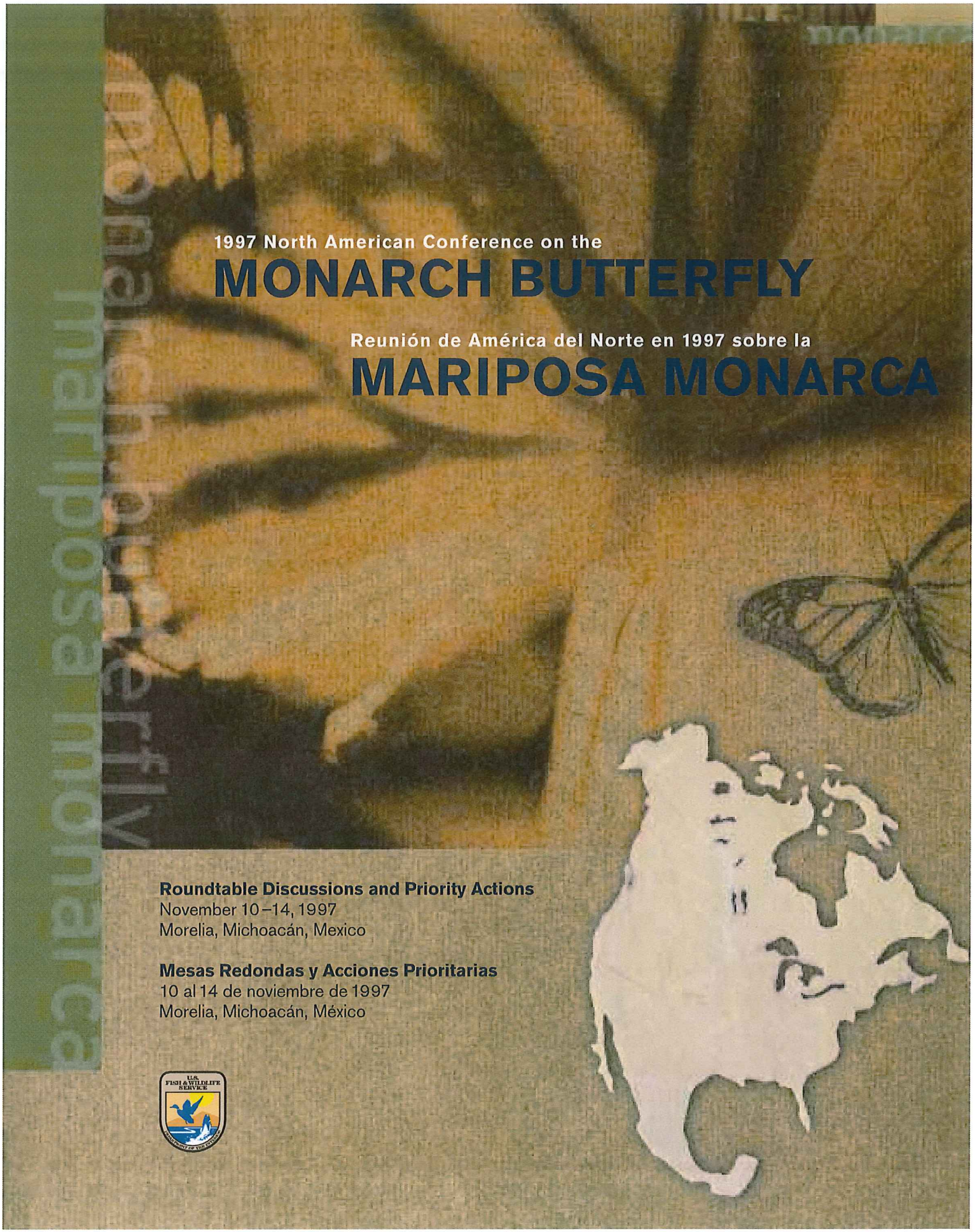

1997 North American Conference on the

MONARCH BUTTERFLY

Reunión de América del Norte en 1997 sobre la

MARIPOSA MONARCA

Roundtable Discussions and Priority Actions
November 10–14, 1997
Morelia, Michoacán, Mexico

