Chapter 5

Biodiversity

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Main Messages

Biodiversity is the variety of all forms of life, including genes, species, and ecosystems. Biodiversity underpins ecosystem services: biological resources supply all of our food, much of our raw materials, and a wide range of goods and services, plus genetic materials for agriculture, medicine, and industry. **Biodiversity has value for current uses, possible future uses (option values), and intrinsic worth. Biodiversity conservation ensures future provision of un-named or "undiscovered" services, and so complements direct maintenance of recognized ecosystem services.**

Recent decades have witnessed significant loss of biodiversity, at a rate two to three times faster than has occurred in geological history. Responses to this crisis focus on the conservation of biodiversity and on the associated problems of sustainable use of biological resources and equitable sharing of benefits arising out of the use of genetic resources. **Effective biodiversity response strategies have a bearing on human well-being in two ways: (1) they conserve a source of current and future goods and services, and (2) they create synergies and trade-offs of biodiversity conservation with other needs of society, including sustainable use of biological resources.**

Assessments covering a wide range of responses highlight several overarching issues. One is that **difficulties in measuring biodiversity make response design difficult, and complicate assessments of the impact of responses.** The potential benefits of integrating biodiversity conservation with management and planning for environmental services are substantial, but few examples of successful implementation exist and measurement problems make assessment of gains uncertain. Few well-designed empirical analyses assess even the most common biodiversity conservation measures.

Measurement and valuation of biodiversity requires attention to local, regional, and global scales. **Biodiversity may be valued differently, and generate human well-being differently, at local versus global scales. Focusing exclusively on either global or local values often leads to a failure to adopt responses that could promote both values, or reconcile conflicts between the two.**

The success or failure of any response to conserve biodiversity will depend on the ecological and institutional setting in which it is applied. Even within the same ecosystem, heterogeneity in institutions, income opportunities, access to markets, and other characteristics of the socioeconomic setting can lead to very different reactions to a given response.

Establishing and managing protected area systems directly conserves biodiversity, but emphasis on establishing new protected areas rather than managing existing ones effectively, area-based targets rather than biodiversity itself, and lack of funding for enforcement and management limit their impact. Success of protected areas systems as responses requires better site selection, incorporating regional trade-offs, in order to avoid the ad hoc establishment that can leave some ecosystems poorly represented. It also requires adequate legislation and management, sufficient resources, greater integration with the wider region within which protected areas are found, and expanded stakeholder engagement. The "paper parks" problem remains: geographic areas may be labeled as some category of protected area but not achieve the promised form of management. Representation and management targets and performance indicators work best when they go beyond measuring total area apparently protected. Percent-area coverage for protected areas associated with the Millennium Development Goals provide a broad indicator, but regional/national-level planning requires targets that take into account trade-offs and synergies with other ecosystem services.

Response strategies based on capture of benefits by local people from one or more components of biodiversity (for example, products from single species or from ecotourism) have been most successful when they have simultaneously created incentives for the local communities to make management decisions consistent with (overall) biodiversity conservation. Response strategies designed to enhance the local benefits derived from a few biological resources also seek to promote management for broader biodiversity conservation (including protection of global values). But even when a product is potentially well-linked to overall biodiversity (as in benefits from biodiversity prospecting) the actual benefits may not flow to the community, which results in inadequate incentives for conservation management. Alternatively, conservation payments can create economic incentives for such management. Overall, long-term success for these response strategies depends on meeting the economic needs of communities whose livelihoods already depend to varying degrees on biological resources and the ecosystem services biodiversity supports.

Management and sustainable use of wild species, with direct links to livelihoods, will remain a key response. Targeted protection of particular species has had mixed success in protecting overall biodiversity. Reintroduction of species, though often very expensive, has been successful, but such success generally will require the consent and support of the people inhabiting the target area. Control or eradication of an invasive species once it is established has appeared extremely difficult and costly. Prevention and early intervention have been shown to be more successful and cost-effective. Successful prevention requires increased efforts in the context of international trade, and in raising awareness. Sustainable use programs must include consideration of social and economic issues as well as the intrinsic biological and ecological considerations related to the specific resource being used. Zoos, botanical gardens, aquaria, and other ex situ programs build support for conservation, support valuable research, and provide cultural benefits of biodiversity.

Incorporating biodiversity into integrated regional planning promotes effective trade-offs and synergies among biodiversity, ecosystem services, and other needs of society. The "ecosystem approach" points to bioregional planning approaches that can achieve trade-offs and synergies. However, developing a quantitative regional "calculus" of biodiversity can enable marginal gains/losses in biodiversity from different places, and from different response strategies, to be estimated as a basis for planning the use of land and water. Assessments highlight synergies and trade-offs when different responses are integrated into a coherent regional framework. Society may receive greater net benefits when setting of biodiversity targets takes all land and water use contributions into account. Within a regional planning structure, effective responses also ensure connectivity between protected areas, promote transboundary cooperation, and incorporate habitat restoration. Different land uses should be seen as part of a continuum of possibilities, linked in integrated regional strategies. The great uncertainty is about what components of biodiversity persist under different management regimes, limiting the current effectiveness of this approach.

Places managed by the private sector can be recognized as possibly contributing to regional biodiversity conservation. Some parts of the private sector are showing greater willingness to contribute to biodiversity conservation and sustainable use, due to the influence of shareholders, customers, and government regulation. Many companies are now preparing their own biodiversity action plans, managing their own landholdings in ways that are more compatible with biodiversity conservation, supporting certification schemes that promote more sustainable use, and accepting their responsibility for addressing biodiversity issues in their operations. Limitations include insufficient synthesis of lessons to date concerning best pathways to "encouragement" and ongoing distrust between conservationists and business. Influence of shareholders or customers is limited in cases where the company is not publicly listed or is government-owned.

Integrating biodiversity issues in agriculture, fishery, and forestry management encourages sustainable harvesting and minimizes negative impacts on biodiversity. Most effective are *in situ* approaches such as some examples of organic farming that have developed synergistic relationships between agriculture, domestic biodiversity, and wild biodiversity. However, assessments of biodiversity contributions from such management often look only at local species richness, and little is known about contributions to regional biodiversity conservation. Effective integration also has a regional focus as in strategies that intensify rather than expand total area for production, so allowing more area for biodiversity conservation.

Governance approaches to support biodiversity conservation and sustainable use are required at all levels, based on the idea that management should be decentralized to the lowest appropriate level. This has led to decentralization in many parts of the world, with variable results. Planning and priority setting at regional scales may require governance and financial inputs at these scales. The key to success is strong institutions at all levels, with security of tenure and authority at the lower levels essential to providing incentives for sustainable management.

International cooperation through multilateral environmental agreements requires increased commitment to implementation of activities that effectively conserve biodiversity and promote sustainable use of biological resources. Numerous multilateral environmental agreements have now been established that contribute to conserving biodiversity. The Convention on Biological Diversity is the most comprehensive, but numerous others are also relevant, including the World Heritage Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Ramsar Convention on Wetlands, the Convention to Combat Desertification, the United Nations Framework Convention on Climate Change, and numerous regional agreements. However, their effectiveness must be measured by their impacts at policy and practice levels. Attempts are being made (for example, through joint work plans) to create synergies between conventions. The link between biodiversity conventions and other international legal institutions that have a major impact on biodiversity (such as the World Trade Organization) remains weak.

Education and communication programs have both informed and changed preferences for biodiversity conservation and have improved implementation of biodiversity responses. Biodiversity communication, education, and public awareness have emerged as a self-standing discipline, though it requires further development. Where change in behavior requires significant personal effort or economic loss, communication and education needs to be accompanied by other measures that assure livelihood support. Strategic approaches to achieve management objectives need to reflect the benefits and perceptions of multiple stakeholders.

5.1 Introduction

This chapter assesses the trade-offs and synergies among global, national, and local interests in conserving biodiversity and using its components (biological resources) sustainably. Based on the assessment of key responses to biodiversity loss, the chapter also provides policy options for decision-makers in the relevant ministries and in the private sector.

5.1.1 Biodiversity Values and Relationship to Ecosystem Services

While this chapter focuses on responses specific to biodiversity, such responses inevitably have to consider trade-offs and synergies involving ecosystem services. In brief, this chapter views biodiversity responses as largely about considering option values at many scales, with strong links to ecosystem service values arising at each of these scales.

While any value generated by a single gene, species, or ecosystem can be seen as part of biodiversity value, this chapter treats the values of such individual components of biodiversity as opportunity costs or benefits to be considered as a key part of effective biodiversity responses, at many scales. Biodiversity responses capture options for future well-being, and these responses may also involve trade-offs and synergies with other more direct ecosystem services. Thus the chapter takes human well-being as its central focus for assessment while recognizing that biodiversity and ecosystems also have intrinsic value and that people take decisions concerning ecosystems based on considerations of both well-being and intrinsic value, with the latter including option values (Reid and Miller 1989). Determining biodiversity option values remains a challenge for policy-makers at all scales, from crop genetic diversity in agroecosystems to global existence values.

5.1.2 Local, National, Regional, and Global Biodiversity Values

The debate over the links of biodiversity to ecosystem services reveals conflict about the scale at which biodiversity generates value. Some argue that *local* biodiversity assessments are most useful and see *global* biodiversity values as ignoring the important local values of biodiversity, especially relating to ecosystem services. Vermeulen and Koziell (2002, p. 89), for example, see the focus on global values as a consequence of the fact that "the global consensus is that of wealthy countries," and recommend consideration of biodiversity in terms of services derived from it and not as an end in itself. But such an approach ignores valid non-local values. This chapter assesses values that derive from biodiversity at all scales, with full recognition of the trade-offs between different types and scales of value.

While trade-offs often seem daunting, this chapter's integrative perspective helps reconcile what can be conflicting requirements for uses at a given place. Consideration of global biodiversity implies value for what is *unique* at a place (or what is not yet protected elsewhere). Ecosystem services may well value exactly what makes that place *similar* to many others, even though this amounts to "redundancy" at the regional scale. But effective biodiversity responses can see both values as valid, with the within-place values seen as costs and benefits to be taken into account at the regional scale.

5.1.3 Goals, Main Points, and Structure of this Chapter

This chapter assesses responses that aim to conserve biodiversity and use biological resources sustainably, using case studies to determine what has or has not been successful under what conditions. Of many responses, this chapter assesses the nine responses that are most widely used and discussed: protected areas; local capture of benefits; wild species management; regional planning, agricultural/forestry and fishery policy; private sector activities; governance; multilateral environmental agreements; and education / communication. These responses may vary from the MA typology applied to ecosystem services—biodiversity is not considered an ecosystem service in the MA—and each response typically addresses more than one driver of biodiversity loss.

The chapter follows this list of responses in order, beginning with protected areas because virtually every country has a PA system as an important component of its efforts to conserve biodiversity. That assessment is followed by a section on responses that enable local people to capture biodiversity protection benefits because many of those responses are employed in and around protected areas to address conflict between local people and the aims of the protected areas. Responses under this heading include ecotourism, integrated conservation and development projects, and conservation payments. The section on the management of wild species deals with local people's reliance on particular species as well as addressing issues of managing invasive species and preventing extinctions. The next section assesses the role of regional planning in identifying synergies and trade-offs across the region that contains protected areas, intense land and water uses, managed ecosystems, and other potentially conflicting uses. Regional planning provides a mechanism for tying together responses that conserve biodiversity both within and beyond protected areas.

Agricultural and fisheries policies deal directly with biodiversity components, and their multiple impacts are assessed. The private sector's impacts on biodiversity are profound, and we assess efforts to minimize negative impacts, or to make them positive. Governance is the broadest response, and several multilateral environmental agreements contain provisions for the conservation of biodiversity by the signatories; although those countries then employ a range of responses to meet their obligations, this chapter assesses MEAs as a biodiversity conservation and sustainable use response in and of themselves. Finally, the chapter assesses the role of education and communication activities in generating support for conservation and sustainable use of biodiversity.

Several themes emerge from these assessments. First, the human well-being of local people dominates the assessment of many responses including PAs, governance, wild species management, and local capture of benefits. Although biodiversity at the global scale creates human well-being for people far removed from where valued biodiversity is found, the contribution of biodiversity to the well-being of local people is critical. Second, the divergence between local, national, regional, and global values of biodiversity (and the human well-being derived at these different scales) presents challenges to biodiversity conservation and sustainable use. A regional perspective can address conflict and create balance over geographic space. Finally, incorporating biodiversity benefits into management decisions permeates the assessments of agriculture, fisheries, MEAs, and private sector responses for conservation.

Taken as a whole, the following assessments lead to several conclusions:

- The current system of PAs is a valuable tool for conserving biodiversity, but these areas do not yet include all biodiversity components that require such protection. Better tools exist for selecting areas for inclusion in PA systems than are currently employed, and better management of individual PAs is required.
- For successful (global) biodiversity conservation, local people must be able to capture benefits from that conservation.
- Integrated conservation and development projects as currently designed rarely succeed in their objective of conserving biodiversity, yet their general concept remains valid. They need more realistic objectives and a stronger link to broader policy issues.
- Regional planning can achieve balance across areas to create a landscape that includes strict conservation areas, managed landscapes, intensively used areas, and other land and water uses.
- Direct incentives for biodiversity conservation usually work better than indirect incentives.
- More income must flow from the people and countries that value biodiversity from afar (at the global level) to the people and countries where much globally valued biodiversity is conserved, often at considerable opportunity cost.

These assessments suggest that in the coming years:

- Direct management of invasive species, particularly efforts to prevent invasions, will become a more important biodiversity conservation response.
- Biodiversity conservation in ecosystems managed for production will become increasingly important.
- Conservation payments appear promising even though they require more testing.
- Regional planning can be better utilized to integrate various biodiversity responses.
- Biodiversity conservation in light of climate change will pose many challenges, calling for improved management of habitat corridors and production ecosystems between protected areas, thereby enabling biodiversity to adapt to changing conditions.

5.1.4 Links to Multilateral Processes

5.1.4.1 Millennium Development Goals

The MDGs were endorsed by members of the United Nations in 2000 to address common pressing global concerns. The timeframe set to achieve the MDGs is 2015. In fact, the MDGs are already showing their potential of bringing together various actors to honor the commitment. For instance, in the African and Asian regions, finance ministers are using the MDGs to focus more resources on development. The New Partnership for Africa's Development is also using the MDGs and has begun reporting on progress toward their achievement. Environmental sustainability, including incorporation of biodiversity into development activities, is one of the eight goals. Like the WSSD Plan of Implementation, the MDGs cover broad and complex issues that will require better institutions and tools to achieve the goals. The Secretary General of the United Nations has initiated a Millennium Project to produce detailed advice for achieving the MDGs; he recognizes biodiversity as providing a foundation for achieving the goals.

5.1.4.2 World Summit on Sustainable Development

The 2002 World Summit on Sustainable Development produced a commitment by governments to address sustainable development. Paragraph 42 of the WSSD Plan of Implementation makes specific reference to the conservation of biodiversity, and many other parts of the Plan are relevant to biodiversity. Despite the commitment made to conservation of biodiversity and the idea of integrating it into development projects, the Plan is very broad and requires multiple institutions to collaborate for its successful implementation. The Plan's goal of reducing the rate of loss of biodiversity by 2010 is challenging because the current rate of loss is not known with any precision. Yet this goal had been adopted by the parties to the Convention on Biological Diversity at its sixth Conference of the Parties in April 2002, and the European Union has adopted an even stronger one (*halting* the loss by 2010). Further, the WSSD considers biodiversity as one of its five major issues; the others are water, energy, health, and agriculture.

5.1.4.3 World Trade Organization

Although the World Trade Organization has established a Committee on Trade and Environment to deal with environmental issues and has contributed to environmental policies such as the Rio Declaration, the WTO still insists that it was established primarily to deal with trade and not environmental issues. It has shown minimal commitment to environmental issues, including biodiversity. Despite its position, some progress can be assessed. One illustration is the tuna-dolphin case between the United States and Mexico (WTO 2003), which gave rise to some positive developments in favor of the environment and marine biodiversity in particular. The case has been brought under Article XX of GATT, which provides general exceptions, and the environment is one such exception (Lang 1995). Although the panel report on the case was not adopted, it nonetheless encouraged countries to take into account the impact trade could have on biodiversity and environment in general, and serves as a guide for countries to consider conservation of biodiversity. However, the reluctance of the WTO to integrate biodiversity and environmental concerns remains a challenge.

5.1.4.4 Other Processes

Numerous other international programs and events are dealing with or relevant to biodiversity. Prominent among them are convention reports (CBD, CCD, Ramsar, CITES, CMS); the Intergovernmental Panel on Climate Change; the *Global Environment Outlook* (UNEP/collaborating centers); the *World Resources Report* (UNEP, UNDP, World Bank, WRI); Earth Trends (WRI); IUCN Red Lists and Species Survival Commission Reports; the *Human Development Report* (UNDP); the *World Development Report* (World Bank); FAO Plant Genetic Resource Assessment; FAO reports on fisheries, forest, and agriculture; and the UNESCO-MAB program.

5.2 Assessing Protected Areas as a Response to the Loss of Biodiversity

5.2.1 Introduction

Protected areas are the most commonly used tool for in situ conservation of biodiversity, a role recognized under Article 8 of the CBD. A ''protected area'' is defined in Article 2 of the CBD as ''a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives.'' Assessments of protected areas as a biodiversity conservation response strategy indicate that protected areas are an extremely important part of programs to conserve biodiversity and ecosystems, especially for sensitive environments that require active measures to ensure the survival of certain components of biodiversity. Most protected areas also contribute to a country's economic objectives in providing ecosystem services, supporting sustainable use of renewable resources, and generating tourism and recreation values. Ecosystem services generated and supported by protected areas include microclimate control, carbon sinks, soil erosion control, pollination, watershed protection and water supply, soil formation, nutrient recycling, inspiration, and a sense of place. Many protected areas are of great importance as tourist and recreation destinations—both nationally and internationally. As the world becomes increasingly urbanized, such values associated with protected areas seem likely to increase.

Protected areas also play an important role in ensuring the respect for, and recognition and maintenance of, important traditions, cultures, and sacred sites (Harmon and Putney 2003). Increasingly, protected areas are being used as mechanisms to promote peace-keeping efforts among nations, notably through transboundary protected areas and ''peace parks'' (Sandwith, Shine, Hamilton and Sheppard 2001).

Protecting specified areas from certain human uses has a long history including North Africa's age-old *hima* system (the reserves established by the Hafside dynasty in 1240 in Tunisia), and the marine protected areas established by local communities in the Pacific hundreds of years ago as a tool to preserve fishing areas (Kelleher 1999). All this indicates that traditional protected areas were an important resource management approach for the societies that established them.

The modern movement of protected areas is rightly associated with the establishment of the first national park in the United States at Yellowstone in 1872 (Phillips 2003). Through the evolution of the modern protected areas movement, some protected areas have been accurately criticized on the grounds that local communities have been excluded from resources that have traditionally supported their livelihoods. On the other hand, many protected areas have substantially contributed to the livelihoods of local people, offering options for alternative economic development (McNeely 1993; EC and IUCN 1999; EC/DFID/IUCN 2001).

Today more than 100,000 sites are recognized by IUCN as protected areas. (See Figure 5.1.) Together they cover about 11.7% of Earth's land area, equivalent to the whole of South America (IUCN/UNEP-WCMC 2003). However, the current global system of protected areas is not sufficient to conserve biodiversity, as a consequence of insufficient coverage, inappropriate location, insufficient management, and related economic and social factors. Some assessments of case studies (MacKinnon et al. 1986; Barzetti 1993) suggest improving the effectiveness of protected areas for biodiversity conservation, through a number of approaches, including: (1) strategies for effective protected areas design and management that are appropriate to their ecological, social, historical and political settings; (2) regional planning strategies that fully take into account the requirements of protected areas management within the context of the land/water uses surrounding them, and seeking trade-offs and synergies with ecosystem services; and (3) a better appreciation of the multiple economic values of protected areas, for local people, the nation in which they are located, and the world at large, and better ways of capturing these so that local people are not disadvantaged. Systems of protected areas that safeguard important biodiversity values at different levels (local, national, regional, and global) can contribute to human well-being when individual protected areas provide measurable benefits through services that complement ''off-reserve'' approaches.

5.2.1.1 Adequacy

Recent assessments have shown that, at the global and regional scales, existing protected areas, while essential, are not sufficient for conservation of the full range of biodiversity (UNEP/CBD/SBSTTA/9/5). Problems include lack of representativeness, impacts of human settlement within protected areas, illegal harvesting of plants and animals, unsustainable tourism, impacts of invasive alien species, and vulnerability to global change (IUCN 2003b).

Marine and freshwater ecosystems are even less well protected. Mulongoy and Chape (2004, p. 5) conclude that ''recent assessments indicate that conservation of marine and coastal biodiversity is woefully inadequate, with less than 1% of Earth's marine ecosystems protected . . . major freshwater systems . . . are

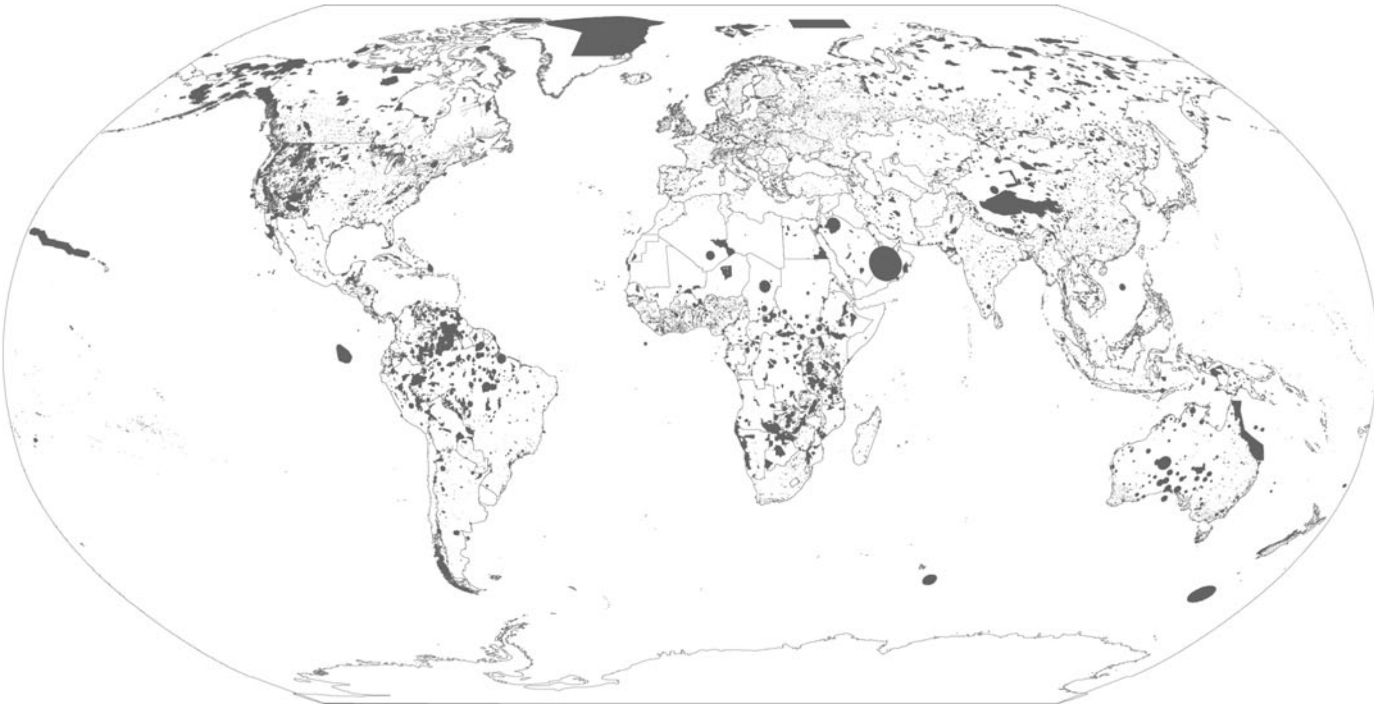

Figure 5.1. Global Network of Protected Areas. The global network of protected areas, according to 2004 World Database on Protected Areas. This map represents all protected areas recorded in the WDPA, except those for which no area information was provided. For some sites, only the central coordinates and total area were known (no polygon boundaries were available), and these are represented as circles. The WDPA includes sites with a variety of land management types and conservation effectiveness, including strictly managed reserves, areas subject to multiple uses, and indigenous reserves. (WDPA Consortium 2004)

also poorly represented.'' Further, global assessments based on area coverage are misleading in suggesting that biodiversity conservation is successful, because the coverage varies from country to country, some ecosystems are better protected than others, and certain kinds of biodiversity are best conserved outside of protected areas.

The country reports of the parties to the CBD provide numerous perspectives on the effectiveness of protected area systems. Stated needs include improved legislation, more effective management, more resources for protected area management, capacity building among protected area managers, effective integration between protected areas and the wider region, and effective involvement of all stakeholders in the establishment and management of protected areas (UNEP/CBD/AHTEG-PA/1/2). Furthermore, the 2003 fifth World Parks Congress identified the following critical factors of success: the sustainable financing of protected areas systems, adequate capacity of PA institutions and managers, and the application of scientific and traditional knowledge to protected areas planning and management (IUCN 2003a).

5.2.1.2 Basis for Assessments

Assessment of PA systems as a mechanism for biodiversity conservation requires attention to fundamental issues for the MA, including trade-offs and synergies at global, national, and local levels.

Because protected areas are a form of land/water use that explicitly rules out other resource uses, establishing them can involve conflict between the need for long-term biodiversity conservation (particularly for globally threatened and endemic species) and more immediate social and economic priorities. Access to products such as fuelwood and charcoal, medicinal plants, timber and game, are curtailed when local residents are prevented from entering a protected area. These restrictions could have cultural implications, depending on the degree to which local people are allowed access to, for example, sacred sites.

However, these conflicts could be minimized through adequate consultation and planning. One useful strategy is to promote the broader use of all IUCN Protected Areas Management Categories (IUCN 1994) that allows a gradation of the level of protection from areas strictly protected to those that support multiple uses of its natural and cultural resources. This could be a useful tool in establishing national systems of protected areas, as required under the CBD Article 8a (Davey 1998). Instead, most countries use only the more strictly protected categories at the national level, thereby foregoing benefits from additional areas established under categories allowing some forms of human use.

Most PAs provide multiple benefits, with different sites providing different mixes of benefits according to the objectives of their management (IUCN 1994). In addition to their conventional conservation objectives, protected areas are now expected to contribute more to social objectives. For example, the secretariat of the CBD (2004, p. 1) recognizes that ''a strong consensus has developed that protected areas need to make a solid contribution to poverty alleviation and sustainable development. The main challenge for using protected areas to alleviate poverty is how to find the right balance between the desire to live harmoniously with nature and the need to exploit resources to sustain life and develop economically.'' This approach demands the maintenance and enhancement of core conservation goals, equitably integrating them with the interests of all affected people, forging synergy between conservation, maintaining life support systems, and supporting sustainable development (IUCN 2003b).

Protected area planning and management with the participation of local communities is becoming more the rule than the exception, and it has been incorporated in the guidelines of development agencies (for example, the World Bank and the European Union) and key donors such as BMZ (the German Federal Ministry for Economic Cooperation and Development), GTZ (the German aid agency), and USAID. Innovative participatory and co-management arrangements for protected area management are being implemented in almost all regions of the world and considerable information and lessons learned from such initiatives are now available (Jaireth and Smyth 2003). Full stakeholder participation, including partnerships between civil society, government, and the private sector, has been also identified as a key guiding principle to integrate biodiversity conservation in development activities (EC/DFID/IUCN 2001).

Adequate attention to global biodiversity conservation will not follow easily from a focus on poverty alleviation. Lapham and Livermore (2003, p.13) state: ''Biodiversity funding is now driven heavily by social and economic objectives, which are not necessarily synonymous with objectives such as avoiding extinctions or protecting unique and biologically diverse landscapes.'' Also (p. 20), ''as poverty reduction becomes the driving force behind development assistance across all sectors, conservation appears to be falling by the wayside . . . Ramifications may include a reduced role for science in shaping biodiversity assistance priorities, decreased funding for crucial conservation activities, fewer projects with clear conservation outcomes, diminished biodiversity expertise within funding agencies, and less political attention to conservation.'' Similarly, Sanderson and Redford (2003, p. 390) are concerned that ''in its new incarnation, poverty alleviation has largely subsumed or supplanted biodiversity conservation. This trend has gone largely unnoticed, but poses a significant threat to conservation objectives.''

