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# The Management of Small Diameter, Lesser-Known Hardwood Species as Polewood in Forest Communities of Central Quintana Roo, Mexico

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**ABSTRACT.** Diversification in resource management can serve as a strategy to increase both economic well-being and environmental sustainability in rural communities, especially in tropical forested regions. This paper documents and analyzes the recent and rapid regional commercialization of small diameter, lesser-known tropical hardwood species as polewood in Quintana Roo, Mexico, presenting the promises and perils for sustainable management and resource diversification in the context of Mexican economic development and community forestry. We present data

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from interviews with local farmers and forestry officials involved in community management of timber resources to reveal baseline information regarding the use and management of polewood, locally called palizada. We found the same permitting system used for high-value timber was implemented for polewood without recognizing the complex ecological characteristics of polewood and the different metrics by which polewood and high-value timber are bought and sold. These factors, coupled with an unstable market for this new forest product and potential for overexploitation, present a difficult situation for the sustainable management of polewood. We conclude that incorporating local ecological knowledge in devising polewood management strategies can strengthen local governance and is an essential aspect of managing this emerging market of forest products.

**KEYWORDS.** Common property, community forestry, forest management, lesser-known species, Maya, Mexico, polewood, Quintana Roo



Over the past decade, researchers have suggested that diversification in resource management can serve as a strategy to increase both economic well-being and environmental sustainability in rural communities, especially in poor forested regions (Ellis, 2000; Angelsen & Kaimowitz, 2001; Vedeld et al., 2004). Mexico—a country with roughly 80% of forests under a common property regime and widespread community forestry—has shown several successful examples of effective governance of forest resources (Taylor, 2001; Bray et al., 2003; Velasquez, Torres, & Bocco, 2003). The Maya forests of the Mexican state of Quintana Roo have been recognized as a major center of community tropical forest management in Mexico. Although most aspects of forest use in this region have been anchored historically around the exploitation of high value timber (Kiernan and Freese, 1997; Kiernan, 2000; Bray et al., 2003); Bray et al. (2004) report a deforestation rate of 0.1%, which is quite low compared to other tropical areas in the country and across Latin America. Still, it is problematic to claim that forest resources in Quintana Roo are not threatened. This is evident from (a) the current effects of historical overexploitation of mahogany and (b) a rapidly expanding tourism sector that places new demand on local resources. This paper presents empirical data on the recent and rapid commercialization of small diameter, lesser-known tropical hardwood species; and discusses the promises and perils for sustainable management and resource diversification in the context of Mexican economic development and community forestry.

The forests of central Quintana Roo are classified as tropical deciduous forests with an annual rainfall of 1000–1300 mm per year (Miranda, 1958; Snook, 1993). There is a marked dry season peaking around March and April, when many tree species drop their leaves for a short time (Pennington & Sarukhan, 1968). Forests stand on extremely calcareous soil, with elevations between 0 and 200 m above sea level. Periodic natural disturbances of hurricanes and fires, and the human disturbance of shifting agriculture have resulted in a landscape that contains various even-aged stands. Mahogany (*Swietenia macrophylla*)—also called big-leaf mahogany or Honduran mahogany—is the tree species around which existing management plans have been structured. It has an average natural distribution of only one full-sized, mature individual per hectare, and occurs in clumped distributions (Snook, 1993). The rest of the forest canopy is composed of more than 100 other tree species of which the most abundant are *Manilkara zapota* and *Brosimum alicastrum* (Miranda, 1958; Medina, Cuevas, & de los Santos, 1968; Pennington and Sarukhan, 1968).

Mahogany and, to a lesser extent, Spanish-cedar (*Cedrela odorata* L.) extraction still accounts for most forestry activity in the region, even though harvests have continued for more than a century (Chaloner & Fleming, 1850; Lamb, 1966; Snook, 1993; Mayhew &Newton, 1998). Mahogany still represents a major source of forest-based income among forest communities in Quintana Roo, whose residents actively control and use approximately 500,000 ha of commercial forests (Richards, 1992; Kiernan and Freese, 1997; Snook, 1998; Kiernan, 2000). However, decades of both legal and illegal exploitation of big-leaf mahogany and Spanish cedar, as well as land-use conversion to agriculture, have led to at-risk populations of these high value timber species in tropical southeastern Mexico (Taylor & Zabin, 2000; Forster et al., 2003). An untapped forest from which new sources of commercial-size high value timber can be obtained no longer exists in central Quintana Roo. Other forest products, including lesser known species (LKS), are currently being explored to diversify timber markets in the region (Forster et al., 2003). However, most potential timber species serve as poor substitutes for mahogany as high valued timber because their specific weight is either too high or too low, and because few species have the desirable red coloring of mahogany (Forster et al., 2004).

The region has also been a focal point of government-initiated large-scale tourism development, which has further strained natural resources.

