ETHNOBOTANY SERVING SOCIETY: A CASE STUDY FROM THE SIERRA DE MANANTLÁN BIOSPHERE RESERVE

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ABSTRACT

The move to place biological diversity and traditional cultural knowledge into the mainstream global economy is based on the premise that economic subsidies will stimulate conservation. This premise is arguably counterproductive if the effects of such subsidies are not felt at the local level. Ethnobotanical research should focus on characterizing traditional knowledge to establish priorities with the local community to ensure that local values are translated into rational use of resources and effective conservation of biological diversity and cultural knowledge. A case study focussing on twenty-five of the most locally valued plants from a community in the Sierra de Manantlán Biosphere Reserve provides an example of recommendations that can be made based on basic ethnobotanical inventories.

RESUMEN

La tendencia a ubicar la diversidad biológica y el conocimiento tradicional dentro de la corriente de la economía global, se fundamenta en la premisa de que las subvenciones estimularían la conservación. Esta premisa resultaría contraproducente si los efectos de tales subvenciones no llegaran al nivel local. La investigación etnobotánica debería enfocarse en el uso del conocimiento tradicional para establecer las prioridades conjuntamente con la comunidad local, para asegurar que los valores locales se traduzcan en el uso racional de los recursos naturales, una conservación efectiva de la biodiversidad y el conocimiento cultural. Un estudio de un caso en una comunidad de la Reserva de la Biosfera Sierra de Manantlán, que examina veinticinco de las especies vegetales con mayor valor local, proporciona un ejemplo de las recomendaciones que pueden hacerse en base a la información de inventarios etnobotánicos.

Ethnobotany has arrived at center stage in the world of biological conservation and sustainable development (Alcorn 1995). The research efforts of ethnobotanists who document and analyze how people and cultures use and classify plants is now much more than an academic exercise, it has become a focal point for biological conservation (Wilson 1992) and sustainable

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development (Reid et al. 1993). Chemical ecologists and natural product chemists have renewed interest in the research ethnobotanists and anthropologists conduct among traditional peoples from remote corners of the world. Renewed interest in ethnobotany stems from a new applied research field known as chemical or biodiversity prospecting (Eisner 1990; Eisner & Beiring 1994; Reid et al. 1993; see also Balick 1994; Cox 1994; Farnsworth 1994). Prospecting refers to the identification and use of previously unstudied genes and the primary and secondary metabolites of organisms that can remedy existing human illness or improve well-being by reducing loss due to crop pests, or by simply increasing the yield of our few cultivated crops. Entrepreneurs hope that placing biodiversity and diverse cultural knowledge into the mainstream global economy, nature's products will facilitate treatment of the many ills that befall society today and at the same time will help us to avert the human induced surge of biological extinction.

The biological conservation agenda (Wilson 1992) sees the importance of biological diversity from this same vantage pointing out that the utilitarian or economic arguement is the strongest in favor of conservation. The valuation of biological diversity will help to avoid extinction which reduces our ability to confront existing and future social costs such as producing enough food, and curing existing and unforeseen disease. There are myriad other arguments that form part of this agenda that hinge on the indirect values of biological diversity or ethical issues such as the right of one species to extinguish another. However, the value of biological diversity has become a central issue among conservationists. And many development efforts today are investing in biological diversity banking on the possibility that this vast store of natural products might yield the gene sequence or new chemical compounds that will revolutionize plant industry or health care possibilities. Many conservationists believe that the value of such discoveries can be translated into far-reaching conservation efforts. We believe they can. However, the economic arguement has significant consequences both for ethnobotany as a discipline and ethnobotany's long-term integration with biological conservation.

Placing ethnobotany and ethnobotanists in this situation may have created a gold rush mentality that is justified because extinction rates are higher than ever before and are increasing most dramatically where biological diversity is greatest. We hope that is not simply an accommodation to global economy that will subject the discipline to the ultimate risk of any fad, viz. waning long-term interest. If we cannot save it, perhaps we can at least model the chemical structure of its secondary metabolites and gain insights that will improve our survival possibilities. The risks of losing future options makes ethnobotanical research worth the investment (Martin 1994; King & Tempesta 1994).

