Environmental Conservation **28** (3): 270–278 © 2001 Foundation for Environmental Conservation

Re-examining local and market-orientated use of wild species for the conservation of biodiversity

CHARLIE M. SHACKLETON*
Environmental Science Programme, Rhodes University, Grahamstown 6140, South Africa
Date submitted: 15 November 2000 Date accepted: 28 March 2001

Summary

The hypothesis of attaching and realising market values as one means of conserving biodiversity has gained ground over the last decade. This has been challenged recently after examination of a number of case studies, largely from tropical Amazonia, on high value logging, marketing of non-timber forest products, and bioprospecting. The conclusion was that market-orientated conservation has seldom generated the financial returns envisaged, and as such cannot be used as an incentive to prevent land transformation. This paper reviews the basis of the challenge to market-orientated conservation on a number of grounds, drawing on examples largely from southern Africa. It concludes that generalizations from tropical Amazonia regarding the failure of market-orientated conservation are probably premature, and that it should remain an option, amongst a number of options, for conservation of biodiversity. Additionally, the prerequisite criteria identified as necessary to create an enabling framework for the success of market-orientated conservation are insufficient. Case studies are presented where the prerequisites do not apply, yet current extraction for market purposes is sustainable. Other potential prerequisites are also considered. There is a need for multivariate analysis, based on a large sample size drawn from across a range of environments and resources, of which factors are important prerequisites for successful market-orientated conservation, and under which circumstances.

Keywords: economics, land use, non-timber forest products, resource use, transformation

Introduction

Within the past decade several seminal works have sought to explain the global loss of biodiversity in economic terms (McNeely 1988; Pearce & Moran 1994). This has been encapsulated in the catch-phrase 'use it or lose it' (Swanson 1992). The basic tenet is that if a meaningful value can be attached to a species or a resource, and this value can be actually realized, then the resource users will appreciate the benefits from capturing the value and thereby use the resource wisely to ensure a continued supply of the value benefits over a long period, as opposed to converting the natural lands to some other intensified land use. This is termed the econocentric or market-orientated approach to biodiversity conservation, rooted with a utilitarian perspective of biodiversity value.

In a recent paper, Crook and Clapp (1998) provided a logical and succinct analysis of case studies of market-orientated use of biological resources as a mechanism for the conservation of biodiversity. After examining three primary approaches for market-orientated conservation, (1) high-value logging, (2) sale of non-timber forest products (NTFPs), and (3) bioprospecting, particularly with respect to tropical forests, Crook and Clapp (1998) concluded that all the approaches were generally unsuccessful in facilitating the conservation of the biological resources upon which the markets were based, except for a few cases operating under specific conditions. Crook and Clapp (1998) finally suggested four generic conditions that need to be in place for market-orientated conservation to be viable. Although not all aspects of their argument were illustrated with cited examples, their conclusion represents a significant finding in the face of much international policy, donor funding and political will subscribing to the econocentric paradigm (Wollenberg 1998). In this paper I set out to examine their argument and offer evidence to the contrary. To do so I (1) take each of the three approaches in turn, and summarize their perspective, (2) present examples contrary to their conclusions, and/or (3) provide comments on aspects of their arguments or conclusions demonstrating that they possibly apply only in particular circumstances, and therefore cannot be viewed as a generic framework opposing the use of biodiversity as a mechanism to enhance its conservation.

High-value logging

Crook and Clapp (1998) cited several studies wherein the extraction and marketing of high-value timber species from natural forests is viewed as one means of ensuring the continued conservation of the forest. The marketing of the high-value timber provides cash returns as an incentive not to convert the forest to some other commercially orientated

* Correspondence: Dr Charlie M. Shackleton Tel: +27 46 603 8615 Fax: +27 46 622 5524 e-mail: c.shackleton@ru.ac.za

land-use, such as plantation forestry or cattle ranching. Based on their case study analysis, Crook and Clapp (1998) argue that such logging is never viable in the long term as a means for biodiversity conservation because (1) it has environmental impacts that sooner or later must effect biodiversity of the forest; for example, damage to neighbouring plants and micro-fauna when the target tree is felled, (2) regrowth rates of valuable species are slow, delaying future cash flows and discounting the final returns, and therefore, it pays to clear the land and establish plantations of fast growing exotic species, (3) clear-cutting a range of all forest species simultaneously is more cost-efficient, even though some of them are of little commercial value except for bulk wood-chips on international markets, and (4) a sustainable management and harvesting regime requires thorough understanding of the biology of the target species, which is costly, and with so many potential species, it becomes unfeasible.

A consequence of these issues, argued Crook and Clapp (1998), is that high-value logging is unlikely to be an incentive for forest conservation in most instances. Where it has been successful, it has been with relatively fast growing species of exceptional value (e.g. *Nothofagus alpina* in Chile), or in tandem with strong regulatory frameworks, and a high volume of plantation timber to meet most of the market demand (e.g. *Podocarpus* species in South Africa).

Whilst some of these issues are correct in certain circumstances, I would caution against viewing them as a generic argument against high-value logging, as only one mechanism within a suite of approaches, for conservation of forests for a number of reasons.