In the 1970s, Mexico's ambitious tourism planning board chose to develop tourism in the Yucatan peninsula to complement the success of Acapulco on the west coast of the country. Large sums of money were invested in infrastructure, highlighting the beaches in the area of Cancun and transforming the area into a premier tourism destination. The tourism industry quickly spread south to an archeological site at the northern limits of Sian Ka'an Biosphere Reserve, forming what is known as the Cancun-Tulum corridor and attracting millions of tourists each year (Cornejo, 2004). Recent works have illustrated some of the detrimental social and environmental effects of tourism—which include cultural stratification and local resource depletion, as well as ecological degradation of forests, ocean, and soils (Pi-Sunyer & Thomas, 1997; Juarez, 2002). Local residents find employment in tourism—mostly in labor and construction—but also sell small volumes of crafts and agricultural and forest products to the tourism centers.

In recent years, several species of hardwood trees have become a popular commodity in central Quintana Roo, with a steady demand for small diameter hardwood trees (5–30 cm diameter at breast height [dbh]) emerging concurrently with the expansion of the state-wide tourism sector. These species are utilized commercially in tourism facilities as polewood, locally termed *palizada*, to build a rapidly increasing quantity of rustic beach huts as well as other constructions. Increasing harvest rates of other LKS reveal its potential to complement mahogany as an important commercial timber resource in the region (Forster et al., 2003). The development of market opportunities for polewood could greatly increase available resource utilization, generate income, and create employment. However, the potential for overexploitation is also strong, as a rapidly growing market creates incentives for increased harvest. Additionally, an increase in the selective harvest of smaller diameter trees may have significant ecological implications. For sustainable management of polewood to develop, an effective management regime must be established. As this article will demonstrate, the current permitting system for timber extraction—originally focused on mahogany harvests—is ill-equipped to handle sustainable polewood extraction for at least three reasons. Firstly, a large number of polewood species with different ecological characteristics makes understanding sustained yield volumes difficult. Secondly, an ease of harvest of polewood, which requires no infrastructure or equipment, may encourage illegal harvests. Management guidelines are difficult to enforce due to the small size of polewood and ease of transport. Finally, rapidly changing demand in a developing polewood market may shift market characteristics unpredictably. Therefore, effective diversification of forest alternatives and management of LKS as polewood requires us to look beyond the traditional framework of mahogany management. This article attempts to do that by examining local knowledge and use patterns of polewood species, and exploring whether existing policies and permitting regulations are suitable for polewood management.

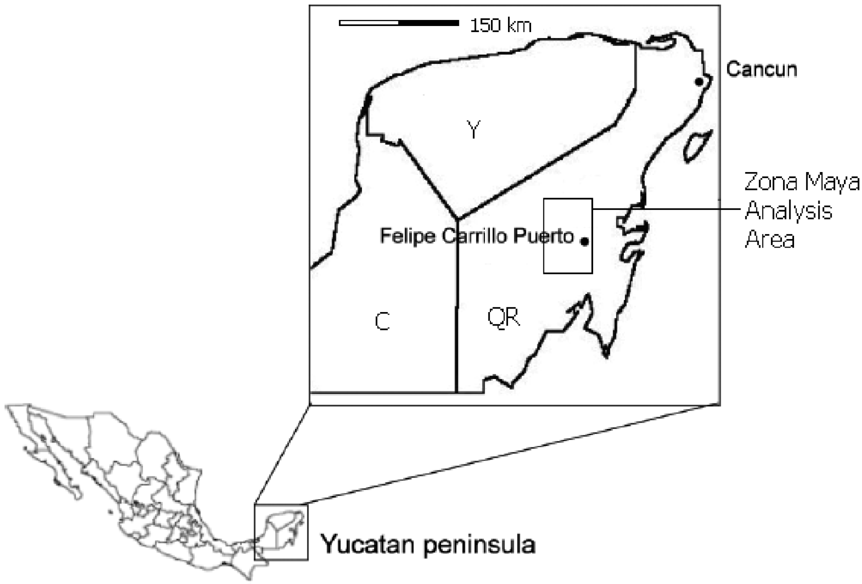
In this context, we present data from interviews with farmers and local and state-level forestry officials involved in community management of timber resources to provide baseline information regarding local knowledge, use, classification, existing permitting practices, and patterns of consumption and exchange. Our objective is to describe local knowledge about species most useful and in high demand as polewood and to examine whether this knowledge matches the mechanisms and information used by forestry officials for permitting polewood. In an attempt to generalize a strategic framework for management that can be applied to this region, we suggest the incorporation of local knowledge into existing forest policy as a tool for participatory management and an incentive for strengthening local governance.

## METHODS

The interviews and observations described in this paper were conducted in two case study forest communities of Central Quintana Roo in the analysis area of the municipality of Felipe Carrillo Puerto (Figure 1) (N19°08.3’, W088°09.2’). Local collaborators identified four communities in the region already involved in the organized sale of polewood. From these we selected one community that seemed most willing to participate in this study. Another case study community was selected from a pool of communities not officially involved in the sale of polewood. This community was selected because of its interest in entering the polewood trade and willingness to participate in the study. The two case-study communities are ejidos, or collective land grants, that have a low stock of commercial high-value timber, and as such, are representative of several other ejidos in the municipality. Thus, this work provides a generalizable, preliminary assessment of polewood extraction and its potential as an alternative source of income for forest communities in the region.