Mesas Redondas y Acciones Prioritarias
10 al 14 de noviembre de 1997
Morelia, Michoacán, México

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Reunión de América del Norte sobre la Mariposa Monarca, 1997

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Compiladores/Edited by
Jürgen Hoth
Leticia Merino
Karen Oberhauser
Irene Pisanty
Steven Price
y/and
Tara Wilkinson

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Reforestation as a strategy for restoring monarch ecosystems

by ***Ed Rashin, Robert L. Small*** and ***José Luis Álvarez Alcalá***

Ed Rashin and Robert L. Small
The Michoacán Reforestation Fund
Santa Clara del Cobre, Michoacán, México

José Luis Álvarez Alcalá
The La Cruz Habitat Protection Project
Santa Clara del Cobre, Michoacán, México

Abstract

Deforestation in the monarch overwintering area in central Mexico has caused a pattern of significant ecosystem changes. This pattern is characterized by a diminished natural resource base for the *ejido* communities in the area, as well as ecosystem degradation associated with the extensive changes in forest cover. The degradation includes direct habitat loss and changes in the microclimate affecting overwintering butterflies, soil erosion and reduced soil productivity, and damage to aquatic ecosystems caused by erosion and sedimentation of streams draining the area, as well as changes in hydrology. The objective of the La Cruz Habitat Protection Project and the Michoacán Reforestation Fund is to conserve the forest ecosystems upon which the monarchs and human inhabitants of the area depend. The primary strategy developed and used by the La Cruz Project is to encourage reforestation of lands comprising *ejidos* as an alternative to ongoing forest thinning. As a result, it may be possible to counteract the conversion of forests to corn or barley fields on lands that are generally not suited to agricultural production (pers. obs.; Snook 1993; Soto Nunez and Vazquez Garcia 1993; Gonzalez de Castilla 1993). This strategy is accomplished by informing *ejido* communities of the values of recreating forests on lands that have been cleared, and providing tree seedlings and follow up support for reforestation. The first sites were reforested under this program in the summer of 1997. Over time, the trees that are planted will provide short-term income through the marketing of Christmas trees, and additional long-term income through the marketing of other forest products. The reforested areas will also be a sustainable source of subsistence wood for fuel and other domestic uses, thereby reducing the pressure on the remaining oyamel forests. Forest conservation and habitat protection goals will be achieved cooperatively, as the *ejido* communities participate in establishing a viable alternative to continued thinning and logging of the natural forests to obtain the wood they need.

Introduction and problem description

This paper describes some of the problems associated with deforestation in the El Rosario/Cerro El Campanario area (Michoacán, Mexico), presents the La Cruz Habitat Protection Project as an example of one solution that addresses these problems, and discusses the benefits of reforestation and its relationship to the conservation of forest habitat. Other studies of the problems caused by deforestation have suggested the development of alternatives, such as intensively managed forestry sites for extractive wood uses, as a way to shift the pressure away from the few areas of remaining oyamel forests (see, for example, Snook 1993). However, reforestation has not been widely implemented as a forest conservation strategy in the monarch areas, for a number of reasons. These reasons include inadequate resources and technical support for reforestation, and a lack of understanding and/or acceptance of this approach by the people who own the land, the *ejidatarios*. The La Cruz Project may be the first such project that focuses specifically on creating usable forest stands on *ejido* landholdings that have been cleared and converted to agricultural uses.

There are at least three categories of problems or effects associated with past deforestation and current forest practices: 1) resource sustainability and economic issues affecting the *ejidatarios* living in the area; 2) ecological effects on the forest ecosystem, including effects on overwintering monarchs; and 3) physical watershed effects.

