based on 12 principles that explicitly acknowledge the trade-offs between local and global biodiversity values and advocate an inclusive and pragmatic approach to decision-making (Box 2).

Of course, international agreements are far from guarantees of agreement or action at the local scales that matter, but at least in principle a large number of national governments are committed to work towards decentralised and collaborative modes of biodiversity management. Inter-governmental and non-governmental bodies are also having to take up this challenge. How then can methods for measuring of biodiversity be made selectively useful as tools in exchange of information among stakeholders, or in shared decision-making?

Box 2. Principles of the Ecosystem Approach

The following 12 principles are complementary and interlinked.

Principle 1: The objectives of management of land, water and living resources are a matter of societal choices.

Principle 2: Management should be decentralised to the lowest appropriate level.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Principle 4: Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:
a) Reduce those market distortions that adversely affect biological diversity;
b) Align incentives to promote biodiversity conservation and sustainable use;
c) Internalise costs and benefits in the given ecosystem to the extent feasible.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the Ecosystem Approach.

Principle 6: Ecosystems must be managed within the limits of their functioning.

Principle 7: The Ecosystem Approach should be undertaken at the appropriate spatial and temporal scales.

Principle 8: Recognising the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

Principle 9: Management must recognise that change is inevitable.

Principle 10: The Ecosystem Approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Principle 11: The Ecosystem Approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

Principle 12: The Ecosystem Approach should involve all relevant sectors of society and scientific disciplines.

Source: CBD 2002

2.3 From concept to measurement

There are an estimated 10 – 100 million species on earth, of which biologists have formally described and named about 1.7 million (Hawksworth and Ritchie 1993). Each of these species consists of populations of varying individuals, and each species interacts with many others, in recognisable patterns of organisation that make up countless ecosystems. So how much biodiversity is there on earth? Clearly the concept of "all the biodiversity on earth" has qualitative meaning, but deriving an informative quantitative measurement of the world's biodiversity is, in practical terms, impossible.

The important implication of this is that all measurements of biodiversity refer to a subset of the facets of total biodiversity. Even at single sites we cannot measure the full range of species diversity, let alone the variation within those species or their processes of interaction; we have not even named many of the species, especially the myriad micro-organisms in any habitat.[1] Thus every biodiversity assessment must be based on a chosen subset of characters that might (or might not) reflect overall biodiversity. Before tackling the more controversial and less explicit aspects of how these choices are made, some general points about measuring biodiversity should be made:

Biodiversity measures are relative. Leading on from the fact that we are incapable of measuring the world's biodiversity at any one moment in time, measures of biodiversity are not absolute. Rather they are used to compare different areas over different periods of time.

Measured biodiversity is an attribute of a group of organisms, usually in a particular area. We are forced to limit measures of biodiversity to a group of organisms. The group could be defined non-spatially (e.g. diversity of a shoal of mackerel, or of the family Rosaceae). More commonly though, measures (or descriptions) of biodiversity refer to a specified area, such as the diversity of trees in Uganda or the genetic diversity of the rice fields of Yunnan.

Biodiversity measures also have a time frame. The biodiversity of an area will tend to change over time, through the seasons, but also as populations rise or fall over longer periods of time or as they adapt to changing conditions. Thus to measure biodiversity, limits of time as well as limits of space need to be defined. For example, a desert will display much higher levels of diversity over the course of a year than in a one-off assessment.[2]

Biodiversity is customarily divided into genetic, species and ecological diversity. Genetic and species diversity are both aspects of taxonomic diversity (Box 3), which refers to the variation in genetic make-up or observable characters among

1. The All Taxa Biodiversity Inventory at Guanacaste, Costa Rica, spent US$ 88 million over five years in the closest science has come to a complete description of taxonomic diversity at a single site.
2. Biologists are also aware that the longer one stays at a site the more variability is recorded. Thus many inventory methods are deliberately time-limited.

a group of organisms. Ecological diversity is a less tangible concept, referring to the variation within and between ecosystems (Box 4).

Biodiversity is sometimes invisible. Smaller, less visible species such as bacteria, fungi, nematodes and organisms found in the deep sea often get overlooked in assessments either because they are simply forgotten about or because measurement is too expensive (and substituting visible organisms as indicators of other biodiversity is not always robust).

Box 3. Taxonomic diversity

Genetic diversity is the variety of genes within a species, or the variety of observable characters that those genes produce. For example, the range of mangoes around the world, from blue-skinned to yellow, from stringy to smooth, is a form of genetic variation. Some useful species display a great deal of external variety; for example cabbages, cauliflowers, broccoli and brussels sprouts are all one species.

Species diversity is the variety of species within a community or collection of organisms. For example, a natural woodland will usually have higher tree species diversity than a timber plantation. What exactly is a species? There continues to be debate amongst biologists over what constitutes a species, but essentially a species is defined as a group of organisms that are able to interbreed with each other to produce fertile offspring. Thus all domestic dogs are one species, in spite of their wide variation in appearances, but the closely related wolf is another species because dogs and wolves cannot interbreed successfully.

However, species are not the only level of classification of organisms. Taxonomists have developed a standard hierarchy based on the similarities and known evolutionary relationships among species. The basic levels are kingdom, phylum (plural phyla), class, order, family, genus (plural genera) and species. Thus an African elephant and an Indian elephant are not the same species but they are similar enough to be classified in the same genus. The overall term **taxonomic diversity** includes diversity at all the levels from genetic diversity through to kingdom diversity, since they are all based on variation in genes.

Box 4. Ecological diversity

Ecological diversity, or **ecosystem diversity**, is a much less tangible concept than taxonomic biodiversity. Overall ecological diversity is the diversity of ecological processes within and among ecosystems. Ecosystem and taxonomic diversity are inextricably linked, each creating the other.

What is an ecological process? Ecological processes concern the interactions among organisms and interactions with their abiotic environment. The most fundamental ecological processes are about food and food webs. In these terms organisms can be divided into producers (mainly plants and single celled organisms that use photosynthesis), consumers (mainly herbivores), predators (mainly carnivores) and decomposers (mainly soil fungi and bacteria in terrestrial ecosystems) and the related ecological processes are production, consumption, predation and decomposition.

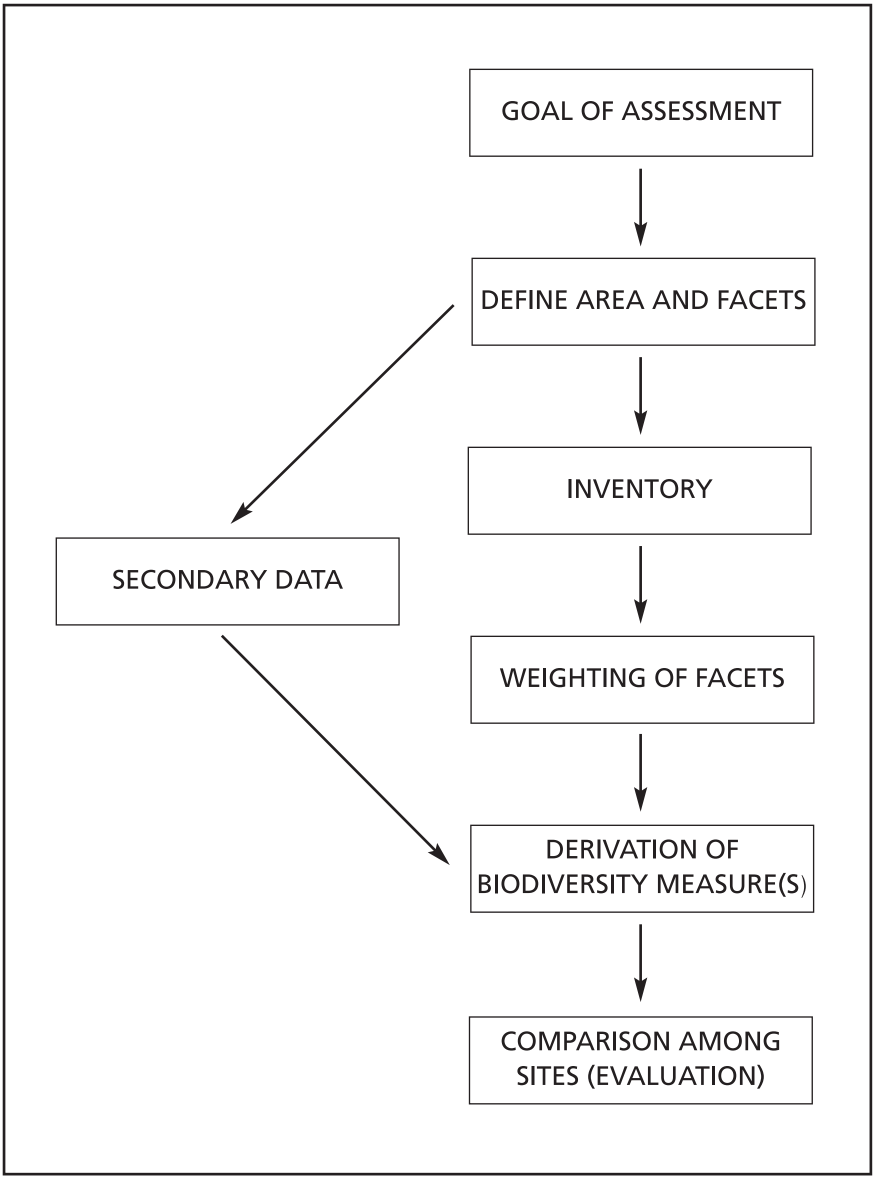
Many other ecological processes also contribute to ecosystem functioning and diversity. Important examples are competition (e.g. between two animals for one prey), mutualism (e.g. pollination of flowers by bees), dispersal (e.g. birds carrying seeds – another mutualism) and ecosystem engineering (e.g. termites building nests that provide new habitats for other organisms).

Ecological diversity is such a broad term that most authors avoid defining it (e.g. Harper and Hawksworth 1994; Gaston and Spicer 1998). This is not generally a problem, as there is overall consensus about the types of processes that are included. However, one distinction that is not always made, but is useful, is to separate within-ecosystem biodiversity (emergent ecological features of taxonomic diversity) from between-ecosystem biodiversity (the different kinds of ecosystem in a landscape).

Biodiversity assessments arise from many different motives, contexts and cultures. But the many approaches to biodiversity assessment have some basic common features, such as frameworks of time and space, and reliance on observation of only a small sub-set of the facets of biological variety and variability. All biodiversity assessments, even of the most casual variety, also entail a general series of steps (Figure 1):

- Motive for the assessment and hence its **goal**
- Choice of the **areas** to be measured (since biodiversity assessments are necessarily relative, there must be at least two areas, or one area at two points in time)
- Selection of the **facets** of biodiversity to be assessed (Box 5)
- An **inventory** of the facets in the area, or use of secondary data
- Derivation of a comparative **expression** of biodiversity for each area at each time
- Overall **evaluation** among areas and times, involving a method to compare among areas (this evaluation is the information that feeds into management planning)

Figure 1. Steps in assessment of biodiversity



Each of these steps requires a decision, essentially a prioritisation of what matters more and what matters less, a value judgment. Within particulars of time and space, biodiversity assessments face further choices must be made about which organisms or processes to measure, and what to measure about them. Of course, given the complexity of the natural world, it is usually only possible to gauge a small sub-set of total variation. This complexity also means that there is no single universal objective measure of biodiversity. On the contrary, all measurements and assessments of biodiversity are predicated on value judgments about which facets of biodiversity matter more and which matter less. The next section considers what we gain from biodiversity, and most particularly how different people desire different – sometimes competing – products and outcomes.

Box 5. Facets of biodiversity to assess

An assessment will need to select a feasible set of facets to measure among the diversity of:

- Genes, taxa (e.g. species or families) and ecosystems
- Structure, process and threat
- Natural and agricultural landscapes
- Plants, animals (vertebrates and invertebrates), fungi and micro-organisms
- Within-site and relevant above-site characters (metapopulation dynamics)

Understanding the diversity of these facets then requires assessment of one or more of the following:

- Number of the chosen facet within the area (e.g. number of species)
- Abundance within each facet (e.g. how many individuals of each of those species)
- Relatedness among facets (e.g. whether the species belong to the same or different families)

3

Values of biodiversity

3.1 What is biodiversity good for?

Nobody would dispute that we are critically dependent on some basic level of biodiversity: we could not eat if there were no plants and we could not reproduce if all humans were female. The kind of biodiversity that we are interested in assessing tends to have more subtle, though important, impacts on our lives. For example, we might want to know what range of predators and parasites would optimise pest control in a field. The value of biodiversity, like the measurement of biodiversity, is more useful as a relative than an absolute ("biodiversity is good") concept.

If biodiversity at large, or any facet of it, *is* good, then it is good because we benefit from it in some way. Biodiversity is not a good or service in itself but a provider of goods and services. The general consensus internationally is that these goods and services fall into three categories – direct use, indirect use and non-use values – though perspectives on what each of these includes vary from author to author (Table 1). If we treat biodiversity as something extra to biological resources (Box 6) – as variability and variety among living things – then our next question is what extra goods and services do we derive from additional biodiversity?

Box 6. Biodiversity values versus biological resource values

The actual valuation of biodiversity has often been based on the assumption that biological resources are "*the* physical manifestation"[3] of biodiversity. Thus, the value of biodiversity has often been taken as equal to that of the value of biological resources. However, if biodiversity is taken to represent the *diversity* of biological resources rather than the biological resources themselves, the value of one will not necessarily be the value of the other. Aylward (1991) argues that this way of valuing biodiversity has perverse effects: valuing biodiversity as biological resources has meant that the role of biodiversity *per se* is actually overlooked in land use decision making. For example, take two competing land use investment alternatives with the *same* biological resource values *and* the same direct costs. Plan A maintains a high level of diversity and Plan B a low level of diversity. If these two plans are compared on the basis of their biological resource value then there will be no discernible difference between the two plans. The value of diversity needs to be made explicit to make the optimal land use decision in these kinds of cases.

3. McNeely (1990) cited by Aylward (with emphasis added) : "Biological resources – genes, species and ecosystems that have actual or potential value to people – are the physical manifestation of the globe's biological diversity".

Biological resources *per se* have direct use, indirect use and option values, so what additional value do we derive from a more biologically diverse compared to a less diverse ecosystem?

At a scientific level, our answers to this question, and indeed our *ability* to answer the question, are only beginning to develop. Empirical evidence to link biodiversity with direct benefits of increased or more stable yields, indirect benefits such as watershed protection or carbon sequestration, or option values of present or yet-to-evolve organisms, is scanty. Much of the challenge is methodological, as experiments on biodiversity are costly and difficult to generalise to other (or more complex) scenarios. Though it is difficult to quantify the benefits of more biologically diverse compared to less diverse systems, we do have a broad qualitative idea of the kinds of goods and services that may be enhanced by increases in biodiversity:

- **Direct use values** of biodiversity accrue from the benefits of a wider range of raw materials (e.g. foodstuffs, medicines, building materials and fodder for livestock). Often the most valuable aspects of biodiversity as a direct use are associated with supply of resources during critical periods of time when staples are not available (e.g. dry seasons or droughts).

- **Indirect use values** of biodiversity are mostly associated with the environmental services that ecological biodiversity sometimes enhances. More diverse ecosystems may be better providers of stable and effective microclimate regulation, protection from erosion, or other services. A perhaps underestimated indirect use value of greater biodiversity is protection from predators, parasites and diseases (Box 7).

- **Non-use values** of biodiversity consist primarily of the option to use biological resources in the future (Table 1). More diverse communities of plants and animals offer a greater variety of potential future uses as well as a greater capacity to evolve new forms and processes. Also included as a non-use value is the concept of intrinsic value, which the school of "deep ecology" would argue overrides all other biodiversity values.

Box 7. The importance of biodiversity in protection against pathogens

Blench (1997), following Ehrlich and Ehrlich (1992), singles out one of the most important services of biodiversity, that of protection against pathogens. In fact evolutionary biologists argue that pathogens are one of the main causes of taxonomic diversity (and the evolution of sexual reproduction). Many plant diseases, such as the fungal rusts and blights that cause highest losses in yields globally, only infect hosts that have a very specific gene-for-gene match with the attacking fungus. As genetic modification of crops and associated intensive farming systems has led to large scale planting of genetically uniform crops, in turn pandemic diseases have caused catastrophic losses, such as the infamous Southern Corn Blight in the USA in the early 1970s. Blench categorises protection against pathogens as an indirect use value, though arguably it could be described as a direct use value, since the disease prevention function of genetic variety within a field of crops contributes directly to yields.

Teasing out the values of biodiversity is worthwhile because it gives us a framework for looking at the different meanings of biodiversity to different people and at different times. The various values of biodiversity can augment or compete with each other, and augment or compete with other direct, indirect or non-use values of biological resources. Of course there are also trade-offs between biodiversity values and the non-biological values associated with alternative land uses. Various stakeholders will rank these sets of competing values differently. Under the circumstances that we can assess only facets of biodiversity at any one time, stakeholders' assessments are strengthened as decision-making tools by clear links between what they measure and what they value about biodiversity. Sections 3.2 and 3.3 look at trade-offs in biodiversity values in more detail.

Table 1. Values of biodiversity according to different authors

Categories	Description	Koziell 2001	Bass et al. 2001a	Gaston and Spicer 1998	CI 2001	Takacs 1996	Blench 1997
DIRECT USE	These concern the ways in which biodiversity contributes directly to people's livelihoods, for example by improving nutrition, health and income. Direct use values are frequently divided between subsistence (or household use) values and productive (or tradable) values to distinguish goods that do not enter the market from those that do.	Subsistence Tradable	Consumptive Productive	Direct use (subsistence and tradable)	International export Regional market Local market Household use	Economic Social amenity	Economic
INDIRECT USE	These derive from the many services biodiversity provides that support human well-being. These are predominantly environmental services, such as regulation of climate, air quality, water quality and soil formation.	Environmental services Informational/ evolutionary	Environmental services	Indirect use (ecological)	Ecological Geopolitical	Ecological	Ecosystem services Protection against pathogens
NON-USE	These include three components: the option to use facets of biodiversity in the future, as uses become apparent (option value); bequest to future generations (bequest value); and the belief that different organisms and ecosystems should be allowed to exist regardless of utility to humans (intrinsic value). Several authors combine these with indirect use values.	Option Intrinsic	Aesthetics and pleasure Option	Option and bequest Intrinsic		Scientific Biophilic Transformative Intrinsic Spiritual Aesthetic	Aesthetic Ethical

N.B. Correspondences are not exact – different authors mean different things by the same term.

3.2 Is more biodiversity better?

Much of the debate around biodiversity is preoccupied with the linked concepts of conservation, human disturbance, biodiversity loss and natural environments. Public opinion, especially in developed countries, is swayed by the perceptions that "increased biodiversity = increased good" and "decreased human activity = increased diversity". Unfortunately these attractively simple propositions can be misleading, as the following points illustrate:

- **Increased biodiversity can decrease biological resource values.** To take the simplest of examples, adding a swarm of locusts to a millet monoculture may double species diversity, but decimate yield.

- **Not all facets of biodiversity, or ranges of biodiversity change, are equally valuable**. The species diversity of ants in a rainforest may have more significance to ecosystem processes than the far greater species diversity of beetles. Similarly, increasing a child's diet from one vegetable to six vegetables will no doubt have greater health benefits than an increase from 20 to 25 vegetables.

- **Different facets of biodiversity do not increase or decrease in tandem with each other**. Species numbers can increase after clear-cutting a forest, but the newcomers may consist of invader species that prevent regeneration of endemic (local) species.