We identified tropical species in the Maya forests that are currently used and sold as polewood using focus groups in each community. The

FIGURE 1. Map of study area. States of the Yucatan Peninsula are depicted as follows: Y = Yucatan, C = Campeche, QR = Quintana Roo.






information from each community was combined to provide a list of species used and sold as polewood, along with a consensus on the use and classification of each species, highlighting the local classification of each species. In July, August, and December 2004 we conducted structured and informal discussions, focus groups, semi-structured and structured interviews, and recorded personal observations. Focus groups were conducted in Spanish and Yucatec Mayan with a local translator. Semi-structured and structured interviews were conducted in Spanish. Extensive data about local use classification and knowledge of distribution of species used and sold as polewood, particulars about market exchange of polewood, harvesting, and building techniques were collected in case study communities. We asked focus group participants to list tree species used as polewood along with any specific uses. One Mayan farmer collaborated through the entire period, participated in the focus group and multiple interviews, and provided much insightful information and clarification. We cross-referenced local common names with a list of scientific names provided by local forestry technicians (based on Pennington & Sarukhan, 1968). Other scientific names were verified with available published works (Pennington and Sarukhan, 1968; Ogata et al., 1999).

Other interviews were conducted with government officials and agency staff to understand and characterize the existing regulatory framework for the use, management, and sale of these species. Formal interviews with forestry technicians from the Organization of Forest Ejidos of the Mayan Zone (OEPFZM)—a local community organization that oversees local forestry issues—and state officials from the Ministry of Natural Resources (SEMARNAT) and the Federal Agency for Environmental Protection (PROFEPA) were conducted in Felipe Carrillo Puerto and Chetumal, respectively. Additionally, 22 forest permits of ejidos in the municipality were obtained from the OEPFZM and reviewed.



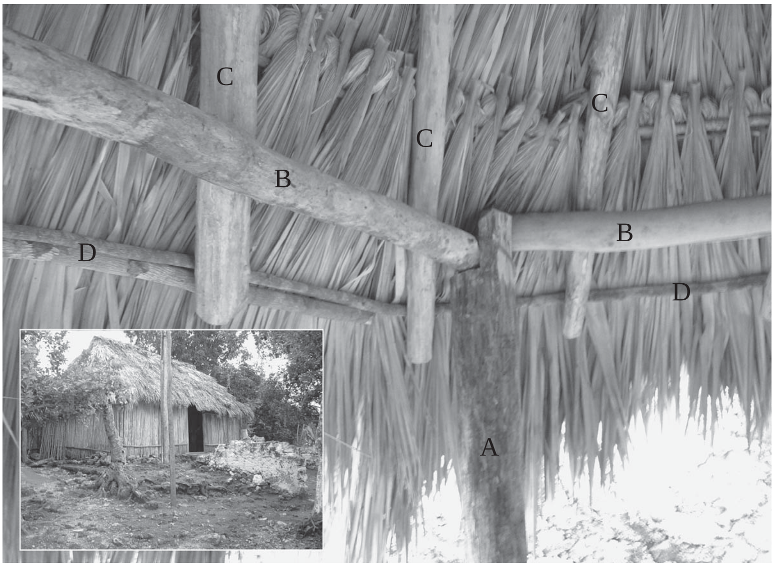
## *RESULTS AND DISCUSSION*

### *Local Use of Polewood*

Historically, local Mayan residents have collected small diameter trees to use as building materials for homes and other constructions, selecting from a gamut of hardwood species from under the forest canopy (Rico-Gray, 1991). A single traditional Mayan home may use more than 90 main poles that serve as the frame, and up to 300 poles that serve as the walls (see Figure 2). Typically, polewood species are extracted from forested areas once they reach a diameter at breast height (dbh) anywhere from 3 to 30 cm, depending on use-classifications (Chemás, & Mandujano, 1991). Local farmers categorize polewood species into five different use-classifications, determined by the species and the diametric size at which they are harvested (Table 1).