Comparison of the returns of high-value logging to other land uses may frequently favour land conversion. However, high-value logging is not the only possible use of forests. Comparison between land uses must include all the benefits and costs. Even if we focus solely on the direct-use value of forests, there are several economic initiatives that can occur simultaneously, such as high-value logging, harvesting of a number of non-timber forest products, bushmeat, honey production, and ecotourism. A relatively intact forest is open to multi-purpose use management (Durrheim & Vermeulen 1996; Houghton & Mendelsohn 1996; Shackleton 1996); a plantation of exotic species or a livestock ranch is limited in this regard. Any economic comparison must include potential income streams from all of the multi-purpose uses for the forest in question. In doing so, it must be appreciated that the design and implementation of multi-purpose land use systems is a difficult task, but working examples do exist. For example, the Knysna forests in the southern Cape, South Africa are managed simultaneously for high-value timber, NTFPs (ferns) and eco-tourism. Conservancies in Namibia are designed around multi-purpose land use, including high-value game species, subsistence game species, NTFPs and in some areas cattle (Jones & Mosimane 2000).

Many of the high-value logging initiatives are based on external management and marketing agencies to supply the timber to national or international markets. However, land tenure is an important factor in this. In the examples provided by Crook and Clapp (1998), the forested land is state land with harvesting concessions, or it is leased from the state for a specific period. Under these circumstances, there is reduced incentive for the external agencies to manage the forest and harvesting operations in a sustainable fashion, particularly in some developing countries with high discount rates due to high inflation, political uncertainty and devaluing currencies. However, on private lands or under a functioning common property regime, there is greater incentive for sustainable management (Swanson 1992; Edwards & Abivardi 1998, Wood & Walker 1999), especially if the logging is undertaken by the land owner or local community that depend upon the forest for other purposes as well. This applies not only to timber. When ownership of game was transferred from the state to rural communities within Namibia's conservancies, conservation of game species by rural communities increased (Jones & Mosimane 2000) as they now received the benefits, in both cash and subsistence use.

The analysis of Crook and Clapp (1998) draws case studies largely from tropical, closed canopy forests. Yet a greater portion of the globe is covered by woodlands and savannas which fall within the forest or 'other wooded land' of FAO (Food and Agricultural Organization) vegetation types (FAO 1995). Whilst these may not have as high biodiversity per unit area as tropical forests, they are more important in terms of total wood supply, surface area, resilience and hence contribution to global ecosystem functioning, and play a role in the livelihoods of millions of people (Solbrig *et al.* 1991; Scholes & Hall 1996). Their biodiversity also merits attention and conservation. Within southern Africa, they are home to a large number of animal and plant species, but due to low beta diversity, have low densities per unit area (Cowling *et al.* 1989). Within these drier environments, the differential in growth rates between indigenous and exotic species is less, undermining the incentive for exotic plantations. Even in absolute terms, the poorer climate and soils undermine the potential profitability of exotic plantations in these regions.

Whether in temperate, tropical or subtropical systems, exotic plantations supply a different commodity than the high value timber species. They are usually associated with bulk, lower value markets. In some areas, it may make current economic sense to convert indigenous forest to some other use. However, as the scarcity of indigenous timber increases, due to increased conversion of the forest or woodland, conventional economics suggests that the value of the remaining stock will increase (Arnold & Ruiz Pérez 1998), adding greater weight to high value logging as one means of contributing to forest conservation. This may be only possible in a well internally or externally regulated environment, otherwise the higher unit value may prompt accelerated logging, as demonstrated by some Amazonian species, such as mahogany.

The cost comparison with exotics does not reflect (1) the government subsidies afforded plantation forestry industries in many countries, (2) the real environmental costs to biodiversity and loss of ecosystem services, and (3) the full cost of the state sponsored research and development into improving yields of exotics. If these were factored in, or indigenous species provided equal research and breeding programmes, it is possible that the alleged superior returns of exotics may be challenged.

In terms of ecological impacts, Crook and Clapp (1998) were correct that it is difficult to implement logging systems within indigenous forests that do not have some negative impacts. Yet there is a variety of strategies to ensure that these are kept to a minimum (Geldenhuys 1997; Miekle 2000). International standards, certification and green-labelling are increasingly important as prerequisites in the international markets (Upton & Bass 1995; Elliot 1997). These aid financial incentives to log in the most environmentally responsible manner. Moreover, whatever impacts do occur need to be viewed relative to the alternatives, rather than in an absolute sense. If the alternative is total forest conversion driven by economic criteria, then high-value logging, along with minimal impacts when effectively managed, would be preferred. Focusing attention on the conservation of key species, in this case high-value timber, results in the conservation of the entire habitat or forest, benefiting many other species. The same concept has underpinned conservation efforts around the African elephant and rhinoceros (Thomson 1986). The ecological impacts of a pre-emptive death logging strategy (e.g. Seydack *et al.* 1995) through loss of species dependent on dead and decaying timber, and the role of such timber in ecosystem functioning, are relatively small since the strategy relates only to the target species. The dead and decaying wood of other woody species remains in the forest to fulfil its ecological function and provide habitat and food to dependent species. The amount removed by pre-emptive logging is small relative to the total biomass. Thus, only species with a very specific association with the high value timber species will be impacted to any great extent. Whilst that is undesirable, it can be argued that it may be a small price to pay for the conservation of most species in the forest, and certainly of minor impact relative to the loss of diversity resulting from changing land use.

Non-timber forest products

Crook and Clapp (1998) summarized the original enthusiasm resulting from several studies in tropical forests of South America reporting that net returns from extraction and marketing of non-timber forest products (NTFPs) were higher than alternative land uses. This was then appraised, and they concluded that extraction of NTFPs has not met, nor is likely to meet, these expectations. The basis of their argument was as follows:

(1) Critical evaluation of some of the early literature on the value of NTFPs suggests that the economic returns from NTFPs have probably been over-estimated due to a number of factors. They conclude that 'ultimately, of a number of forest use activities, extraction of NTFPs yields among the lowest gross returns per hectare' (Crook & Clapp 1998, p. 135).