However, this conflict is not an irresolvable problem: an increasing number of successful cases show how protected areas can achieve both conservation and the *sustainable use* of biodiversity (MacKinnon 2001). Box 5.1 gives several examples. In other sections, this chapter argues for biodiversity to be more widely considered in other policies that may be aimed at poverty alleviation in much the same way that PAs, although largely focused on biodiversity conservation, also contribute to local and regional economies.

The degree to which global biodiversity conservation is ''swept along'' by the increased attention to poverty alleviation is largely unknown, with case studies supporting various conclusions. Vermeulen and Koziell (2002, p. 52) call for ''indicators that are able to measure progress towards integrating different biodiversity values across the landscape.'' They acknowledge that local values may correspond to specific biological resources more than to biodiversity generally. Sanderson and Redford (2003, p. 390) argue that complementarity between global, national, and local values ''can only be achieved if we respect the strengths and weaknesses of both conservation and poverty alleviation efforts and the trade-offs inherent in integrating them. Calls for 'pro-poor conservation' that ignore these trade-offs will end up in failure, with both the poor and biodiversity suffering.''

5.2.2 Management of Protected Areas

While significant progress has been made in the establishment of a global network of protected areas, assessments suggest that many protected areas are not managed in ways that will enable them to achieve their objectives. The most appropriate way to manage protected areas depends very much on local conditions, and opinions vary as to the effectiveness of existing PA strategies (Brandon and Wells 1992; Terborgh et al. 2002). Some protected areas are ''paper parks,'' with little or no investment in management. Yet an assessment of protected areas in Africa, the Caribbean, and the Pacific noted that even so-called ''paper parks'' play an important role in the development and further consolidation of national protected areas systems (EC and IUCN 1999). This role has been supported by recent research that suggests that simply establishing protected areas on a map does afford at least some protection to biodiversity (Bruner et al. 2001).

The 2003 fifth World Parks Congress identified increased PA management effectiveness as one of the key goals for the next decade (IUCN 2003a). A survey assessed that less than 25% of forest protected areas were well managed, with many forest protected areas having no management at all (IUCN 1999). The need to assess the effectiveness of protected area management and governance more systematically was also emphasized (Goal 4.2) in the CBD Programme of Work on Protected Areas, adopted at the seventh Conference of the Parties in Kuala Lumpur, Malaysia, in February 2004.

Recent assessments indicate several widespread weaknesses of PA management (WWF 2004). In a survey of management effectiveness of nearly 200 protected areas in 34 countries, only 12% were found to have implemented an approved management plan. The assessment concluded that PA design, legal establishment, boundary demarcation, resource inventory, and objective setting were relatively well addressed. But management planning, monitoring and evaluation, budget security, and law enforcement were generally weak among the surveyed protected areas. WWF judged poaching, encroachment by agriculture, ranching, urban development, logging, and non-sustainable collection of non-wood forest products to be the major threats. This situation is not confined to the developing world. A recent assessment of the ecological integrity of Canadian National Parks revealed many similar problems and identified long-term actions required to enhance the management of the system (Parks Canada Agency 2000), and in Europe, agricultural development policies have been identified as a major threat to protected areas management (Synghe 1998).

While today's PA management emphasis on community issues far exceeds what it was in the recent past, activities relating to people were often seen as poorly managed, especially with regard to tourism management. Thus the fifth World Parks Congress (Durban, South Africa, 2003) recommended promoting the role of tourism as a tool for biodiversity conservation and for support of protected areas through measures such as conservation education, encouraging stewardship among locals, and reinforcing local community development and poverty alleviation. But the WPC also noted that if tourism is not appropriately planned, developed and managed, it can contribute to the deterioration of cultural landscapes, threaten biodiversity, contribute to pollution and degradation of ecosystems, displace agricultural land and open spaces, diminish water and energy resources, and drive poverty deeper into local communities (IUCN 2003a).

WWF (2004) noted examples of protected areas working successfully with people, suggesting that success depends on a collaborative management approach between government and stakeholders, an adaptive approach that tests options in the field, comprehensive monitoring that provides information on management success or failure, and empowerment of local communities in a participatory system that provides direct access and ownership of resources. (See Box 5.2 for an example in Indonesia.) Others have given considerable attention to issues associated with indigenous and traditional peoples and protected areas. A long process

BOX 5.1

Benefits from Protected Areas: Marine Examples

Protected areas provide numerous benefits, including contributing to sustainable fisheries (see Bahamas and Samoa examples) and supporting recreation and tourism (Bonaire Marine Park and Merritt Island National Refuge).

Exuma Cays Land and Sea Park (45,620 hectares) in the *Bahamas* was established in 1958 covering both the terrestrial and marine environments associated with these islands. The Park became a no-take fisheries reserve in 1986. Research has shown that the concentration of conch in the park is 31 times greater than outside the park, providing several million conchs per year to areas outside the park available to be harvested by fishers. Additionally, tagged grouper from Exuma Park have been caught off of both north and south Long Island (Bahamas), indicating the Park is replenishing grouper stocks in areas as far as 250 kilometers away. Tagged spiny lobsters from the Exuma Park are found replenishing the marine environment of Cat Island, 100 kilometers away. The success of fisheries resource replenishment in the Exuma Park led the government to announce a policy decision in 2000 to protect 20% of the Bahamian marine ecosystem, doubling the size of the national protected areas system (WCPA News 2002).

In the Pacific Island of *Samoa,* like in many countries in the tropics, catches of seafood from coastal areas, lagoons, and inshore reefs have been decreasing over the past 10 years. Reasons for this decline include overexploitation, the use of destructive fishing methods (including explosives, chemicals, and traditional plant-derived poisons) and environmental disturbances. In order to address this problem, the Samoan Fisheries Division initiated in 1995 a community-based extension project in 65 villages which recognized the village *fono* (council) as the prime agency responsible for actions. A large number of villages (38) chose to establish small village fish reserves in part of their traditional fishing areas and decided to actively support and enforce government laws banning the use of explosives and chemicals for fishing. Some villages also set minimum size limits for capturing fishes. While many of the village reserves are small (ranging from 5,000 to 175,000 square meters), their number and the small distance among them forms a network of fish refuges. In just a few years, fisheries stocks have increased 30–40% and there are signs of recovery in reefs previously affected by destructive fishing methods. As the fish reserves are being managed by communities which have direct interest in their success, prospects for long-term sustainability of this initiative are high (King and Faasili 1998).

Bonaire Marine Park (2,700 hectares) was created in 1979 and cvers all reef areas around the island. While the resident population of the island is less than 15,000, 17,000 to 20,000 scuba divers visited the park every year, and diving tourism represented the main economic activity of the island. Total gross revenue from dive-based tourism was estimated to be $23.2 million in 1991. In addition to this, $340,000 was generated through taxes levied on divers. Visitor fees thus more than covered the cost of the establishment of the park ($518,000) and the recurrent management cost ($150,000) was. The park also generates employment for over 1,000 people. By 1994, the number of divers had increased to 24,081 and the total annual visits was about 70,000 (The Commonwealth of Australia 2003).

Located at Cape Canaveral, Florida, United States, *Merritt Island National Wildlife Refuge* contains two areas, with a total extension of 4,000 hectares, that have been closed to fishing since 1962. Before these areas were closed, commercial and recreational fishing in the areas was intensive, causing fish stocks to be heavily depleted. The value of this reserve for the recreational fishery outside its borders has been assessed by the number of record-size ("trophy") fish caught by recreational fishers. The area extending 100 kilometers to the north and south of the reserve provided 62% of record-size black drum, 54% of red drum, and 50% of spotted sea trout. Fish tagging studies showed that these species indeed moved out of the reserve into the surrounding waters (Roberts et al. 2001; Commonwealth of Australia 2003).

BOX 5.2

Komodo National Park, Indonesia
(http://www.komodonationalpark.org/downloads/CMP10.pdf)

The government of Indonesia has formed a team consisting of park rangers, navy, police, and fishery services that carries out a routine patrolling program. Since the team's inception in 1996, blast fishing has declined by over 80%, and marine biodiversity is reported to have increased dramatically. Law enforcement was emphasized because of the threat of outside fishers who used more destructive fishing practices. Even with the patrolling, it was found that a more intensive enforcement system had to be considered, as the improved condition of the marine park made it even more attractive to outside fishers. In combination with enforcement activities, exclusive fishing rights were proposed for traditional use zones to park inhabitants and for buffer zones to communities in the direct surroundings of the park.

of consultation among protected areas managers and indigenous peoples' groups assessed successes and failures in addressing the full integration of the concerns of indigenous peoples in PA planning and management. As a result, agreed principles, practical policy, and technical guidance on this issue have been developed and widely distributed (Beltrán 2000).

A strong consensus exists among protected area experts that the minimum critical ingredients for effective PA management are appropriate staffing, good public education and community outreach, and excellent enforcement capacity (Hockings et al. 2000). Because law enforcement is strongly correlated with management effectiveness, well-trained, well-equipped, and well-motivated teams of rangers and other field staff are fundamental. But to be effective, the local enforcement effort needs to be backed by a broader environment of good governance that ensures that laws and regulations are respected and enforced. Although protected areas management increasingly adopts an inclusive rather than exclusive approach, law enforcement efforts will remain an essential element of effective management of protected areas, even where communities are involved in decision-making and are compensated or offered alternative livelihood opportunities.

An assessment of anthropogenic threats to 93 protected areas in 22 tropical countries reveals that most protected areas are under constant pressure from land clearance, grazing, fire, hunting, and logging (Bruner et al. 2001). The effectiveness of "protected area" was shown to be a function of the number of guards and the existence of "significant" sanctions for those caught breaking the law. Effectiveness did not appear to be affected by the number of people living in the park, the area's accessibility, local support for the protected area nor the involvement of local communities in park management. However, the authors used a narrow definition of "effectiveness" as the protection of biodiversity against human access, and ignored any adverse impact the protected areas may have had for the local communities' use of ecosystem services.

Despite conflicts between those responsible for the PA and those who historically have relied on resources within the PA, a growing consensus suggests that PAs will be more effective when:

- strong institutions define boundaries, access rights, and user participation,
- local communities have "bought in" to the protected area,
- local communities have alternative livelihood opportunities or receive direct payments and so are not made worse off by the PA, and
- sufficient resources are available for funding enforcement effort.

The funding of recurrent costs of protected areas management is a key problem. Trust funds to support protected areas are currently in place at least in Argentina, Bhutan, Bolivia, Brazil, Costa Rica, Ecuador, Indonesia, Jamaica, Mexico, Panama, and Peru. Payments for ecological services that are supporting protected areas are being implemented in Costa Rica and Brazil. However, the Global Monitoring Report (IBRD and World Bank 2004, p. 15) notes that "aid to developing countries to support improved environmental practices, both bilaterally and through multilateral vehicles, has declined after a short-lived increase following the 1992 Rio Convention." WWF (2004, p. 18) concludes that "environmental services provided by protected areas (such as provision of clean potable water) need to be recognized and paid for; national funds for protected areas must be strengthened; the budget of the Global Environment Facility (GEF) should be substantially increased in its replenishment, so as to meet the challenges of supporting the implementation of the [GEF's] Programme of Work."

The fifth World Parks Congress identified that $25 billion in additional annual support was required to establish and maintain an effective global system of protected areas. The CBD Ad hoc Technical Expert Group on Protected Areas (CBD 2003a) has argued that GEF funding is crucial for developing countries, because studies suggest that developing-country governments may only allocate only between $50 and $100 million annually towards direct costs of protected areas and conservation.

The multiple benefits provided by protected areas can help provide the basis for various innovative mechanisms for financing them. This highlights the need for effective valuation of these goods and services, which stimulate funding of protected areas. Such evaluations have been implemented, or are in the process of being undertaken, in many countries so as to counteract the general tendency to reduce budgets of protected areas.

5.2.3 Design of Protected Areas

Selection and design issues concerning individual terrestrial and marine protected areas include aspects relating to size, shape, connections, corridors, and edge effects. The application of all these aspects needs to be tailored to national and local environmental and socioeconomic circumstances. While "population viability analysis" clearly indicates protected area design considerations for some single species, PA design would benefit from an equivalent "biodiversity viability analysis" that takes into account the needs of *all* species in a region (Faith et al. 2003).

A recent extensive review of case studies relating to PA design (Environmental Law Institute 2003, p. 2) argues, "given the inherent complexity of ecological systems, scientists are understandably reticent about providing exact prescriptions for spatial (land and water use) planning and design because answers vary depending on the species, ecosystem, or scale in question." Nevertheless, even partial knowledge about species or ecosystem responses to human disturbance and fragmentation needs to be applied to land use decisions, ensuring that it is informed by the best available science. The review recommended certain "potential ecological threshold measures," which relate to habitat patch area, percent of suitable habitat, edge effects, and buffers. On the other hand, it would not give any guidance concerning a key design issue, corridors, given the current information. The assessment highlights the inadequacy of the information currently available to planners of protected areas.

An important consideration for PA design is the future impact of climate change. In this context, corridors and other design aspects to give flexibility to protected areas are regarded as good precautionary strategies.

5.2.4 Regional and Global Planning for PA Systems

In the past, many protected areas were selected simply because they were not suitable for agriculture or human settlement, or because they had scenic value. These factors help explain why existing PA systems are not representative of biodiversity. Recent developments in "systematic conservation planning" provide strategies to locate protected areas that maximize biodiversity representation and persistence, while minimizing conflict with competing land use needs.

One aspect of systematic conservation planning is "gap analysis," where "gaps" are habitat types that are under-represented in an existing network of protected areas (Noss 1996). Systematic PA selection seeks to fill such gaps (Pressey and Cowling 2001). Gap analysis now uses the principle of complementarity in setting priorities: the complementarity value of a place is indicated by those *additional* biodiversity elements it provides relative to an existing set of protected areas (Pressey et al. 1993).

The sophisticated framework for selecting sets of priority conservation areas on the basis of complementarities has been criticized as a scientific approach with limited practical use. For example, recent CBD documents describe it as too "data-hungry" for practical application, and such methods are seen by some to run counter to the need for more value-laden decision-making. Jepson and Canney (2003) argue against the need for experts, who are supposedly the only ones who can identify units of conservation. On the other hand, Noss (2003) and others see the involvement of "experts" and scientists as an essential element of the decision-making process. Overall, a systematic framework can make best possible use of all available data, however meager, and provide science-based decision support. The decisions themselves are matters of public choice, not science, so it should not be surprising if the ideal protected area system is hardly ever implemented (Noss 2003).

The nature of global values points to critical trade-offs and synergies with local values. Mulongoy and Chape (2004, p. 38) suggest, "within the network, individual protected areas are also designed to maximize their effectiveness . . . a protected area should usually be positioned to include the maximum biodiversity possible." But emphasis should be given to the complementarity value of the location, if global biodiversity values are the priority. Given that such marginal gains are not normally expressed in dollar terms, forms of multicriteria analysis have been used to explore regional trade-offs in the design of protected areas systems. This approach is in accord with overall response strategy options in the

MA focused on "integrated responses" (Brown et al. 2001). (See Chapter 15 of this volume.)

Case studies (Faith et al. 1996; Ando et al. 1998) have illustrated how better trade-offs (providing greater net benefits for society) can be achieved by explicitly taking variable opportunity costs of conservation into account in setting regional priorities for location of protected areas. In Uganda, a five-year $1 million program proposed expansion of the PA network in a way that minimized opportunity costs (Howard et al. 2000). The problem of "paper parks" might be addressed in part by having estimates of costs, including opportunity costs, presented "up front" when designing a protected area system. This provision is now applied in most countries, but often underestimates the difficulty in obtaining additional funding from external sources (grants, projects, etc.) to cover these costs.

Even in regions with very high potential conflict between biodiversity conservation and provision of other ecosystem services, planning based on trade-offs reveals a potential to achieve high conservation at remarkably small cost. In a Papua New Guinea planning study (Faith et al. 2001a, 2001b), high-value biodiversity areas often overlapped with high opportunity cost areas—areas presenting good opportunities for agriculture that would have to be forgone under conservation. Application of complementarity-based selection of priority areas for biodiversity conservation nevertheless identified a set of areas having low opportunity cost. The use of multicriteria analysis in the Papua New Guinea study revealed possible ways to minimize conflict among different land use needs, and found synergies in the location of priority protected areas. Areas that were given priority had high complementarities and also known distributions of rare or threatened species.

The few case studies available suggest that the use of multicriteria analysis to guide selection of such priority biodiversity conservation areas would (to some unknown degree) increase the regional net benefits provided by ecosystem services and biodiversity option values. To date such approaches appear to have seldom been applied.

In the Global Strategy for Plant Conservation (annex to decision VI/9), the sixth Conference of the Parties of the CBD specified (1) that by 2010 at least 10% of each of the world's ecological regions should be effectively conserved, implying increasing the ecological representation and effectiveness of protected areas; and (2) that protection of 50% of the most important areas for plant diversity should be assured through effective conservation measures, including protected areas.

Simple percent coverage targets at the global scale have several advantages (Hoft 2004) including easy compilation of the information base, applicability to various scales, and effective communicability. Such percent targets may be most applicable as a broad-scale indicator of performance, but with the caveat that achievement is expected to be via some country-scale spatial planning.

A complement to these approaches may be global priority setting that identifies regions where conservation planning is a priority. Such an approach may identify "narrowing" windows of opportunity for balanced planning (Faith 2001) as a way to incorporate well-being considerations into global biodiversity priorities. Although information on biodiversity at the species level in most freshwaters is poor (Revenga and Kura 2003), it has been possible to effectively identify "hotspots" or priority places for conservation action. At the global scale, "hotspots" point to the regions that may most urgently demand such systematic planning, because of high complementarity with other regions and high threat, the latter possibly indicating high opportunity costs of conservation.

Complementarity is important even at the global scale of planning and priority setting. The 25 global biodiversity hotspots identified by Conservation International are based on endemism, which is a special case of complementarity (Myers et al. 2000). Efficiency of resource allocation for this set of hotspots can be argued because high endemism values mean that each region contributes additional species (conserving such a "hotspot" also has been seen as a less cost-effective way to conserve biodiversity; see Ando et al. 1998). Similarly, the Global 200 priorities (WWF 2003) implicitly use complementarity in order to seek representation of all ecosystems within regional conservation and development strategies.

Any measure of the effectiveness of protected area systems that is based on area-coverage must consider that a system can be extensive in total area yet poorly represent the region's biodiversity (Pressey and Tully 1994). Allocating land for the protection of biodiversity has always faced, implicitly or explicitly, the opportunity costs of making the land unavailable for competing human uses. Because many protected areas were specifically chosen because they were not suitable for human use, the percentage of a country's surface that is a designated protected area says relatively little about the actual biological diversity protected (Pressey 1997; Barnard et al. 1998). This is further discussed later in this chapter.

Percent target strategies for protected area systems often call for percentage coverage of each forest or land cover type or biome within a region, in order to better address representativeness rather than just total amount of area. Percentage targets remain open to several criticisms (Faith et al. 2001b):

- They depend on nominated "types" that can be defined at different scales; the scale of types can determine the total area needed for any nominated percent target.
- Different land types vary in terms of internal heterogeneity or diversity; more diverse types arguably deserve a higher target.
- Different types vary in terms of likelihood of persistence in the absence of conservation action (for example, because of differences in geographic extent). Percent targets can run counter to types with greatest need for protection, because models of probabilities of persistence suggest that geographically extensive habitat types may have a reasonable probability of persistence of their components even in the absence of action, and so require a *smaller* not larger percentage area protection.

Rodrigues et al. (2004), in a species-based, global-scale, study of gaps in protected areas suggests that regions most in need of additional protected areas are not those indicated by application of percent targets. They analyzed 4,735 mammal species, 1,171 threatened bird species, 5,454 amphibian species, and 273 freshwater turtle and tortoise species. Of these, 149 mammals, 232 birds, 411 amphibians, and 12 tortoises are threatened with extinction and have habitats are not protected anywhere. This indicates that about 80% of birds and over 90% of the other taxa are contained within the protected area system, but significant numbers remain unprotected. A caveat is that the list of unprotected taxa, interpreted as broader biodiversity surrogates, may not predict where protected areas are most needed for biodiversity in general.

Biodiversity surrogates based upon best possible use of a combination of environmental and species (for example, museum collections) data may provide greater certainty in estimating biodiversity patterns. Such a "calculus" of global and regional biodiversity may allow biodiversity targets to be formulated in ways that integrate socioeconomic factors and avoid weaknesses of types and percent targets (discussed further below).

5.2.5 Assessment

The substantial progress in declaring land protected has successfully conserved much biodiversity, especially when protected areas are specifically designed to conserve particular species of concern. But many species and ecosystems are not included in the current system. There is a need to apply an integrated approach to land/water use management beyond protected areas, in addition to expanding PA systems to make them more representative. Even when the system is well designed, investments in managing the protected areas remain inadequate. The total cost of establishing and maintaining effective protected area systems has been estimated (Balmford et al. 2002), but the estimate is based on relatively old data, and the needs and costs of such systems urgently need updating. Further, pressures on protected areas are likely to increase as growing populations consuming more resources make more demands on the remaining natural habitats at a time of rapid climate change.

For protected areas to effectively address their conservation and development objectives several actions need to be taken urgently. With respect to policy, the following are needed:

- Build effective synergies between global conventions and agreements that are dealing with biodiversity conservation and sustainable development.
- Give priority to promoting the effective implementation of the CBD Programme of Work on Protected Areas, including increasing international funding.
- Promote the application of a full range of revenue generation and sustainable financing mechanisms for protected areas management, while removing the policy and institutional barriers to sustainable financing solutions.
- Adopt an ecosystem perspective and multisectoral approach to development cooperation programs that include support for protected areas and take into account the impact of activities in adjacent and upstream areas.
- Ensure that development cooperation supports the development of effective institutions for PA management, giving priority to build effective, transparent, accountable, inclusive, and responsive institutions.
- Identify and apply policy and institutional options that promote the fair and equitable sharing of costs and benefits of protected areas at local, national, regional, and international levels.
- Develop, through legal, policy, and other effective means, stronger societal support for PAs, based on the benefits and the value of the goods and services they provide.
- Ensure the availability, understanding, and use of accurate, appropriate, and multidisciplinary information by all key stakeholders dealing with PA planning and management.
- Give priority to promoting and applying the best scientific and traditional knowledge to PA planning and management.

A number of technical issues need consideration as well:

- Use better approaches, based on best practices, to design and plan protected areas, including the use of the whole range of IUCN protected areas management categories and their integration into land/water use planning.
- Promote application of tools and methods to assess PA management effectiveness in both terrestrial and marine protected areas as a tool to improve management.
- Complete global, regional, and national gap analyses using best-possible surrogate information for all of biodiversity, to improve representation and persistence of biodiversity conservation in protected area systems. Such analyses should also include the assessment of the social costs and benefits of establishing and managing such systems. Give priority to completing the global system in relation to marine protected areas, freshwater ecosystems, and desert and semi-desert ecosystems.
- Promote the effective application of the principles of good governance for effective protected areas management. These principles must contribute to the full participation of local communities and indigenous peoples in both management and decision-making processes on protected areas.
- Develop better tools to evaluate the impact/effectiveness of PAs on biodiversity conservation.

5.3 Helping Local People to Capture Biodiversity Benefits

One of the fundamental challenges for biodiversity conservation is that the benefits of that biodiversity protection often accrue to people who are far removed from the resources while the costs (especially in terms of lost access to resources) are primarily paid locally. Where people do receive benefits from biodiversity locally, which provides incentives for local management, those benefits may be different from the benefits that accrue to people living farther away. An example would be sustainable harvesting of a species by local people that would create the incentive to conserve the species, thus meeting the desire of people far away for the mere existence of the species. Even when the benefits are the same, economists contend that local people have little incentive to manage resources to provide benefits (here, protect biodiversity) beyond their own communities unless they have some means of capturing some of the value of those non-local benefits. "Capturing" means any method that allows local people to receive payment or compensation for undertaking biodiversity conservation or sustainable use that provides benefits to non-local people. The idea is that compensating local people for their biodiversity-friendly actions based on the value of those actions beyond the local area will improve their well-being and thereby maintain higher levels of biodiversity.

Mechanisms to promote local capture of national and global biodiversity benefits include economic incentives, integrated conservation and development projects, ecotourism, and benefit sharing. Establishing any of these mechanisms requires that a significant share of the cost to develop and maintain the institutional capacity to manage biodiversity be paid by international conservation organizations, donors, and nations. As Barrett et al. (2001, p. 501) say, "The global beneficiaries of biodiversity must not abdicate complete authority and responsibility to either tropical states or indigenous communities, but rather must work to improve the capacity of nested institutions to induce and enforce tropical conservation." But this is not in accord with current political reality, as donor funding for biodiversity continues to fall far short of the needs.

Because local people are de facto the primary resource managers in most regions, it can be concluded *with a high degree of certainty* that working with the local communities is essential to conserve biodiversity in the longer term. Local human populations are best placed to ensure effective husbandry of the resource, and because resources figure strongly in the livelihoods of rural populations, particularly the poor, these groups are particularly important stakeholders. Community-level benefits are central to sustainable management, particularly when the resource is large and distant from major administrative centers, and the relevant government departments are understaffed.

Yet community involvement in protecting biodiversity is most likely to be effective only with appropriate property rights systems in place. Land tenure and property rights are closely linked to the ability of local communities to capture the benefits of biodiversity conservation and hence to their incentives to protect biodiversity. Weak property rights undermine community involvement in the protection of biodiversity because the community is unable to restrict external access to local resources; and because the community has little incentive to adopt long-term strategies to manage these resources, decision-making tends to be short-term and opportunistic. For example, in the francophone territories in West Africa, forest residents have no authority and hence no ability to restrict the exploitation of game by "outside hunters" (Bowen-Jones et al. 2002). Hence any schemes to compensate the local community for biodiversity protection would be rendered ineffective. Not surprisingly, the most successful and well-documented cases of wildlife management in Africa come from the dry savanna zone in the south (the best known is CAMPFIRE, Communal Areas Management Programme for Indigenous Resources, in Zimbabwe), where, inter alia, the tenurial context is much more favorable.

In Ghana, encouraging local community management of wildlife resources has involved the proposal that the government Wildlife Division devolve property rights over wildlife to certain local communities, thereby providing an incentive for the community to conserve and manage the natural resource base (ULG Northumbrian Ltd 2000). Simply given this authority, the community would be expected to manage the resource to maximize its own benefits, not biodiversity benefits. However, giving the property rights to manage the resource to the local community provides a mechanism through which outside agencies concerned with biodiversity conservation can negotiate with the community, and through which the community can have the legal backing to protect the resource from "outsiders."

In practice, achieving improvements in both local people's well-being and biodiversity protection has proven elusive. This section assesses several important policy responses that have sought to bring in the two elements together.

5.3.1 Economic Incentives: Indirect versus Direct

"Incentives" broadly cover any mechanism for changing actions. Individuals make decisions based on preferences, opportunities, and constraints. Economic incentives can alter the outcome of a decision process by changing the constraints or the relative net benefits of the set of opportunities. The institutional and market setting in which the decision is made affects the relative values of opportunities or constraints. Incentives are recognized as a key issue for biodiversity conservation. For example, Article 11 of the CBD states that "each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity."

Incentives may be negative (disincentives), such as taxation or access and user fees, or positive, such as tax credits. Responses that create positive incentives work by altering an individual's behavior toward more conservation activities, generally by establishing a mechanism through which the individual captures, or is compensated for creating, some of the social benefits associated with conserving biodiversity. Negative incentives aim at reducing negative impacts on biodiversity by ensuring that full costs of resource exploitation are paid. Typically a combination of negative and positive incentives will be used to halt losses of biodiversity.

A combination of controls and positive incentives will be more cost effective than relying on one or the other, and hence will be more sustainable in the long run. Positive incentives can be used to compensate people for loss of access to resources within PAs. Wells et al. (1992) caution against making the unsupported assumption that people made better off by development projects will refrain automatically from illegal exploitation of a nearby PA; to increase conservation activities, the compensation must have some mechanism for creating a conservation incentive within the decision framework. In addition, incentives are unlikely to work without a monitoring and enforcement system.