Resulting data from a focus group show that, aside from *bajareques*, all other polewood is collected from the understory, not from the secondary succession. Farmers involved the focus group report that they harvest poles for posts, beams, and frame supports (*hiles*) from under the forest canopy because these poles meet the silvicultural properties that they seek. They agree that they would never collect these materials from successional forests, because these stems would not likely be of the same "quality" as those collected from the forest understory. Specifically, farmers seek specific tree species that are known to be dense and rot resistant, as in the case of those harvested as posts and beams, or thin and flexible yet

FIGURE 2. Example of frame of a Mayan home, depicting the many different components of construction. A = posts (*postes)*, B = cross beams (*largeros)*, C = roof beams (*encañaduras)*, D = flexible frame supports (*hiles)* (Inset: Mayan home, central Quintana Roo, Mexico).




durable for use as *hiles*. *Hiles* are used as frame support, and must be flexible enough to bend around the frame. Farmers report that many trees species growing under the canopy and in the absence of light develop slower and are therefore denser. *Bajareques*, on the other hand, are straight poles, non-discriminatorily harvested in terms of species and collected from secondary successional forests within a couple of days of the full moon, which reportedly makes them less susceptible to insect infestation (Vogt et al., 2002). Under the other polewood use classifications, aside from *bajareques*, a total of 32 species are harvested and sold (Table 2), several of which are considered commercial timber by forestry officials.

The historic exploitation of understory tropical trees for polewood has recently increased dramatically in response to an emerging market for use in the construction of touristic huts and buildings in the expanding tourism sector of the Cancun-Tulum corridor. Extraction is expected to escalate to meet new demand resulting from recently approved plans for the mass development of tourism of the coastal area north of the Belizean border (Pavelka & Ell, 2003).

TABLE 1. Local use-classification of polewood and specific characteristics

| Local Use-Classification | Use | Diametric Requirement (dbh) | Silvicultural Properties | No. of Different Species Reported | Area in which Harvested |
|---|---|---|---|---|---|
| *Postes* | Post | 25–30 cm | Rot resistant hardwood | 10 | Under forest cover |
| *Largeros* | Cross beam | 15–20 cm | Rot resistant hardwood | 16 | Under forest cover |
| *Encañaduras / wikinche* | Roof beam | 10 cm | Rot resistant | 20 | Under forest cover |
| *Hiles* | Frame support | 3–5 cm | Flexibility | 6 | Under forest cover and sometimes from secondary forests |
| *Bajareques* | Wall poles | 5–8 cm | Resistant to insect borers | Many | Successional forests |

An increase in the selective harvest of smaller diameter trees may have significant ecological implications, especially in ejidos with low volumes of high value timber. Many of these trees are harvested at small diameters and some of the species, such as *canatzin* (*Lonchocarpus rugosus* (Lundell) M. Sousa) (see Table 2), are harvested at various diameters for various uses. If harvested as *hiles* (3–5 cm dbh), it is likely that *canatzin* is cut before its reproductive age, and therefore high levels of extraction could affect future populations. Additionally, these trees are typically harvested from relatively intact forest stands, and as such these individuals add to forest structural diversity by serving as the midcanopy and as replacement trees for the upper canopy (SEMARNAT, personal communication, August 2004). The removal of such individuals may have severe effects on forest composition, structure, and regeneration.

Locals unanimously agree that the harvesting of understory individuals can have serious implications for sustainability. Local harvesters recognize that many high quality polewood species are increasingly rare, especially for posts and beams. Trees collected from under a forest canopy are more desirable, since these stems are considered more durable and resistant to rot than poles collected in secondary growth. Although locals only use poles from the forest understory to build their own homes, many

TABLE 2. Polewood species and uses, as identified by focus group

| Common Name | Scientific Name | Family | Use | | | |
|---|---|---|---|---|---|---|
| | | | Posts (28–32 cm dbh) | Cross Beams (15–25 cm dbh) | Roof Beams (8.5–10 cm dbh) | Hiles (2.5–4 cm dbh) |
| Bohom, bohum | *Cordia alliodora* (Ruiz & Pav.) Oken[a] | Boraginaceae | | X | | |
| Boob | *Coccoloba spicata* Jacq.[b] | Polygonaceae | | | X | |
| Canatzin | *Lonchocarpus rugosus* (Lundell) M. Sousa[2] | Leguminosae Fabiodeae | X | X | X | X |
| Canchunup | *Thouinia paucidentata* Radlk.[b] | Sapindaceae | | | X | |
| Chackte | *Acosmium panamense*[c] | Leguminosae Fabiodeae | | | | X |
| Chacktekok | *Simira salvadorensis* (Standl.) Steyer.[a,b] | Rubiaceae | | X | X | |
| Chackteviga | *Caesalpinia platyloba*[c] | Leguminosae Caesalpiniodeae | X | X | X | |
| Chakni´che | *Eugenia* sp.[c] | Myrtaceae | | | X | |
| Chanche | Unknown | | | | | X |
| Chauche | *Adelia barbinervis* Cham & Schl[b] | Euphorbiaceae | | | X | |
| Chintok | *Krugiodendron ferreum*[c] | Rhamnaceae | X | X | | |
| Cokche | *Castilla elastica* Cerv.[a] | Moraceae | | X | | |
| E´juule´ | Prob. *Drypetis lateriflora* | Euphorbiaceae | | | | X |
| Elemuy | *Mosanona depressa* (Bailon) R.E. Fries[b] | Annonaceae | | | X | X |
| Ickche | Unknown | | | X | X | |
| Jabim | *Piscidia piscipula* (Blake) I.M. Johnst.[a] | Leguminosae Fabiodeae | X | | | |

