30 Land Use, Ethnobotany and Conservation in Costa Rican Montane Oak Forests

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30.1 Introduction

A large number of studies on human impact on tropical mountains underline the vast destructive and often irreversible effects that settlements and inappropriate land use practices may have on local forest resources (e.g., Baker and Little 1976; Budowski 1982; Stadel 1986; Churchill et al. 1995; Kappelle 1996, 2004; Kappelle and Brown 2001; Bewket 2002; Benítez 2003). However, still little is known about the impact of man on tropical highland oak forests, the often unsustainable use, and the utilization of native plants by indigenous peoples and locally dwelling peasants (*ladino* colonists). At many places in Mexico, Central America and Colombia, oak trees have been cut for timber, fuelwood and other uses, and entire oak forests have been converted to pastures and croplands (Kappelle and Juárez 1995; Helmer 2000; Chaps. 16, 17, 21 and 31).

In order to gain a better insight into the past and present use of these forests and their vascular plants, we conducted a case study and assessed land use history, changing trends in agricultural practices, and current ethnobotanical knowledge in the montane oak forest zone of Costa Rica's Talamanca Mountains, with emphasis on the largely cleared Los Santos Forest Reserve, a Human Inhabited Protected Area (HIPA).

30.2 Colonization, Deforestation and Land Use History

The Costa Rican montane oak forest zone has suffered from human intervention since the arrival of the first indigenous peoples over 10,000 years ago. Today's valley of Santa Maria de Dota at 1,500 m elevation is believed to have

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been inhabited in recent pre-Columbian times by a Huetar indigenous tribe known as 'Ota' – hence, the county name Dota from 'De Ota', in the central sector of the Los Santos Forest Reserve (Chinchilla 1987; Ureña 1990). However, it was not until the mid 19th Century that this upland oak forest region became colonized by settlers, with dramatic consequences. During that historic period, landless sons of traditional coffee farmers in search of new land migrated from the Central Valley of Costa Rica, from rural towns around San José and Cartago, to the mountains of the high Talamancas (Rodríguez and Vargas 1988; Ureña 1990; Carrière 1991). They settled especially in what is presently known as the Los Santos Forest Reserve, by that time an area where land was still available without any legal constraints (Kappelle and Juárez 2000). In this way, new rural population centers were established at 1,000–1,500 m elevation, such as Santa Maria de Dota (since 1863), San Pablo de León Cortés, and San Marcos de Tarrazú. During the early and mid 20th Century, new generations of farmers continued to migrate even further southeast, establishing small hamlets known as *caserios*, e.g., Providencia de Dota, San Gerardo de Dota, and Villa Mills. During the 1940s and 1950s, these hamlets started to grow and develop into villages, as the construction of the Panamerican highway (*Carretera Interamericana Sur*) opened up new markets (Schubel 1980; Siles de Guerrero 1980).

The farmers that settled at elevations above 1,800 m – the altitudinal limit of coffee growth in Costa Rica – initially practiced slash-and-burn techniques, extracted timber for fence posts, fuelwood and charcoal, and cultivated crops (maize, legumes) for domestic use. They also gathered blackberries and edible palm hearts locally known as *pejibaye*, and raised dairy cattle and pigs (Kappelle and Juárez 1995; Kappelle et al. 2000). In the upper Savegre Valley, near the village of San Gerardo de Dota, deforestation rates reached their peak between 1950 and 1980, according to a study based on retrospective monitoring and interpretation of historical sets of aerial photographs covering almost 60 years (1941, 1956, 1969, 1984, 1992, and 1998), validated by ground data collected in 1996 and 2001 (van Omme et al. 1997; Acevedo et al. 2002). Deforestation rates increased from an initial 6.6 ha year^{-2} in 1954–1956, to as much as 21.3 ha year^{-2} over the period 1956–1969, the value being 20.2 ha year^{-2} for the period 1969–1984. Between 1984 and 1996, the deforestation rate dropped significantly (0.4 ha year^{-2}), and finally leveled off to almost zero in 2001 (Cháves et al. 2001). As a result, today the valley of San Gerardo de Dota comprises a landscape mosaic of old-growth montane oak forest, successional stages of recovering forests, blackberry fields, apple orchards, and pastures (Fig. 30.1).