Although many underlying principles for introducing incentives have been discussed, interventions must be case specific, and approaches typically will include a combination of incentive measures that may include economic and regulatory measures, as well as measures such as stakeholder involvement and public education, to build an enabling framework (OECD 1999). The classification of incentives as positive or negative relates to the actor's behavior. From the perspective of the implementation of incentives as a response, the distinction between indirect and direct incentives is more important. Both positive and negative incentives can be direct or indirect.

5.3.1.1 Indirect Incentives

Development interventions in or near endangered ecosystems *indirectly* seek to provide desirable ecosystem services through three mechanisms: (1) redirecting labor and capital away from activities that degrade ecosystems (for example, agricultural intensification); (2) encouraging commercial activities that supply ecosystem services as joint outputs (for example, ecotourism); or (3) raising incomes to reduce dependence on resource extraction that degrades the ecosystem. These mechanisms are not always successful. In the case of redirection of labor or "conservation by distraction," the response may not reduce the labor allocated to the degrading activity if other people are hired to take advantage of the opportunities provided (Muller and Albers 2004). Commercial activities that maintain ecosystem services may be successful on a limited basis but rarely is the demand for the outputs large enough to support more than a small fraction of the local population. Lastly, raising incomes leads to conservation only if the extracted products are "inferior" goods that are replaced by preferable and less degrading goods as incomes rise.

Community-based natural resource management initiatives, also called integrated conservation and development projects, are one type of indirect incentive intervention In order to truly integrate conservation-based and development-based projects, ICDPs must use the development project to create incentives for conservation, establishing a direct and on-going link between the two objectives. Given the issues with indirect incentives already described, it is not surprising that many assessments of ICDPs report that they have had limited success in achieving their joint conservation and development objectives (Wells and Brandon 1992; Ferraro et al. 1997; Wells et al. 1998; Oates 1999; Ferraro 2001; Terborgh et al. 2002). ICDPs have been assailed for several reasons: erroneous assumptions about the desires of local people to protect nature, ambiguous effects on conservation incentives, complex implementation needs, failure to recognize the role of the market setting, and lack of conformity with the temporal and spatial dimensions of ecosystem conservation objectives (Brandon 1998; Southgate 1998; Chomitz and Kumari 1998; Simpson 1999; Ferraro 2001; Terborgh and van Schaik 2002; Muller and Albers 2004).

ICDPs are intuitively appealing because they assume either that local people will forgo harvesting in the protected area if they are offered a development project (school, dispensary, road, etc.) as an incentive, or that local people harvest in the PA because they have no alternative, and they will stop if alternatives are provided. However, the assumption that development will automatically favor conservation is not supported by the evidence (Braken and Meredith 2000). An early assessment of ICDPs worldwide (Wells et al.1992) concluded that they were reasonably effective in meeting development objectives but very few had a significant positive impact on conservation.

An even more pessimistic view on ICDPs is exemplified in Terborgh et al (2002), who argue that a bitter lesson is that when rural communities derive substantial benefits from the sustainable use of natural resources, the improved local economy can set in chain a process that drives conservation and development apart.

ICDPs allow local populations to improve their well-being by capturing non-local people's willingness to pay for biodiversity conservation, but in practice ICDPs rarely turn that ''capture'' into on-going incentives for conservation. Integrating conservation and development objectives can help identify trade-offs (see discussion below) but the project's success must be used as an incentive for conservation.

In an example of how important the setting can be in determining success of responses, the WWF and the Royal Netherlands Development Agency's Tropical Forest Portfolio, composed of seven ICDPs in six countries, recognized that linking conservation and development is constrained by a variety of circumstances that collectively threaten projects such as these. Funding was provided to identify and better understand these constraints through rigorous monitoring, technical assistance, capacity development, and improved information exchange. Details of the portfolio and other ICDP experiences can be found in McShane and Wells (2004). The main portfolio lessons are:

- *Implementation must take place at different scales.* It is easier to integrate conservation and development at larger scales that have increased area for protection, buffer zone, and development activities. The challenge for practitioners is not to decide the best scale at which to operate, but rather the optimal combination of actions that are required at different scales.
- *The policy environment is as important as field-based approaches.* The success of conservation and development efforts depends on the policy and market setting. Without supportive laws, policies and regulations, and their enforcement, it is unlikely that these efforts will be either successful or sustainable.
- *Sound institutions are the foundation of effective resource management.* The institutional characteristics of conservation and development initiatives include several different aspects: legal and organizational frameworks, formal and informal property rights and rules that govern resource management, and the norms and traditions of the different stakeholders and actors. Such initiatives require institutional forms with the capacity to deal with ecological, social, economic, and even political change.
- *Acknowledge and negotiate trade-offs.* Rather than the ''win-win'' outcomes promoted (or assumed) by many practitioners, conflict is more often the norm, and trade-offs between conservation and development need to be acknowledged. Identifying and then negotiating trade-offs is complex, involving different policy options, different priorities for conservation and development, and different stakeholders. The challenge in negotiating these trade-offs is determining levels of acceptable biodiversity loss and stakeholder participation.

ICDPs are just one kind of indirect incentive. Another type is nature-based tourism. This is a popular enterprise whose goal is to allow local people to capture the value non-local people are willing to pay for the local environment by charging them for access and services (such as guided tours, meals, and housing). Nature-based tourism according to the World Tourism Organization includes all types of tourism where the primary motivation of tourists is the observation and appreciation of nature, as well as cultures. Nature-based tourism projects purport to create an incentive for conservation because the income generated is a function of the quality of the environment: fewer tourists will come to a degraded area than to a more attractive one.

Several market studies show that a preserved environment, well-managed protected areas, and high biodiversity are becoming important elements in the choice of a recreation destination. The World Tourism Organization has conducted market studies in Europe and North America which show that consumers are willing to pay for these characteristics particularly when they were guaranteed that money goes ''towards preservation of the local environment and reversal of some of the negative environmental effects associated with tourism'' (Goodwin 2003, p. 278).

As with other indirect methods of value-capture by local people, however, in most situations, tourism income is generated without creating incentives for biodiversity conservation for local people. In an assessment of ecotourism in the Ecuadorian Amazon, Wunder (2000) found that tourism as a local conservation incentive works only if it changes labor and land allocation decisions. Tourism can also have potential adverse impacts for the sustainable use of biological resources and their diversity. For example, the demand of tourists for water, fuel, food, or other needs can strain the local resource base. Similarly, noise, jeeps, and garbage from tour groups can degrade the natural environment. The CBD Guidelines on Biodiversity and Tourism Development (http://www.biodiv.org/programmes/socio-eco/tourism/guidelines.asp?page=6) provide impact assessment, management, and mitigation guidance. They are currently being tested on case studies all over the world.

In many areas, the people who gain the income from tourism are not in control of the natural resources and cannot protect the resources even though they have an incentive to do so. In Khao Yai National Park, Thailand, tourism provides conservation incentives in some villages but the tourist groups and their demand for services is simply too low to create such incentives in more than a small fraction of the villages surrounding that park. Also, most income from tourism accrues to tour companies and hotels staffed by non-locals, thereby creating no conservation incentive for locals. In other areas, such as Zabalo in Ecuador, the community came together to place and enforce limits on hunting in order to improve the ability of tourists to observe these species (Wunder 2000).

In southern Africa, tourism for viewing and hunting animals has spurred farmers to abandon farming and let the land regenerate to wildlife habitat. Heal (2002) reports that about 18% of land in southern Africa has been converted into ''game ranches'' to allow tour companies and local people to capture non-local values for biodiversity through tourism. Assessments suggest that many species have rebounded, particularly elephants, from low levels as a result of this form of tourism. Heal also notes that biodiversity protection does not occur only in these ranches but also on farmland because of the legal system concerning property rights for wild animals—a critically important component of success—in much of southern Africa, which encourages farmers to capture animals and then sell them to game ranches instead of killing them. Southern Africa appears to be one large example where the incentives for conservation created by tourism, combined with the institutional setting and value of alternative land and labor uses, are large and widespread enough to have had a positive impact on biodiversity conservation.

5.3.1.2 Direct Incentives

An alternative approach to encouraging the conservation of endangered natural ecosystems is to pay for conservation performance *directly.* In this approach, domestic and international actors make payments in cash or in kind to individuals or groups conditional on specific ecosystem conservation outcomes.

In many countries, tax incentives, easements, and tradable development permit programs are widespread. In fact, these financial incentives have been shown to be useful for conserving land voluntarily (Boyd et al. 1999).

Perhaps the most obvious payment scheme is the purchase of full property interests in which a landowner who may develop the land transfers the land to a party who wishes to conserve it. Although such a purchase may preclude other activities that are compatible with the conservation goal, full-interest acquisitions are the most institutionally straightforward of all the conservation payment mechanisms and the costs of monitoring and enforcing an agreement are relatively low.

Tax credits or other subsidies equal to the difference in value between developed and undeveloped uses can also remove land from development uses. Alternatively, instead of using tax credits as a reward, the government can use taxes to punish development. Many complications arise concerning the relationship between taxes and income flows from property, and with other tax issues. Like easements, and indeed most incentive-based responses, tax-based conservation incentives require monitoring in order to confirm that the taxpayers are maintaining the land as they claim to be maintaining it. A potential advantage of tax-based incentives is that most of the administrative resources and systems needed are largely already in place.

Another incentive response is the use of tradable development rights, which require a restriction on the amount of land that can be developed in a given area. A government can award landowners the right to develop some percentage of their land and then permit these development rights to be traded. Because property owners can, in effect, choose among themselves where development will ultimately be restricted, it leads to the least-cost development restrictions. Institutionally, TDRs are relatively complex because they require the establishment of a new market and will impose monitoring and enforcement requirements. Also, TDRs can be problematic if the ecosystem value of the land is highest on the properties where the cost of development is least. In such a case, the market will lead to development on the most ecologically valuable property. This problem can be corrected by introducing an additional level of complexity to the market—''trading differentials'' that reflect property-specific ecological characteristics. But this change clearly implies an additional and formidable set of administrative challenges. Lastly, the costs of ''thin markets'' (few users of the market) add to the overall cost of implementation.

One potentially large drawback of both TDRs and tax incentives is the inability to target specific habitat types and even specific properties. Because effective conservation may depend not only on the total area preserved, but also on the configuration of conserved lands, the conservation efficacy of tax incentives and TDRs is difficult to predict. Still, these tools could be used in addition to regulations and easements that target particular parcels. Tax incentives, tradable rights, and rights purchases all rely on voluntary decisions made by property owners in response to incentives in order to promote conservation on properties where the value of alternative uses is lowest and thus conservation is attained at the lowest opportunity cost.

Another type of incentive is a conservation easement or ''partial interest,'' which is a contractual agreement between a landowner and a conservation interest. In exchange for payment or a tax deduction, a landowner agrees to relinquish rights to future land development. Institutionally, easements involve complex contracting issues but are a well-established legal mechanism. From the perspective of biodiversity conservation where particular parcels are more important than the total amount of area, easements have the potentially important advantage of allowing sensitive parcels to be targeted. A chief complication arises from the need to monitor the terms of the easement contract, especially over long periods of time and as ownership changes.

Taken as a group, financial incentives have been useful methods for encouraging the private conservation of land, but few analyses exist that quantify the contribution of this land to biodiversity conservation.

In countries with less well-established property rights, legal institutions, and tax infrastructure, experimentation with direct payment initiatives has just begun. Examples include the use of forest protection payments in Costa Rica (Box 5.3), conservation leases for wildlife migration corridors in Kenya, conservation concessions on forest tracts in Guyana, and performance payments for endangered predators and their prey in Mongolia. South Africa and American Samoa have over a decade of experience with ''contractual national parks,'' which are leased from communities. Other payment initiatives are being designed or are under way in Mexico, El Salvador, Colombia, Honduras, Guatemala, Panama, Russia, and Madagascar (Ferraro and Kiss 2003).

Proponents of the direct payment approach argue that such an approach is preferable to indirect approaches because it is likely to be more effective, efficient, and equitable, as well as more flexibly targeted across space and time (Simpson and Sedjo 1996; Ferraro 2001; Ferraro and Simpson 2002; Ferraro and Kiss 2002, 2003). Payments can be made for protecting entire ecosystems or specific species, with diverse institutional arrangements existing among governments, firms, multilateral donors, communities, and individuals (du Toit et al. 2004).

However, direct payments have also been criticized. Like indirect interventions, they require on-going financial commitments to maintain the link between the investment and the conservation objectives. They may also transfer property right enforcement responsibilities to local participants, which can lead to inter- and intra-community conflict. Others express concern that direct payments turn biodiversity into a commodity (Swart et al. 2003). To date, no rigorous analysis of direct payments in these settings assesses the amount of biodiversity that is protected or conserved by each program.

5.3.1.3 Combining Incentive Schemes

Although the above discussion of direct and indirect approaches suggests a dichotomous choice, in practice interventions cover a spectrum from those that are most to those that are least direct. In many settings, a combination of incentives and disincentives, and of indirect and direct mechanisms may prove best in order to alter decisions toward conservation and to compensate people for lost access to resources (Muller and Albers 2004). Whether incentives are direct or indirect, if they are not large enough they will not induce biodiversity conservation.

Although some combination of direct and indirect incentives may prove most useful in any given situation, the Pigouvian principle, which prescribes that damages to the environment be taxed according to the damage they do, suggests that direct incentives will generally be preferred because it is more efficient to provide incentives for the ''appropriate'' use of the factor in question, rather than to tangentially related things.

BOX 5.3

A Direct Approach: Costa Rica's *El Programa de Pago de Servicios Ambientales*

In response to substantial deforestation in the last fifty years, practitioners and policy analysts working in Costa Rica have developed a pioneering, nation-wide system of conservation payments to induce landowners to provide ecosystem services: El Programa de Pago de Servicios Ambientales, or PSA. With help from multilateral aid agencies, Costa Rica's natural resource managers broker contracts between international and domestic "buyers" and local "sellers" of sequestered carbon, biodiversity, watershed services, and scenic beauty.

Established in 1996, the PSA grew out of an existing institutional structure of payments for reforestation and forest management, but contained two notable changes: (1) payments were made for ecosystem services rather than for support to the timber industry per se, and (2) funds came from earmarked taxes and environmental service buyers via a newly created National Fund for Forest Financing (FONAFIFO) rather than from general revenue funds. Suppliers of services are primarily individual landowners, associations of landowners, or indigenous reserves. Buyers of services include the Global Environment Fund (biodiversity), Costa Rica's Office of Joint Implementation (carbon), domestic hydroelectricity and municipal water providers (watershed services), and Costa Rican citizens paying via a gasoline tax (for carbon, biodiversity, water, and scenic beauty). By 2001, over 280,000 hectares of forests had been incorporated into the PSA at a cost of about $30 million, with pending applications covering an additional 800,000 hectares. Typical payments have ranged from $35 to $45 per hectare per year for forest conservation (Castro et al. 2000; Chomitz et al. 1999; Ortiz et al. 2002).

The mere existence of direct payment initiatives, however, does not imply that practitioners who use them have been successful in achieving conservation and development objectives. Even in high-income nations, where direct payment programs are more established, empirical analyses about actual impacts are rare.

A recent study (Barton et al. 2003) explored prioritizing PSA environmental service payments to private landowners and suggested that gains could be made by integrating the program into a regional trade-offs framework that targets payments to landowners, taking both biodiversity contributions (for example, from national parks) and costs into account. Current payments are approximately based on national averages for opportunity costs of foregone cattle ranching and the direct financial costs of the different forestry activities which are promoted. The study compared existing PSA allocations to a cost-effective allocation based on biodiversity complementarity values—estimated biodiversity gains relative to the existing PSA areas and the national parks. Targeting of PSAs based on complementarity has provided a more cost-effective approach, and lends support to the idea of integrating various biodiversity responses (national parks, incentives schemes, etc.) into a regional trade-offs framework.

Similarly, some combination of positive and negative incentives may prove most useful in a given setting. In the case of biodiversity conservation, negative incentives include fines and penalties for misuse, such as hunting in parks or illegal conversion of habitat. Taxes and user fees also create negative incentives for biodiversity degrading activities and are widely used in situations where property rights are well-defined and markets are well-functioning. Such negative incentives fit with a "polluter pays" approach in that the activity that degrades biodiversity is discouraged directly. As in the case of pollution, taxes or fines (negative incentives) make the biodiversity degrading activity less attractive for all, and unprofitable for some.

One complication with negative incentives for biodiversity conservation, especially in poor, remote, and rural areas, is that the enforcement and implementation costs of such programs can be high and fall on the government. For example, it is not illegal to possess fuelwood, but it is illegal, and destructive of biodiversity, to extract fuelwood from some areas, and so the enforcer must employ expensive patrols to catch the extractor (nearly) in the act. Positive incentives are more state-based in that if the forest is still there, the payment is made. This structure has advantages for the government but does place the burden of enforcement on local people to keep everyone, including non-locals, from extracting.

Another problem with user fees, taxes on extraction, and fines is that they cause conflict between the local people, who may have traditionally used the resource or who may be heavily reliant on the resource, and biodiversity conservation actors (NGOs and government). Positive incentives have the advantage of generating goodwill and recognizing that local people often feel that they have rights to the resource, for which they are compensated through payments. Positive incentives for biodiversity conservation allow local people to capture some of the non-local benefits that biodiversity creates rather than putting them in the situation of bearing the costs of generating those non-local benefits.

Positive incentives may pose problems in implementation because some baseline must be established concerning who should receive what levels of payment, tax credit, or other incentive. The announcement of such a policy may induce migrants to enter the area and may encourage more destructive activities by residents seeking to demonstrate high levels of dependence on the resource and thus higher need for payment. In addition, payment policies increase the income of rural people and that income can increase demand for the resource, thereby decreasing the effectiveness of the incentive created. This "income effect" would, however, have to be quite large to completely offset the incentive created (Muller and Albers 2004). The characteristics of a given setting will determine whether these problems are more substantial than the costs of enforcement of tax/fine policies, the conflict between groups, and the socially wasteful avoidance activities people undertake to lower the fines that they pay.

The IUCN and other organizations believe that one of the most cost-effective approaches to biodiversity conservation is not the creation of new pro-biodiversity incentives but rather the removal of widespread and powerful anti-biodiversity incentives known as perverse incentives. Perverse incentives induce the reduction of biodiversity and are often an unintended side effect of a policy meant to address a different issue. "Perverse incentives can include subsidies, tax relief and below-cost resource pricing in the agricultural, energy, forestry, fisheries, mining and transport sectors, as well as marketing restrictions and seed distribution systems which encourage a narrower range of agricultural species and varieties" (IUCN n.d., p. 1). Such policies and the resulting perverse incentives abound across the world.

One oft-cited example is the perverse incentives created by the Brazilian government that caused rapid rates of deforestation in the Amazon. One policy lowered taxes on agriculture, which increased the profitability of converting land from forest to cropland. Another policy, also aimed at supporting agriculture, granted rights to unclaimed land to squatters who "use" the land for a length of time, which linked land ownership to clearing of the forest. These policies each created, probably unintentionally, perverse incentives to remove biodiversity (Binswanger 1989; Mahar 1989). Similarly, subsidies that encourage agriculture also discourage biodiversity conservation. Logging practices on government land in many countries also create perverse incentives that lead to too little conservation of forests and biodiversity.

Although the repeal or redirection of perverse incentives appears to be an important response option that could prove quite cost-effective, this important mechanism for biodiversity conservation is not widely used. In addition, such incentives continue to be created anew as side effects of new policies. Integrating biodiversity into regional planning and into agricultural and fisheries policy would limit the creation of new perverse incentives, and perhaps aid the removal of existing perverse incentives.

5.3.2 Importance of Community-based Responses and Implementation

5.3.2.1 Access and Benefit Sharing with Indigenous and Local Communities

Through benefit-sharing mechanisms, countries and sometimes, local communities can capture some of the non-local values of biodiversity. Such mechanisms may be implemented to address equity considerations, but unless the income captured provides on-going incentives for conservation to the effective resource managers, conservation will not occur. In addition, legal complications abound and may diminish the effective incentives for conservation.

Community-based management of natural resources can contribute significantly to human well-being, but conservation of biodiversity is rarely considered in these approaches. To the extent that community-based management, such as Joint Forest Management in India (Box 5.4), encourages long-run management as opposed to the degradation that often comes with open access forest, such management can both improve local human well-being and conserve biodiversity.

The CBD has developed a program of work on its Article 8(j), which concerns the knowledge, innovations, and practices of indigenous and local communities. Several of the 18 tasks outlined by the Working Group on 8(j) relate to access and benefit sharing.

The International Treaty on Plant Genetic Resources for Food and Agriculture has provisions on prior informed consent, benefit-sharing, and farmers' rights. While most benefits will be shared on a multilateral basis (rather than with the specific provider of genetic resources), benefits such as the exchange of information, access to and transfer of technology, capacity building, and even a commercial benefit-sharing package should be available to communities through the system. Communities may also benefit through involvement in conservation and sustainable use activities.

The sixth Conference of the Parties to the CBD adopted the so-called Bonn Guidelines on Access and Benefit Sharing. These guidelines were drafted to help parties develop and draft legislative, administrative, or policy measures on access and benefit sharing. They cover roles and responsibilities, suggested elements for transfer arrangements, possible other approaches to access and benefit sharing, capacity building, and the relation between the access and benefit sharing provisions and the agreement on Trade-related Aspects of Intellectual Property Rights and the WTO.

Considering access and benefit sharing merely in the context of the relationship between providers (local communities, national administrative bodies) and users (private companies) has not been successful. It is important to consider the broader institutional environment in which access and benefit sharing is nested (Tobin 2001; Rosenthal 2003). Important steps in the direction of the creation of a more appropriate institutional environment are

BOX 5.4

Community-managed Forests in India

Communities managing forests is no new phenomenon in India. Over 6,000 village committees have initiated efforts in the past century to conserve and use forest resources sustainably on their village common land, perhaps as a response to biomass scarcity (Murali et al. 2002). However, such efforts were isolated in nature and a government resolution on Joint Forest Management issued in 1990 opened new possibilities for these communities to strengthen their conservation of forest resources. The primary concern for communities to undertake forest conservation is the use of forest resources, in other words, to maintain the diversity of species that exist in forests.

JFM, envisaged that degraded lands would be protected through combined efforts of the community and the state would improve regeneration and enhance forest cover and meet community needs. The state would share the profits from timber sales as an incentive to the people. The motive was to enhance timber production through community effort despite the growing evidence that non-wood resources have more to contribute to the rural economy and state exchequer.

The effort toward participatory forestry management is more for livelihood security than for biodiversity conservation, though the idea was to do both. A comprehensive assessment of the ecological impacts of the community forestry program in India highlighted that more species were found in villages with self-initiated forest protection committees having a long history of protection (Murali et al. 2002; Ravindranath et al. 2000).

The species diversity in forest protected by committees formed prior to the 1990 resolution is high, indicating that the people maintained high species diversity for meeting their diverse biomass needs. The plantations raised by the forest department mainly constituted the fast growing non-native species such as *Eucalyptus, Acacia,* and *Casuarina,* to meet the immediate firewood demands. Furthermore, the area allocated for community protection was highly degraded, rendering the area less species rich. Thus JFM neglected to develop forest resources into biodiversity-rich resources. However, the species diversity was high in community forestry areas (Murali et. al. 2002).

The primary actors in the community forestry program are the forest department and the forest-dependent community. Influential actors at the policy level are donor agencies at the national and international levels, and nongovernmental organizations at the local level. The definition of success differs for all these four actors. The government may conclude community forestry to be successful if the forest is regenerated, while the community may feel success if some economic improvements are delivered. NGOs may see success if equity concerns are addressed, while the donor agencies may want a stable institution in place for sustainable use of forests. Thus concern for biodiversity conservation has not been given a priority. Overall, in the Indian context, it can be concluded that the participatory forestry program has returned to the country. However, more emphasis has been laid on improvement of livelihoods of the local people than on the conservation or enhancement of biodiversity.

the development of an international system for tracing the flow of genetic resources and the development of networks of codes of conducts for gene banks or botanical gardens. Finally, it is important to further develop the legal framework of intellectual property rights.

Two recent attempts successfully integrated the issue of IPR in the access and benefit sharing issue. First, the ITPGR regime proposes a system of farmers' rights, including research exemption and farmers' privilege in the development of new varieties. The treaty, however, does not address biodiversity conservation directly, as it is focused on food security, and concerns only a specified list of key species. Second, in India the 2001 Plant Variety Protection and Farmers' Rights Act (2001) grants plant breeders' rights to local communities (Lalitha 2004).

Acknowledging the Bonn Guidelines as an important first step, the seventh Conference of the Parties adopted Decision VII/19 on access and benefit sharing as related to genetic resources. It accepted the need for further work on the definition of certain terms in the Bonn Guidelines. It also discussed other approaches to assist with the implementation of the access and benefit sharing provisions of the Convention; measures related to prior informed consent, capacity building for access and benefit sharing, and the negotiation of an international regime on access to genetic resources and benefit sharing. The seventh Conference of the Parties also mandated the Ad Hoc Open-ended Working Group on Access and Benefit-sharing to negotiate a possible international regime on access and benefit sharing and adopted an Action Plan on capacity building for access and benefit sharing.

Overall, the trend is moving gradually toward more creative benefit sharing as experience and "best practice" in benefit sharing advance. Benefits shared through commercial partnerships today include the monetary (for example, fees, milestone payments, and royalties) and the non-monetary (for example, research collaborations, access to information and research results, training, technology transfer, and capacity building). They are spread across the short, medium, and long term, and vary by partnership and commercial sector, but a standard of "best practice" has emerged. The bulk of benefits for conservation and development resulting from commercial use of genetic resources have primarily resulted from the research process, and through an increasing use of partnerships between companies and source countries (usually represented by research institutions, only in a very few cases community groups). Direct benefits for conservation do not necessarily result from these partnerships, although some include payments to protected areas, and support national biodiversity inventories and biodiversity science necessary for national conservation plans. Indirect benefits include the promotion of sustainable economic activities based on the supply of genetic resources, and in some cases the supply of raw materials for manufacture (ten Kate and Laird 2002).

In the marine realm, as much as in the terrestrial one, the sharing of benefits arising from the utilization of biodiversity resources is intimately linked with the access to those resources.

5.3.2.2 Impact of the Setting on Effectiveness

The socioeconomic and institutional setting in which any of these responses are applied can significantly alter the outcome of the response. Understanding the potential interaction of a given response with the setting, local to national, can assist in determining which policies are likely to be effective in a particular setting.

From a theoretical perspective, the impact of improved market access on forest degradation and biodiversity is ambiguous (Omamo 1998; Key et al. 2000; Robinson et al. 2002). Without access to markets, most resource use will be for home consumption (Sierra 1999). As market access increases, the impact on the resource base, whether positive or negative, will depend on the relative strength of two effects. Some households will increasingly switch from purely subsistence extraction to commercial extraction, whereas other households, especially those with high opportunity costs of labor, may choose to purchase forest resources from the market rather than extract, using their labor for alternative activities (Robinson et al. 2002). In addition, policies or programs that improve market access to create economic incentives will typically interact with the distribution of labor opportunity costs (Robinson et al. 2002). The creation or improvement of roads allows a policy-maker to reduce market access costs directly (Bluffstone 1993; Cropper et al. 1999; Imbernon 1999). Resource use incentives change because roads reduce the cost both of accessing resources and of removing resources. Working in the opposite direction, the same roads also reduce the cost of accessing substitutes for forest resources (Robinson et al. 2002). The creation of roads also changes opportunities for labor, which may alter resource management decisions (Muller and Albers 2004).

5.3.3 Assessment

Positive incentives to induce local people to conserve biodiversity and use biological resources sustainably have the potential to improve local human well-being and protect biodiversity. These responses allow local people to capture non-local values of biodiversity and thereby place some of the cost of conserving biodiversity on those who value it outside the local area. The effectiveness of economic incentives for inducing biodiversity conservation, however, is strongly dependent on the setting in which the decision is made.