(*Continued*)

TABLE 2. (*Continued*)

| Common Name | Scientific Name | Family | Use | | | |
|---|---|---|---|---|---|---|
| | | | Posts (28–32 cm dbh) | Cross Beams (15–25 cm dbh) | Roof Beams (8.5–10 cm dbh) | Hiles (2.5–4 cm dbh) |
| Jabón | Unknown | | | | X | |
| Katalox | *Swartzia cubensis* (Britt.& Wilson) Standl.[a] | Leguminosae Fabiodeae | | | X | |
| Pakalche | Unknown | | | X | | |
| Pi´, Pichiche | *Psidium sartorianum* (O. Berg) Nied.[a] | Myrtaceae | | X | X | |
| Pukulsikil | Unknown | | | | X | |
| Sakukum | Unknown | | | X | | |
| Subinche | *Platymiscium yucatanum* Stand.[a] | Leguminosae Fabiodeae | | X | | |
| Sumche | Unknown | | | X | | |
| Tastab | *Guetarda combisii* Urban[b] | Rubiaceae | | X | X | |
| Titzya | *Dipholis salicifolia* [c] | Sapotaceae | X | X | | |
| Tsutzuk | *Parmentiera aculeata* (Kunth) Seem.[a] | Bignoniaceae | X | | | |
| Tzalam | *Lysiloma latisilqua* (L.) Benth.[b] | Leguminosae Mimosoideae | X | | | |
| Ulchuche, Siliil | *Diospiros cuneata* Standley[b] | Ebenaceae | | X | X | |
| Xulil | Unknown | | | | X | |
| Ya´ - zapote | *Manilkara zapota* (L.) Van Royen[a,b] | Sapotaceae | X | X | | |
| Yaax´eek | *Prosopsis juliflora* (Swartz) DC[b] | Leguminosae Mimosoideae | X | | | |

[a]Pennington & Sarukhan (1968), [b]Ogata et al. (1999), [c]OEPFZM, personal communication, August 2004.

locals have shifted their commercial harvests from the understory to secondary growth forests in cases where intermediaries do not or cannot discern the different qualities. However, under the current regulatory framework, secondary growth areas are not typically included in the legally harvestable area. Therefore, commercial harvests are usually restricted to relatively older forests, and government regulation ignores potential harvests from younger forests that may have a lower ecological impact.

In addition, several respondents recognized the potential for polewood removal as a tool for active forest management—as a form of forest thinning. Selective polewood removal can open up space and light which may aid the development of lower growing, more valuable timber species. The implications of this practice—while quite promising—have not yet been fully explored.

## *Managing Polewood Extraction*

Forestry is highly regulated in Mexico; all legal extraction activities require a detailed and costly management plan conducted by a forestry technician and approved by the federal government. Communities have rights to the monetary benefits of timber extraction. However, they must harvest timber under government guidelines. This system functions relatively smoothly for permitting mahogany extraction, but the current system is ill-equipped to handle polewood permitting simply due to the physical nature of the resource.

Common property theory suggests that certain resources are easier to govern than others due to their physical characteristics (Ostrom, 1990). Resources that are easier to govern include those that have a small geographic range, have clear boundaries, can be stored, are stationary, and are difficult to transport (i.e., a small, fenced-in pasture is easier to govern than wild game in a large forest with many entry points). Literature on decentralization of natural resource governance suggests that the central governments should be able to set and enforce minimum standards for resource extraction by local groups in order to ensure sustainable management without excessively burdensome management plans (Ribot, 2004). The existing system of commons management and government regulation allows for sustained mahogany harvests under a common property regime. However, polewood presents a potentially different scenario. Based in the theories above, examination of (a) the physical characteristics of the resource and (b) the current polewood permitting process shows that under the current system of management, permitting, and enforcement; polewood may not be successfully governed in the future.

Although mahogany and polewood are both considered timber resources, several important physical differences make management and enforcement of polewood difficult both at the community and government level. These include the fact that polewood is smaller, much more mobile than mahogany, requires no special equipment to harvest or transport, and has a shorter harvest rotation. The first three characteristics—size, mobility, and ease of extraction—create incentives for rule-breaking and difficulties in monitoring polewood harvests. In contrast, for a community to harvest mahogany, they need to mark trees, fell them with chainsaws, and transport logs out of the forest to the mill. It is very difficult for individual, illegal mahogany harvests to occur in the area, simply because individuals do not have access to the required technology. Even if access were available, community members or government officials would take notice, either in the felling and transport process or at the mill. This is clearly not the case with polewood. Any person, either on his own community's land or on another's, can cut a number of poles with a machete and carry them away with little effort. This activity is very difficult to monitor, and therefore illegal harvests would be very difficult to detect. Adding to these monitoring difficulties is the fact that polewood is used for personal consumption in the construction of homes (see Figure 1), which does not require a permit. Authorities from PROFEPA report that individuals may harvest a few poles at a time, making it difficult to determine whether polewood is extracted for subsistence or for sale. Combine these physical characteristics with inadequate permitting (described below) and increased demand (described in the next section), and the potential for unsustainable management is evident.