An equally important justification for ethnobotanical research is no less academic than chemical prospecting but is complementary and practical. Ethnobotanical research should not focus solely on the big ticket items but also on a more general knowledge of local plant use because such information is relevant in regional land use planning frameworks to ensure rational use of natural resources at the local level and provide the basis for sustainable conservation programs. Efforts to conserve biological diversity are contingent upon the willingness and capacity of the local human population. Willingness is determined by the value the biota has to the local community. Capacity is determined by the local communities' ability to translate this value into realistic economic terms. Loss of traditional knowledge about utility of the local biota hinders conservation efforts because the local population may no longer consider the biota or its utility valuable or lack the ecological capacity to translate it into relevant social and economic terms. Ethnobotany should be conducted within this conservation-development framework because effective conservation of biological diversity depends on the individual or community's ability to apply their own culturally relevant cost-benefit analysis of conserving or extinguishing the local biota in attempting to resolve local community problems. The best justification for conducting ethnobotanical research is simply that such research is one way of assuring that arguments in favor of conserving local biota are based upon local values.

Here we provide one example of how ethnobotanical research can be used in integrating conservation and development. This example provides a short list of plant species with local value and recommendations of how such uses might be integrated into a community forestry project in a Biosphere Reserve in western Mexico.

The Sierra de Manantlán Biosphere Reserve (SMRB) is an integrated conservation and rural development project in southern Jalisco and Colima, Mexico (Graf et al. 1995; Jardel 1992). The SMBR developed out of the discovery of a wild perennial relative of corn (maize), *Zea diploperennis* Iltis, Doebley and Guzman. This species was discovered in a very restricted area of agricultural lands in the community of Ayotitlán in Manantlán (Benz et al. 1990; Iltis et al. 1978). The combination of the potential economic value of this endemic species, the extremely rich biota of Manantlán (Jardel 1992) and the social and economic problems of the rural populace led to the creation of a research institute by the University of Guadalajara devoted to the administration of the Reserve in 1985 and the establishment of the Reserve by federal decree in 1987.

This biosphere reserve extends across the community-held lands of twenty-eight *ejidos* or indigenous communities and the private properties of seventy families. Creation of this reserve did not change land tenure, but

it did place limits on land use in certain areas. The reserve's buffer zone has guidelines for natural resource use while natural resource use is prohibited in the core zone.

The area's biological diversity is especially significant with more than 2770 vascular plant species and 560 species of vertebrate fauna occurring in at least nine distinct types of vegetation (Vazquez et al. 1995). Agriculture and animal husbandry have been the dominant forms of livelihood in spite of the fact that the area is dominated by forest ecosystems. During the last century, utilization of Manantlán's forests has increased in importance. Unfortunately, the area's rural communities did not receive the economic benefits that resulted from forest exploitation during the last fifty years, because the concessionaires frequently avoided paying the appropriate tax, or the community as a whole was not the recipient of such a tax (Jardel 1992). There can be little doubt that the area's principal vocation is forest use. From a conservation and development standpoint it should be stressed that use of the forests must be primarily for the benefit of the local population which must counterbalance use with maintenance of existing biological diversity.

At present only a single community in the Sierra de Manantlán Biosphere Reserve (SMBR) holds a permit for commercial timber extraction. Most community lands in the Reserve are subject to harvesting of forest products by the local population because these activities are alleged to have less impact upon the forests than commercial timber harvesting and they are not regulated by existing legislation. The single community holding a commercial permit, El Terrero, is an *ejido* of ca. 3000 hectares with a population of 360 which operates its own saw mill.

The ejido of El Terrero is located on top (between ca. 2000 and 2500 meters above sea level) of the Cretaceous-age massif known locally as Cerro Grande located at the east end of the Reserve. Forests are composed of mixtures of pines and oaks while the highest altitude peaks are forested by fir (*Abies* spp.) and cypress (*Cupressus lusitanica* Mill.) and the protected drainages are blanketed by diverse and relictual stands of Montane Mesophytic Forest (Rzedowski 1988).