Economic incentives that use development activities cannot be all things to all people as the approach has so often been marketed to raise funds. Better management arises when trade-offs between biodiversity, income generation, and societal needs are realistically acknowledged. The promotion of "win-win" outcomes has been politically correct at best and naive at worst. Despite the importance of compensating people for the costs they bear, responses that only compensate people and do not create conservation incentives do not lead to biodiversity conservation.

A key constraint in identifying what works and what does not work to create economic incentives for ecosystem conservation is the lack of empirical data supporting or refuting the success of *any* approach. Project analyses focus on whether the project became self-sufficient or generated income, but almost never fully characterize the project's impact on biodiversity conservation. Few rigorous and systematic empirical evaluations assess whether an existing initiative to allow people to capture benefits from biodiversity is achieving the conservation and development objectives it purports to achieve. Empirical research on the use of economic incentives to achieve ecosystem conservation and economic development goals in low-income nations is a critical next step.

5.4 Promoting Better Management of Wild Species as a Conservation Tool

During the past 15 years, the 7,000 scientists affiliated with IUCN's Species Survival Commission have contributed to the development of more than 50 species action plans. These plans review the current situation for those taxa and suggest conservation actions needed to alleviate the threats to that species. A review of 42 of these action-plans reports some clear priorities among suggested conservation activities for the future (Schachter

1998). A clear majority of actions (54%) relate to the need for more research to fully understand the problems and potential solutions, while 15% relate to legislation and policy action. The majority of this policy action is related to gaze ting of protected areas, with a secondary emphasis on implementation of international multilateral agreements. Other recommendations are as follows: ecological management, such as control of invasive alien species, reintroduction of individuals and adaptation to climate change, and issues related to sustainable use each represent 7% of recommended actions and capacity building/public awareness activities account for 6%. Ex situ management recommendations represent 5% of suggested actions.

While the relative proportion of each of these management options may change with the taxa, generally speaking they are all employed in a broad-based conservation plan. Increased and improved knowledge is a critical tool for all the other management options. The following sections assess in more detail the experiences with these options.

5.4.1 Legislation and Policy Action

5.4.1.1 Protected Areas for Species Conservation

Protected areas have already been discussed and will not be discussed further here except to note a critical issue: whether a sample of species can act as adequate "surrogate" information for the general biodiversity patterns we need if we are to address "all" of biodiversity. One perspective on this problem is that if species conservation is a goal, providing protected areas based on a goal of representative habitat types is not an adequate strategy, as it can result in omission of species with restricted ranges and endemic species which often are most in need of conservation action (Brooks et al. 2004). An alternative view (Cowling et al., 2004) is that we will have to make best-possible use of all available data, and this will require combining species and habitat data in some appropriate ways (this view is discussed below).

5.4.1.2 Legislation

A few key international agreements are based on the species level of biodiversity, including CITES, the Convention on Migratory Species, and the International Convention for the Regulation of Whaling. The ICRW has come under considerable scrutiny, as the debate at the meetings of the parties has not been able to move beyond political agendas.

While CITES has had some notoriety in its role with respect to regulation of the ivory trade, and has succeeded in reducing international trade in some species, the "success" of this convention as a tool in conserving commercially important taxa such as fish and timber is yet to be proven. An IUCN report examining the effectiveness of CITES (IUCN 2000a) concluded that CITES had been effective in (1) providing a comprehensive database on international trade in wildlife, and (2) providing some incentives for conservation. However, the convention cannot be expected to have impact beyond its mandate of regulating international trade and domestic economic issues, and other pressures confound the effectiveness of CITES.

Despite the problems, these agreements provide an important opportunity for countries to debate issues relating to the sustainable use of their natural resources and to share ideas on the best ways to cooperate in this effort.

5.4.2 Ecological Management and Reintroduction

5.4.2.1 Reintroduction of Species

Reintroduction of species to their native habitats has become a major tool for species conservation. The principal aim of any reintroduction should be to establish a viable, free-ranging population in the wild (whether species, subspecies, or race) that has become globally or locally extinct (extirpated) in the wild. It should be reintroduced within the species' former natural habitat and range, the conditions that led to its previous demise should have been corrected, and should require minimal long-term management (IUCN 1998). IUCN guidelines consider the impact of reintroduction of species on human populations. Socioeconomic studies are recommended to assess impacts, costs and benefits of the reintroduction program to local human populations. In addition to the general guidelines, guidelines are available for specific taxa including elephants, non-human primates and galliforme birds (http://www.iucnsscrsg.org/pages/3/index.htm).

Reintroduction and restocking projects have been undertaken with more than 120 species. Typically such projects are carried out by a consortium of zoos and in cooperation with the coordinators of the relevant regional ex situ programs and taxon advisory groups. Examples of successful reintroduction or restocking projects, most of them involving several zoos, include Southern white rhino, Golden lion tamarin, Golden-headed lion tamarin, Mexican grey wolf, Black rhino, Przewalski's horse, European bison, Arabian oryx, Scimitar-horned oryx, Addax antelope, Sable antelope, Mhorr gazelle, Alpine ibex, Bearded vulture, California condor, Andean condor, Mauritius kestrel, White stork, Great eagle owl, Western Australian swamp turtle, Puerto Rican crested toad, Mallorcan midwife toad, Jersey agile frog, and many others. A compendium of reintroduction and reintroduction practitioners was completed in 1998 and highlighted projects that covered a broad spectrum of taxa and geographic regions. Plant reintroductions are reviewed by geographic region and 217 animal reintroductions are listed by taxa.

Lessons learned from some of these reintroduction projects have been compiled by Beck et al. (1994) and Reading et al. (2002). Beck noted that reintroductions of birds and mammals predominated, and that 48% of the projects reported involved species that were listed as threatened on the IUCN Red List. He reports a success rate of only 11% while noting that another study by Griffith et al. (1989) estimated a 38% success rate. Success depends mainly on a deep knowledge of the species biology and ecology, availability of suitable habitats (as remnants or restored habitats), an initial stock of individuals of high genetic and genetically-based phenotypic diversity, and a long-term monitoring of the reintroduced populations. Successful projects tend to be large in time scale and in numbers of species introduced. In addition, involvement of local people was found to be a key factor. When attempts fail, the reasons are probably related to the narrow focus on biological and technical aspects of the reintroduction (Reading et al. 2002).

5.4.2.2 Management of Invasive Alien Species: Prevention, Control, or Eradication

Invasive alien species are a growing threat to biodiversity and the 2003 IUCN Red List of Threatened Species documented several specific cases (www.iucnredlist.org). The CBD (Article 8h) calls on parties to "prevent the introduction of, control, or eradicate those alien species which threaten ecosystems, habitats, or species." Within that context a strong consensus agrees that preventing species invasions is the safest and most cost-effective approach to the problem of invasive species (Mooney and Hobbs 2000). However, the expansion of global trade is moving more species around the world more quickly and overwhelming efforts to prevent invasions.

Several models are available for ecological and economic assessment of controlling biological invasions (Higgins et al. 1997; Wadsworth et al. 2000; Perrings 2002) and cost-benefit analyses conclude that costs of eradication are always higher than costs of prevention.

Eradication and control of invasive species has taken the shape of many different strategies (Wittenburg and Cock 2001; Veitch and Clout 2002). Chemical control of invasive plant species, sometimes combined with mechanical removal like cutting or pruning, has been useful for controlling at least some invasive plants, but has not proven particularly successful in eradication. In addition to its low efficiency, chemical control can be expensive: in 1990 in the United Kingdom, the average cost of treating a hectare invaded by *Heracleum mantegazzianum* was $705 to $1,764 (Sampson 1994). Biological control of invasive species has also been attempted. The rationale behind this approach is to take advantage of ecological relationships like competition, predation, parasitism, and herbivory, between an invader and another non-native organism introduced as controlling agent. Results are mixed. For example, the introduction of a non-native predatory snail to control the giant African snail in Hawaii led to extinction of many native snails (Civeyrel and Simberloff 1996). Also, the prickly pear moth (*Cactoblastis cactorum*) used to fight the invading *Opuntia* species in Australia, has recently invaded the United States, posing a serious threat to the native *Opuntia* species (Stiling 2002). Some 160 species of biological agents, mainly insects and fungi, are registered for controlling invasive species in North America and many of them appear highly effective (Invasive.org, n.d.). At least some of the biological agents used are themselves potential invaders (Hoddle 2004).

Successful eradication cases have three key factors in common: particular biological features of the target species (for example, poor dispersal ability), sufficient economic resources devoted for a long time, and widespread support from the relevant agencies and the public (Mack et al. 2000).

When complete eradication is not possible, or it is not desired, as in the case of invading native species, some measures of "maintenance control" aimed at maintaining populations of the invading species at low, acceptable levels have been attempted. However, the chemical and mechanical controls used pose many problems, including the high cost and low public acceptance of some practices (Mack et al. 2000).

Although biological invasions are complex ecological, evolutionary and socioeconomic problems, a better understanding is being achieved, especially in ecology, both of invasiveness and habitat vulnerability to invasion. This knowledge is essential to determine how much effort to invest in controlling an invasive species that has already become established or to clarify the trade-offs managers and land planners will have to consider. Social and economic aspects have received less attention, perhaps because of difficulties in estimating the trade-offs involved in biological invasions (Perrings 2002). Developing models that include the different factors comprehensively and attempt to calculate cost-benefit ratios would be the best approach both for preventing and controlling biological invasions.

The Global Invasive Species Programme is an international response to address the problem, supported by the CBD Conference of the Parties. GISP has called for improved monitoring, better quarantine practices, an improved legal framework, greater attention to the problem of ballast water, better worldwide regulation of species trade, a more rational approach to biological invasions by the public and users of both native and non-native biodiversity, better mechanisms of control of established invasive species, and adequate monitoring and evaluation to test for success of eradication and control programs (McNeely et al. 2001). The CBD has adopted Guiding Principles on Invasive Alien Species (Decision VI/23) as a basic policy response, but it is too early to assess the effectiveness of implementation.

5.4.2.3 Adapting for Climate Change

A recent report has suggested that between 15% and 37% of species could be at risk of extinction due to the impacts of climate change (Thomas et al. 2004); an alternative view is that these estimates have a high degree of uncertainty, and many other reports have documented shifts in species distribution as a result of global change (Pounds et al. 1999; Parmesan and Yohe 2003; Root et al. 2003). Today's species conservation plans may effectively incorporate adaptation and mitigation aspects for this threat. Several potential tools are available to help assess species' vulnerability to climate change (IUCN 2003b). The first, which could be undertaken with or without detailed species information, is to produce a matrix of data available for species by geographic region, using point occurrence data or high-resolution grid data. The second method involves using global and/or regional climate models over different time scales, with impact models, to predict responses of species within particular habitats, and thereby appreciate expected habitat changes. A third method involves development of vulnerability criteria based on inherent biological characteristics of the species that would hinder adaptation to a changing climate. Some of these characteristics would include restricted ranges, poor dispersal, extreme habitat specialization, and susceptibility to climatic extremes. Further work on all these methodologies is needed before a full assessment can be prepared.

5.4.3 Sustainable Use Programs

Key multilateral environmental agreements such as the CBD include within their objectives sustainable use of natural resources. Sustainability can be defined as using resources "at rates within their capacity for renewal" (IUCN/UNEP/WWF 1991). At its simplest, the concept of "sustainable use" supposes with appropriate restraint and efficiency of harvesting, the wild species can be used without it becoming depleted (Mace and Hudson 1999). However, the term "sustainable use" also describes the approach of actively promoting use as a conservation strategy (Allen and Edwards 1995; Hutton and Dickson 2000). The argument is that promoting use, or allowing use to continue, encourages people to value wild resources. And when wild species and their habitats have value, this discourages the conversion of natural habitat to other competitive land uses.

Three management approaches parallel the three management goals for sustainable use of wild species: managing for the species, ecosystem-based management, and resource management. Conserving exploited species directly is the approach classically adopted in wildlife management (Caughley 1977; Beasom and Roberson 1985) and fisheries (Larkin 1977). Where the goal is species conservation, and where a specific population has a distinct identity and can be managed directly, the species management approach can be effective. However, managing for a single species is rarely a good substitute when the goal is ecosystem health, which is tied to the entire suite of species present in the area. Where human livelihoods depend on single species resources, species management can be effective, but where, as is frequently the case, people depend on a range of different wild resources, single species management is not the approach of choice.

Conserving exploited species when the management approach is ensuring resource availability to support human livelihoods is frequently unsuccessful. This is because optimal management for resources frequently requires overexploitation of particular wild species and an overall loss in biodiversity (Hulme and Murphree 1999). For example, the loss of large predators might be acceptable under a resource management approach in southern Africa grasslands if this allows private landowners to maintain high enough stocks of ungulates to be economically viable, and thus avoid conversion to other land uses. Maintaining resource availability can result in increasing the production from valued species at the expense of those species of less concern, even those, which have resource value. This increased specialization on certain species and homogenization of the resource base is akin to the conversion of a natural landscape into an agricultural landscape (Salwasser 1994; Freese 1998).

Regardless of the management goal and approach for sustainable use of wild species, the IUCN/SSC Sustainable Use Specialist Group has identified a set of considerations necessary to achieve successful sustainable use, based on global collective experience. To increase the likelihood that any use of a wild living resource will be sustainable requires consideration of the following principles (IUCN 2000b):

- The supply of biological products and ecological services available for use is limited by intrinsic biological characteristics of both species and ecosystems, including productivity, resilience and stability, which themselves are subject to extrinsic environmental change.
- Institutional structures of management and control require both positive incentives and negative sanctions, good governance, and implementation at an appropriate scale. Such structures should include participation of relevant stakeholders and take into account land tenure, access rights, regulatory systems, traditional knowledge, and customary law.
- Wild living species have many cultural, ethical, ecological, and economic values, which can provide incentives for conservation. Where an economic value can be attached to a wild living species, perverse incentives removed, and costs and benefits internalized, favorable conditions can be created for investment in conservation and sustainable use of the resources.
- Levels and fluctuations of demand for wild living resources are affected by a complex array of social, demographic, and economic factors, and are likely to increase in the coming years. Thus attention to both demand and supply is necessary to promote sustainable use.

Sustainable use of natural resources is an integral part of any sustainable development program, yet remains a highly controversial subject within the conservation community (Hutton and Leader-Williams 2003). Attention to all factors, beyond the biological and ecological characteristics of the resource involved is a key to success. In particular, care in establishing positive incentives for conservation and sustainable use is critical.

5.4.4 Communication/Awareness Raising

Education and communication for conservation is discussed at length later in this chapter. The principles outlined there are a useful basis for establishing communication strategy for species conservation.

5.4.5 Ex Situ Management

More than 1,000 zoos, aquaria and botanical gardens worldwide welcome in excess of 600 million visitors annually. The justification of these institutions is to complement in situ conservation in several ways including: (1) to provide increased knowledge about species that need conservation effort; (2) to raise awareness among the general public of the value of those species; (3) to raise funds for *in situ* action; and (4) to help build capacity both in country and abroad for global conservation. These objectives are enshrined in Article 9 (ex situ conservation) of the CBD. Successful captive management programs have also provided individuals for reintroduction programs. IUCN's Statement on the Management of Ex Situ Populations for Conservation (2002) provides specific direction to ensure that captive management of species contributes to in situ conservation.

As of September 2003, no less than 174 international studbooks for threatened species or subspecies, covering a wide range of taxa from Partula snails to large apes, were kept under the auspices of the World Association of Zoos and Aquariums. In addition, the regional zoo associations keep regional studbooks and have run, since 1981, cooperative ex situ population management programs for selected species. For example, the American Zoo and Aquarium Association, whose membership includes 218 accredited zoos and aquaria throughout North America, currently administers 106 Species Survival Plans® covering 171 species. However, the majority of these (64%) are for mammals, 13% for birds, and only 6% each for reptiles/amphibians and fish. No plants are included in these plans. The European Association of Zoos and Acquaria operates 138 European Endangered Species Programmes in which about 300 institutions from Europe and the Near East participate. Similar networks also exist in the Australasian Region (the Australasian Species Management Program of the Australasian Regional Association of Zoological Parks and Aquaria) and in Africa (the African Preservation Programme of the Pan African Association of Zoological Gardens, Aquaria, and Botanic Gardens). As extensive as some of the efforts to manage threatened species may be, they still represent a very small proportion of species diversity and primarily that of the charismatic megafauna.

That said, ex situ zoo populations can directly support the in situ survival of some species in a number of ways—through ongoing research to understand the biology and ecology of threatened species, training of specialists in conservation, public awareness raising and generation of resources for conservation on the ground. Finally, populations of captive specimens can provide the nuclei for reestablishment or reinforcement of wild populations in nature. The World Zoo Conservation Strategy emphasizes that such reintroductions and restocking projects, when properly applied (that is, in agreement with the IUCN/SSC Guidelines for Re-introductions), can bring great benefits to natural biological systems. However, while captive breeding programs are often touted as an important conservation contribution, especially when part of a reintroduction plan, they can also create uncontrolled demand for live specimens of endangered species. Clayton et al. (2000) presented a case study on trade in the endangered Indonesian Babirusa (*Babyrousa babyrussa*). International interest in the captive breeding of this species gave hunters and dealers the false impression of a potentially lucrative and officially sanctioned demand for any live Babirusas they might catch. Swift action by the Indonesian authorities halted this trade, but the study provides a warning about the damage that can be caused to the conservation of a species if management programs are instituted without a full understanding of the practicalities of its conservation, particularly interactions between the species and local people.

5.4.6 Assessment

This assessment of possible approaches to species conservation leads to the following conclusions:

- It is imperative to develop approaches for species conservation that take into account impacts on affected human populations. Management and sustainable use of wild species will remain a key response at the species and population level, with, in most cases, a direct link to livelihoods. It is therefore essential to design targeted approaches, with clear objectives, and measurable indicators for monitoring the outcome.
- Reintroduction of species, though often very expensive, has often had very good results. For many species, knowledge and technical expertise required for a successful reintroduction exist. However, reintroductions are unlikely to be successful without the consent and support of the people inhabiting the target area, so programs that consider and respond to local people's concerns are likely to be more successful and cost-effective. The success of some reintroduction efforts should not imply any weakening of conservation of species in their natural habitats.
- Control or eradication of an invasive species once it is established has appeared extremely difficult and costly. Prevention and early intervention have been shown to be always more successful and cost-effective than late responses. Successful prevention requires more efforts, especially in the context of international trade, and in raising awareness of the threat of invasive species.
- Sustainable use programs must include consideration of social and economic issues as well as the intrinsic biological and ecological considerations related to the specific resource being used.
- Zoos, botanical gardens, aquaria, and other ex situ programs are essential elements in building support for conservation, supporting valuable research, and providing cultural benefits of biodiversity to the visiting public.

It is noteworthy that the vast majority of these tools have been used on a very limited range of taxa—primarily the charismatic megafauna and some commercially important species such as fish. Moreover, we still know relatively little about the effectiveness of these tools for many plants, invertebrates, or species in the marine realm.

5.5 Integrating Biodiversity into Regional Planning

5.5.1 Introduction

The need to integrate conservation and sustainable use of biodiversity into relevant sectoral and cross-sectoral plans, programs, and policies is highlighted as a requirement in the CBD (Article 6b). This integration is commonly referred to as "the mainstreaming of biodiversity" and includes situations where biodiversity and economic gains can be simultaneously achieved, where biodiversity losses are exceeded by biodiversity gains, or a sectoral activity is dependent on sustainable use of biodiversity and the inclusion of biodiversity concerns into sectoral policies. The many examples of mainstreaming activities are showcased in several documents, including Pierce et al. (2002).

A major mechanism for mainstreaming is the incorporation of biodiversity into regional plans (discussed earlier). These plans are usually the outputs of a spatial systematic assessment of the region, identifying areas of conservation and development values, threats, constraints, and opportunities. Planning systems are an essential component of most sectors as they identify what happens where on the landscape, and ensure an effective land use system meeting the needs of the development sectors without compromising the needs of the environment. These regional plans have in the past been conducted by separate authorities with the conservation community usually identifying areas of biodiversity concern for conservation efforts and the development planning authorities assessing and identifying development opportunities in the area for farming, mining, tourism, etc.. In many instances these independent plans were based on different datasets and methodologies, and did not feed into one another. As is often the case with conservation and development, areas important to one are often important to the other (van Rensburg et al. 2004), resulting in conflicting demands of conservation and development sectors for the same land.

However, recent initiatives have shown that if one were to conduct these planning assessments concurrently for both development and conservation and have the planners talking to one another, then the options for trade-offs and win-win scenarios are increased (Faith et al. 1996; Ando et al. 1998; Cowling and Pressey 2003; Gelderblom et al. 2002). This realization has led to regional plans that cater to both development and conservation concerns. Many governments and planning authorities have identified this approach as an appropriate way of managing their natural resources.

At the heart of regional planning is the question of how best to accommodate development that meets the social and economic objectives of the region while ensuring that the condition of regional biodiversity is maintained. Sustainable development relies on biodiversity conservation as an integral part of regional policy and planning. Integrated regional planning is not new; these types of plans were already abundant in 1992 at a workshop on *The New Regional Planning* at the sixth IUCN World Congress on National Parks and Protected Areas in Caracas, Venezuela, where 50 case studies focused on integrated regional-scale planning in Africa, Asia, and North, Central, and South America.

Integrated regional plans focus on integrating sectors, scales, and responses and fall into the ecosystem approach described in detail by the CBD; this approach provides principles for integration across scales and across different responses. Its seventh Conference of the Parties, for example, has addressed "Principle 10," on achieving appropriate integration of biodiversity conservation and use of biological diversity. Central to its rationale is that "the full range of measures is applied in a continuum from strictly protected to human-made ecosystems" and that integration can be achieved through both spatial and temporal separation across the landscape, as well as through integration within a site.

The seventh Conference of the Parties made the following recommendations associated with Principle 10:

- develop integrated natural resource management systems and practices to ensure the appropriate balance between, and integration of, the conservation and use of biological diversity, taking into account long and short-term, direct and indirect, benefits of protection and sustainable use, as well as management scale;
- develop policy, legal, institutional, and economic measures that enable the appropriate balance and integration of conservation and use of ecosystems components;
- promote participatory integrated planning, ensuring that the full range of possible values and use options are considered and evaluated;
- seek innovative mechanisms and develop suitable instruments for achieving balance appropriate to the particular problem and local circumstances;
- manage areas and landscapes in a way that optimizes delivery of ecosystem goods and services to meet human requirements, conservation management, and environmental quality;

- determine and define sustainable use objectives that can be used to guide policy, management, and planning, with broad stakeholder participation.

Case studies evaluating implementation of the ecosystem approach are limited, and CBD has called for additional case studies. Some existing case studies (CBD 2003d, p. 8) have suggested a need to "dispel the myth that 'win-win' situations between development and conservation objectives were widely achievable, and concentrate instead on understanding how trade-offs and equitable compromises could be attained." Other lessons emerging from experiences so far suggest that mainstreaming the ecosystem approach would require increased take-up by parties to multilateral environmental, trade, and development agreements, and by financial institutions in their funding decisions (CBD 2003e).

Case studies point to the need for addressing trade-offs and synergies in regional planning. A recent review of experiences in 15 Asian countries (Carew-Reid 2002) found that biodiversity planning has greater influence if it is viewed more as a political and economic process in which hard decisions are made on resource allocation and use.

Regional plans that integrate biodiversity can be drawn up in a number of ways. Conservation priorities may be identified using standard procedures of systematic conservation planning mentioned earlier in this chapter. In this way, all development sectors are informed of development options and can direct development away from areas of high biodiversity conservation value. This is an improvement on the ad hoc planning that happened formerly in both the conservation and development sectors (Pierce et al. 2002).

The earlier section on protected areas assessed how a regional planning framework that incorporates complementarity can focus on the problem of integrating intrinsic and future values of biodiversity into a trade-off decision framework for regional planning. When global biodiversity values are integrated into multicriteria analysis, policy decisions about one "place" in a region are linked to overall regional net benefits/trade-offs. In this regional planning framework, the contribution of a place to global biodiversity conservation is necessarily estimated by its complementarity value. Other, local, values in a given place (which are sometimes related to biodiversity) enter the multicriteria analysis either as measurable additional benefits of conservation land/water use, or as opportunity costs of conservation in that place.

Resulting conservation priorities can form core conservation areas supported by buffer and transition zones under models like the biosphere reserve model. A key component of this partnership between development and conservation is often the formation of a cross-sectoral partnership between the conservation and planning authorities (Gelderblom et al. 2002; Cowling and Pressey 2003).

This focus on spatial priorities and trade-offs follows the ideas of Saunier and Meganck (1995), who highlight that integrated regional planning focuses on spatial units while cutting across sectors, instead of the older forms of planning which focus on sectoral units. Australia's use of Integrated Natural Resource Management planning at the catchment and subcatchment level follows a similar approach of conservation planning inputs into natural resource planning (Lowe et al. 2003). Both South Africa and Australia make use of the idea of "living landscapes" as the ideal end point of these integrated regional plans (Steiner 2000). "Living landscapes" as defined by Driver et al. (2003, p. 1) are "landscapes that support life of all forms, now and into the future." Lowe et al. (2003, p. 59) define a plan for a "living landscape" as one that "aims to protect a landscape's ecological health by integrating nature conservation into the farming landscape so that life on the land continues both for the flora and fauna and for farmers and their families."

5.5.2 Integration of Regional Response Strategies

Integrated regional planning relies not only on integrating different sectors, but also on the use and integration of a number of responses in the region. These responses are discussed in other sections and include protected area systems, promotion of local benefits, economic incentives, and mainstreaming biodiversity into development sectors like agriculture and the sustainable use of wildlife. Integration among these responses (or instruments) will promote effective trade-offs and synergies among regional values and sectors, and with global biodiversity values as well. Regional perspectives on payments to private landowners and accounting for biodiversity contributions from agricultural lands illustrate integration of strategies in a trade-offs/synergies framework. For example, local-global trade-offs benefit when location of protected areas seeks complementarity with the biodiversity contributions already provided by other land. Global biodiversity benefits from sustainable harvesting of native species, if quantified, can lower overall regional opportunity costs of biodiversity conservation. Subsidies for biodiversity-friendly agriculture can be targeted to those places where the consequent complementarity values, taking into account the region's other conservation efforts, are greatest.

Successful integration will be facilitated when global biodiversity gains and losses are quantified in a unified way over various response contexts, so that complementarity values can be calculated. Complementarity values resulting from alternative land uses then can be compared for effective decision-making. Biodiversity surrogates at present provide poor levels of confidence in estimating biodiversity gains and losses, particularly those resulting from management regimes such as ecoforestry and wildlife harvesting. Surrogates are often selected for their supposed ability to indicate rich sites or sets of sites with high overall biodiversity. Trade-offs-based planning requires surrogates that indicate both high and *low* complementarity values. Confidence in a low complementarity value means that a place might be assigned a land use that focuses on local rather than global benefits, promoting the ability to make trade-offs at the regional scale.

Regional-scale decision-making, over a range of responses, can focus on trying to retain the potential net benefits of the region, by looking at how scenarios of land use affect the capacity of the region to balance its competing objectives (Faith 2001). The useful concept of "irreplaceability" of places refers to the goal of retention of a region's capacity for biodiversity conservation. This term might be extended to sometimes refer to cases where a land use for a given place is "irreplaceable" for the region's capacity for balancing biodiversity conservation and other human well-being objectives.

Integration can play an important role in linking "reserve" and "off-reserve" conservation. A polarized debate rages about the relative value of formal protected areas versus lands that are more intensely used by people but that conserve (at least some) components of biodiversity. The two approaches are more properly seen as part of a continuum of possibilities, correcting weaknesses of both approaches by linking them in integrated regional strategies. For example, areas used to provide certain provisioning services can lead to destruction of habitat and biodiversity; but a regional perspective may help mitigate some lost biodiversity because a given area need only contribute certain "attributes" of biodiversity to overall regional biodiversity conservation. Formal protected areas are often vulnerable because they foreclose other opportunities for society, but a regional perspective in planning protected areas can minimize conflict through appropriate and balanced land-use allocations. It can also build on the biodiversity protection gains from the surrounding lands, thereby reducing some of the pressure for biodiversity protection in the face of other anticipated uses over the region. Rather than using the weaknesses of one approach to argue for the other, it is more effective to have an integrated regional strategy.