(2) These supposed low returns, they suggest, often result in forest users over-exploiting NTFPs to increase cash incomes, which are dictated by external markets over which the collector has little influence. They suggest that in areas where resources are from commons ('open to access by all'; Crook & Clapp 1998, p. 136) market expansion, often in a boom and bust scenario, accelerates depletion.

(3) Extraction of NTFPs has ecological impacts. Users may actively select for the species to increase its relative abundance. Alternatively, heavy harvesting may decrease recruitment or abundance.

The issues raised in the case studies cited by Crook and Clapp (1998) are important. Yet, their importance relative to the potential for total forest conversion, and precisely how widely applicable they are, requires greater consideration. I will highlight five specific caveats to their argument.

They focus on case examples from Amazonian forests, but the conclusions are deemed generic and of implied significance to all forests. This may not be valid. There are many recent studies, using approaches that have limited the shortcomings of the pioneering study of Peters *et al.* (1989), from other forest and woodland systems that continue to substantiate the original conclusions, i.e. extraction of non-timber forests can be a competitive land-use system (Grimes *et al.* 1994; Houghton & Mendelsohn 1996; Melnyk & Bell 1996; Neumann & Hirsch 2000; Shackleton & Shackleton 2000). This is probably even more likely in arid and semi-arid savannas and woodlands, for which the alternative land uses are limited due to less favourable climate and soils.

The cited case studies deal with situations where the NTFPs are marketed. In many areas, the role of NTFPs in direct household provisioning is more important to households than the marketing of NTFPs in local and regional centres (e.g. Clarke *et al.* 1996; Campbell *et al.* 1997; Shackleton & Shackleton 2000). It is necessary to appreciate the direct household use, since, if the land is converted to some other use, local households have to source these multiple goods elsewhere. What are essentially free goods in cash terms to the local households would have to be purchased, substitutes located or subsidized by the state. Few households or developing nations can afford that. For example, in South Africa the use of indigenous medicines operates in parallel to the state-subsidized system. Over 70% of South Africans make use of traditional medicines from the wild. The value of material traded is approximately US$ 60 million per annum (Mander 1998). Were this to be lost due to over-harvesting, land transformation, or state regulation, the state would have to allocate additional resources to the state health-care system to an equal or higher value (due to salaries and administrative costs), or be faced with a large decrease in the health of its citizens. Similar arguments can be made for resources used for nutrition, shelter and energy. The value attached to direct-provisioning is therefore in effect an opportunity cost that should be factored into the cost-benefit analysis of alternative land uses. Summed across the full range of NTFPs, this can be significant (Shackleton *et al*. 2000). Whether or not local communities recognize the value of this opportunity cost in assessing alternative land use options depends upon a number of factors, especially the degree of monetization of local goods and services. Thus, in some areas it may be an incentive not to convert land uses, in other areas short-term cash needs may override the perceived benefits of long-term sustainable use, especially as commercial markets first develop (Neumann & Hirsch 2000). However, the continued reliance upon and use of NTFPs for direct-provisioning when the net benefit is assessed as negative after deduction of opportunity costs of labour (e.g. Melnyk & Bell 1996; Dovie 2001), indicates the inherent value of NTFPs to rural households and communities, that cannot perhaps be adequately expressed using current economic approaches.

Crook and Clapp (1998) blur common property with open access. There are a number of significant differences between these two regimes, particularly in institutional controls and compliance or enforcement thereof (Bromley & Cernea 1989; Ostrom 1992). Market-orientated conservation would be difficult to implement in open-access systems, but, as mentioned above, not so in functioning common-property systems characterized by appropriate institutional regulations (Ostrom 1992; Taylor 1999; Neumann & Hirsch 2000; Shackleton & Campbell 2000).

In terms of the ecological impacts of harvesting or managing for NTFPs, it needs to be acknowledged that few, if any, forests are pristine systems. The current structure and composition of all forests, including the tropical forests of Amazonia, are the product of a number of biotic and abiotic factors, of which humankind is a key one (Feely 1987; Denevan 1992; Hoffman 1997). Humankind has played both negative and positive roles in forests and savannas across the globe for millennia, including both the simplification of forests in some areas, and enrichment in others. Many species have been actively or passively selected for (Blackmore *et al*. 1990; Reid & Ellis 1995; Tipping *et al*. 1999). Thus, concerns about market-orientated conservation leading to such changes by gatherers overlooks the fact that it has already been the case for millennia within the very same forest, independent of the existence of a cash-based market. Whether or not a local, national or international market for a particular NTFP will exacerbate or detract from such positive or negative impacts on the forest as whole, is currently difficult to predict. But managers and decision-makers should not intervene on the erroneous assumption that current forest composition, structure and function is untouched by humans, and that they therefore must seek to limit continued use. Thus, it is the relative impacts of harvesting that need to be considered for each and every resource that is extracted, rather than starting from a premise that forests and woodlands are pristine, and therefore any consumptive use is undesirable.

There is an incongruency in the arguments between high-value logging on the one hand and NTFPs on the other. For high-value logging, Crook and Clapp (1998) dealt with national and international markets, but for NTFPs they dealt with local harvesters and markets. Yet high-value logging can be directed largely at domestic markets (e.g. *Podocarpus* spp. and *Pterocarpus angolensis* in South Africa), and NTFPs can also be marketed at national and international levels, either raw or with increasing value addition (e.g. *Aloe ferox* gel in South Africa [Newton & Vaughan 1996], *Harpagophytum* from Namibia [TRAFFIC 2000], mopane worms from Botswana [Gashe & Mpuchane 1996], rattan and bamboo from Asia [Kumar & Sastry 1999]). In most instances, the local harvesters do not capture much of the final value, but the external markets do provide a stimulus for marketing of a good that may otherwise have little cash value; they help increase prices, and also help buffer against fluctuations in the local market. Much effort is currently expended globally in trying to facilitate greater returns to local communities by stimulating value addition close to source rather than simply marketing the raw material (see papers in Wollenberg & Ingles 1998). Differentiation between local and national or international markets is therefore necessary in considering opportunities and financial returns to use of NTFPs and high-value logging, especially in comparison to other land-uses for the forest area, and arguments need to be consistent for both.

