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55

Linking Biodiversity Conservation and Poverty Alleviation: A State of Knowledge Review

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Linking Biodiversity Conservation and Poverty Alleviation:
A State of Knowledge Review

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Compiled by Dilys Roe, IIED

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FOREWORD

Biodiversity conservation and poverty reduction are both major – but seemingly separate—global challenges. Nevertheless, the overarching policy frameworks that guide action towards them recognize that they are inextricably linked. From the outset, the Convention on Biological Diversity has sought to take account of poverty reduction. The Preamble acknowledges that "economic and social development and poverty eradication are the first and overriding priorities of developing countries". In 2002, the Conference of Parties set a target to "achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and the benefit of all life on Earth". This was subsequently endorsed by the World Summit on Sustainable Development (WSSD); the WSSD Plan of implementation includes a reciprocal reference to the importance of biodiversity for sustainable development and poverty eradication.

Similarly, the Millennium Development Goals (MDGs) take account of the need for biodiversity conservation. MDG7 is to "ensure environmental sustainability". When first agreed this included the target to "reverse the loss of environmental resources" with indicators of success including protected area coverage and forests. At the UN General Assembly in 2006 it was agreed that the 2010 biodiversity target should be included as an additional target within MDG7 and the set of biodiversity indicators was expanded.

The Millennium Ecosystem Assessment (MA) further emphasised the link between biodiversity conservation and poverty reduction. The MA asserts that biodiversity underpins the delivery of a range of "ecosystem services", which in turn contribute to human well-being (with poverty being "the pronounced deprivation of well-being"). The MA also warns that long-term sustainable achievement of the MDGs requires that biodiversity loss is addressed. This report affirms these policy prescriptions.

Evidence suggests that not only do the poor depend on biodiversity for their subsistence needs, we all do. The rural poor depend disproportionally on local ecosystems for their survival however, while the rich can access vital ecosystem services through different markets. When the circumstances are right, biodiversity conservation can be a route both out of poverty and away from unsustainable development.

Creating these conditions cannot be done without addressing the current development model. Here lie most of the root causes of the current biodiversity crisis as well as structural socio-economic problems. By consequence, a new development model is needed for real solutions.

We have failed to meet the 2010 target, and the latest MDG report notes the grave consequences of this for poor people: "The irreparable loss of biodiversity will also hamper efforts to meet other MDGs, especially those related to poverty, hunger and health, by increasing the vulnerability of the poor and reducing their options for development."

The CBD has long emphasised the need for integrating biodiversity and poverty agendas. The new post-2010 Strategic Plan places considerable emphasis on the need for mainstreaming: poverty and other development issues need to be better integrated into the biodiversity conservation agenda and vice versa. This approach represents a major challenge – both for policy makers and practitioners – but without it we seriously limit our chances of addressing either of these global priorities.

Dr. Ahmed Djoghlaf
Executive Secretary
Convention on Biological Diversity

EXECUTIVE SUMMARY

Over recent decades, biodiversity conservation and poverty reduction have both become international societal and political goals. There is recognition of the links between these two goals both within the Convention on Biological Diversity and the Millennium Development Goals. However, the causal relationships are not so simple either that one can say poverty causes biodiversity loss, or improvements in biodiversity reduce poverty. This suggests a need to be more specific in defining what types of poverty and biodiversity issues are being assessed.

Two "state of knowledge" reviews were commissioned to explore the evidence base for two common assumptions about the link between biodiversity conservation and poverty reduction: 1) that the poor depend on biodiversity; and 2) that biodiversity conservation can be a mechanism for poverty reduction. These attempt to tease apart the issues of what type of poverty and what type of biodiversity are being assessed.

DEPENDENCE OF THE POOR ON BIODIVERSITY

This review focuses on the question: which groups of the (differentiated) poor depend, in which types of ways, on different elements of biological diversity? The review focused on two particular types of dependence: (a) biodiversity as offering a means of subsistence or income to the poor; and (b) biodiversity as offering insurance to the poor from risks and shocks, thereby preventing them from falling deeper into poverty.

The methodology for the review included an examination of the peer-reviewed literature, as published in journals and books, and an examination of websites and portals of major organisations/forums working on biodiversity conservation and poverty alleviation. Literature identified through these processes was systematically analysed to examine the empirical evidence on the extent and nature of dependence. Aggregation of the findings from this meta-analysis is difficult, given the methodological differences in the underlying case studies, but this paper reports on the trends that have emerged from this review.

There is considerable variation reported in the extent of household income that is contributed by biodiversity-based resources. Some of this dependence is very specific to particular groups, especially the poor. Some multi-sited studies demonstrate variability across different sites, reflecting both the availability of alternative income sources, as well as access issues and previous resource use patterns. Levels of participation in biodiversity based livelihood activities are also high, although there is some variation when this is broken down by wealth class, with the poor typically showing higher levels of dependence.

The literature suggests that biodiversity provides the poor a form of cost effective and readily accessible insurance against risk, particularly food security risks, risks from environmental hazards, and health risks. There is also some discussion in the reviewed material of the risks associated with declining ecosystem resilience. The evidence suggests that, as the poor have few alternative sources for protecting themselves, they have a higher dependency on biodiversity for dealing with risk.

The reviewed studies suggest that the poor tend to depend disproportionately on relatively low value or 'inferior' goods and services from biodiversity, while the more affluent groups may get interested in such resources if they have higher commercial values (often crowding out the poor in the process). Similarly, risk dependence of the poor on biodiversity takes the form of a last resort, in the absence of alternatives. This dependence of the poor on low value activities (and on biodiversity as a last resort against various forms of risk) may confirm the suggestion in some recent literature of a resource-based 'poverty trap'. This may have important policy implications, as it suggests that the poor may need to break their dependence on biodiversity in order to improve their livelihood outcomes.

BIODIVERSITY CONSERVATION AS A MECHANISM FOR POVERTY REDUCTION

This review examined more than 400 documents that focus on the nexus between biodiversity conservation and poverty reduction specifically seeking conservation interventions—or "mechanisms"—for which there is empirical evidence of impacts on poverty.

Ten conservation mechanisms are identified with empirical evidence of poverty reduction benefits to the rural poor: non-timber forest products (NTFPs), community timber enterprises, payments for environmental services, nature-based tourism, fish spillover, mangrove restoration, protected area jobs, agroforestry, grasslands management, and agrobiodiversity conservation. Sometimes these mechanisms are a route out of poverty for local people. Sometimes they provide modest poverty reduction benefits or a safety net to keep people from falling deeper into poverty, and sometimes when upended, a few can become poverty traps. In six of the mechanisms, what reduced poverty was not increased biodiversity but increased biomass—the amount harvested rather than the variety.

There are also mechanisms that have benefited the rural poor but lack hard evidence of conservation benefits including trophy hunting, bushmeat harvesting, medicinal plant collection, woodcarving, and bio-prospecting. All of these could benefit from evidence-based studies that measure poverty and conservation impacts in a rigorous way.

There are a number of common challenges that limit the level of benefits to the poorest: households with higher assets and higher levels of social capital are more likely to participate in a conservation initiative; elites often capture the benefits of an initiative; conservation initiatives may widen income disparities; and there is a need to build in provisions for reducing discrimination against women.

Finally, there are considerable gaps in the existing poverty-conservation knowledge. Overall, the number of poverty-conservation studies with hard evidence is insufficient to allow solid conclusions to be drawn about many mechanisms.

CONCLUSIONS

Despite a limited evidence base it is clear from these reviews that a) **the poor depend disproportionately on biodiversity for their subsistence needs—both in terms of income and insurance against risk,** and b) **biodiversity conservation can be a route out of poverty under some circumstances.**

However there are some important caveats:

1. It is often the relatively *low value* or 'inferior' goods and services from biodiversity that are most significant to the poorest members of the community. Resources of higher commercial value attract the attention of the more affluent groups, often crowding out the poor in the process.
2. Even when biodiversity conservation can be shown to make a contribution to poverty reduction the scale of impact may be limited. Despite some good intentions many conservation interventions just do not lend themselves well to poverty.
3. A focus on cash benefits obscures the real poverty reduction potential of biodiversity conservation. Poverty is not simply the result of low income but also reflects a deprivation of requirements to meet basic human needs.
4. Biomass may matter more than biodiversity—at least in the short term—but biodiversity matters in the longer term, particularly as an insurance or risk management strategy.

Recognition of the link between the status of biodiversity and the fate of poor people implies that biodiversity should be a priority in international efforts to address poverty reduction. However, the accessible nature of biodiversity that makes it so important to poor people—the fact that ecosystem services and biodiversity resources are public good—ironically also means that it is under-valued, if valued at all, in national economies.

1. INTRODUCTION: WHY LINK BIODIVERSITY CONSERVATION AND POVERTY REDUCTION?

Dilys Roe, IIED, Matt Walpole UNEP-WCMC and Joanna Elliott, AWF

1.1 COHERENCE ON BIODIVERSITY-POVERTY LINKS AT THE INTERNATIONAL POLICY LEVEL

Over recent decades, biodiversity conservation and poverty reduction have both become international societal and political goals. The Convention on Biological Diversity (CBD), agreed in 1992, was drafted in response to escalating biodiversity loss, while the Development Assistance Committee of the Organization for Economic Cooperation and Development published a set of seven poverty-focussed targets in 1996 (OECD 1996) which were repackaged in 2000 as the eight Millennium Development Goals (MDGs) resulting in an unprecedented level of international commitment to poverty reduction (Satterthwaite, 2003).

Although aimed at very different communities of interest, both of these overarching policy frameworks recognise links between their objectives:

- The preamble of the CBD recognises that "economic and social development and poverty eradication are the first and overriding priorities of developing countries" (United Nations 1993). In 2002, it adopted a target "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level *as a contribution to poverty alleviation* [emphasis added] and to the benefit of all life on earth" (SCBD 2002).
- The Millennium Development Goals (MDGs) fulfil the same overarching function for poverty reduction efforts. Goal 7 includes a target to "reverse the loss of environmental resources", one indicator of which is the area of land under protection for biodiversity. In 2006 the CBD "2010 Target" was included as a new target within MDG7 (United Nations 2006) with additional biodiversity indicators (United Nations 2008).

The Millennium Ecosystem Assessment (MA) published in 2005, further emphasises the link between biodiversity conservation and poverty reduction. The conceptual framework of the MA views biodiversity as underpinning the delivery of a range of ecosystem goods and services on which human well-being depends (poverty being "the pronounced deprivation of well-being" (Millennium Ecosystem Assessment 2005a, p 29). The MA further notes that "many aspects of biodiversity decline have a disproportionate impact on poor people" (Millennium Ecosystem Assessment, 2005b, p 6). These findings are reaffirmed in another international study, the G8-initiated Economics of Ecosystems and Biodiversity (TEEB) (Sukhdev 2008).

1.2 THE SHARED GEOGRAPHY OF BIODIVERSITY AND POVERTY

The existence or otherwise of a spatial link between biodiversity and poverty is often presented as a basic rationale for why biodiversity conservation and poverty reduction can or cannot be pursued jointly or separately (e.g. Malloch Brown 2004; Fisher and Christopher 2006). It may be too simplistic to say that the majority of the world's biodiversity is in the South which is also where the poorer countries of the world are (Schei 2007; Matiku 2008), and it is certainly not the case that significant biodiversity only occurs in areas of poverty. Yet there is mounting evidence to suggest that, at a variety of scales and in many different ways, biodiversity and poverty do coincide (Hernandez-Morcillo *et al.* 2010).

As we discuss below, there are many dimensions of poverty and biodiversity, therefore many ways of measuring and mapping them. Patterns of overlap differ from place to place and between different elements of poverty and biodiversity

At regional/national scales, it is clear that many countries and regions with high biodiversity, measured in terms of species richness and levels of endemism (Caldecott et al. 1994) also have high levels of poverty. This is particularly true of sub-Saharan Africa and Asia which have the greatest proportion and number of poor people respectively (according to MDG data; UN DESA 2010). Equally, some of the areas identified as globally significant 'hotspots' of threatened biodiversity by conservation agencies occur in regions with severe and multifaceted poverty (e.g. Fisher and Christopher 2006).

At finer scales, whilst many poor people live in urban areas, poverty remains generally higher in rural areas where ecosystems are becoming increasingly degraded (Millennium Ecosystem Assessment 2005a). Yet the most acute poverty is often in remote or inaccessible areas of low human population density where 'biodiversity' is most intact (Hernandez-Morcillo *et al.* 2010). However poverty and biodiversity are measured, it is clear that those practising biodiversity conservation and poverty alleviation will often find themselves side by side in the same places.

1.3 A DIVERGENCE OF OPINION ON BIODIVERSITY-POVERTY LINKS AT THE PRACTICAL LEVEL

Despite the apparent convergence between biodiversity and poverty both geographically and at the international policy level, there is considerable divergence of opinion at the practical level as to the nature and scale of biodiversity-poverty links and the role and responsibilities of different interest groups in addressing them.

One of the reasons for this divergence of opinion is that there is no single relationship between biodiversity conservation and poverty reduction. Nadkarni (2000), for example, describes six different relationships: from a vicious cycle of poverty leading to environmental degradation and thence to more poverty; to a win-win scenario where environmental conservation contributes to poverty alleviation. There is certainly no linear relationship—the MA demonstrates that while many millions of people have benefited from the transformation of ecosystems and exploitation of natural resources, the benefits have not been evenly or equitably distributed, with the poor being the biggest losers (Millennium Ecosystem Assessment 2005a).

Other commentators have noted the dynamic and context-specific nature of the conservation-poverty relationship (Kepe *et al.* 2004; Redford and Sanderson 2006; Birdlife International 2007). In particular, cross-cutting determinants such as governance, policies on poverty and biodiversity protection, and population growth and density which are associated with the socio economic context and are critical in determining whether or not biodiversity leads to actual poverty reduction (Tekelenburg *et al.* 2009).

Thus, the causal relationships are not so simple that one can say poverty causes biodiversity loss, or improvements in biodiversity reduce poverty. This suggests a need to be more specific in defining what types of poverty and biodiversity issues are being assessed (Steele *et al.* 2004; Walpole and Wilder 2008).

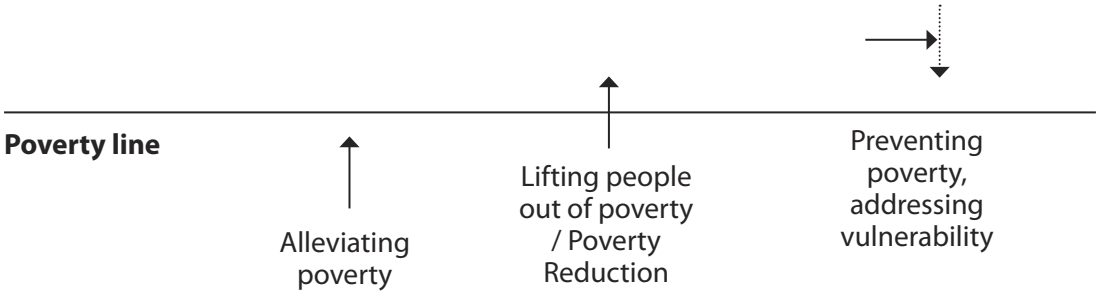
1.4 A PROBLEM OF TERMINOLOGY

The issue of terminology is critical. There exists a tendency to talk in generalisations—for example, that "biodiversity conservation contributes to poverty reduction"—without clearly defining either what we mean by these terms or how we are measuring impacts and outcomes. Biodiversity is defined by the CBD as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine

and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". This focus on variability is often missing, however, when assertions such as the above are made. As we will see in Sections 2 and 3, species abundance or biomass, or the economic value of a single species or habitat can often make a far more significant contribution to poverty reduction—at least in the short term—than variability.

Similarly, "poverty reduction" implies lifting people beyond a defined poverty line—transforming them from poor to non poor. But often poverty is alleviated (i.e. some of the symptoms or poverty are addressed but people are not actually transformed from "poor" to "non-poor") or it is prevented (i.e. people are prevented from falling into—or further into—poverty) rather than actually being reduced. Figure 1.1 highlights the differences between these outcomes. Furthermore, the beneficiaries of conservation activities are often not "the poor" (i.e. those identified as living below a defined threshold of income or well-being) but simply rural communities or those who live local to conservation areas or who are primary users of living natural resources (who may or may not be poor) (Roe *et al.* 2010).

FIGURE 1.1: Poverty Reduction, Alleviation and Prevention



Source: adapted from King and Palmer 2007

Even defining "the poor" is not easy. The target beneficiaries of MDG1 are the 1.2 billion people living on less than a dollar a day. But it is widely recognized that poverty is multi-dimensional and includes a lack of power, security, voice—not just a lack of money. The World Bank, for example, describes poverty as *'a pronounced deprivation in well being…. To be poor is to be hungry, to lack shelter and clothing, to be sick and not cared for, to be illiterate and not schooled. But for poor people, living in poverty is more than this. Poor people are particularly vulnerable to adverse events outside their control. They are often treated badly by the institutions of state and society and excluded from voice and power in these institutions' (*World Bank 2001, p15).

