CHAPTER 12

Environmental policy for sustainable development and biodiversity conservation: a case study involving the exploitation of *Beaucarnea recurvata*

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Abstract

The government agenda for sustainable development in Mexico is based on national priority issues and international agreements for environmental management, most notably regarding biodiversity conservation. This priority is reflected in government policies and programs that seek to implement strategies of management and biodiversity conservation at a national scale. One of the most important environmental programs in the last decade has been the Management Units for the Conservation of Wildlife (UMA, for its Spanish acronym). UMAs promote the conversion of conventional production into multiple systems that contribute to the conservation of species and habitat restoration, facilitate the legal production of biodiversity in rural nurseries, generate employment and additional income, and contribute to the sustainable management of natural resources. Under this government scheme, landowners and users of biodiversity are integrated into the management of 16% of the national territory although the environmental impacts and socioeconomic repercussions of the scheme are still under evaluation. To illustrate the local implementation of the UMA, in this chapter we present the case study and overall strategy of conservation and use of the species *Beaucarnea recurvata* Lemaire (Nolinaceae), an endemic species of ornamental importance officially listed in Mexico as ‘threatened’. A biological and ecological diagnosis was carried out and training workshops held covering various production and dissemination activities. We review the operation of the UMA for *B. recurvata* and analyze the achievements and sustainability challenges of the project.

*Keywords: Environmental legislation, integrated management, management units, threatened species, tropical dry forest.*
1 Introduction

One way to achieve sustainable development is the implementation of comprehensive management plans for the natural resources available to a community; this implies knowledge of the spatial and temporal aspects of the resources of interest and also of their context, that is, their history, development dynamics, and forms of use and availability within the community [1, 2].

Biodiversity in Mexico is in crisis due to the lack of planning in development policies, the impact of industrial scale extractive production, inefficient exploitation of natural resources, and the social crisis caused by land abandonment, social disintegration, loss of identity, and migration of the rural population to other parts of Mexico and abroad [3]. In this context, research concerning the exploitation of resources of high biological and economic value requires comprehensive proposals for interdisciplinary and interinstitutional work that considers social densification with the training of highly skilled human resources [4]. The main challenge is the formation of local institutions to generate ideas, systems, methodologies, and capacities that facilitate sustainable development [5, 6].

In this chapter, we illustrate the operation of existing environmental policy, which combines elements of integrated management for sustainable development, including the triad of environment, economy, and society [7]. Conservation management is shown to be an experience that, in addition to the specific success it represents, can provide lessons for the improvement of integrated resource management. The work of conservation and use of *Beaucarnea recurvata* began as an academic project in 2001. Its objectives were: 1) to assess the conservation status of the ponytail palm (*B. recurvata*) in central Veracruz; 2) to determine its ecological requirements and assess the feasibility of nursery propagation; 3) to generate a plan for its use within the management framework of the Management Units for the Conservation of Wildlife (UMA, for its Spanish acronym); 4) to facilitate the organization of legal production and marketing of the species; and 5) to have a positive impact on the conservation of tropical deciduous forest (TDF) and on the value of its biodiversity.

1.1 The framework of sustainability in Mexico

Agenda 21, UNCED Rio de Janeiro 1992, will soon be two decades old and with it the integration of sustainable socioeconomic development of countries, the environmental issue that was one of the main promoters of this area of government policy planning designed to improve the mechanisms of management and local development. Mexico is undergoing one of the most advanced and promising social and ecological experiments, because it is making collective efforts toward the appropriate use and conservation of biodiversity that involve academic institutions, government agencies, private initiatives (national and international), and non-governmental organizations, as well as representing its historical roots through the indigenous, traditional farmer, and fishing communities, all converging together in what may be called the conservationist movement [3]. The issue
of effective adoption of the precepts and practices of sustainable development has yet to be verified, but numerous government reports show progress in public policy designed to alleviate poverty and economic and social underdevelopment, and to generate opportunities for local development and improved environmental planning. However, international development indices place Mexico in the middle of the table among the 160 United Nations member countries, which illustrates the challenge that still remains.