Bioprospecting

The current and potential value of new medicines and drugs from wild plants has been much vaunted as a reason for the conservation of forests and other natural habitats, particularly those with high biodiversity (Pearce & Moran 1994). Most of the world's untransformed areas are in developing countries. But the research and development capacity around genetic resources and medicines is concentrated in the developed world. Consequently, there is potential for large multinational research and development institutions to pay communities or state departments in developing nations for the right to prospect for potentially useful biomedicines or genetic resources in untransformed habitats. Such payments could be used to conserve natural habitats. But as with high-value logging, and NTFPs, such systems of incentives for conservation are not perfect. In particular, Crook and Clapp (1998) identified five problems in viewing biodiversity prospecting as a useful, potential market-orientated mechanism for the conservation of forests.

The probability of a new drug being developed from a species is small, from between one in 1000 or one in 10 000 species. Thus, the main value in bioprospecting rights will not be royalties from a new drug, but payment for access to, and screening, of selected species. This phase of bioprospecting does not yield large financial returns.

Should a species be used to develop a new drug, then a royalty would be paid. The precise value of the royalty depends upon a number of factors, but could range between one and 10 billion US dollars. Averaged across the remaining area of global tropical forests, this represents a probable minimum value of between one and 11 US dollars per hectare at current rates. This does not compare favourably with returns from alternative land uses after clearing the forest. With future discounting, this would be reduced.

If, after bioprospective screening, a species in the wild demonstrates useful properties for a new drug, there is no guarantee that the development company will source all material from the country where the plant was originally collected. They may source it from other countries. They may also encourage cultivation of the organism in other, non-source countries as a means of ensuring long-term supplies. Alternatively, they may synthesize a derivative, making future use of the drug independent of supply from natural sources. All of these post-discovery approaches towards ensuring long-term supplies (out-sourcing, cultivation, synthetic substitutes) serve to diminish or undermine returns to the original country where the species was conserved.

Benefits from successful bioprospecting are usually negotiated with governments and not the local communities effecting conservation on the ground. If the government then fails to channel those funds into appropriate policies and developments that benefit the local populace, then the incentive for conservation is lost, and forest conversion will continue.

Where bioprospecting is successful, the subsequent large-scale extraction of the target species has ecological impacts, not just for that species, but also for the forest as a whole.

Once again, Crook and Clapp (1998) raised pertinent points that should be heeded by the commercialization school, but there are issues arising from bioprospecting that require further attention before it is sidelined as a potential contributory mechanism for forest conservation. I will highlight four such issues.

It is not easy to debate the real benefits (amounts and to whom) of bioprospecting and royalties because (1) there are few concrete examples for evaluation, (2) commercial interests preclude full revelation of the details of the agreements, and (3) it is still a relatively new field, so there is bound to be a period of trial-and-error and evolution of models before mechanisms for optimal benefit sharing between all stakeholders and conservation of the forest are developed. Secrecy around commercial interests is a cause for concern, but there is a growing international lobby around indigenous property rights and fair distribution of benefits which bodes well for future agreements (Dürbeck 1999; GRAIN 2000). It is perhaps too early to conclude that bioprospecting cannot play a role, but a degree of healthy scepticism is not amiss until the real benefits (and who gains) of more working examples can be assessed.

The strengthening of such lobby groups is a useful means of ensuring that natural products from the wild are not replaced by synthetic or *ex situ* cultivation as a means of reducing benefits and royalties due to local communities with rights to the forest and its resources. However, the pragmatic need of business or industry to have an assured supply must be acknowledged. Therefore, the primary value in conserving forests will be as a potential source for new drugs, but not necessarily a continued supply. Hence, the value of bioprospecting needs to be increased, relative to payments for subsequent sustainable yields.

In terms of their concerns regarding ecological damage resulting from bioprospecting and possible damage from harvesting, my response is the same as for NTFPs and high-value logging. Some damage will occur, but there are ways and means to minimize it. The type and extent of damage vary widely, depending on the nature of the product to be extracted, and the distribution of the resource in the forest. Moreover, it may well be that market demand can be satisfied by harvesting from only a small proportion of the resource. It is problematic to generalize about possible harvesting impacts given that there are so many unknowns associated with many NTFPs (Wollenberg 1998), especially in terms of bioprospecting where the specific species and use for the product have not yet even been identified. Nevertheless, minimal damage may be a better option than forest conversion.

Averaging of the potential financial returns across the entire area of remaining forest is unrealistic, since any newly discovered wonder species is unlikely to occur throughout the total world distribution of tropical forests. Indeed, it may have a very restricted distribution. Thus, rather than all forests receiving a low average return, it will rather be a case of some forests receiving no returns, and some receiving significant returns. The uncertainty may undermine the national and local incentives to conserve forests for biosprospecting purposes, but there again it may not. For those leaders and decision-makers at national and local scales willing to play the odds, then the potential returns from bioprospecting remain an incentive, as part of a suite of others, for forest conservation.

Can market-orientated conservation really work?