A management plan for the *ejido*'s forest was drafted by the University of Guadalajara's Instituto 'Manantlán' de Ecología y Conservación de la Biodiversidad (IMECBIO) under agreement with the community (Jardel et al. 1995). This management plan and accessory environmental impact statement are a prerequisite for commercial logging. This plan establishes the parameters of cutting, monitoring actions and mitigation alternatives in the event that exploitation has adverse effects on existing natural or cultural heritage. One of the appendices to the management plan included an ethnobotanical evaluation of the area's flora and vegetation. This techni-

cal document, which is the basis for this essay, was made available to the *ejido* assembly to complement the economic and ecological plans for harvesting timber from the *ejido*'s forests. The focus of the aforementioned appendix was to recommend forest product use from the results of ethnobotanical research that might satisfy some of the *ejido*'s immediate needs. Readers interested in the specifics of timber harvesting are referred to the original management document (see Jardel et al. 1995).

ETHNOBOTANICAL RESEARCH GOALS AND METHODS

Ethnobotanical inventory in the Sierra de Manantlán was undertaken to assess the variation in cultural knowledge about the area's flora, determine the effects of current utilization on the area's flora, and to systematically record ideas, species and traditional management techniques that could suggest land use alternatives that would ensure a more rational use of resources (Benz et al. 1994, Jardel 1992:257–265). The needs of each local community were given first priority based on the premise that this focus would gain community support for any subsequent proposed actions that might be needed to mitigate conservation problems. Hence species occurring in the immediate vicinity of the communities - those occurring within a two kilometer walking distance - that were identifiable (i.e. had flowers or fruits), were used in interviews during our short but seasonal visits. The general inventory was concerned with recording and analyzing the diversity of ethnobotanical knowledge using a systematic method of data collection (details of collection, interviewing, and data management are provided in Benz et al. 1994).

Persons providing information were informed of the goals of this project and of its relevance to the implementation of the Reserve's management plan. While not all informants were in complete agreement with the Reserve's objectives (principally because of potential conflicts over land tenure), all who agreed to collaborate provided information on plant use knowing that it was being collected to assure its conservation and would be made available to them upon request. Our own interest in the systematic collection of this information included securing alternatives that might assist in resolving existing and future needs of the community, as well as for seeking solutions to the needs of other communities in the Reserve. We felt justified in considering alternatives for all communities because of the need to conserve the biota in the Reserve as a whole, not just that in any one community even though information discussed here was elicited from El Terrero informants using species that occur in close proximity to the community.

Of the 517 plus species occurring in the forests of El Terrero, at least 152 of the 253 species used in informant interviews have been designated

as useful. A total of 43 informants (17 males, 46.3 ± 14.4 years old, range 21 to 72 and 26 females, 37.3 ± 17.5 years old, range 12 to 88) were interviewed over a four year period. On average each provided 8.4 ± 10.6 reports of use for all of the species used in interviews (see Benz et al. 1994). Each species was recorded as useful by an average of 5.3 ± 4.9 informants. Eleven species were recognized as useful by more than 15 informants and thirty-six species reported as useful only once and by a single informant.

Importance values were calculated to provide each species with a relative measure of local use value based upon the assumption that the total number of reports of use, the sum of the different types of use and the total number of informants agreeing that a species is useful provide appropriate measures of a species' usefulness to the community (Benz et al. 1994; Phillips & Gentry 1993; Phillips et al. 1994; interested readers should consult the original articles for details on calculating these indices). These importance values have been utilized as a means for recommending species based on the belief that a higher value indicates the species has greater relative importance to community members and thus has greater potential for resolving community needs.

Relevant information of a species' utility also comes from outside the community. A local herbal remedy (or other specific use for a species) that is used throughout the country (hence our frequent citation of Mexico's Instituto Nacional Indigenista publication on medicinal plants [INI 1995]) leads us to suggest that potentially greater economic benefit might be available to the community if greater investment was made to increase production and/or distribute the product more widely. Such occurrences need to anticipate demand and plan production to ensure the local resource is not over exploited. In a similar fashion, when a particular species is locally preferred for a specific use, e.g., house construction, recommendations for its extraction or planting need to be contemplated in anticipation of community needs.