1.2 Government measures to reform the legislation of natural resource use

There have certainly been significant developments regarding the legislation and formulation of public policies designed to abate environmental degradation [3, 8], improve environmental planning and provide a complementary contribution of initiatives and opportunities for social development. In the past 50 years, there has been a radical change in how natural resources are perceived, assessed, and managed. In the late 1990s, significant legislative progress was made in terms of environmental impact assessment, land planning, definition of new offenses and penalties, liability for environmental damage, legal action aimed at protecting the environment, mechanisms for citizen participation, and limitation of property rights for environmental reasons. There were also reforms of federal laws governing the exploitation, use, and conservation of non-renewable resources, [9, 10].

Natural areas and wildlife were no longer considered to be inexhaustible resources. The ‘protectionist’ and ‘hands-off’ doctrine that prevailed in the mid-century were also changed, and ecosystem management schemes were in existence by the 1990s, allowing society to benefit. Here, Mexican national and residents can benefit from the proper use and exploitation of resources. Through the state, Mexican society acquired these precepts, adopting them in the formulation of new environmental laws and programs that permit the sustainable use of resources, and promote innovative schemes of resource appropriation and management. Among these is the management and use of wildlife, which includes threatened species and ecosystems [11].

2 The case of B. recurvata

The exploitation of wildlife resources by traditional farmers is generally based on traditional practices passed down from generation to generation, and on the knowledge of their natural environment; in this manner, the species get their local names, which vary according to culture, and are exploited. The ponytail palm can be found in the central region of the Mexican state of Veracruz, within TDF remnants, in pastures, and on patios. The ponytail palm is named for its morphological characteristics (the foliage forms a ponytail shape) and is highly sought after in the international market and also, in the last 20 years, nationally as an ornamental plant (Fig. 1).
Figure 1: B. recurvata. a) Individual adult, b) male flower, c) female flower, d) fruit formation, e) ripe fruit and f) seed.
2.1 Biology and ecology of the species

The species is included in a group of monocotyledonous plants belonging to the family Ruscaceae (AGP II, 2008) or Asparagaceae (AGP III, 2010). For practical purposes, and because its classification has not stabilized in the last 10 years, it can still be considered within the family Nolinaceae, and in this case, under the nomenclature of the listed classifications, it may be classed as Nolinoideae subfamily or Nolineae tribe. Currently, there are 11 recognized species of the *Beaucarnea* genus: 10 species occur in Mexico, of which 9 are endemic and most are considered ‘threatened’.

The species *B. recurvata* Lemaire (1861) is known locally as ‘*palma monja*’ or ‘*apachite*’ in Mexico. It is a species of biological importance and is protected and officially classified as threatened in Mexico [12], because its distribution area is restricted and endemic, and its seeds, juvenile, and adult individuals are overexploited in their natural habitat and traded illegally. *B. recurvata* inhabits TDF, an ecosystem that is considered to be an area of high biodiversity [13], but which has suffered a sharp decline in distribution area due to changing land use, urbanization, and the expansion of the agricultural frontier.

In 2004, a strategy of conservation and production, arising from studies of the biology, ecology, and demography of *B. recurvata* in TDF, was proposed to owners of sites containing the species. To put the proposal into operation, an UMA known as the 3rd of May was established and adopted in 2005 by the Ministry of Environment and Natural Resources (SEMARNAT-UMA-IN-VIV-00035-VER/05). The UMA is located in the town of Loma de Rogel, Municipality of Emiliano Zapata, in the center of Veracruz State, Mexico.

Under this management scheme, consideration was given to the conversion of conventional production into multidiversified systems – integrating agriculture, livestock production, and forestry – of various species; enabling habitat conservation and restoration; the legal production of biodiversity in rural nurseries; and also creating employment, additional income, and the sustainable management of natural resources.

2.2 Distribution and habitat

The Nolinaceae family is endemic to North America and northern Central America. All *Beaucarnea* species in Mexico are found within a narrow distribution area in semiarid regions and TDF in northern, southern, and southeastern Mexico. *B. recurvata* is an endemic species distributed only in the states of Veracruz and Oaxaca [14–16], growing on rocky nutrient-poor soils, on cliffs, and steep mountains [16–18]. Its habitat is the TDF.