Having considered the above three mechanisms of market-orientated conservation, Crook and Clapp (1998) concluded that it fails to meet expectations more often than not because (in most case examples), four necessary conditions are absent. The four conditions proposed by Crook and Clapp (1998) were: (1) the forest system is well understood so that appropriate management can take account of the impacts of harvesting, (2) the target species has a high growth rate, such that only a small proportion of the total population needs to be harvested, (3) the most cost-effective means of producing the resource is from natural forests and not from plantations or synthetic substitutes, and (4) beneficiaries of sustainable forest use must be able to enforce exclusive rights and control over the forest.

Table 1 Application of the four conditions of Crook and Clapp (1998) to currently sustainably harvested NTFPs in South Africa.

Resource	*Conditions for successful market-orientated conservation*				*Sources*
	Well understood	*High growth rate*	*Cost-effective from natural supply*	*Can enforce exclusive rights*	
Rumohra adiantiformis leaves	Yes	Yes	Both (also cultivated)	Yes (state forest)	Geldenhuys and van der Merwe (1988); Milton (1987, 1991); Durrheim and Vermeulen (1996)
Cymbopogon validus thatch	Reasonably	Yes	Probably	Occurs under various tenure and institutional regimes with differing capacities to enforce rights	Shackleton (1990); Shackleton and Mentis (1991); Shackleton and Shackleton (1994)
Commercial dead wood	Limited	No	Yes	Occurs under various tenure and institutional regimes with differing capacities to enforce rights	Shackleton (1994, 1998)
Aloe ferox sap	Reasonably	No	Unknown	Occurs under various tenure and institutional regimes with differing capacities to enforce rights	Newton and Vaughan (1996)
Mopane worms	Reasonably	Yes	Domestication not attempted	Occurs under various tenure and institutional regimes with differing capacities to enforce rights	Gashe and Mpuchane (1996)
Woodroses	Reasonably	No	Yes	No	Dzerefos (1996); Dzerefos *et al*. (1998, 1999)
Flagellaria guineensis fibre	No	Unknown	Probably	Limited	Cawe and Ntloko (1997); Cawe (1999)

These conditions make sense despite my responses raised under each of the three market-orientated approaches discussed above. There can be little doubt that with each of these in place, market-orientated conservation for a specific forest or resource will have a greater probability of success in countering pressures to convert the forest to alternative land-uses. However, whether or not all four need to be in place, and whether or not there are other conditions, needs further debate. For example, Table 1 summarizes whether or not each of the four conditions apply for a number of products extracted from forests and savannas in South Africa. In each instance a commercial market exists for the resource, and on the basis of current information, the product is harvested within sustainable limits. It may be that future information will reveal the use to be unsustainable, either because of inadequacies in current understanding, or growing market demand leading to changes in current conditions. In each instance at least one of the four conditions proposed by Crook and Clapp (1998) is absent. In some cases, as many as three of the four conditions have not been fully met (Table 1). Thus, the best we can conclude is that even if not all four are necessary, the greater the number that are met for a specific forest or region, the greater is the probability of success for market-orientated conservation.

Other potential facilitating conditions

The success or failure of market-orientated conservation within a specific area depends upon a multitude of factors, some of which apply in one instance, but not at another. There are at least five others which have a bearing over and above the four suggested by Crook and Clapp (1998), which I now outline.

Maximal opportunities for multi-purpose land use

The analysis of Crook and Clapp (1998) deals with only three market-orientated mechanisms for conservation of biodiversity. The returns to each alone may not compare to returns from converting the forest to other land uses, but the three together are not incompatible with one another, and hence one can sum the returns from each. Additionally, there are other market-orientated uses that are also compatible with these three, which serve to increase potential returns through conservation of the forest, for example, ecotourism, intensification of resource production within the intact forest (e.g. coppice management to optimize regrowth rates to reduce harvest intervals, or provision of hives for wild bees to increase honey yields) or sale of high-value NTFPs in international, rather than domestic, markets (e.g. florist materials, oils). For example, Wunder (1998) found a strong link between increased ecotourism and more conservation-orientated behaviour in villages around Cuyabeno Wildlife Reserve, Ecuador, because the villagers received the real benefits from a reasonably intact environment, whilst at the same time still extracting some NTFPs from the forest. Jones and Mosimane (2000) report on increased conservation of game species in Namibia after transference of ownership from the state within designated conservancy areas, which still supply other products and income streams to the inhabitants. The key issue is that a relatively intact forest or woodland offers a range of multi-purpose land-use options that should be developed both for conservation of the forest, as well as to enhance the security of local livelihoods. Other land uses rarely offer the same number of multi-purpose land use opportunities and frequently decrease the range and flexibility of local livelihood systems.

Marginal areas that mitigate against alternative land uses

The discussion and examples provided by Crook and Clapp (1998) were largely from Amazonian tropical forests. Although high in biodiversity Amazonia contains only a small proportion of the world's forests and woodlands. Countries that are not endowed with tropical forests also need to pursue a conservation agenda, and do so in the other forest and vegetation types. Many countries lack adequate financial resources for comprehensive conservation initiatives, and have a burgeoning population. Thus, whether they have tropical forests or not, they too are interested in market-orientated conservation. Or is it possible only in the high biodiversity hot spots of the world? I would suggest not. Indeed, it may be more viable in the arid and semi-arid savannas or dry forests of the world than the tropical forests, because the climatic and edaphic factors mitigate against the economics of converting the natural vegetation to other forms of land use. In these areas, the probable returns from bioprospecting will be low, but opportunities around NTFPs, high-value logging, ecotourism, bushmeat, and resource intensification are high (Campbell 1996; Shackleton 1996).