The current lower deforestation rate is largely explained by a significant change in land use practices that has taken place since the mid 1970s when the Los Santos Forest Reserve was established. At that time, activities such as traditional logging for timber and charcoal, and forest conversion to pasture were progressively replaced by fruit tree cultivation on former pastures,

Fig. 30.1. Panorama of the western slope (with east orientation) of the Savegre River valley at 2,000–2,300 m elevation near San Gerardo de Dota, Costa Rica. The view shows a landscape mosaic with old-growth montane *Quercus copeyensis*-dominated oak forest along the crests, successional stages of recovering forests at its lower edges, pastures with isolated dark-leaved *Quercus* and gray-leaved *Buddleja* trees, fences of live cypress trees (*Cupressus lusitanica*), and young apple orchards (*Malus pumila*) with uncovered soil at the bottom. Photograph taken by M. Kappelle in 1992

hatching of introduced rainbow trout (*Oncorhynchus mykiss*), and exploitation of ecotourism as non-traditional sources of income. This account is probably one of the first reporting a significant change in human behavior toward a more responsible attitude in conserving human-inhabited neotropical montane oak forest.

30.3 Altitudinal Zonation of Agroecological Belts

The mid-montane, oak-dominated highlands of Costa Rica's Talamanca Range (1,000–3,000 m) show a sequential altitudinal zonation of different agroecological belts (Kappelle and Juárez 1995), similarly to those of the Andes (Zimmerer 1999; Fig. 30.2). Coffee plantations have replaced most of the premontane and lower montane forest zones, and dominate at 1,000–1,800 m – the upper limit of coffee growth in the country. Examples are found in the Pacific counties of León Cortés, Tarrazú, Dota, Pérez Zeledón, and Coto Brus.