Most *Beaucarnea* populations are in critical condition due to changing land use. Moreover, the situation is exacerbated by the illegal harvesting of seeds, seedlings, juveniles, and adults for sale. This process of exploitation exposes the species to a heightened state of threat or possible extinction, through reduction of the minimum size of viable populations, as well as deterioration of their genetic diversity.
TDF covers 32.5 million hectares in 578 municipalities and 21 states of Mexico, Challenger [22]. The distribution area covers major portions of the Atlantic and Pacific coastal plains (Fig. 2).

In the early 1980s, only 45% of the original cover of TDF remained [24]. TDF fragments located in the mid-basins of the rivers Actopan and La Antigua in central Veracruz are considered refuge areas for an important group of species [13, 25]; about 34 plant species are reported to be endemic to the region or to Mexico [26].

TDF occurs in areas with average annual temperatures greater than 20°C and maximum annual precipitation of 1200 mm although it is more commonly of the order of 800 mm, with a dry season of 7 or 8 months (November to May). These forests occur from sea level up to 1700 m. TDF tree heights range from 4 to 10 m, and almost all species lose their leaves for a period of 5 to 7 months, causing a huge contrast in the appearance of vegetation between dry and rainy seasons.

Most species of this forest have resinous or laticiferous exudates. The trees are robust, crooked, and branched; their crowns are very open; and many species have scaly bark with spiny or corky ridges (Fig. 3). Succulent plants are common, particularly those of the genera Agave, Opuntia, Selenicereus, and Cephalocereus [26].

Due to these characteristics, few species are of interest to the forest industry. However, some trees and shrubs are the basis for the production of vegetable gardens, where they can be used as stakes, such as white manjack (Cordia dentata). Other plants such as the pitaya (Hylocereus undatus), white leadtree (Leucaena leucocephala), nopal (Opuntia spp.), and pinguin (Bromelia penguin) are edible,
while the araguaney (*Tabebuia chrysantha*), jobo (*Spondias radlkoferi*), lime prickly-ash (*Zanthoxylum fagara*), and some leadtrees (*Leucaena* spp.) have potential uses as timber and for reforestation.

Generation of knowledge regarding this type of forest requires a thorough analysis of the needs of human populations living within. Only in this way can strategies be developed for the sustainable management of the wealth they contain [27] (Fig. 4).
2.3 Illegal extraction of *B. recurvata*

The commercialization of *B. recurvata* is for the most part illegal; the *modus operandi* of buyers is to visit the sites and ask the traditional farmers to collect as many juveniles and adults as possible in exchange for a daily payment. The plants are then taken to clandestine nurseries in order to acclimate and are subsequently placed in pots and are offered to local and national, legally registered, nurseries. The plants are then prepared for overseas sale, the majority as part of the illegal trade that leaves Mexico in cargo transport and containers and together with other species of high economic value. In recent years, strong commercial demand for this species has increased illegal sales, exceeding the monitoring capabilities of environmental institutions.

3 The formation of the UMA 3rd of May

In 2004, only one UMA existed in Veracruz with permission to produce various ornamental plants such as *B. recurvata*, the nursery called ‘*Mundo Verde*’, located in the municipality of Coatepec. The UMA 3rd of May was the first to exclusively produce *B. recurvata* under a comprehensive management plan for research, conservation, reforestation, production, and legal sale in the State.

3.1 Social organization for conservation and production

In Mexico, as in other countries, traditional farmers work the land directly, produce their own food, and hunt or gather natural products for personal consumption. These practices are adapted to the changing environment and socioeconomic needs. Therefore, to integrate into the rural economy, the UMA had to expand and conduct technology transfers [28–30]. To facilitate the organization of production and explore the interest of the local population in adopting a sustainable approach to the use of *B. recurvata*, activities were carried out involving approaches, awareness, training, dissemination, organization, and business development [31]. These are described more fully in the further sections.