A recent South African case study (Cowling and Pressey 2003) illustrates some ways in which a regional assessment of biodiversity (including setting of targets for different habitat types) can take into account the expected status and contributions of lands outside of formal protection. However, the process of setting biodiversity targets suggests that biodiversity conservation may be served to the detriment of effective trade-offs that might have been achieved in the region. In that study, differential targets were set for different habitat types that served as surrogate biodiversity information. A type that was judged highly vulnerable to destructive use will not be expected to make as large an ''off-reserve'' contribution to overall regional biodiversity persistence, and so will be given a higher target (say, in percent area represented) for formal protection. A difficulty may be that trade-offs suffer: non-conservation opportunities will be unduly foreclosed because a habitat/vegetation type is given greater percentage protection simply because it can provide other benefits for society.

Setting higher protection targets on habitat types that are ''threatened'' because they are attractive for other uses can limit effective trade-offs between biodiversity and other ecosystem services (although such limitations may be appropriate in some settings). This loss occurs even when it can be assumed that some types are protected, to some extent, off-reserve. Box 5.5 looks at the place of biodiversity in environmental impact assessments.

5.5.3 Linking Protected Areas to the Landscape

Although the linking of protected areas to the landscape was discussed earlier, several additional points are relevant here. The land and water area required to satisfy the conservation of regional biodiversity are well known to be in excess of the land and water area made available for formal conservation (Rodrigues et al. 2004). For example, an assessment of protected areas in Indonesia (World Bank 2001) concluded that few of the protected areas in the country are large enough to maintain viable populations of their constituent species, and recommended stronger linkages of the protected areas system with surrounding areas. The advantages of conserving biodiversity on production or other off-reserve lands are therefore obvious (Pressey and Logan 1997). A land or water use may provide some ''partial protection'' of biodiversity and ensure the maintenance of biodiversity conditions of that region. Grazing and other light intensity forms of use (for example, wildflower harvesting) have been shown to be more amenable to biodiversity conservation (Pressey 1992; Scholes and Biggs 2004). This combination of conservation and development sectors in the same place naturally increases regional net benefits and forms part of the ideology of UNESCO biosphere reserves, which include combinations of core conservation areas surrounded and linked to zones of differing intensities of alternate land uses.

A recent South African study (Pence et al. 2003) found that 80% of the costs for acquiring protected areas might be saved by meeting biodiversity targets in part on private lands. Similarly, an integrated biodiversity trade-offs framework (Faith et al. 2001a, 2001b) suggests how such partial protection (for example, from private land) can contribute to the region's trade-offs and net benefits.

Arguments for such landscape-based synergies arise also from studies suggesting that clever arrangement of human-use habitats can promote biodiversity. This is embodied, for example, in ''reconciliation ecology,'' which is based on the idea that habitat loss will imply species loss, but that ''we can stop most of them by redesigning anthropogenic habitats so that their use is compatible with use by a broad array of other species'' (Rosenzweig 2003, p. 194). Rosenzweig cites case studies demonstrating the potential of reconciliation ecology to increase compatibility of human use and biodiversity conservation.

BOX 5.5

Addressing Biodiversity Issues in Environmental Impact Assessment

Environmental impact assessment has been adopted by countries and financial and lending institutions, such as the World Bank and the Asian Development Bank, as a tool to assess development projects in many countries. EIA originally focused on pollution issues, but has expanded to include potentially adverse impacts on biodiversity.

The Convention on Biological Diversity has played a key role in encouraging governments to include biodiversity in national EIA frameworks. Article 14 of the CBD provides an explicit mandate for encouraging EIA as a planning tool for responsive environmental planning of development initiatives in a manner that ensures prevention or significant reduction in biodiversity resources and the enhancement of biological diversity wherever possible (UNEP 1998). However, the process often fails to incorporate biodiversity in full. Decision V/18 of fifth Conference of the Parties of the CBD called on its Subsidiary Body on Scientific, Technical, and Technological Advice (SBSTTA) to develop guidelines for incorporating biodiversity-related issues into legislation and/or processes on strategic environmental assessment and impact assessment.

Many specialized disciplines (for example, social impact assessment, technology impact assessment, health impact assessment) are gradually emerging within the EIA. It is now becoming increasingly common to also address impacts on biodiversity as a distinct category of assessments.

Checklists of biodiversity impacts are being developed (CEAA 1996; World Bank 1997; Rajvanshi 2003). Manuals are now available to guide data gathering and interpretation for decision-making (DEA 1992; UNEP 1996; EC 2001; UNEP 2002). Several good-practice guides (DOE 1993; CEAA 1996; World Bank 1997) and outline methods are available for assessing biodiversity impacts.

Several problems need to be addressed. A lack of formal requirements and inconsistent mechanisms of evaluating compliance constrain the role of EIA from a biodiversity perspective (IUCN 1999; Mathur and Rajvanshi 2001). Lack of information (regional biodiversity data and resource status reports), lack of clearly defined EIA terms of reference in relation to biodiversity, and weak enforcement of legislation are common barriers identified by most countries. In many situations, particularly for larger river basins, the appropriate region of analysis may extend across two or more countries, adding to the challenge of undertaking an EIA for a data-poor system.

Although techniques for eliciting biodiversity values are gradually being put into place, consideration of biodiversity is still not included as a "trigger" for EIA in most countries. If countries adapt their EIA legislation to address all threats to biodiversity, and if the lack of information can be addressed, EIA could play a greater role in biodiversity conservation.

Integrated coastal management plans and programs worldwide have shown that ICM plays an important role in maintaining natural resources and ecosystems. However, studies suggest that ICM practices have successfully provided a response to biodiversity conservation only in those cases having a significant degree of integration of sectoral policies in coastal areas (Cicin-Sain and Knecht 1998). In the context of ICM, policy integration is not an absolute, but arguably should be considered as a continuum, that is, from sectoral fragmentation to communication among sectors, coordination, harmonization, and eventually integration (Cicin-Sain 1993). A policy response in this direction has been agreed in the context of the CBD, whose Parties have advocated a better integration of the ecosystem approach into current integrated marine and coastal area management plans and programs (CBD 2000a).

Integrated river basin management, also known as integrated catchment management and integrated watershed management, is a landscape approach with the potential to address both biodiversity conservation and sustainable resource use considerations through implementation of a range of strategies and levels of protection. Although Gilman et al. (in press) found that IRBM has been variously defined by managers around the world, and that biodiversity conservation has only sometimes been the primary driver of IRBM efforts, IRBM is nonetheless grounded in the need to understand trade-offs, often of upstream versus downstream activities. With a river basin as the ''landscape'' of interest, it is possible to apply IRBM principles to identify complementary land and water uses: for example, a river identified as a priority for biodiversity protection might be designated ''off-limits'' for a new hydropower dam, but another river of lower priority might be designated a suitable alternative for new impoundments. Protected areas have been a relatively rare feature of IRBM efforts, but IRBM nonetheless has great potential for effective protected area design and management, both for aquatic and for terrestrial biodiversity conservation.

When assessing individual areas and their contribution to the off-reserve conservation of biodiversity, it is essential to assess the complementary contributions they make to conservation, that is, their contribution in terms of biodiversity not already represented in protected areas. For example, case studies that attempt to document biodiversity gains from organic agriculture, wildlife harvesting, or other land uses, often fail to address complementarity or how those gains fit with gains/losses elsewhere. The key to demonstrations of success in protecting global values of biodiversity would be increases in the marginal gains from those lands in the regional context. A review of case studies and approaches for ''monitoring of biological diversity'' (Yoccoz et al. 2001) documents the typical focus on species-richness, not complementarity. An increase in abundance of species, or even an increase in richness, is not as persuasive as an increase in the degree to which the land offers biodiversity gains *complementary* to those of other places (Faith and Margules 2002).

Failure to assess biodiversity contributions of managed lands using complementarity can misdirect conservation priority setting. For example, it has been argued that the European Union must prevent the decline of its ''nature-rich'' farmlands or it will fail to reach the MDG target of reducing species loss by 2010 (EEA 2004). Agricultural subsidies targeted at vulnerable farmland areas based on their ''biodiversity'' values (as estimated from the higher species' population sizes compared to abandonment of the land) would promote socially desirable levels of biodiversity from private land. However, the report at the same time acknowledges that, while land abandonment may lead to lower species diversity at field level, the natural habitats resulting from abandonment in fact may add to *overall* biodiversity at the regional scale. The call for priorities for these farmlands remains poorly justified in the absence of the contributions to decision-making that could be provided by estimates of complementarity contributions of different land uses, in different places.

In the absence of more exact information, sensitivity analysis of the contributions of off-reserve lands can influence the priorities for formal protection. The case study from Costa Rica shows how regional planning can integrate protected areas and payments for biodiversity conservation on private land. The study demonstrates that the effectiveness of conservation payments on private lands can be greatly increased through regional planning that targets payments using complementarity values, and can effectively complement efforts through formal protection in national parks in the region.

Approaches that use sensitivity analysis and simple surrogate information for biodiversity may help to bridge the gap between non-quantitative mainstreaming efforts and idealized complementarity-based approaches.

These assessments indicate that landscape links may increase the viability of protected areas, and so ensure their contributions to biodiversity in the broader region. More generally, land use / management decisions in different places in the landscape will imply incremental gains to biodiversity conservation in the region quite apart from any links to protected areas. Although these ideas of off-reserve management of biodiversity are theoretically appealing, the reality of implementation is far more complex. The establishment of biodiversity-friendly land use management on land (or water) of regional biodiversity concern requires the development of incentives for private and communally owned land (these incentives are discussed later in this chapter).

South Africa and Australia, as well as other countries making use of integrated regional planning, have learned many lessons on how to integrate biodiversity into regional planning (Lambert et al. 1995; Driver et al. 2003; Read and Bessen 2003; Lowe et al. 2003; Bennett and Wit 2001; Gelderblom et al. 2002). Conservation assessment involves identifying spatial priorities for conservation actions, which in turn forms a component of conservation planning; this planning should also involve the development of an implementation strategy and action plan (Knight and Cowling 2003).

There are several essential elements of successful regional plans. One of these elements is adequate scientific knowledge of the region, including defining boundaries that are sensible from a biological and administrative point of view and the collation of high quality data in the area. All successful plans highlight the need to involve all stakeholders from the beginning of the planning process. These stakeholders include communities in the region, as well as government and nongovernmental organizations responsible for implementation of these plans. As Driver et al. (2003, p. 11) highlight, planners need to ''think implementation from the outset.'' All too often conservation plans end up as technical or academic exercises and do not lead to conservation action on the ground. In order to avoid this they suggest that an operational framework must be set up with the following key ingredients:

- ask ''who wants this plan and what are the plan's aims?'';
- pay attention to project design;
- involve implementing agencies in the conservation assessment team;
- involve stakeholders in a focused way that addresses their needs and interests;
- conduct the conservation assessment according to the best scientific principles; and

- interpret the conservation assessment results and mainstream the planning outcomes.

Monitoring and evaluation through the use of performance indicators is also of critical importance both in order to monitor the maintenance and recovery of biodiversity values and to encourage involvement (Lambert et al. 1995). Read and Bessen (2003) have identified several success and limiting factors in regional planning through 16 case studies based on an assessment of 154 projects as well as semi-structured interviews. These have been grouped into motivational, financial, and regulatory factors. Their recommendations for strategic action focus on: establishing clear values, priorities and cultures; understanding biodiversity values and threats; managing at the landscape scale; using science, information, and knowledge; building capacity; using a mix of mechanisms; and encouraging factors that drive integration.

5.5.4 Assessment

We can state with *high confidence,* based on 150 studies on large scale, regional planning for conservation linking networks of protected areas with other land uses (Bennett and Wit 2001), that a "landscape approach" that, for example, manages neighboring production forests as buffer zones and integrates protected areas with broader regional spatial planning, helps overcome stated limitations of protected areas on their own. Successful landscape approaches:

- focus on conserving biodiversity at the ecosystem, landscape. or regional scale, rather than in single protected areas;
- emphasize the idea of ecological coherence by encouraging connectivity;
- involve buffering of highly protected areas with eco-friendly land management areas;
- include programs for the restoration of eroded or destroyed ecosystems;. and
- seek to integrate economic land use and biodiversity conservation.

Overall, it is seen to be essential in these efforts to recognize the importance of regional context for implementing the ecosystem approach and monitoring progress. Our assessment suggests that the ecosystem approach implementation guidelines approved by CBD's seventh Conference of the Parties could add a requirement for a "calculus" of global and regional biodiversity. This would allow global biodiversity gains and losses to be quantified in a unified way over various response strategies, thereby clearly identifying the trade-offs involved at a regional level. Such a calculus of biodiversity depends on effective biodiversity surrogates. These will be based upon the best possible use of a combination of environmental and species (for example, museum collections) data, and will provide greater certainty in estimating such biodiversity gains and losses (Faith et al. 2003; Reyers 2004).

5.6 Encouraging Private Sector Involvement in Biodiversity Conservation

One of the most significant differences between the WSSD summits at Rio de Janeiro (1992) and Johannesburg (2002) was the greater presence of the business community as a major stakeholder at the 2002 WSSD. Although specified as an "actor" in the text of the CBD (Articles 10e, 16.4), business was perhaps slow to recognize its role in biodiversity conservation, and the CBD has been slow to recognize the link between industry and biodiversity. However, business has a wide impact on biodiversity, especially through the products and processes associated with mass consumption. How can business be given the inspiration, incentives, tools, and management systems to play an effective part in the biodiversity debate?

Companies exist to make a profit and thereby generate value for shareholders, so a company must have a business case for being involved in biodiversity conservation (Abbott et al 2004).

An embryonic business case is now emerging, with the following key elements:

- The activities of certain companies have significant impacts on biodiversity.
- As understanding increases about biodiversity and how ecosystems function, more evidence emerges of the potentially destructive impacts of some business activities.
- As with other environmental impacts, regulators and civil society increasingly require these negative impacts to be managed and, if possible, reduced or reversed, in order for a company to retain its license to operate from communities and regulators.
- Biodiversity impacts can be managed alongside a company's other environmental impacts, as part of an integrated environmental management system.
- Employees will prefer to work for a company that is a good corporate citizen.
- Companies with a better reputation will have easier access to investment capital.

This list of key elements, however, leaves out other positive aspects that depart from the conventional perspectives on "impacts." Land that is well-managed by a private sector company (for example, by a mining company) may make a measurable positive contribution to the conservation of regional diversity (see earlier discussion). This regional perspective has a second positive aspect. The private sector needs information about key biodiversity areas as part of its own regional planning, and so is encouraged to become part of partnerships that enhance the availability of such biodiversity data (for example, the "Proteus" scheme, see below). Table 5.1 highlights the particular interests of many sectors in biodiversity.

Some companies and sectors are dependent on biodiversity and healthy ecosystems in order to maintain their current operations. Obvious current examples include nature-based tourism and companies based on harvesting biological resources. Sustainability of supplies perhaps provides the most compelling case for business involvement in biodiversity conservation, although many companies remain uncertain as to precisely what they should do, once they have identified such a risk exposure.

A further source of uncertainty has been the perception that, since much biodiversity expertise lies especially with NGOs and academic institutions, simply funding biodiversity programs through such organizations should fulfill a company's requirements. Although the most enlightened companies have understood that biodiversity risks and impacts need to be managed alongside other such environmental issues within the company, corporate philanthropy remains a relatively common approach to dealing with biodiversity. While such funding is welcome, one perspective is that it remains relatively modest and is not a sufficient response to address fully the biodiversity impact of a company.

5.6.1 What Companies Are Doing

Once a company accepts that it has an important relationship with biodiversity, an increasingly standardized means of managing the issue, outlined in Bertrand (2002), becomes available. Essentially, the process is to align biodiversity management with a company's environmental management system. This approaches the problem

Table 5.1. Business Sectors with Direct Relevance to Biodiversity Conservation

Sector	Main Issue
Agriculture	increase food production while maintaining a healthy agroecosystem, integrate biodiversity and food production in more sustainable ways, include more efficient use of irrigation water
Aquaculture	minimize impacts on marine and freshwater biodiversity by, for example, culturing native species, minimizing risk of escape of individual animals, avoiding the conversion of sensitive or keystone habitats such as mangroves, and minimizing pollution
Engineering/ architecture/ planning	address the environmental impact of human settlements and the built environment (in the context of vulnerability to natural disasters and global change, but also related to biodiversity more generally)
Fisheries	minimize impacts on marine biodiversity and address overfishing to ensure the sustainability of the industry itself
Forestry	reduce impact of operations; important strategy: move toward more sustainable practices through market-based mechanisms such as certification
Hydropower	minimize impacts on aquatic and surrounding terrestrial systems through implementation of the World Commission on Dams recommendations and through engagement with regional planning efforts
Insurance/ financial sector	create incentives for the private sector to address biodiversity issues substantively; potential source of funds for restoration
Mining	minimize impacts and set industry standards on biodiversity generally and protected areas specifically
Oil and gas	minimize impacts and move toward "net benefit" concepts; mobilize them to encourage best practice in ancillary industries (e.g., shipping), and to address protected areas issues (e.g., "no go" commitments)
Shipping	address the spread of invasive alien species and the risk to biodiversity from shipping disasters (e.g., oil spills).
Tourism	encourage the tourism industry to be a force for good for biodiversity and to minimize impacts; standardization/certification of ecotourism practices
Water providers	integrate ecosystem management concepts

at the site level, where a biodiversity action plan (site-level BAP) enables the company to manage issues at a local level; at the company level, a company-wide biodiversity action plan enables the business to take a strategic approach to its relationship with biodiversity globally.

Certain sectors have an obvious and immediate relationship with biodiversity. For example, some companies have products, which are dependent on biological resources, such as fish and timber, or tourism. Other companies require access to mineral, oil or gas reserves that may be found in areas of high biodiversity, and often their extraction will have a significant impact on biodiversity. Many companies are major users of water, both as a component of their products and in the production cycle, and company interests in ensuring future sources of water may dovetail in part with the needs of aquatic ecosystems.

Such an obvious and immediate primary relationship with biodiversity has led to initiatives on both a company-by-company and a sectoral basis, the latter usually being linked to certification schemes or an industry-wide sustainable development program. These industry-led sectoral approaches are important, because they offer hope of reaching non-listed (that is, state and private) companies.

Examples of company initiatives include Unilever's objective to source all its fish from sustainable sources by 2005 and British Petroleum's biodiversity action plans. According to BP Australia (2000, p. 11), examples include, "Construction of wetlands at Bulwer Island refinery with different water depths and the planting of 17,000 seedlings since 1998. The sub-tropical wetland is now home to 96 species of birds. . . . The planting of the 1.4 million trees has provided protection to several hundred species of plants found only in the agricultural and woodland zones of southwestern Australia."

To give an idea of scale, in the United Kingdom, perhaps 40 of the FTSE-350 companies have a company-wide biodiversity action plan or take a strategic approach to biodiversity management. This number doubled between 2001 and 2003.

Some initiatives involve consortia of companies together with biodiversity conservation organizations. An example is the "Proteus" initiative, involving Anglo American, British Petroleum, and others as sponsors in collaboration with UNEP-WCMC (www.unep-wcmc.org). It plans to help make high-quality conservation information, such as that from museum collections, available to decision-makers via the Internet. The intention is to enable, for example, the overlay of company information on to biodiversity maps to assess potential environmental implications of business operations in different places.

Private sector efforts may help address perceived under-funding of the Global Environment Facility. Because the GEF focuses on financing the cost "increment" that will achieve global biodiversity benefits (the difference between national or local benefits that could be expected and the global biodiversity benefits arising from the project), there has been a perception that one limitation of GEF programs is that some national/local costs are left in need of funding (Horta and Round 2002).

5.6.2 What More Needs to Be Done

At the heart of company approaches lie three fundamental questions: What is the company's relationship with biodiversity? How can the impact of the company be measured? And what are the consequences for the value of the company? To date, as with many sustainability initiatives, the driving force has come from large companies in the private sector, driven by a combination of reputational and supply sustainability factors. This means that small and state-owned companies have been less involved in biodiversity initiatives, even though their collective impact may be greater. The business case made for and accepted by larger, private-sector, companies clearly might be extended to other companies as well. Efforts to involve other companies may be focused on voluntary and sectoral initiatives driven by the need to secure supply chains or maintain reputational value for an entire sector. This, for example, might give continued access to mining sites, or access to genetic resources.

Further developments are likely to focus on two main areas. First, the debate will move away from simply looking at the impact of companies on biodiversity, important though this is. Increasing emphasis will be given to ecosystem services, and how companies rely on them. This will require development of mechanisms for companies to understand their risk exposure and to manage those risks. Second, the biodiversity conservation community will accept that business has a role to play in the debate. This may be difficult to accept when controversial issues relating to genetically modified crops and to intellectual property cloud the debate. Nevertheless fully engaging the corporate sector is a necessary condition.

One tool which may encourage further companies to accept the challenge of managing biodiversity is an increasing ability to measure both the impact that biodiversity has on companies and the impact that companies have on biodiversity. A corollary of measurement would be a coherent cost-benefit analysis. Although individual companies will undoubtedly make the case to their own satisfaction, the development of such tools should help increase the involvement of companies. This may highlight a role for investors, who use such tools regularly in assessing companies' strengths and weaknesses in other mainstream financial areas.

Some risks to biodiversity may also arise from private sector involvement, for example, if the exploiting and the regulating party are the same. Exchange of personnel between governments and commercial enterprises can also lead to abuses that do not arise when the regulators are well distinct from the resource exploiters.

5.6.3 Assessment

Where decision-makers and the general public have accepted the role business can and must play, constructive dialogues have been established, leading to initiatives at the company, sectoral, or higher level. Much discussion has focused on biodiversity impacts, and attention to ecosystem services may be more likely to help business understand its impact and find methods to mitigate it.

Engaging business has been easiest where a business case exists for the company concerned. A key strategy is to engage businesses that do not have a direct link with biodiversity or ecosystem services, or do not face the consumer pressure that publicly listed companies face. Regulation is likely to remain a key tool for influencing business, but establishing a climate for companies to move beyond compliance is essential.

5.7 Including Biodiversity Issues in Agriculture, Forestry, and Fisheries

5.7.1 Introduction

Early farmers played an important role in creating and maintaining crop genetic diversity through the domestication and selection of crops suited to a wide range of environments (Harlan 1975). The livelihoods and well-being of millions of farmers still depends on this diversity (Richards 1986; Bellon 1996). The success of breeders in developing high yielding varieties has built on crop genetic diversity, identifying genes for improving adaptation, yield, and disease resistance (Plucknett et al. 1987). Moreover, substantial evidence is now accumulating on the way in which the continued maintenance of high levels of crop genetic diversity in agroecosystems, based largely on traditional cultivars, meets the needs of resource-poor farmers (Engels 1996). A similar dynamic has been followed with livestock (FAO 1999; Hall and Ruane 1993).

Pressures are growing on natural habitats that contain the wild relatives of crops or domesticated animals, and on farmers who maintain significant amounts of crop or animal genetic diversity in the form of local varieties. Increased population, poverty, land degradation, economic, and environmental change, combined with the introduction of modern varieties, have contributed to the erosion of genetic resources in both animals and crops (Prescott-Allen and Prescott-Allen 1982; Wilkes 1985; Pistorius 1997). The availability of large gene pools, including wild relatives, becomes even more important as farmers need to adapt over time to changing conditions that result from these pressures (Jarvis and Hodgkin 1999).

Agriculture is directly dependent on biodiversity, but agricultural practices in recent decades have focused on maximizing yields by focusing research and development on relatively few species, thus downplaying the importance of biodiversity. Subsequently, a large amount of genetic diversity has been lost. Conversion of natural habitats into domesticated ones has continued (Pagiola et al. 1997), and the use of chemical fertilizers and pesticides has continued to expand (Gunningham and Grabosky 1998). Both of these trends can be detrimental to biodiversity and harm agriculture in the long run rather than improve it. On the other hand, agricultural practices in some regions have developed landscapes that include considerable biodiversity; abandoning such lands can lead to the loss of at least some species.

The use of living modified organisms in agriculture is a topic of major international concern. As movements of LMOs pose potential risks to new environments they may enter, the Cartagena Protocol under the CBD (entered into force in 2003) sets out certain measures to be followed to avoid risks to biodiversity in general and agricultural biodiversity in particular. The Cartagena Protocol requires advanced informed agreement procedures and careful assessment of risks before allowing import of living modified organisms. Such risk assessment is based on the precautionary approach (Bail et al. 2002), using procedures and tools to help decision-makers make sound decisions that are compatible with agriculture, biodiversity, and trade.

This section focuses on biodiversity issues in agriculture (for example, maintaining genetic and crop diversity), forestry (for example, certification), and fisheries (for example, marine protected areas for biodiversity conservation), and defers to other chapters in this volume for a discussion of sustainable food production and fisheries (see Chapter 6) and sustainable forestry management (see Chapter 8).

5.7.2 Agriculture

5.7.2.1 In Situ Conservation Responses

In situ conservation of agricultural biodiversity has been defined as "the maintenance of the diversity present in and among populations of the many species used directly in agriculture, or used as sources of genes, in habitats where such diversity arose and continues to grow" (Brown 2000). It concerns entire agroecosystems, including the management of domesticated species (such as food crops or forage species) on fields or in home gardens, as well as their wild and weedy relatives that may be growing in nearby areas or natural ecosystems.

Supporting conservation and use of agricultural biodiversity requires an understanding of when, where, and how agricultural diversity will be maintained, who will maintain the material, and how those maintaining the material can benefit. This requires:

- measuring the amount and distribution of germplasm used by farmers within their agroecosystems;
- gaining an understanding of the processes used to maintain this germplasm;
- identifying the key persons or groups of people responsible for maintaining the germplasm;
- comprehending what factors influence these people to maintain diversity; and

- using the information and genetic materials for sustainable livelihoods and ecosystem health and services (Jarvis et al. 2000).

The International Plant Genetic Resources Institute's work on on-farm conservation of crop genetic diversity has involved over 20 countries and 30 crops. The UNU/PLEC program (United Nations University/People, Land management and Environmental Change), which focuses more at the landscape level, has also involved many countries in all parts of the developing world and in centers of agricultural and crop diversity (Brookfield et al. 2002). IPGRI (2001; see also Jarvis et al., in press) has recently prepared a state of the world review for the CBD on the current status and trends for management of crop diversity in agroecosystems by national programs and international initiatives, identifying some key issues.

First, assessments have shown that local cultivars and breeds on farm are complex and highly varied in their genetic structure (Achmady and Schneider 1995; Kshirsagar and Pandey 1996; Sebastian et al. 2000; CBDC-Bohol 2001). Different communities and cultures approach the naming, management, and distinguishing of local cultivars in different ways, and no simple relationship exists between cultivar identity and genetic diversity (Quiros et al. 1990; Zeven 1998; Cleveland et al. 2000). Considerable debate surrounds the use of farmer names as a basis for arriving at estimates of cultivar numbers (Jarvis et al. 2000).

Second, management practices are linked to the survival of certain cultivars. At high elevations in Nepal, farmers re-route cold water from the main valley rivers to raise the water temperature before irrigation so as to induce earlier flowering and timely maturation of their rice cultivars (Rana et al. 2000). The informal sector is an important provider of seeds needed for sustaining agricultural biodiversity (Almekinders et al. 1994). In Morocco, less than 13% of durum wheat seed and 2.5% of food legumes, in Nepal less than 3% of rice, and in Burkina Faso less than 5% of sorghum are bought as certified seeds each year from the formal sector, indicating that the majority of seeds used are from local crop diversity or from seed saved from earlier purchases (Mellas 2000; Ortega-Paczka et al. 2000; Kabore 2000). Improving on-farm seed storage was also shown to be important in the maintenance of traditional cultivars in the Philippines (Morin et al. 1998).

Third, many factors influence the choice of how many and which varieties to grow and on what proportions of crop area. In developing economies, crop cultivar diversity on farms has been attributed to risk avoidance or to management of such issues as, for example, climatic uncertainties or pest and disease problems (Bellon 1996; Pimentel et al. 1997); food security in relation to total food supplies and nutritional well-being (Johns 2002); income generation, providing products that can be sold in different markets or are of high value (Smale et al.1999; Gauchan et al. 2003); optimizing land use to ensure cultivars are available for difficult (stony, wet, cold) lands (Bellon and Taylor 1993; Rijal et al. 2000); and adaptation to changing conditions such as increasing drought (Sadiki et al. 2001). In advanced economies, diversity may be conserved through demand for specialized goods and services. Concerns for human and ecosystem health may influence societies to follow a policy goal of supporting local crop cultivars because of the social benefits they contain (Smale et al. 1999; Smale 2002).