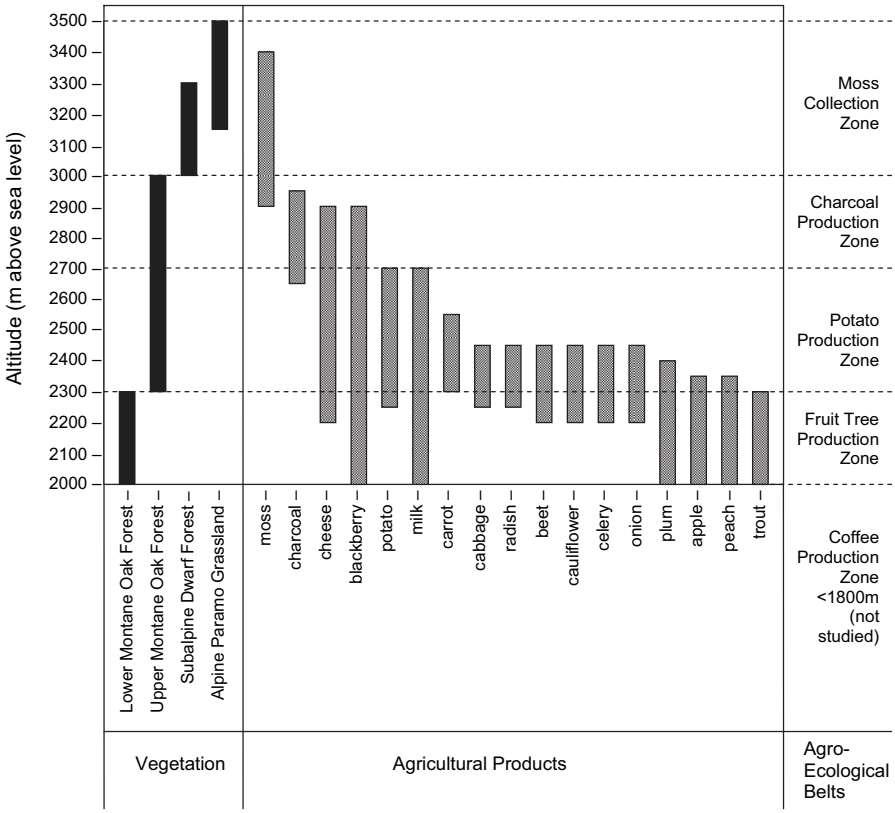

Fig. 30.2. Altitudinal zonation of mountain vegetation, agricultural products, and agroecological belts above 2,000 m elevation along the slopes of the Savegre River valley, Costa Rica. The highest altitude corresponds to the summit of the La Muerte peak at 3,491 m

Climbing up the mountains, starting at the upper limit of the coffee belt, one passes through a lower montane oak forest zone (1,800–2,300 m) that has largely been cleared during the mid 19th Century. After forest removal, these lands were initially used as pastures. However, during the mid 1970s, they were converted into fruit orchards of introduced species such as apple, peach, and plum (Kappelle and Juárez 2000). Other lands were kept as blackberry orchards, and planted with native *Rubus* species. The agricultural lands around the Dota County villages of Trinidad, Copey, Providencia and San Gerardo, in the heart of the Los Santos Forest Reserve, offer a good example of how today's fruit tree plantations thrive.

Higher up the mountain, at 2,300–3,000 m, is found the upper montane forest belt. In its pristine state, this belt is dominated by oak species such as *Quercus seemannii*, *Q. copeyensis* (now known as Q. *bumelioides* – K.C. Nixon, personal communication, Chap. 1) and *Q. costaricensis* (Chaps. 4 and 10).

However, many oak forest patches at 2,300–2,700 m elevation have been removed over the last century, and have been replaced by annual crops (vegetables) such as potato (two harvests a year), beet, carrot, onion, cauliflower, cabbage, celery, lettuce and radish (Fig. 30.2). Many of these vegetable crops are grown applying high inputs of fertilizer and pesticides (herbicides, fungicides, nematicides, and insecticides). They are artificially irrigated by means of overhead sprinklers during the dry season (January–May). Vegetables are largely sold at markets in San José, Cartago, and San Isidro del General (Kappelle and Juárez 1995).

Even higher, at elevations of 2,700–3,000 m, oak forest has been cleared for charcoal production (Schubel 1980). This was still a major source of income for farmers during the early 1990s (Chap. 31), and beyond (M.E. Juárez, personal observation). Charcoal is produced mainly on the basis of oak (*Quercus seemannii*, *Q. copeyensis* and *Q. costaricensis*), and to a lesser extent, alder (*Alnus acuminata*), *Buddleja nitida*, *Drimys granadensis*, *Nectandra* spp., *Ocotea* spp., Podocarpaceae and *Weinmannia pinnata* (Kappelle and Juárez 1995). Today, the production of charcoal from living trees is prohibited by national legislation. Therefore, charcoal producers currently uncover decaying oak logs still scattered around in pastures (Chap. 31). They represent evidence from historic clearing campaigns that often took place in the 1950s, 1960s and early 1970s.

In the subalpine dwarf forest and alpine paramo grassland environments, poor peasants gather mosses and hepatics for ornamental arrangements, especially in the period before the Christmas season. These non-vascular plants are locally important as non-timber forest products (NTFPs) of considerable commercial value (Siles de Guerrero 1980; Romero 2002). They are sold to truck drivers who take them to urban markets ('*ferias*') in Costa Rica's Central Valley.