Recognizing increased rates of polewood harvest, SEMARNAT began to issue permits for commercial polewood extraction to complement any pre-existing community rules for subsistence use. However, the same system used for mahogany was implemented for polewood, without recognizing (a) the need for polewood-specific forest inventories, (b) the complex ecological characteristics of polewood, (c) the need for polewood-specific permits, and (d) the different metrics by which polewood and mahogany are bought and sold. These specific issues are each discussed below.

Polewood permits are based on forest inventories; however, these inventories were conducted prior to the commodification of polewood and focused on high-value species—mahogany and Spanish-cedar in particular. For this reason, existing inventories likely do not reflect true populations of polewood and thus may be inaccurate (SEMARNAT, personal communication, August 2004). In addition, forest inventories are restricted to older, relatively mature forests, and thus ignore the potential for using secondary forests outside of the permitted harvestable area. This presents problems in determining total potential volume and maximum allowable harvests, and consequently there is lack of available information for making management decisions.

In addition, polewood permitting is problematic because of the numerous species used as polewood and the relatively poor understanding of their ecological characteristics. Polewood permits are extrapolated from forest inventories of standing timber stocks and take no consideration of population ecology and the reproductive/regenerative dynamics of each polewood species (SEMARNAT, personal communication, August 2004). Additionally, little is known about the ecological characteristics of polewood species that could potentially be harvested from secondary growth forests. Furthermore, in some timber permits, polewood allotments are not species-specific and instead are assigned as a general category. For example, in many cases, a list of species may be included on a permit for polewood but no specific harvest amounts are listed for each individual species. In other words, an ejido with an allowable harvest of polewood could choose evenly from the list and diversify their harvest, but may have incentives to lean towards the most common species, the species which can command the highest price, or the species that is easiest to access or harvest. This is potentially problematic because certain species may be overexploited while others are not used at all, presenting issues for species and ecosystem diversity conservation.

Even more fundamental than the proper distribution of species harvested is the inaccurate description of polewood species listed on the permits. Since little is known about polewood on a regulatory level, permits for polewood are seemingly assigned to species that fit two basic criteria: straight and long. For example, of the species listed under polewood in the permit for the case study ejido, results from focus groups show only two of the nine species listed on the permit are actually considered useful for polewood. Many of the trees that locals say are best for construction and most commonly sold as polewood are not listed under the official permit. In addition, species such as *tzalam* (*Lysiloma latisilqua*) and *jabin* (*Piscidia piscipula*) are listed on the official permits under a different category, termed tropical hardwoods. This is a saw log category, and as such, the timber extracted has higher diametric limitations, and harvesting these species as polewood is in effect against regulations. In other ejidos in which no polewood species are specifically listed on permits, species listed under tropical hardwoods may potentially be harvested as polewood, and hence are harvested at a smaller diameter. These examples show how inaccuracies in the permits create direct contradictions of permitting standards. All of these issues present problems for sustainable management.

Finally, polewood as a marketable product is sold per pole, not per cubic meter as is sawn lumber. The metric used in all permits, however, is the standard of cubic meters, and therefore is inconsistent with pricing standards. A “cubic meter of polewood” has no fixed price or market reality. The value depends on pole size, length, and species. Thus, as communities harvest polewood, they may tend to maximize the value of their allowed “cubic meters” by overharvesting valuable species, creating further management issues.

The preceding discussion highlights the potential difficulties in community management and government enforcement, as well as an inaccurate understanding of what is being taken from the forest. The permitting system has regulated and sustained mahogany harvests within a common property framework. However, this framework may not work with polewood; extraction may become more of an open access situation, and the impacts on the forest may not be well managed or understood.

## *Polewood Market Dynamics*

Concerns about the regulatory system are even more justified given the rapidly expanding and highly incomplete market for polewood. An analysis of 22 forest permits from communities in the Maya Zone shows that polewood harvest may represent almost 10% of total timber harvests in the region (Table 3). In 6 of 22 communities (28% of the communities reviewed), polewood represents 15% or more of total harvestable timber— a significant portion of potential income. Data from interviews with several community members and local forestry technicians suggest that this market is growing and has the potential to continue expanding in the future. This potential is further exemplified by the regulatory reaction: polewood permits have only been recently issued in an effort to curb exploitation and in anticipation of growing demand with the expansion of the tourism sector in the southern part of the state (OEPFZM, personal communication, July 2004).