Fourth, home gardens are important locations for agricultural biodiversity conservation, providing microenvironments that serve as refuges for crops and crop varieties that were once more widespread in the larger agroecosystem. Home gardens can serve as buffer zones around protected areas, as is the case with the Sierra del Rosario Biosphere Reserve in Cuba (Herrera and Garcia 1995). Farmers often use home gardens as a site for experimentation and introduction of new cultivars arising from exchange and interactions between cultures and communities, or as sites for domestication of wild species. These useful wild species are often moved into home gardens when their natural habitat is threatened, such as in the case of Loroco (*Fernaldia pandurata*) given the high rate of deforestation in Guatemala (Leiva et al. 2002). Studies of the genetic diversity of key home garden species in Cuba, Guatemala, Ghana, Indonesia, Sri Lanka, Venezuela, and Viet Nam have demonstrated that significant crop genetic diversity does exist in home gardens, and that home gardens can be a sustainable in situ conservation system (Watson and Eyzaguirre 2002).

Fifth, many options are available for increasing the benefits to farmers from local crop diversity (Jarvis et al., 2000). These options include (1) improving the material through participatory methods including participatory evaluation, improvement, and breeding (Soleri and Cleveland 2001; Joshi and Witcombe 1998; Castillo et al. 2000; Ceccarelli and Grando 2000; Bellon et al. 1999); (2) increasing consumer demand through public awareness, for example, through diversity fairs or nutritional awareness building (Gauchan et al. 2003; Johns 2002); (3) improving access to materials and information (Bellon 2001, Mazhar 2000); (4) adaptation to microniches and reduced agricultural inputs; (5) improving ecosystem health and services (CONSERVE 2001, Rijal et al. 2000); and (6) developing supportive policy recommendations (Gauchan et al. 2000, 2003; Correa 1999; Cromwell and van Oosterhout 2000).

5.7.2.2 Ex Situ Conservation Responses

One response to the loss of global crop diversity has been to conserve germplasm in ex situ conservation facilities. Over 6 million accessions of the world's major food plants are now conserved in over 1,300 gene banks worldwide, with about 90% of the accessions conserved in the form of seeds (FAO 1998). Various methodologies and approaches have been developed so that specific traits and alleles are conserved.

Seed banks have well advanced technologies for conserving and managing orthodox seeds (Engelmann and Engels 2002). However, for many developing countries, the maintenance of seed banks is difficult, as electricity supplies are unreliable and fuel is expensive. Various research projects have recently focused on the development of "low-input" alternatives to medium- and long-term cold storage (Engelmann and Engels 2002). One option is the development of the so-called "Ultra dry seed storage technology" (Zeng et al. 1998), which allows the storage of seed germplasm at room temperature, thereby obviating the need for refrigeration. Other research conducted on drying techniques such as sun and shade drying (Hay and Probert 2000) offers promising alternatives to improve the capabilities of resource-poor countries to conserve their seeds.

Field gene banks are the preferred method for species that produce short-lived seeds or are vegetatively propagated. Field gene banks have some drawbacks. Accessions are exposed to pests and diseases, natural hazards, and human error, all potential sources of erosion (Engelmann and Engels 2002). Field collection can pose a heavy burden on the national institutions, implying an urgent need for implementation of other measures to conserve plant genetic resources more effectively and cost-efficiently.

In-vitro techniques have been devised for the collection, multiplication, and short- and medium-term storage of plant germplasm (Engelmann 1997). In-vitro culture protocols have been published for well over 1,600 species (George 1996). Slow-growth storage is used routinely in a limited number of national, regional, and international germplasm conservation centers for a few species including bananas, some root and tuber crops, and temperate fruits (Engelmann 1999).

Cryopreservation, that is, storage at ultra-low temperature, usually that of liquid nitrogen (−196° Celsius), currently offers the only safe and cost-effective option for the long-term conservation of genetic resources of species. Techniques can now be considered operational on a routine and large-scale basis (Engelmann and Takagi 2000).

DNA storage is rapidly increasing in importance. DNA is now routinely extracted and immobilized into nitro-cellulose sheets. These advances have led to the formation of an international network of DNA repositories for the storage of genomic DNA (Adams 1997).

Pollen storage has also been considered as an emerging technology for genetic conservation (Towill and Walters 2000). In the past 10 years, cryopreservation techniques for pollen have been developed for a number of species (Hanna and Towill 1995) and cryobanks of pollen have been established for fruit tree species in a few countries (Ganeshan and Rajashekaran 2000).

Botanic gardens have long been the main center for the conservation of wild species (Heywood 1991). More recently, the contributions of botanic gardens in conserving different kinds of germplasm that are relevant to crop diversity have been recognized (Heywood 1999). Over 1,800 botanic gardens and arboreta are found in 148 countries worldwide and maintain more than 4 million living plants accessions (Wyse Jackson and Sutherland 2000). Many botanic gardens also have seed storage facilities, maintaining more than 250,000 accessions (Laliberte 1997).

Typically, ex situ conservation is carried out by universities or national institutions, which have developed facilities (storage, laboratories, information) and field production capacity necessary to undertake long-term commitments to store and make available the accessions. In addition, international gene banks are maintained by the research centers of the Consultative Group on International Agricultural Research. International collaboration on conservation and use of these plant genetic resources has been considerable, involving the work of the FAO Commission on Plant Genetic Resources and the development of the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (FAO 1996) that was signed by about 150 countries. The International Treaty on Plant Genetic Resources was agreed in 2002 (FAO 2002) and is now in force.

Ex situ conserved materials are essential for the production of new improved cultivars and provide a basis for increasing productivity and the genetic diversity needed for production with, for example, reduced use of pesticides, fungicides, and herbicides, and improved water use efficiency. Genetic resources are sent from gene banks to users throughout the world, and developing-country users benefit considerably from these flows (Fowler et al. 2001). In areas affected by natural and man-made disasters, crop genetic diversity can help restore natural and agricultural ecosystems.

5.7.2.3 In Situ Conservation of Crop Wild Relatives in Natural Ecosystems

New crop cultivars are often obtained from wild or weedy materials. These processes continue to affect the genetic diversity of crops in centers of diversity as farmers adopt new genotypes into their farming systems (Jarvis and Hodgkin 1999; Altieri and Montecinos 1993; Quiros et al. 1992). In addition, farmers may bring wild varieties into their farming systems. Wild relatives of crop species (also called crop wild relatives) have already made substantial contributions to improving food production through the useful genes they contribute to new crop varieties (Hodgkin and Debouck 1992).

Genes that provide resistance to pests and diseases have been obtained from crop wild relatives and used in a wide range of crops, including rice, potato, wheat, and tomato. A classic example is the interspecific tomato hybrid between wild *Lycopersicon peruvianum* and cultivated *L. esculentum,* which led to scores of tomato varieties with resistance to root knot nematode (Rick 1963). Genes from crop relatives have been used to improve protein content in wheat and vitamin C content in tomato. Broccoli varieties producing high levels of anti-cancer compounds have been developed using genes obtained from wild Italian *Brassica oleracea.* Crop wild relatives have also been a source for genes for abiotic stress tolerance in many crops.

With the advances made in molecular genetics it is now possible to transfer genes between distantly related taxa or even taxa from different kingdoms, thereby broadening the value of crop wild relatives. Natural populations of many crop wild relatives are increasingly at risk. They are threatened by habitat loss, deforestation (for example, coffee in Ethiopia; Tadesse et al. 2002), and overgrazing and resulting desertification. Meilleur and Hodgkin (2004) have reviewed the current status and trends of conservation activities on crop wild relatives in about 40 countries throughout the world. Crop wild relatives are also traditionally found in agroecosystems in and around farms; the increasing industrialization of agriculture is reducing their occurrence.

While it is clear that the continuing development and deployment of more genetically uniform improved crop varieties has an effect on the amount and distribution of the diversity of traditional crop varieties in production systems, it is not clear what the effect of genetically modified varieties will be. Some are concerned that genetically modified crops will tend to reduce further the amount of crop diversity in production systems and that they might affect diversity of non-crop components (such as insect species), or that transgenes will move from crops to their close wild relatives. Others point to the dependence of conventional agriculture on agrochemicals as a major problem that genetically modified varieties could help overcome (Gepts and Papa 2003).

5.7.2.4 Eco-agriculture as a Response for Conserving "Wild Biodiversity"

Sustainable agriculture and sustainable management of crop diversity often depend on sustainable management of the surrounding natural ecosystem. One means of linking agriculture with other land uses is eco-agriculture, defined as a framework that seeks to achieve simultaneously improved livelihoods, conservation of biodiversity, and sustainable production at a landscape scale (McNeely and Scherr 2003).

Enhancing environmental responsibility as an aspect of on-farm management has driven the evolution of an array of sustainable agriculture and natural resource management models, including organic agriculture, agroecology, integrated crop management, and conservation farming. The relative economic, social, and environmental benefits of adopting any particular model are very situation specific, influenced by the needs, local use conditions, and resource capacities of individual practitioners, and also the nature of adjacent resource management strategies being implemented. Achieving meaningful benefits to biodiversity beyond farm level demands further coordination between strategies at the landscape scale. Eco-agriculture aims to build upon extant models and intentionally integrate the knowledge and activities of practitioners, policy-makers, researchers, educators, and extension services within the sectors of agriculture, conservation, and rural development. An integrated approach, encompassing a range of strategies, offers practitioners more choice to adopt the management system most appropriate to their needs.

Eco-agriculture can be supported through six overarching implementation strategies (McNeely and Scherr 2003):

- make space for biodiversity reserves within agricultural landscapes;
- develop simple, low-cost habitat niches and networks for wild biodiversity on and around farmlands;
- modify farming systems to mimic natural ecosystems;
- reduce pressure to convert further land to agriculture, enhancing the productivity of extant agricultural systems;
- reduce the use of external inputs within integrated pest, livestock and nutrient systems; and
- encourage soil, water, and vegetation resource management strategies with potential to benefit biodiversity.

These encompass activities that can be implemented by individual practitioners at a farm or ecosystem level and, at a landscape level, collaborative strategies that can enhance the adoption of strategically complementary approaches among neighboring land users.

Of the 36 cases reviewed by McNeely and Scherr (2003), 28 principally benefited poor, small-scale farmers. Enhanced ecosystem productivity and stability reduced production-associated risks, raised food and fiber production, and thus improved livelihood security. Net income increases were demonstrated in 15 cases, with other reviewed cases exhibiting significant economic potential. However, data on farm income impacts remain poor. The considerable overlap between regions where agricultural productivity increases are vital for food security and poverty reduction, and areas where wild diversity is richest, highlights eco-agriculture's significant potential to have positive impacts on rural poverty and biodiversity, provided that socioeconomic and political conditions are enabling.

5.7.3 Forestry

For a detailed discussion of sustainable forestry management, the reader is referred to Chapter 8 of this volume. Discussed here are two issues related to including biodiversity issues in the forestry sector.

5.7.3.1 Non-Wood Forest Products

Natural forest ecosystems are especially rich in biodiversity. However, unsustainable logging practices result from the lack of adequate planning and from biased policies focused on logs more than on the entire value of the natural forest. Despite these circumstances, various innovative measures that consider biodiversity in the natural forest ecosystems have emerged. One such measure is giving greater attention to non-wood forest products (IUCN 2000c). Unlike large-scale commercial logging, harvesting NWFPs can be less harmful environmentally, as it takes into account the entire value of the natural forest ecosystem, and can contribute to conservation of biodiversity. However, NWFPs require careful management and must take into account sustainable use practices in order to avoid overharvesting of certain species, as witnessed in the case of Brazil nuts in the Amazon, ginseng in North America, and rattan in Southeast Asia.

While policies geared toward promoting NWFP can be beneficial to biodiversity conservation and social and economic sectors, industries based on NWFP are only now emerging, and require more attention and full integration into forest policies of countries. This would balance the policies of countries that focus on large-scale commercial logging projects that are targeted at earning fast money, as can be witnessed in many temperate and tropical countries (Filer and Sekhran 1998).

5.7.3.2 Certification and Sustainable Forest Management

A measure that is voluntary in nature, but is gaining widespread recognition due to market pressures and conservation needs in the forestry sector, is certification for forest products harvested in a sustainable manner (Hirakuri 2003). Certification of forest products is market driven but at the same time contributes to conservation of biodiversity. Certification is now working in Europe, North America (Raunetsalo et al. 2002), and individual countries such as Brazil (Hirakuri 2003). The practice is expanding into other products such as coffee, where environmentally friendly cultivation practices that integrate biodiversity are encouraged. Coupled with certification is the forest tracing system used in sustainable forest management now found, at least in rhetoric, in countries such as Indonesia (Jakarta Post 2000), Russia (Forest.ru n.d.), Canada, and the United States to prevent illegal logging. The forest tracing system has contributed to SFM.

However, deforestation still continues in most parts of Africa, Latin America, Asia, and the Pacific, caused by poverty, population growth, economic growth, urbanization and the spread of agriculture (UNEP 1999). New and innovative initiatives including NWFP policies, certification, and SFM have to be designed to minimize deforestation. Furthermore, policies, legislation, and institutions need to be designed to support sustainable forest management.

5.7.4 Marine Reserves, Biodiversity, and Fisheries

This section focuses on marine reserves for biodiversity conservation, and the links to fisheries management. For a detailed discussion of fisheries for food, the reader is referred to Chapter 6 of this volume.

Fully protected marine reserves (a special kind of marine protected areas) can be defined as "areas of the ocean completely protected from all extractive and destructive activities." Marine protected areas are defined as "areas of the ocean designated to enhance conservation of marine resources." The level of protection within MPAs varies, and in many MPAs certain activities such as fishing may be allowed (Lubchenco et al. 2003, p. 53).

A meta-analysis of 89 studies (Halpern 2003) concluded that marine reserves, regardless of their size, in almost all cases lead to increases in density, biomass, individual size, and diversity (species richness) of species in the reserve (with the exception of invertebrates). The diversity of communities and the mean size of the organisms are between 20% and 30% higher compared to unprotected areas. The density of organisms is roughly double and biomass nearly triple. Proportional increases occur in reserves regardless of size. But for conservation and fisheries purposes, absolute increases in numbers and diversity are important (for example, to sustain viable populations, to ensure spill-over effects, and to protect against catastrophic events). It is therefore likely that at least some large reserves are required for biodiversity conservation.

The science of selection and design of marine reserves is now well developed (Roberts et al. 2003a; Hastings and Botsford 2003; Roberts et al. 2003b; Sala et al. 2002). Methods of MPA design and implementation have affirmed themselves as effective tools for biodiversity conservation (Crosby et al. 2000). These methods recognize the use of a whole set of tools—including no-take zones—that should be made available to all sectors of society that are concerned, directly or indirectly, with MPA design and implementation. In fact, the growing recognition of the importance of MPAs by sectors of society that are not, traditionally, conservation-driven, calls for an authoritative and at the same time adaptive approach for MPA implementation to achieve a balance between biodiversity conservation and economic development. Clear and pragmatic guidance with regard to MPA design and implementation is provided in a recent paper on the subject (Agardy et al. 2003). According to the authors, an appropriate mix of various management tools should be utilized in MPA setting and management, depending upon specific conditions and management goals.

Benefits to commercial fisheries outside the reserves are poorly documented so far and still the subject of debate (Ward et al. 2001), and benefits beyond the actual reserve limits (for example, benefits for fisheries) may be limited (Kura et al. 2004). Part of the problem is that few marine reserves have been strictly protected and monitored for a sufficiently long period that benefits in surrounding waters could show up. Even fewer reserves have been set up specifically to enhance a commercial fishery. In addition, monitoring and demonstrating the spillover effect is no easy matter, and documenting benefits to distant waters is even more difficult.

One understated strength of marine reserves is that they provide a clear example of an "ecosystem-based" approach to fisheries management, since they protect both fish and the ecosystems where they live. In marine reserves, all species—regardless of their commercial value, sex, or size—are protected. Reserves can also maintain the structure of marine communities intact, allowing important interactions among species to function unimpeded. This can provide a good complement to typical fishery management approaches that focus on maintaining a single species only (and only where there is a commercial incentive). This may be especially useful in the tropics, where many species may be commercially exploited in one fishery. A marine reserve approach, in this case, is probably easier to implement and enforce than trying to regulate the fishing effort or catch quota of each species separately (Ward et al. 2001; Roberts and Hawkins 2000).

Aquaculture is likely to grow further in importance, but is no panacea. It uses large amounts of wild fish, processed into fish food, and has other negative environmental impacts that need to be reduced (for example, the risk of invasive alien species through escape, diseases, impacts of genetically modified fish, conversion of natural ecosystems).

In 2000, the Conference of the Parties to the CBD charged its Ad Hoc Technical Expert Group on Mariculture with the task of assessing the consequences of mariculture for marine and coastal biodiversity and promoting techniques that minimize adverse impact. In 2003, the Group released its report, which, while stressing that all forms of mariculture affect biodiversity at all of its levels (mainly through habitat degradation, disruption of trophic systems, depletion of natural seedstock, transmission of diseases, and reduction of genetic variability, as well as the biodiversity-effects of pollutants and contaminants), also pointed out that, under certain circumstances, local mariculture activities can enhance biodiversity (CBD 2003b). A significant contribution by this group has been to agree on recommended methods and techniques for preventing the adverse effects of mariculture on biodiversity, the most important of which are proper site selection, optimal management practices (such as proper feeding) and technological enhancements, culturing different species together (polyculture), and the use of enclosed and, in particular, recirculating systems (CBD 2003b). The group also recommended the use of aquaculture-specific certification of the product, which highlights that the species in question has been produced according to guidelines, codes of practice (sometimes followed by eco-labeling), or quality standards such as organic mariculture (CBD 2003b).

5.7.5 Assessment

We can conclude with a *high degree of confidence* that the benefits from ex situ conserved genetic diversity are substantial, though much more work is required in this area to develop adequate appreciation and estimates of the full benefits. While the technology continues to improve, the major constraint is ensuring that an adequate range of genetic diversity is contained within the ex situ facilities, and that these remain in the public domain where they can serve the needs of poor farmers. In addition, ex situ facilities are unlikely to conserve the full range of genetic diversity of species. To achieve more effective conservation a complementary approach to conservation using in situ conservation should be adopted (Engelmann and Engels 2002).

The technologies for in situ conservation in domesticated landscapes are well developed. However, the economic incentives seem to favor a narrowing of genetic diversity and greater uniformity of crops. While attractive on the surface, this trend carries significant long-term dangers in terms of maintaining the capacity to adapt to changing conditions.

While the importance of wild relatives of domesticated plants and animals is well recognized, we conclude that very little is being done to carry out detailed inventories of their status and trends, and to ensure that protected areas are managed in ways that both conserve the wild relatives and make their genes available for use.

War, famine, and environmental disasters may limit the availability to poor farmers of many of the crop varieties that they have traditionally grown. Seed and other propagating materials may be lost or eaten, supply systems disrupted, and seed production systems destroyed. At the same time, aid organizations may distribute seed of new cultivars from a very narrow genetic base that often require rather different production practices than those practiced locally. The net effect of this can be substantial loss of traditional cultivars or changes in the numbers and types of varieties grown (Richards and RuivenKamp 1997).

Assessing the impact of eco-agriculture suffers from a lack of consistent, comprehensively documented research on eco-agricultural systems, particularly regarding agricultural production–ecosystem health interactions, but all 36 eco-agricultural initiatives reviewed by McNeely and Scherr (2003) demonstrate benefits to landscape and ecosystem biodiversity, while impacts on species biodiversity were very situation specific. The greatest benefits were realized when intentional ecosystem planning achieved coordinated adoption over large areas. However, even when adoption was limited to individual farm-level activities, significant benefits to "wild" biodiversity were recorded.

Conserving biodiversity in forest production systems has received considerable attention (Szaro and Johnson 1996; Lindenmayer and Franklin 2002), and the necessary policies and practices are well known. However, the incentives needed to put these into practice are still insufficient in most countries.

It can be stated with a *high level of confidence* that protecting marine areas is a good investment for the conservation of marine biodiversity. In some cases, MPAs may also help the recovery of fish stocks beyond reserve boundaries.

A scientific consensus on the science of marine reserves is emerging. Some of the key findings for biodiversity conservation are (Lubchenco et al. 2003):

- reserves conserve both fisheries and biodiversity;
- networks of reserves are necessary for long-term fishery and conservation benefits (a network of reserves provides significantly greater protection than a single reserve);
- reserves result in long-lasting and often rapid increases in the abundance, diversity, and productivity of marine organisms;
- reserves reduce the probability of extinction for marine species resident within them;
- increased reserve size results in increased benefits, but even small reserves have positive effects; and
- full protection is critical to achieve this full range of benefits.

It should be emphasized, however, that the importance of marine protected areas as a tool for in situ conservation depends also on factors outside the reserve boundaries, such as pollution, climate change, and overfishing.

5.8 Designing Governance Approaches to Support Biodiversity

5.8.1 Introduction

Designing governance approaches to support biodiversity is both a response in itself, and creates enabling conditions for other responses to succeed. For example, establishing laws for access to resources in PAs supports biodiversity conservation directly. Maintaining a well-functioning legal system enables other responses, such as PAs, to be effective because the enforcement of laws carries consequences without which the PA would become a paper park. This section assesses what kinds of governance work best for what aspects of biodiversity and under what conditions.

Governance as "the act or manner of governing" (*Oxford Concise Dictionary,* 8th edition, 1990) is used broadly here, and often relates to the exercise of governmental authority at various levels, but can also involve the exercise of some control or authority by other actors, for example indigenous peoples or the private sector. "Good governance" involves establishing and enforcing appropriate laws, developing management and other institutions, and maintaining a system that limits corrupt activities.

The CBD in its description of the ecosystem approach (Decision V/6) acknowledges that "the scale of analysis and action should be determined by the problem being addressed," and includes as two principles of the ecosystem approach that "management should be decentralized to the lowest appropriate level" and that "the ecosystem approach should be undertaken at the appropriate spatial and temporal scales." The similar approach in "subsidiarity" means that a higher level of authority should only act if the objectives of the intended action cannot be sufficiently achieved by a lower level of authority.

Many central governments have decentralized certain responsibilities, sometimes with insufficient attention to whether appropriate powers and responsibilities are being devolved from the center and whether the necessary local institutional infrastructure is in place to receive newly decentralized powers and obligations.

This decentralization can take different forms, varying in how much authority, accountability, and representation is assigned to the lower levels of governance. For example, since 2002, Mexico has decentralized the authority and responsibility for enforcement of federal environmental rules to states and local entities that demonstrate that they have the institutional capacity to take on those responsibilities. With respect to Mexico's megabiodiversity, such decentralization has required large investments in the management and institutional capacity at the local and state levels. The fact that biodiversity generates benefits beyond local and even regional boundaries implies that decentralization of biodiversity conservation management could shift management toward local benefit provision if proper national or international incentives and management structures are not nested with local management.

Devolution takes place when decision-making powers are devolved to local branches of the central state (prefects, administrators, or technical agents such as foresters). These upwardly accountable bodies are local administrative extensions of the central state. They may have some downward accountability built into their functions, but their primary responsibility is to central government. When authority and decision-making powers are devolved to local government authorities, issues of representation are at stake. One key question is how these local authorities are chosen. Are they elected by the communities they are supposed to represent, or are they appointed by central government?

Privatization is also often done in the name of decentralization and participation, and devolves public resources to private groups, such as individuals, corporations, management committees, NGOs, etc. These bodies may be accountable within certain legal and moral bounds, but their objectives are often determined by their members, not the public as a whole (Ribot 1999). Such privatization can lead to more exclusion than participation and to less public accountability.

The renewed focus on indigenous groups under the CBD's Article 8(j) has led to calls to reinforce "traditional" authorities in natural resource management. The role and legitimacy of these authorities may differ from community to community. Chiefs can be administrative auxiliaries of the state (hence upwardly accountable), dedicated to the local population (downwardly accountable), or autocratic local powers (Ribot 1999). Many decentralized and participatory environmental management policies and projects rely on NGOs, project or government-organized management committees, local project administrators, local government administrators, or technical service agents, to represent local communities in matters of natural resource decision-making (Ribot 1999, UNESCO 2000). When representative local government is in place, the empowering of alternative authorities (including "traditional authorities") undermines the function and ultimately the legitimacy of the local authorities (Ribot 1999). In some cases, this is aggravated by a constant shifting of power over resources from one set of authorities to another and back again (Spierenburg 2003).

Barrett et al. (2001) argue for stepping beyond the "false dichotomy" of community versus central government and recognize the value of diversity in approaches to governance. Community-based methods work best if social control at the local level is strong enough to restrict access to the resource. Government systems work best if they are run by a competent bureaucracy. Where authority should be placed depends on the resource to be managed and the relative strengths of the different levels of authority.

5.8.2 Examples of Governance Approaches in Biodiversity Conservation

Governance in practice requires institutions and a framework including rules on accountability, enforcement, reporting, and distribution of benefits. Sound institutions are essential for successful governance.

In 152 case studies of net loss of tropical forest cover, Geist and Lambin (2002) analyzed the underlying driving forces of tropical deforestation, including demographic, economic, technological, political, institutional, and cultural factors. Policy and institutional factors (including property rights, policy climate, and formal policies) were found to be an underlying cause of tropical deforestation in 78% of the case studies (second to economic factors, with 81%).

At the end of the 1990s, the Indonesian government devolved management responsibility for all forests outside protected areas to the district level within provinces (criteria and standards were still to be set by central government), in the context of new legislation that promoted regional autonomy. Many districts did not have the capacity to manage and enforce a sustainable forestry policy, resulting in logging concessions in biodiversity rich areas and illegal logging. The Indonesian Directorate of Nature Conservation acknowledged the problem and stated that the military may be needed to protect national parks instead of local police (Jepson et al. 2001).

Kellert et al. (2000) assessed the success of a number of Community Based Natural Resource Management approaches in Kenya, Nepal, and the United States using six variables, one of which was empowerment. They found that although all case studies intended to devolve authority from higher to more local levels, the actual extent of this devolution was uneven, "often questionably effective," or not equitable (with only small groups in local communities benefiting). A clear judicial and legislative mandate for devolution and well-developed institutions were identified as factors for success of the CBNRM scheme and, more specifically, its "empowerment" aspect.

Smith et al. (2003) investigated the correlation between quality of country governance and changes in three components of biodiversity (forests, African elephant, and black rhinoceros). The results (though less strongly for forests) confirm the link between corruption and conservation failure, emphasizing the need to strengthen institutions.

Local councils oversee the Masai Mara National Reserve in Kenya. Because few fees have been collected or effectively invested, local communities that were entitled to 19% of reserve revenues as compensation for human-wildlife conflict had received little or no money since the mid-1990s. The local council (Trans Mara County Council) has now contracted a private consortium to manage part of the reserve (ticketing, revenue collection, tourism management, security, and wildlife conservation), resulting in a significant increase in revenue collection and increased donor funding. If the consortium can ensure that the benefits do flow to neighboring communities, this becomes an example of a public-private partnership that successfully addresses governance problems (Walpole and Leader-Williams 2001; Caldecott and Lutz 1996).

5.8.3 Assessment

Where authority is devolved to a lower level because action at that level will be more effective (for example, better adapted to the resource that will be managed, or more capable to create incentives to conserve a resource), such devolution can allow local capture of benefits of biodiversity, combined with a sustainable management of the resource. Where a higher government level devolves authority for reasons not related to the achievement of the conservation goal (for example, to reduce the burden on a central government administration), or where devolution happens without institutional capacity at the lower level, it has not helped biodiversity conservation, and has even led to the loss of biodiversity.

Without good governance and strong institutions, the level at which authority is located may only marginally influence the success of responses to biodiversity loss. This statement, however, does not reduce the importance of the principles of decentralization or subsidiarity as a guiding principle for reasons of efficiency, democratic legitimacy, and ethics. Institutional diversity and nested institutional arrangements (Ostrom 1998) may be the way forward, as all levels of authority have their strengths and weaknesses (Ostrom et al. 1999).