As clearing of forested land became illegal in the Los Santos Forest Reserve, after its establishment in 1975, loggers (*madereros*), charcoal producers (*carboneros*) and cattle-farmers (*ganaderos*) had to change their non-sustainable land use practices. However, only few farmers and their rural families were able to successfully develop alternative socioeconomic activities by growing fruit trees, establishing artificial ponds for hatching of introduced rainbow trout (*Oncorhynchus mykiss*), or initiating activities in the field of ecotourism (e.g., bird-watching tours). A large number of farmers, however, lacked technical knowledge and skills to implement other land use systems, neither did they have the capital needed (including bank loans) for initial investments, nor could they count on appropriate social networks in order to achieve their production goals. Today, many of them still produce charcoal, or grow blackberries in the upper parts of the watersheds and try to seek new, economically remunerative agricultural activities in order to improve their relatively low living standards (Kappelle and Juárez 2000).

30.4 Ethnobotany

On all (sub)tropical continents, montane forest products and services have extensively been used for many centuries and probably millenniums, to maintain local populations. Traditionally, but also in modern times, rural communities have gathered numerous timber and non-timber forest products from these forests, including food, fodder, fiber, fuel, medicines, dyes, gums, oils, antioxidants, spices, poisons, ornamental plants, and pets. The use of plants for a variety of purposes is still a common phenomenon in neotropical montane oak forests, such as those that we studied in Costa Rica.

An ethnobotanical survey among farmers (*campesinos*) in the Costa Rican village of San Gerardo de Dota in Savegre River valley (Los Santos Forest Reserve) demonstrated that 32.0 % of the vascular plant flora (189 of 590 species) known from the area is perceived by farmers as useful (Kappelle et al. 2000). The number of useful plant species per farm varied strongly in the range 22–117, depending largely on the origin of the farmer family, the age of the interviewees, and the time of arrival in the Savegre Valley. In general, elder farmers originating from neighboring valleys and living several decades in the area had a greater knowledge of useful plants than was the case for colonists of younger age who recently immigrated from regions further away. Similarly, about 57 % of the useful plant species was known by only one or two *campesino* families, whereas widely known species were few and corresponded mainly to introduced fruit and timber trees.

Plant families that were found to be richest in useful species were Poaceae (13 species), Asteraceae (12), Rosaceae (9), Lauraceae (8), Solanaceae (8), Apiaceae (6), Cucurbitaceae (6), Verbenaceae (6), Brassicaceae (5), and Fabaceae (5). Of the 189 useful plant species (100 %), 23.8 % was used for medicines, 39.7 % for food, and 24.3 % for construction (timber) or as combustible (fuelwood, charcoal; Fig. 30.3). Types of less important use included dye, ornamental, fodder, gum, oil, and poison. A total of 61.9 % of all plants had only one kind of use. The introduced and exotic trees *Cupressus lusitanica* (cypress) and *Eucalyptus globulus* showed the highest diversity in use types (7), together with the native tree *Alnus acuminata* (alder). Trunks (53 %) and fruits (47 %) were the main plant species' organs used, followed by leaves (33 %) and branches (30 %). Over 27.5 % of all plants were used on a daily basis, and 34.9 % only occasionally. About 11.6 % was very rarely used (Kappelle et al. 2000).

At present, use of traditional and native species is becoming less common in San Gerardo de Dota. Trends in use frequency are in favor of introduced and economically important species. Therefore, it is questionable if folk knowledge of useful native plants – especially medicinal plants – will remain common good or disappear on a short or medium term. Today, the farmers' village of San Gerardo rapidly transforms from a rural hamlet depending on