1.5 THE EVIDENCE BASE FOR BIODIVERSITY-POVERTY LINKS

Compounding the issue of terminology is the state of the evidence base. Even if we can agree common understandings of key words and concepts, what evidence is there that reducing the rate of biodiversity loss can make a contribution to poverty alleviation—as assumed in the CBD 2010 target and elsewhere? In many cases the evidence is constrained because case study outcomes are measured differently and are therefore difficult to compare or aggregate. In other cases the empirical evidence is weak, both in terms of quantity and quality. In addition, causality is often assumed but not proven where biodiversity conservation and poverty reduction coincide.

In sections 2 and 3 of this report we seek to clarify the current state of knowledge about biodiversity-poverty links at the local level. These two sections review the evidence base for two common assumptions that often underpin arguments for linking biodiversity conservation and poverty reduction:

1. That the poor are dependent on biodiversity for their day-to-day livelihoods;
2. That biodiversity conservation can be a mechanism for poverty reduction.

These two studies are both based on a review of the empirical evidence contained in published literature. We recognize that much knowledge on the relationship between biodiversity and poverty at the local level is undocumented and captured in traditional knowledge systems rather than in scientific literature and that this therefore limits the conclusions that can be drawn from these studies. Nevertheless we hope these provide a useful starting point in better understanding what is assumption and what is fact and where the key knowledge gaps are.

2. DEPENDENCE OF THE POOR ON BIODIVERSITY: WHICH POOR, WHAT BIODIVERSITY?

Bhaskar Vira and Andreas Kontoleon, University of Cambridge

2.1 INTRODUCTION

As noted in Chapter 1, although the links between the biodiversity conservation and poverty alleviation agendas have been widely accepted, the specific nature of the relationship between biodiversity and poverty is still not well understood. At their broadest level, two types of links can be identified: (i) biodiversity as a means of subsistence or income, providing inputs into poor peoples' livelihoods; and (ii) biodiversity as insurance, providing a buffer against risks and shocks, helping smooth livelihoods and consumption patterns. While these relationships have been empirically documented in a wide variety of circumstances, there is still a considerable need to investigate these linkages more critically, and with greater analytical clarity. Crucially, recognising that both biodiversity and poverty can manifest themselves in different guises, it is important to interrogate a more nuanced question: which groups of the (differentiated) poor depend, in which types of ways, on different elements of biological diversity?

This review represents a first attempt to address this question. It is based on a systematic review of literature on the ways in which poor people depend on biodiversity as a direct contribution to their subsistence, income and other livelihood needs, and as a source of risk coping and insurance. It examines the published literature, in order to document broad trends emerging from existing knowledge about these relationships, and to identify key areas where there are knowledge gaps.

2. 2 DEFINITIONAL ISSUES

2.2.1 BIODIVERSITY

As noted in Section 1, biodiversity is widely understood to refer to three dimensions within which variability occurs: *genetic*, meaning the variation of genes within a species, sub-species or population; *population/species*, meaning the variation between living species and their component populations at different spatial scales (local, regional or global); and *community/ecosystem*, meaning the variation within ecological complexes of which species are a part.

Defined in this way, relatively few of the detailed micro studies that were reviewed here explicitly focused on 'biodiversity', although the term is used more often in the risk and insurance literature. In the direct livelihood context, the term 'nature's resources' better captures the generic categories of resources that have been studied in this literature. These include forests, both in terms of wood-based and non-timber forest products (NTFPs) (forming a clear majority, together 18 out of 27 detailed cases); mangroves; fish; wild animals (bushmeat) and wild plants (including herbs); and common pool resources (CPRs) more generally (see also Figure 2.1). Many studies focus on tropical natural environments, so it is possible to make inferences about the importance of biodiversity, but we would suggest that these links need to be established more carefully.

Keeping this in mind, we need to be cautious about how we interpret the material that has been the subject of this review. While nature's resources are clearly very central to the livelihood strategies of the poor, we cannot make the assumption that these activities require or depend upon the existence of biodiversity. Indeed, lack of diversity may not harm certain types of uses (such as the harvesting of particular NTFPs), as long as the specific resource that is being exploited remains relatively abundant. Monoculture plantations of the most valuable species may provide sustainable inputs into household livelihoods, but may not be related to biological diversity in any recognisable sense.

Moreover, as several studies document, wild plants that are in increasing demand (for instance, for medicinal purposes) are frequently being domesticated for cultivation as their values increase, bringing their use patterns closer to those of farming systems (and thereby breaking the link with 'biodiverse nature'). The dependence of poor (and rich) rural populations on these species for their livelihoods does not necessarily change, but they are being managed in conditions that are very different to their origins in the wild. This raises important challenges to the ways in which we conceptualise these use patterns, although these distinctions (between 'wild' and 'farmed') may in some cases be less meaningful to the communities who are actually engaged in the management and exploitation of these species. In the agricultural context, studies show that *in situ* conservation of agro-biodiversity and the protection of wild species may have additional insurance value.

The different components of biodiversity (genetic, species and ecosystem) are not necessarily equally important in order to maintain the flows of resources on which the livelihoods of the poor depend. The literature on resource dependence does not trace the links between these components, the resources that emerge from nature, and the livelihoods of the poor. In terms of contributions to livelihoods, what is often valuable is the volume (in terms of extent and abundance) of a resource, rather than diversity. While an assumption can be made that wild resources, harvested from nature, do depend on the existence of biological diversity in a general sense, there is an urgent need to document more clearly the specific parameters of this relationship. Diversity at the ecosystem level is likely to be important for enhancing resilience, but the precise nature of this relationship needs to be explored in greater detail. Although these links are often asserted (as for instance, in the Millennium Ecosystem Assessment Conceptual Framework, where Biodiversity (Life on Earth) underpins all ecosystem services), the specific pathways through which changes in biodiversity affect poor people's livelihood choices and strategies need to be more carefully identified (Ash and Jenkins 2007).

2.2.2 POVERTY

Understanding of poverty has evolved considerably from its original definitions, which focused on (a lack of) income or wealth. As noted in Section 1, poverty is now seen as multi-dimensional, encompassing material deprivation, the lack of access to other basic needs (education, health, nutrition and food security), the absence of political autonomy and empowerment, as well as the lack of freedom of choice and social inequality. Differentiation is also made between the occurrence of poverty (its 'incidence'), its intensity, the extent of inequality (i.e. the distribution of income between rich and poor), its temporality (chronic versus temporary poverty), and its spatiality. Mainstream poverty research is becoming more sophisticated in its handling of some of these issues, both through a diversification of methods (quantitative and qualitative), as well as by more inclusive processes of assessment which increasingly include the perspectives of the poor (see reviews in Addison *et al.* 2009).

In a wide ranging review, Angelsen and Wunder (2003) address the links between poverty and forests, and engage with the emergent, more sophisticated approaches to conceptualising poverty, and their potential implications for our understanding of the livelihoods of forest-dependent people. They suggest that it may be useful to distinguish between the way we 'think about' poverty, which can be multi-dimensional and complex, and the way we 'measure' it, which needs robust and reliable techniques that lend themselves to replication and comparison. To this extent, measurement may continue to rely on more narrow indicators, such as income, levels of consumption, or composite indices which assess wealth or stocks of assets, while discussion about livelihoods may focus on wider concepts which include both poverty (in this narrow sense), and 'human well-being', which can include many of the more difficult to measure concepts that have been highlighted in recent discussions about poverty.

In their review of the links between poverty, development and biodiversity conservation, Agrawal and Redford (2006, p.12) propose a useful way of "parsing poverty" in two ways: first, 'aspects' of poverty, in terms of incidence, intensity, inequality, temporality and spatiality; and second, 'dimensions' of poverty,

such as income/wealth, education, health, nutrition, food security, political autonomy, empowerment, and social equality. These two concepts were used to interrogate the detailed case studies that form the focus of this review (see Appendix, Table A1). Unfortunately, the reviewed material does not engage with poverty in its multiple aspects and dimensions, and tends to focus almost exclusively on the incidence of poverty defined in material wealth, or income terms (although the concept is usually expanded to include the values of non-market goods and services derived from nature). Some studies also pay attention to issues of inequality, though this is still measured in terms of income inequality (typically through the use of the Gini coefficient).

This parsimonious approach appears to be the general rule that has been adopted in the literature that is under review for the current context, which adopts a traditional and narrow approach to the measurement of (income) poverty. What is missing from most of these analyses are several of the more interesting dimensions that have been highlighted in recent poverty research, many of which have potential impacts on the ways in which rural people interact with nature's resources. For instance, while studies point to the seasonality of resource use, and the importance of natural resources both for meeting consumption and employment/income needs during lean seasons (for instance, de Merode *et al.* 2004; Bene *et al.* 2009), these analyses do not address the volatility of poverty, and the extent to which some rural populations cycle in and out of poverty, while others remain chronically poor. If nature's resources help to temporally smooth consumption and incomes, their poverty impacts may be better captured through an explicit focus on this temporality as part of our poverty measure, instead of restricting our understanding to annualised income or consumption (in which these temporary contributions from nature do not always feature as significant). Similarly, trying to incorporate wider issues of empowerment, social exclusion and autonomy may be very important in understanding the context within which particular groups experience material deprivation, and may help frame our understanding of the potential for resource based interventions to offer potential pathways out of poverty. So, for instance, increasing the value of nature based goods and services may result in their capture by politically powerful local actors, thereby excluding the very poor from access to potential benefits. Unless issues of political decision making and social inclusion are tackled at the same time, such resource based interventions may do little to help the resource dependent rural populations who are their intended targets.

2.3 METHODOLOGY

This review is based on a careful analysis of the current state of knowledge in publically available literature (restricted by language limitations to English language). It differentiates between claims that are based on robust, empirical evidence, and those that are less well-founded. Furthermore, it highlights where there are uncertainties and differences of opinion in the available literature. The specific steps that were undertaken as part of this process were:

i. An examination of the peer-reviewed literature, as published in journals and books. A number of search terms were used to carry out a web-based search in major electronic databases of journal articles and books (including Web of Science, JSTOR, IngentaConnect, Science Direct, Digital Library of the Commons, CAB Abstracts, OCLC FirstSearch, as well as catalogues from the British Library and US Library of Congress). Access to these was secured using the resources of the Cambridge University Library, including both print and electronic holdings.

ii. An examination of websites and portals of major organisations/forums working on biodiversity conservation and poverty alleviation. Key websites that were examined were: Poverty and Conservation Learning Group; the Equator Initiative; UNEP-WCMC; International Institute for Environment and Development (IIED); Department for International Development (DFID); World Bank; Conservation International; The Nature Conservancy; Worldwide Fund for Nature (WWF); Center for International Forestry Research (CIFOR); and the Millennium Ecosystem Assessment (MA).

The literature that was identified in these two steps was short-listed to focus on studies that provided direct evidence that was relevant to this review. A final set of 200 studies were examined in detail (as

listed in the bibliography). From these studies, 27 provided empirical evidence for the dependence of the poor on biodiversity for their income and subsistence needs (see Appendix Table A2 for details), while a further 22 provided evidence on risk coping and insurance.

2.4 DEPENDENCE ON BIODIVERSITY: DIRECT LIVELIHOOD LINKAGES

This review focused on the question: which groups of the (differentiated) poor depend, in which types of ways, on different elements of biological diversity? As has already been discussed, the extent to which the different case studies provided evidence on these issues varied greatly. Table A2 in the Appendix summarises the evidence from these case studies, which provides the basis for the discussion in this section. Given the variation in the extent to which each study has covered issues such as differences between different income classes in the population, impacts on economic and social inequality, and extent of dependence on identifiable elements of biological diversity, this section will summarise key trends that are emergent from this literature, but will not attempt any overall summary. Furthermore, all meta-analyses suffer from an important limitation, which is that the lack of consistency in case study methods precludes any easy aggregation of results, so this will not be attempted here.

Figure 2.1 provides details of the geographical regions that were represented in the 27 studies that were the subject of more detailed analysis, while Figure 2.2 breaks the studies down by resource type.

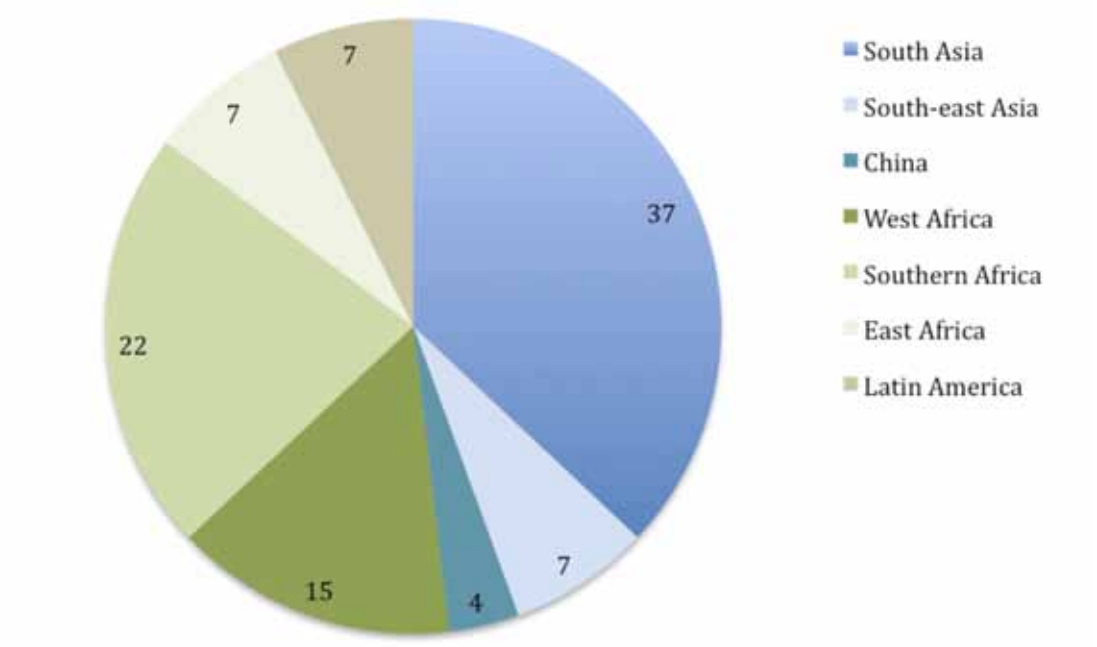


FIGURE 2.1: Case Studies by Geographical Region (numbers are percentages)

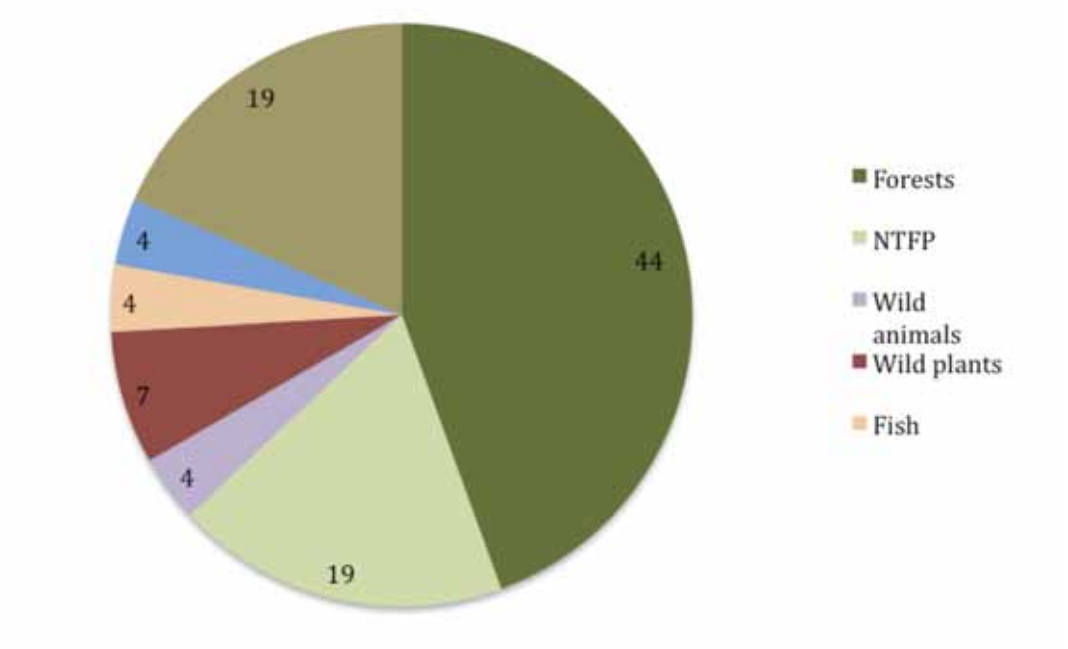


FIGURE 2.2: Case Studies by Resource Type (numbers are percentages)

This section provides an overview of the evidence on different types of dependence on biodiversity-based resources, primarily derived from micro studies at specific local sites. Unsubstantiated claims, such as those that are often found in larger macro- or sectoral studies, have not been included here, since the evidence for these claims is not available. What emerges from this review is a complex picture, with site- and resource-specific patterns of access, use and dependence, often reflecting very divergent patterns, although some regularities can also be observed from these studies.