The case studies reviewed identify the following issues as relevant when deciding on a governance approach:

- Not all functions can be decentralized usefully (Caldecott and Lutz 1996). For example, tangible benefits of biodiversity might most often be harvested locally, and local management may include the social control required to prevent overharvesting. At the same time, protection from, for example, armed poachers may require a higher-level authority.
- A necessary condition for successful decentralization is a national framework that supports it. Moreover, decentralization is a political process involving the redistribution of power, requiring a mediating body between the different levels (this can be central government, but also, for example, an NGO).
- Complications may be added where local people or authorities are unaware of some of the consequences of management options. Awareness and education are essential.
- Sound institutions and high quality of governance at all levels—including well-established tenure rules at the local level (Ostrom 1998)—are essential prerequisites for successful decentralization of environmental management.

5.9 Promoting International Cooperation through Multilateral Environmental Agreements

The most pressing global environmental issues—the loss of biological diversity, deforestation, invasive alien species, climate change, the loss of wetlands, overgrazing, the protection of international waterways, desertification, ozone depletion, and toxic waste—create major challenges for legislation-based responses. Various treaties have emerged in the past few decades to address these issues. These multilateral environmental agreements play a crucial role in the conservation and protection of the environment, and they are inextricably linked to the alleviation of poverty in developing countries. (See Box 5.6.)

But how effective have they been in protecting the environment? The effectiveness of multilateral environmental agreements has been widely discussed and well-documented (Jacobson and Brown Weiss 1997; Sand 1992; Werksman n.d.; May et al. 1996; Bilderbeek 1992; Cameron et al. 1996). Effectiveness varies according to the objective assessed, such as solving the problem, achieving the goals set out in the treaty, altering behavior patterns, and enhancing national compliance with the rules in international agreements (Birnie and Boyle 2002). Therefore, the effectiveness of different MEAs is influenced by the nature of the environmental problem and several other factors. Possible measures of success differ for the different MEAs. Boxes 5.7 and 5.8 discuss the relative success of two international agreements.

5.9.1 Key Factors Leading to Effective Implementation of Treaties

Several studies on implementation and compliance present similar findings on the effectiveness of environmental agreements. One empirical study indicates that although compliance has been low, the overall implementation of treaties is positive (Jacobson and

BOX 5.6

How Multilateral Environmental Agreements Affect Rural Poverty

Few multilateral environmental agreements address the poverty alleviation priority of developing countries, but the Convention on Biological Diversity, in its preamble, recognizes "that economic and social development and poverty eradication are the first and overriding priorities of developing countries." The CBD (Article 20.4) and UNFCCC (Article 4.7) also state that "eradication of poverty" is one of the commitments by the parties.

One of the key decisions of the seventh UNFCCC Conference of Parties (FCCC/CP/2001/L.24/Add.2) is the establishment of a Clean Development Mechanism, a mitigation measure that could assist developing countries achieve sustainable development, while recognizing economic growth as essential for alleviating poverty. Moreover, UNFCCC has recently adopted the COP 8 "Delhi Ministerial Declaration" (FCCC/CP/2002/L.6), which emphasizes the implementation of energy policies that support developing countries' efforts to eradicate poverty. The Convention to Combat Desertification also has several provisions toward alleviating poverty that create an enabling environment to achieve sustainability objectives. The CCD is considered one of the tools for poverty eradication, particularly in Africa (WSSD, Plan of Implementation para. 7(l)).

The Ramsar Convention does not specifically provide for the involvement of local people in wetland management. Nevertheless, the COP recommendation 6.3 calls for the inclusion of local and indigenous people in the management of Ramsar wetlands. Subsequently, in 1999 the COP adopted guidelines for establishing and strengthening local communities' and indigenous people's participation in the wetland management (Res. VII.8). This is the most systematic guideline on participatory management. As stated in the Ecosystem Approach Principles (Principle 2), management should be decentralized to the lowest appropriate level, and boundaries for management shall be defined by indigenous and local peoples, among others (Principle 7, CBD 2001–2004).

Brown Weiss 1997). The study shows that the governance features of a country determine the quality of its treaty implementation, and effective implementation and compliance involve numerous other factors, including the characteristics of the treaty, the political will to support it, the human resources committed to monitoring and reporting, the financial resources allotted, sanctions and enforcement, and country capacities. In addition, monitoring by civil society can encourage implementation.

Agreements that impose precise obligations are easier to assess, such as the Montreal Protocol on Substances that Deplete the Ozone Layer and CITES. On the other hand, agreements with vague obligations that do not establish clear standards make it difficult to judge the extent of compliance, such as the World Heritage Convention or the International Tropical Timber Agreement. A second characteristic involves the quantity of regulated objects. For instance, the Montreal Protocol deals with a limited number of substances, but CITES deals with thousands of species. This makes CITES difficult for customs officials to implement.

A second important factor for the implementation and compliance of MEAs is political will. Jacobson and Brown Weiss (1997) report that when the parties agreed to deepen their specific commitments, better implementation and compliance resulted.

Third, a reporting mechanism is essential (Chasek 2001). The parties to a convention need to report the measures used to comply with the obligations (Glasbergen and Blowers, 1995). National reports are critical because they provide the specific information to show that each country is meeting its obligation under a convention. Indeed, the ineffective monitoring of MEAs results in a lack of accurate, complete, and objective information on the performance of the parties (Werksman n.d.). A reporting system helps government officials understand their obligations under the treaties and the means that might be used to aid compliance. It has also been found that a standardized form improves the effectiveness of the reporting. For instance, the cooperation between CITES and the World Conservation Monitoring Center has shown that reporting improves effectiveness (Jacobson and Brown Weiss 1997).

Fourth, the availability of sufficient human resources to monitor compliance is essential. The secretariats of the conventions are expected to analyze the country reports submitted by the parties to the convention, but the secretariats are usually small in size—many less than 30 people—which makes it difficult to conduct a thorough and timely analysis (Jacobson and Brown Weiss 1997). CITES has been enhanced by the close monitoring for infractions through national and independent reporting by the secretariat. The infractions are reported in the Conference of the Parties and are widely publicized (Werksman n.d.).

A fifth factor for effective implementation and compliance is the availability of financial resources (Richardson 1992). A study in Cameroon shows that limitation of financial resources is the main reason for noncompliance with the procedural requirements of treaties (Jacobson and Brown Weiss 1997). To help assure their effectiveness, the Vienna Convention and the Montreal Protocol have an amendment to provide financial assistance in preparing inventories for the production and consumption of ozone-depleting substances, and in transforming production facilities (Jacobson and Brown Weiss 1997).

Some treaties have provisions for developed countries to assist developing countries in meeting their international obligations. For instance, the CBD (Article 20, 2) calls for "the developed country parties to provide new and additional resources to enable developing country parties to meet the agreed full incremental costs to them of implementing measures which fulfill the obligations of the convention."

A sixth factor for effectiveness is the establishment of sanctions. Mechanisms for dealing with noncompliance are important to enable punishment of violators (Chasek 2001). Typically, biodiversity-related treaties do not establish sanctions for noncompliance or for failure of parties to adhere to the procedural provisions (Chayes and Chayes 1991). The lack of monitoring and enforcement provisions in the treaties is a common shortfall of MEAs (Richardson 1992; Miles et al. 2002).

Although few MEAs impose any sanctions for noncompliance, most do include a dispute resolution mechanism. Formal dispute settlement mechanisms are rarely used, however, because countries have preferred to use negotiation to solve problems (Bilderbeek 1992). Most multilateral environmental regimes have no compulsory jurisdiction for dispute settlement. In the absence of a supranational regulatory institution, the implementation is carried out by national institutions (Sand 1991). However, the difficulty of monitoring and enforcement is compounded since implementation by the individual countries is so variable (Richardson 1992).

Table 5.2 lists 15 MEAs, which directly or indirectly relate to the protection and conservation of biological diversity. It also

BOX 5.7

The Convention on Biological Diversity

The 1992 Convention on Biological Diversity is arguably the most important multilateral environmental agreement dealing with biodiversity. An assessment of the effectiveness of the CBD needs to include consideration of progress towards the CBD's objectives, the external impact of the CBD, and the nature of the CBD as a mechanism (that is, what it may reasonably be expected to achieve).

A central strength of the CBD is the integrative nature of its three linked objectives of conservation, sustainable use, and benefit sharing. However, these are "process" rather than "outcome" objectives. Many of the CBD's provisions have vague formulations, whose content can only be tested in implementation (Rosendal 1995). The national biodiversity strategies and action plans, which form a central implementation mechanism, have resulted in positive actions at the national and local level, but experience varies. Weaknesses include the absence of a clear process for assessing, verifying, or discussing national reports on implementation (Global Forest Coalition 2002). The absence of consensual scientific knowledge in support of the CBD has been viewed as one of its greatest shortcomings (Le Prestre 2002).

Disaggregated, the CBD has had positive effects, notably at the national level because its main emphasis has been on national implementation. However, one could argue that a global response option is needed, one that can advance a coordinated and results-oriented international effort across the spectrum of complex, interacting forces that drive biodiversity loss. The CBD should be playing this role. In this respect, it has not yet succeeded.

In 2002, the target of achieving ". . . by 2010 a significant reduction of the current rate of biodiversity loss . . ." was included in the Strategic Plan for the Convention (Decision VI/26). This target date was reinforced by the Plan of Implementation adopted at the 2002 World Summit on Sustainable Development, which also confirmed the need for new and additional financial and technical resources for developing countries.

For the first decade of its existence, the CBD has been a process-oriented and relatively marginal convention, if viewed in a broad political context. Achievement of the 2010 target will require unprecedented political and financial commitments across a wide range of sectors. Other developments, such as the proposal for a new regime on benefit-sharing by the Group of Like-minded Megadiverse Countries, and the growing recognition of the importance of biodiversity to the Millennium Development Goals, raise the possibility of reinforcing the CBD to address the new agenda. This could involve the Conference of the Parties making use of Article 23.4(i), which states that it is to: "[c]onsider and undertake any additional action that may be required for the achievement of the purposes of this Convention in the light of experience gained in its operation." Currently, the CBD seems to stand at a crossroads, with its Biosafety Protocol recently entering into force, nearly 190 States Parties, and regular meetings of its Conference of Parties and various subsidiary bodies. On the other hand, government enthusiasm and funding seem to be waning, and relatively few nongovernmental organizations are stepping in to support decisive action to actually implement the CBD on the ground.

BOX 5.8

The Bolivian National Strategy for Biodiversity Conservation

Bolivia ratified the Convention on Biological Diversity in 1994, so the government needed to develop a corresponding framework for implementation. In a pluricultural and multiethnic country such as Bolivia, where many people depend directly on biodiversity services without being necessarily aware of the need for conservation, agreeing on biodiversity's role has been a major challenge.

The Bolivian process of developing its National Biodiversity Conservation Strategy was through committees led by the Ministry of Sustainable Development and Planning. Several committees were established involving specialists, experts, and representatives from the government and civil society. Hundreds of people participated in departmental, sectoral, and national workshops, raising the level of awareness of biodiversity of most of the decision-making levels of society and the government.

The Strategy was validated and approved by all participants in the process (civil society and the government) through an act signed at the concluding national workshop, and subsequently officially ratified through a Supreme Decree. Within the Strategy framework, Bolivia recognizes the strategic character of biodiversity to improve the quality of life of the population and promote national development, in addition to the need to promote its integration in development planning through plans and strategies at the national, departmental and sectoral levels. This includes linking strategies for the use of nonrenewable and renewable natural resources.

The objective of the Strategy is the conservation of biological resources, in particular those of ecological, economic, and cultural importance. It is recognized that the conservation of ecosystems, species, and genetic resources affected by destructive processes is fundamental to ensure the maintenance, functionality, productivity, and dynamism of the environment and to maintain the productive base of the country. At the same time the economic potential of biodiversity is recognized as a current and potential source of benefits at many levels in the medium and long term.

The Strategy has become a governmental policy and a principal challenge is to reach beyond traditional government and jurisdictional boundaries. Civil society has validated the Strategy, but does not feel sufficient ownership to promote its implementation. The Strategy was designed as a mechanism for multilateral and bilateral fundraising, and it will be possible to measure whether the future conservation funding was facilitated by the elements included in the strategy.

indicates where an MEA contains provisions related to implementation as discussed above.

Enforcement mechanisms differ among the treaties. In general, the expressions used in the treaties, which impose the obligations, are criticized as vague, thus lacking effective force (Boer 1998; Bilderbeek 1992). For instance, most of the treaties listed in Table 5.2 do not have clear provisions for implementation. Rather, they use expressions such as "to explore," "to encourage," or "where appropriate and feasible," which weaken the provisions.

Some treaties state explicitly that each country's domestic legislation should provide sanctions for noncompliance with the regulations of the agreements. For instance, the Basel Convention (Article 9.5) imposes strict trade sanctions. CITES (Article 8.1) requires the parties to take measures to penalize illegal trade, and to confiscate illegally traded specimens.

Table 5.2. Selected Provisions Related to Implementation and Enforcement of International Environmental Agreements (modified from Association on Scientific Uncertainty 2003)

	Convention	Enacting/ Strengthening of Domestic Laws and National Strategies	Identification of Policy Measures/ Performance standards	Notification/ Reporting System	Recommen-dations/ Accountability	Monitoring by Non-state Entity	Financial Resources	Eradication or Alleviation of Poverty	Non-compliance Measures	Sanctions	Dispute Settlement	Coordination with Other Conventions
1	Ramsar Convention (1971)	Art. 2; 3; 4; 5	Art. 4.1	Art. 2.5; 3.2	Art. 6.2(d)(e)	Art. 7.1	COP Resolution 4.3	COP Recommendation 6.3; Resolution VII.8				
2	WHC (1972)	Art. 5; 17; 18	Art. 11	Art. 11.1; 29	Art. 13.5	Art. 8.3	Art. 15–18		Operational Guidelines E. 46 (a), (b); 47.			
3	CITES (1973)	Art. 3–8; 10; 14	Art. 2; 3; 4.2; 5	Art. 8.7; 13.1; 13.2	Art. 8.8; 11.3(e); 12.2(h); 13.2; 13.3	Art. 11.6; 13.1		Resolution Conf. 10.9; 10.14; 10.15;		Art. 8.1	Art. 18.1, 2	Art. 14.2–14.6
4	CMS (1979)	Art. 3.4; 3.5; 5.5	Art. 5	Art. 3.7; 6.2; 6.3	Art. 3.6; 7.5(e)(g)(h)	Art. 8.2					Art. 5.4(e); 13.1, 13.2	Art. 12
5	Vienna Convention (1985)	Art. 2; 3.2		Art. 5	Art. 6.4(c)(f)	Art. 6.5					Art. 11.1; 11.2; 11.3(a) (b); 11.5	Art. 7.1(e)
6	Montreal Protocol (1987)	Art. 2; 4; 5	Art. 2; 4; 5	Art. 2.5; 2.7; 2.8(b); 4B.3 (Amendment); 5.4; 5.6; 7 (Amendment R); 9.34	B.4 (Amendment)	Art. 11.5	Art. 10; Article 1. T (Amendment); 13		Art. 8	Art. 8 and Art. 4	Art. 14	
7	Basel Convention (1989)	Art. 3; 4.1–4.10; 6–9		Art. 3; 4.1(a); 4.2(f); 5.1; 6.1; 6.4; 6.9; 6.10; 7; 11.2; 13		Art. 15.6	Art. 14			Art. 4.4; 9.5	Art. 20.1; 20.2; 20.3 (a) (b)	Art. 1.4; 4.12; 16.1(d)
8	UNFCCC (1992)	Art. 3; 4	Art. 4	Art. 4.1(a)(j); 4.2(b); 12	Art. 7.2(g)	Art. 7.6	Art. 4.2–10; 5; 11; 12.4; 12.5; 12.7; 21.3	Preamble; Art. 4.7			Art. 14.1; 14.2(a) (b); 14.5–14.7; 13	Art. 8.2(e)
9	CBD (1992)	Art. 6; 10;14.1; 15.7; 16.3; 16.4; 19.1; 19.2; 19.4	Art. 7(a); 8; 9	Art. 14.1(c)(d); 26		Art. 23.5	Art. 20; 21; 39	Art. 20.4			Art. 27.1; 27.2; 27.3(a) (b); 27.4	Art. 22; 23.4(h); 24.1(d); 32

10	ITTA (1994)	Art. 1(l); 25		Art. 29.2	Art. 12	Art. 3.1	Art. 1; 21; 25; 27; 28; 30.5; 34				Art. 31	Art. 14
11	Straddling Stocks Agreement (1995)	Art. 5; 6; 7.2; 10(c); 12.1; 14.1; 16; 18; 19; 21–23; 33.2	Art. 5; 6.3; 18.3	Art. 7.7; 7.8; 20.3; 21.4; 21.5–21.9; 21.12		Art. 10(h)	Art. 24–26				Art. 7.4; 10(k); 27; 29; 30.3; 30.4	Art. 4; 20.6; 44
12	UNCCD (1996)	Art. 4; 5; 9–11; 13–15;	Art. 10	Art. 26		Art. 22.7	Art. 4.2(h); 4.3; 6; 7; 9.2; 12; 13; 16–21; 26.7	Preamble; Art. 4.2.(c); 10.4.; 20.7.; Annex I, Art. 4.1.(a); 5.1.(a); 8.1.; 8.3.(a); Annex II, Art.4.2.	27		Art. 28.1; 28.2(a) (b); 28.3; 28.6	Art. 8; 22.2(i); 23.2(e)
13	Convention on Int'l Watercourses (1997)	Art. 5; 7; 20–23; 26.1; 27; 28		Art. 9; 12; 28.2							Art. 10.2; 33.1–33.8; 33.10 (a) (b)	Art. 3; 4; 8.2
14	Kyoto Protocol (1997)	Art. 2; 3; 5; 10	Art. 2; 3; 5; 10	Art. 3.2–3.5; 4.2; 7; 10(b ii)(f)	Art. 13.4(f)	Art. 8.5; 13.8	Art. 2.3; 3.5; 3.6; 3.10; 3.12–14; 6; 10; 11; 12; 13.4(g)		18		Art. 16; 19	
15	Cartagena Protocol (2000)	Art. 2.1; 2.2; 14.4;16; 17; 18; 25	Art. 11.6(a); 15.1; 18.2	Art. 8; 11.1; 11.5; 12.1; 13; 17; 20.3; 21.2; 25.3; 33	Art. 29.4(a)		Art. 28		34			Preamble para. 10; Art. 2.3; 14.3; 32

Notes:
1. Convention on Wetlands of International Importance as Waterfowl Habitat.
2. UNESCO Convention on World Heritage.
3. Convention on International Trade in Endangered Species of Wild Fauna and Flora.
4. Convention on Migratory Species.
5. Vienna Convention for the Protetion of the Ozone Layer.
6. Montreal Protocol on Substances that Deplete the Ozone Layer.
7. Basel Convention on the Transboundary Movements of Hazardous Waste and their Disposal.
8. United Nations Framework Convention on Climate Change.
9. Convention on Biological Diversity.
10. International Tropical Timber Agreement.
11. Agreement for the Implementation of the Provisions of UN Convention on the Law of the Sea (1982) Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stock.
12. United Nations Convention to Combat Desertification.
13. Convention on the Law of the Non-navigational Uses of International Watercourses.
14. Kyoto Protocol to the United Nations Framework Convention on Climate Change.
15. Cartagena Protocol on Biosafety to the Convention of Biological Diversity.

Most treaties have a reporting system and publish data on the relevant parties' follow-up of regime decisions. However, these data are often incomplete (Wettestad 1999). Some conventions do not have a specific requirement for reporting. In the case of the Ramsar Convention, this is compensated by a Conference of the Parties recommendation which stipulates that ''all Parties should submit detailed national reports to the Bureau at least six months prior to each ordinary meeting of the Conference of the Parties'' (Recommendation 2.1). In addition, Recommendation 5.7 on national committees mentions the opportunity for nongovernmental organizations to have input in the preparation of the report (Isozaki 2000). Nevertheless, many countries have not submitted their report because the recommendation does not specify content or guidance for preparing the report.

Together with a reporting system, notification from the concerned country is important for monitoring. In the case of CITES, it helps to detect cases such as illegal transboundary movements and illegal trade of specimens; it also helps to notify affected or potentially affected states that may suffer adverse effects on the conservation and sustainable use of biodiversity, and on human health (Biosafety Protocol, Article 17, 1).

Some treaties have concrete provisions on noncompliance, while others use other enforcement methods, such as imposing sanctions or making recommendations. The World Heritage Convention itself does not provide noncompliance measures, but the operational guidelines establish procedure for eventual deletion of properties from the World Heritage list when the property has deteriorated or when the necessary corrective measures have not been taken.

Some treaties provide for monitoring by non-state entities, such as nongovernmental organizations and experts in the concerned area. Most treaties have provisions to ensure coordination with other conventions.

5.9.2 Overcoming the Limitations

Implementation and compliance can be improved by taking into account the factors discussed above. Existing multilateral environmental agreements have been piecemeal, so the coordination of actions among various MEAs is essential for better implementation (Bilderbeek 1992). In this regard, the WSSD Plan of Implementation recognizes the need for cooperation between the relevant international organizations. As a priority to improve implementation, it advises actions ''to encourage effective synergies among multilateral environmental agreements dealing with the protection and conservation of biodiversity, through the development of joint plans and programs with due regard to their respective mandates, regarding common responsibilities and concerns'' (Paragraph 42 (c).

In fact, some conventions have been successfully implementing cooperative works in areas of the common interests among them. The Ramsar Convention has been promoting cooperation and coordination with other treaties to achieve the objectives of the convention. For instance, the Ramsar and World Heritage conventions have cooperated to identify and strengthen conservation of those sites of international importance, which are of mutual interest and benefit (Article II, Ramsar MOU with the World Heritage Convention, May 14, 1999). Furthermore, cooperation between the Ramsar Convention and the Convention on Migratory Species has been in effect since 1997, in terms of joint conservation action, data collection, storage and analysis, institutional cooperation, and new agreements on migratory species (Ramsar 1997). The Ramsar Convention has adopted its third joint work plan with the Convention on Biological Diversity, covering the period 2002–2006.

Although some treaties do provide financial resources, the terms usually avoid specifying concrete measures, such as how much assistance, to whom, and on what terms (Boer et al. 1998). For instance, to implement a convention like CITES requires significant financial resources for training, but that convention does not provide any means or financial mechanisms for doing so. Likewise, the Ramsar Convention does not have a provision for financial assistance. However, Conference of the Parties resolution 4.3 set up the Ramsar Small Grants Fund for Wetland Conservation and Wise Use in 1990 to provide assistance for wetland conservation initiatives in developing countries or countries with economies in transition. Since the level of funding has not been sufficient to fund many of the projects submitted to the fund, the Conference of the Parties has adopted measures to increase the wetland conservation fund (Kushiro Res. 5.8), to cooperate with the Global Environmental Facility and its implementing agencies (Brisbane Res. VI.10), and to consider receiving official development assistance and external funding to meet their obligations under the Convention (Brisbane Res. VI.6). Despite its modest funding mechanism, the Ramsar Convention has been exploring new ways to cope with and protect its listed wetlands.

In addition to formalized international cooperation among legally-binding instruments as discussed above, several initiatives among non-legally binding instruments help overcome the limitations. Expanding countries' participation in relevant bilateral, regional, and sub-regional agreements, initiatives, and networks is quite important for the effective implementation of MEAs. For instance, the Convention on Migratory Species has extended its work beyond its signatory parties. It has promoted regional actions and agreements among its parties, like the ''Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa, Abijan, 1999.''

One long-standing case is that in which Japan maintains bilateral agreements for the protection of migratory birds with the United States (1974), Australia (1981), China (1981), and Russia (1988). The countries exchange information on measures taken within each country and discuss the needs for further joint research. Another example of a successful regional agreement is the ''Asia-Pacific Migratory Waterbird Conservation Strategy'' started in 1996 with the objective to promote the conservation of migratory waterbirds and wetlands in the Asia-Pacific region (Wetlands International 2001), resulting in the establishment of major waterbird flyways in the Asia-Pacific Region. Another example is the International Coral Reef Initiative, a comprehensive framework of international cooperation for coral reef conservation and management, with a special focus on ecosystem and community-based management (UNEP–CAR/RCU 2000–2003). Box 5.9 discusses carbon sequestration as a policy response.

5.9.3 Assessment

Existing MEAs cover the most pressing drivers and issues related to the loss of biodiversity. Additional global agreements are therefore not required at this time, but better coordination between the existing conventions, especially at implementation level, would increase their success and avoid duplication or even contradictions that lead to inefficient use of the limited resources available. Regional instruments can be useful to address conservation issues, for example, at the scale of a river basin or a transboundary terrestrial conservation area, and have been shown to help implementation of global MEAs.

BOX 5.9

Assessing Carbon Sequestration as a Conservation Response in the Andes

Carbon sequestration is increasingly understood as an important global ecosystem service (Daily et al. 1997). Bolivia has gained experience with climate change mitigation through carbon sequestration through the Noel Kempff Climate Action Project. The project was co-designed and is executed, since 1997, by the Bolivian NGO Fundación Amigos de la Naturaleza (FAN), together with the government of Bolivia, the Nature Conservancy, and three energy companies (American Electric Power, PacifiCorp, and BP Amoco). The project is the largest forest-based carbon project in the world, protecting about 1.5 million hectares of tropical forests in the Bolivian Amazon for at least 30 years. The project was developed under the Activities Implemented Jointly pilot phase of the Kyoto Protocol and conserves natural forests that would otherwise have been subjected to continued logging and future agricultural conversion. It is expected to sequester seven million tons of carbon (Powers 2003; Brown et al. 2000).

For the first time in Bolivia, a market-based mechanism, rather than a donation, was to generate the funds needed to manage a large protected area. Carbon-sequestration-forest-conservation projects seemed to be an adequate response to the problem that nature conservation, in comparison to traditional land-use forms, does not provide sufficient benefits for local people in developing countries. Consequently, many local actors, such as indigenous communities and municipalities, developed a strong interest in carbon trading as an alternative and sustainable income. However, for diverse reasons conservation projects have yet to become eligible under the Clean Development Mechanism of the Kyoto Protocol, which for the time being allows only for forestry measures.

Nevertheless, the Noel Kempff Climate Action Project continues based on a voluntary commitment of the investors. The project has been and continues to be very important for the conservation of biodiversity, and is breaking ground to establish credible and verifiable methods to quantify greenhouse gas benefits of land-use change and forestry projects (Brown et al. 2000). Furthermore, household level economic analysis (Milne 2001) has demonstrated a net positive economic benefit to park-bordering communities, particularly through working to secure land tenure and facilitating "carbon tourism." Another study suggests that community benefits, while present, may have been overstated (May et al. 2003).

Currently, the CDM contains enormous potential for large restoration measures in degraded areas in the tropics. An array of native tree species could potentially restore the Andean montane ecosystems, assure the availability of water, prevent erosion and sedimentation, and support agricultural production (that is, through shade, nutrients, soil formation, etc.). One limiting factor has been the costs that could be covered neither by development projects nor by the local communities (Ibisch 2002). However, this might change completely should carbon credits yield a given income in the framework of the CDM.

The negotiation processes leading to the adoption of MEAs have succeeded in catalyzing political and scientific debate on environmental issues of international importance. The existence of MEAs has most likely also contributed to greater environmental awareness, though this does not mean that MEA provisions have been implemented on the ground.

The main issue, therefore, is implementation at the national level of existing MEAs (Bowker and Castellano 2002). It is worth reviewing the implementation of international treaties at the national level, especially the application of international environmental law by national courts. One study shows that national courts could play a supplemental role in implementation (Bodansky and Brunnée 1998). For example, in a Philippines timber court case, the Supreme Court ruled that the plaintiffs have standing to sue on behalf of their generation and subsequent generations (IC-SEA 1999); in a Tasmanian Dam case, the High Court of Australia held that the acceptance by Australia of an obligation under the World Heritage Convention as such sufficed to establish the power of the Commonwealth to make to fulfil the obligation (Bodansky and Brunnée 1998); and in Japan's Kogen Highway Plan case, the plaintiffs challenged the Hokkaido provincial government decision authorizing the construction of a road through Daisetsu National Park that threatened the "Naki rabbit" population and other wild flora and fauna (Isozaki 2000). These cases demonstrate that domestic courts play a vital role in the application of international environmental agreements.