Information collected suggests that this new market still has not fully developed; this is evident from differing levels of integration into

TABLE 3. The relative contribution of polewood to total allowable annual timber harvest in 22 forest communities in the Maya Zone, Quintana Roo, Mexico

| Community | Total Allowable Timber Harvest ($m^3$/year) | Polewood $m^3$/year | Polewood % of Total |
|---|---|---|---|
| Yoactun | 2600 | 100 | 3.8% |
| Laguna Kana | 1750 | 100 | 5.7% |
| Tulum | 3430 | 200 | 5.8% |
| Kampocolche | 830 | 50 | 6.0% |
| X-Maben | 4600 | 300 | 6.5% |
| Chuhunhub | 1525 | 100 | 6.6% |
| Santa Maria | 3050 | 200 | 6.6% |
| Naranjal Poniente | 2800 | 200 | 7.1% |
| Cafetal | 1790 | 140 | 7.8% |
| Yaxley | 1850 | 150 | 8.1% |
| Tres Reyes | 1800 | 200 | 11.1% |
| Ch. Sta. Cruz | 1335 | 150 | 11.2% |
| Chanca De repente | 1266 | 145 | 11.5% |
| Chuhuas | 1700 | 200 | 11.8% |
| San Juan | 735 | 100 | 13.6% |
| Andres Quintana Roo | 1400 | 200 | 14.3% |
| Reforma Agraria | 665 | 100 | 15.0% |
| Cuauhtemoc | 300 | 50 | 16.7% |
| Dzoyola | 1100 | 200 | 18.2% |
| Tabi | 925 | 200 | 21.6% |
| San Antonio | 377 | 100 | 26.5% |
| X-conha | 645 | 195 | 30.2% |
| TOTALS | 36473 | 3380 | 9.3% |

*Source:* Delegación Federal en Quintana Roo, Programa de Manejo Forestal para el Aprovechamiento de Recursos Forestales Maderables—Forestry Permits 2001–2003, unpublished data.



commodity chains and highly variable prices. Not all communities with polewood permits are selling regularly or at widely accepted prices. There are two types of seller communities: those that are integrated into a commodity chain and those that sell polewood opportunistically. For those integrated into a commodity chain, intermediaries enter a community and order a set quantity of wood, returning in 3 to 7 days to collect the polewood in a large trailer. Community members go into the permitted harvest area and select stems that fit the buyer's diametric and length criteria. Within a limited harvest area, a complete removal of individuals of a specific species within a diametric range is common. The few remaining individuals usually do not meet either the size limits or expected bole quality (i.e., distorted or forked). If a large quantity is ordered, polewood extraction can be quite intense and exhaustive in a given area. Typically, the money earned from sales is supposed to be evenly distributed among all community members, although it is proportionally given to those who help with harvest and processing.

In the case of opportunistic sellers, smaller-scale intermediaries enter communities and usually transport orders in a pick-up truck, and often deals fall through. It is common to see cords of polewood on the roadside, many of them decaying. In general, interview data suggests that sellers that are integrated into the commodity chain make sales that are more regular and in line with permit guidelines. Opportunistic communities make more irregular sales and may make more clandestine harvests. This bifurcated market may present issues both in regulating polewood extraction and reaching the market equilibrium.

Unlike the steady prices of high value timber, prices for polewood are highly variable. Typically, communities that have integrated into a commodity chain can command a higher price, while others that sell their polewood opportunistically usually sell at a reduced rate. The difference between these prices is large and prices for polewood are very volatile, with the prices depending predominantly on the relationship of the sellers with the intermediary (OEPFZM, personal communication, July 2004). In the case of one community where the intermediary is a community member, the prices are relatively high. According to Victoria Santos, technical codirector of the Organization of Forest Ejidos of the Maya Zone, prices estimated per cubic meter can be competitive with that of mahogany; with the price of posts (30 cm dbh by 5 m length) reaching 300 pesos (about US$30) per stem. However, other ejidos may sell these same stems for 30 pesos (US$3).

Exacerbating the potential problems of the highly imperfect polewood market is the shifting property rights regime in Mexico. The modification of Article 27 of the Mexican Constitution in 1992 made it possible for communities, upon agreement of members, to subdivide communal land into titled, private plots. While this is not intended to apply to forested land, some ejidos may have used this as an opportunity to further subdivide communal forests illegally (Braña-Varela & Martinez-Cruz, 2004). The extent and impact of the change in agrarian laws varies widely across communities, and in some ejidos that have voted to privatize all land—including forested lands—these changes further complicate polewood management. In these ejidos, community members are simply selling their proportional share of authorized volume of polewood, allowing intermediaries to purchase their annual individual share of wood; undermining the communal management of forest resources. There could also be the effect of initial overexploitation as locals find a new opportunity for income generation, as has occurred in parts of India (Agrawal, 2001). While subdividing communal land may create new opportunities for income generation through polewood harvests, the benefits of common property management are lost; including, perhaps most importantly, locally-driven monitoring and enforcement (Ostrom, 1999).