High direct use value to local communities

Crook and Clapp (1998) were reviewing the efficacy of market-orientated conservation in response to enthusiasm for econocentric approaches, yet they did not consider resource use by rural communities for direct-provisioning. This is not a contradiction, in that the loss of such resources through conversion to some other land use represents an opportunity cost to the alternative land use. In areas where there is a strong reliance on and use of large volumes of NTFPs for household consumption, this cost will be high, militating against conversion to other land uses. If these resources are lost, the households or state have to finance alternatives for energy, housing, food, and the like.

Low human population density

High human population pressures are frequently invoked as the primary cause for over-harvesting of specific NTFPs and increased rates of land transformation. Models of sustainable supply seek to explore the anticipated effects of increasing human populations. Rather than absolute population density, the condition is rather a ratio of human population density to area available for harvesting, which is an index of potential per caput supply (Cunningham 1995). The lower the ratio, the greater the probability of resource exploitation being able to accommodate local and commercial demand.

The nature of the resource

In terms of the nature of the resource, Crook and Clapp (1998) considered only the growth rate of the species in question. Yet there are a number of other attributes of resources that are more prone to over-exploitation (market-orientated or not) than those that tend to be used sustainably (Cunningham 1995; Shackleton 1996). For example, a commercial venture based on harvesting of the whole organism (such as timber), is less likely to offer the same potential for forest conservation as one that does not involve the death and harvesting of the whole organism, such as in the case of sap, leaves, or fruits. The harvesting of dead organs such as dead branches, woodroses, dried flowers or culms lends itself more to sustainable harvesting than use of live organs. If a sap or dye is harvested, species with high concentrations of the required ingredient will require less absolute amounts to be harvested than species with lower concentrations. Species that reach reproductive maturity at an early age, and have a high reproductive output (e.g. insects, annual or weedy plants), should be favoured over species with the opposite attributes (e.g. large mammals or slow growing trees). Species that react to harvesting by coppicing will have a shorter harvest interval than species that do not.

Conclusion

Crook and Clapp (1998) identified some key issues that need attention if market-orientated conservation is to assist as one means to conserve biodiversity. This is a challenge to those advocating commercialization of natural products as an approach for forest and woodland conservation. Yet the generic arguments advanced by Crook and Clapp (1998) cannot be applied in every situation. Sustainable resource use, or not, through commercialization is a result of the interplay of a multitude of micro and macro factors that differ in time, space and per resource. While the four conditions highlighted by Crook and Clapp (1998) are undoubtedly important in many instances, they are insufficient in others. There is a need for a rigorous multivariate analysis, based on a large sample size drawn across a range of environments and resources, of which factors are important under which circumstances. Until that is possible, we can only conclude that the existence of a market for forest resources does not guarantee conservation of the resource, but, under the right circumstances, it can be a vehicle for some of the resource values to realized, thereby providing some incentive to some stakeholders to conserve the resource in question and the forest as a whole. As yet, there has been too little examination of precisely what are the right circumstances within the different institutional settings throughout the developing world, and thus predictive capacity regarding the probable success or failure of market-orientated conservation at any given forest is unfortunately limited.

Acknowledgements

I am grateful to Etienne Nel and Ed Witkowski for constructive comments on earlier drafts of the paper, as well as three anonymous referees.

References

Arnold, J.E.M. & Ruiz Pérez, M. (1998) The role of non-timber forest products in conservation and development. In: *Incomes From the Forest: Methods for the Development and Conservation of Forest Products for Local Communities*, ed. E. Wollenberg & A. Ingles, pp. 17–42. Bogor, Indonesia: CIFOR.

Blackmore, A.C., Mentis, M.T. & Scholes, R.J. (1990) The origin and extent of nutrient enriched patches within a nutrient poor savanna in South Africa. *Journal of Biogeography* **17**: 463–470.

Bromley, D.W. & Cernea, M.M. (1989) The management of common property natural resources: some conceptual and operational fallacies. World Bank Discussion paper 57, World Bank, Washington DC, USA.

Campbell, B. ed, (1996) *The Miombo in Transition: Woodlands and Welfare in Africa*. Bogor, Indonesia: CIFOR: 265 pp.

Campbell, B.M., Luckert, M. & Scoones, I. (1997) Local level valuation of savanna resources: a case study from Zimbabwe. *Economic Botany* **51**: 59–77.

Cawe, S.G. (1999) Spatial and temporal utilisation patterns of *Flagellaria guineensis* Schumach. in demarcated forests of the Lusikisiki district of Transkei, South Africa. *South African Journal of Botany* **65**: 69–74.

Cawe, S.G. & Ntloko, S.S. (1997) Distributions, uses and exploitation of *Flagellaria guineensis* Schumach. with particular reference to Port St. Johns, South Africa. *South African Journal of Botany* **63**: 233–238.

Clarke, J., Cavendish, W. & Coote, C. (1996) Rural households and miombo woodlands: use, value and management. In: *The Miombo in Transition: Woodlands and Welfare in Africa*, ed. B. Campbell, pp. 101– 135. Bogor, Indonesia: CIFOR.

Cowling, R.M., Gibbs Russell, G.E., Hoffman, M.T & Hilton-Taylor, C. (1989) Patterns of plant species diversity in southern Africa. In: *Biotic Diversity in Southern Africa: Concepts and Conservation*, ed. B.J. Huntley, pp. 19–50. Cape Town, South Africa: Oxford University Press.

Crook, C. & Clapp, R.A. (1998) Is market-orientated forest conservation a contradiction in terms? *Environmental Conservation* **25**: 131–145.