- **Biodiversity is a product of both natural evolutionary and human selective processes.** There is now a growing awareness that, even those areas traditionally perceived by western scientists to contain "pristine" biodiversity, have actually been shaped and moulded by successive generations of people (Koziell 2001).

3.3 Global values and local values: whose count?

Biodiversity is a moving target: its manifold facets, ever dynamic, confer numerous and sometimes competing goods and services. All humans value direct use, indirect use and non-use values of these goods and services in some conscious or subliminal way, but the specifics of those values are also liable to change over time, and vary considerably among the people that hold them. Different people can be expected not only to have very different understandings of what biodiversity means, but also to prioritise the various facets of diversity differently, and to make different judgments on the trade-offs between biodiversity and non-biodiversity values. The values that people attach to biodiversity will affect the ways in which biodiversity is assessed, and in turn the land use and natural resource management decisions that are based on these assessments.

> *"Understanding" refers to perceiving a complex and changing environment, but different stakeholders perceive reality according to their own world views. Perception of environmental degradation may vary even between individuals within a given stakeholder group as a result of socio-economic, religious, gender or age group differences…Perception is also greatly influenced by the media used to capture and communicate it.*
>
> ILEIA (1996) in Abbot and Guijt (1998)

Management of biodiversity, then, is just as much a battleground as management of any other aspect of biological resources – fraught with competing perceptions, competing claims and competing priorities – and chosen assessment methods are part of the battle (and potentially part too of shared vision and alliances). However, the ways in which biodiversity assessments reflect different sets of values, and the links between these sets of values and management decisions, are arguably even less explicit than is the case for other dimensions of biological resource management.

One of the root causes of the lack of transparency in the biodiversity debate is our poor empirical understanding of how biodiversity delivers goods and services, as noted in Section 3.1. Under these circumstances, a sensible management policy is the "precautionary principle" (Myers 1993), that where there are threats, we should not wait for full scientific knowledge before taking steps to protect the environment. The precautionary principle tends to guide management of biodiversity to the extent that the terms "biodiversity" and "conservation" are almost synonymous, at least at global and national levels[4]. In the absence of understanding which facets of biodiversity maintain which direct and indirect use values, conservation of the broadest range possible of ecosystem and taxonomic diversity is the best way to maintain benefits to production, environmental services and options for the future. These benefits accrue ultimately to everyone on earth, and thus can be described as "global values".

For the vast majority of the world's population who are poor and rural, these global values matter, but may not matter as much as more immediate goods and services gained from biodiversity locally, or "local values" (Box 8). This

4. Similarly biodiversity commentaries tend to be preoccupied with the concepts of biodiversity loss, extinction and degradation.

Box 8. Some features of local biodiversity values, with illustrative examples

- **Biodiversity is especially important as a contribution to food security**. In the Altiplano Andes of southern Bolivia, each family cultivates 3-4 varieties of quinoa belonging to two main groups: (a) varieties of high productivity in good years and (b) varieties of high resistance to frosts, pests and other environmental pressures, that yield a minimum production even in a bad year (Gari 1999).

- **The frontier between wild and domesticated biodiversity is dynamic**. African crops and livestock remain closely enough related to their locally occurring wild relatives that gene exchange continues. Minor crops and "weeds" make critical contributions to food security, particularly in marginal environments, and farmers regularly experiment with cultivation of "new" species (Blench 1997).

- **Links between the diversity of resources (species and genetic diversity) and the diversity in supporting processes (ecological diversity) are well recognised.** The Damara people of Namibia base their timetables and techniques for harvesting a wide range of grass seeds on detailed knowledge of the habitats and habits of the various harvester ants that store the seeds in nests (Sullivan 1999).

- **Maintenance of biodiversity at the community level may be more important than diversity maintained by individuals or households.** In Idere, western Nigeria, individual farmers specialise in favourite crops – perhaps indigenous tobacco, a particular green vegetable, or tangerines – and make use of local exchange to maintain diversity in their own consumption (Guyer 1996).

difference in emphasis translates directly into different priorities for management of land and biological resources. For example, given the choice between 100 ha of a globally rare type of forest or 50 ha of that forest and 50 ha of diverse cropland, global values would prioritise the first option and local values the second, even if overall biodiversity (say plant species diversity) were identical.

Applying a broad brush, there are some noteworthy contrasts between global and local biodiversity values (Table 2). In particular, global values link conservation primarily with indirect (environmental service) and non-use (option and existence) values of biodiversity rather than with direct use values. Sustainable use of biodiversity tends to be seen as a pragmatic, but not ideal, means to achieve conservation via compromise with local direct use values of the biological resources and their diversity – impacts on global direct use values are seldom mentioned. Meanwhile, local biodiversity values, of all kinds, remain poorly documented and poorly represented in the global political arena.

Table 2. Differences between global and local biodiversity values

GLOBAL	LOCAL
Indirect use and non-use values are primary concerns	Direct use values as important or more important than indirect use and non-use
Emphasis on conservation, with or without sustainable use	Emphasis on sustainable use
Usually no specified user groups	Specified user groups
Endemics (species that occur locally only) and other rare species given high values	Endemics no more important than other species
Focus on genotypes (genetic information)	Focus on phenotypes (observable qualities)
Wild and agricultural diversity treated separately	No clear boundary between wild and agricultural biodiversity

Biodiversity assessment as advocated and practised by national and international bodies – including governments, the private sector and NGOs – is overwhelmingly predicated on global values, dominated by implicit conservation goals based on the precautionary principle. There are perhaps two main reasons for this. One is the strong influence of the international conservation lobby. The other is the absence of good information on local biodiversity values, and a more fundamental dearth of good methods to assess biodiversity in terms of these values.

Many institutions, such as national governments and bilateral donor agencies, are anxious to do biodiversity assessments that are more useful to decision-making, cost-effective, representative and communicable among different interest groups. One of the biggest challenges is integrating measures of biodiversity as it is important to different people. The gulf between global and local values is most apparent, but there are conceivably many other levels of contrasting values that may be difficult to weigh up against each other or to integrate (Box 9). Rather than holding simple sets of global and local values, real stakeholders fit into a suite of competing and complementary groupings. The diversity of a single forest, for instance, might interest local people, national, provincial and village-level governments, farmers' unions, traditional rights activists, pharmaceutical firms, logging companies, tourism businesses and environmental groups.

The overall aim of the following sections of this study is to give a critical review of methods of biodiversity assessment, with emphasis on opportunities for integrating local and global values. We are not advocating a pluralist approach for every biodiversity assessment, nor are we suggesting that local values are inherently more important than global values. What we are arguing is that practical decisions about land use and natural resource management would benefit from biodiversity assessments that, case by case, make explicit decisions about which values to incorporate, then use these decisions to shape the process of decision-making throughout the assessment cycle.

Box 9. Different perspectives on biodiversity

FOREST A is more diverse because…

Forester
It has a bigger variety of timber species

Healer
Even in drought years I can collect roots for medicines

Dana the fruit merchant
It has sour plum trees that fruit from November to March

National land-use planner
It is the only example of dwarf forest in the west of the country

FOREST B is more diverse because….

Conservationist
It has two orchid species which don't occur anywhere else in the world

Honey collector
It has plants that the bees visit for pollen, which flower in winter as well as summer

Dani the fruit merchant
It has ten different species of fruit I can get on one visit

Local land-use planner
It has a wide range of valuable resources, timber, fruit, graze & game

FOREST C is more diverse because...

Agriculturalist
There are plots of crops within it as well as trees

Herder
It has lots of noxious plants that poison my cattle

Dina the fruit merchant
We have planted bananas and mangoes among the indigenous trees

Regional land-use planner
It has a proper understorey that is very important in protecting the escarpment erosion

4

Scientific biodiversity assessment tools[5]

Published literature and internet sites provide a bewildering array of tried and suggested techniques for assessing biodiversity. This section examines a selection of the scientific methods in use, with emphasis on those that are well known or innovative. The purpose is to demonstrate some of the *tools* that are available to express biodiversity in ways that are, or might be, useful to decision-makers. It is impossible to cover all of the methods that have been developed – some important approaches such as those of Conservation International Rapid Assessment Program (CI RAP), the All Taxa Biodiversity Inventory and the Nature Conservancy Rapid Ecological Assessment (REA) have been left out.

Scientific biodiversity assessment methods often use original inventories rather than secondary data and are invariably quantitative. One of the important steps that a quantitative assessment allows is *weighting* of the individual facets measured in an inventory (Figure 1). This involves multiplying the individual abundance measures of each facet by a number that represents their relative importance according to pre-set criteria. For example, a common type of weighting in species diversity assessments is a global rarity weighting, by which each species at a site is weighted according to how abundant it is globally. Weighting makes explicit the values assigned to different facets of biodiversity.

4.1 IUCN's red data books

The red data books categorise species according to their risk of extinction. Since these categories apply to single species rather than groups of species, they do not constitute biodiversity assessments, but the method of classification is described here because it contributes to, or even underpins, many of the evaluations of biodiversity carried out today. For example, red data books are seen as an important information source for the framework of indicators being developed by the secretariat of the Convention on Biological Diversity.

A species can fall into any of nine categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern,

5. This section derives mainly from a case study of scientific assessment methods by James Gordon of the Oxford Forestry Institute (Gordon 2001).

data deficient, or not evaluated (IUCN 2001). A set of clear quantitative criteria determine placement into any of the nine categories. Three of the categories – critically endangered, endangered and vulnerable – rely on detailed observations or predictions of population decline. Analysis is done by experts using current knowledge and is reviewed by a panel established by IUCN. The system has been under constant revision and refinement since its inception, for example improving its usefulness for vascular plants (Keith 1998). The IUCN classification is theoretically applicable to any species whether plant, animal, fungus or unicellular organism, and in practice is a dynamic analysis requiring periodic revision to reflect changing circumstances.

Although the classification was originally intended for application at a global scale, national and regional red data books have also been compiled. This has lead to some discussion of the relationship between global and regional classifications (Hilton-Taylor et al. 2000, Rodríguez et al. 2000). Is it logical, for example, that a species could be classified as less threatened at a national level than it is at a global level? Despite such problems the system has considerable influence judging by how often the classifications are used in debate about conservation priorities.

4.2 Checklists

Checklists do not in themselves constitute biodiversity assessments, but they are perhaps the most commonly used tools in measuring biodiversity. A checklist is simply a list of the names of species known to be found at a stated location. It is invariably limited to a subset of organisms (e.g. vascular flora, Lott 1993) and is made more useful by annotations. When these annotations include information on local names and uses it has the potential to become a cheap and useful tool for integrating external and local biodiversity values. The link between local and scientific names is especially important – primarily an issue of communication, but one that is likely to impact on methodology.

Checklisting usually involves no sampling design beyond delimiting the area of interest and is rarely accompanied by any immediate statistical analysis. Nonetheless, checklists can also provide the basis for comparative analysis. Based on information from previously published checklists, Gentry (1995) was able to draw useful conclusions about conservation priorities by comparing species richness and endemism of different tropical dry forest sites in the neotropics. Similarly McLaughlin (1992) used a database of 101 checklists from the United States to identify areas of high diversity and endemism. He was able to apply simple diversity indices (Jaccard's index and Simpson's index) to the data and used ordination techniques, based solely on presence-absence data, to delineate botanical areas.

This lack of technical sophistication makes checklisting an appropriate tool for assessments that rely on non-technical staff and amateurs. For example, Droege et al. (1998) described an assessment of birds in Canada using checklists built up by amateur ornithologists. Even though checklists are relatively cheap, however, the time and skill needed to identify considerable numbers of botanical specimens from tropical forests should not be underestimated. Further, if a systematic attempt is made to link scientific names to local names and other annotations relating to local plant use, the required resources and expertise may be enormous in ethnically diverse regions.

4.3 Smithsonian Institute/Man and the Biosphere Program

The Smithsonian Institute and UNESCO's Man and the Biosphere Biological Diversity Program (SI/MAB) has, since 1987, been developing a plot-based methodology for the assessment and long-term monitoring of forest biodiversity in UNESCO's biosphere reserves. Standard protocols have now been applied at about 200 research sites throughout the world, mainly in tropical forest. These protocols are comprehensive including everything from plot establishment to data management and training activities (Dallmeier 1996, 1998). This "cradle-to-grave" approach gives the approach efficiency and analytical potential, but is very expensive. To establish and collect baseline data for a single 1 ha plot, Dallmeier (1992) estimated labour costs of 832 person-days.

The overall goal of the programme is the provision of "timely information for other researchers and decision-makers concerned with the fate of temperate and tropical forest ecosystems" (Dallmeier 1996). The specific questions addressed (detailed in Dallmeier 1998) concern furthering understanding of global and regional patterns of diversity and endemism, and the identification of new conservation units for the protection of remaining habitats. Questions relating to the use value of biodiversity appear not to be addressed directly, or only rarely so. This is despite a stated aim of the biosphere reserve programme being "the conservation of biological diversity and the sustainable use of its components" (UNESCO undated).

Despite the stated intention to influence policy-makers, the considerable literature available (Dallmeier and Comiskey 1998 and references therein) suggests that so far the primary audience has been the applied research community. Nonetheless the SI/MAB Program will likely benefit biodiversity assessments elsewhere by providing long-term, comprehensive, reliable data sets, especially useful in the identification and validation of biodiversity indicators.

4.4 Hotspots

The use of the term "hotspot" in relation to the conservation of biodiversity has become particularly associated with Russell Mittermeier and Norman Myers (Myers 1989) who apply the term to large geographical areas (e.g. "Mesoamerica", "Cape Floristic Province") where concentrations of important diversity are found. Their classification uses degree of endemism and degree of threat, rather than species richness, to determine a hotspot. Hence lowland Amazonia is excluded despite high diversity because the degree of threat is low. The analysis is based on published sources and expert opinion rather than primary data, which is not practical to collect over such a large geographical scale. Plants were initially the principal "indicators" of hotspots, though vertebrates have been incorporated more fully in recent work (Myers et al. 2000).

Mittermeier et al. (1998) identified 24 global hotspots; this was increased to 25 by Myers et al. (2000) who added the criterion that each hotspot should contain plant species comprising at least 0.5% of all plant species worldwide. Given their scale, hotspots are best interpreted as an initial stage in a hierarchical assessment that directs further finer scale assessment. However, it is possible that at finer scales there exist priority areas, such as mountain tops or islands, outside of the global hotspots. A strictly hierarchical assessment system would result in these areas being overlooked.

A much discussed problem with the hotspot concept, at whatever geographical scale, centres on the degree of congruence between different species groups in their patterns of richness and endemism: are hotspots that are defined largely on plant data likely to occupy the same locations as those of other groups of organisms? Myers et al. (2000) reported that for tropical hotspots, congruence between the plants and vertebrates under consideration was good, but less so in Mediterranean climates. However at smaller scales several studies have found that congruence among different taxa is poor (e.g. Robbins and Opler 1997; Reid 1998; van Jaarsveld et al. 1998). Regardless, the concept has had considerable influence on conservation planning, beyond a purely scientific audience. For example, the MacArthur Foundation uses the system to direct grant-making (Reid 1998). Perhaps its popularity hinges on the idea that most of the world's diversity could be conserved by the successful conservation of a relatively small percentage of the Earth's surface.

4.5 Endemic Bird Areas

Perhaps the most comprehensive global conservation assessment attempted yet is the International Council for Bird Preservation's identification of Endemic Bird Areas (EBAs) described by ICBP (1992). Endemic species are prioritised for conservation because of the limited size of their habitats and their usually small populations, which renders them particularly susceptible to extinction. An endemic or "restricted range" species was defined in this case as having a breeding range of less than 50 000 km^2. By this definition 27% of known bird species are of restricted range. An area qualified as an EBA if it contained at least two such species. In this way 221 EBAs were identified across the world, with most in tropical latitudes and many on oceanic islands.

To distinguish among the 221 EBAs, methods were devised to compare them by "biological importance" and by "threat". Biological importance was first determined by the number of restricted-range species of birds in an EBA on a per unit area basis, giving a score of 1 - 3. Another refinement was weighting of the species by taxonomic distinctness, calculated by multiplying the reciprocal of the number of species in its genus by the reciprocal of the number of genera in its family. Thus a member of a genus with 72 species from a family of 13 genera would have a weighting of 1/13 x 1/72 = 0.001. Application of this method gave 17 EBAs outstandingly high scores for taxonomic distinctness: these had their biological importance score raised by one if not already in the highest group.

The threat status of each EBA was evaluated both by consideration of each species using the threat categories of Collar and Andrew (1988) – a precursor of the IUCN system – and by the percentage area of the EBA which fell within a pre-existing protected area. Each EBA was given a score of 1 - 3, in ascending order of threat. With three categories of threat and three categories of biological importance a contingency table can be constructed (Table 3) with each EBA falling into one of the nine categories produced. From this is derived a three point scale encompassing both importance and threat that denotes priorities among EBAs. This simple but effective methodology for combining two distinct biodiversity criteria has not been applied to other organisms – its feasibility and reliability in this example is due to the wealth of pre-existing data on bird distribution.

Table 3. Combined categories of threat and biological importance for 221 Endemic Bird Areas

Threat score	Biological importance score			
	***	**	*	Total
***	12	21	28	61
**	46	28	25	99
*	31	19	11	61
	89	68	64	221

Combined score for importance and threat

***	79 EBAs of high priority
**	87 EBAs of medium priority
*	55 EBAs of lower priority

4.6 Bioquality: Star System and Genetic Heat Index

The star rating system is a methodology for comparing the conservation merit of plant species (Hawthorne 1996), based primarily on global distributions (endemism), but with the potential for other factors to be incorporated. Distributions are gleaned from herbarium specimens and botanical monographs and ranked in order of increasingly wide distribution, and therefore decreasing conservation importance, as black, gold, blue or green stars. Green star species have such wide distributions that they are considered of no conservation concern. Secondary criteria used to make adjustments to species' star type include moving a species up a star if it is a close relation of an economically important species or if it is a species unique to its genus.

The Star System is analogous to the IUCN red data book system, providing ratings for individual species. These ratings can then be used to generate biodiversity measures for individual sites so that sites can be prioritised for various land uses. First relative weights for black, gold, blue and green star species are calculated, by finding the average number of degree squares (of latitude and longitude) occupied by species of that star rating, using only species for which recent monographs are available. Weights are then calculated in inverse proportion to these distributions based on green stars having a weight of 1. Finally the green star score is arbitrarily reduced to zero to reflect the lack of conservation importance given to these species. In this way Hawthorne and Abu-Juam (1995) arrived at scores of 27, 9, 3, 0 for black, gold, blue and green star species respectively.

Different sites or samples can then be assigned a "Genetic Heat Index" (GHI), a measure of biodiversity based on the abundance of species in different star groupings (Box 10). Hawthorne coined the word "bioquality" to describe the Genetic Heat Index of sites: the site with the highest GHI does not necessarily have the highest diversity of tree species, but it does have the highest abundance of rare species and therefore the highest quality in conservation terms. The term bioquality makes explicit the human values (in this case global non-use values) that shape assessment of biodiversity.

Box 10. Calculation of genetic heat index

$$GHI = \frac{[(BkS \times BkW) + (GS \times GW) + (BuS \times BuW)]}{N} \times 100$$

where:

BkS	= Number of black star species
BkW	= Weight applicable to black star species
GS	= Number of gold star species
GW	= Weight applicable to gold star species
BuS	= Number of blue star species
BuW	= Weight applicable to blue star species
N	= Total number of species in a sample.