2.4.1 EVIDENCE ON DEPENDENCE

Most studies use income from biodiversity based resources as a percentage of total household income as their indicator of the extent of dependence. Table 2.1 summarises the findings from these studies.

TABLE 2.1: Evidence on dependence on biodiversity for income

Source	Region	Evidence	Resource type
Bahuguna 2000	South Asia	48.7% of household income	Forests: fuel, fodder, employment
Bene *et al.* 2009	West Africa	Varies from 90% (poorest)—29.7% (richest)	Fish
Cavendish 2000	Southern Africa	35.4% of household income in 1993-94; 36.9% in 1996-97	Wild foods, wood, grasses and other environmental resources
Coomes *et al.* 2004	Latin America	20% of household income	Fish, palm products, timber, hunting
de Merode *et al.* 2004	West Africa	24% of cash sales	Wild foods
Fisher 2004	Southern Africa	30% of household income	Forests
Fu et al. 2009	Asia	1.7% of household income in Site 1, 12.2% in Site 2	NTFPs
Jodha 1990	South Asia	14-23% of total household income	Common pool resources
Kamanga *et al.* 2009	Southern Africa	15% of total household income	Forests
Levang *et al.* 2005	South-east Asia	30% of total household income	Forests
Mamo *et al.* 2007	East Africa	39% of total household income	Forests
Narain *et al.* 2008a	South Asia	Quartile1: 9%, Quartile2: 7.2%; Quartile 3: 7.9%; Quartile 4: 8% of permanent income	Fuelwood, dung for fuel, manure, fodder, construction wood
Shaanker *et al.* 2004	South Asia	Site 1: 16%, Site 2: 24%, Site 3: 59% of household income	NTFPs
Viet Quang and Anh 2006	South-east Asia	For 30% of households, over 50% of total income; further 15%, 25-50% of total income	NTFP

As Table 2.1 demonstrates, there is considerable variation reported in the extent of household income that is contributed by biodiversity-based resources. Some of this dependence is very specific to particular groups (such as the poorest fish-dependent groups in Bene *et al.* 2009, for whom fishing represents 90% of household income). Moreover, some multi-sited studies demonstrate variability across different sites, reflecting both the availability of alternative income sources (such as in the case of Fu *et al.*'s 2009 study of two sites in China), as well as access issues and previous resource use patterns (such as the variation across three proximate sites reported in Shaanker *et al.* 2004).

A number of studies additionally report the proportion of households engaged in particular types of activities, which will be used here as an indicator of the 'depth' of dependence on biodiversity resources. These findings are summarised in Table 2.2.

TABLE 2.2: Evidence on depth of dependence on biodiversity resources

Source	Region	Evidence	Resource type
Coomes *et al.* 2004	Latin America	66% of households depend on resource extraction	Fish, palm products, timber, hunting
Dovie *et al.* 2007	Southern Africa	98% of households use NTFPs	NTFPs
Dovie *et al.* 2007	Southern Africa	91% of households use wild herbs	Wild herbs
Glaser 2003	Latin America	68% of households depend on mangroves	Mangrove resources, especially crabs and fish
Jha 2009	South Asia	70% of households depend on beedi making or firewood	Forests
Jodha 1990	South Asia	84-100% of poor depend on CPRs	Common pool resources
Jodha 1990	South Asia	10-19% of rich depend on CPRs	Common pool resources
Levang et al. 2005	South-east Asia	72% of households depend on forest products	Forests
Mamo *et al.* 2007	East Africa	42% of households depend on forest for grazing	Forests
Narain *et al.* 2008a	South Asia	Quartile1: 77.5%, Quartile 2: 81.5%; Quartile 3: 72.8%; Quartile 4: 61.4% of households collect NTFPs	Fuelwood, dung for fuel, manure, fodder, construction wood
Shackleton and Shackleton 2006	Southern Africa	96-100% of households purchase NTFPs	NTFPs
Shackleton and Shackleton 2006	Southern Africa	8% (rich), 15% (middle), 36% (poor) households sell NTFPs	NTFPs
Sharma *et al.* 2009	South Asia	75% of household fuel and fodder needs from forests	Forests

Table 2.2 shows that the depth of dependence reported in these studies is high, although there is some variation when this is broken down by wealth class, with the poor typically showing higher levels of dependence.

A further set of studies also focus on biodiversity based resources as part of household consumption and production strategies (without monetising these values as a proportion of income). These studies are summarised in Table 2.3.

TABLE 2.3: Other evidence on dependence on biodiversity resources

Source	Region	Type of data	Evidence	Resource type
Bene *et al.* 2009	West Africa	Consumption	Varies from 33% (poorest)—20% (richest)	Fish
de Merode *et al.* 2004	West Africa	Consumption	10% of household consumption	Wild foods
de Merode *et al.* 2004	West Africa	Production	31% of household production	Wild foods

Overall, this data suggests reasonably high levels of dependence on biodiversity-based resources, in terms of contributions to household incomes, as well as production and consumption strategies. Levels of participation in biodiversity-based livelihood activities are also high, suggesting that the depth of dependence on these resources is significant.

2.4.2 RELATIVE DEPENDENCE ON BIODIVERSITY RESOURCES: ARE THE POOR DISPROPORTIONATELY DEPENDENT?

The evidence on the relative dependence of richer and poorer groups on biodiversity-based resources has been the subject of considerable interest, and is somewhat mixed. An early set of studies seemed to suggest unambiguously that the poor were disproportionately dependent on such resources (e.g. Jodha 1990, and Cavendish 2000). This became accepted wisdom, with overviews of the field consistently suggesting that the poor depend proportionately more on nature for their resource needs (Millennium Ecosystem Assessment 2005c). However, more recent work has started to question this accepted view, and the studies reviewed here present a more mixed picture.

One factor that has been highlighted in recent work is the complementarity between asset ownership (especially land and cattle), and the use of certain types of biological resources (see for instance, Adhikari *et al.* 2004, Coomes *et al.* 2004, Coulibaly *et al.* 2009, Fisher 2004 and Narain *et al.* 2008a). In these circumstances, asset rich households tend to depend more on nature's resources. If this difference in asset ownership is further reflected in greater political power at the local level, rich households are also able to use their dominance to secure access to resources, and to exclude the relatively poor.

These differences in political power suggest another reason why resource use may be skewed in favour of the rich. While a biodiversity-based resource remains relatively low value, rich users tend not to feel the need to restrict access. However, with returns to certain types of resources increasing as they become more valuable and in greater demand, the rich and powerful groups may try and capture these resources, and may exclude the poor from access (see for instance, Fisher 2004).

Table 2.4 summarises the evidence of the reviewed studies on the extent to which resource access increases or decreases with increases in household wealth and a number of interesting patterns emerge:

1. 'Inferior', or low value, goods and services tend to be the ones that reflect the conventional wisdom that the poor are disproportionately dependent. On the other hand, where commercial production and sales are involved, or if resources complement existing assets such as land and livestock, this relationship may be reversed. This has important implications for the potential of biodiversity-based resources to be used as part of poverty-alleviation strategies, which is the subject of Section 3. If the rich capture resources once they become more valuable, increasing the value of biodiversity-based resources may not be a feasible strategy, since the poor may eventually lose out in such a scenario (Angelsen and Wunder 2003).
2. There appears to be some confirmation of what Angelsen and Wunder (2003) have referred to as a 'poverty trap'. The poor appear to be linked with low value resource use, but these low values may serve to perpetuate poverty. Here, poverty is endogenous, in the sense that biodiversity resource dependence is a symptom of poverty, and it is only by 'leaving the forest' that the poor can hope to escape poverty (Levang *et al.* 2005). This, of course, is an important issue for discussion, since it has been widely believed that biodiversity-based resources provide an essential safety net for the poor, preventing them from destitution. But, if this dependence is reproducing or reinforcing existing patterns of poverty, it may be important to examine alternative livelihood strategies in order to benefit these economically marginalised groups.

TABLE 2.4: Evidence on relative dependence of rich/poor on biodiversity resources

Reference	Region	Resource	Relative dependence
Adhikari *et al.* 2004	South Asia	Fodder	Increases with wealth
Adhikari *et al.* 2004	South Asia	Leaf litter	Increases with wealth
Babulo *et al.* 2008	East Africa	Forests	Decreases with wealth
Bene et al. 2009	West Africa	Fish	Decreases with wealth
Cavendish 2000	Southern Africa	Multiple	Decreases with wealth
Coomes *et al.* 2004	Latin America	Hunting	Increases with land ownership
Coomes *et al.* 2004	Latin America	Palm fruit	U-shaped: first decreases then increases with wealth
Coulibaly *et al.* 2009	West Africa	Forests	Increases with wealth
De Merode *et al.* 2004	West Africa	Bushmeat	Consumption/sale increases with wealth
De Merode *et al.* 2004	West Africa	Fish	Consumption/sale increases with wealth
De Merode *et al.* 2004	West Africa	Wild plants	Consumption/sale decreases with wealth
Fisher 2004	Southern Africa	Low return forest activities	Decreases with wealth
Fisher 2004	Southern Africa	High return forest activities	Increases with wealth
Fu et al. 2009	Other Asia	NTFP	Decreases with wealth
Jha 2009	South Asia	Firewood	Decreases with wealth
Jha 2009	South Asia	Beedi making	Increases with wealth
Jodha 1990	South Asia	CPRs	Decreases with wealth
Kamanga *et al.* 2009	Southern Africa	Forests	Decreases with wealth
Levang *et al.* 2005	South-east Asia	Forests	Decreases with wealth
Mamo *et al.* 2007	East Africa	Forests	Decreases with wealth
Narain *et al.* 2008a	South Asia	Fodder, construction wood	Increases with wealth
Narain *et al.* 2008a	South Asia	Fuel, dung fuel, dung manure	Decreases with wealth
Paumgarten and Shackleton 2009	Southern Africa	NTFP	Sale decreases with wealth
Reddy and Chakra-varty 1999	South Asia	Forests	Decreases with wealth
Sapkota and Oden 2008	South Asia	Forests	Decreases with wealth
Shaanker *et al.* 2004	South Asia	NTFP	Decreases with wealth
Shackleton and Shackleton 2006	Southern Africa	NTFP	Sale decreases with wealth
Shackleton and Shackleton 2006	Southern Africa	Fuelwood	Consumption decreases with wealth
Shackleton and Shackleton 2006	Southern Africa	Edible herbs	Consumption decreases with wealth
Sharma et al. 2009	South Asia	Forests	Decreases with wealth
Viet Quang and Anh 2006	South-east Asia	NTFP	Decreases with wealth

2.4.3 IMPACTS ON INEQUALITY: DOES THE INCLUSION OF BIODIVERSITY-BASED RESOURCES IMPROVE DISTRIBUTIONAL OUTCOMES?

If the poor do depend disproportionately on biodiversity-based resources for their livelihoods, one outcome that emerges is that the inclusion of such resources in estimates of household income are likely to improve equity (measured in terms of reducing income inequality, or a lower Gini coefficient). A number of studies explicitly focus on this issue, and their findings are reviewed in Table 2.5, below.

TABLE 2.5: Equity implications of biodiversity resource dependence

Reference	Region	Resource	Impact on inequality
Fisher 2004	Southern Africa	Forests	Reduces by 12%
Jodha 1990	South Asia	CPRs	Lowers Gini coefficient
Kamanga *et al.* 2009	Southern Africa	Forests	Lowers Gini coefficient
Mamo *et al.* 2007	East Africa	Forests	Lowers Gini coefficient
Reddy and Chakravarty 1999	South Asia	Forests	Reduces inequality
Shaanker *et al.* 2004	South Asia	NTFPs	Lowers Gini coefficient

While the data in Table 2.5 clearly demonstrates that these studies find improvements in distributional outcomes due to the inclusion of biodiversity dependent livelihood strategies in their analyses, there is reason to be cautious in light of the previous discussion about the dependence of wealthier groups on certain high value resources. Clearly, in these circumstances, distributional outcomes would be worse if we were to include biodiversity resources in our analysis, and a biodiversity-based strategy would not necessarily improve equity.

Apart from their focus on measures of income inequality, a couple of studies also looked at other indicators of social inequality. Thus, Adhikari *et al.* (2004) report a lower level of resource dependence amongst both female-headed households, as well as lower social castes. This is explained both due to restrictions on access, as well as the lack of ownership of complementary assets such as land and livestock. The influence of caste is also remarked upon by Sapkota and Oden (2008), although they show a greater degree of dependence among lower castes. In their study, Bene *et al.* (2009) report than while only 69% of women sell fish, 98.6% of men do so, thereby suggesting that women are less likely to engage in commercial or market driven development opportunities in this context. Glaser (2003) remarks that 'pure subsistence products' are most important for the weakest sections, especially women and children. Levang *et al.* (2005) reflect on the importance of geographical isolation, and suggest that resource dependence is highest in remote areas due to the lack of alternatives (suggesting an interesting spatiality to the issue of biodiversity resource dependence). This is also reflected in Fu *et al.'s* (2009) study which shows greater dependence in the less developed (remote) village as compared to the more developed (better connected) village.

2.5. DEPENDENCE ON BIODIVERSITY: INSURANCE AND RISK COPING

This section focuses on reviewing the empirical evidence on the importance (in terms of various measures of impact on human welfare) that specific 'components' and/or 'attributes' of biodiversity have on the ability that the poor have to deal with risks and shocks. In other words we assess the 'insurance value' of biodiversity to the poor based on how biodiversity is defined or conceptualised in each study. The empirical literature on biodiversity as a means for risk coping is *considerably smaller* than that on biodiversity as a source of livelihood. The bulk of this risk coping literature is related to food security. There are considerably fewer studies on natural hazards and no specific studies on the insurance value of biodiversity with respect to the risk of reduction in ecosystem resilience, or the risk of ill health. Moreover, the methods used to assess 'dependency' are more varied than those on biodiversity as a source of livelihood. This makes tabulation of results (as in the previous section) less informative.

The literature discussed below focuses on three main categories of risks in relation to biodiversity: food security risks (e.g. high variability in crop production); environmental and weather hazards (e.g. storms; floods, mudslides, etc.), and health risks (e.g. risk from infectious diseases; risk of illness due to lack of wild medicinal herbs, etc.). A fourth type of risk that is discussed in the biodiversity and poverty literature is that of risks that are associated with degrading ecosystem resilience. This refers to a stability property of ecosystems that reflects the capacity of a system to absorb shocks (Perrings 1995), or the rate at which a system variable returns to the reference state after perturbation (Schläpfer *et al.* 2002). This is a more complex risk to isolate as it permeates the three other type of risks mentioned above. The literature also argues that low levels of biodiversity lead to lower levels of resilience which 'lowers the bar' of the tipping point for a particular ecosystem; i.e. the threshold point below which the ecosystem is not capable of providing the same type, level and quality of ecosystem services as before.

2.5.1 AGRO-BIODIVERSITY FOR FOOD SECURITY INSURANCE

There is considerable evidence from the ecology and agronomy literatures on the relationship between agro-biodiversity and crop productivity, variability and yield shocks. There are various complex channels that give rise to these effects. For example, diverse crop species are shown to adapt better to environmental changes since the larger pool of different metabolic traits and metabolic pathways enables them to more effectively use resources (such as water and soil nutrients) over a broad range of environmental conditions (Schlapfer *et al.* 2002). Also, biodiversity has been shown to improve ecosystem resilience which provides insurance against crop failure due to shocks (Perrings 1995, Tilman and Downing 1994; Tilman 1996).

At an economic policy level the benefits of agro-biodiversity for the poor have been acknowledged within the environment and development literature (e.g. review papers by Heal 2000; Jackson *et al.* 2007; Pascual and Perrings 2007; Perrings 2001; Perrings *et al.* 2006; Perrings 2007; Ravi *et al.* 2006; Smale and Drucker 2008). Further, the theoretical economics literature has developed bio-economic models that have clarified and defined in economic terms the insurance benefits or value that agro-biodiversity entails (e.g. Evenson *et al.* 1998; Weitzman 1993; Polasky and Solow 1995; Baumgartner and Quaas 2008; Chavas 2009; Heal *et al.* 2004; Schläpfer *et al.* 2002; Quaas and Baumgärtner 2006). These biodiversity benefits are then conjectured to be more important for the poor as they provide a cost effective insurance policy against the risk of food insecurity to segments of the populations that do not have alternative risk coping mechanisms (Heal 2000).

Our review suggests that the empirical evidence documenting the degree and nature of this dependence (i.e. how valuable is this insurance value to the poor) is a dynamic body of work with several notable advancements but with significant shortcomings. The most informative body of work concerns studies that have explored the impact of on-farm crop genetic diversity on output (mean of yields) and

variability (variance of yields). Various measures of diversity have been used depending on the nature of the study. The main examples of these studies are: Just and Candler 1985; Smale *et al.* 1998, 2003, 2008; Widawsky and Rozelle 1998; Meng *et al.* 2003; Di Falco and Perrings 2005; Di Falco and Chavas 2008b; Heisey *et al.* 1997.