3.2 Awareness and information

During the ecological study in 2001, five owners of properties containing populations of *B. recurvata* were contacted in order to obtain permission to conduct environmental studies on their properties. This led to dialogue with the owners, who were informed of the federal law for the exploitation of wildlife which establishes the legal concept of management and use of wildlife (the UMA). With postgraduate students from the Institute of Ecology A.C. (INECOL) and residents of communities with an interest in the cultivation of the species, three Participatory Rural Appraisals (PRA) were conducted in the localities of Trapiche del Rosario (2002), Chicusen (2003), and Comapa (2005), involving around 3000 inhabitants [32].
These community work methodologies helped communication between technicians, producers, and residents where the TDF is located (Fig. 5).

During the PRA, the traditional farmers recognized the importance of the ponytail palm and key stakeholders and authorities were identified [33, 34], in addition to illustrating the historical and cultural value of the TDF. Together with the stakeholders, alternatives for sustainable use were identified within the UMA scheme. The PRA results indicated the feasibility of sustainably exploiting *B. recurvata* to support the initiation of a possible social project. The work was disseminated through various mass media: the press and both national and French television. Segments were produced for commercial and college radio, and leaflets were distributed. This campaign aimed to inform regarding the value of the species and the alternatives for its use and also had an impact on buyers of the species in the urban population of the region. Similarly, the campaign promoted the purchase of legal plants in fairs and local markets, and in trade and academic shows such as the National Forestry Exhibition (2006 and 2007). All this fostered the sale of plants grown in nurseries in the UMA, and which possessed a ‘green certificate’, that is, a label guaranteeing that the plant had not been illegally extracted. Over the next 7 years, advice was provided to over 100 producer groups in order to organize the UMA and train in the production of ponytail palms. For example, five meetings of producers were held with about a thousand attendees. This effort was expected to ultimately increase the value of all local species found in the ecosystems of the region.

### 3.3 Legal registration of the UMA

The environmental authority requires that the application for registration of a UMA is performed by a legally constituted organization. The Loma Rogel
producers had a ‘Triple S’ (Society of Social Solidarity) with 17 members. After discovering what an UMA actually is, three of these members recognized the concept as being the most appropriate for the organization of the production and conservation of the species. Based on technical studies, the management plan was established and the producer group followed the following steps: 1) collection of wild seeds not exceeding 10% of the annual production, 2) care of reproductive individuals in TDF fragments in their area, and 3) agreement to allocate 30% of production to conservation, reforestation, and education activities, and 70% to the market.

In 2004, based on previous biological and ecological studies, a management plan was prepared to register the UMA. The legal requirements necessary for conducting commercial activities were met (UMA registration, preparation of labels for each plant to be sold, and official receipts). Two training courses (2005 and 2006), with a total of 152 participants, were organized covering issues of knowledge and potential use of TDF species, environmental legislation and regulations, experiences of management of species of flora and fauna in other UMAs, and the basis for productive organization.

4 Results, achievements, and challenges

The nursery was successfully established in the first year (2000) with a batch of 4500 plants, the result of research studies on germination and propagation of the species, donated by INECOL. In 2004, 10 ha of TDF were reforested with 2000 *B. recurvata* plants with the financial support of the National Forestry Commission. The first sales year was 2005 with 800 plants sold. An economic analysis was performed to estimate the profitability of production and the cost benefit. The results show that for every dollar invested, 26 cents are earned, which is close to the 3% obtained in other agricultural activities. It is predicted that the investment will be recouped after 5 years.