Two points about the formula in Box 10 are worth emphasising. Firstly, the zero weighting for green star species ensures that they make no contribution to the numerator, thus reflecting the lack of conservation concern attached to such species. Secondly, because the denominator, N, is all species in the sample, the GHI is effectively an average per species, that therefore allows comparison of samples with different numbers of species. Ideally N should be reasonably large (> 25) to ensure GHIs are not overly sensitive to the inclusion or loss of single black or gold star species.

Hawthorne (1996) proposed a second classification system of "reddish" stars, running perpendicular to the black star to green star scale, developed to identify local tree resource priorities. Species given reddish stars are not globally rare but are of local economic importance and under threat of over exploitation. The classification was developed to identify areas in Ghana where logging had severely diminished populations of commercial species. It is equally applicable to non-timber species.

A fundamental difference between the reddish star scale and the black to green star scale is the data requirements of each. A reddish star is assigned according to percentage reduction of a population and therefore requires abundance data for a given area. This contrasts with the requirement for global presence/absence data for the black to green scale. Reddish stars are common green star species that are subject to significant exploitation and are defined as follows:

- Scarlet: Common but under serious threat from heavy exploitation. Exploitation needs to be curtailed if usage is to be sustained. Protection on all scales vital.
- Red: Common but under pressure from exploitation. Need careful control and some tree by tree area protection
- Pink: Common and moderately exploited. Also non-abundant species of high potential value.

Reddish stars are assigned weights proportional to the degree to which they are exploited. In the Ghanaian example cited, the weighting was 3:2:1 for scarlet:red:pink, because populations of scarlet star species were reduced by a factor of 3 times more than those of pink stars. This reddish star rating could be seen as another type of bioquality, one where the quality is in terms of a use rather than a non-use value.

4.7 GIS and gap analysis

Geographic information systems (GIS) are not a biodiversity assessment methodology, but an important tool that can be used to combine different strata of information and hence potentially different biodiversity values. GIS has received increasing attention as a useful tool in conservation assessment, particularly as computer technology has advanced and remotely sensed data has become readily available. The advantage offered by GIS that it allows the "layering" and simultaneous visual display of various geographic data sets. GIS offers the opportunity to approach biodiversity assessment in a hierarchical manner reflecting the classification of ecosystem-species-gene. Indeed proponents of GIS contend that the inherent flaws in species assessments make top down assessments, starting with ecosystem or landscape assessments, the only realistic way forward. It also offers the possibility of combining biological and socio-economic data.

One of the most comprehensive applications of GIS technologies in conservation is the Gap Analysis Program (GAP) developed jointly by the US Fish and Wildlife Service, the US National Park Service and other organisations (Scott et al. 1993) for the assessment of habitat protection in the USA. Vegetation types were mapped from LANDSAT satellite imagery whilst predicted species distributions from existing range maps and other distributional data. These are then overlaid with different land management and ownership categories to identify gaps in the biodiversity protected areas network. Similar applications of GIS have been made elsewhere, for example in the Western Ghats of India (Ramesh et al. 1997). Other GIS based technology has been designed specifically with biodiversity conservation in mind. A good example is WORLDMAP, which is capable of assessments from global to relatively local scales (Natural History Museum 2002). It accommodates large amounts of species distribution data making it suitable for the analysis of endemism and rarity.

However GIS imagery should be interpreted with caution. The emerging analysis can only be as good as the information that goes in. The danger is that the attractive images and use of technology associated with GIS may give a spurious appearance of accuracy and reliability. The main use of GIS is that it provides the best way of integrating the results of biodiversity assessment – it is not an assessment method in itself, but an aid to assessment methods.

Prendergast et al. (1999) showed that GIS-based approaches to reserve selection have not been readily incorporated into management planning. From discussion with conservation practitioners in Europe and the USA, they concluded that lack of awareness of the potential of such tools was the main reason, followed by "low levels of funding, lack of understanding of the purpose of these tools, and general antipathy towards what is seen as a prescriptive approach to conservation".

4.8 Indicator-based assessment

The recognition that complete assessments of biodiversity are rarely if ever practicable has led to interest in indicators as tools that summarise and simplify data on the complex series of environmental and social variables related to forest ecosystems (Box 11). The prevailing argument is that the use of simply understood measures, which are (hopefully) indicative of other facets of biodiversity, bridges the gap between scientists and decision-makers. In fact the indicator approach is not new to biodiversity assessment. For instance Peterken (1974) used indicator species as a tool for identifying ancient woodland. More recently interest has grown and a wide range of sets of indicators have been proposed and debated, though they are applied less frequently.

Box 10. What makes a good indicator?

Indicators are measurable surrogates of broader phenomena. In general, indicators of biodiversity should be:

- Relevant to objectives of assessment
- Sensitive to change
- Concise
- Unambiguous
- Repeatable
- Financially and technically feasible

International organisations are leading in more widespread testing and application of indicator sets, for example the Centre for International Forestry Research (Stork et al. 1997; Boyle et al. 1998) and working groups of the Convention on Biological Diversity (CBD; see Section 7.1). One of the biggest challenges to these initiatives is how to capture the complexity of biodiversity in a cost-effective and easily understood set of indicators. WWF and IUCN are developing landscape-level criteria (standards for judging quality) and indicators (measures of those standards) to identify shortcomings in current forest planning, and to measure progress towards improving forest management for the supply of human and ecological needs (WWF/IUCN 1999). Indicators of forest quality are grouped under three headings: authenticity, environmental benefits, and economic and social benefits. The protection of biodiversity is considered an indicator of environmental benefit and hence demands an appropriate assessment technique itself. Application of these indicators, which is being tested in various parts of the world, may be through “Rapid Forest Quality Assessment”, an expert-driven process, where time and resources are limiting, or by “Participatory Forest Quality Assessment”, which requires stakeholders’ participation in both the selection and assessment of indicators appropriate to each site and context.

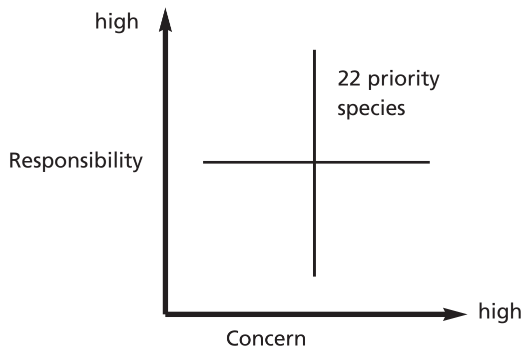
For indicators to work as a comparative evaluation tool as well as a tool for monitoring change at one site, they must be equally applicable at different locations. However the current level of interest in indicators is not yet matched by successful validation (Lindenmayer 1999). As part of the CBD secretariat's wider development of indicators, WCMC undertook to investigate the applicability of indicators of ecosystem quantity and quality for biodiversity assessment in OECD countries (WCMC undated). They chose two relatively simple indicators: amount of natural ecosystem as a measure of biodiversity quantity, and population time-series data as a measure of biodiversity quality. In both cases digitised data was available for manipulation by GIS. While they concluded that the methodology was robust because they were able to chart changes in the chosen indicators, they also acknowledged that "the extent to which trends in species characteristic of a given habitat class can be taken as indicative of prevailing trends in that habitat, and whether this might be a property of all habitat types and communities of species, have been little explored".

4.9 Prioritisation of Canada's avifauna

Dunn et al. (1999) proposed a novel method to prioritise bird species for conservation in Canada. Each species occurring in Canada was ranked in two ways, by "concern" and by "responsibility". Concern is a composite based on population decline and vulnerability (abundance, sizes of breeding and wintering ranges), which reflects both future and current risk of extinction. The assessment was made relatively easy by the ample information available on Canada's birds, including national surveys and abundance rankings – detailed secondary sources like these do not exist for most groups of organisms in most parts of the world. The second ranking, responsibility, is the degree to which a species is concentrated within a politically defined area (in this case Canada) and therefore the responsibility of the corresponding political entity (the Canadian government).

The system does not try to combine concern and responsibility into a single index: since they are biological and socio-economic scales which do not run along parallel axes, a combined index would be difficult to interpret. Instead priority species are identified by the overlap of concern and responsibility. Of the 297 species assessed in this case, 22 were considered both of high concern and high responsibility at a national level (Figure 2). Digitised maps of summer and winter ranges revealed the additional information that the priority species were mainly summer migrants that winter further south. Although it is not yet clear how much effect this work has had on conservation policy in Canada, it stands out as an attempt to consider both biological and political criteria together.

Figure 2. Combined plot of responsibility and concern for 297 bird species in Canada



Tools to assess biodiversity in terms of local values

National and international policy (notably the CBD) is creating demand for assessment of local biodiversity values. What is needed is not so much a means for people to assess local biodiversity for themselves, but a means to *communicate* their values and assessment of local biodiversity to other stakeholders. A number of methods, mostly external in origin, are now emerging as potential tools to evaluate biodiversity as it is perceived locally in ways that are meaningful to outsiders. Here we describe some of the most promising approaches.

5.1 Ethnobotany

Ethnobotany is the study of how cultural groups classify and use plants. Ethnobotanical surveys typically produce annotated checklists of local plant species, detailing their local uses and names in various languages. The usual aim is to be as comprehensive and as accurate as possible, which means that ethnobotanical checklists can be invaluable sources of information about local use of plants of different types. Information linking biodiversity to local livelihoods can also be included, such as indications of which plants are used in carpentry, herbal medicine, domestic cooking (firewood and food) and so on (e.g. Dounias et al. 2000; Pandey and Kumar 2000).

A major advantage of ethnobotanical checklists is that they present information largely in the terms of local people, for instance without drawing false distinctions between “wild” and “cultivated” species. Ethnobotanical studies have also revealed some fascinating general principles, for example that all over the world ethnobiological systems of classification are based primarily on the affinities that humans observe among the taxa themselves, quite independent of the actual cultural significance and uses of those taxa (Berlin 1992).

In general, ethnobotanical studies are not conducted with the primary aim of informing local or national policy. The usefulness of simple checklists as assessments of local biodiversity utilisation and values may be limited by the absence of prioritisation among species. Furthermore, they do not usually include estimates of abundance and they tend to deal only with species diversity without reference to genetic or ecological diversity. Despite these kinds of technical limitations, ethnobotanical checklists can provide a good starting point for more detailed quantitative or qualitative assessments of biodiversity in terms of local values. Of course, ethnobotanical data can feed into quantitative statistical analyses or other discriminatory techniques (Hoft et al. 1999). However, there remains an ethical challenge in that publication of local knowledge about plants and their uses without full permission can constitute an infringement of intellectual property rights.

5.2 Ecological anthropology

Case studies by ecological anthropologists can provide much deeper understanding of local biodiversity values than any of the other methods described here. Ecological anthropologists investigate the links between human beings and their environments, or how culture and nature are interdependent in the broadest sense. Their holistic approach draws on sociology, economics and biology, though with an emphasis on qualitative rather than quantitative perspectives. Not surprisingly, work in this field draws attention to both cultural and biological diversity.

Over time, ecological anthropology has moved from a paradigm of materialism, in which human culture is interpreted as a product of adaptations to our natural environment, towards a less deterministic and more historical approach. Furthermore, many ecological anthropologists now present their work in an explicitly political context, as constructive critiques of prevailing environmental policy. For example, a careful study in Africa has refuted the popular concept of "virgin" rainforest and shown instead that human beings have practised shifting cultivation over wide areas of forest for thousands of years (Fairhead and Leach 1996). This kind of evidence has indisputable implications for the level of human activity allowable in protected areas.

Through their particular interest in the cultures of societies who live close to nature, ecological anthropologists regularly act as a voice for poor rural people to the outside world. This role is strengthened by the strenuous efforts that anthropologists make to articulate peoples' own perceptions of their environments. For instance, a recent study in Namibia reveals not only the extensive use and trade among women of a wide variety of perfumed plants, an "invisible" resource to official natural resource managers, but also conveys the importance that women attach to these plants and their preparation, as manifestations of their identity and autonomy (Sullivan 2000).

To sum up, ecological anthropology tends to be skills-intensive, labour-intensive and academic, but very useful in providing critical insights into local systems of interaction with biodiversity that can inform more standardised assessment methodologies and provide a wider perspective of value than can be expressed in formal economic terms (see below).

5.3 Participatory rural appraisal

PRA methodologies are now well known and used throughout the world. They comprise selections of tools to elicit group knowledge and perceptions – tools such as maps, time-lines, transect walks and ranking exercises – used to guide and stimulate discussion. Ideally, the methods are introduced by outsiders but become co-opted and adapted by local people into ongoing planning processes. The methods can also be useful to provide other decision-makers, including regional and national policy-makers, with a practical understanding of how the day-to-day managers of biodiversity use and value their natural environments. PRA has the capacity to draw attention to facts obvious to local people but obscure to outsiders. For instance, PRA can demonstrate how availability of useful species is not simply a function of their abundance per area (as measured in scientific biodiversity assessments) but also of the many factors that limit access to resources, such as tenure rights, seasonality or proximity to roads or paths.

During the 1990s, a great deal of research effort was put into applying the principles of PRA to economic valuation techniques (see Section 5.4 below) in order to evaluate the total value of goods and services provided by biological resources to local people. The rationale was that formal methods tend to ignore the wide suite of goods and services that are not marketed in the monetary economy (dubbed the “hidden harvest” by Guijt et al. 1995) and the multiple values co-existing within a single community. The new participatory valuations not only incorporated a wider range of biodiversity and functions of biodiversity, as valued locally, but also drew attention to some of the shortcomings of conventional economic assumptions, for example that households seek to maximise economic welfare, rather than, say, social obligation (Guijt and Hinchcliffe 1998). Put to best use, PRA techniques are a means of empowerment, for example by giving communities tools to track the sustainability of local development (Lee-Smith 1996).

Of course, PRA also has several limitations. Direct comparison between questionnaire-based and participatory valuations suggests that many of the claims made for PRA, such as its superior capacity to capture real behaviour and attitudes, are overstated (Davies et al. 1999). Another important problem is that while PRA expresses data in an easily accessible, often visual, format, national-level policy-makers can find micro-macro linkages difficult to make from what appears as very locally specific information. To date participatory valuation has focussed on individual resources, treating biodiversity as the sum of these rather than as the added value of variety and variability. A further need might be to elicit to what extent this bias reflects local perceptions of biodiversity and, if appropriate, to develop PRA methods for discussing the value of diversity itself.

5.4 Economic valuation methods

In recent years economic valuation techniques have become sophisticated tools for comparing and evaluating goods and services from biological resources, with particular emphasis on valuation of non-marketed benefits. There are five broad types of approach (IIED 2001):

- **market price** valuation, including estimating the benefits of subsistence production and consumption;
- **surrogate market** approaches, including travel cost models, hedonic pricing and the substitute goods approach;
- **production function** approaches, which focus on biophysical relationships between forest functions and market activities;
- **stated preference** approaches, mainly the contingent valuation method and variants;
- **cost-based** approaches, including replacement cost and defensive expenditure.

These techniques are useful for assessing biodiversity in terms of individual biological resource values. Each technique has a suite of advantages and disadvantages, beyond the scope of the present discussion, but all in all they provide a flexible approach to assessment of local values attached to various taxa (e.g. Grieg-Gran et al. 2002) or to various goods and services provided by one taxon (e.g. Lynam et al. 1994). There are several strengths of these types of economic valuations as assessments of local biodiversity values. They give relative estimates of value that permit comparisons of resources within sites and among sites. By assigning monetary values to non-marketed values they allow direct comparisons among different goods and services. The use of monetary terms also facilitates communication to a wide audience, including local people, though to many people to express a cultural value – say the value of a group of trees as a social meeting place – in monetary terms is meaningless. Another weakness of these techniques for assessing biodiversity is low cost-effectiveness in terms of time and required expertise. Also these tools have not been well applied to biodiversity in its strict sense, meaning variety and variability.

Biodiversity with this strict meaning is usually classed by economists as being exclusively an option value (Aylward 1991; IIED 2001). Future options are based on utilisation in the pharmaceutical and agro-chemical industries. In an unusual example of economic assessment of the added value of diversity on top of the underlying biological resource value, the biodiversity value of Indonesian forests has been calculated in terms of their pharmaceutical bioprospecting potential based on estimates of the number of plant species in the country, probability of any single species providing a commercial drug and average royalties earned from new drugs (Aylward 1995).

5.5 Multidisciplinary landscape assessments

A major initiative to improve methods of assessing biodiversity in terms of local values, and of expressing express this information in ways useful to governmental decision-makers, is presently underway at the Centre for International Forestry Research (CIFOR). The central premise is the same as the central premise of this study: that biodiversity assessments are predicated on particular value systems. Thus practical methods of assessment require more explicit attention to what is important to whom and how to weigh up alternative land use options in terms of these values.

> *"Many biodiversity scientists claim that policy-makers ignore their research. There may be a number of reasons, but perhaps the most important is that the policy-makers do not see why it matters. The research described here is based around the development of a new paradigm that explicitly recognises the value-laden aspects of real world decision making. We cannot just record species, formations and sites and expect that to be useful, we need to indicate the relevance of this information and how it might be weighed against other considerations."*
>
> **Sheil (2000)**

As a start to developing appropriate methods of local valuation, a multidisciplinary case study is underway at Paya Seturan village in Bulungan, Indonesia (Sheil 2000). The researchers aim to derive what they term "decisive information" about biodiversity, meaning information that is feasible to obtain and that reduces the level of uncertainty in decision-making. The study has combined a short technical biophysical assessment (e.g. soil samples) to give a basic characterisation of the environment with a holistic set of qualitative and quantitative assessments of how the natural landscape is used and valued by local people. Innovative methods are emerging from the research. For example a classic PRA group ranking exercise – in this case ranking a number of forest species (both plants and animals) under various use categories – was combined with a statistical analysis for salience (Smith's S). This technique can give a range of useful outputs, such as overall values of the forest for different uses and the relative values of different landscape types. The results from Paya Seturan revealed that forest products were used for subsistence while most cash income came from non-forest products, but that people did not value the forest below other landscape types.

The study has also identified some key unsolved methodological challenges, such as:

- A way to measure the *accessibility* of products
- A way to measure the *scarcity* of products
- A way to measure the *frequency of use* of products
- A way to measure the *quantity* of a product (i.e. how much product can be harvested from an individual plant)
- How to *weight* species, products and landscapes according to their importance

This pilot study illustrates that there is great possibility for novel approaches to assessing biodiversity in usefully value-specific terms. At the same time the rationale for the CIFOR study is a reminder that we have a long way to go before we arrive at an adequate array of methods for cost-effective, reliable and policy-conversant assessments of local biodiversity values.

Local-level biodiversity assessment[6]

Not much literature is available on how people assess local biodiversity for themselves. This would not normally be remarkable – why should local assessments of local conditions be of interest elsewhere? – but in the modern world, as territory becomes more hotly contested (e.g. locations of protected areas or commercial activities like mining), local residents need increasingly to defend their own values against outside threats. Many rural people, especially those living outside the cash or market economy, are very much reliant on diverse biological resources to fulfil their nutritional, productive, health, clothing, housing, social and spiritual needs. Local biodiversity assessments occur as part of normal livelihood routines, as rural people gather practical information on the current and future availability and health of the different resources they require. The CBD and other processes are also realigning towards greater acknowledgement of local understandings of and priorities for biodiversity.