A very strong and consistent finding across all these studies is that the coefficient of on-farm crop genetic diversity has a strong positive effect on the mean of crop yields and a negative effect on the variance of crop yields. This implies that agro-biodiversity reduces food risk insecurity, something which is particularly important for the poor. It is important to note that this result is robust against different production function specifications, different types of crops, different scales of data (regional versus plot specific) and different measures of crop genetic diversity. This body of evidence suggests that agro-biodiversity can buffer and insure the poor against negative environmental effects and support the resilience of the system under adverse weather conditions associated with climate change (Di Falco and Perrings 2008).

A few recent studies (Di Falco and Chavas 2006, 2008a, 2009)have also tried to examine the value of biodiversity not only as insurance against yield variability but also against the risks of total crop failure due to exogenous shocks (e.g. storms, new invasive pests etc.). For example Di Falco and Chavas (2009) use plot level barley production data from Ethiopia and show that agro-biodiversity (more diverse portfolio of barley landraces) increases productivity. Further they show that agro-biodiversity decreases downside risk exposure (by increasing skewness of the crop yield distribution). This effect is shown to dominate other confounding effects so that higher biodiversity tends to reduce the cost of risk (as measured by their estimated risk premiums). Finally, they also find that the risk benefit of biodiversity becomes larger under less fertile soils which offers empirical evidence that biodiversity can aid farmers to cope with harsh climatic conditions, especially in degraded lands. This last finding has implications for poorer segments of the population that tend to use and occupy less fertile, degraded, and marginal lands.

Beyond the relatively homogenous type of work mentioned above (relying on production function approaches) there are a few other empirical studies that shed light on the dependency of the poor on agro-biodiversity for food security insurance. Some studies try to compare more directly the impact of adopting modern crop varieties (often provided by aid agencies) as opposed to using traditional landraces on agricultural production decisions and outcomes. Though modern varieties are developed to be more efficient they do require specific types and quantities of inputs and hence may not be helpful in remote poverty-stricken areas where labour and other inputs are scarce. The rationale in this empirical work is that widespread adoption of modern varieties erodes genetic diversity and this may have implications for coping with food security risk in marginal low productivity lands. For example, in a study of subsistence level sorghum production in Ethiopia, Lipper *et al.* (2008) show that the likelihood of crop failure due to drought increases as the likelihood of adopting modern crop varieties (over traditional landraces) increases. This effect is found to be worse for marginal low production farms occupied by the poorer segments of the population. This provides further support regarding the insurance value of traditional landraces (which have a higher degree of genetic diversity as compared to modern varieties).

Other evidence comes from the literature that assesses the factors that impact decisions to conserve in-situ crop and animal diversity (see Van Dusen and Taylor 2005). For example, Van Dusen *et al.* 2007 study decisions to conserve diverse rice landraces in Nepal. They find the decision to conserve a diverse portfolio of rice landraces declines with income and increases with distance to markets. Both effects suggest a dependence of the relatively poor on agro-biodiversity. Similar findings are reported in Mexico (in Van Dusen *et al.* 2000). Lastly, a few stated preference studies (e.g. Birol *et al.* 2006 and 2009) show that landrace conservation has a significant welfare enhancing effect (measured as a change in consumer surplus) on farm households in developing countries.

With respect to the role of livestock as insurance for the poor, there is discussion and evidence in the development economics and development studies literature which suggests that this is significant (e.g.

Dercon 1998, Fafchamps *et al.* 1998, Kinsey 1998). Further there is some recent literature discussing the special role of animal genetic resources (as a distinct concept from livestock), characterised by the properties of flexibility, resilience and diversity. It is suggested that such animal genetic resources provide an enhanced form of insurance, as they are vital assets for the livelihoods of the poor (Anderson, 2003, Wollny 2003). However, there are no empirical studies which detail the insurance value of access to diverse animal genetic resources. Likewise, there has been little empirical exploration of the benefits to the poor of landscape level biodiversity as an insurance mechanism against high levels of crop variability (for example via its function as enhancing resilience), although this link is scientifically plausible and explainable both in ecological and economic terms.

2.5.2 WILD FOOD PRODUCTS, BIODIVERSITY AND FOOD SECURITY

The literature on the dependence of the poor on biodiversity-related income is also useful in providing insights on the role of wild food products, in particular for coping with the risk of food insecurity. For example Vedeld *et al.* (2007) suggest that together with fuel wood, wild food products are the main source of forest-related income and consumption. This sort of evidence lends support to the idea of forests as 'safety nets'. Yet (and what concerns this review), the value of the 'diversity' of wild food items or the value of diverse ecosystems as providing better qualities and quantities of such wild foods is not well documented.

A few studies assess the role of tropical forests (and hence biodiversity-rich ecosystems) as an insurance against food security (and income) variability. Pattanayak and Sills' (2001) study on the Peruvian rainforest and Takasaki *et al.'s* (2002) work on the Brazilian Amazon suggest that poor households in these tropical areas use the forest to cope with *ex-ante* risks and *ex-post* shocks. Pattanayak and Sills (2001) found that time spent collecting forest-products was correlated with agricultural yield risks (an income smoothing response) and unforeseen production shocks (a consumption smoothing response). One of the main findings of the Takasaki *et al.* (2002) study was that the insurance value of the forest (as a source of NTFPs during unforeseen shocks) was much more significant for the poorest segments of their sample. The micro-econometric study by Fisher and Shively (2003) on communities living at the margins of tropical forest of Malawi corroborates and complements these earlier findings. They find that rural households rely on tropical forests (for wild foods) for coping with income and consumption shocks and that asset-poor households are even more dependent on forests for dealing with such shocks. Similar findings are reported in Akinnifesi *et al.* 2006; World Bank 2007; McSweeney 2003; and Sunderlin *et al.* 2000. Hence, at least for the case of poor communities living close to tropical forests, there appears to be support for the conjecture that forests act as a safety net against food insecurity.

2.5.3 BIODIVERSITY AND NATURAL HAZARDS

Poor rural communities face serious risk from natural hazards – the most common being floods, fires, hurricanes and storms, landslides and dust storms. The lack of formal insurance mechanisms against such hazards that are available to the poor has been shown to lead to an exacerbation of poverty (Dercon 1996, 2004, 2005, 2006, Dercon and Krishnan 2000, Zimmerman and Carter 2003). Natural ecosystems can play an important role in mitigating these risks as they provide cost-effective insurance. This is achieved through complex inter-relationships between local geo-morphological traits, weather conditions, as well as soil and land-cover characteristics. Of these, vegetation and soil conditions are more susceptible to human interference (at least at the local level and in the short run).

Ash and Jenkins (2007) summarise the links between genetic diversity (be it at the soil, vegetation or landscape level) and the mitigation of flood and fire risks. There is less evidence on the possible links between biodiversity and mitigating against other hazards, such as landslides, hurricanes and dust storms. The risk of flooding is directly related to the water retentive capacity of the soils. This is related to soil and forest land traits. Diversity in soils and forests (e.g. type of plant coverage) is important for

regulating water flows, though the exact mechanisms are not entirely clear. Still, the literature does seem to conclude that natural forests (which to some degree implies higher levels of biodiversity compared to plantation forests and agricultural landscapes) are associated with higher degrees of flood protection.

Higher levels of biodiversity are associated with improved ecosystem capacity to regulate fire patterns, their frequency and their severity. For example, diverse plant species allow vegetation to adapt to fires and reduce wider disturbance of ecosystem integrity. Eroding plant biodiversity and introducing invasive tree species alter fire patterns by reducing their frequency but severely increasing their intensity and extent.

Natural resources such as mangroves have been shown to help local communities deal with the risk of hurricanes and storms (Das and Vincent 2009). Yet, case study evidence linking diversity *per se* and protection against such harsh climatic events is scant. Both landslides and dust storms are impacted by the extent and nature of vegetation coverage across the relevant ecosystem landscape. With respect to the nature or type of vegetation, there is scientific evidence that shows that endemic vegetation outperforms invasive or introduced tree or bush varieties. Yet, links with biodiversity *per se* seem to be weak or at least not well understood (Ash and Jenkins 2007).

2.5.4 BIODIVERSITY AND HEALTH RISKS

There is a sizable body of research on the links between environmental conditions and health from the medical, epidemiological and social science literatures (see World Bank 2007 for a review). A small subset of this literature tries to investigate the links between biodiversity and health vulnerability (see Daily and Ehrlich 1996, and Chivian and Bernstein, 2004, 2008). Recent literature has identified two main avenues through which biodiversity provides a means for mediating health risk for the poor. The first has to do with the impact that biodiversity has on reducing the risk of infectious diseases. The second has to do with biodiversity as a source of accessible medicinal regimens which are not only curative but are also preventive, thereby reducing health risks (Burlingame 2000; Chivian and Bernstein, 2004, 2008; Frison *et al.* 2005**;** Grifo and Rosentha 2007; Huynen *et al.* 2004, Johns 2006**;** Johns and Eyzaguirre 2006).

a) Biodiversity and risk of infectious disease

Biodiversity at the ecosystem level produces the appropriate balance between predators and prey, hosts, vectors and parasites which allows for appropriate controls and checks for both the spread of 'endemic' infectious disease as well as the resistance towards invasive pathogens (from humans, animals or insects). Ash and Jenkins (2007) identify a large list of diseases as being particularly dependent on changes in ecosystem biodiversity. Most of these diseases are of particular relevance to the poor and include malaria (in all ecosystem types), schistosomiasis (bilharzia), lymphatic filariasis, and Japanese encephalitis (particularly in cultivated and inland water systems in the tropics), dengue fever (particularly in tropical urban centers), leishmaniasis and Chagas disease (in forest and dryland systems), meningitis (in the Sahel), cholera (in coastal, freshwater, and urban systems), and rabies transmission (in tropics forest lands).

It is evident that regions in the world with the highest levels of poverty are most vulnerable to such diseases. Biodiversity plays a role not only in reducing the risk of such diseases spreading within an ecosystem and the human population living within it but in many cases also reduces the risk of allowing invasive diseases from entering a particular system. For example, there is evidence to show that cholera, kala-azar, and schistosomiasis have not become established in the (biodiversity rich) Amazonian forest ecosystem despite the risk of this happening from human migration and settlements (Ash and Jenkins 2007).

b) Biodiversity and preventive wild medicines

Biodiversity has been recognised as an important source of traditional medicines (such as herbal medicines) for people in developing countries, especially where they have little (if any at all) access to formal

health care. This lack of access to medicines and health services is even more acute in the remote and normally more poverty stricken areas of the developing world. It is estimated that approximately 75% of the world's population depends primarily on traditional medicines gathered from the wild. For example, the sweet wormwood plant (*Artemisia annua)* produces traditional medicines that are increasingly important in combating drug resistant strains of malaria, particularly in Africa (DFID 2001). Though traditional medicines may not be as effective as compared to scientifically tested drugs, they do provide a cost effective and accessible option in poverty stricken communities. Ash and Jenkins (2007) make reference to the importance of biodiversity as a medicinal source by providing some evidence of the number of wild plant species used as a source for curative and preventive drugs. For example, this number includes well over 50,000 wild Chinese species (around 20% of all Chinese flora), over 7,000 wild species in India, and 10% of Indonesia's flora.

Though these facts are interesting they do not provide a robust empirical indication of the degree of dependency. For this, we would need an assessment of the lives saved or illness incidents avoided as a result of higher levels of biodiversity and then use appropriate value of statistical life estimates to assess the magnitude of these impacts on human welfare. Such studies are non existent.

2.5.5 BIODIVERSITY AND RESILIENCE

The term "resilience" has been used to denote an ecosystem's ability to maintain its basic functions and controls under disturbances (*Baumgartner* and Strunz 2009, Holling 1973, Carpenter *et al.* 2001). Higher degree of resilience is found in ecosystems that exhibit higher degrees of biodiversity (see Swift *et al.* (2004) for a review of these studies from an ecological perspective). The economic relevance of ecosystem resilience is obvious, as a system flip may entail huge welfare losses since the continued provision of several key ecosystem services would be at risk of total collapse. For example, a combination of drought, fire and ill-adapted livestock grazing management in sub-Saharan Africa, central Asia and Australia have lead to severe degradation and desertification of semi-arid rangelands that provide subsistence livelihoods for more than one billion people. Once these grasslands are degraded they can no longer be used as pasture (*Baumgartner* and Strunz 2009). Hence, resilience is related to the threat of 'irreversible' ecosystem damage.

There is a growing literature that discusses the value of resilience as insurance against irreversible damage. While reference is made to this value in relation to the world's poor, the discussion is mainly conceptual and model based (e.g. *Baumgartner and* Strunz 2009; *Baumgartner and Quaas 2008a and 2008b; Maler 2008; Perrings 2006*; Perrings and Stern 2000*)*. There are no empirical studies on the degree of dependency on biodiversity as a source of protection against the risk of declining resilience. This is to be expected, given that resilience is associated with a form of 'wider insurance' against potentially multiple risks. It is also a concept related to 'entire systems' and not specific aspects of biodiversity, and as such is not easy to isolate nor trace back to specific behavioural decisions.

2.6 CONCLUSIONS

This review has examined the published literature which studies links between biodiversity and poverty. Interestingly, while many papers refer to the existence of such a relationship, there are relatively few studies that subject this relationship to critical empirical scrutiny. One (surprising) finding of our review is that there is such a paucity of grounded empirical information about the particular ways in which people (especially the poor) use and benefit from the existence of biological diversity. However, the studies that do exist point to some interesting patterns which are worthy of generalisation. Indeed, it is not necessarily clear that adding to our stock of case study material would necessarily result in the discovery of a hitherto-unknown dimension of the poverty-biodiversity nexus; many of the current known patterns are likely to be repeated in additional studies. More case studies may add some empiri-

cal depth, but are not necessarily going to result in a different conceptualisation of the ways in which poverty and biodiversity are related.

The limited use of the poverty concept in the existing literature was a particular source of disappointment. Here, we would suggest that there are significant missed opportunities, and a more expanded notion of poverty is likely to result in much greater analytical traction for an understanding of the biodiversity-poverty link.

On income and subsistence, our review suggests that there is some evidence supporting the hypothesis that the poor do depend significantly on biodiversity, but this needs to be looked at with some caution. In some cases, there is clear evidence that the poor make extensive use of their natural resources, as long as these remain relatively low-value and subsistence oriented, but there is also evidence that these same groups either lose access or are actively excluded from more highly valued resource uses. This suggests that there is some evidence of a possible 'poverty trap', with poorer users stuck in low value extractive uses but unable to make the transition out of this resource dependent mode.

There is relatively robust information to show that the poor rely on farm agro-biodiversity to insure against food (in)security and risk. However, we still know very little empirically about the significance of other forms of biodiversity in terms of risk insurance, protection against natural hazards, health and ecosystem resilience. This is an important knowledge gap, and our review points to the need for more systematic and robust studies which examine these linkages in greater depth.

The evidence that is available in the reviewed literature suggests that the poor benefit from the existence of, and access to, natural resources, rather than biodiversity in its strict sense. There seems to be inadequate published evidence that strongly supports the conjecture that the diversity of biological systems themselves is significant for the livelihood strategies of the poor. This is not to suggest that these claims are not valid, but simply to point to the lack of robust empirical support for such relationships. In many ways, this is an important challenge for the research community. As decision makers increasingly demand a clear evidence base in support of policy interventions, it is important to conduct systematic research which looks more closely at the ways in which biodiversity affects poor people's dynamic livelihoods, and their trajectories over time and across different spatial scales.

3. DOES CONSERVING BIODIVERSITY WORK TO REDUCE POVERTY?

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3.1 INTRODUCTION

In 1987, the former prime minister of Norway, Gro Harlem Brundtland, chaired a UN commission that produced a report called *Our Common Future*. The report stated "poverty is a major cause and effect of global environmental problems". In 1996, Duraiappah, examining new evidence, concluded that the Brundtland Commission's "causal link is too simplistic, and the nexus is governed by a complex web of factors". A few years later, Ekbom and Bojö (1999) untangled some of the complexity. They found that when it came to the environment, potential win-wins that "combine poverty alleviation with environmental management measures" were possible—for example, reducing indoor air pollution from cooking fires, protecting a clean water source, or cleaning up a polluted place where the poor live. After Ekbom and Bojö, experts and governments began to look hard to see if these win-wins also exist in a sub-sector of the environment: biodiversity conservation.

For more than two decades, it has been clear that the rural poor are often highly dependent on the goods and services provided by biological diversity, and that these goods and services are frequently taken for granted, underpriced and overexploited. Twenty years ago, the dominant view was that "the only hope for breaking the destructive patterns of resource use is to reduce rural poverty and improve income levels, nutrition, health care and education" (Wells and Brandon 1992). Perhaps at some point this will break the destructive usage patterns, but it has not happened in many developing countries. China, Indonesia and Brazil, for example, have greatly reduced rural poverty while continuing to draw down their natural capital. There are two primary reasons why reductions in rural poverty and improvements in incomes, health care and education are unlikely to break the destructive resource-use patterns: natural resource consumption tends to increase with income; and better-off people are often the ones who benefit the most from natural resource use because they have the capital to exploit the resources. Reducing rural poverty by itself is thus unlikely to save imperilled nature. There are good reasons, though, why reducing local poverty in conservation areas matters. Ethically, a conservation initiative should help people and not hurt them. Practically, a conservation initiative needs to provide tangible and lasting benefits to local people or the initiative will not be socially sustainable.