Resource sustainability and economic issues

One of the most critical problems caused by deforestation is the loss of a sustainable natural resource base for the *ejidatarios* who inhabit the area. This loss has both ecological and socio-economic implications. The reforestation approach being carried out by the La Cruz Habitat Protection Project, as discussed in this paper, is presented as a strategy to address these effects.

The oyamel fir forest (*Abies religiosa*) which comprises the monarch butterfly sanctuary at Cerro El Campanario is surrounded by extensive areas where the forest was cleared and subsequently converted to fields used for the growing of corn and other crops, such as barley (pers. obs.; Snook 1993; Soto Nunez and Vazquez Garcia 1993; Gonzalez de Castilla 1993). The human inhabitants of this area, members of the El Rosario *ejido*, are primarily subsistence agriculturalists. They need both fields for growing food crops and grazing, and forests to supply their wood needs and supplement their meager incomes. However, when forests were initially cleared for exploitation of timber resources, reforestation of the cleared lands was not accomplished. As a result of the extensive change in vegetative cover in the El Rosario/Cerro El Campanario area, the only wood source available to the *ejidatarios* is the remaining oyamel forest within and adjacent to designated sanctuaries and buffer areas. As a result, forest thinning continues.

These problems are not unique to Ejido El Rosario. Deforestation, forest thinning, and land conversion to agricultural uses threaten other monarch colonies and sanctuaries as well. Conservation of this oyamel forest ecosystem, the monarch overwintering habitat, and preservation of the endangered biological phenomenon of the monarch migration (Brower and Malcolm 1991), are difficult if not impossible to address without reversing the trend of converting forest lands to agricultural fields. It is essential that any viable solution provide local residents, who own these lands, with an alternative to continuing to thin the remaining oyamel forest in order to meet their needs for subsistence wood and income from the sale of logs.

The *ejido* communities in many of the monarch areas have no viable alternatives to exploiting the remaining natural forests for their domestic wood uses. Substantial amounts of wood are used on a daily basis for domestic purposes and to supplement household income by producing charcoal or building materials and selling firewood. Although figures on the amount of local fuelwood use by residents of the El Rosario *ejido* are not available, Snook (1993) presented estimates of domestic fuelwood consumption in the fir forest zone in the Mexican state of Veracruz at about 15 tons or 35 m^3 per year per household. She concluded that if similar levels of consumption occurred in the monarch areas, it would equate to a total consumption of 40,000 average-size fir trees per year by *ejidatarios* living in the areas surrounding the Chincua, Chivati-Huacal, and Cerro El Campanario sanctuaries. Since many of the families living in the El Rosario area are totally dependent on wood as a fuel for cooking and heating, reforestation of some of the cleared lands may be the only way to provide a sustainable local supply of wood for domestic uses in a manner that allows the remaining natural fir forests to be preserved.

Although lands where fir and mixed fir-pine forests were cleared are currently used to produce agricultural food crops, this is not necessarily the best use of the land from the standpoint of the *ejidatarios*. Because of the marginal nature of the soils and climatic conditions, corn crops grown on steep mountain sites have relatively little subsistence or cash value, producing only a fraction of what can be grown on more suitable agricultural fields. Shifting a portion of these steep lands to the production of trees for domestic wood consumption and income will need to be accompanied by a combination of more intensive agricultural production on more suitable fields (e.g., flatter land, with better soils), and use of income from tree growing sites to purchase corn that may have otherwise been produced on the reforested lands.