Section 5 reviewed some of the most promising methods for outsiders to assess biodiversity in terms of local values. This section considers how local practitioners have assessed biodiversity in real situations, either on their own – as in the case study of the Irula people of India – or in collaboration with outsiders. Local biodiversity assessments may not be recognised as such. Given that the word "biodiversity" is a relative newcomer to the English language (it did not get listed in the Concise Oxford Dictionary until 1995), describing and discussing biodiversity assessment activities at local level – especially in other cultures and other languages – can seem paradoxical. However, whilst direct translations of biodiversity do not yet exist in all languages, this does not mean that the notion of biodiversity has not been pertinent and prominent for many other cultures and societies for many years (e.g. Box 12).

6. This section is based in large part on a case study of biodiversity assessment in India by Bansuri Taneja, Ashish Kothari and Manju Raju.

Box 12. A view of biodiversity among the Yoruba people of Nigeria

The "principle of *asuwada*" [is] the purposive clumping of diverse "*iwa*" (*iwa* referring to existence, being, character). *Iwa* refers to diverse different creatures and also to the diversity of people; *iwa* are maintained, however, by *asuwada*, "purposive clumping" into communities that is a fundamental condition of their existence.

Source: quoted from Guyer (1996), from original work by Akiwowo (1986)

6.1 Assessments by the Irula people[7]

The Irula hunter-gatherers, a semi-nomadic tribe living in the plains of Northern and Eastern parts of Tamil Nadu, South India, have traditionally depended on forests for their entire livelihood needs. Living in small groups on the outskirts of other villages and renowned for their snake catching skills and their ability to treat snakebites, they are often landless and lie low in the socio-economic hierarchy. The following statements demonstrate how they continually assess (mainly wild) biodiversity, and the indicators they use in the search for the biodiversity they use.

> *"We decide on where to settle down (near which village or forest) after assessing the area from our livelihood point of view."*
> *"When I enter the forest I will, at a first glance, look for medicinal plants because collecting them for treatment and sale is my means of sustenance. I then look for snakes … and then other animals (rats, rabbits, mongoose, etc.) that I can catch for food. There is no useless plant in these forests. Those not used for anything else can always be used for fuel."*
> *"When in a forest, I will first look for rabbit, mongoose, wild cat, which I hunt for food and money. We look for tracks/pug-marks of these animals. By the frequency of their spotting we know the extent of their availability; by the kind of vegetation in the forest patch we know what we can get there. For example, we can find rabbits near a patch of arugampullu (a kind of grass). We also keep in mind the medicinal plants that we have seen, so that we can collect them when needed."*

As nomads, the Irulas must make continual "biodiversity" assessments of new territory, as follows:

7. This case study is based on interviews held during a brief visit to the Irula Tribal Women's Welfare Society (ITWWS), aimed to investigate how they assessed biodiversity themselves.

"We would always use the picture we have in our minds of the forest we usually frequent in order to assess the new forest. For example, in the humid forests of Kutralam (we visited) we found more greenery and vegetative growth. But the plants in our area have a stronger medicinal content."
"After getting married, I moved to my husband's village. During my trips to the forest I would keep observing, which plants are available and which are not, by comparing with the forests I frequented from my parental home."

They also study species interactions in order to identify other species with use values or to assess the condition of the ecological services necessary to support them. For the Irulas:

"We get to know which plant grows where by keenly observing animals that use them. For example, the mongoose knows where to find medicinal plants that are used to treat snake bites."
"Those of us who catch snakes can identify species from tracks, droppings and shed skins and trace them to their burrows. We also look out for typical sounds made by other animals as clues to locate snakes."

For others it is about improving understanding about future options, as identified below by Shivram Duga, a resident of the village of Mendha Lekha, Maharashtra State in India. This sort of assessment for future use purposes is perhaps closest in its underlying motives to some of the assessments undertaken by conservationists today, focussed on the option and bequest values of biodiversity.

"Very often forest officials think villagers are thieves of forest resources because they like to roam around in the forest. If a villager has to pass through the forest, as a habit, he will never just follow the road and come back without having seen much else. Being in the forest is a question of survival, our eyes are always open, we are taking in everything: new things that have come up; what has been cut; what has been planted. This is because next time when we need something from the forest we won't go looking for it then, we would already know where we can get the best deal and all we would have to do is go and get it."

It is important to note that the methods used by local people to gain information about biodiversity and the surrounding environment have evolved through extended processes of observation, testing and use, much in the way that modern science developed. They build on rigorously studied and finely tuned collective knowledge that has been handed down through the generations. For example, the transfer of knowledge from the observation and assessment of biodiversity is so integral to the Irulas lifestyle that it is transmitted through their folk songs, articulated in Box 13.

Box 13. Songs of the Irulas

These songs are often sung when we move in groups through the forest, hunting or gathering food or other useful items.

- *....about the different trees in the forest, and why the messenger has not eaten its fruit*
- *....about the different birds we see in the forest and they trees on which they perch*
- *....while we collect honey in the forest we sing about the varieties of honey we can find*
- *....about the interdependence of different elements of nature (including us as human beings)*

6.2 Joint assessments

Sometimes local level assessments have been carried out as a joint effort with outsiders. While researchers are endeavouring to improve the process of these kinds of joint evaluations into more thoroughly participatory biodiversity assessments (Section 12.2), experience on the ground remains scattered. For instance, wild biodiversity might be jointly assessed at the start of a community-based conservation initiative, or to measure during the implementation of the initiative, to measure progress. Agricultural biodiversity may be measured to assess whether it poses a threat, as with pests and diseases, or a benefit, such as new crop varieties with attractive characteristics.

One example of this sort of agrobiodiversity assessment was carried out by the Deccan Development Agency (in collaboration with IDRC) in two districts of Andhra Pradesh in India. A detailed study on farmer perceptions of agricultural biodiversity was undertaken to better understand reasons for its disappearance and to use this information to develop strategies for conserving agro-biodiversity. The study revealed that an appraisal of the characteristics of various seeds, no doubt learnt through long-term uses of these seeds, led to each variety being imbued with particular significance. For example, specific grains assume importance in different festivals (Box 14).

Box 14. Exploiting ecological niches and fulfilling different livelihood needs with crop diversity

- Different crops suit different soil types, e.g. chickpea, safflower and winter *jowar* are grown on black soils, pearl millet, monsoon sorghum, niger, horsegram, dry sown paddy and little millet are grown on less fertile soils
- Some crops mature earlier than others thus helping maintain regular food crop production throughout the year, e.g. *gareeb jonna* matures earlier than other varieties of sorghum
- Planting different varieties of the same crop can allow two or more harvests to take place during a year, e.g. green & black grams
- There are crops that rejuvenate soil fertility, e.g. niger
- Or which do not require weeding, e.g. niger and sunhemp
- There are crops which help ward off/reduce pest incidence, e.g. mustard, marigold and others which are prone to pest attack, e.g. pigeonpea, field beans and *lablab*
- Others help prepare the land and soil for the next crop, e.g. green manure crops such as sunhemp
- The existence of diverse crop species also enables different livelihood needs to be fulfilled, e.g. Bishop's Weed for income; sorghum and pulses for pod mix/straw/dry fodder; pigeonpea for thatching/fencing material and fuelwood; amaranthus and sunhemp for fibre; safflower for oil; mustard for medicinal purposes
- Some store well but require more labour for processing, e.g. foxtail millet, kodo millet and little millet
- Different crops are appropriate for different festivals, e.g. pyalala jonna and foxtail millet are austere seeds used as offerings to salute the snake and to respect departed ancestors respectively, while peanuts and chickpeas are rich seeds used to celebrate the new year and other joyous occasions

Source: Taneja et al. 2001

As a reaction to the Green Revolution and the dependence on singular varieties of rice that it imposed on farmers, the Save the Seeds Movement, based in Hemvalghati, Uttar Pradesh in India, started to document and conserve (both by storage and by bring the seeds into cultivation) the agricultural diversity of the area in the early 1990s. Members of the Movement travelled throughout the Uttar Pradesh Himalayas, carrying out assessments of agrobiodiversity in order to identify traditional varieties and the areas where they were still actively cultivated. By the mid-1990s, 126 varieties of rice, 8 of wheat, 40 of finger millet, 6 of barnyard millet, 100 of common beans and 8 of traditional soybean and 10 of French beans were once again being cultivated in the region.

Another attempt at incorporating community stakeholders' perceptions and assessments in formal monitoring of forestry operations is being conducted by the International Network on Ethnoforestry at the Indian Institute of Forest Management. A course – Measures of Success for Sustainable Forestry – has been developed for various representatives of community, government forest departments and voluntary agencies working in sustainable forest management in south Asia. The course aims to improve participants' understanding of criteria and indicators that can measure progress towards sustainable forest management and also to equip the participants with participatory design and field application skills. It remains to be seen how effective this attempt will be in achieving this and whether or not it can integrate local and global level interests.

6.3 Peoples' Biodiversity Registers

The Biodiversity Conservation Prioritisation Project in India instituted a series of People's Biodiversity Registers (PBRs) across seven states in India in the late 1990s, in one of the first formal approaches to integrating local knowledge about biodiversity with more standard techniques. PBRs are called people-centred assessments, in that while they were initiated locally, they were carried out in close collaboration with local people, and the outputs were made accessible to as wide an audience as possible (Gadgil et al. 2000). The aims of the PBR exercise were firstly to transfer biodiversity knowledge, from both local people and professional biologists, into the public realm, secondly to inform state and national level conservation policy (especially the Biodiversity Strategy and Action Plans) of local people's views and natural resource management practices, and thirdly to regenerate faith in local wisdom and local capacity for self-governance.

PBRs followed the same basic format at all sites. Taking a broad view of biodiversity, information was collected under the following headings, mainly during village meetings:

- Peoplescape: Local people were divided up into social classes based on their biodiversity use ("primary" e.g. hunters and fishers, "secondary" e.g. rubber planters and land-owners, "non" e.g. road builders and potters). Gender differences, seasonality and influence of outsiders were also considered. Individuals with specialist knowledge in the community were identified.
- Lifescape: The local landscape was classified by use. Species lists were

collected from group meetings (plants, birds, mammals, reptiles, amphibians, fish) and from professional surveys. Social class values attached to various species were mapped out and the overall 30 most important species listed.

- Ecological history: Time line and maps of major trends and events in land use were drawn out.
- Development aspirations: Local trade-offs between development and biodiversity were analysed.
- Institutions: Key decision-making bodies and mechanisms for resolving social conflicts and building consensus (e.g. between rich and poor and between locals and outsiders) were noted.
- Management options and action points were devised, identifying species considered too abundant (e.g. Bonnet monkeys, wild boars and fruit bats) as well as those that are rare.

PBRs attached biodiversity values to individual species, rather than at broader ecological scales or in terms of the value of variety or variability. Nonetheless, a broad view of value was taken, incorporating subsistence, cultural, religious, commercial, environmental, ethical and medicinal values, and treating wild and agricultural biodiversity equally (Bhatta and Bhat 1997). In general, the 30 species rated as most important were valued for their economic importance rather than cultural, religious or subsistence values.

The PBR process illustrates the difficulty of attempting assessments that are aim for as much local determination as possible, but also a workable level of standardisation and comparability across sites. For example, reports of PBRs from two different villages (Achar 1997; Bhatta and Bhat 1997) both stated, “A need was felt to gradually standardise the local nomenclature so that eventually every patch had a name which indicated both its geographical location as well as ecological habitat type”. Clearly this need was felt not so much by local people as by the external facilitators of the PBRs! Among villagers involved in these PBRs, most felt excluded from decision-making over land management, but unable or unwilling to suggest alternatives within the PBR process.

Along the same tack, proponents of PBRs draw attention to the high value both of indigenous knowledge and of making knowledge public. Local resource users may find more of conflict than synergy between these two goals. For instance, Chatterjee et al. 2000 found that villagers in Arunachal Pradesh declined to participate in a local PBR through fear that surveying their land would lead to occupation of the land by government. Joint assessments may be useful for collating information and even for capacity-building, but they do not usually make much progress in tackling the real challenges to self-determination faced locally.

7

Biodiversity assessment by international policy-makers

The last decade has seen a surge in international agreements and policy processes that address biodiversity. Several of these stipulate biodiversity assessment, either as an essential activity for signatories (e.g. the Convention on Biological Diversity), or as a selection process for inclusion within the terms of the convention (e.g. the World Heritage Convention). Other international processes that have a broad developmental focus include biodiversity assessment as a measure of environmental sustainability at the national level (e.g. Commission on Sustainable Development). Whatever their aim, most of these ongoing caucuses have endorsed indicator-based methods of biodiversity assessment.

7.1 Convention on Biological Diversity

Article 7 of the Convention on Biological Diversity (CBD) calls explicitly for parties (national governments) to assess biodiversity (Box 15). Other articles, specifically 8(j), 12 (a), 25 and 26 also refer to biodiversity assessment, albeit less directly, for example by referring to the need to maintain relevant indigenous knowledge. Overall, these articles stipulate the need for the identification and monitoring of: biodiversity, activities that are likely to have significant adverse impacts on biodiversity, and progress on implementation of the conservation measures of the CBD and the effectiveness of these measures.

Box 15. Article 7 of the CBD: Identification and Monitoring

Each Contracting Party shall:

a. Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;
b. Monitor, through sampling, and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;
c. Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and,
d. Maintain and organise, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Annex I includes:
1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes.
2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and,
3. Described genomes and genes of social, scientific or economic importance.

Under the terms of the CBD, a liaison group of experts has been working together over a period of years to develop a core set of indicators of biodiversity to guide policy-makers (Box 16; CBD 1997). The originally suggested set of core indicators aimed to respond to multiple levels: genes and species, and forest, marine, coastal, inland water, dryland, mountain and agricultural ecosystems. Many parties considered it premature to establish a proposed core set of biodiversity indicators (CBD 1999). This reluctance could be a manifestation of the political concerns inherent in biodiversity assessment and the indicators selected: individual countries were perhaps reluctant to participate in what could be construed as a "league table" of biodiversity status and protection, which was in itself based on various assumptions and a very rough approach to what is best for biodiversity. It is also likely that most countries could not dedicate sufficient resources or capacity to carry out the extensive assessments that the indicators proposed would require.

Box 16. The 1997 CBD core set of indicators: a state-pressure-response approach

The Conference of Parties (COP) chose to develop a two-track approach to biodiversity assessment: the *first track* considers existing and tested indicators of **state** and **pressures** related to the conservation and sustainable use of biodiversity; the *second track* should consider the identification, development and testing of **response** indicators for the three objectives of the CBD.

Those related to *pressure* should measure:
- The most important direct and indirect threats
- Whether these primary threats to biodiversity stable, declining or worsening?
- The nature of linkages between primary threats and changes in biodiversity status?

Proposed indicators: habitat loss, overharvesting, species introductions, pollution and potential climate change.

Response indicators should answer questions such as:

- How much capacity there is to implement the Convention
- How much financial support and incentives are currently provided by Parties to implement their commitments under the CBD
- How much financial support is provided by developed country to developing country parties
- What additional means are still needed to address the threats

Proposed indicators: habitat management (e.g. %protected), special habitat (e.g. % remaining and % protected) and financial resources.

Source: UNEP/SBSTAA/3/9 10 July 1997 Recommendations for a core set of indicators of biological diversity.

Instead, parties requested the liaison group to develop a set of key questions and guidelines for national monitoring, plus a menu of existing and potential indicators, all of which had to take account of the Ecosystem Approach adopted by the Convention. COP 5 (the fifth Conference of the Parties) adopted a similar decision, and urged the GEF to fund projects that enable countries to strengthen capabilities to develop monitoring programmes and suitable indicators, but there has been very limited progress on this to date – at present, a menu of possible indicators is being circulated among the parties. This means that the requirement for actual assessment of biodiversity by national governments continues to be delayed.

While the CBD is a slow machine, especially in terms of operationalising agreements, what it does offer is a widely known and respected model for understanding and evaluating biodiversity in a way that gives credence to multiple values. The Ecosystem Approach of the CBD, as discussed in Section 2.2, offers a broad set of principles to guide both assessment and decision-making over biodiversity at national and sub-national levels. The Ecosystem Approach explicitly advocates negotiation and acknowledgement of trade-offs among different biodiversity values, with decision-making vested at the lowest appropriate local scale. These principles could provide a suitable framework for governments and civil society groups, if and where they are able to overcome institutional and resource constraints and implement thorough systems of biodiversity monitoring and evaluation (discussed further in Section 12.4).

7.2 Natural Heritage (World Heritage Union)

Over 160 countries have ratified the World Heritage Convention, which was adopted in 1972 to “provide for the protection of those cultural and natural properties deemed to be of outstanding universal value". Types of "natural heritage" sites worthy of protection are defined as the following in Article 2 of the World Heritage Convention:

- Natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view.
- Geological and geographical formations and precisely delineated areas that constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation.
- Natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

In principle, a site is inscribed on the World Heritage List if it satisfies at least four of a list of criteria, as well as compulsory conditions of integrity (Box 17). However, in practice, many inscribed sites meet only two criteria. Roughly 60 % of nominations for "natural heritage" sites attain World Heritage status. Sites are nominated by national governments, but evaluations of the suitability of individual sites are carried out by the Protected Areas Programme of the World Conservation Union (IUCN) and then sent on to the World Heritage Bureau for review. The evaluation process involves five elements: data assembly, external

Box 17. Quality indictors used for assessing the importance of a proposed World Heritage site

- **Distinctiveness**. Does the site contain species/habitats/physical features not duplicated elsewhere? There is nowhere, for instance, that is comparable to Uluru in Australia, which is not only a natural site but also a cultural landscape.

- **Integrity**. Does the site function as a reasonably self-contained unit? This is a key feature for biologically important areas such as the 5 million ha Salonga National Park in the Democratic Republic of Congo.

- **Naturalness**. To what extent has the site been affected by human activities? The Nahanni World Heritage site in northern Canada is obviously a landscape where nature dominates and where human impact has been minimal.

- **Dependency**. How critical is the site to key species and ecosystems? The Komodo National Park in Indonesia is an example of a site where 95% of the world's population of Komodo dragon occurs.

- **Diversity**. What diversity of species, habitat types and natural features does the site contain? Sites like Sian Ka'an in Mexico with a combination of marine, coastal and forest habitats along with cultural values are usually more favourably received than single feature sites.

review, field inspection, panel review (within IUCN) and final recommendations. It is not clear whether broader participation is sought from local or at least regional experts, nor is it clear which are the relevant local and national authorities.

World Heritage sites must of "outstanding universal value". Therefore, criteria and indicators used to select and evaluate a site are more likely to incorporate global values, as these should correspond most IUCN and the World Heritage Bureau's notions of universality. Advocacy groups that have most access to these fora will have the greatest influence over what is treated as being of "universal" value. Whether or not these groups represent a sufficiently broad base of opinion is a moot point. Of course, it could also be argued that as any new nomination comes through the national government, this part of the process should provide space for national interpretation of "outstanding universal value", and national priorities should represent the priorities of its citizenry, but without clear procedures for participatory decision-making, this is unlikely to happen.

7.3 Commission on Sustainable Development

The Commission on Sustainable Development (CSD) is developing Indicators of Sustainable Development (ISDs) in response to Agenda 21[8]. The aim of this initiative was to have an agreed set of indicators available for all countries to use by 2001. Chapter 15 of Agenda 21 refers directly to "conservation of biological diversity" and the chapters on oceans, freshwater, agriculture and forests also point to relevant indicators (Box 18). So far a working list of 134 indicators and related methodology sheets have been developed and are intended to be tested voluntarily at national level as a complement to national reporting on the state of the environment.