So are there specific interventions that can benefit both the poor in rural areas and biodiversity? As this knowledge review shows, the answer is yes. There are conservation "mechanisms"—meaning a conservation intervention or approach—that can contribute measurably to reducing poverty while conserving biodiversity. Sometimes these mechanisms are a route out of poverty for local people. Sometimes they provide modest poverty reduction benefits or a safety net to keep people from falling deeper into poverty, and sometimes when upended, a few can become poverty traps.

To illuminate the pitfalls and highlight what works, this review summarizes the conservation mechanisms with empirical evidence of poverty reduction, how they work, who they benefit, which components of biodiversity are important, and what are the uncertainties.

3.2 METHODOLOGY

A total of 431 documents were collected from the peer-reviewed publications, books, grey literature, and Poverty Conservation Learning Group membersWithin this body of knowledge, the review highlights the English-language documents that present multi-site empirical evidence of a conservation mechanism's poverty benefits or have been widely cited by others as per Google Scholar. The knowledge review includes literature up to February 2010 and goes as far back as 1985. To cast a wide net, any definition of poverty was sufficient for inclusion.

This review does not include *all* conservation mechanisms believed to benefit poverty. We looked at 16 mechanisms but included here only those mechanisms for which there is publicly available empirical evidence that the conservation mechanism contributed to poverty reduction.

Several constraints became increasingly evident as the knowledge review proceeded. The first was the limited number of studies that generated hard evidence of poverty impacts. The second was the generalizations made in this knowledge review miss the individual variations in costs and benefits from a conservation initiative. Third, most of the hard evidence for poverty reduction focuses on changes in income and thus does not fully reflect the multi-dimensional nature of poverty. Finally, there is the lack of uniformity of poverty indicators that are used to measure impacts, and consequently empirical evidence that a mechanism was a route out of poverty depends greatly on how poverty impacts were measured. These constraints mean that the conclusions reached in this review should be treated with caution.

3.3 CONSERVATION MECHANISMS

3.3.1 NON-TIMBER FOREST PRODUCTS (NTFPS)

What is the NTFP mechanism? The proceedings of a 2007 international conference on "The Role of NTFPs in Poverty Alleviation and Biodiversity Conservation" gave a summation of the potential of non-timber forest products: "…NTFPs can play a critical role in providing both food and income for the poorest households, notably by creating income and employment opportunities for women. However, […] there are also concerns about the potential impact of NTFPs collection on biodiversity" (IUCN 2008). And these are the NTFP optimists.

NTFP projects have been criticized as at best, a safety net (Wunder 2001), and at worst, a poverty trap (Dove 1993). Much of the difference comes in how NTFPs are defined. Sceptics tend towards a broad definition: "all products other than timber that come from forests" (Belcher 2003). The proponents use a definition that has evolved to recognize that "NTFPs are shifting from forest to agricultural fields to become 'non-timber *farm* products' that are cultivable, desirable, profitable and innovative" (IUCN 2008). NTFPs are viewed by proponents as a tool to help the poorest of the poor in rural areas transition to new and more beneficial livelihoods. The benefits to biodiversity from NTFPs, in the proponents' view, come from reducing pressure on natural forest resources. The sceptics point out there is no empirical evidence of NTFP commercialization benefiting biodiversity.

How does the mechanism work? Classically, this mechanism works via the sustainable gathering of NTFPs from natural forests by poor collectors who then sell the products to buyers thereby earning income, buying assets, creating savings, and reducing poverty. These financial benefits give local people an incentive to protect the natural forest which benefits biodiversity. More recently, this view has been amended to: NTFPs are cultivated outside forests and sold for poverty reducing income, while keeping collectors out of the forest thus reducing pressure on biodiversity.

Which groups of poor benefit from NTFPs? There is compelling evidence that the poorest of the poor are those who use NTFPs the most (Neumann and Hirsch 2000) and that NTFPs are often the employment of last resort (Angelsen and Wunder 2003). There is also compelling evidence that NTFPs can prevent a decline deeper into poverty but rarely sustainability reduce local poverty (Wunder 2001). Dove (1993) notes that there is a history of external powers taking control of NTFPs once it is clear that money can be made. Dove cites the Indonesian examples of latex, gems, minerals and rattan, where historically many poor have fallen into the poverty trap of collecting the NTFPs for powerful bosses who provide them with income and credit sufficient to keep them indentured. The evidence for NTFPs being a poverty trap is old and based on maximum exploitation models. No evidence was found of an NTFP *conservation* project that made poverty worse.

BIO*DIVERSITY* VERSUS BIO*MASS*

Conservation efforts almost always focus on preserving biological diversity. Yet for generating direct benefits to poor people, is it biological diversity or biological mass that matters in the near term? Balmford *et al.* 2008 shows that the direct benefits to people depend more on the abundance of particular species than the number of different species. This suggests that direct benefits to poor people are more about biomass than biodiversity. Of course, in the longer term, biodiversity is the foundation for biomass production.

For NTFPs to reduce poverty, there needs to be local commercialization of one or more NTFP. When this happens, women are often beneficiaries. Marshall *et al.* (2006) studied 16 NTFP value chains in Mexico and Bolivia and found that "NTFP activities are one of the few cash-generating opportunities for women in marginalized rural communities". Moreover, among female-headed households, forest resources often contribute significantly more total household income than in male-headed households (Shackleton and Shackleton 2004). Available evidence suggest that NTFP commercialization tends to benefit the poorer people in a community, especially women, unless there is significant money to be made, in which case the powerful and better-off people take control.

Which biodiversity components are most important? For NTFPs to reduce local poverty, it is largely about increasing the quantity of an NTFP or the value added. Biological diversity itself has little to do with the direct benefits except by underpinning the ecosystem that produces the NTFP. The NTFPs that appear to generate poverty reduction benefits for the poor include honey, bamboo, fuelwood and mushrooms.

What are the uncertainties? A study of 61 cases of NTFP production and trade in Asia, Africa and Latin America found that NTFPs have not reduced poverty in most cases (Belcher *et al.* 2005). "The same factors that tend to make NTFPs important in the livelihoods of the poor, also limit the scope of NTFPs to lift people out of poverty" (Sunderlin *et al.* 2005). Four factors are critical. First, NTFPs are often collected in open-access areas, and thus overexploitation is common. Second, access to NTFP markets tends to be poor for many forest dwellers. Third, fluctuations in the quantity and quality of NTFPs cause an unpredictable income stream, and fourth, middlemen often take the bulk of the added value (Pandey *et al.* 2007).

Benefits to biodiversity are also uncertain. No quantitative evidence of an NTFP project helping conserve biodiversity was found during the knowledge review. Even anecdotal evidence of biodiversity benefits from NTFP projects is limited (IUCN 2008).

Ros-Toten and Wiersum's analysis of NTFP projects (2003) gives some specific recommendations for ensuring NTFPs benefit the poor:

- Producers have secure tenure rights.
- Producers combine NTFP production with other rewarding economic activities.
- Products can be harvested efficiently from areas where abundance of NTFP-producing species has

increased as a result of tending, enrichment planting, and domestication.

- Products have established markets or potential to reach promising niche markets.
- Producers have the capacity to add value to the products.
- Producers are organized and maintain effective alliances with outsiders who may help identify new markets and potential donors.

MEDICINAL PLANTS, BUSHMEAT AND WOODCARVING

In various places and times, medicinal plants, bushmeat and wood carving have all been shown to produce beneficial impacts on poverty, but could they be a conservation mechanism as well? For medicinal plants, there is lots of evidence that they are important to the poor but no evidence that better managing their collection in the wild can make the harvests sustainable. Conceivably, commercialization of medicinal plant production could take pressure off of natural supplies, but empirical evidence of this happening was not found. For bushmeat, there is evidence for it being a safety net for the poor. The sustainability of most bushmeat sources is questionable, however. For woodcarving, there is empirical evidence of it being a route out of poverty, but the sustainable supply of the woods favoured by carvers is doubtful without the creation of new sources.

Summary conclusion: Overall, non-timber forest products are only rarely a route out of poverty. Whether or not a project to promote NTFPs can benefit biodiversity is uncertain. Here biomass rather than biodiversity is more significant in determining the poverty reduction potential.

3.3.2 TIMBER

What is the timber mechanism? In 2004, approximately 25 percent of forests in developing countries were owned by communities, and with the current trend, this is likely to double by 2020 (Scherr *et al.* 2004). In addition to more secure tenure of forest lands, forest communities are benefiting in some places from decentralization coupled with democratization and anticorruption campaigns, growing demand for forest products, market deregulation, retreat of forest concessionaires, payments for forest environmental services, and new technologies that make small-scale harvesting and processing easier (Sunderlin *et al.* 2007). This has created a renewed interest in community forestry. (Community forestry initiatives can include NTFPs—covered above—and mangroves—covered below.) It is within community forestry that the evidence of timber benefiting the rural poor is found.

How does the mechanism work? Small-scale wood processing is the most common community forestry mechanism and where most of the timber win-wins are found. These are frequently contractual arrangements between communities and companies to supply fibre, pulp or construction timber. The income generated helps reduce poverty. By harvesting the timber at sustainable levels, communities also help conserve biodiversity.

Which groups of poor benefit from timber? Historically, timber harvesting has rarely benefited the rural poor for several reasons. First, local and national elites capture much of the wealth for themselves. Second, timber "represents a long-term, high-risk investment whereas low-income people generally need short-term income and want to avoid risk" (Sunderlin *et al.* 2005). Third, there is little 'trickle-down' benefit from timber harvesting. Fourth, "tree growing for timber requires secure land tenure and the poor are often landless or only have informal control over the land they use" (Sunderlin *et al.* 2005). Fifth, dependence on forestry resources can be a poverty trap when access to markets is very limited: Chomitz *et al.* (2007) show how forest poverty correlates strongly to the number of hours to the nearest major market. Finally, forests and trees are rarely the economic mainstay of communities, and forestry needs to be part of a larger economic development framework (Mahanty *et al.* 2006).

Even with the challenges, however, there is considerable evidence that community-forestry timber enterprises can reduce poverty and conserve biodiversity. A study of 14 community-forestry timber enterprises in developing countries found that they can be quite profitable (Molnar *et al.* 2007), and in Mexico, community-forestry enterprises have been shown in a rigorous analysis to have reduced poverty (Bray and Tardanico 2005). Sunderlin *et al.* (2007) write that "community forestry is potentially a key vehicle for lifting rural people out of poverty in forested areas, particularly if it is implemented on the basis of tenure transfer and enhanced marketing opportunities…" For biodiversity, community forestry can also be a benefit. There is empirical evidence from Nepal (Gautam *et al.* 2002, Oli and Kanel 2006), Mexico (Bray *et al*. 2003) and Vietnam (Nguyen *et al*. 2009) that community forestry has led to increases in forest cover.

It is not only timber that can benefit poor communities but the forest itself. A meta-analysis of 51 case studies from 17 countries found that forest environmental income represents on average 22 percent of the total income (Vedeld *et al*. 2004). Fuelwood, fodder and wild foods are often an integral part of the livelihood strategies of the poor, and simply maintaining an intact forest has benefits to the rural poor that are often overlooked.

Which biodiversity components are most important? As with NTFPs, benefits to the poor from timber come from the abundance of particular tree species (biomass) rather than the number of tree species (biodiversity), and more specifically, the benefits frequently come from the faster-growing commercially valuable tree species.

What are the uncertainties? While the poor can benefit from community-managed forestry, this has not always been the case. Equity issues within communities have hampered the benefit sharing of community-based resource management projects in several countries. Blaikie (2006) makes the point that community management of resources is viewed by many as "progressive and transformative" but it can just as easily be "laggard and traditional".

Failure rates can be high. A study of small and medium-sized timber enterprises found that on average, 75 percent of enterprises fail in the first three years (Mayers 2006).

Summary conclusion: Overall, timber harvesting in community forests can be a route out of poverty and conserve biodiversity. The challenges are forest tenure, market access, and ensuring the poor benefit. Therefore, removing market and regulatory barriers and ensuring solid benefit-sharing arrangements are crucial to success. Biomass (quantity and size of trees) rather than biodiversity (species diversity) is more significant in determining the immediate-term poverty reduction potential.

3.3.3 PAYMENTS FOR ENVIRONMENTAL SERVICES (PES)

What is the PES mechanism? The most widely used definition of a payment for environmental/ecosystem/ecological services is that of Wunder (2005): *Payments for Environmental Services (PES) are voluntary transactions where a well-defined environmental service is bought by an environmental service buyer from an environmental service provider if and only if the environmental service provider secures environmental service provision.* PES is one mechanism used many different ways. PES can include bioprospecting, eco-labelling, conservation easements, conservation concessions, watershed protection, and carbon sequestration or storage (Richards and Jenkins 2007).

How does the mechanism work? To date, the evidence of PES benefiting the poor is in payments for watershed services and in carbon sequestration and storage. In payments for watershed services, downstream water users pay to protect their upstream water supply. It is often cheaper for downstream cities to protect their upstream water sources than increase water treatment. New York City is a classic example (Pires 2004). In carbon sequestration, CO_2 emitters pay landholders to reforest an area thereby

offsetting their CO_2 emissions. In carbon storage, CO_2 emitters pay landholders to not deforest or degrade an area thereby keeping the forest intact. Whether the benefits to the poor are linked to biomass or biodiversity depends on how the payments mechanism is structured.

REDD, POVERTY AND CONSERVATION

Reduced Emissions from Deforestation and Degradation (REDD) is often viewed as one of the most cost-effective means of tackling climate change (Stern 2007, Strassburg et al. 2009). It is also expected that REDD will help conserve biodiversity, deliver ancillary environmental benefits, and reduce poverty (Brown et al. 2008). REDD has the potential to deliver substantial funding to rural, impoverished communities, though it could lead to elite capture of benefits and exacerbate conflict over land tenure (among other potential pitfalls) (Griffiths 2007, Peskett et al. 2008). With pilot REDD projects just getting underway in many parts of the world, there is not yet substantial evidence that REDD can deliver poverty-conservation benefits (Peskett et al. 2008). An older 'avoided deforestation' project in Bolivia has had mixed success in delivering livelihood benefits to local communities (May et al. 2004). Yet an analysis of current pilot projects shows that many are likely to deliver socio-economic benefits (Wertz-Kanounnikoff 2009). Some see the ability of REDD to be a mechanism for reducing poverty as questionable (Campbell 2009), with any benefits that REDD could provide to poverty alleviation ultimately contingent on both how REDD is structured by the international community (Peskett et al. 2008, Boersema et al. 2009) and how the benefits are shared at the national and sub-national levels.

Which groups of poor benefit from PES? This mechanism is almost always linked to how land is used, and because the poorest of the poor rarely own or control land, they rarely benefit from a PES. In fact, if a conservation practice encouraged under a PES is less labour intensive, the poor and landless may be harmed (Pagiola *et al.* 2005, Angelsen and Wunder 2003). It is the moderately poor smallholders and the better-off landowners who generally benefit from a PES. The inclusion of the poor is "more by accident than design" (Porras 2008), and most PES initiatives do not explicitly aim at reducing poverty (Pagiola *et al.* 2005). Fortunately, "most PES gains are not large enough to really attract the interest of the powerful" (Wunder 2008).

Even so, PES has been shown to reduce poverty. A payment for watershed services project in Ecuador (Echavarría *et al.* 2004) and a forestry PES in the Osa Peninsula of Costa Rica (Muñoz 2004) both provided greater than 30 percent of household income for poor PES sellers and helped reduce poverty. These examples may be outliers, however. Porras *et al.* (2008) reviewed 50 watershed PES programmes and found that "the cash payments appear to be relatively insignificant, and there is an opinion that they function more like supports or a bonus than a real incentive for land-use change". Wunder (2008), Porras *et al.* (2008) and Bond and Mayers (2010) all cite non-income gains as significant PES benefits. These include strengthening property rights, capacity building, and improvements in social organization. Bond and Mayers (2010) caution, however, that "these effects are rarely specific to payments for watershed services and could potentially be generated through alternative actions".

Which biodiversity components are most important? The majority of PES initiatives are not dependent on biodiversity *per se*. Once again, biomass rather than biodiversity seems to be important in delivering the ecosystem services for which people are prepared to pay (such as watershed services or carbon sequestration in trees). There is evidence, however, that for some PES initiatives, biodiversity is important. Higher levels of plant biodiversity, for example, result in faster and higher concentrations of soil carbon storage.

What are the uncertainties? PES is a relatively new mechanism, and the knowledge is rooted as much in the theoretical as in the empirical. There are several factors believed to limit where a PES can work. First, PES sellers need to have the right to exclude people from their land and the ability to do so, or they cannot ensure the delivery of the agreed environmental service. This is often not the case for the poor who lack recognized land tenure. Second, there are high transaction costs if there are a large number of landholders (though there are examples of how bundling small PES sellers can lower transaction costs). Third, "PES makes the most sense at the margin of profitability, when small payments to landowners can

tip the balance in favour of a desired land use" (Wunder 2005). Fourth, only those who pose a credible threat to an environmental service are likely to be paid—if they are not a threat there is no need to pay for the service: "The ideal environmental service seller is, if not outright environmentally nasty, than at least potentially about to become so" (Wunder 2005). Engel *et al.* (2008) sum it up: "The scope for application of PES, then, is to a narrow set of problems".