Cunningham, A.B. (1995) Wild plant use and resource management. In: *Conservation of Biodiversity in Africa: Local Initiatives and Institutional Roles*, ed. L.A. Bennun, R.A. Aman, & S.A. Crafter, pp. 109–126. Nairobi, Kenya: National Museums of Kenya.

Denevan, G. (1992) The pristine myth: the landscape of the Americas in 1492. *Annual Association of American Geographers* **82**: 369–385.

Dovie, D. (2001) Woodland resource utilisation, valuation and rural livelihoods in the lowveld, South Africa. M.Sc. dissertation, University of the Witwatersrand, Johannesburg, South Africa.

Dürbeck, K. (1999) Green trade organisations: striving for fair benefits from trade in non-wood forest products. *Unasylva* **50**: 9–11.

Durrheim, G.P. & Vermeulen, B.J. (1996) Sustainable multiple use management of indigenous evergreen high forest in the southern Cape, South Africa. In: *Sustainable Management of Indigenous Forest in the Dry Tropics*, ed. P.T. Mushove, E.M. Shumba, & F. Matose, pp. 62–69. Harare, Zimbabwe: Zimbabwe Forestry Commission/SIDA.

Dzerefos, C.M. (1996) Distribution, establishment, growth and utilisation of mistletoes (Loranthaceae) in the Mpumalanga lowveld. M.Sc. thesis, University of the Witwatersrand, Johannesburg, South Africa, 169 pp.

Dzerefos, C.M., Shackleton, C.M. & Witkowski, E.T. (1999) Sustainable utilisation of woodrose-producing mistletoes (Loranthaceae) in South Africa. *Economic Botany* **53**: 439–447.

Dzerefos, C.M.,Witkowski, E.T.F. & Shackleton, C.M. (1998) Seedling survival, post-harvest recovery and growth rates of the woodrose-producing mistletoe *Erianthemum dregei* (Loranthaceae) on *Sclerocarya birrea*. *South African Journal of Botany* **64**: 303–307.

Edwards, P.J. & Abivardi. C. (1998) The value of biodiversity: where ecology and economy blend. *Biological Conservation* **83**: 239–246.

Elliot, C. (1997) *WWF Guide to Forest Certification*. Godalming, Surrey: WWF.

FAO (1995) Forest Resources Assessment 1990: Global Synthesis. Rome, Italy: FAO: 45 pp.

Feely, J.M. (1987) The early farmers of Transkei, southern Africa. *Cambridge Monographs in African Archaeology* **24**: 1–142.

Gashe, B.A. & Mpuchane, S.F., eds. (1996) *Phane: Proceedings of the First Multidisciplinary Symposium on Phane*. Gaborane, Botswana: University of Botswana: 139 pp.

Geldenhuys, C.J. (1997) Sustainable harvesting of timber from woodlands in southern Africa: challenges for the future. *Southern African Forestry Journal* **178**: 59–72.

Geldenhuys, C.J. & van der Merwe, C.J. (1988) Population structure and growth of the fern *Rumohra adiantiformis* in relation to frond harvesting in the southern Cape forests. *South African Journal of Botany* **54**: 351–362.

GRAIN (2000) Global trade and biodiversity in conflict no. 4. Barcelona, Spain: Genetic Resources Action International (GRAIN): 19 pp.

Grimes, A., Loomis, S., Jahnige, P., Burnham, M., Onthank, K., Alarcon-Walter, R., Cuenca, P., Martinez, C., Neill, D., Balick, M., Bennett, B. & Mendelsohn, R. (1994) Valuing the rain forest: the economic value of non-timber forest products in Ecuador. *Ambio* **23**: 405–410.

Hoffman, M.T. (1997) Human impacts on vegetation. In: *Vegetation of Southern Africa*, ed. R.M. Cowling, D.M. Richardson, & Pierce, S.M., pp. 507–534. Cambridge, UK: Cambridge University Press.

Houghton, K.T. & Mendelsohn, R. (1996) An economic analysis of multiple use forestry in Nepal. *Ambio* **25**: 156–159.

Jones, B.T. & Mosimane, A.W. (2000). Empowering communities to management natural resources: where does the new power lie?

Case studies from Namibia. In: *Empowering Communities to Manage Natural Resources: Case Studies from Southern Africa*, ed. S.E. Shackleton & B. Campbell, pp. 70–102. Lilongwe, Malawi: WWF/ SADC Wildlife Sector Natural Resources Programme.

Kumar, A. & Sastry, C.B. (1999) The international network for bamboo and rattan. *Unasylva* **50**: 48–53.

Mander, M. (1998) Marketing of indigenous medicinal plants in South Africa: a case study of Kwazulu-Natal. FAO, Rome, Italy: 151 pp.

McNeely, J.A. (1988) *Economics and Biological Diversity*. Gland, Switzerland: IUCN: 236 pp.

Melnyk, M.A. & Bell., N. (1996) The direct-use values of tropical moist forest foods: the Huottuja (Piaroa) Amerindians of Venezuela. *Ambio* **25**: 468–472.

Miekle, S. (2000) Environmental codes of practice and auditing. In: *South African Forestry Handbook 2000*, ed. D. Owen, pp. 583–588. Pretoria, South Africa: SAIF.

Milton, S.J. (1987) The effect of harvesting on four species of forest ferns in South Africa. *Biological Conservation* **41**: 133–146.

Milton, S.J. (1991) Slow recovery of defoliated seven-weeks fern (*Rumohra adiantiformis*) in Harkville forest. *South African Journal of Forestry* **158**: 23–28.