Box 18. Suggested indicators for Chapter 15 of Agenda 21

a. Threatened species (all endangered, vulnerable, rare and indeterminate species as registered in the IUCN red books) as a percent of total native species. With four sub-indicators:

i. % threatened vascular plant species, total all classes;
ii. % threatened species within each vascular plant class;
iii. % threatened vertebrate species, total all classes; and
iv. % threatened species within each vertebrate class.

b. Protected land area as a percent of total land area; protected marine area as a percent of total marine area.

8. Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which human impacts on the environment, It was adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 3 to 14 June 1992.

These indicators potentially set up the kind of "league table" that signatories to the Convention on Biological Diversity have been trying to avoid. Therefore no targets have been set internationally – rather it is up to individual countries to set their own targets. Indicator (a) focuses entirely on the species level of biodiversity and on global rarity. The straightforwardness of the sub-indicators (simple percentages) is a strength, but masks the heavy investment of skills and time needed to inventory rare species. Indicator (b) has been chosen because "protected areas are an essential tool for ecosystem conservation, with functions going well beyond the conservation of biological diversity. As such, they are one of the building blocks of sustainable development." Clearly the usefulness of this indicator depends on classifying protected areas according to the levels and types of human uses that are allowed.

7.4 International Development Goals (DAC/OECD)

The international development goals of the Development Assistance Committee (DAC) of the Organisation for Economic Cooperation and Development (OECD) emerged from a series of UN Conferences held in the 1990s. They are designed are milestones against which progress towards poverty elimination can be measured. The "Environmental Sustainability and Regeneration" goal requires that "there should be a current national strategy for sustainable development, in the process of implementation, in every country by 2005, so as to ensure that current trends in the loss of environmental resources are effectively reversed at both global and national levels by 2005."

Several indicators, against which countries should measure progress towards this goal, have been identified. For biodiversity the indicator is "% land area protected". The DAC / OECD intends to improve this indicator by "scoring the importance of the areas protected and level of protection in force." Criteria by which protected areas will be selected for their "importance", or what "level of protection" actually means, has not been clarified. Some experts would for example argue that protection is more effective where local people are allowed to reside within the protected area, others would argue the contrary. However, the wording seems to imply that "levels of protection" should be taken to mean levels of non-use.

At an international level, the percentage of land area protected in a country is perhaps the most popular biodiversity indicator. While protected areas are indeed important havens of biodiversity, alone they cannot achieve every necessary aspect of biodiversity conservation. Other measures that encourage conservation across the productive landscape need to put in place, such as the sorts of incentives and technologies that will facilitate the integration of biodiversity objectives into agriculture, forestry or fishing. Associated with this is the need to develop indicators that are able to measure progress towards integrating different biodiversity values across the landscape.

8

Biodiversity assessment by bilateral donor organisations

Bilateral donors usually build consideration of biodiversity into both pre-implementation planning and post-implementation review of their programmes and projects in partner countries. A common feature is that the term "biodiversity" is used very broadly, but practitioners and assessors are given little guidance as to how it might be evaluated in more detail. This leaves the term open to wide interpretation, which can lead to confusion. Tackling some of the conflicts between biodiversity and development, by identifying ways of linking these two objectives in a mutually supportive way, remains undeveloped within the assessment methodologies of agencies surveyed. However, donor organisations are fairly flexible for institutions of their size, and several examples exist of efforts to make biodiversity assessment more cost-effective, straightforward, representative and mainstreamed into policy and practice.

8.1 Swedish International Development Cooperation Agency (Sida)

Currently, biodiversity assessment within Sida occurs as part of their Environmental Impact Analysis (EIA) process. Sida's EIA guidelines contain a series of checklists that include questions on biodiversity (Sida 1998). It is worth noting that Sida has had the foresight to ask questions relating to impacts on genetic diversity – a rare feature in other donors' EIA guidelines or screening checklists. As part of Sida's EIA, consideration is also given to how the proposed activities relate to the partner country's environmental legislation and its responsibilities under the biodiversity-related conventions and agreements.

Sida also has guidelines for "Strategic Environmental Analysis" at country level to be used during the "Country Strategy" process (Sida 2000). These guidelines present a series of questions that aim, for example, to ask questions on the interactions between poverty and the environment. Some of the questions have an indirect bearing on biodiversity, which non-specialists may easily overlook. The only guidance on assessing biodiversity is found in the appendices, where a menu of suggested environmental indicators is provided. Those relevant to biodiversity are two environmental status indicators – threatened species (% of the total number of species) and protected areas (% of country's total surface area) – and one response indicator – whether the country has signed international agreements on biological diversity.

Sida are eager to improve their practice with respect to biodiversity. "Mainstreaming of Biodiversity at Sida" is an ongoing process that aims for officers to build their understanding and develop the tools they need to ensure that biodiversity is mainstreamed in all projects and programmes. A comprehensive review of internal experience and attitudes provided the following better practice recommendations (Bystrom 2000):

- EIA– especially its sectoral approach – is a suitable entry point for biodiversity assessment. However, it cannot go into too much detail without becoming overly complicated. Analysis must therefore be kept fairly broad to be workable.

- Existing checklists could be improved by assessing how biodiversity changes over time, the impact of interventions on ecosystem function, acknowledging different stakeholder perspectives and values, and a measure of how different stakeholders' understanding has improved (Box 19).

- Tools developed should reflect the different requirements of different levels of administration within Sida. This will help improved internal understanding.

- Monitoring at project/programme level needs to be:
  simple hence cost/effective, manageable and replicable;
  based on local knowledge;
  an integral part of the programme monitoring system.

- Indicators need to simple, locally based and closely linked to the objectives of the programme/project.

Box 19. Suggested improvements to the Sida EIA checklist

Existing questions for the agriculture and forestry sector:

Does the proposed project or programme:

1. Exploit or substantially change important or sensitive ecosystems (for example areas which are covered by natural vegetation), or restore such ecosystems?
2. Reduce natural biodiversity through threatening plant or animal species, or increase diversity by supporting and protecting ecosystems and species?
3. Encourage or discourage local sustainable use of wild and cultivated biodiversity, local animal and plant breeding and the development of knowledge of local biodiversity?
4. Contribute to or counteract the introduction of new species in areas where they do not belong naturally?
5. Result in a greater or smaller risk that plant and animal diseases are spread to cultivated or wild species?
6. Result in a greater or smaller risk of the spread of transgenic organisms or genes from such organisms?

Suggested changes:

- Adapt no. 3 to "encourage or discourage local sustainable use of natural and agrobiodiversity."
- Delete nos. 1 and 2 as these are very static and one-sided views of the dynamics of biodiversity.
- Delete no.4 as it is impossible to say whether a species naturally belongs to an area or not and what the impact of a new species on the environment might be.

Suggested add-ons:

- Directly relate to biodiversity and biosafety?
- Adhere to the relevant local, national and/or international policy and legislation for biodiversity or biosafety?
- Substantially contribute to capacity building among stakeholders towards participatory management of biodiversity and biosafety?
- Enhance the local and national knowledge based on the different domains of biodiversity and biosafety?
- Have, provide or improve the access to knowledge bases for all stakeholders?
- Elaborate agreed protocols on biodiversity issues for the respective stakeholders?
- Strengthen or weaken, over time, the functional relationships between and within the different domains of biodiversity?

Source: Bystrom 2000

8.2 UK Department for International Development (DFID)

DFID assesses potential impacts on biodiversity that might result from proposed projects through its Environmental Assessment (EA) procedure. This procedure is supposed to help identify constraints and opportunities for projects at the screening stage. Screening involves assessing the proposed project against the checklists listed in the DFID Environmental Guide (DFID 1999), which include some questions related to biodiversity (Box 20). These questions focus mainly on assessing whether or not the project might have negative impacts on biodiversity. There are no questions that could help identify any potential development or livelihood opportunities that could arise from biodiversity as a result of the proposed project, despite the fact that DFID has made significant recent efforts to turn their EA procedure into more of an opportunity seeking exercise. The questions do not directly address the conflicts between biodiversity conservation and development objectives, and the assessor is left with complicated task of finding suitable trade offs him/herself.

Box 20. Specific references to biodiversity in the screening checklists of the DFID Environmental Guide

A. Environmental features

- Identify aspects of the environment that are particularly sensitive, important or valuable e.g. semi-arid areas and desert margins; mountainous areas; moist or dry tropical forest (especially primary forest); wetlands; small islands; coral reefs and seagrass beds; rivers and lakes etc
- Habitats providing important resources for vulnerable groups
- National parks, nature reserves and protected areas
- Areas containing rare or endangered species or high concentrations of biological diversity

B. Development features

Determine whether the proposed project/programme is potentially damaging to the environment. There is no specific mention of biodiversity here but all these activities have the potential to have impacts on biodiversity – whether or not these are always "damaging" cannot always be immediately assumed.

C. Potential adverse and beneficial impacts

Determine whether the proposed project/programme is likely to result in specific environmental damage. Biodiversity is mentioned only under (i) Water quality "pollution control can improve water quality, protect biodiversity and improve human health…."

(ii) Global impacts "tackling global environmental issues often has localised benefits ... issues include biodiversity…" (iii) Conservation "The protection of wildlife habitats may provide benefits for local income and global biodiversity. Issues are loss of species or genetic erosion and the impoverishment of flora and fauna."

D. Impact characterisation

Helps decide whether the nature or scale of impacts is likely to cause problems: e.g. "What is the scale of the impact, in terms of area affected (off and on site) numbers of people or animals etc.? Are any laws, conventions or regulations likely to be infringed?

DFID also has a Project Information Marker System (PIMS), which is used to assess the policy objectives to which DFID projects contribute. Among the 33 possible policy markers (each DFID project over a specified budget must have a policy marker assigned to it), some are targeted to meet the Rio reporting requirements, one in particular on biodiversity. The criteria used to decide whether a project or programme qualifies for a PIMS "biodiversity policy objective mark" are extremely broad, bringing in planning, capacity building and training in addition to conservation (Box 21). All projects that have been assigned a PIMS policy marker are entered into a PIMS database that enables DFID to keep systematic information on which projects incorporate biodiversity objectives.

Box 21. Activities that qualify for a PIMS biodiversity policy objective mark

- Policy and management: preparation and implementation of national plans, strategies and studies covering the status, conservation and management, valuation and sustainable use of biodiversity.
- Capacity building: development of institutional capacity to manage and research biodiversity resources.
- Training (e.g. in plant and animal taxonomy).
- Conservation: conservation, sustainable management or restoration of habitats and ecosystems (terrestrial or aquatic) which may be components of forestry, fisheries, agriculture or wildlife projects as well as projects specifically directed at protected areas such as national parks or nature reserves or their buffer zones. Also in-situ and ex-situ of genetic resources (wild or cultivated species, varieties or land races of animals or plants) including on-farm conservation, in-site forest genetic resource conservation, gene banks, botanical and zoological gardens and through the application of biotechnology.

DFID has also funded various projects where biodiversity assessment has been conducted as a stand-alone activity as opposed to the "gross" screening level approach described above, such as the Biodiversity Assessment in Tropical Moist Forests project funded by Forest Research Programme. The findings of this research have yet to be adopted and integrated into DFID's formal procedures.

Biodiversity assessment in national processes

Government departments around the world are rising to the challenge of how to carry out useful and cost-effective surveys of biodiversity in their countries. Assessment of biodiversity does not occur only in response to international conventions on biodiversity, but forms part of more general natural resource assessment and land use planning. Here we look at two such examples from practice – conservation planning in India and forestry management planning in Malawi – and follow these with a brief review of the World Conservation Monitoring Centre's guidelines for national level biodiversity assessment.

9.1 National biodiversity assessment in India[9]

The Botanical Survey (BSI) and the Zoological Survey of India (ZSI) have carried out exhaustive inventory and taxonomic classifications in India since the colonial period. A vast amount of information has been collected on the range and distribution of certain species. Traditionally this was done with respect to specific administrative state or district boundaries rather than only in areas of perceived biodiversity value. BSI and ZSI inventories are now taking place in protected areas as well, and the two organisations have assembled Red Data Books for some plant and animal species. However, these types of exhaustive inventories are on the decline in India.

Today biodiversity management in India is dominated by the concept of ecological equilibrium, meaning the minimisation of all disturbance. Non-use protected areas are seen as the chief mechanism to put this concept into practice. However, in most cases, protected areas have been sited rather arbitrarily, without any formal biodiversity assessment or prioritisation exercises. This raises some serious questions over their ecological integrity and the relevance of their boundaries. Unwritten criteria that are occasionally employed include: presence and (where known) range of threatened species, human settlement patterns and administrative feasibility (i.e. getting the boundaries to follow district or state borders rather than ecological ones).

9. This section is based largely on a case study of biodiversity assessment in India by Bansuri Taneja, Ashish Kothari and Manju Raju.

The Wildlife Institute of India is campaigning for a better planned and integrated approach to siting protected areas, but with little success so far.

In terms of ongoing assessments of the status of biodiversity held within protected areas, occasional population counts of some mammals and birds are carried out. But, in general, such census operations in protected areas (which are incidentally the only areas where they are carried out) are not comprehensive nor are they regularly conducted. Usually they are part of some time-bound research initiative. That said, some non-governmental initiatives, such as the survey of the Bombay Natural History Society, have made a significant and continuing contribution to inventories of biodiversity. In recent years "biodiversity assessment" has also come to mean ecological studies of impacts of various factors on protected areas, conducted under the auspices of specific research assignments.

Recently a non-governmental organisation undertook an exhaustive biodiversity assessment in India over a period of over two years from 1996 to 1998. This exercise – the Biodiversity Conservation Prioritisation Project (BCPP) – resulted in a nationwide prioritisation of sites, species and strategies for biodiversity conservation. Priority taxa were selected at a national workshop, depending very much on the availability of expertise in the country. Subsequent analyses were based on IUCN criteria, but were also revised, as appropriate, in four to five day Conservation and Management Planning (CAMP) Workshops. The CAMP workshops were essentially gatherings of experts on particular taxa, who pooled their knowledge according to factors such as locality records, distribution, habitat preferences, threats and perceptions of decline. Much of this collated information remains unpublished.

Information on priority taxa for conservation was then used to rank sites for conservation. There was broad consensus that ranking could not be based on biological criteria alone, and socio-economic values would have to follow as a second set of parameters. The biological criteria employed – representativeness, uniqueness, naturalness, endemism, richness, rare species, major population, size (and viability of conservation) and connectivity – were considered at all levels: ecosystem, community, species and genetic. Socio-economic values relating to non-consumptive use were seen as adding to the biodiversity value of a site, while direct use values were seen as detracting from overall biodiversity value. Participants in the ranking exercise pointed out that the dataset used for priority setting was inadequate and that there is no sense of urgency to design or implement a standard inventory process.

9.2 Malawi National Forestry Programme

National Forestry Programmes (NFPs or nfps) are the most recent incarnation of internationally driven national forestry planning processes, of which previous versions have been National Forestry Action Plans (NFAPs) and Tropical Forestry Action Plans (TFAPs). Malawi is one of the first countries in the world to have embarked on the nfp process (Malawi Ministry of Natural Resources and Environmental Affairs 2000). A series of multi-stakeholder working groups have assessed present challenges and identified ten key strategies, each with prioritised actions, to improve the contribution of forestry to sustainable livelihoods in Malawi.

The working groups identified clearance of woodland which "threatens Malawi's considerable stock of biodiversity" as one of the reasons that Malawi needed an NFP. How then did the working groups incorporate assessment of biodiversity? The answer is that no appraisal of biodiversity was included. One of the ten strategies identified in the resultant NFP document was to manage forest reserves for a variety of services, including conservation of biodiversity – the only further mention of biodiversity in the document. The Malawian forest stakeholders recommended detailed assessment of particular biological resources that are central to local livelihoods, for example firewood and charcoal, but deemed appraisal of biodiversity unnecessary. Essentially, they did not regard biodiversity as a national priority, although they acknowledged maintenance of indigenous biodiversity as an added bonus of certain land use choices (e.g. forest reserves). For these stakeholders, who represented national and local interests, direct use values of biological resources are presently more important than the array of biodiversity values.

9.3 World Conservation Monitoring Centre guidelines

In 1996 the World Conservation Monitoring Centre published a booklet to "outline approaches suitable for use by less wealthy countries to assess, with reference to socio-economic factors, the status and sustainability of national biodiversity" (WCMC 1996). The WCMC work does not offer any original methodology, but rather presents a set of existing methodologies and recommendations on how to use them. It has not been widely adopted by government departments but is worth considering here, as it is a good example of how biodiversity assessment at the national level might balance scientific rigour and inclusion of multiple perspectives, while not being unrealistically ambitious.

The WCMC booklet advocates a dual approach to biodiversity planning, with separate (but where possible complementary) efforts to maintain first the indirect and non-use values and second the direct use values of biodiversity. The focus of maintaining indirect use values is conservation of a desired range of ecosystems (and hence measurable via ecological diversity). For direct use the values the focus is specific resources, usually individual species. Suggestions as to how the status and potential sustainability of these two groups might be assessed are pragmatic. Existing information are the recommended basis of any assessment. The most outstanding information gaps are best addressed via a combination of in-depth case studies and rapid assessments. The WCMC booklet also suggests what types of assessment are less advisable. For example, although genetic diversity can be of crucial importance, particularly to local use of agricultural resources, scientific inventories are probably not worth the costs (in time, money and skills) that they entail.

Overall, the WCMC guidelines capture the following themes:
- Trade-offs in biodiversity values among different sectors of society and global, national and local values
- Genetic, species and ecological diversity and the links among them
- Wild and domesticated, marine and terrestrial diversity
- Assessment of both state and pressure variables
- Difficulties of measuring ecosystem health and sustainability and hence the need to apply the "precautionary principle" to maximise conservation efforts
- Need for socio-economic data to understand trends in use and threats to biodiversity

10

Private sector approaches to biodiversity assessment

As biodiversity is increasingly recognised to have commercial value, so the private sector is becoming concerned with how to measure it. In addition, there is ever more pressure from consumers and governments for companies to show evidence that their operations do not destroy or threaten biodiversity. Thus individual companies seeking to maintain or create a competitive market share now have to concern themselves with assessment of biodiversity. In the timber industry, for example, the ability to supply certified quality-assured wood allows access to lucrative northern European markets. Both social and ecological criteria are included in the certification process, but the challenge remains of how to integrate the two, to include assessment of biodiversity in terms of local values. Another initiative, the Race to the Top assessment of supermarket performance in the UK, is beginning to face the associated challenge of how to incorporate a measure of who bears the cost of biodiversity conservation. The final example given here is of one suggestion of how biodiversity might be measured for trading purposes, in terms of "biodiversity credits".

10.1 Forest Stewardship Council certification

Forest certification is an internationally recognised system of assurance to consumers of wood and wood products that the products that they purchase have come from well managed forests. The Forest Stewardship Council (FSC) has formulated ten general principles of equitable and sustainable forest management, which forest producers must fulfil in broad terms to achieve FSC-accredited certification. Principle six reads, "Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and integrity of the forest." The text goes on to make specific reference to genetic, species and ecological diversity. Principle nine reinforces the need to conserve "high conservation value forests", defined either according to national priorities or in IUCN-based terms (presence of globally rare, threatened or endangered species). Local biodiversity values are enshrined in principle three, which calls for protection of the rights of indigenous people to resources, to sites of cultural, ecological, economic and religious significance and to control over indigenous knowledge.