Effects on monarch habitat

In addition to the problem of a declining natural resource base for the *ejidatarios*, ecosystem changes associated with deforestation threaten the long-term survival of the monarch colonies that overwinter at Cerro El Campanario. Deforestation is directly associated with the loss of existing and available forest habitat for overwintering monarch populations. Furthermore, thinning of the remaining areas of oyamel forests, while a somewhat less definitive agent of habitat loss, may render some areas of forest unsuitable as habitat for successful overwintering by monarchs. It has been shown that forest thinning, where individual trees or limbs are selectively harvested, causes important changes in the microclimate, particularly wintertime temperature and moisture regimes, which adversely affect the overwintering butterfly colonies (Brower 1996; Alonso et al., these proceedings). These adverse effects include increased mortality due to exposure to freezing weather conditions and increased predation, as well as microclimate effects that trigger changes in the timing of spring migrations, leaving migrating butterflies susceptible to adverse early season conditions along their northward migration route.

Another adverse effect is the loss of a forest type and ecosystem which cannot be re-created through reforestation or intensive forest management. The oyamel forest ecosystem, which is the only suitable overwintering habitat for the entire migratory monarch population that breeds throughout eastern North America, is a relict forest ecosystem (Rzedowski 1978 in Snook 1993). The contemporary distribution of this forest type may be attributed to Pleistocene glaciation and the climatic changes that occurred over the 10,000 years after the glaciers receded. Today, these oyamel forests exist as islands on mountain tops in the transvolcanic belt of Michoacán and México States and a few other areas of Mexico. It has been estimated that only 40–50,000 hectares of oyamel forest remain in Mexico, and this estimate is based on an inventory that is over 20 years old (Snook 1993). Snook concluded that the patchy distribution and limited extent of the oyamel forest may make it the most vulnerable forest type in Mexico to the effects of deforestation.

Watershed effects

Adverse watershed effects of the extensive deforestation and past forest management practices include changes in hydrologic regimes and geomorphologic processes, affecting the condition of water resources and aquatic ecosystems. These effects were apparent during field observations of the severely aggraded condition of streams draining the El Rosario area (pers. obs. 1997). These streams are tributaries of Arroyo La Hacienda and the Rio Zitacuaro. The sediment load in this river system is out of balance with the capacity of the streams to transport sediment. This has resulted in substantial shallowing and widening of the stream channels, or aggradation, due to the excess of stored sediment. Combined with the effects of removing streamside riparian forests, this has negative impacts on aquatic life which rely on the habitat within streams (Waters 1995). It can also lead to increased flooding and stream bank erosion that affects human uses of productive agricultural land adjacent to the streams. It was also observed that, during seasonal runoff events, the chronic soil erosion and sediment pollution results in highly turbid water in the streams. This condition further affects the suitability of water resources for human and aquatic life uses (Newcombe and MacDonald 1991). By contrast, the streams flowing from forested areas in the upper basin produce clear water during runoff events.

There are several sources of the sediment pollution observed downstream of deforested areas. In other areas subjected to intensive timber harvesting, studies of sediment budgets have shown that logging roads are often the major source of sediment delivered to streams (Swanson et al. 1982; Rashin et al. 1997). Severely eroded logging roads that have not been properly designed and maintained to control drainage are common throughout the area, especially in the mixed fir-pine forests and pine-oak forests (pers. obs.). They are probably one of the major sediment sources in this drainage basin. Other sediment sources observed in the basin include landslides and gully erosion in the steep uplands where forests have been cleared, as well as surface erosion from agricultural fields. Degradation of soil resources due to erosion and depletion of soil nutrients are additional adverse effects of deforestation and conversion of forests to agricultural fields, that have long-term implications for the future of both forest and agricultural productivity in the area. Furthermore, depleted soils commonly require chemical additives to sustain even biennial or triennial corn crops. If these additives are used improperly, excess nutrients or pesticides can contribute to adverse water quality conditions downstream of the agricultural fields.