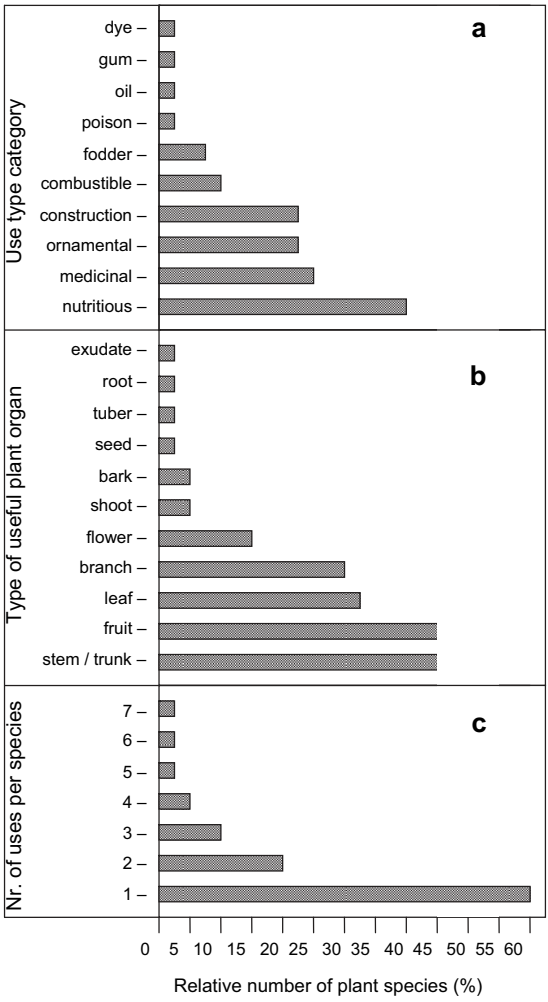

Fig. 30.3a–c. Relative number (in percentages) of vascular plant species (n=189) distributed as **a** use type category, **b** type of useful plant organ, and **c** number of use types per plant species

agricultural subsistence into a booming town where fruit and trout export and ecotouristic enterprises dominate.

30.5 Protected Areas Preserving Montane Oak Forests

In 1982, the UNESCO designated the transboundary La Amistad Biosphere Reserve in mountainous eastern Costa Rica and western Panama (Talamanca highlands). The 612,570-ha Costa Rican sector of this oak forest-dominated Biosphere Reserve included the 50,920-ha Chirripó National Park established in 1975, the 58,495-ha Tapantí–Macizo de la Muerte National Park established

in 1999, the Costa Rican part of the 193,929-ha La Amistad International Park (PILA) established in 1982, the Las Tablas Protected Zone, as well as a number of Indigenous Reserves. The 62,000-ha Los Santos Forest Reserve (LSFR), established in 1975, was not included in this biosphere reserve, as it was considered to be in an advanced state of degradation. However, during the 1990s the LSFR has been considered a vital buffer zone for the La Amistad Biosphere Reserve, due to its strategic location between the urban centers of the Central Valley to the north and west, and the densely forested Biosphere Reserve to the east (Kappelle and Juárez 1994).

In 1983, a large part of the La Amistad Biosphere Reserve was designated as a World Heritage Site. Ten years later it was categorized as a Center of Plant Diversity and as a key Endemic Bird Area (Chaverri et al. 1994; Kappelle and Juárez 1994). It also serves as one of the main cores of the Mesoamerican Hotspot of Biodiversity (Myers et al. 2000). Since 2003, Amistad includes Costa Rica's eleventh Ramsar site – the unique high-altitude peat lands locally known as the *Turberas de Talamanca* (Ramsar site no. 1286).

Due to these national and international conservation action strategies, over 60 % (i.e., 6,489 km^2) of Costa Rica's upland territory (>1,000 m elevation) had at least some status of protection in 1999 (Kappelle and Juárez 2000). Knowing that about 80–90 % of these protected highlands had a dense forest cover during the mid 1990s (Kappelle and Juárez 2000), we may conclude that Costa Rica's montane oak forests are currently among the best protected in the Neotropics. However, lower montane oak forest patches below 2,000 m, immediately east and south of the highly populated metropolitan Central Valley, still lack any protected status (Castro and Kappelle 2000). Therefore, it is stressed that these threatened areas should receive major attention from conservation policy makers over the coming years.