Taken together, the FSC principles support a holistic approach to assessing biodiversity in forests, incorporating local, national and global values. The FSC does not offer guidelines on how to assess whether principles are met – more specific standards are meant to be set by individual country programmes and certification bodies, a process still underway (Bass et al. 2001b). In practice there has been huge variety in how actual certification audits have interpreted and used the principles to assess biodiversity in managed forests. Certification audits, perforce limited by time and funding, have taken mostly pragmatic approaches to “quick-and-dirty” biodiversity assessment. In spite of this and other attempts to keep the costs of audits down, poorer producers and processors have largely been excluded from certification because of the high costs involved, a challenge that the FSC is now tackling with initiatives such as group certification (FSC 2002).

To give a flavour of the various approaches, four detailed examples (Annex 1) illustrate how the assessment of biodiversity differs according to how well developed certification and biodiversity assessment methodologies are in different countries. Only one of the four case studies was careful to draw in local values (Hoopa Tribal Forestry, USA), even though all except Stora-Ludvika (Sweden) clearly involved a high level of dependence of local livelihoods on the forest or agroforestry land. In spite of this, and the fact that little original measurement of biodiversity was carried out, one common positive feature of certification audits is an emphasis on measuring biodiversity in terms of desired outputs, making the values of different stakeholders explicit.

10.2 Race to the Top

The Race to the Top (RTT) initiative, coordinated by the International Institute for Environment and Development, aims to assess the performance of British supermarkets on social, ethical and environmental issues (IIED 2002). The initiative has established a process whereby the various affected stakeholders and relevant groups in the UK have identified the critical issues, grouped them and developed suitable indicators. These indicators will provide comparative data necessary for the benchmarking process, and have been grouped the following areas: animal welfare standards, biodiversity and landscapes, environmental and social performance, management and reporting, labour standards, public health, regional sourcing and local regeneration, and terms of trade with primary producers. A total of about 21 overarching indicators have been identified so far. The intention is to benchmark the major supermarket companies annually and to publish the results individually, not as a composite index, possibly in combination with case studies of supermarket and supplier best practice.

The RTT initiative is interesting in the way it has attempted to tackle the complex array of issues that surround supermarket policy and practice. It clearly recognises that raising standards in one area may inevitably cause problems elsewhere in the system. For example, encouraging supermarkets to ensure that their suppliers only acquire products that meet high biodiversity conservation standards may inadvertently harm the livelihoods of farmers, who often bear the costs of such requirements. Adopting a multi-stakeholder approach can help circumvent a focus on single objectives, without acknowledging how they link up and affect other areas. However, finding suitable win-win indicators every time is by no means an easy task, given the wide range of issues at stake. Possibly one of the greatest benefits of the multistakeholder approach has been to raise different groups' awareness of the links between different social and environmental issues.

The biodiversity and landscape issues and indicators selected are identified in Table 4. For reasons described above, it proved difficult to identify indicators that could manage the delicate balance between achieving biodiversity conservation objectives without adversely affecting livelihoods along the supply chain, or transferring unacceptable costs to supermarkets or consumers. The difficulty in finding suitable "win-wins" is a superficial manifestation of a much more deeply rooted problem: that normal market incentives and production technologies remain unsupportive of biodiversity conservation. So as to avoid an uneven distribution of the costs of improved performance on biodiversity across the supply chain, the indicators selected assess what both supermarkets and producers are doing, e.g. by assessing whether or not supermarkets have helped sponsor producers to adopt whole farm conservation plans.

Table 4. Proposed issues and indicators for the biodiversity and landscapes module of the Race to the Top initiative

Issue: what are we are trying to find out with this indicator?	Indicator(s): how do we propose to measure retail commitment and action on this issue?	Sources: where might data come from?	Existing data	Verification: how do we verify responses from retailers on this issue?
Commitment to improving biodiversity management (wild species and habitat) through sourcing policies and cost-sharing	Whole farm conservation audits of suppliers; plans addressing maintenance/ enhancement of biodiversity and landscapes, protection and management of soil and water, responsible use of agri-chemicals (%)	Conservation/ advisory bodies, suppliers and farmers	Questionnaire, supermarket literature, interviews with buyers	
Commitment to preservation of pristine/natural habitats	Existence of published company policy that pre-cludes clearing of primary forest, destruction of aquatic and/or terrestrial habitats of special scientific/ cultural interest, in the production of own-brand foodstuffs (Y/N)		Questionnaire to supermarkets, annual and environmental reports	Reports from conservation bodies and NGOs
Support for sustainable and wildlife-friendly fisheries	Fish products sourced from sustainable fisheries using wildlife-friendly fishing methods (%)		Shopping basket questionnaire; environmental reports	Reports from Marine Stewardship Council and other accreditation bodies, NGOs

10.3 Biodiversity credits

The concept of carbon credits is now beginning to be applied to biodiversity in some countries, though such initiatives are still at an early stage of planning. A leader in this field is Australia, where progress has been made to propose methods of calculating biodiversity credits for particular areas from biodiversity assessments. These are interesting to examine in the context of this study, because they are one of the first attempts to derive a compound index of biodiversity – one number that reflects several different attributes. Shields (2001) suggests a trading unit called a "Bio" which is calculated as follows:

$$B = [(EC*A) + (EC*U) + (EC*V)] + 1000\ (1/D)(CO)$$

The first part of the equation, in square brackets, represents a summed value EC, which "essentially comprises the food chain and has sub-terms for each biological entity that makes up the system… the producers, consumers, predators, detrivores", multiplied in turn by an abundance term (A), a uniqueness or relatedness term (U) and a vulnerability term (V) based on conservation status (perhaps the IUCN rankings). Thus the equation includes all of the basic measures of abundance: number of elements, abundance of each element (A) and relatedness (U). The second part of the equation concerns the habitat. The 1000 is an arbitrary figure representing 1000 ha, D is distance from the closest equivalent habitat (a measure of how likely the focus area is to be re-colonised in the event of local extinction) and CO is a measure of the condition of the habitat.

This type of assessment is typical of the scientific approaches to biodiversity assessment described in Section 4. It is yet to be put to the test, but in all likelihood will be met with heated debate over which taxa should or should not be included, how habitat condition should be rated, and so on.

11

Summaries and conclusions from different approaches

A plethora of approaches to biodiversity assessment have been reviewed here, from broad natural resource management and land use planning exercises that consider biodiversity as one (often small) component, to detailed evaluations of biodiversity that are done for their own sake. Some are proposed techniques while others are part of ongoing formal or informal planning cycles. The variety of aims behind the reviewed assessment approaches means that comparisons across the full set are not very helpful, but here some general observations and comparisons are made for each of three basic types of assessment methods: scientific methods, methods for local assessments, and methods used by higher-level policy-makers and practitioners. The purpose of the analysis here is to draw out some of the strengths, weaknesses and lessons from experience of the different approaches. Learning from these examples is not only useful for current practice, but to inform emerging attempts to bring multiple priorities into biodiversity assessment and management.

11.1 Scientific assessment tools

Some of the scientific assessment tools reviewed in Section 4 were designed for a specific purpose, such as for choosing prime conservation sites for birds, while others have a more general applicability (see summary in Table 5). If anything, they have not been applied widely enough, as they offer several reliable and cost-effective techniques that both local and higher-level decision-makers could draw on – in spite of their historical focus on global conservation priorities, they have considerable potential for integrating local values. To make some general points, the reviewed scientific methods are:

- **Focused on global biodiversity values, with emphasis on indirect use and non-use values**. Most scientific assessment techniques are concerned – implicitly more often than explicitly and in practice more often than in potential – with the global conservation value of biodiversity. The primary concerns embodied in the methods used are the retention for global benefit of the non-use values (including option, bequest, aesthetic and scientific values; see Table 5) and to a lesser the indirect use (environmental service) values of biodiversity. These methods are based within a western scientific framework, and furthermore the "global" values that they reflect are defined by the values held in the wealthy countries from which they by and large emerge. This may not be much of a problem in setting global conservation priorities, but use of them as the sole tool for measuring biodiversity, as is often done, neglects for example how the establishment of a protected area will impact on local biodiversity and natural resource values, and hence on people's livelihoods. This is fundamentally a problem in the value system on which the methods are based, rather than on shortcomings of the techniques themselves. As is discussed in Section 12, quantitative scientific methods could be a useful starting point for devising replicable methods for comparing among local sites or for assessments that integrate global and local biodiversity values.

- **Quantitative.** Numerical measures and indices have considerable advantages for comparing and prioritising among sites. A potential problem with quantitative assessments, however, is that analysis and interpretation might be difficult for people outside the scientific community. This challenge has in fact been met well by the reviewed scientific assessment methods: the end product of most of them are easily understood point or ranking systems, such as Hawthorne's multi-coloured stars or the rare/vulnerable/endangered categories in the IUCN red data books. If anything, the danger with scientific biodiversity assessments is that audiences may take the results as unequivocal, ignoring their degree of uncertainty or simplification.

- **Expensive in terms of time, money, equipment and expertise**. Most of these methods rely on high level of western scientific knowledge and expertise. Some are mathematically complex (e.g. the Star System) while others require high-tech equipment (e.g. GIS-based assessment). Transfer of such methods to non-western countries is therefore likely to be prohibitively expensive, requiring a large investment in training, capacity building and technological inputs. Given prevailing resource constraints in these countries, the transfer of such techniques is unlikely to be universal or sustainable, and thus scientific assessments are only likely to be carried out under the auspices of well-funded donor or government programmes. Since raw data emerging from many scientific assessments requires considerable analysis before it is of use to decision-makers, data are often collected and then left in their raw form due to lack of suitable resources to take analysis further.

- **Reliant on available rather than ideal data sets**. Although the aim is to be as objective as possible, scientific methods of biodiversity assessment often rely on pragmatism, for example using data on bird populations to identify hotspots, simply because data sets on birds are plentiful and reliable. These shortcuts clearly have advantages in terms of cost-effectiveness and in fulfilling national and international legal obligations, such as the monitoring required under CITES. They are usually also good representatives of the facets of biodiversity associated with global option and bequest values. On the other hand, while birds or rare species have proved to be an extremely useful proxy for biodiversity, there are many other aspects of biodiversity that they cannot represent, leading to possible errors in interpretation if the easy mistake is made of thinking that they give a full picture of the biodiversity at a site.

- **Largely limited to species assessments**. Most information is on species, less on other taxonomic levels (e.g. genera, families or kingdoms), let alone sub-species genetic variation, ecological processes, or threats and pressures that bear on biodiversity. Of even more concern is the fact that there is hardly any information available on how changes in biodiversity might affect the wide range of services that it provides, or even whether it provides some of these services at all. Although substantial experimental work is devoted to questions such as how biodiversity contributes to stability in natural and agricultural systems, the patterns and processes involved are complex, and it has been difficult for the scientific community to supply decision-makers with easy guidelines.

- **Widely varied in approach and potential applications**. A great deal of effort, imagination and rigour has been put into the development of scientific assessment methods, only a few of which are reviewed here (Table 5). Each of the methods has strengths and drawbacks, so that no one approach can be advocated over the others. For example, the SI/MAB protocol is expensive and largely disconnected from the values and interests of non-biologists, but also very useful for informing our understanding of processes, which is the precisely the type of information that will lead to better indicators in the long run. While most of the methods have been designed to deal with global efforts to conserve non-use values of biodiversity, almost every approach has potential, and sometimes already existing, applicability to local contexts, or better still to integrate global and local biodiversity values. The utility to decision-makers of many of these scientific approaches, with their appealing combination of accuracy and communicability, has yet to be fully exploited.

Table 5. Summary and comparison of scientific biodiversity assessment methods

Assessment	Goal of assessment	Scale of measurement	Facets of biodiversity measured *	
IUCN's red data books	Evaluation of extinction risk of species	National; more recently local	1. taxa (species) 2. wild 3. structure, impact	
Checklists	Multiple applications	Local or national	1. taxa 2. wild or agricultural 3. structure	
SI/MAB Plots	Study and monitoring of biodiversity in protected areas	Local	1. ecosystem, taxa 2. wild 3. structure, process, impact	
Hotspots and ICBP EBAs	Identification of priority conservation sites	Global	1. taxa (bird species for EBAs) 2. wild 3. structure, impact	
GHI	Prioritisation of sites for tree conservation	Local or national	1. taxa (tree species) 2. wild 3. structure	
GAP & GIS	Collation and analysis of spatial data	Global, national or sub-national	1. ecosystem, taxa 2. wild, agricultural 3. structure	
Indicators, including CBD, UNEP-WCMC, CIFOR & WWF-IUCN	Multiple applications: based on using a small number of variables to track total biodiversity	Global, national or local	1. ecosystem, taxa, genes 2. wild, agricultural 3. structure, process, impact	

* 1.ecosystem/taxa/gene 2. wild/ agricultural 3.structure/ process/impact
** 1. global / local 2. direct use / indirect use / non-use

Implicit or explicit values**	Cost-effectiveness	Communicability and potential usefulness as policy tool	Potential for integration of local and global values
1. global 2. non-use	High: usually based on secondary data	High: simple, emotive categories; worldwide application	High: local or national values could also be expressed in simple categories
1. global, local 2. direct, indirect, non-use	Medium to high: cheap sampling method but identification may be expensive	Low: difficult to express higher scale patterns	High: possibility for incorporation of local names and uses
1. global 2. indirect, non-use	Low: large scale and long-term, requiring high expertise	Low: complex scientific analysis needs careful spin to become a policy tool	Medium: holistic approach and potential for indicator verification
1. global 2. non-use	High: usually based on secondary data	High: readily comprehensible and visually communicable indices	Low: scale too large, though concept could be adapted at more local scales
1. global, local 2. direct use, non-use	Medium to high: minimal field costs but sometimes high cost of identification	High: readily comprehensible and visually communicable indices	High: already successfully adapted to include local economic values GAP & GIS
1. global, local 2. direct use, indirect use, non-use	Low: high hardware and technical costs plus variable need for primary data	Low: has already met with considerable resistance from natural resource managers	High: socio-economic and biological layers could be compared
1. global, local 2. direct use, indirect use, non-use	Variable: dependent on scale, data availability and need for verification	Medium to high: simple and powerful indices, but can be misconstrued or difficult to integrate	Medium to high: potential to include locally relevant indicators, but integration is a challenge

11.2 Local-level assessments

The approaches to assessing biodiversity in local terms differ from most of the other approaches described here in that they have not been driven by international conservation agendas. Therefore methodologies are far more ad hoc. Section 5 described some of the tools used by social scientists and development practitioners to elicit local viewpoints, methods that can be, and occasionally have been, applied to biodiversity assessment: ethnobotany, ecological anthropology, participatory rural appraisal (PRA) and economic valuation techniques. The final method described in this section, multidisciplinary landscape assessment, is a much more specific set of biodiversity-oriented methods to measure some of the more intractable facets of biodiversity, such as substitutability. Section 6 examined how actual biodiversity assessments have been performed at local levels, carried out by local people either working on their own or in collaboration with outsiders. Overall, this motley selection of potential and utilised methods (summarised in Table 6) offer means to capture local biodiversity values, but are less useful as working models for broader-scale biodiversity assessment or policy inputs, mainly because of their context specificity. Some general observations can be made that these local approaches are:

- **Revealing of the values and facets of biodiversity important to local people**. Local users of biodiversity often place value on facets of biodiversity that tend not to be addressed by scientific assessments – facets such as seasonal availability and use, or importance during drought years. Although concerned with more than direct use values, local biodiversity assessments usually emphasise resources that are harvested and used, and which may be invisible to outsiders. Understanding principles, criteria and indicators applied in local resource users' assessments of biodiversity can only be achieved after long periods of association and intensive interaction with the community. Thus, incorporating such local resource users' perceptions in formal assessments might increase the cost and time required for assessment. On the other hand, semi-structured interviewing and group exercises with local groups can draw out local perspectives and serve to make formal assessments more relevant and efficient. Certainly, ethnobotany, ecological anthropology and PRA have developed a variety of techniques that can be used as a first step to identify what should be measured to capture biodiversity in terms of local values.

- **Non-quantitative and often not documented**. Biodiversity assessments by local groups have, on the whole, clear objectives relative to scientific assessments, for example noting the prevalence of foods for subsistence, or pests on crops.

Indigenous appraisals, such as that described for the Irula people (Section 6.1) also tend to take a continual monitoring approach, and therefore offer a more complete picture, than for instance one-off scientific assessments even if these occur periodically, of how different organisms and ecosystems change over time. However, much of the information collected in indigenous appraisals remains inaccessible to outsiders, because most measurements are non- or semi-quantitative, and are maintained orally rather than being recorded.

- **Focused on utility of individual species rather than addressing variety and variability**. Techniques to elicit local biodiversity values have proved effective at analysing the usefulness and value of individual species or the range of species that may be of use to rural people. Local knowledge of particular species tends to be more complete than taxonomic classifications as it usually encompasses life-cycle, productivity and use characteristics. Furthermore, the information collected is continually being applied and adapted to specific uses. However, there has been much less progress on the more challenging task of understanding how much and why the *diversity* of these species is important and valued by people. Economic valuation methods have come closest to addressing this issue – and more generally to unpacking the term "biodiversity" with some degree of rigour – but have failed to gain wider credibility as a policy tool.

- **Difficult to extrapolate above the level of the site**. Any measure of biodiversity is intrinsically relative rather than absolute (see Section 2.3). Without anything to compare against, it is impossible for local groups to express how much biodiversity there is in their locale. Meaningful comparisons can be made between areas (e.g. comparing a local woodland and wetland in terms of their array of biological resources), or in one area over time, but it is much harder for local groups to say anything about the overall quantity and quality of biodiversity available to support their livelihoods. Historically this hardly mattered, because local people could assess biodiversity in ways useful to themselves. Now indigenous groups need more and more to defend their values and resources against outside claims, such as protected areas or commercial activities like logging or mining. Meanwhile regional, national and international policy-makers, however sympathetic they might be, find it difficult to extrapolate from detailed case studies to the macro level. The format of local biodiversity assessments, often qualitative and open-ended, adds to the difficulty of communicating with outside audiences. Both local groups and higher-level policy-makers have a clear need for a "go-between" approach to expressing biodiversity in mutually understandable terms, of the sort that the People's Biodiversity Registers are attempting.