4.1 Evaluation of the regional impact of the project

4.1.1 Socioeconomic impacts

The project for sustainable production of ponytail palm is an interdisciplinary initiative that has generated biological, ecological, social, and technological knowledge. It has allowed researchers to link with the productive sector, the inter-institutional collaboration with the governmental sector through the Ministry of Environment and Natural Resources (SEMARNAT, by its Spanish acronym), the Federal Attorney for Environmental Protection (PROFEPA, by its Spanish acronym), the National Forestry Commission (CONAFOR, by its Spanish acronym), and the Municipalities. Currently, the UMA 3rd of May comprises 130 producers (from 10 municipalities and 21 localities). It aims to supply one million cultivated plants to the national and international markets.
4.1.2 Environmental impacts

Together, the 130 producers own 200 ha of TDF with potential for conservation, reforestation, and use. The producers have two main perspectives: those who are, by principle, convinced to work for legitimate businesses and for the conservation of their community, despite the unfair competition from sellers of illegally extracted ponytail palm. The other perspective involves a perceived lack of support from consumers in urban areas, and from governmental authorities that are not committed to sustainable production. They think that most of the tasks of sustainability are left to the rural communities, with no economic incentives to produce, monitor, and legally commercialize high-value biological resources. In the immediate future there will be participation in the creation of a ‘Center for the Study of Species of Biological and Economic Importance (CEIBE, by its Spanish acronym)’ in the region, which has proposed the formation of rural organizations and strategic alliances with companies that facilitate ethical trade. Sustainability involves changes in the valuation of natural resources, in traditional farmer work, and in the values of consumption in urban populations, especially in countries with developed economies.

4.2 Academic output

The project results were published in scientific papers and technical manuals, for example, The Development of \textit{in vitro} Culture Technique [35], A Cultivation Manual for \textit{B. recurvata} [36], and Diagnosis of the Habitat and Ecology of the Species [18, 27]. Training of human resources was also achieved out through academic degrees, social service, and student practicals and internships. The project was also presented as a model and case study of natural resource management in several courses, seminars, and conferences, both nationally and internationally. The project was selected to demonstrate the work of INECOL and spread the impact of the scientific research to the lawmakers of Congress, the INECOL Evaluation Committee, and Committees of the National Council for Science and Technology (CONACYT, by its Spanish acronym). For its significant achievements, INECOL received the State Environment Prize of Veracruz in 2008, in the Academic category, awarded by the government of Veracruz through the State Ministry of the Environment.

In 2008, the Network of \textit{Beaucarnea} spp. in the National System of Phytogenetic Resources for Food and Agriculture (SINAREFI, by its Spanish acronym) with a team of 12 academics and 8 students interested in the systematics of the group and the study of different species distribution. The network was formed with the general aim of investigating the \textit{Beaucarnea} species for the conservation and exploitation of this national phytogenetic resource, specifically to: 1) generate knowledge – fundamental and applied – of the species and their habitat; 2) strengthen scientific collections, herbariums, germplasm banks, and botanical gardens; 3) market the plants within a framework of public policies and environmental standards; and 4) train human resources and build capacities for knowledge of the genus.
The work of the Beaucarnea network was aimed at designing a medium and long-term project to share specific experiences in order to standardize methods of study and information to contribute to the formation of a working team and to support the PROFEPA and customs representatives to recognize seized species as products of illegal harvesting and trade. Future work includes a comparison of the most well-known species (B. pliabilis, B. recurvata, B. inermis, and B. gracilis), field work, and organization of the information for medium-known species (B. goldmanii, B. purpursii, and B. hiriartiaeae), and the generation of knowledge for lesser-known species (e.g. B. compacta, B. guatemalensis, B. sanctomariana, and B. stricta).

5 Concluding remarks

The experience of the project shows that traditional farmers identify and value their natural resources, but most lack the technical skills and capital to exploit these sustainably. Species of high biological and economic value can be incorporated into production processes, facilitating the conservation of biodiversity within the framework of the UMA. By diversifying production, additional financial resources are obtained that can help improve the living standards of rural communities, generate employment, and reduce migration of rural workers. UMAs, where properly managed by the owners of the resource, can be a viable method by which to conserve and exploit the resources of the region. This depends on the technical capacities, such as ecological knowledge, organization for production, and access to markets. Finance schemes are required for sustainable conservation projects. The establishment of the UMA 3rd of May could help counter the illegal trade in ponytail palm and the destruction of its habitat, and the tropical dry forest in general. Participatory research and knowledge transfer, coupled with greater interinstitutional coordination, is the most appropriate process by which to influence actions and policies of conservation.

References