Recommendations are offered for the *ejido* of El Terrero in its entirety. The forest management plan proposes timber harvesting in only a fraction of the total *ejido* area (Jardel et al. 1995). Because the habitat requirements of some plant species are found only in certain vegetation types and these will probably not be subject to timber exploitation, some recommendations may seem out of place. It should be made clear that our recommendations were offered for planning management of all the *ejido*'s forests, not only those slated for timber harvest. Furthermore, the data on which these recommendations are based are derived from existing knowledge and patterns of resource use. Our recommendations attempt to integrate these traditional patterns with recommended timber harvesting schedules. Recommendations for many species will have to be made compatible with the *ejido*'s forest management plan, restricting, for example, exploitation of

species found only in Mesophytic Forest which is protected by standards outlined in the Reserve's Management Plan.

The forest management plan divides the *ejido*'s 38 most common tree species into four management categories (Jardel et al. 1995). A single species of oak, *Quercus crassipes* Humb. & Bonpl. is included in Category I, the species considered most significant for timber production. One of the species included in Category 2 of the *ejido*'s management plan and in our short list, *Q. obtusata* Humb. & Bonpl. (Table 1 and 2), is recommended for exploitation, not for lumber, but for cellulose, firewood or charcoal. Three of the species listed in Table 2, *Arbutus xalapensis* McVaugh and Rosatti, *Prunus serotina* Ehrh. and *Ternstroemia lineata* DC. are included in Category 3 which are destined for producing firewood, charcoal, posts, cellulose and woodworking because the species occur on *ejido* lands in low volumes. Other tree species considered below (Table 2) are placed in Category 4 of the *ejido*'s management plan. Exploitation of natural populations of these species is restricted because the species are rare, regeneration is low, or current legislation or reserve management guidelines mandate special protection. The species listed in Tables 1 or 2 and included in this category are *Q. laurina* Humb. & Bonpl., *Q. rugosa* Nee, *Alnus jorullensis* H.B.K., *Cercocarpus macrophyllus* C. Schneid., *Styrax ramirezii* Greenm., and *Symplocos citrea* Lex. Species listed in Tables 1 and 2 and not mentioned above are not given additional management recommendations by Jardel et al. (1995).

ETHNOBOTANICAL RECOMMENDATIONS FOR EL TERRERO

It should be made clear that we have not yet validated the efficacy of the traditional remedies or determined the economic feasibility of marketing additional quantities. The former will require extensive toxicology and clinical evaluations which will be undertaken in the future. Marketing of plant products from the species described below has been a subsistence endeavor of the local people for many years. Unfortunately, harvest and sale of some may have given them an unfair market advantage that clandestine exploitation offers (i.e. no limits on harvest quantities, no payment of institutional overhead, sale at unofficial rates). Whether increased production of theses products through managed exploitation can be accommodated in existing markets will require a detailed market evaluation. However, interviews with retail and wholesale vendors have established the existence of local, regional and national markets that are far from saturated with the products that might be available from El Terrero. Literature citations are provided to indicate that certain uses have persisted over time or that other markets may have existed in the past. Recommendations are offered to suggest that local processing of marketable plant products appears to be feasible because the market is already known to exist.

TABLE 1. Useful plant species from the ejido of El Terrero with values greater than two standard deviation units from the mean for one or more indices of importance. Most species are included because their values on Phillips' overall use value exceed 2s. The importance values listed include: number of reports of use from all informants (Reports; see Benz et al. 1994), total number of informants that identify the species as useful (Infos), the number of occasions when the species was presented to an informant to elicit information (Events), the number of general categories the plant is used for (of thirteen possible), and use value and overall use value described in detail by Phillips and Gentry (1993:19).