Table 6. Summary and comparison of local biodiversity assessment and methods

Process	Goal of assessment	Scale of measurement	Facets of biodiversity measured *	
Ethnobotany	Documentation of names and uses of local biological resources	Local	1. taxa, gene 2. wild, agricultural 3. structure, impact	
Ecological anthropology	Open-ended evaluation of biodiversity values	Local	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	
PRA	Multiple applications	Local	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	
Economic valuation	Deriving monetary values for non-marketed resources	Local, national, global	1. taxa 2. wild, agricultural 3. structure	
Multi-disciplinary landscape assessments	Development of tools to express local biodiversity values in terms meaningful to higher-level policy-makers	Local	1. taxa 2. wild 3. structure, impact	
Irulas	Tracking availability of biological resources	Local	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	
People's biodiversity registers	Transfer of local / expert knowledge and wisdom into public realm	Local	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	

* 1.ecosystem/taxa/gene 2. wild/ agricultural 3.structure/ process/impact
** 1. global / local 2. direct use / indirect use / non-use

Implicit or explicit values**	Cost-effectiveness	Communicability and potential usefulness as policy tool	Potential for integration of local and global values
1. local 2. direct use, indirect use	Medium: depends on knowledge and reliability of key informants	Low: extrapolation above local levels difficult	Low: remain focussed on local issues with few techniques to scale-up or weigh up against considerations of public good
1. local 2. direct use, indirect use, non-use	Low: high investment of expertise, communicated mainly to academic audience		
1. local	Medium to high: mainly simple techniques but sometimes high investment of time demanded from local people		
1. global, local 2. non-use	Low: reliable estimates require intensive primary data collection	Medium: clear, financially oriented messages, but basis considered dubious	High: explicit means for measuring and combining different values
1. local 2. direct use	Medium: current high requirements for expertise will decrease when methods have been developed	High: specifically designed to facilitate communication and weigh up alternative land use options	Low: so far focussed on local direct use values
1. local 2. direct use, indirect use, non-use	High: well incorporated into daily resource use	Low: narrative, song-based style unsuitable for broad-scale policy inputs	Low: locally specific rather than transferable techniques
1. local 2. direct use, indirect use, non-use	High: standardised methods under clear categories; mix of group and local expert interviews	High: standardised methods detract from recording local uniqueness but allow broad view for policy-makers at state and national levels, drawing attention to wide range of values	Low: so far no means for combining or trading off local values, let alone external values

11.3 Assessments by higher-level decision-makers

Policy-makers at sub-national, national and international levels, and in both public and private spheres, often need to consider, design or carry out biodiversity assessments, typically as one aspect of broader land use planning or natural resource management. Table 7 provides a summary. International processes towards sustainable development and poverty alleviation, for example, include criteria for maintenance of biodiversity, while other processes, notably the Convention on Biological Diversity (CBD), focus specifically on biodiversity management (Section 7). Bilateral donors are presently attempting to mainstream biodiversity considerations into all of their operations (Section 8). At the national level, some processes have considered and rejected biodiversity as a priority for assessment and management (e.g. the Malawi National Forestry Programme), while elsewhere, as in India, national biodiversity assessment has become an end in itself (Section 9). The private sector has begun to develop more local-level methods for biodiversity assessment, for example to meet goals of sustainable production and supply chains, or with the expectation of biodiversity trading (Section 10). Methods used by policy-makers and practitioners to assess biodiversity, at national and international levels and in the public and private spheres, are, on the whole:

- **Vague about the purpose of the assessment**. Governmental institutions typically undertake biodiversity assessments as part of environmental impact procedures, in keeping with international guidelines about biodiversity monitoring and conservation. The innate problem with this approach is that the facets of biodiversity measured reflect global conservation values only. For example, national institutions and donor organisations tend to use threatened or endangered species as a key impact assessment indicator, but do not look at impacts on local food resources, or other direct use values. As with the scientific methods, these assessments implicitly or explicitly dwell on the non-use (option, bequest and intrinsic values, see Table 1) of biodiversity. Furthermore, biodiversity is judged as being valuable in itself, rather than in terms of the services it delivers – a traditional emphasis that implicitly places global non-use values over local and direct use values of biodiversity. An emerging counterpoint to this is the growing interest in biodiversity assessment within certain activities of the private sector, where although global non-use values remain the focus, market incentives tend to encourage a more goal-driven approach to biodiversity assessment.

- **Reliant on simple, indicator-based techniques.** Most efforts to assess biodiversity by international and national institutions focus on the species level and take an indicator-based approach. One of the primary reasons for this is limited finance. Sida, for example, has tried to expand the horizon of analysis to include genetic diversity, but this makes assessment much more complex and costly. Indicators can of course provide powerful shortcuts in biodiversity assessment. What indicators are chosen reflects the objectives and ultimately the values of the biodiversity assessors. National institutions and donor organisations commonly choose indicators based on global non-use values, such as changes in the percentage of land designated as protected areas or the numbers of endangered species, even when conservation for the global good is not the stated primary goal of biodiversity management. Many institutions appear to have adopted these indicators as default options rather than because they actively seek to emphasise global over local values, or non-use over use values. That there are few other appropriate, understandable or measurable indicators available reflects in part the hard lobbying by conservation groups for the adoption of conservation-oriented indicators. We cannot ignore that selection of indicators, like all aspects of biodiversity assessment, is a highly politicised process.

- **Often committed to inclusion of local values, but unable to operationalise.** National governments and international donor organisations often have strong commitment to local values, in terms of their central aims of poverty alleviation and sustainable development, and well-intentioned approaches of supporting good governance and participation. Biodiversity assessment by institutions such as these are hampered not by a direct commitment to global over local values, but by missing the next step of "how to". For example, DFID recognises potential links between global biodiversity values and local benefits, but does not have a mechanism for identifying this link in specific cases. In the private sector, a range of biodiversity assessment methods aimed specifically at local-level evaluation, such as forest certification audits and biodiversity credits, have been developed, but which nonetheless characterise biodiversity exclusively in terms of non-use, global values.

- **Beginning to mainstream and take a broad view of biodiversity.** The CBD takes a commendably broad view of biodiversity, including all scales from broad ecosystem variation to genetic variability within crops, and an explicit state-pressure-response approach, which includes consideration of a country's capacity to implement agreements under the CBD. This broad perspective

Table 7. Summary and comparison of biodiversity assessments within international and private sector processes

Process	Goal of assessment	Scale of measurement	Facets of biodiversity measured *	Implicit or explicit values**
CBD	Tracking progress against aims of CBD	National	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	1. global, local 2. direct use, non-use
Natural Heritage	Selection of sites of outstanding global value	Local	1. ecosystem, taxa 2. wild 3. structure, process	1. globall 2. indirect use, non-use
CSD and international development goals (DAC/ OECD)	Measuring progress towards sustainable development and poverty alleviation	National	1. taxa 2. wild, agricultural 3. structure	1. global 2. non-use
Sida	Environmental impact assessment	Local, national	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	1. global, local 2. direct use, indirect use, non-use
DFID	Award of PIMS biodiversity policy objective mark	Local, national	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	1. global, local 2. direct use, indirect use, non-use
FSC certification	Audits of forests against principles of sustainable forest management	Local	1. variable 2. wild 3. variable	1. global 2. non-use
RTTT	Benchmarking of supermarkets	Local	1. ecosystem, taxa, gene 2. wild, agricultural 3. structure, process, impact	1. global, local 2. direct use, indirect use, non-use
Biodiversity credits	Derivation of economic value of land in terms of biodiversity	Local	1. taxa 2. wild 3. structure	1. global 2. non-use

Cost-effectiveness	Communicability and potential usefulness as policy tool	Potential for integration of local and global values
Under debate: core set of indicators will need careful trade-offs between cost and comprehensiveness	Medium: a commonly agreed set of indicators could aid international debate, but is prone to disagreement and glossing over local differences	Medium: the CBD process is slow and vague, but remains flexible enough to allow considerable local adaptation
Not clear	High: due to the high support from national governments and international bodies, giving Natural Heritage sites high prestige	Low: Natural Heritage sites are chosen to reflect global value, and trade-offs with local values are not made explicit
Not clear	Low: indicators are optional and poorly developed, adding bureaucratic load more than utility	Medium: proposed indicator sets have focused on global non-use values, but are open to local selection and adaptation
High: comprehensive checklist of factors to consider, but low requirements for primary data	High: dynamic, utilitarian view of biodiversity that incorporates multiple perspectives	High: emphasis on stakeholder relationships, protection of knowledge, and local biodiversity values
High: efficient scoring system and computer-based records	Medium: an internal audit system, but broad opportunity-oriented approach includes training and capacity building as well as conservation	Medium: includes local capacity building, but retains emphais on biodiversity of global value
Medium: usually based on scanty secondary data	Medium: certification is an increasingly recognised market and policy tool, but the treatment of biodiversity in audits is imprecise	Medium: good links between biodiversity and desired outcomes for all stakeholders, but low investment so far in eliciting local values
Not yet clear, but explicit efforts to transfer costs to supermarkets as well as suppliers	High: potential for high consumer buy-in	Medium: inevitable trade-offs with values held by consumers in wealthy countries
Not clear	Medium: simple composite indices will be needed for biodiversity trading, but the potential of a biodiversity market is still to be seen	Low: local values are unlikely to be tradeable in a broader market

* 1.ecosystem/taxa/gene 2. wild/ agricultural 3.structure/ process/impact
** 1. global / local 2. direct use / indirect use / non-use

extends beyond the technical aspects of biodiversity to governance, as encapsulated in the Ecosystem Approach, which recommends locally-based, adaptive decision-making. Bilateral donor organisations such as Sida and DFID are putting into operation similarly broad approaches, with an additional emphasis on the opportunities that biodiversity supplies as well as the traditional attention given to threats to biodiversity. In the private sector the view remains more old-fashioned: biodiversity is regarded as purely an environmental feature, in parallel with separate social and economic sets of criteria, as seen for instance in most forest certification audits (Section 10.1; Annex 1).

- **Limited by the fear of league tables**. An important lesson from the process towards an international CBD core set of indicators is that national governments resist systems that permit ranking of countries according to their effectiveness in managing biodiversity. This will always be a challenge to generalising biodiversity assessment techniques, and to using shared sets of indicators in negotiation and policy formulation. More generally, the extent of governments' and private companies' support of different international processes is probably a good gauge of how biodiversity assessment might fare as a broader policy tool: widely accredited processes such as the CBD, FSC forest certification and Natural Heritage sites are perhaps the most promising loci of change for biodiversity management policy (Table 7).

11.4 Lack of exchange among approaches

The approaches to biodiversity assessment reviewed here all have strengths and weaknesses. Scientific methods have mainly been applied to conservation priority setting, even though they have plenty of potential for broader applications. Local assessments capture what matters locally but are difficult to link – for the good of local or national policy – to higher-level processes. Partly for this reason, assessments driven by national and international agendas, as well as those emerging in the private sector, almost invariably emphasise global biodiversity values over national or local values. The outstanding problem, then, is *exchange* among the independent tracks of biodiversity assessment. Policy-makers and practitioners have been influenced by the inputs of conservation campaign groups, but have not been able to make the most of the wealth of assessment techniques developed, often collaboratively with local groups, by natural and social scientists. Even among policy-makers themselves, exchange has been poor, for example between the international and national IUCN red data book processes (Rodriguez et al 2000).

Ways forward

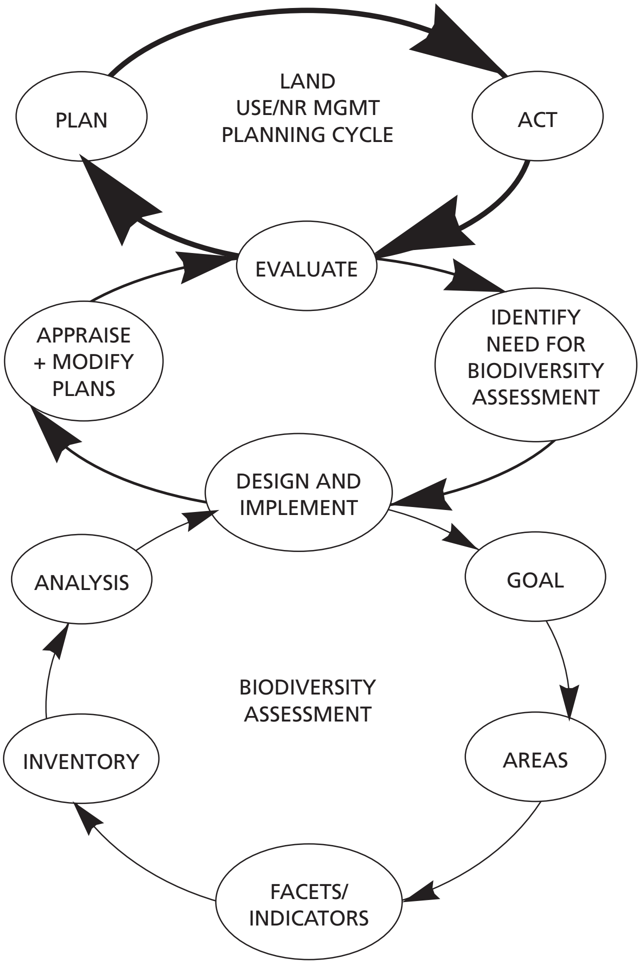
12.1 New frameworks for biodiversity management and assessment

Biodiversity assessments need to provide information that is useful to biodiversity managers. The most direct management decisions are made at local levels, and in this sense the most useful biodiversity assessments are those based locally. However, there are also a number of other levels at which decision-making affects biodiversity and livelihoods connected with it. National and local governments, land-owners and development or conservation organisations are some examples of others whose policies and activities are influential, and many of these agencies implement biodiversity assessments of their own. At both local and non-local levels, evaluation of biodiversity is part of broader cycles of land-use and natural resource management, either purposively or not (Figure 3).

Currently, most biodiversity assessments are poorly coordinated among different groups of decision-makers. This is only one component of a broader uncoupling among their respective management cycles – in short, a natural resource governance challenge that needs to be tackled on all fronts. Biodiversity assessment might be a usefully tractable part of this challenge, and indeed a tool for broader progress towards pluralist decision-making, for example by providing empirical information that serves as a basis for dialogue, negotiation or cooperation among different groups.

By adopting the principles of the Ecosystem Approach as the primary framework for operationalising the Convention on Biological Diversity, a large number of governments have committed to locally driven biodiversity management. Although international statements do not of course guarantee national or local change, the Ecosystem Approach nonetheless provides a framework for natural resource management in which, while other interest groups have their say, local roles, values, priorities, knowledge and decision-making are put in the lead. The CBD is an example of a broader trend of decision-makers in government, NGOs and the private sector recognising the utility of decentralised and democratic natural resource management, for

Figure 3. How biodiversity assessment fits as a sub-component of land use and natural resource management planning cycles



reasons of efficiency if not equity. Trade-offs and synergies between global and local biodiversity values are increasingly on policy agendas at local, national and international levels. Conservation discourse is also putting more emphasis on conservation of biodiversity outside reserves, with integration rather than segregation of global biodiversity and local livelihoods (Vane-Wright 1996; Prendergast et al. 1999).

Devolved, pluralist and adaptive management of biodiversity has obvious implications for assessment. Fundamentally, all the details of choosing, planning, conducting and learning from biodiversity assessments (Figure 3) need to be decided locally, shared and flexible. In response to this, one of the most promising directions internationally is the growing interest in, and practice of, participatory biodiversity assessment (Lawrence and Ambrose-Oji 2001; Rodriguez and van der Hammen 2002). These kinds of approaches (e.g. multidisciplinary landscape assessments, reviewed in Section 5.5) take up the challenge of finding a broad middle ground between local and wider biodiversity values, not only through communication of local values to global audiences and vice versa, but by sharing ownership of both the responsibilities (e.g. planning, fieldwork) and the benfits (e.g. access to information, financial rewards) of biodiversity assessment.

Not all biodiversity assessments need to be joint activities. Often stakeholders see no benefit in mutual evaluations or understandings of biodiversity. Local users all over the world rely on independent appraisals. Sometimes biodiversity may not be an issue at all, even among a broad range of interest groups. For example, the multi-stakeholder Malawi National Forestry Programme places much emphasis on biological resource values, but none on biodiversity, in defining the country's ten key areas for immediate action in the forestry sector. Biodiversity assessments can be expensive, or even risky. There can be serious disadvantages to local people, especially disempowered or indigenous groups, to getting involved in biodiversity assessment: not only the obvious transaction and opportunity costs, but also the potentially negative impacts of sharing information with outsiders, such as biopiracy (Shiva 1997). Much is made in international circles of the need to mainstream biodiversity issues into the full spectrum of national and regional planning processes. Perhaps instead the emphasis should be on mainstreaming – at a decentralised level – the *option* of collaborative biodiversity assessment and management.

Better governance and better information go hand-in-hand. The remainder of Section 12 identifies some strategies and tactics for getting the outputs of biodiversity assessments to serve broader goals of integrated evaluation and decision-making among different stakeholders. Section 12.2 draws some general lessons from the reviewed examples of tools and practice to guide designers of biodiversity assessments in planning approaches that will be relevant to different groups of decision-makers. Section 12.3 examines whether and how different biodiversity values can be brought together into composite indices. Section 12.4 considers a broader principles-based framework for biodiversity assessment.

12.2 Lessons learned: some guidelines for biodiversity assessment

One of the most important messages for decision-makers at all levels is to approach biodiversity assessment with pragmatism and scepticism. Formal biodiversity assessment is expensive, sometimes so much so that it takes away from management (Sheil 2001). The jargon of scientific assessments can hide a great deal of uncertainty, resulting in land management decisions based on spurious conclusions about local biodiversity (e.g. Homewood and Brockington 1999). Decision-makers want evaluations of biodiversity that answer specific questions as effectively as possible within the time and other resources available. Of course, good assessment results are contingent on good processes, and decision-makers need to be aware, and take advantage, of the political and other contexts surrounding and implicit in biodiversity measurement (Box 22). Researchers have an associated role to play in developing assessment approaches that are relevant to decision-makers who use the information generated.

Box 22. Putting biodiversity assessment into context

What decision-makers can do

- Rationalise biodiversity assessment – only assess biodiversity when there is good reason to do so, be explicit about the goals of assessment and base the methods used on these goals
- Be aware of the limitations of existing methods, and put more resources into developing integrated methods
- Identify relevant indicators rather than relying on internationally sanctioned conventional indicators (e.g. numbers of endangered species)
- Invest in the CBD process – ensure at an international level that a broad range of interests are reflected, especially those of local resource users and less wealthy countries, and nationally take advantage of the loose guidelines to set up a pragmatic and nationally specific programme of assessment
- Simplify requirements for biodiversity assessment in audits (e.g. forest certification and environmental impact assessments)

What researchers can do

- Provide more user-friendly evidence of the causal links between biodiversity and its ascribed indirect use values – e.g. Does biodiversity really offer environmental services such as watershed protection? Under what circumstances?
- Work together (natural scientists, economists and social scientists) to design methods for measuring biodiversity in terms of the value that people derive from it – including measures of accessibility, substitutability, and the added value of variety and variability (capacity to change) over the sum of biological resource values
- Look into how the knowledge and equipment needed for specific scientific assessment methods can be transferred and used without significant cost to less wealthy contexts
- Act as 'go-betweens' to link local managers of biodiversity to higher-level policy-makers

Working together, examples from both researchers and decision-makers – the tools and procedures reviewed here – suggest some general guidelines for designing biodiversity assessments:

- **Start planning any biodiversity assessment by disaggregating values**. For practical purposes, biodiversity is not a feature of living organisms, but rather a catch-all term for all the types of variety that might be useful to us (e.g. the range of decomposers in the soil) or might not (e.g. the range of deadly viral diseases). Treating biodiversity as one composite property, then, is not helpful. An especially useful way of disaggregating biodiversity is in terms of the values we attach to it: the relevant direct, indirect and non-use values. These can be further broken down according to the relative values to different beneficiaries – the differences between local and global values have been stressed here, but other distinctions among stakeholders may be more relevant in other contexts. Considering biodiversity in terms of what people derive from it, rather than as an end in itself, helps us phrase much clearer questions and objectives for assessment.

- **Acknowledge trade-offs between biodiversity and other benefits, among different aspects of biodiversity, and among the values attached to biodiversity**. Biodiversity assessment could and should be a powerful tool for making difficult decisions about what aspects of conservation and management of biological resources to prioritise. As a start, separating biodiversity values from general biological resource values would overcome a lot of confusions (e.g. "biodiversity" is said to provide watershed protection, but it may be found that a monoculture does just as well). Other key trade-offs are among direct use, indirect use and non-use values of biodiversity (e.g. maximising genetic variety in economic species versus maximising existence of unused species for future option values), between local and global values (e.g. conservation of all local bird species or concentrating on the one species that is rare globally), and among ecosystem, taxonomic and genetic levels of biodiversity (e.g. whether to maintain many different families of flowering plants versus many examples of a family deemed especially important).