National implementation of MEA provisions, compliance with reporting mechanisms, transparency of the reports, support to convention secretariats, and national capacity building are essential for success.

5.10 Education and Communication

5.10.1 The Case for Education and Communication

Policy-makers and biodiversity managers must deal with a vast array of external audiences and stakeholders, many of whom are not concerned with conservation. To at best reverse and at least mitigate detrimental human impact on ecosystems, policy-makers and natural resource managers must manage change in perceptions and actions. "Without communication, education and public awareness, biodiversity experts, policy makers and managers risk continuing conflicts over biodiversity management, ongoing degradation and loss of ecosystems, their functions and services. Communication, education and public awareness provide the link from science and ecology to people's social and economic reality" (Van Boven and Hesselink 2002, p. 3).

While much attention is usually given to bringing about change through individual-level learning, increasing attention is being given to change through organizational-level learning, whereby the institutions or governance structures are adapted to cope with the complexity and multilevel actions of sustainable development. This systems approach is often embodied in the term capacity development (Lusthaus et al. 2000), and makes use of the disciplines of communication and education to bring about innovation and transformation.

The benefits of investing in communication and education to manage change are widely recognized. At the international level, the environmental conventions include articles on public education and the Johannesburg Plan of Implementation cites education, awareness, and capacity building as means to achieve its objectives as well as to creating effective social institutions.

Regional case studies also document successful use of education and communication programs. For example, a study illustrated how a 12-year education program influenced the practices of eating seabirds in Quebec, Canada, documenting an increase in the populations of formerly threatened species of seabirds (Byers 2004). The Haribon Foundation in the Philippines has used communication, education, and mobilization of networks to motivate fishers and their communities to create marine sanctuaries to allow for fish populations to revive, since fishers were experiencing problems with declining catches. As a measure of success, over 1,000 reserves have been set up, resulting in economic benefits for fishers (Lavides et al. 2004).

Equally, when communication and education are not used, conservation efforts can be stymied and resources wasted. When caimans were reintroduced into a river in Uruguay, the local community, uninformed about the project, killed the animals, as they feared for their children's lives.

Information technology has facilitated cost-effective information sharing, enabling e-mail exchange among communities of practice, list servers among environmental journalists, on-line debates, e-learning and discussion forums. The Internet has been used to mobilize people quickly and in large numbers on specific issues.

A host of non-formal learning situations are provided in environment clubs, scouts, and adult and family education programs provided by museums, zoos, aquaria, botanical gardens, field studies centers, protected areas educational and interpretative programs, and ecotourism. These programs attract hundreds of millions of visitors annually, thereby contributing to developing a constituency for nature policy, though the extent to which these programs influence change in action for the environment has not been assessed here.

The success of communication and education efforts in terms of ''awareness'' are revealed by the fact that in most countries, nature conservation, environment, and sustainable development feature among the top ten—though not the top five—public concerns, (Hesselink 2003). However, some research suggests that this widely held concern is shallow, and support for biodiversity protection is easily eroded when countervailing considerations come into play, such as jobs, property rights, or human convenience (The Biodiversity Project 1999).

Biodiversity communication, education, and public awareness (CEPA, Article 13 of the CBD) is a powerful tool for mainstreaming biodiversity into sectoral practices, bringing local perceptions to the attention of the decision-making process, and potentially changing behavior (CBD 2000b, 2000c; CBD 2001, CBD 2003c). Biodiversity CEPA is more than environmental education, in that conventional educational approaches that have succeeded in raising environmental awareness are not adequate to reflect the complexity of the biodiversity concept (Hall-Rose and Bridgewater 2003). In the coastal marine area, many examples worldwide demonstrate that communication, education and public awareness activities do have a positive impact with regard to preventing the further erosion of ecosystems and reducing the main factors responsible for biodiversity loss, provided local communities are empowered with the capacity to take decisions on how to actually manage the ecosystems under consideration, on the basis of the information provided through CEPA programs (Mow et al. 2003). As with any other program, CEPA programs need regular evaluation, but they must also reflect the reality of the environmental, social, and economic context in which they are implemented.

5.10.2 Constraints Regarding the Use of Education and Communication

On the one hand, communication and education is a relatively weak instrument to bring about change if that change involves high barriers, such as great personal effort or economic loss. In these cases education and communication must be accompanied by other measures to ensure livelihood support. In organizational learning, education is often accompanied by incentives for promotion or assessing performance. On the other hand, it is evident that education and communication can be used more professionally, and the approaches used require some evaluation, reflection, and reconsideration.

Lessons have been drawn from the mistakes of imposing development or conservation solutions on populations that neglected the opinions and habits of the beneficiaries, leading to a lack of acceptance of the change or even to outright conflict (Mefalopulos and Grenna 2004). The result has been more willingness to involve stakeholders in formulating decisions, and a willingness to engage in partnerships and public-civil co-management of natural resources. This engagement is essential to developing trust between conservation organizations and the public (Stern 2004).

In most developed countries, with strong environment departments staffed by communication professionals, communication is used as a policy instrument to achieve policy and management objectives, as well as to mainstream environmental concerns in other sectors. Still difficulties can arise, as in the Netherlands, where the Nature Plan, largely conceived by ecologists, met with conflict from farmers who did not accept it, and had not been involved in its development. Despite informative and motivational communication, the plan did not create the desired acceptance because it neglected the ''cultural factor'' whereby people's rationality or perspectives take on those of the group to which they belong. The communication and policy formulating approach neglected the fact that people change as a result of discussion about issues that they think are important. (van Woerkoem et al. 2000).

Information on the state of the environment is available via the Internet, though information packaged as a support to decision-making is less well developed. In reviewing the impact of environmental information, Denisov and Christoffersen (2000) noted that it is not enough to tell people repeatedly that there are environmental problems; in the longer run, concrete information and ideas of what to do to resolve environmental problems are needed. Yet in Australia a study showed that having environment and wildlife information was not sufficient to drive interest within the community; rather, it is important to provide motivators and create relevance to encourage participants to actively seek information (NSW National Parks and Wildlife Service 2002). ''Research in the field of environmental education and in commercial marketing has shown that there is no cause and effect progression from knowledge to attitude to behavior as educators have long believed'' (Monroe et al. 2000, p. 3).

Since the 1970s, efforts have been made to integrate environmental education into the formal education systems with varying success. Schooling has focused on ecology, nature conservation, the impacts of pollution, and the need to recycle waste. More lately education is being challenged to deal with sustainable development, though the impact of education on long-term behavior for sustainable development is hard to assess. Palmer (1995) found that education, particularly at tertiary and upper secondary level, was the most important influence in developing commitment of only 9% of some 232 environmental educators, having much less impact than childhood contact with nature (29%) or the influence of parents, teachers, and other adults (26%).

5.10.3 Conditions for Success in Communication

Conduct research before implementation. Sometimes, communication means and media are decided on without assessing the critical target group that needs to be reached in order to effect change and how this should be done. Perceptions and social behaviors related to conservation issues and facts are not properly analyzed, and the communication systems used by the groups are not clearly defined. Lack of understanding of the relevant social factors is combined with poor practice in evaluation research, and a failure to use the latest in professional information on communication, media, and techniques (Encalada 2004).

Apply change models and appropriate communication. Most conservation practices that need to be promoted require a social response. This may be viewed as a revamped model of ''diffusion of innovations'' (Rogers 1983) in which communication contributes to: (1) creating consciousness about the existence of the innovation; (2) raising interest toward the innovation; (3) generating knowledge about the innovation; (4) motivating trying out the innovation; (5) helping achieve an appropriate evaluation of the tryout; (6) motivating decisions in favor of a solid adoption of the innovation; and (7) supporting with new and timely information for reevaluation of the adoption in order to consolidate it over time. Each of these steps requires different communication and it is important to apply the appropriate communication according to the stage of the process that people are going through.

Manage reputation and relationships. Stern (2004) suggests that as the global conservation community focuses much of its attention on attempting to provide alternative livelihoods to resource exploitation for residents living within the immediate vicinities of protected areas, careful attention must be paid to meaningful and appropriate engagement and communication with local populations. Results from his study (covering the United States, Ecuador, and the Virgin Islands) suggest that the ability to trust park managers is the most consistent factor associated with how local residents actually respond to national parks. Thus the ways in which parks and partner organizations engage local communities can make or break any projects designed to work with them. The most common explanations of distrust for park authorities included a lack of meaningful personal connection to these entities, a lack of genuine local involvement in park-related decisions or initiatives, complaints of broken promises made by park authorities and their partner organizations, and perceived inconsistency in park-related communication and in enforcement practices.

Manage stakeholder processes effectively. Social learning involves different actors with different interests being able to engage in dialogue. For this to occur, individuals need to be aware of, or be assisted to become aware of, the underlying assumptions and values that lead them to take a particular position. Conflict resolution and negotiation require individuals or groups to seek out common values, which requires being explicit about their assumptions. Reflection becomes a key tool in working through problem situations where values are in conflict and need to be reassessed.

To communicate effectively, deal with communication issues, not just with biodiversity issues. Each biodiversity conservation issue that management is addressing contains a specific communication issue. The communication issue is about how the people concerned relate to the biodiversity issue: what do they know, how do they feel, what do they perceive, what motivates their actions? Quite often a lot of technical information is communicated without giving any clue as to what the audience can do or contribute.

Communicate in understandable terms. One perspective on awareness programs is that they need to avoid jargon and technical terms such as ''biodiversity'' and ''sustainability,'' which are abstract and remote from most people's lives. These ''container'' concepts arguably need both to be broken down into concrete issues that are closer to people's lives and to have actionable steps—a healthy river, a rich native bush land, sustained fish catch (Robinson and Glanznig 2003). However, there is little certainty that appreciation of biodiversity ''option values'' will follow from a focus on such current, concrete, issues.

Start with perceptions and motives of the people. Scientific facts often are communicated in the expectation of changing behavior. In Slovenia (Trampus 2003) conservationists wanted to stimulate people to conserve village ponds for biodiversity through various communication interventions. However, after asking a focus group to explore the ideas with the village people, the conservationists discovered that people were not motivated by biodiversity conservation but rather by cultural factors. These motives were used to promote the restoration of ponds. The engagement in action and the benefits felt as a community worked together to restore a pond had a strong motivating impact. Word spread from community to community with the result that many wanted to restore their ponds.

Create pride and involve in action. Based on work in some 35 tropical countries to stimulate conservation action, Manzanero (2004) has argued that the conditions for success include choosing a charismatic species, developing pride in that species, making a mascot, and sending a message to every segment of society, from religious leaders to children by way of music, stickers, and posters. Results from their approach include new protected areas, changes in legislation, change in behavior, and collective learning. Case studies are needed that examine whether biodiversity in general can benefit from this approach—either being ''swept along'' with efforts focused on the charismatic species, or itself being viewed as charismatic and a matter of pride.

5.10.4 Assessment

Communication and education are essential to achieve the objectives of the environmental conventions, the Johannesburg Plan of Implementation, and the sustainable management of natural resources more generally. Barriers to the effective use of communication and education include a failure to use research and apply modern theories of learning and change. While the importance of communication and education is well recognized, providing the human and financial resources to undertake effective work is a continuing barrier. Attention is often thrust on school education and providing information, yet evidence shows that more effective change strategies are required that address the individual, organizational, and institutional levels. More strategic approaches to achieve management objectives and policy need to consider the benefits and perceptions of the stakeholder, building relations with, and honoring input from, stakeholders.

5.11 Lessons Learned

5.11.1 Introduction

We have examined nine responses relating to biodiversity conservation, evaluating their strengths and weaknesses. These assessments are intended to contribute to decision-makers' understanding of the scientific basis and implications of decisions. Decision-making in practice almost always will involve more than consideration of biodiversity. While the responses were defined based on the broad goals of biodiversity conservation, sustainable use, and equitable distribution of benefits, discussion of strengths and weaknesses inevitably also addressed the degree of success in integrating these goals with demands of society for ecosystem services. Our assessments lead to several conclusions:

- The current system of PAs is a valuable tool for conserving biodiversity, but these areas do not yet include all biodiversity components that require such protection. Better tools exist for selecting areas for inclusion in PA systems than are currently employed, and better management of individual PAs is required.

- For successful (global) biodiversity conservation, local people must be able to capture benefits from that conservation.
- Integrated conservation and development projects as currently designed rarely succeed in their conserving biodiversity objectives, yet their general approach remains valid; they need more realistic objectives and a stronger link to broader policy issues.
- Direct incentives for biodiversity conservation usually work better than indirect incentives.
- Regional planning can achieve balance across areas to create a landscape that includes strict conservation areas, intensively used areas, and other land uses.
- More income must flow from the people and countries that value biodiversity from afar (at the global level) to the people and countries where much-valued biodiversity is conserved, often at considerable opportunity cost.

Problems affecting biodiversity often involve complex conflicts of interests, so solutions require approaches that synthesize contributions from numerous sectors (that may not always be used to cooperating). One solution is to establish localized and manageable points of intervention where practical solutions can be applied and tested. If successful, such a ''small win'' scenario can create a sense of control, lend credibility to conservation activities, and help build public confidence and enthusiasm (Heinen and Low 1992). A series of ''small wins'' can contribute to an overall strategy for conserving biodiversity or prompt political support for its wider application.

5.11.2 How ''Biodiversity'' Is Addressed in Responses

The MA conceptual framework (MA 2003, p. 7) ''places human well-being as the central focus for assessment while recognizing that biodiversity and ecosystems also have *intrinsic* value and that people make decisions concerning ecosystems based on considerations of both well-being and intrinsic value.'' At the same time, ''few decisions take account of indirect use value and very few take explicit account of existence values. As a result, many decisions about intervention into ecosystems are not based on the best possible information (p. 181).'' This information problem is a critical one for biodiversity assessment, and for the success of trade-offs and synergies with other services. For example, one concern with the ''hotspots'' approach has been that any claimed efficiency is illusory if the indicator taxa are not broad indicators of more general endemicity patterns. We can never ''prove'' the value of any surrogate, but can make best-possible use of all available data in surrogacy strategies.

As part of strategies for addressing uncertainty, effective trade-offs (and synergies) of biodiversity and ecosystem services require more effective measurement or estimation of biodiversity at all scales. Common ''mistakes'' in designing biodiversity indicators have led to management strategies that have proven to be inconsistent and indefensible on the ground and have hidden trade-offs at the policy level (Failing and Gregory 2003). A general lesson is that poor measurement of biodiversity reduces the capacity to discover and implement good trade-offs and synergies between biodiversity and ecosystem services.

Sometimes responses to this information problem may overstate the ''user needs'' perspective and neglect the difficult problem of finding surrogates for global option values. For example, Failing and Gregory supposed that successful indicators for biodiversity vary depending upon the ''end points'' desired by the users in any particular context. The Royal Society (2003) similarly argues: ''each biodiversity assessment would clearly identify: i) interested parties; ii) the attributes that those parties value and are seeking to measure. . . .'' (p. 22). One example value includes commercial foresters' values placed on biodiversity ''attributes'' that are equated with ''volume of timber that can be extracted'' (p. 14). Such user-needs requirements may need to be balanced with efforts to measure intrinsic and option values that do not have immediate advocates.

The biodiversity of a place often is highly valued by the people living there, but these values may not be particularly relevant to global biodiversity values. For example, increased local diversity (genetic and species level) in agricultural systems often leads to better control of pests and diseases, but the consequent incentive for local protection of biodiversity may not link to any important global values. A lesson is that values at all scales are important in the design of response options, and decision-making can benefit from addressing trade-offs and synergies among them.

The pitfall of imagining diminishing returns from additional biodiversity is highlighted when considering the list of unanticipated services that may be important in the future. Biodiversity serves as a surrogate for a multitude of possible future services, and its conservation therefore can maintain options for the future.

We have seen that this ''open-endedness'' calls for trade-offs with other needs of society. The ecosystem approach has provided a framework for finding a balance among different needs, for example, through integrated natural resource management systems and through various policy, legal, institutional, and economic measures. Associated ''mainstreaming'' of biodiversity into other sectors has promoted balanced outcomes, even in cases where biodiversity gains are not measured.

Such trade-offs also may benefit from a ''calculus'' of biodiversity, so that gains and losses at the level of biodiversity option values can be quantified. A simple calculus must be based on surrogate information for general biodiversity patterns, so that these gains and losses (''complementarity values'') are predictions of changes in amount of variation retained in a region. While it has been argued that biodiversity advocates have wrongly focused on ''inventory'' of species, genes, ecosystems (Norton 2001), a ''calculus'' of biodiversity that captures option values is appropriately based on ''inventory.'' However, inventory and systematic efforts can be more strategic in filling knowledge gaps.

We have noted that arguments based on global biodiversity values ignore important local values of biodiversity relating to ecosystem services. An alternative to a preference for local values of ''biodiversity'' is to pursue balanced trade-offs and synergies among local, national, and global values. As long as local values and opportunities, whatever their source, are given appropriate weight, defining (or redefining) the ''important'' values of biodiversity as local not global is not an issue. Apparent conflict may be resolved also by realizing that often the local values and opportunities may have little to do with the biodiversity (biotic variation per se) of the place, instead linking to specific components of biodiversity (often valued species).

Clarifying local-versus-global values avoids misinterpretations about biodiversity's value. Examples can be put forward suggesting that *low* biodiversity, manipulated systems—such as wheat fields—provide most benefits to human well-being (Jenkins 2003). But such arguments, interpreted as casting doubt on links from biodiversity to human well-being, in fact highlight how biodiversity *does* matter. Individual low diversity places may be important in their complementary contributions to overall global biodiversity option values. Therefore, even the most dramatic successes in individual places at deriving extensive benefits from *low* biodiversity, manipulated systems provide no evidence that biodiversity is of less importance to human well-being.

We conclude this section by summarizing how a trade-offs/synergies perspective has suggested new perspectives on measuring biodiversity. First, good biodiversity surrogates must focus more on what matters in the context of trade-offs: do they predict general complementarity (marginal gain) values provided by a given place? This need is in accord with the general lesson that aggregate (global scale) estimates of ecosystem value are of limited use, given the fact that only marginal values are consistent with conventional decision-aiding tools (Turner et al. 2003). Second, more detailed information is required than that provided by conventional coarse-scale summaries such as species-area curves. The MA scenarios have made effective use of the idea of a species area curve: if some quantity of total area-extent of a given biome is not retained, then the curve implies that a certain proportion of species will be prone to extinction in the future. Biodiversity responses therefore might be seen as attempts to maintain a certain total area of each biome as sufficiently intact to support all the species found there. However, an amount of area lost could correspond to high or low biodiversity (and high or low opportunity costs); such curves do not distinguish well among these outcomes.

This chapter has focused more on trade-off curves, which substitute the ''area'' axis with the more informative ''opportunity costs'' axis. We have seen that a scenario for a region implying a total amount of, say, agricultural production does not necessarily imply (as a species-area relationship would suggest) that some given proportion of species is lost. Instead it implies a variable number that depends on the effectiveness of responses such as regional planning. A lesson in this chapter was that several aspects of responses can boost effectiveness: (1) regional planning may allocate forestry, agriculture, or other human uses in a way that least conflicts with biodiversity conservation; (2) human use may be carried out in a way that such places also make a contribution to regional biodiversity conservation and sustainable use; and (3) intensification of production may imply that a smaller total area conflicts with biodiversity conservation.

The contrast between an ''area'' focus and a ''trade-offs'' focus also has revealed lessons for how biodiversity targets are approached. Case studies have suggested how the same total amount of area protected can lead to large or small foregone opportunity costs, and large or small amounts of biodiversity protected. A percentage area target may be a good, rough, global-scale indicator, but at the scale of national/regional policies and planning, targets that are related to trade-offs will be more useful.

Trade-offs curves share a key property with species-area curves: the same incremental loss of intact area (say, to non-conservation uses) can imply a greater biodiversity loss the second time it occurs. An observed change in the rate of loss of intact area of a biome therefore can be a misleading indicator of actual rate of biodiversity loss. Accepting an observed reduced rate of area loss as indicating achievement of the 2010 biodiversity target could amount to acceptance of an increased rate of biodiversity loss (Faith, in press). Such curves also indicate a positive strategy for addressing the 2010 target. Even the same rate of area loss could correspond to a reduced rate of biodiversity loss, through response strategies that provide effective trade-offs and synergies where they do not yet occur. Further, effective trade-offs could mean that a greater gain in biodiversity results from a given level of increase in conservation area (Faith, in press).

5.12 Research Priorities

The biodiversity extinction rate is worrisome given that we do not have names for most of the 10 million plus species on the planet, and we do not know much even about the species that have been named. This section identifies some key questions that need to be answered if responses to the loss of biodiversity are to be more effective in the future.

5.12.1 How Does Biodiversity Underpin Ecosystem Services and Human Well-being?

Better quantification and integration of these benefits would provide greater impetus for biodiversity protection. Effective response strategies will help overcome the fact that ecosystem services currently are not fully captured in commercial markets (a caution highlighted in this chapter is that apparent links of ''biodiversity'' to some services, that in fact are not scientifically supported, may mean that pursuit of those services does not help biodiversity conservation). Better quantification and integration of benefits also would promote effective trade-offs and synergies in the regional integration of response strategies.

5.12.2 What Patterns of Biodiversity Represent Value for the Future?

A key dualism for understanding and designing responses is that biodiversity benefits are both global and local. Global loss is more a concern about long-term option values, and hence defines a critical knowledge gap that goes beyond current perceived services. Again, better quantification and integration of these non-use benefits provides greater impetus for biodiversity protection, because protection of an area may look more beneficial than some other land (or water) use when these values are taken into account. Research is critically needed to provide not only greater species distribution information (more species, more places), but also environmental data (to aid prediction of biodiversity patterns). An increase in systematic research is vital. Research can move beyond the conventional focus on ''what is the total number of species?'' to strategic filling of knowledge gaps, promoting a global calculus of biodiversity that allows statements about gains and losses in particular places.

In addition to better valuation of biodiversity benefits, better information about levels of uncertainty about biodiversity and its values could also greatly assist decision-making. For example, we may not know which species are most likely to go extinct but we may know something about the probabilities of losing certain functions or species overall. Incorporating that type of information into a description of our uncertainty about future biodiversity values into a decision framework for irreversible decisions under uncertainty could lead to better decisions about what irreversible actions to avoid and could identify what types of information would be most useful in refining decisions.

5.12.3 How Can Biodiversity Values Be Quantified?

Better quantification of biodiversity values (including option values) and of the services provided by existing or potential new protected areas will enable these values to be taken into account in land-use planning, policy-making, and other decisions about development. This research needs to recognize the dangers in directly estimating ''dollar values'' for all these benefits; option values arguably cannot be fully quantified this way, and even for local ecosystem services (say, provision of food) conversion to dollar values on ''open markets'' can easily underestimate true values to local people. Option values, at least, can be quantified in non-dollar ways, as gains in species representation or persistence from a given response option, and then fed into multicriteria analyses for trade-offs. Research is particularly needed on the gains/losses from human use lands, put into a regional context.

The importance of biodiversity and natural processes in producing ecosystem services upon which people depend remains largely invisible to decision-makers and the general public. Unlike goods bought and sold in markets, most ecosystem services do not yet have markets or readily observable prices. Assembling evidence on ''non-market values'' should be a high priority research topic. A substantial body of research in economics on non-market valuation is now available, though applying these methods to biodiversity is not fully developed. Existence value of species and other ''non-use'' values pose a difficult challenge to those who would try to measure the complete value of conserving biodiversity and natural processes. Despite the difficulty, it is worth gathering better evidence about benefits created by natural systems. One goal of such research could be to establish a system of biodiversity accounts to track changes in the status of biodiversity, in much the same way that national income accounts are used to track the status of national economies. For example, application of a calculus of biodiversity may provide one pathway for addressing the monitoring requirements of the 2010 biodiversity target.

A related point is that research is needed on how to establish and implement targets for biodiversity conservation and sustainable use. Our assessments have pointed to pitfalls in using ''rates'' of extinction, threatened species, area amounts, land-use threats, and other information. At the same time, our assessments point to the need for targets to somehow take into account the realities of trade-offs and synergies with other needs of society.

5.12.4 What Are the Social Impacts of Biodiversity Loss?

Greatly hindering any general assessment of the impact of responses on biodiversity loss, and resulting conservation, is the sheer lack of rigorous social science analysis of that impact. Empirical analysis of conservation responses lags significantly behind other social policy fields in its ability to draw inferences about the relationship between policy and biodiversity conservation. Conservation donors have only recently begun to even request evidence that their funds have the desired effect. With hundreds of millions of dollars spent annually, and with many species and rural livelihoods at stake, empirical analysis of the impact of the full range of policy options on biodiversity conservation, including the nine major ones assessed in this chapter, appears long overdue.

The available evidence allows us to say with *high certainty* that the rapid loss of biodiversity is a serious problem that threatens the functioning of natural systems and human well-being. Biodiversity is at risk largely because of human activity, but human well-being depends on the provision of ecosystem services from natural systems. Therefore, better management of human affairs, and better understanding and management of human interactions with the environment hold the key to finding solutions to conserving biodiversity, using biological resources sustainably, and ensuring equitable distribution of benefits derived. In order to successfully achieve these goals, more information is needed about how various human actions affect biodiversity and how biodiversity affects human well-being.

5.12.5 How Do Human Actions Affect Biodiversity and the Structure and Function of Ecosystems?

Understanding what human interventions in natural systems cause beneficial or detrimental changes is an important prerequisite for managing human interactions with the environment. Given the complexity of natural systems, our understanding of impacts and the ability to manage those impacts will be imperfect. Even so, increased understanding of the effect of human actions is of great value in trying to steer human actions towards less destructive practices while encouraging beneficial ones.

5.12.6 How Can Effective Incentives Be Designed for Conserving Biodiversity?

Market prices that do not incorporate the value of biodiversity or ecosystem services send the wrong set of signals to decision-makers. One solution to resolve the problem of incorrect incentives is to attempt ''get the prices right'' so that they truly reflect underlying values. Taxes on harmful activities and subsidies on beneficial activities are one means to shift prices to provide better signals of value. Often, powerful political forces will block tax measures, or will push for subsidies on activities that are harmful for the environment but beneficial to economic interests of a particular segment of society. Government regulatory approaches may face a similar set of political hurdles. In addition, if not carefully designed, regulations may have unintended consequences that are harmful to conservation. Research on the most effective ways to promote conservation and to coordinate actions through markets, government actions, and the supporting activities of non-governmental organizations is needed.

Understanding how to design, implement, and enforce conservation policy is particularly important in developing countries, which contain a large share of biodiversity, but often have weak institutions that may preclude effective enforcement of conservation laws. Developing countries also have great need for economic development to improve the well-being of their citizens. How economic development can occur while maintaining biodiversity and natural processes is one of the most important topics facing humanity at the start of the twenty-first century.

5.12.7 Who Gets to Make Decisions Affecting Biodiversity?

Decisions made by the current generation will shape the world that is handed down to future generations. Questions of sustainability and what constitutes responsible stewardship are important research topics. Many conservation benefits, such as carbon sequestration and providing habitat for the continued existence of species, provide global public goods. Yet local decision-makers often determine whether such benefits are provided, and may ignore important benefits that accrue outside their community. Allowing outside groups who may have a wider view to override local interests brings its own set of problems. How to put the slogan ''think globally, but act locally'' into practice is a recurring problem.

5.12.8 When Is It Better to Integrate or to Segregate Human and Conservation Activity?

A debate has flared in conservation circles in recent years between those who favor community-based conservation and integrated conservation and development projects versus those who favor emphasis on protected areas that seek to exclude people. Quantification of the value provided by existing or potential new protected areas, versus the value provided in landscapes that allow some economic activities, would provide guidance to land-use planning, policy-making, and other decisions about development. Response options typically must by their nature consider marginal gains in biodiversity conservation, posing a research challenge for quantification. The contribution of production or mixed-use lands to regional biodiversity protection is not well-indicated by the usual assessments of consequent species richness. Future assessments could instead examine how well these areas provide marginal gains and so be integrated with contributions from protected areas, conservation payments on private lands, and other policies aimed at reversing the loss of biodiversity.

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