Taxon	Reports	Infos	Events	Uses	Use Value	Overall Use Value
Prunus serotina	73	21	24	69	61.0	2.9
Quercus laurina	48	19	25	45	34.7	1.8
Symplocos citrea	39	14	18	37	28.5	2.0
Styrax ramirezii	39	17	24	38	26.2	1.5
Rubus adenotrichos	35	17	22	34	26.5	1.6
Ternstroemia lineata	32	12	14	26	23.5	2.0
Baccharis pteronioides	30	19	19	27	27.0	1.4
Comarostaphylis discolor	30	12	16	30	21.5	1.8
Celastrus pringlei	28	18	23	28	22.5	1.2
Rubus pringlei	27	17	18	24	23.0	1.4
Crataegus pubescens	26	12	12	24	24.0	2.0
Smilax moranensis	25	16	20	24	19.5	1.2
Quercus rugosa	22	9	10	22	20.0	2.2
Quercus obtusata	17	5	5	13	13.0	2.6
Fragaria mexicana	16	16	16	16	16.0	1.0
Quercus scytophylla	13	5	5	13	13.0	2.6
Cercocarpus macrophyllus*	11	5	5	10	10.0	2.0
Quercus crassipes*	6	3	3	6	6.0	2.0
Xylosma flexuosum*	4	2	2	4	4.0	2.0
Zanthoxylum arborescens*	2	1	1	2	2.0	2.0

* These species have been eliminated from Table 2 because they have importance values that although significant appear to be an artificially high because the number of different uses is exactly twice the number of informants.

The order of presentation of the species is based on Table 1, the order of local importance based on relative use values calculated from reports of use elicited from the inhabitants of El Terrero.

Capulín, (**Prunus serotina** Ehrh.) is a widespread but locally rare tree occurring in the Mesophytic, *Abies*-Pine-Oak and Pine-Oak Forests of the *ejido* of El Terrero. It is used for a wide variety of purposes by the local population (Tables 1 and 2). The fruit is highly appreciated for making fruit drinks and punches. The bark and less often the leaves and flowers are prized ingredients for preparing cough remedies, and treating abdominal pain and diarrhea among other ailments (INI 1995; Hill 1952). The wood has been worked into fine furniture and cabinetry in the past (Hill 1952) but because of limited availability it has fallen into disuse.

The bark and leaves from felled trees should be collected and processed for sale. The wood of this species was previously used for furniture and

TABLE 2. Twenty-seven plant species recommended for incorporation in forest exploitation program for the *ejido* of El Terrero based upon importance values, their potential in *ejido* forestry programs and the existence of a local market for some or all of a species' products. The uses listed are arranged in order of the frequency in which they were elicited.

Taxon	Local Uses
Prunus serotina	Edible, medicinal, construction, firewood, furniture, forage, fence posts, instruments
Quercus laurina	Construction, firewood, instruments, furniture, forage, medicinal, edible, fence posts
Symplocos citrea	Edible, instruments, construction, forage, fence posts, furniture
Styrax ramirezii	Forage, construction, edible, firewood, instruments
Rubus adenotrichos	Edible, medicinal, forage
Ternstroemia lineata	Medicinal, construction, firewood, fence posts, instruments
Baccharis pteronioides	Instruments, medicinal, forage, edible
Comarostaphylis discolor	Edible, firewood, fence posts, forage, furniture
Celastrus pringlei	Forage, edible
Rubus pringlei	Edible, medicinal, forage
Crataegus pubescens	Edible, medicinal, forage
Smilax moranensis	Edible, forage, instruments
Quercus rugosa	Edible, firewood, instruments, forage, construction
Quercus obtusata	Construction, firewood, forage fence posts, furniture
Fragaria mexicana	Edible
Quercus scytophylla	Construction, edible, forage, medicinal, furniture, firewood
Alnus jorullensis	Instruments, firewood, construction, fence posts, forage, medicinal
Arbutus xalapensis	Medicinal, instruments, firewood, furniture, forage, edible
Marrubium vulgare	Medicinal
Sambucus mexicana	Medicinal
Lepechinia caulescens	Medicinal
Buddleia sessiliflora	Medicinal
Gnaphalium americanum	Medicinal
Myrcianthes fragans	Edible, medicinal, construction

cabinetry and also as support bases for scientific instruments, for making patterns and turnery (Hill 1952:97) because of the beauty of its grain and the ease with which it is worked. While many of the uses of this wood are no longer competitive, the beauty and ease of working will always be appreciated. Local use in furniture manufacture would appear to be a promising enterprise. Anticipating relatively low quantities in existing forests leads one to suggest that this species be incorporated into nurseries.