Neumann, R.P. & Hirsch, E. (2000) *Commercialisation of Non-timber Forest Products: Review and Analysis of Research*. Bogor, Indonesia: CIFOR: 176 pp.

Newton, D.J. & Vaughan, H. (1996) South Africa's *Aloe ferox* plant, parts and derivatives industry. TRAFFIC, Johannesburg, South Africa: 36 pp.

Ostrom, E. (1992) The rudiments of a theory of the origins, survival and performance of common property institutions. In: *Making the Commons Work: Theory Practice and Policy*, ed. D.W. Bromley, pp. 293–318. San Francisco, USA: Institute of Contemporary Studies.

Pearce, D. & Moran, D. (1994) *The Economic Value of Biodiversity*. London, UK: Earthscan: 172 pp.

Peters, C., Alwyn, M., Gentry, H. & Mendelsohn, R.O. (1989) Valuation of an Amazonian rainforest. *Nature* **339**: 655–656.

Reid, R.S. & Ellis, J.E. (1995). Impacts of pastoralists on woodlands in south Turkana, Kenya: livestock mediated tree recruitment. *Ecological Applications* **5**: 978–992.

Scholes, R.J. & Hall, D.O. (1996) The carbon budget of tropical savannas, woodlands and grasslands. In: *Global Change: Effects on Coniferous Forest and Grasslands*, ed. A.I. Breymeyer, D.O. Hall, J.M. Melillo & G.I. Argen, pp. 69–100. New York, USA: Wiley.

Seydack, A.H., Vermeulen, W., Heyns, H., Durrheim, G., Vermeulen, B., Willems, D., Ferguson, Huisamen, J. & Roth, J. (1995) An unconventional approach to timber yield regulation for multi-aged, multispecies forests. II. Application to a South African forest. *Forest Ecology & Management* **77**: 155–168.

Shackleton, C.M. (1994) Growing more trees for fuelwood in the Northern Transvaal or redistribution after sustainable harvesting? *Development Southern Africa* **11**: 587–598.

Shackleton, C.M. (1996) Potential stimulation of local rural economies by harvesting secondary products: a case study of the central eastern Transvaal lowveld. *Ambio* **25**: 33–38.

Shackleton, C.M. (1998) Annual production of harvestable deadwood in semi-arid savannas, South Africa. *Forest Ecology & Management* **112**: 139–144.

Shackleton, C.M. & Shackleton, S.E. (2000) Direct use values of savanna resources harvested from communal savannas in the Bushbuckridge lowveld, South Africa. *Journal of Tropical Forest Products* **6**: 21–40.

Shackleton, S. E. (1990) Socio-economic importance of *Cymbopogon validus* in Mkambati Game Reserve, Transkei. *South African Journal of Botany* **56**: 675–682.

Shackleton, S.E. & Campbell, B., eds. (2000) *Empowering Communities to Manage Natural Resources: Case Studies from Southern Africa*. Lilongwe, Malawi: WWF/SADC Wildlife Sector Natural Resources Programme.

Shackleton, S. E. & Mentis, M. T. (1991) Response of *Cymbopogon validus* tillers to three clipping frequencies. *Journal of the Grassland Society of Southern Africa* **8**: 35–36.

Shackleton, S. E. & Shackleton, C.M. (1994) Habitat factors influencing the distribution of *Cymbopogon validus* in Mkambati Game Reserve, Transkei. *African Journal of Range and Forage Science* **11**: 1–6.

Shackleton, S.E., Shackleton, C.M. & Cousins, B. (2000) The economic value of land and natural resources to rural livelihoods: case studies from South Africa. In: *At the Crossroads: Land and Agrarian Reform in South Africa into the 21st Century*, ed. B. Cousins, pp. 35–67. Cape Town, South Africa: PLAAS & NLC.

Solbrig, O.T., Menaut, J.C., Mentis, M., Shugart, H.H., Stott, P. & Wigston, D. (1991) Savanna modelling for global change. *Biology International* **24**: 1–122.

Swanson, T.M. (1992) Economics of a biodiversity convention. *Ambio* **21**: 250–257.

Taylor, D.A. (1999) Requisites for thriving rural non-wood forest product enterprises. *Unasylva* **50**: 3–8.

Thomson, R. (1986) *On Wildlife Conservation*. Cape Town, South Africa: United Publishers: 244 pp.

Tipping, R., Buchanan, J., Davies, A. & Tisdall, E. (1999) Woodland biodiversity, paleo-human ecology and some implications for conservation management. *Journal of Biogeography* **26**: 33–43.

TRAFFIC (2000) Harpagophytum. TRAFFIC East/Southern Africa Species Update, Johannesburg, South Africa: 2 pp.

Upton, C. & Bass. S. (1995) *The Forest Certification Handbook*. London, UK: Earthscan: 240 pp.

Wollenberg, E. (1998) Methods for assessing the conservation and development of forest products: what we know and what we have yet to learn. In: *Incomes from the Forest: Methods for the Development and Conservation of Forest Products for Local Communities*, ed. E. Wollenberg & A. Ingles, pp. 1–16. Bogor, Indonesia: CIFOR.

Wollenberg, E. & Ingles, A., eds. (1998) *Income from the Forest: Methods for the Development and Conservation of Forest Products for Local Communities*. Bogor, Indonesia: CIFOR: 227 pp.

Wood, C. & Walker, R. (1999) Saving the trees by helping the poor: a look at small producers along Brazil's Transamazon highway. *Resources* **136**: 14–17.

Wunder, S. (1998) Promoting forest conservation through ecotourism income? A case study from the Ecuadorian Amazon region. *CIFOR Occasional Paper* **21**: 1–24.