At the same time, our assessment demonstrates that deterioration of the ecological integrity of these tropical montane oak forests may positively be counteracted by new socioeconomic alternatives implemented by a rural, visionary population of mountain people, who are well aware of the strong relation between the health of the ecosystem they inhabit and the future perspectives of their population (see also Messerli and Ives 1997). This trend is a hopeful sign for numerous other tropical montane forest sites that still suffer from continued deforestation, biodiversity loss, and degradation of ecosystem goods and services, which doubtlessly affect the long-term future of mankind (Aldrich et al. 1997; Kappelle and Brown 2001; Kappelle 2004).

30.6 Involving Local People in Conservation Action

In an even broader perspective, we may conclude that the management of protected areas in tropical montane forest environments has undergone significant changes over the last two decades (Aldrich et al. 1997; Kappelle and Brown 2001; Bubb et al. 2004; Kappelle 2004). The most important aspect of this transformation concerns the involvement of local people in protected area management. Whereas in the 1960s and 1970s national parks, wildlife reserves, and other protected nature areas were places managed only by guards under national command – as was the case in the Costa Rican Los Santos Forest Reserve (LSFR) discussed in this chapter – today, the participation of local populations in conserving protected areas is considered a prerequisite for successful management in many regions.

However, not only protected areas have benefited from the active involvement of local people in management. In many places, the people themselves have profited, while conserving natural resources and reducing poverty in an integrated manner. A striking example of this new and successful approach is the development of ecotouristic activities, like in the LSFR. Here, for instance, local people have been able to make a living out of protected areas while preserving endangered species such as the resplendent quetzal (*Pharomachrus mocinno*), a bird of mythical significance for the locals and for foreign birdwatchers, too (Chap. 25). Today, local people treasure the presence of magnificent trees and mammals as an asset in attracting North American and European nature visitors. Colonists came to understand that a huge tree has much more economic value when it can be admired over decades by international ecotourists, rather than being chopped down and 'once and for all' sold as timber at the local market. This example demonstrates the ability of protected areas to contribute to poverty alleviation locally as well as regionally, as people's willingness to protect biodiversity in situ is increasing (Adams et al. 2004).

If we understand that both local people as well as civil society as a whole can directly benefit from environmental goods (e.g., food, fodder, fiber, water, soil) and services (e.g., soil erosion control, flood prevention, climate regulation) provided by biodiversity conserved in situ, then we are on the right path toward successful conservation action (Daily 1997; MA 2005; Chap. 33). Indeed, it is the integration of biodiversity conservation with sustainable development that helps to directly alleviate poverty among the poorest and most marginalized on Earth (Adams et al. 2004).

30.7 Linking Biodiversity Conservation to Poverty Alleviation

The key to successful poverty alleviation is participatory conservation, particularly in developing and transitional economies (Adams et al. 2004). Here, ecotourism directly focused at supporting the poor can play an important role. Policy makers and other stakeholders involved in ecotourism should be specifically working on developing ways for tourism to genuinely alleviate poverty in and near economically poor but biodiverse, human-inhabited protected areas (HIPAs). Thus, a viable and attractive tourism product is necessary if people are to visit, and benefits to be felt by all involved – poor local people, national and international visitors, the tourism industry, policy makers, and conservationists alike.

Today, protected area systems in developing and transitional countries aim to protect not only biodiversity but also the environmental goods and services this provides (Daily 1997; MA 2005). As such, local people wish – and often need – to have access to these natural goods and services. Unfortunately, strikingly different interests among stakeholders often cause conflicts, especially at the borders of protected areas. Protected area managers frequently have goals and objectives that contrast strongly with those of local dwellers. Therefore, over the years, state departments as well as private organizations have included different levels of buffer zones around core areas, generally following the UNESCO Man and Biosphere Principles. The LSFR in Costa Rica is an example of this approach, as it serves the Amistad Biosphere Reserve as a key buffer zone (Kappelle and Juárez 1994).