The encino chilillo (**Quercus laurina**) is one of the oak species listed in Category 4 of the *ejido*'s management plan that show potential but whose merits have not yet been evaluated. The species occurs principally but not exclusively in Mesophytic Forest. Apart from the wood being highly prized for construction timber, firewood, tools, furniture, and fence posts, its acorns are a preferred fodder and acceptable foodstuff, and its bark is widely appreciated in Mexico for treating tooth-aches, diarrhea and other less commonly cited maladies (INI 1995).

Exploitation of this species should consider harvesting the bark as soon as

the tree is felled. It should be dried in the shade if sold for commercial purposes.

Symplocos citrea Lex., or Chico, is a medium to large tree occurring most frequently in Mesophytic Forest. The most frequently cited use by the local inhabitants is for its edible fruits, consumed both by humans and domestic animals. Other reports refer to use of the wood which is suitable for tool handles, construction timbers and fence posts. No reference is made to its use as firewood.

Felled timber might be used first to satisfy domestic construction and fencing needs. Consumption of the fruit is widely acknowledged suggesting that nutritional evaluation would be useful to determine its potential as a foodstuff. Fruit-harvesting does not appear to be intense enough to warrant concern or regulation.

Palo de Casa (**Styrax ramirezii** Greenm.) is a small understory tree found principally in Mesophytic Forest. Leaves and small branches are used as fodder for domestic animals and the stout branches and trunk are preferred for use in house construction, hence its common name. Populations of the species might need to be monitored if house construction increases.

Two species of blackberry (zarzamora, **Rubus adenotrichos** Schlecht.and **R. pringlei** Rydb.) are actively collected in El Terrero. Both species occur in Mesophytic Forest while the latter also appears as an element of Oak Forest. The acid fruits are used in fruit drinks and liqueurs and the leaves, branches and roots are prepared to treat diarrhea (INI 1995).

Both species are colonizers of forest openings and aggressively hold territory once established. Openings in Oak forest created by timber harvesting might be planted initially with blackberry while regeneration is underway. Cultivated populations would probably have to be managed under such conditions to ensure that pine or oak seedlings are not affected. Collection and sale of fruits from natural populations is a very remunerative activity that would be greatly enhanced through cultivation. Harvest of leaves or the roots for sale as ingredients in traditional remedies would be possible once forest regeneration had begun to limit fruit production.

Tila or Jazmincillo (**Ternstroemia lineata** DC.) is a common understory tree of the Oak and Mesophytic Forests on *ejido* land. The most common use of the species is as a medicinal remedy (INI 1995) although its wood is also used for construction timber, firewood, fence posts and tool handles. Fruits and flowers (actually the sepals and pistil that persist after the corolla has fallen) are collected during the dry season from trees in forest clearings, along roadsides and in house gardens, dried, and sold. Although collection may involve all members of the family, women and children devote substantially more time to all aspects of commercialization than men. A large national market exists for the flowers and fruits of tila.

Tila is a shade tolerant species that is widespread in the forests of the

ejido. Exploitation of the wood is contemplated in the *ejido*'s management plan. The wood is reported to be useful for construction and firewood, less so for fence posts or tool handles. Cultivation of the species for its wood does not appear to be a priority (Jardel et al. 1995) due probably to its ecological requirements and a lack of known marketability. Integrating the species into management of the forests should be sought knowing that a national market exists for the fruits and flowers, and that members of the community already devote considerable time to collection and commercialization. Integration may be difficult because tila is a late successional species and does not produce well under such natural conditions. One alternative might be to plant it in openings along logging roads and along the margins of clearcuts. Cultivation in such open areas might permit greater fruit production earlier than normal allowing flower and fruit collection during periods when forests in adjacent areas are regenerating. A second alternative might be to experiment with mixed plantings of oak and tila thinning tila as the oaks begin to dominate.

Baccharis pteronioides DC. (cuaracata) is an understory shrub of *Abies* Forest. It is locally prized for making brooms and for use in medicinal remedies. Domestic needs appear to be satisfied without undue pressure on local populations. Insufficient information is available to determine whether the species might be cultivated for medicinal purposes.