So long as a PES is voluntary, it is unlikely to become a poverty trap. But poverty can be made worse in cases where there is *de facto* forced participation in a PES, and the payments do not offset the losses from the land-use changes (Wunder 2005).

There are also uncertainties in some cases about whether or not PES initiatives are delivering the environmental services promised. Porras *et al.* (2008) notes, for example, that "evidence of the delivery of watershed services has proved elusive", and "research on the Mexican and Costa Rican national programmes suggests that their additionality has been limited". This may be a systematic problem related to how biodiversity conservation is measured and reported. Often, however, the assumption that a strategy is doing good for nature is just that, an assumption.

Summary conclusion: Overall, PES is rarely a route out of poverty but does have limited poverty reduction benefits. When a PES is not truly voluntary, it can become a poverty trap, though this has rarely been documented. Biodiversity is not a prerequisite for a successful PES initiative, but it can enhance the delivery of some ecosystem services and hence make the initiative more attractive.

3.3.4 NATURE-BASED TOURISM

What is the nature-based tourism mechanism? The nature-based tourism mechanism includes community-based operations on one end, and at the other end, all-inclusive international eco-lodges and safari operations. Tourism is often a lucrative enterprise for wildlife-rich areas.

How does the mechanism work? Nature-based tourism offers a number of opportunities for reducing poverty. These include jobs in the formal tourism sector such as accommodation and guiding, and in new markets for local services and products including sales of crafts, cultural services, food and drinks. Tourism also often brings infrastructure development, including roads, telecommunications and healthcare facilities that, while provided for the benefit of tourists, can also benefit poor people.

Which groups of poor benefit from terrestrial tourism? A meta-review of 27 tourism case studies in Asia found income gains for all economic levels, while those already better off gained most (Shah 2000). In Zambia, a World Bank study (2007) found that nature-based tourism had reduced poverty, but those with most assets (the less poor) benefit more than the very poor by up to 50 percent. The indirect benefits may be important to the poor, however. There is the multiplier effect whereby tourism "creates opportunities and downstream effects for…more people besides the wage earners, such as casual labourers, crafters and small businesses" (Ashley and Roe 2002). A study of global tourism (Markandya *et al.* 2003) found that the typical tourism multiplier is between 2 and 3, meaning each dollar spent by a tourist generates 2 to 3 more in the national economy. Many of these economic benefits flow to women. Hemmati (1999) reviewed a decade of global tourism data and found that tourism is a particularly important sector for women and that women comprise a higher percentage in the tourism sector than in the general workforce (46 versus 34 per cent). This is not surprising given the service nature of the industry. A high proportion of the jobs involve low-skill domestic type work, something often accessible to women (Ashley *et al.* 2000). There are also indirect benefits such as the roads, communication infrastructure, clinics and schools, often in remote areas, created to support a tourism venture (Shackleton 2007). Where tourism operators commit to hire and train local people, the poverty reduction benefits are much greater. In Indonesia's Bunaken National Marine Park, for example, a study found that the commitment by local tourism operators to hire 80 percent of staff from local communities resulted in approximately 1,000 new jobs in tourism over five years (Davis 2005).

Which biodiversity components are most important? Nature-based tourism depends on both the existence (and likelihood of viewing) certain key species and on the overall attractiveness of the landscape. Wunder (1999) notes: "the tourism appeal of a natural site (and hence its income-generating potential) tends to be closely related to its conservation level". Thus, biodiversity is important in terms of maintaining an intact ecosystem. Terrestrially, evidence suggests that it is large, charismatic animals, such as mountain gorillas, tigers and pandas, which attract tourists. In the marine realm, the tourism draws include corals, dolphins, stingrays, whales, turtles and reef fish.

What are the uncertainties? There are several uncertainties about nature-based tourism as a poverty-conservation mechanism. First, tourism can be a fickle business. A terrorist event (e.g. the bombings in Kenya, Tanzania and Bali in recent years), an economic downturn, spillover from civil war, or a SARS-like outbreak can cause a sudden drop in visitors. Decades of conservation success can be wiped out as tourism-dependent local people are forced to use tourist-attracting natural resources like wildlife and forests just to survive. Second, when skilled staff and luxury items are imported for a tourism operation and profits exported, there are fewer poverty-reducing benefits from tourism. This is called 'leakage'. Concerns about leakage, however, may be overrated as a World Bank (2007) Zambia tourism study notes: "Although overseas services constitute over 70 percent of the total [tourist] package price, they are not a leakage from the Zambian economy. Rather, they are payments for services in the source markets, including representation, marketing, insurance and flights; services that are used to sell the Zambian product, without which there would be no benefit at all to Zambia". Third, tourism is often seasonal and thus provides an uneven income stream. Fourth, tourism's ecological impact can exceed the limits of acceptable change in a location and jeopardize both biodiversity and tourism, though Wunder (2000) notes that tourism's negative environmental impacts are often more aesthetic than systemic.

Summary conclusion: Overall, under the right conditions, nature-based tourism can be a route out of poverty provided there are natural attractions people will pay to see, reasonably easy access, and systems to ensure local people benefit directly. Yet unlike most of the other mechanisms in this review, this mechanism is less about restoring degraded ecosystems in order to generate greater benefits to poor people and more about keeping ecosystems intact to generate the benefits. Biodiversity matters for this mechanism. It is, however, a mechanism whose reliance on visitors makes it vulnerable to global events unrelated to local conditions.

3.3.5 FISH SPILLOVER

What is the fish spillover mechanism? Protecting a key area of marine habitat from fishing can allow fish stocks to replenish, and as stocks increase, some fish will spillover into adjacent areas where they can be caught by fishers.

How does the mechanism work? Creating a no-fishing area gives space for fish to grow bigger, and bigger fish generally have exponentially more offspring than smaller fish (PISCO 2007). After three to five years of protection, the fish begin to spill over into the area outside what is commonly called the 'no-take zone' (Gell and Roberts 2003). The greater fish catches generate more income for fishers and hence help reduce poverty, while the no-take zone provides protected habitat for marine biodiversity.

There is evidence that the spillover mechanism works better where there is active participation of local communities in the resource management (McClanahan *et al.* 2006). There is also evidence that size matters. If a no-take zone is too large, spillover will not offset the losses to fishers from closing sections of the fishing grounds (PISCO 2007). "From the perspective of fisheries, networks consisting of many smaller marine protected areas may be preferable to a few very large marine protected areas" (IUCN 2008a).

Which groups of poor benefit from fish spillover? The poorest of the poor can benefit from spillover because the barriers to collecting marine resources are often low. In places where many people are poor, and fishing is in crisis, the medium-term poverty reduction benefits can be significant. WRI

(2005) and Leisher *et al*. (2007) found that spillover from two community-managed marine areas in Fiji roughly doubled local incomes within five years of establishing the no-take zone compared to control sites, and women were the primary beneficiaries. Successful sites are also usually within the community's line of sight (IUCN 2008a).

The indirect benefits to the poor are also important. Organizing a community to manage a no-take zone often strengthens the social fabric of the community, giving them a ready decision-making body and a more unified voice to solve other community issues (Leisher *et al*. 2007). The stronger social cohesion also improves local security and empowers local decision-making, two key elements of poverty reduction (World Bank 2001).

Which components of biodiversity are important? It is the near-shore fish biomass that is critical, and this biomass in turn is affected by the levels of biodiversity. There is empirical evidence that greater biological diversity creates greater fish biomass in marine ecosystems (Worm *et al*. 2006).

What are the uncertainties? There is a growing body of empirical evidence of the fisheries benefits of no-take zones. Gell and Roberts (2003) cite 14 marine protected areas where biomass was greater inside the no-take zone than outside and where spillover of fish or larva has been empirically documented. The uncertainty here is about spillover's potential contribution to poverty reduction. Abesamis *et al*. (2006) caution that "advocates of reserves are sometimes overly optimistic about the potential benefits of spillover". They found that spillover in a site studied for more than 20 years (Apo Island, Philippines) contributed less than 10 percent of the total fish catch. Harmelin-Vivien *et al*. (2008) studied six Mediterranean no-take areas and found "fish spillover beneficial to local fisheries occurred mostly at a small spatial scale (100s of metres)". The differences between advocates and sceptics of spillover's poverty reduction benefits come from, *inter alia*, differences between no-take area size and connectivity. Nakeke (2008) shows that if the no-take zone is too small, fish learn that when they leave the no-take zone, they are caught, so they stay. Tupper (2007) notes, "marine protected areas that are physically connected by contiguous reef structures will likely provide more spillover to adjacent fished sites than those that are separated by habitat barriers". Rules of thumb for marine protected area network design currently recommend that no-take zones should be a minimum size of 10 km^2 and that they should be separated by a distance of less than 15 km^2 (Friedlander *et al*. 2003, Fernandes *et al*. 2005, Mora *et al*. 2006, reviewed in McLeod *et al*. 2008).

Pollnac and Crawford's 2001 study of community-based marine protected areas in the Philippines collected data from 45 sites with no-take zones. This study found that the most likely predictors of poverty-conservation benefits from a community-based no-take zone were: "if the community in our sample 1) has a relatively small population, 2) a perceived crisis in terms of reduced fish populations before the marine protected area project, 3) has successful alternative income projects, 4) manifests a relatively high level of community participation in decision making (high on the democracy scale), and 5) has continuing advice from the implementing organization".

Summary conclusion: Overall, fish spillover has been a route out of poverty, but it needs specific conditions to work (noted above). This mechanism depends more on biomass (how much fish) than biodiversity per se (the specific kinds of fish).

3.3.6 MANGROVE CONSERVATION AND RESTORATION

What is the mangrove conservation and restoration mechanism? There is ample literature on the benefits mangroves provide to people and nature (see Walters *et al*. 2008 for a review). Mangroves have been shown to increase the biomass of commercially important species on nearby coral reefs in the Caribbean (Mumby *et al*. 2004). Fisheries landings in the Gulf of California are positively correlated to areas of nearby mangrove forest (Aburto-Oropeza *et al*. 2009). Mangroves are also a source of valuable

wood products, provide protection against coastal erosion, capture sediments from rivers, and serve as storm barriers (Sathirathai and Barbier 2001) that can save lives (Das and Vincent 2009).

How does the mechanism work? This mechanism works by restoring or conserving mangroves, which improves the productivity of the mangrove and adjacent ecosystems, thereby benefiting local livelihoods. In three mangrove areas in India, the most intact mangrove area yielded approximately four times as much income from shellfish and finfish per day as the less robust mangrove areas (Kathiresan and Rajendran 2002). The mechanism also works by mitigating the impact of storms on the coastal poor.

Recent work suggests that the length of mangrove forest fringe is more important than total mangrove area for fisheries benefits (Aburto-Oropeza *et al.* 2009).

Which groups of poor benefit from mangroves? Mangroves can benefit the poor through associated fisheries that provide income and food (Rönnbäck 1999, Magalhaes *et al.* 2007), and there is evidence that mangroves can be a route out of poverty. A community-based mangrove project in Thailand, for example, increased income from crab harvesting for poor, landless families while boosting the abundance of other marine products (Soontornwong 2006). More often, however, mangroves provide only modest poverty reduction benefits as they do in Bangladesh where small-scale and mostly poor fishers in the Sundarban mangroves produce 95 percent of the total marine catch in the country (Islam and Haque 2004).

Women may also benefit from mangrove restoration if they are involved in collecting or processing mangrove products. Processing crabs harvested from mangroves in Brazil, for example, provides an important supplemental source of income for women (Magalhaes *et al.* 2007).

Which components of biodiversity are important? Replanted mangroves often contain trees with high value for people such as various species of *Rhizophora*. Though these stands are less diverse, they provide much of the same structural functionality as native mangroves and have been shown to hold equivalent populations of commercial crab species (Walton *et al.* 2007). One review concluded that fish and crustacean communities can have a "remarkable recovery of biodiversity in restored mangroves" (Bosire *et al.* 2008). This evidence suggests that the benefits to the poor from mangroves are more dependent on the biomass than the biological diversity of the mangroves.

What are the uncertainties? There are several scientific uncertainties. It is difficult to show a direct relationship between fish catches and specific mangrove habitats (Manson *et al.* 2005). The value of mangroves for coastal storm protection is well established (Barbier 2007), but there is an ongoing debate as to whether mangroves serve a similar role for larger wave events, such as the 2004 Indian Ocean tsunami (Alongi 2008, Walters *et al.* 2008). Mangroves are also highly threatened by conversion to shrimp farms and palm plantations.

Summary conclusion: Overall, the benefits vary widely, but restoration of mangroves can provide at least moderate benefits to the poor by generating natural resources and providing protection from storms. Here it is biomass rather than biodiversity that is most important to the poor.

3.3.7 PROTECTED AREAS

What is the protected area mechanism? This conservation mechanism is focused on the poverty reduction benefits that flow directly from protected areas themselves. Thus, it does not include mechanisms like NTFPs, tourism and PES which may depend on a protected area but are not exclusive to protected areas. There are multiple benefits provided by protected areas, but only one direct benefit from protected areas can show empirical evidence of having reduced poverty: employment generation.

How does the mechanism work? When a protected area is established, it often hires local people to help operate the protected area. A study by WWF (2004) surveyed more than 200 protected areas across 37 countries and found the average protected area has 40 permanent staff. In South Africa, for example, the 21 national parks employed 3,776 people in 2006 and had a payroll of US$ 37.5 million equivalent (Urban-Econ 2008). The average wage for a South African national park employee in 2006 was two times greater than the average wage in the forestry sector. Local jobs provided by a protected area can reduce poverty, and the protected areas can help conserve biodiversity. While the number of protected area jobs and the pay may be modest, the multiplier effect of the new jobs in the local rural economy can be significant (Versa 2004, Fortin and Gagnon 1999).

Which groups of poor benefit from protected areas? Those hired by protected areas tend to be the moderately poor to the better off. The poorest of the poor rarely have the basic skills or the connections needed to secure protected area jobs.

Which components of biodiversity are important? It is the biodiversity itself that is important here because this is most protected areas' reason for being.

What are the uncertainties? There is a lot of anecdotal evidence of the employment benefits from protected areas but very little hard evidence showing that working for a protected area can be a route out of poverty. Moreover, many protected area jobs do not go to local people, and positions that require a knowledge of the local area, such as guides and guards, often pay too little to lift a local person out of poverty. Governments usually pay protected area staff, yet these payments often pass through multiple levels with much "leakage" along the way and may stop when there is a political or economic crisis. There is also the uncertainty about the net benefits to local people from a protected area. Establishing a new protected area may generate new local jobs, but it can also negatively impact the livelihoods of other local people by restricting access to natural resources inside the protected area or involuntarily resettling people living inside the protected area (Brockington 2006).

Summary conclusion: Many poverty reducing benefits ascribed to protected areas can also be stand-alone activities such as tourism, PES and NTFP collection and hence are covered separately in this review. Of the poverty reduction benefits that flow directly from protected areas themselves, only employment by the protected area management authority has some empirical evidence of reducing poverty, scanty though it is. Here it is biodiversity that matters more than biomass for the poverty reduction benefits.

3.3.8 AGROFORESTRY

What is the agroforestry mechanism? Agroforestry is the practice of integrating domesticated trees into agricultural landscapes. The poverty reduction benefits include: improved soil fertility from "fertilizer trees" that can increase the productivity of existing crops (Garrity 2004, Sileshi *et al*. 2009, Jose 2009); diversification of food production for both commercial and subsistence needs (Schreckenberg *et al*. 2006); and non-timber tree products such as oils and medicines (Leakey *et al*. 2005).

In addition to providing livelihood enhancement, agroforestry has benefits for biodiversity by providing structurally similar habitat for forest species, serving as biological corridors, and reducing human pressure on natural forests (Schroth 2004, Perfecto *et al*. 2007, Bhagwat 2008). While agroforestry landscapes do not contain the same level of biodiversity as natural forests, they generally play host to significantly more species compared with monoculture agriculture (Harvey *et al*. 2006).

How does the mechanism work? Trees are incorporated into the agricultural landscape in order to obtain economic and ecological benefits. Agroforestry can diversify and improve income through the harvest of tree products or by providing enhanced soil and hydrological functions for existing crops. Agroforestry also encompasses the culturing of specific trees, such as cacao or coffee, in natural forest settings.

Which groups of poor benefit from agroforestry? Agroforestry can provide benefits to many different economic levels, though it is often targeted at the poor as a means to reduce poverty. Evidence from West Africa suggests that indigenous domesticated fruit trees can improve the livelihoods of poor households, especially women (Leakey *et al.* 2005, Schreckenberg *et al.* 2006). In one study, women perceived greater livelihood benefits from agroforestry tree products than men (Akpabio 2009). In India, agroforestry was found to augment income from rice monocultures by 2-3 times compared with non-agroforestry households (Pandey 2007). The income was also distributed throughout the year and thus helped even out household income fluctuations. As the cultivation of trees requires a multi-year investment, those without secure property rights are less likely to participate in agroforestry initiatives (Garrity 2004).