In the buffer zones where protection and extraction of resources are often combined, integrated conservation-and-development projects should be carried out. The Spanish Government-funded ARAUCARIA project in LSFR's Savegre River valley is a good example of such an approach (Acevedo et al. 2002; Chap. 25). It is here, at the edge of the strictly protected area and the less protected multipurpose area, that the greatest successes in addressing the dual issues of biodiversity protection and poverty alleviation may be achieved. Particularly, the involvement of local people, such as former hunters and gatherers, in the preservation of 'their' protected area is crucial. Therefore, empowerment of local communities should be promoted and enhanced wherever possible, particularly as poor local people often depend for their survival on the use of natural resources such as found in Costa Rica's upper montane oak forests (Kappelle and Juárez 1995, 2000).

If we were to empower local people as 'owners' of protected land they use and concurrently conserve, the elimination of poverty as well as the strengthening and conservation of biodiversity may go hand in hand. Stimulating participatory management of biodiversity in situ is the key, and should therefore be promoted by policy makers and decision makers alike. However, capacity

building, and particularly the transfer of skills, knowledge and technology to local people – the future custodians of biodiversity – is a prerequisite. At the same time, local people will not need to abandon their villages and migrate to cities in search of work and income – as is happening today in Costa Rica's LSFR – as local natural resources will not necessarily diminish but rather remain intact as a result of more sustainable management. Women and youngsters can play a particularly important role in this new approach, and should be encouraged to do so. Gender issues should receive special attention from conservation planners and decision-makers alike.

30.8 Macroeconomic Trends, Conventions and Conservation Implications

Other points of interest are macroeconomic processes and international trade relations. All these issues may affect biodiversity while being intended to alleviate poverty in first instance. They deserve our special attention. The liberation of trade through free-trade agreements (e.g., the Central American Free Trade Agreement, CAFTA), and the prevention of new trade barriers may help to positively impact poverty reduction and biodiversity conservation as well, but should be put forward within the framework of UN conventions, especially the Convention on Biological Diversity (CBD), targeted for the year 2010 (Balmford et al. 2005), and the associated CoP-7 procedure related to national gap assessments for protected area networks in CBD-signatory countries. Socioeconomic inequity among countries, peoples, regions, and localities should be minimized while preserving biodiversity. The participative management of protected areas may form a sustainable basis for achieving these larger goals, especially as we are to reduce biodiversity losses significantly by the year 2010 – one of the CBD's main targets – while offering a sustainable livelihood to local people, the custodians of biodiversity, today and in the future.

30.9 Conclusions

We conclude that, if we are to preserve a large part of the remaining neotropical montane oak forest and its variety of life as expressed in its genes, species and ecosystem types in the long term, we will need to elaborate a conservation strategy in which not only networks of protected core areas, buffer zones, and corridors form a fundamental component, but also participatory planning strategies in which different local and regional stakeholder groups and decision-makers are entirely involved, in order to estab-

lish a broad-based, consensus-oriented conservation framework (Calderón et al. 2004; Kappelle 2004).

Active restoration will be one of the key conservation strategies in recovering the neotropical montane forest landscape matrix over time (Holl and Kappelle 1999; Peterson and Haines 2000; Wijdeven and Kuzee 2000). The ecoregional and site conservation planning strategies applied by The Nature Conservancy and its partners are a good example of such an approach (Benítez 2003; Groves 2003; Calderón et al. 2004). Such an actor-oriented conservation planning process is particularly vital as a prerequisite for long-term conservation and sustainable use, for it is the recognition and valuation of the whole set of environmental goods and services offered by these forests to local and regional peoples (Chap. 33) – and strategies including compensation payments to forest owners for these goods and services ('easements' or *servidumbres*) – that will make its conservation economically successful (Daily 1997; Kappelle 2004; Balmford et al. 2005).

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