It is hoped that markets for sustainable forest products can both reduce incentives for forest clearing and provide economic benefits to local communities. However, the current market conditions may not achieve desired outcomes for sustainable resource management and poverty alleviation. Since polewood prices have not yet stabilized in a competitive environment and harvests may not be well-regulated, there is a risk that some communities could avoid management rules, capture the majority of sales, and overexploit forests. Therefore, satisfying existing demand could result in uneven harvests (ecological pressure) and uneven distribution of economic benefits from this expanding forest product market. Volatile prices have become a major issue among ejidos, with many community members expressing a desire for price floors to stabilize prices and prevent them from falling. However, price floors can induce more harvesting than what is economically optimal, leading to greater incentives to over-harvest and break rules; and this type of policy tool is increasingly unacceptable in a market-driven economy. A better option may be to try to correct market imperfections: the government can—in addition to redesigning the permitting process—support the sustainable expansion of polewood markets by making price information widely available to communities, intermediaries, and buyers. This would decrease the likelihood of communities accepting prices well below the market rate.

## *CONCLUSION*

A diversified participatory approach to ecosystem management has frequently been stressed by researchers and policymakers but in many cases inadequately applied in practice (Angelsen and Kaimowitz, 2001; Vedeld et al., 2004). In Quintana Roo, forest communities have placed emphasis primarily on high value timber production. A growing market for polewood—accompanied by the decline of mahogany harvests in the forestry sector—warrants the development of markets of these lesser-known species. Polewood, given its accessibility for harvest and transport, represents a promising as well as perilous forest alternative. The potential value of polewood may contribute significantly to forest livelihoods, and polewood removal may assist the development of other high value timber species as a form of forest thinning. However, the demand for these resources has yet to peak, and many locals are eager to exploit these resources to meet the market demand. The market for polewood is still in its infancy, characterized by imperfect information and a division of regular and opportunistic sellers. In this context, there are a host of inaccuracies in the permitting process, as well as a gaping discrepancy between local knowledge and permit information. These factors together present a difficult situation for the sustainable management of polewood.

The combination of community-level management and government regulation has been responsible for creating a system of sustainable mahogany harvests. This general strategy is also necessary for polewood; however, the specific system designed requires a different approach. Although a refined permitting process may facilitate a reduction in clandestine harvest of polewood currently observed, enforcement will be very costly (SEMARNAT, personal communication, August 2004). In addition, advocating for permits specific to each polewood species may be unreasonable because of the years of ecological research required, the costs of creating more detailed inventories and management plans, and the undue monetary burden this would place on communities to create plans. Overly complex management plans can be a barrier to local resource management, and a system of minimum standards can often achieve a similar goal (Ribot, 2004). In addition, as we have shown, local knowledge of polewood ecological characteristics is highly developed—far beyond the knowledge of forestry technicians. We suggest that a minimum standard approach can be applied, combined with less detailed plans that rely more on local knowledge than on forestry technicians. This would allow for adequate regulation as well as more accurate management than currently exists. For example, government regulations could specify a certain maximum percentage of total polewood that a community can harvest per year. The community would then be required to document estimates of existing quantities of each polewood species, and based on their local knowledge of ecological characteristics, determine which species should be harvested. This participatory process has the potential not only to improve the management system, but also create more community involvement in a growing polewood market. This could create more stakeholder involvement, reduce the potential for cheating, and make government enforcement less problematic (Klooster, 2000). This example is of course, only one possibility. The key aspects of these recommendations include not increasing the burden of government-issued permits and incorporating more participatory management. We conclude that incorporating local knowledge can strengthen local governance and is an essential aspect of managing this emerging forest products market.

The results presented in this article demonstrate a growing incongruence between local management and ineffective policies imposed by governmental agencies. An effort must be made to institutionally reinforce common understanding of forest situations and strategies among individuals, communities, and regulating and permitting agencies. Local involvement in this process can encourage management strategies according to shifting social and ecological realities of working forests. The growing market of polewood presents a unique opportunity for local cooperation and participation to help shape environmental and economic consequences. Assistance and encouragement by government—whether in the form of economic incentives, research, information exchange, or an attempt to facilitate cooperation and participation—should be seen as co-investments in a sustainable future (Taylor, 2001). We stress the need to modify forest policies and approaches in order to promote new ways for sustainable diversified forest management.

Further research will be needed to fully inform local land managers and governmental agencies of the environmental and economic implications of increasing polewood harvest. Specifically, more information is needed on the market chain of exchange and distribution, highlighting details of exchange, market prices, schedules, and sellers. Additionally, general demographic patterns of polewood populations subject to harvesting pressures can be projected using modeling tools to identify at-risk species. Other options for polewood production—such as in some local agroforestry systems—show promise but need further exploration (Racelis, 2003). To date, the potential of exploiting secondary forests have been overlooked because the current permitting and harvesting processes are restricted to inventoried areas. Research studying the ecological and economic dynamics of polewood harvest is currently underway, designed to be both participatory and interdisciplinary in order to effectively synthesize this information to provide an informed assessment of current and potential polewood exploitation.

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