Madroñillo (**Comarostaphylis discolor** (Hook.) Diggs), is an understory shrub that occurs in Mesophytic Forest. The fruit is edible and the wood is commonly used for firewood and fenceposts. Fruit palatability appears to be quite variable suggesting that nutritional profile and palatability studies be made if the species is considered a candidate for managed production.

Celastrus pringlei Rose (bejuquillo relumbroso) is a canopy liana occurring principally in Mesophytic Forest. It often appears in clearings and along roadsides throughout the *ejido* as well. It is one of the locally preferred forage plants and the aril is also edible. The bark is infrequently reported to have medicinal properties.

The importance of the plant as a forage is widely recognized suggesting that when stands destined for logging that contain the species are located, harvest of the foliage should take place prior to logging to ensure that the felling of large canopy trees acting as supports for this and other lianas (e.g. see *Smilax moranensis* below) will not disturb subcanopy trees. Such harvesting could satisfy some of the forage needs of families that possess livestock.

The edible fruits of tejocote (**Crategus pubescens** (H.B.K.) Steud, also known locally as manzanillo) are widely appreciated in Mexico as an ingredient in holiday punches. The fruits are widely sold in markets though price differentials for larger cultivated varieties and wild collected fruit are

not apparent. This species occurs in disturbed areas, as well as in Oak and Mesophytic Forests. The roots of tejocote are also very widely harvested for medicinal purposes for a vast array of illnesses and extracts are known to have cardiotonic activity (INI 1994).

This species could be cultivated more widely in the *ejido* especially in abandoned *milpas* and pastures. It has a significant though seasonal local market that is otherwise satisfied with fruit transported from regional market centers. Local focus on extraction of roots for medicinal purposes may have had a negative impact on existing populations. Determination of the efficacy of extracts from other parts of the plant could be an especially timely undertaking to anticipate and understand the impacts of root harvesting.

Asierrilla (**Smilax moranensis** Martens & Galeotii) is a canopy liana apparently restricted to Mesophytic forest. It is highly esteemed locally as an edible green (Cevallos 1992). Medicinal use of the roots is well-known in other parts of Mexico (INI 1994) as is that of tropical relatives (Arvigo & Balick 1993).

If restricted to Mesophytic Forest, it is unlikely that this species will be encountered in forests destined for timber harvest. Cultivation of the species in clearings and house gardens is suggested should collection of local stands ever intensify. The root of the species is commercialized throughout Mexico. Harvest of populations existing in logging tracts should be planned in anticipation of cutting for reasons already mentioned in the case of bejuquillo. Market evaluation should be undertaken if pharmacological activity shows promise. The species is extracted from natural stands in other parts of Mexico suggesting that protection may be necessary in the future.

Two additional species of oak (avellano, **Quercus rugosa** Nee and roble negro, **Q. obtusata** Humb. & Bonpl.) are widely recognized as useful by the people of El Terrero. Jardel et al. (1995) report both from a variety of forest types in addition to Mesophytic Forest. Avellano (roblillo in Jardel et al. 1995) is most frequently reported for its edible acorns and less frequently for the multiple uses of its wood while roble negro is more often identified for the usefulness of its wood or the medicinal value of its bark (INI 1995). The latter species is included in Category 2 in the *ejido*'s management plan and will probably be exploited commercially.

Harvest and commercialization of the bark of *Q. rugosa* should be considered if the species is incorporated into timber harvesting cycles. Use of oak barrels for aging tequila or mescal might be pondered as a viable market for the wood of these oaks. The fact that *Q. rugosa* has edible acorns implies that acorn production of this species and perhaps other oak species might be systematically harvested by livestock (cf. Peattie 1950:210–211).

Fresa cimarrona (**Fragaria mexicana** Schlect.) is an herb found principally in *Abies* or Pine-Oak Forests. Its edible fruit are widely appreciated

but the plant does not produce sufficient quantities nor large enough fruits to merit large-scale sytematic harvesting nor commercial production. The populations found in El Terrero may be useful as a source of germ plasm.