Which components of biodiversity are important? In many areas where agroforestry is promoted, native trees are sought out and bred to enhance farm productivity. The World Agroforestry Centre lists 670 species in its "agroforestree database". Among the species with proven poverty reduction benefits are trees that produce fruit, fuel, fodder or fertilizer, including *Garcinia kola, Dacryodes edulis, Tephrosia candida, T. vogelli,* and *Sesbania sesban*.

What are the uncertainties? Agroforestry in theory has much to contribute to both poverty reduction and biodiversity conservation goals (Garrity 2004). Experiences in three sub-Saharan African countries, however, illustrate how uncertain and conflicting legal environments governing the use of trees and tree products (even on private land) can undermine potential benefits from agroforestry (Ashley *et al.* 2006). Furthermore, without access to markets, households are not able to capture many of the benefits that agroforestry tree products could provide (Leakey *et al.* 2005). Also by some estimates, up to 10 percent of tree species used in agroforestry systems are non-native, potentially negatively affecting local biodiversity (McNeely 2004).

Trade-offs exist when deciding to maximize either the biodiversity or economic benefits in agroforestry systems—typically when deciding how much natural tree cover to maintain. Many agroforestry systems maintain a significant portion of biodiversity found in natural forests, though specialized species (often of high conservation value) are frequently less able to adapt to agricultural landscapes (Steffan-Dewenter *et al.* 2007).

Summary conclusion: Overall, agroforestry can be as a route out of poverty, and for biodiversity, some trees are generally better than none. For near-term benefits to the poor, biomass matters more than biodiversity.

3.3.9 GRASSLANDS MANAGEMENT

What is the grasslands management mechanism? There is evidence that some grassland types have greater grass productivity with grazing than without grazing (Guo 2007). In fact, many types of grassland are ecologically dependent on grazing to maintain their biodiversity (Fratkin and Mearns 2003). Livestock is also the primary form of wealth for a number of often poor, nomadic communities in grasslands (Eriksen and Watson 2009). These three facts underpin grasslands management as a poverty-conservation mechanism.

Evidence for this mechanism is found primarily in dryland grass habitats. Dryland pastoralism is "a successful adaptation to the high uncertainty of dryland environments" and is one of the "few production systems that is genuinely compatible with 'formal' nature conservation" (WISP 2008). The ability of livestock to be mobile is an essential element in effective semi-arid grasslands management.

How does the mechanism work? A study in the Mongolian Gobi grasslands gives an example of how the mechanism works (Schmidt 2006). The study compared five years of data from pastoralist communities who practiced rotational grazing with control communities that did not. The rotational grazing

communities were significantly better off, and "the number of poor households was reduced to half between 2002 to 2005" (Schmidt 2006). The communities organized themselves to increase mobility and thus access better grazing lands. There were also benefits to the communities from becoming better organized, such as enhanced education and alternative income activities.

Which groups of poor benefit from grasslands management? Despite grasslands being used by poor people on nearly all continents, hard data for better grasslands management lifting people out of poverty is limited to the Mongolia example. Campbell *et al.* (2002) found that there are many restrictions on the expansion of natural capital in dryland areas of Zimbabwe, but those who are better off generally have the assets to capitalize on the rapidly changing opportunities in dryland habitats. There is some scope, however, for animal husbandry in grasslands benefiting the poorest of the poor. This group often does not own livestock, but if they can acquire animals, it can be a pathway out of poverty (Peden *et al.* 2003).

Which components of biodiversity are important? There is complementary evidence that in many grasslands, the grazers, the grass productivity, and the biodiversity are interdependent. Increased productivity of the grasslands (biomass) depends on the biological diversity of the grasses which in turn is dependent on the grazing of animals.

What are the uncertainties? There are considerable challenges to better grasslands management and pastoralist livelihoods in general. Expanding agriculture, private ownership of land and water resources, fencing of rangelands, commercialisation of livestock production, global competition in the livestock market, expanding protected areas, and climate change have all been shown to push poor people out of pastoral livelihoods (Eriksen and Watson 2009). For the Maasai in Kenya and Tanzania, Homewood *et al.* (2009) presents evidence that the current land-use policies in the two countries are unlikely to benefit biodiversity conservation or poor pastoralists who depend on the grasslands. "Above all, there is the political structure that favours agricultural communities over pastoral" (Homewood *et al.* 2009). Finally, wild animals (e.g. lions, wolves or landscape modifiers like elephants) are often actively harassed by pastoralists keen to protect their stock.. The loss of such keystone animals can have a ripple impact on the integrity of the ecosystem.

Summary conclusion: Overall, grasslands management has a theoretical potential to help reduce poverty at least marginally, but there have been almost no studies demonstrating this in practice. Both biomass and biodiversity matter here because they are interdependent in grassland ecosystems.

3.3.10 AGROBIODIVERSITY CONSERVATION

What is the agrobiodiversity mechanism? Agrobiodiversity encompasses all the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture (FAO 1999). Initiatives for in-situ agrobiodiversity *conservation* generally help poor farmers diversify the types of crops they raise either within a particular crop (such as different varieties of plantains) or among crops (such as adding native varieties of beans to maize fields). There is a strong gender component to agrobiodiversity conservation because it is often women who grow native species as companion crops to the household's cash crops.

How does the mechanism work? There is some evidence that promoting agrobiodiversity can benefit poor farmers through better nutrition and more stable food production (Frison *et al.* 2004). Conserving traditional landraces can also help poor farmers address local challenges like droughts, floods and pests and thus help with food security (Scherr and McNeely 2007).The conservation benefits come from conserving native varieties of plants and animals and thereby making an agricultural landscape more species diverse. This in turn helps wild pollinators, birds and some mammals.

Which groups of poor benefit from agrobiodiversity? The poorest of the poor rarely benefit because they rarely own land. Poor farmers can benefit directly from an agrobiodiversity conservation initiative if a farming household is malnourished from a local diet that lacks diversity and critical micronutrients like Vitamin A and iron (Johns and Eyzaguirre 2006).

Which components of biodiversity are important? The most important agrobiodiversity elements are traditional landraces that are uniquely adapted to local conditions such as soil characteristics, rainfall, diseases and pests. Here genetic biodiversity is what matters.

What are the uncertainties? In agrobiodiversity, the "agro" comes first—the primary focus is on agriculture, and it is biodiversity conservation for the benefit of agriculture. The direct benefits to conservation are largely about the preservation of genetic material and tend to be small and incremental at the local level but can be quite important at the global level. Moreover, the expansion of agriculture has historically been the number one driver of natural habitat loss. Thus, agrobiodiversity generally lacks a constituency within conservation organizations.

Agrobiodiversity is crucial to increasing global crop yields because it can provide the genetic material to ward off new pests and diseases, help speed adaptation to climate change, and increase yields of staple crops. The local cost-benefit ratio, however, may be highly dependent on local conditions. An agrobiodiversity initiative to conserve traditional landraces, for example, may provide a small benefit to local farmers but at a large opportunity cost when compared with planting non-native high-yield varieties.

For low-input agriculture in marginal lands, promoting agrobiodiversity has been shown to benefit poor farmers (Scherr and McNeely 2007). There is, however, scant empirical evidence of an agrobiodiversity conservation project directly reducing local poverty (Kontoleon *et al*. 2008). The International Plant Genetic Resources Institute (now known as Bioversity International) has extensively documented a project that focused on poverty reduction in coconut growing communities (Batugal and Oliver 2005). In several countries, the project increased the varieties of coconuts grown in a community and found evidence that poverty had been reduced. Yet in most of the project areas, the poverty reductions came not from greater agrobiodiversity but from alternative income generating activities funded by microcredit. One of the challenges with measuring the local impact of an agrobiodiversity conservation initiative is showing a causal link between a local increase in agrobiodiversity and a reduction in poverty.

Summary conclusion: Overall, agrobiodiversity conservation has the potential for strong global benefits for poor farmers but evidence of local poverty reduction from a project designed to increase agrobiodiversity is scarce. Genetic biodiversity matters most here.

3.4 COMMON CHALLENGES TO ENSURING THE POOR BENEFIT

Over 100 policy evaluation studies were examined to identify common challenges faced by conservation projects with poverty impacts. From these studies, four largely interrelated challenges were common and are illustrated by case-study evidence below:

- Better-off households with higher social capital were more likely to participate in a conservation initiative.
- Not only were elites more likely to participate, but they were often times the main recipients of conservation-induced livelihood benefits.
- Conservation projects sometimes led to a widening of income disparities.
- There was some evidence that women could have realized greater livelihood gains from projects but were excluded due to discrimination.

Households with higher assets and higher levels of social capital are more likely to participate in a conservation initiative. Weber *et al.* (2009) undertook a policy evaluation study on the livelihood impacts of a forest micro-enterprise programme as part of an integrated conservation and development project in the Brazilian Amazon. Individuals who participated in the scheme could earn a flat fee as local trail guides in ecotourism operations or a daily wage if they worked in the community enterprise that made and sold NTFPs. They found that participation in the programme increased cash income by approximately 30 percent and hence the programme has clear impacts on welfare (at least in the short term). But the authors concluded that households with higher assets and with higher levels of social capital were more likely to participate in the programme.

Groom *et al.* (2010) evaluated the livelihood impacts on Chinese farmers participating in a PES-type reforestation programme. Their study focused on the programme's impact on both income and off-farm labour supply and found that households with higher assets and higher levels of social capital were more likely to participate in a conservation initiative. The results imply that in order to improve the cost effectiveness of such programmes, subsidies should target constrained households. Moreover, they concluded that the programme should focus not only on households with large land endowments, as is currently the case, but should also consider the education level, household structure, and institutional environment of recipient households.

Elites often capture the benefits of an initiative. A study by Jagger (2008) focused on the impact of governance reforms (in the context of community forest management) on the income of forest-edge communities in Uganda. For households living adjacent to one of the community forest study sites, the study found significant gains in average annual household income from forest activities, though these were confined to households in the highest income quartile and were primarily attributed to the sale of illegally harvested timber. Here the elites captured the benefits from the timber. This signals a policy failure, as the main objectives of the programme were to promote non-timber related activities and increase incomes in the poorer segments of the population.

Bandyopadhyay and Tembo (2009) examined the impacts of introducing a game management policy in Zambia. They found that poverty does not affect the probability of a household participating in this programme. Yet they also found that the positive welfare impacts on households living in a game area and participating in ecotourism activities only apply to the non-poor households. Hence, though the poor have good access to the programme, they did not derive many welfare gains from it. The study also explored whether the game parks may have provided other benefits to the poor in the form of improved infrastructure, but the presence of a game management park showed no such positive effect. The programme thus appears to have led to elite capture of benefits.

Jumbe and Angelsen (2006) collected data from 404 randomly selected households to explore the impacts on total income from participation in a community forest management programme in Malawi that focused on the production of NTFPs. Analysis showed that wealthier participants captured most benefits from the programmes due to discrimination and differences in capital endowments.

Widening income disparities. Vyamana (2009) used quasi-experimental data to explore poverty impacts of a participatory forest management programme in Tanzania. Vyamana found that the programme had provided new (albeit small) sources of community-level income that improved community physical capital. The incomes of households from villages included in the programme increased only slightly for most income groups. Technical and administrative obstacles prevented the poorest from benefiting from programme income-generating activities. Thus, the programme sometimes led to a widening of local income disparities.

A study by Maharjan *et al.* (2009) undertaken in Nepal found the poorer people not benefiting from the programme and an increase in income disparities.

Discrimination against women. Jumbe and Angelsen (2006) found a positive overall impact on income (increases of 13 percent to 65 percent) for women participants in a community forest management programme in Malawi. Yet further disaggregation of the results suggests the programme would contribute even more to the livelihoods of female-headed households if the women were afforded the same opportunities as the men.

3.5 KNOWLEDGE GAPS

This state of knowledge review found the major constraint in assessing the link between biodiversity conservation and poverty reduction is the lack of hard evidence. Despite a wealth of case studies, the vast majority of the existing body of work does not use the analytical and empirical methods required to make reliable inferences about the actual impact of a conservation intervention on measureable poverty indicators (Wilshusen *et al.* 2002, Barret and Arcese 2005, Weber 2009). Overviews and meta-analyses that have been carried out (e.g., Naughton-Treves *et al.* 2005, Schreckenberg and Luttrell 2009) are largely inconclusive or unsubstantiated by hard evidence of statistically rigorous analysis. In general, the poverty-conservation literature suffers from conjectural and anecdotal assertions.

Fully understanding the link between biodiversity conservation and poverty reduction in any given context requires the ability to make causal inferences about a counterfactual. What would have been the changes, for instance, in household income in the *absence* of the conservation initiative? To appropriately answer these types of impact-assessment questions, there is a need for greater use of counterfactual cases. Before and after assessments of a conservation initiative are not sufficient.

Case studies that reach conclusions about poverty-conservation mechanisms without reference to a counterfactual have to be treated cautiously because income (or any other welfare related measures) may have been affected by other confounding effects. Such effects include historical trends as well as environmental and social characteristics. For example, Pandey (2007) presents case-study evidence from India that suggests communities engaged in agroforestry increased their income from rice by two to three times compared with non-agroforestry communities. Yet this type of analysis does not account for other confounding effects such as differences in levels of social capital that may have been the cause of this income effect. Without applying appropriate evaluation methods, we simply cannot know what causes what.

Overall, far fewer studies than anticipated could provide some reliable assessment of poverty impacts. Even here, the livelihood outcome indicators that these studies focus on are mainly forms of income, assets and labour-allocation decisions. Work that focuses on other forms of livelihood such as social capital development is lacking.

There are at least four main reasons for this lack of hard evidence (see Ferraro and Pattanayak 2006 for a detailed discussion):

- There is a lack of political will among government and policy organisations involved in policy design and intervention.
- A multiplicity of objectives across donor and implementing agencies makes undertaking a structured and focused policy evaluation difficult.
- There is a lack of knowledge of policy evaluation methods among many conservation practitioners and policy makers.
- There is a misconception that policy evaluation is expensive, is not "value for money", and diverts scarce conservation funds to nonessential "academic" activities.

In addition to the general lack of hard-evidence studies with counterfactuals, there are some knowledge gaps specific to individual mechanisms summarized in Table 3.1 below. This is by no means an exhaustive list.

TABLE 3.1: Some knowledge Gaps within each conservation mechanism

Mechanism	Knowledge Gap
NTFPs	Ros-Toten and Wiersum (2003) call for: • Identifying forest laws and regulations that hinder or facilitate the commercialization of NTFPs. • Developing optimized [NTFP] production systems in human modified and man-made vegetation types. • Developing processing techniques which add value to NTFPs.
Community Timber Enterprises	Sunderlin *et al*. 2005 calls for: • "Detailed GIS and field analysis[…]to better understand how many of the world's rural poor do in fact live in or nearby forests, and to what extent they depend on them". • More studies of small-scale, wood-based processing enterprises. • Greater study of tree planting partnerships between communities and private enterprises.
PES	More study is needed "because of the rapid recent growth of such initiatives, divided viewpoints on their utility, and a clear need for guidance on how to better include the poor in such programs" (Sunderlin *et al*. 2005). With payments for watershed services in particular, "better evidence is needed of the beneficial impacts of sustainable land-management practices on water flow and quality and on the ability of payments to influence the behaviour of landholders" (Porras 2008).
Nature-based Tourism	More research is needed on how to ensure tourism operations benefit local poor people. In other words, what are the replicable approaches used by forest and marine tourism projects that have helped reduce local poverty?
Fish Spillover	Evidence from more sites is needed on the magnitude of the benefit to fisheries from spillover. There is also a need to better understand what factors, such as size, management and location, most influence fish spillover.
Mangroves	A better understanding of the relationship between fish catches and specific mangrove habitats would help to make a stronger case for conserving mangroves and the benefits they provide to the poor.
Protected Area Jobs	Empirical evidence from more sites on the impact of new protected area jobs on the local economy.
Agroforestry	Poverty-conservation initiatives would benefit from evidence showing how agroforestry can measurably decrease pressure on natural forests.
Grasslands	There is a need to understand the details of how intensive rangeland management regimes can be organized in the absence of clear tenure rights, and in some cases, the rule of law.
Agrobiodiversity	There is a general lack of hard evidence of how conserving local agrobiodiversity can benefit the poor and conservation.

There are also initiatives that might benefit both the rural poor and biodiversity but lack hard evidence of *conservation benefits,* including trophy hunting, bushmeat harvesting, medicinal plant collection, woodcarving, and bio-prospecting. All of these mechanisms could benefit from evidence-based studies that measure poverty *and* conservation impacts in a rigorous way.

3.6 CONCLUSIONS

Overall, there is empirical evidence that at least six conservation mechanisms have been *a route out of poverty* for some people in some places: community timber enterprises, nature-based tourism, fish spillover, protected area jobs, agroforestry and agrobiodiversity conservation. There is also evidence that four conservation mechanisms may not have been a route out of poverty but at least *contributed to reducing poverty* or *provided a safety net* in times of need: non-timber forest products (NTFPs), payments for environmental services, mangroves restoration, and grasslands management. Table 3.2 and Figure 3.1 provide a summary.