- **In deciding what to measure, begin with a wide view of biodiversity and narrow down from there**. Measuring the array of facets of biodiversity is a daunting proposition, and in practical terms an inefficient use of valuable expertise, time and finances. On the other hand, it is difficult to have a standard means of prioritising what should be measured for all circumstances. Noss (1990) recommends starting with a coarse-scale, wide-reaching characterisation of a site, under the themes of composition, structure and function (alternatively other typologies such as structure/process/impact, state/pressure/response or ecosystem/taxa could be used), from which the key facets to measure are identified by comparing against data on "stress levels" (once again alternative criteria such as utility to local livelihoods, access, or rate of environmental change could be substituted). The underlying idea is to start by considering biodiversity in its broadest sense and then to use criteria to discard possible aspects to measure until a manageable set, based on the objectives and questions at hand, is reached. Even if the original characterisation of the site and the criteria are based on patchy evidence, a comprehensive checklist of possible factors is a very low-cost means of helping decision-makers to consider biodiversity more widely.

- **Measure the desired good or service rather than the associated biodiversity**. Links between levels of biodiversity and levels of delivered goods and services are poorly understood. Therefore it makes sense to assess the desired good or service rather than measuring biodiversity – evaluate seasonal availability of food, reduction in crop diseases, or landscape beauty, rather than the biodiversity that is considered to be providing it. Direct assessments of biodiversity are valid mainly for answering questions about non-use (option) values or questions of scientific interest, such as to provide baselines of genetic variation and variability in crop species, or to find out how many species there are in the world. Vanclay (1998) provides several other examples of where biodiversity is used as a surrogate and where biodiversity surveys are justified.

- **Design indices and indicators for specific land-use decisions and management processes**. There will never be a universal index of biodiversity. The growing plethora of approaches and formats to express biodiversity is an encouraging rather than dismaying sign. Assessment techniques, indicators and indices need to be tailored to particular land-use or management decisions. For example, the certification audit for Stora-Ludvika (Annex 1) recommended a "Rio index" of conservation value, based on a set of parameters that are available and relevant at the intended site, but would need to be adapted at other sites. What is transferable is the basic tool, in this case a composite index.

- **Accept imperfection – and be open to change**. Biodiversity assessments simply cannot be comprehensive. To carry out even a rough charaterisation of the biodiversity in a particular place is an expensive exercise if primary data collection is involved. Each stage of a biodiversity assessment – choosing values, choosing which facets of biodiversity reflect these values, designing and implementing field inventories, weighting data, combining data into one index for a site, assessing among sites or against a baseline – involves compromises. No one approach is perfect, and the usefulness and relevance of techniques changes over time. Well established approaches to tracking biodiversity, such as the IUCN red books, accept (and, where possible, estimate) uncertainty, as well as updating the ranking system to reflect changes in, or refinements of, knowledge and values.

- **Be aware of multiple perspectives and the political context of biodiversity assessment**. Practitioners have become so accustomed to indices and descriptions of biodiversity as a valuable end in itself that it is easy to forget that these portrayals of biodiversity are based on a view that the worth of biodiversity is in its non-use values (conservation for option, bequest and intrinsic benefits) to the whole of humanity. Criteria such as those used in selecting Natural Heritage sites (Section 7.2) appear to be based on some sort of global consensus over what is and what is not of "universal natural value". In reality, the global consensus is that of wealthy countries, and the most energetically promoted means of assessing biodiversity are those of wealthy conservation lobbies. This is not to say that poorer people would decline, given the opportunity, to support biodiversity conservation based on non-use values – simply that practitioners should be aware that the views and values of less powerful groups are shamefully absent from prevailing national and international approaches to biodiversity assessment and management.

12.3 Combining multiple values into single indicators

Real life trade-offs in the management and assessment of biodiversity will be solved via political processes rather than through derivation of "objective" indicators that combine different sets of biodiversity values. Nonetheless, policy-makers at national and international levels need biodiversity assessments that assist planning and priority setting. If policy decisions are to depend on local as well as national or global biodiversity values, reliable and generalisable methods to contrast or combine different measures are required. Scientists have already designed several methods for integrating multiple measures. The scientific methods of biodiversity assessment described in Section 4 provide a choice of three of the simplest methods for combining different measures:

- **Category method.** Different sites are put into different categories according to clear criteria. Multiple biodiversity values can be included by a hierarchical system of classification or by categories having more than one criterion each. For example, the categorisation of hotspots (Section 4.4) combines parallel criteria for endemism and threat. A local value, for instance contribution to food security, could be substituted or added. The category method is applicable to both qualitative and quantitative data. It is perhaps the most commonly used system for combining multiple global conservation values, but has not been widely applied as a means of co-assessing local and global biodiversity values.

- **Equation method**. Multiple values are combined into a single index using an algebraic equation. Each term can be used to represent one facet or value of biodiversity. The different terms can be weighted according to their importance by using different factors of multiplication. For example, the formula for calculating biodiversity credits (Section 10.3) has weighting terms for abundance, uniqueness and vulnerability, the relative importance of which can be adjusted by increasing or decreasing their relative weightings. Any one of these terms could be substituted by a term expressing local value, which could be weighted according to perceived (or negotiated) relative importance. For example, an obvious substitute for "uniqueness" would be "substitutability", a measure of how many replacements people have for a species used for a specified purpose.

- **Graph method**. Rather than lumping very different biodiversity values together, the graph method plots out different indices on opposite axes, to give a visual representation of difference. For example, the prioritisation of Canada's bird species (Section 4.9) plotted a measure of threat of extinction on one axis and the degree to which a species is concentrated in Canada (and therefore the responsibility of the Canadian government) on the other. Graphical means of combining more than one factor do not conflate factors that vary in different ways, without correlation, and therefore are more transparent than the category or equation methods.

Each of these three methods has associated strengths and weaknesses (Table 8). In the examples presented in Section 4, these methods have been applied mainly to integrating multiple conservation aims (e.g. endemism and threat of extinction). They could be just as easily used to combine multiple biodiversity values, such as direct, indirect and non-use values, or global and local values.

Indeed, some planning processes have already integrated multiple values in this way. For example, the Star System and Genetic Heat Index not only combine all three methods but have also gone further to incorporate a term for local economic value on top of the conservation values. This technique has recently been successfully applied to incorporate local use values in biodiversity management planning in Cameroon (Wong et al. 2002).

Table 8. Key strengths and weaknesses and examples of each of the category, graph and equation methods of combining multiple biodiversity values

	Category method	Equation method	Graph method
Key strength	Clear message (ranking) and applicable to qualitative data	Gives continuous index (e.g. useful to convert to monetary value)	Trade-off between axes explicit
Key weakness	Hides method of calculation (and therefore biases)	Obscures individual variables	Limited to a maximum of three variables
Examples	IUCN red data books Hotspots Endemic Bird Areas Star System	Genetic Heat Index Biodiversity credits	Genetic Heat Index Prioritisation of Canada's avifauna

More complex methods for integrating multiple values are also possible. Presentation of results of participatory biodiversity assessments, for example, often entail what might be called "scientification" of local knowledge, such as the application of formal statistical techniques, especially nonparametric rank-based tests, to information about local practice and perceptions (Hoft et al. 1999; Sheil et al. 2002). More broadly than biodiversity management, modern approaches to integrated natural resource management have begun to tackle how best to combine multiple values attached to natural resources, values based on different and sometimes conflicting stakeholder perspectives. Techniques include multivariate statistical methods such as principle components analysis, radar diagrams and canonical correlations (Campbell et al. 2001).

Integrated measures calculated in the above ways could be described as indices of "bioquality" (sensu Hawthorne 1996) rather than "biodiversity", in that sites that have the highest diversity of *beneficial* taxa, biological processes or potential impacts might be different from the sites that have the highest overall diversity of taxa, biological processes or potential impacts (in Hawthorne's usage, the forest with the highest bioquality did not necessarily have the highest diversity of tree species, but it did have the highest abundance of rare species and therefore the highest quality in conservation terms). The usefulness of a term such as bioquality is that it places emphasis on the values that people derive from biodiversity.

Real consensus over measurement of biodiversity, with common vision and minimum compromise, cannot really be hoped for. Without consensus among stakeholders over how measures of biodiversity are derived (from which facets are chosen through to how they are recorded, weighted, calculated and combined), any uni-dimensional index of biodiversity will always be questioned. The fact remains that stakeholders with different values will always need space for dialogue. Measures of biodiversity, and more importantly the management decisions that are made on their basis, will continue to be determined, ultimately, by negotiation rather than through rational exercises based on state-of-the-art techniques.

12.4 Principles-based approaches to biodiversity assessment

Biodiversity is just one of many examples of a natural resource that is valued widely but managed locally, and therefore requires approaches that are locally adapted yet broadly approved. A popular, and potentially very powerful, solution to achieving both ends is an evaluation system based on sets of principles that are agreed among a wide group of stakeholders, but allow substantial flexibility in decisions and actions taken locally. This is analogous to "loose-tight" models of business management that expect employees to work within core principles but to take most responsibility for local decision-making.

There are many working examples of principles applied to environmental and natural resource management. Some, such as the certification scheme overseen by the Forest Stewardship Council (Section 10.1), rely on compliance from applicants in order to participate, but sets of principles that provide non-compulsory best-practice models for participants (e.g. the Global Compact) may be just as useful – the primary utility of principles is in their role as learning tools for organisations and alliances. Principles are usually succinct, and general enough to apply to many different types of stakeholders, which means that they are excellent tools for negotiation and collaborative management if they are backed up by sufficient mechanisms for accountability.

A principles-based approach may be well suited to biodiversity assessment that needs to incorporate both global and local values. One of the big challenges of biodiversity assessment is the sheer amount of information that could potentially be gathered and evaluated. Principles provide the fundamental questions that need to be answered by assessment – a good starting point for choosing what to measure. Well-developed principles often include menus of potential indicators or targets within wider guidelines for implementation, which can be selected from or adapted to suit very different needs in different localities (e.g. in forest certification; Appendix 1).

More importantly, principles-based approaches have a broader applicability to the process as well as the content of assessment and management procedures. The twelve principles of the CBD's Ecosystem Approach (Box 2 in Section 2) are a good example of a set that includes both principles for how the resource ought to be managed (e.g. Principle 6: Ecosystems must be managed within the limits of their functioning) and principles for how management decisions ought to be made (e.g. Principle 2: Management should be decentralised to the lowest appropriate level). A biodiversity assessment based on this model would include questions on how close an ecosystem is to its limits (e.g. its state, rates of change, resilience, adaptability) and on how far management was decentralised (e.g. institutional rights and responsibilities, legal frameworks, budget control).

The principles of the Ecosystem Approach may or may not be an appropriate basis for collaborative approaches to biodiversity assessment, depending in part on whether the CBD can develop and sustain credibility and impetus at local levels. A global set of principles is only one of many potential ways forward – principles rooted in national or local realities could be just as good at bringing multiple biodiversity values into more open debate.

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Annex 1. Case studies of certification

Muzama Crafts, Zambia

Muzama produces wood and leather crafts. The company emerged from a donor-funded development project in 1989 and has remained heavily funded by international donors (a Dutch agency SNV paid for the certification process). Muzama's shareholders include representatives of the 400 pitsawyers and 150 carpenters who work through the company. Wood is cut from state-owned, communally managed natural forests around the villages in which the pitsawyers live.

Certificate profile

Date of certificate: 11 May 1998
Type of certificate: FSC natural forest management and chain of custody
Area certified: Initially 1.3 million ha, subsequently reduced to 0.8 million ha
Certifier: Woodmark
Motivation for certification: To gain access to export markets

The unsystematic assessment of biodiversity in this audit is perhaps typical of approaches to certification in countries where standards and methodologies have not been formalised. There were no local nor indeed Zambian representatives on the audit team, nor anyone trained in biology. No original measurements of biodiversity were done. The audit report used the section heading "Safeguards for maintaining biodiversity" to refer to two aspects of biodiversity: anecdotal reports of reductions in densities of large mammals and secondly existence of patches of *Cryptosepalum* forest and *Baikiaea* forest. These were deemed to be of conservation interest, the former because they are a rare example of evergreen forest outside Africa's equatorial rain forest zone and the latter because they represent the most northern extent of *Baikiaea*, a common type of woodland further south. The only biodiversity-related condition for certification was to prepare and implement a fire management programme within five years.

This audit presented the conventional professional view of biodiversity as important *per se*. The auditors addressed global biodiversity values only, emphasising protection of vegetation types of particular interest to scientists. They did not investigate local values or draw attention to the links between local socio-economic issues and either the maintenance or use of biodiversity. However, since the pitsawyers were found to have a low impact on the forest (a slow rate of cutting spread over a wide area, with little use of mechanised transport or roads), perhaps the low degree of attention given to biodiversity in this audit was perhaps entirely appropriate.

Stora-Ludvika, Sweden

Stora-Enso is one of the world's largest forest products companies, based in Sweden. Under pressure from environmental NGOs in the 1980s, the company began to modify its management of forest lands in Ludvika district, adopting a system of "Ecological

Landscape Planning" (ELP). Stora-Enso chose the Ludvika district to test the usefulness of certification for maintaining a share of the competitive northern European market for softwood products. The company estimates that about 10 % of productivity has been lost by applying ELP.

Certificate profile

Date of certificate: August 1996
Type of certificate: FSC natural forest management
Area certified: 309 000 ha
Certifier: SCS
Motivation for certification: Overall company policy to secure northern European markets

This audit took place earlier than that of Muzama Crafts in Zambia, but was able to draw on a much greater base of information and policy guidance on account of Sweden's long history of intensive land use and considerable investment in forestry. Two of the three members of audit team were Swedish, though none local. The assessment of biodiversity in the audit did not incorporate any new measures of biodiversity, but the auditors were able to draw on plentiful data from Stora's full-time ecologists and from other sources. The result was by far the most comprehensive and sophisticated appraisal of biodiversity among the four case studies presented here.

Biodiversity was approached in a number of ways in the audit report:

- Assessment of biodiversity at a hierarchy of spatial scales and over time, couched in straightforward terms of management (e.g. giving evidence to justify maintenance of 30 % of remaining habitat to ensure species survival).
- Identification of indicators of "forest community structure and composition", "long-term ecological productivity" and "biodiversity management actions, strategies and programmes" all geared towards maintenance of diversity, albeit not all expressed in unequivocal or quantitative terms.
- Consideration of the history of trade-offs between biodiversity and production.
- Appraisal of current biodiversity trade-offs (e.g. the choice to maintain high densities of moose and red deer reduces the diversity of deciduous tree species).
- Recommendation to manage landscape for full range of habitat types and disturbance regimes and diversity of stand sizes, juxtapositions and configurations.

Stora-Ludvika uses a "Prio index" to determine which stands should be cut to maximise economic yield. The auditors suggested an analogous "Rio index" to include conservation values of different stands. The index would be based on measures such as the amount of old deciduous trees and the distribution of decay stages of dead wood (less intensely managed stands have a higher distribution of late successional stages of decay).

Local livelihoods are less tightly linked to forest management in the Stora-Ludvika example than in the other three certification case studies. Furthermore, Sweden is one of world's most equitable and wealthy countries and therefore high congruence among local, national and global biodiversity values would be expected. The auditors did not neglect local biodiversity values however. Among the recommended indicators of biodiversity were "regular involvement of ecological planning expertise, including local NGOs" and "status of working relationships with entities such as county and community authorities and NGOs". The auditors were also able to suggest innovative approaches to maintenance of biodiversity, such as financial transfers to conservation organisations to avoid opportunity costs on forest lands. Overall this was an example of a thorough assessment of biodiversity, well-suited to the circumstances in which it was conducted, but far too resource-intensive an approach to have wide applicability.

Xylo Indah Pratama, Indonesia

Xylo Indah Pratama sources over 80 % of wood supplies for its pencil factory in Sumatra from smallholder rubber farms, where the *pulai* trees that are used for pencils occur naturally among the rubber. Since 1996 the company has encouraged local farmers to establish *pulai* plantations on marginal lands, either in monoculture or intercropped with coffee. Hundreds of small-scale farmers are involved in this scheme. The company relies on their co-operation to fulfil the requirements of certification.

Certificate profile

Date of certificate: 15 March 2000
Type of certificate: FSC natural forest management and chain of custody
Area certified: 210 000 ha
Certifier: SmartWood
Motivation for certification: Unknown. Possibly for reasons of international publicity

Three out of four members of the certification audit team convened by SmartWood in this instance were Indonesian, though none were local to the district of Xylo Indah Pratama's operations. The team included one ecologist. The team's audit did not mention biodiversity specifically, nor did it undertake any new measurements that could be used as biodiversity assessments. This was essentially because *pulai* agroforestry was seen as an improved land use compared to the cover of scrub prior to planting of *pulai*. The low impact of *pulai* harvesting was noted (e.g. low rates of rubber stand damage, use of well-established public roads, by-products left to decompose on site or burnt in factory as boiler fuel), though no comments were made on the effects of harvesting on rubber plantations or home gardens, where *pulai* grows wild. Under the heading "Environmental impacts and biological conservation", the team set conditions for granting of certification related to environmental impact assessment, reduction in use of agro-chemicals and prevention of soil erosion.

In terms of biodiversity, the audit of Xylo Indah Pratama's novel outgrowing schemes with local farmers was based on the assumption that *pulai* agroforestry fields constitute a more usefully diverse system than the scrub lands that they replaced. This contrasts with the other case studies of biodiversity in that the emphasis was on direct use values of biodiversity, and the diversity of cultivated plants, rather than on the option values (associated with maintenance of wild species) that are more often emphasised by external assessors. However, the extent to which this assumption tallied with local biodiversity values is unknown as the opinions of the small-scale farmers involved in the *pulai* scheme were not elicited.

Hoopa Tribal Forestry, USA

The Hoopa tribe of California gained self-governance of local commercial forests in 1991. These conifer forests provide a major proportion of income to the Hoopa tribe. Forestry operations have received financial support from the government, but this is slowly being phased out. The Tribal Council seeks to balance maximisation of income and employment for tribal people with maintenance of conservation and cultural sites, which are demanded by local interest groups. Standards of management of the forest exceeded the strict California State Forest Rules even before certification.

Certificate profile

Date of certificate: 15 April 1999
Type of certificate: FSC natural forest management
Area certified: 35 600 ha
Certifier: SmartWood
Motivation for certification: Independent validation of silvicultural and environmental practices

This audit provided a comprehensive assessment of biodiversity without using the word at all. The audit team were all USA nationals, two with ecological training, and included a Native American forester. Original inventories of biodiversity were not carried out for the audit, but extensive records of past forest management were available, allowing a thorough appraisal, albeit not as detailed as that of Stora-Ludvika in Sweden. An assessment headed “Ecological issues” was derived from past and present landscape structure (ages and species composition of different stands), status of threatened and endangered species as defined in state legislation (in this case three species of bird) and a recent survey of “category 2” (rare or vulnerable) species. This survey linked state and local biodiversity values by giving special attention to fish, which are traditionally important to the Hoopa people.

Of the four certification case studies, this was the most explicit in connecting the status of biodiversity with desired outcomes. This was due in part to the comprehensive environmental laws in California, which provide a framework of legal justifications for biodiversity assessment and management. More than this, the auditors chose to take a systems viewpoint, assessing the ecosystem at multiple scales in terms of inputs (e.g. pesticides) and of desired functions of the ecosystem, essentially biodiversity functions (e.g. presence of desired landscape mosaic, presence of rare indigenous bird species). In all, this audit provides a good example of how to side-step biodiversity *per se* and instead to concentrate on the outputs of ecosystems that are of interest to key stakeholder groups.