Roble negro (**Quercus scytophylla** Liebm.) is a canopy tree that occurs principally in Mesophytic Forest. The utility of its wood is well-known though it is just as likely to be mentioned as a source of edible fruit or for its medicinal bark. The same recommendations made for *Q. rugosa* or *Q. obtusata* can be made for *Q. scytophylla* though its distribution in Mesophytic Forest will probably restrict its exploitation.

Aile (**Alnus jorullensis** H.B.K. subsp. **jorullensis**) is a medium-sized tree occurring in *Abies*, Pine-Oak Forests and Oak Forests. It is prized locally for tool handles fabricated from its wood as well as for its use as a construction material and for fuel. Leaves and wood are used medicinally in Puebla and Sonora (INI 1995). It is reported least frequently as a forage in El Terrero.

The species might be useful in restoring degraded areas as a forage because it is known to grow with associated nitrogen fixing organisms (Langenheim & Thimann 1982; Noggle & Fritz 1976).

Madroño (**Arbutus xalapensis** McVaugh & Rosatti) is a locally rare but widely occurring medium-sized tree found in most all forest types in the *ejido*. It is recognized locally for the medicinal properties of its bark. A related species is used medicinally in the state of Baja California Sur. The wood is very hard and has recognized potential for tool handles, furniture or firewood.

This species is included in Category 3 of the *ejido*'s management plan, hence exploitation of its wood is anticipated. Local use of the bark for medicinal purposes might signal economic potential.

Five of the six species added to Table 2 are discussed here because most have known market value and are commercially exploited for the national medicinal plant market (INI 1995) even though their use value indices are not significantly greater than the norm. Local vendors in Jalisco and Colima obtain these plants from wholesale markets (Los Abastos, in Guadalajara) or from local collectors. All five species occur in forest openings or disturbed areas. Three of the five (*Marrubium vulgare* L., *Lepechinia caulescens* (Fernald) Epling, *Buddleia sessiliflora* H.B.K.) are aggressive perennial weeds and could be cultivated in forest clearings prior to or during replanting and regeneration and harvested very intensely once the regenerating tree species establish themselves. The last species in Table 2, (*Myrcianthes fragrans* (Sw.) McVaugh) is a small to medium-sized tree that occurs in Mesophytic Forest. The fruits are consumed fresh or used to make fruit drinks. The species is highly esteemed as a flavoring agent and medicinal species and shows great potential for commercial use in herbal teas. Consideration might

be given to intensifying fruit production in areas that are opened up through clear-cutting by planting the understory after the forests have regenerated.

It should be noted that many of the species listed in Table 2 that have economic value individually, could be combined and commercialized as herbal teas or as traditional remedies. For example, Sauco (*Sambucus mexicana* Presl.), is a widely sold medicinal species that has been combined with other species, e.g. *Quercus rugosa* and *Crataegus pubescens* as a cough remedy (cf. INI 1995). Other combinations from the list of 152 species are possible but should be evaluated to determine whether a market exists.

CONCLUDING REMARKS

Recommendations offered to the *ejido* of El Terrero focus on a few selected products available from local forests whose importance is already recognized by community members. Our suggestions attempt to integrate existing patterns of use with a more focussed and systematic commercialization of timber and nontimber forest products into the *ejido*'s forest management plan. Benefits derived from these recommendations will be available first to members of the community; thus investments made by the *ejido* itself to evaluate the potential of certain resources in greater detail, e.g. nutritional quality or pharmaceutical activity of certain species, will confer benefits over the long-term directly to the community. Decisions to implement these recommendations will be a function of the *ejido*'s own understanding of potential costs and benefits. The ethnobotanist's input in helping the *ejido* to understand these costs and benefits is crucial because both social and economic impacts of implementing these recommendations require both the perspective of the community and an independent ecological and economic assessment on the part of the researcher. Loss of biodiversity through inappropriate use of natural resources might not be readily apparent to community members but its impact will be felt globally. Recommendations for use of forest resources need to be evaluated periodically to ensure that benefits to community and environment outweigh their costs. Ethnobotanical work in the ejido of El Terrero is only beginning. We now need to follow up on the community's evaluation and implementation of our recommendations and those made on the remaining 127 species of plants that the community recognizes as useful.

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