TABLE 3.2: Summary of Poverty Reduction Evidence for Conservation Mechanisms

Mechanism	Number of studies?	Poverty reduction benefits?	Which groups benefit?	Other benefits?	Is it biodiversity or biomass that is important for poverty reduction?
Non-Timber Forest Products	Many	Low	Very poor and better off	Nutritional benefits and medicinal properties	Biomass
Community Timber Enterprises	Many	Medium	Very poor, moderately poor, and better off	Stronger community organization	Biomass
PES	Moderate	Low	Landowners	Stronger property rights, capacity building, social organization	Biomass
Nature-based Tourism	Moderate	High	Moderately poor and better off	Infrastructure and social services	Biodiversity
Fish Spillover	Moderate	High	Very poor, moderately poor and better off	Stronger social cohesion	Biomass
Mangroves	Moderate	Medium	Very poor, moderately poor	Reduced coastal erosion, storm protection, and greater fish stocks	Biomass
Protected Area Jobs	Few	Low	Moderately poor and better off	Multiplier effect of local jobs	Biodiversity
Agro-forestry	Moderate	Medium	Moderately poor and better-off landowners	Helps even-out income fluctuations	Biomass
Grasslands	Few	Low	Not enough evidence	Stronger social cohesion	Both
Agro-biodiversity	Few	Medium	Moderately poor and better-off farmers	Global benefits to agriculture	Biodiversity

Many = more than 50 studies. Moderate = 10 to 50 studies. Few = less than 10 studies.

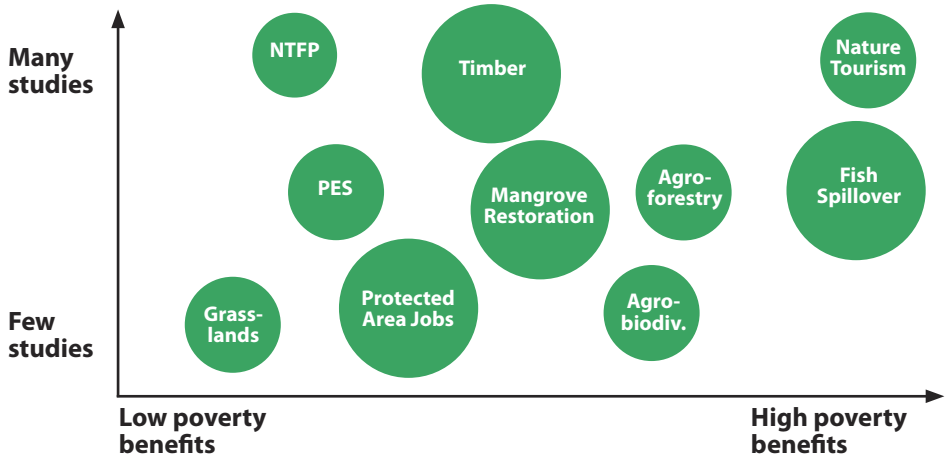

FIGURE 3.1: Evidence Base, Poverty Reduction Benefits, and Importance to Biodiversity for Specific Conservation Mechanisms

Reviewing more than 400 poverty-conservation documents had the benefit of giving a sense of where poverty-conservation thinking is overall. In general, optimism has waned. Optimism waned because, from ICDPs (integrated conservation development projects) to NTFPs, we know a lot about what does not work. Yet we know too little about what does work. As MacKinnon (2008) states, we need to "identify the key interventions which promote biodiversity conservation and effective poverty alleviation, and highlight conditions for success".

It is clear from the review that there is considerable scope for increasing the poverty reduction benefits of conservation initiatives. One approach that has been mentioned prominently (e.g., Millennium Ecosystem Assessment 2005a; Kaimowitz and Sheil 2007) is to focus on meeting the basic needs of the poor, such as medicinal plants and food sources, via a conservation initiative. Despite good intentions, such a focus may be counterproductive to conservation efforts and are unlikely to actually meet the real needs of the poor in our view. Those who are better off in many rural areas where conservation initiatives take place often have a high dependence (like the poor) on natural resources. Meeting the basic needs of the poor is socially challenging to sustain, as the rich and well connected are likely to capture much of the benefits from nature-based resources that increase in value. Further, pro-poor conservation strategies may not meet the rising expectations of rural people, even in remote places, for a better life. Meeting the basic needs of the poor provides a safety net for local poor, but safety nets alone are not sufficient to provide the incentives to protect natural resources. Rather, we believe conservation organizations should focus on creating equitable opportunities for socio-economic development within poor communities via activities that are *intrinsically linked* to maintaining biodiversity such as fish reserves, certified community timber enterprises, and nature-based tourism.

Finally, for conservation to survive in a world headed to 9 billion people by 2050, a shift in focus is needed. Over the past two decades, natural scientists have focused on identifying the global areas of maximal biodiversity. Conservationists now know where they need to work, but much less about *how* they should work. It is the local people that make or break most conservation initiatives—especially in the long run. Conservation needs to ensure local people—many of whom are poor—benefit tangibly from biodiversity. For conservation to be relevant in the 21st century, this has to be a primary focus.

4. CONCLUSIONS: VALUING NATURE FOR THE POOR

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The "state of knowledge" reviews presented in this report were intended to provide some clarity as to the nature and extent of biodiversity conservation-poverty reduction linkages at the local level. Despite a limited evidence base it is clear from these reviews that a) **the poor depend disproportionately on biodiversity for their subsistence needs – both in terms of income and insurance against risk** and b) **biodiversity conservation can be a route out of poverty under some circumstances.**

However there are some important caveats:

1. It is often the relatively *low value* or 'inferior' goods and services from biodiversity that are most significant to the poorest members of the community. Resources of higher commercial value attract the attention of the more affluent groups, often crowding out the poor in the process unless conscious efforts are made to target the poor and marginalised (as in some conservation enterprises). This suggests that where biodiversity resources have poverty reduction potential (especially when measured in monetary terms) it is not likely to be the poorer members of the community that benefit from this. Biodiversity more often acts as a *safety net* to keep people from falling deeper into poverty, and occasionally it can become a poverty trap.
2. Even when biodiversity conservation can be shown to make a contribution to poverty reduction the scale of impact may be limited. Few conservation interventions specifically target the poorest—indeed, households with higher assets and higher levels of social capital are more likely to participate in conservation initiatives. Despite some good intentions many conservation interventions just do not lend themselves well to poverty.
3. A focus on cash benefits obscures the real poverty reduction potential of biodiversity conservation. The problem may not be so much the lack of impact but that benefits and incentives seem to be much too narrowly conceived in the conservation literature, focusing on monetary benefits rather than wider socio-economic benefits. This approach is not consistent with the idea that poverty is not simply the result of low income but also reflects a deprivation of requirements to meet basic human needs.
4. Biomass may matter more than biodiversity—at least in the short term—but biodiversity matters in the longer term. In the short term, it is not so much the diversity, or variety of biological resources, that makes an important contribution to poor peoples' livelihoods—particularly in terms of fulfilling immediate needs (e.g. for food and fuel) and for generating cash—but rather their abundance or mass. Diversity does however provide poor people with a strategy for risk management—particularly in terms of the ability to switch to alternative resources in the face of changing conditions—whether climate change, harvest failure, etc. This is particularly true for agricultural biodiversity. Furthermore, biodiversity can underpin biomass production in some ecological systems—for example fisheries.

Recognition of the link between the status of biodiversity and the fate of poor people implies that biodiversity should be a priority in international efforts to address poverty reduction. However, the accessible nature of biodiversity that makes it so important to poor people—the fact that ecosystem services and biodiversity resources are public goods—ironically also means that it is under-valued—if valued at all—in national economies. The Millennium Ecosystem Assessment and the study on The Economics of Ecosystems and Biodiversity (TEEB) both highlight the fact that until the values of biodiversity and ecosystem services are properly taken into account they will continue to be depleted and their potential to support poor people jeopardised.

GDP—the traditional measure of national income and economic progress—is a misleading indicator of societal progress since it does not take into account changes in the national stocks and flows of natural resources or measures of distribution. However, there are examples of "green accounting" approaches that do take natural assets into account. A study in India showed that ecosystem services accounted for 7% of national GDP but that when the GDP approach is focussed on a subset of the national population—the poor—this changes to 57% (TEEB 2008).

Currently biodiversity is treated as an environmental issue and addressed at the national level by environment ministries. Maximising the contribution of biodiversity to poverty reduction requires acknowledgement that it is also a development issue and requires serious engagement by finance and planning ministries as much as by environment ministries. More widespread application of concepts such as "GDP of the poor" described in the Indian example above, would provide much greater recognition of the importance of ecosystem, services and the link between biodiversity and poverty alleviation.

At the international level, the new CBD strategic plan beyond 2010 continues to recognize the dual challenge of linking conservation and sustainable use of biodiversity with development and poverty reduction. The CBD has been recommending the mainstreaming of biodiversity since its inception. This requires not just better dialogue between environment and development communities at the national and international level and better integration of national and international biodiversity and development agendas, but also vertical coordination and coherence between global and regional agreements, national policies and local implementation.

Without these kinds of approaches, biodiversity and ecosystem services will continue to be depleted and their potential to act as a safety net for the poor—let alone to contribute to poverty reduction—will be in jeopardy.

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APPENDIX

TABLE A1: List of Detailed Case Studies

Reference	Region	Resource	Activity	Aspect	Dimension
Adhikari *et al.* 2004	South Asia	Forests	Multiple	Incidence	Income
Babulo *et al.* 2008	East Africa	Forests	Multiple	Incidence	Income
Bahuguna 2000	South Asia	Forests	Multiple	Not specified	Not specified
Bene *et al.* 2009	West Africa	Fish	Multiple	Incidence	Income
Cavendish 2000	Southern Africa	Multiple	Multiple	Incidence	Income
Coomes *et al.* 2004	Latin America	Multiple	Multiple	Incidence	Income
Coulibaly *et al.* 2009	West Africa	Forests	Multiple	Not specified	Not specified
de Merode *et al.* 2004	West Africa	Wild animals	Multiple	Incidence	Income
Dovie *et al.* 2007	Southern Africa	Wild plants	Subsistence consumption	Incidence	Income
Fisher 2004	Southern Africa	Forests	Multiple	Incidence	Income
Fu *et al.* 2009	Other Asia	Other NTFP	Multiple	Incidence	Income
Glaser 2003	Latin America	Mangroves	Multiple	Incidence	Income
Jha 2009	South Asia	Forests	Multiple	Incidence	Income
Jodha 1990	South Asia	Multiple	Multiple	Incidence	Income
Kamanga *et al.* 2009	Southern Africa	Forests	Multiple	Incidence	Income
Levang *et al.* 2005	South-east Asia	Forests	Multiple	Incidence	Income
Mamo *et al.* 2007	East Africa	Forests	Multiple	Incidence	Income
Narain *et al.* 2008a	South Asia	Multiple	Multiple	Equality	Income
Narain *et al.* 2008b	South Asia	Multiple	Multiple	Incidence	Income
Osemeobo 2005	West Africa	Wild plants	Multiple	Not specified	Not specified
Paumgarten and Shackleton 2009	Southern Africa	Other NTFP	Multiple	Incidence	Income
Reddy and Chakravarty 1999	South Asia	Forests	Multiple	Equality	Income
Sapkota and Oden 2008	South Asia	Forests	Multiple	Incidence	Income
Shaanker *et al.* 2004	South Asia	Other NTFP	Multiple	Incidence	Income
Shackleton and Shackleton 2006	Southern Africa	Other NTFP	Multiple	Incidence	Income
Sharma *et al.* 2009	South Asia	Forests	Multiple	Incidence	Income
Viet Quang and Anh 2006	South-east Asia	Other NTFP	Multiple	Incidence	Income

TABLE A2: Findings from detailed case studies

Reference	Region	Explanatory factors	Extent of dependence	Relative dependence	Inequality
Adhikari *et al.* 2004	South Asia	Education reduces dependence; complementary productive assets: livestock and land increase use		Tree/grass fodder leaf litter increases with wealth; fuelwood does not vary (slight increase with wealth, not statistically sig.)	Female-headed, lower caste collect less
Babulo *et al.* 2008	East Africa	Lack of education, female headed, lack of land, access to credit, roads, livestock increases dependence		Poverty trap: forest dependence inferior	
Bahuguna 2000	South Asia		48.7% of total income from forests, mainly fuel, fodder and employment		
Bene *et al.* 2009	West Africa	Periodic use: fish as bank in the water	Consumption: Q1 33%, Q2/Q3 23%, Q4 20%; income Q1 90%, Q2 67%, Q3 64% Q4 63%, 29.7% fish only source of cash income	Poor more dependent on fish for income, consumption	98.6% men, 69% women sell fish;
Cavendish 2000	Southern Africa		Environmental income 35.4% in 93-94, 36.9% in 96-97	Poor more dependent than rich; quantity consumed increases with income; cash income falls with welath (93;94: lowest quintile 50%, middle 60% ±30%; richest 25%; 96-97: 34% poorest, 6% richest)	
Coomes *et al.* 2004	Latin America	Younger households (hhs), more nets, more members fish more; younger hhs, land, equipment, experience hunt more; species level explanations	66% hhs depend on resource extraction, value 20% of total income	Resource draw not related to poor hhs; reliance for fishing not linked to wealth, reliance on hunting more for land rich hhs, palm fruit reliance declines with wealth, then increases	
Coulibaly *et al.* 2009	West Africa	Age impact depends on product, hh size, ethnicity, land, livestock		Higher incomes increase dependence	
de Merode *et al.* 2004	West Africa	Seasonality of use	Wild foods 31% of hh production, 10% of self consumption, 24% of sale	Bushmeat, fish consumed/sold less by poor, wild plants more by poor	
Dovie *et al.* 2007	Southern Africa		98% hhs use NTFPs, value USD 559/hh; 91% wild herbs, value USD 167/hh	No association with wealth - all depend	
Fisher 2004	Southern Africa	Lack of land, education, goats reliance on LRFA; lack of education, goats, available male labour, location reliance on HRFA	Forest income 30% of hh income	As income increases, reliance declines for LRFA; reliance increases for HRFA	Addition of forest income reduces inequality by 12%
Fu *et al.* 2009	Other Asia		Income from NTFPs, % of income and dependence more in less developed village	Poor more dependent on NTFP income	
Glaser 2003	Latin America		Over 50% depend on crabs, 30% commercial fishing, 80% on mangroves overall, 68% earn income from mangroves		Pure subsistence products most important for voiceless - women and children

Reference	Region	Explanatory factors	Extent of dependence	Relative dependence	Inequality
Jha 2009	South Asia		70% depend on beedis or firewood	Dependence decreases with increased income, except beedis which are made by rich	
Jodha 1990	South Asia		Poor: 84-100%, rich 10-19%; overall CPR income 14-23% of total	Poor more dependent	Inclusion of CPR income lowers Gini coefficient
Kamanga *et al.* 2009	Southern Africa	Younger, less educated, more members have greater forest income	Cash income from forests low; Fuelwood 66-78% of forest income	Poor lowest forest income, but poor/medium poor depend more (22%) compared to less poor (9%)	Gini coefficient increases with removal of forest income
Levang *et al.* 2005	South-east Asia	Cash income less in remote areas	72% of hhs depend on forest products, 30% of total income, main cash activity for 16%	Poverty trap - get out of the forest	Dependence high in remote areas because of few options
Mamo *et al.* 2007	East Africa		39% of hh income, firewood most imp (59%); 42% depend on forest for grazing	Poor rely more (59%, while rich 30%) but extract less (95 USD vs 191 USD)	Gini coefficient increases with removal of forest income
Narain *et al.* 2008a	South Asia	Private land holdings reduce need; higher availability of biomass increases dependence	Q1:11.6%; Q2: 8.9%; Q3: 10.9%; Q4: 13%.	Fuel, dung fuel, dung manure declines, fodder, construction wood increases with income	
Narain *et al.* 2008b	South Asia		Middle income hhs most likely to collect	Conditional on collection, rich use more CPRs	At income extremes, bimodal use and dependence
Osemeobo 2005	West Africa		Av value of wild plants/ hh: USD11957; net income USD 6743		
Paumgarten and Shackleton 2009	Southern Africa		Negligible effect of wealth on NTFP use; all use	Poor sell more NTFPs, rich sell high value curios	
Reddy and Chakravarty 1999	South Asia		Poverty increases if forestry income set to zero	Poorest of the poor disproportionately dependent	Inequality increases if forestry income not included
Sapkota and Oden 2008	South Asia	Proximity to source		Share of fuelwood from CF higher for poor	Lower castes more dependent
Shaanker *et al.* 2004	South Asia		3 sites: 16%, 24%, 59% of cash income	Decreased with increase in weath index	Inclusion of NTFP income lowers Gini coefficient
Shackleton and Shackleton 2006	Southern Africa			Poor more involved in sale of NTFPs; per capita consumption of fuelwood and edible herbs greater for poor, but no difference for grass brushes	
Sharma *et al.* 2009	South Asia		75% of fuel and fodder from forest	Poor more dependent	
Viet Quang and Anh 2006	South-east Asia	Urban proximity	30% of hhs: NTFP income over 50% of total; further 15%, NTFP income 25-50% (all poorest)	Poor more dependent	