A Solution: the La Cruz Habitat Protection Project

The La Cruz Habitat Protection Project is taking steps to reverse the trends of forest conversion to agricultural fields and the continuing thinning of remaining mature forest stands. This is accomplished by shifting marginal agricultural lands back to forested lands that will provide usable resources and other economic benefits to the landowners. The project is focusing on reforestation of *ejido* lands where natural forests have been cleared for agricultural uses, as well as to exploit timber resources. In the El Rosario area, such plots of land are typically owned by individual *ejido* families. The focus on reforestation of cleared agricultural fields distinguishes this project from government-sponsored tree planting efforts in the Cerro El Campanario area. The government programs have tended to direct their efforts on planting seedlings in existing oyamel or mixed forest stands in order to supplement natural regeneration (pers. obs.). The La Cruz Project relies on voluntary participation by *ejido* landowners who have come to understand the benefits of growing trees on their lands for their own use. The degree of participation is determined by the number of seedlings available and the interest on the part of individual *ejidatarios*. The purpose of these reforestation efforts is to provide El Rosario residents and the residents of other *ejido* communities with an alternative to relying on remaining areas of natural forests, such as the monarch habitat areas, for their wood. The approach being used by the project was developed through experience gained by working with *ejido* communities on reforestation projects in the Santa Clara del Cobre area (Michoacán, Mexico).

The La Cruz Project is supporting reforestation at El Rosario in several ways. These include developing community awareness about the reforestation alternative, provision of seedlings, logistical and technical support for tree planting, and follow-up support and training for the long-term management of the reforestation sites. Before the first reforestation site was planted, substantial efforts were devoted to informing *ejido* leaders and individual landowners of the potential benefits of reforestation. The forest engineer who had been working with the *ejido* participated in this informational effort. As the *ejido*'s key community leaders became familiar with the reforestation concept, they assisted by obtaining the cooperation and participation of individual landowners.

Oyamel fir and pine seedlings are raised for the La Cruz Project at its nursery near Santa Clara del Cobre in central Michoacán. These are supplemented as needed with seedlings obtained from local nurseries in the Angangueo area, and delivered to the participating landowners at El Rosario. Locally-obtained oyamel seed is used to grow the reforestation stock for this species, in order to preserve the genetic properties of local forests. Because of special requirements, successful nursery culture of oyamel seedlings is more difficult than that of other tree species. This may explain why many other nurseries in the area focus on raising cedar. However, planting cedar does not offer the same benefits for ecosystem restoration and resource sustainability. In fact, planting the wrong trees works against the goals of restoring soils and forest ecosystems, because they are not a natural component of the high altitude, fir-pine forests characteristic of the El Rosario area (Soto Nunez and Vazquez Garcia 1993).

Monetary and in-kind contributions from individuals in the United States and Mexico have funded the La Cruz Project. These contributions make it possible to propagate the seedlings used by the project in its reforestation efforts. The contributions also cover the costs of transporting the seedlings to the sites where they are planted, and help pay for assistance with planting on individual sites. The planting provides an opportunity to train landowners, local workers, and volunteers in proper spacing and tree planting techniques. All this work must be accomplished during the brief rainy season from July through late August, which is the critical time for planting. Landowners are also instructed in the proper care of the young seedlings after they are planted. For example, the importance of protecting seedlings from damage by grazing animals is emphasized. The project continues to work towards the goals of sustainable forest management by providing follow up support for managing the woodlots established through these reforestation efforts. This includes monitoring tree survival and growth at the reforestation sites, and coordinating necessary maintenance activities such as re-planting and fencing to protect the trees from livestock damage.

After successfully establishing people-to-people relationships and increasing community awareness of the benefits of reforestation, the first sites were planted with fir and pine trees under this program in July and August of 1997. Four separate plots of land owned by members of Ejido El Rosario were reforested. The four plots totaled approximately 3.5 hectares. The location of the 1997 reforestation sites is shown on a map of the area in Figure 1. This map also shows the extent of forest cover, based on analysis of 1990 aerial

photographs of the area, and the approximate boundaries of the Cerro El Campanario monarch sanctuary and associated buffer zone. Roads and the major streams draining the area are also shown in Figure 1.

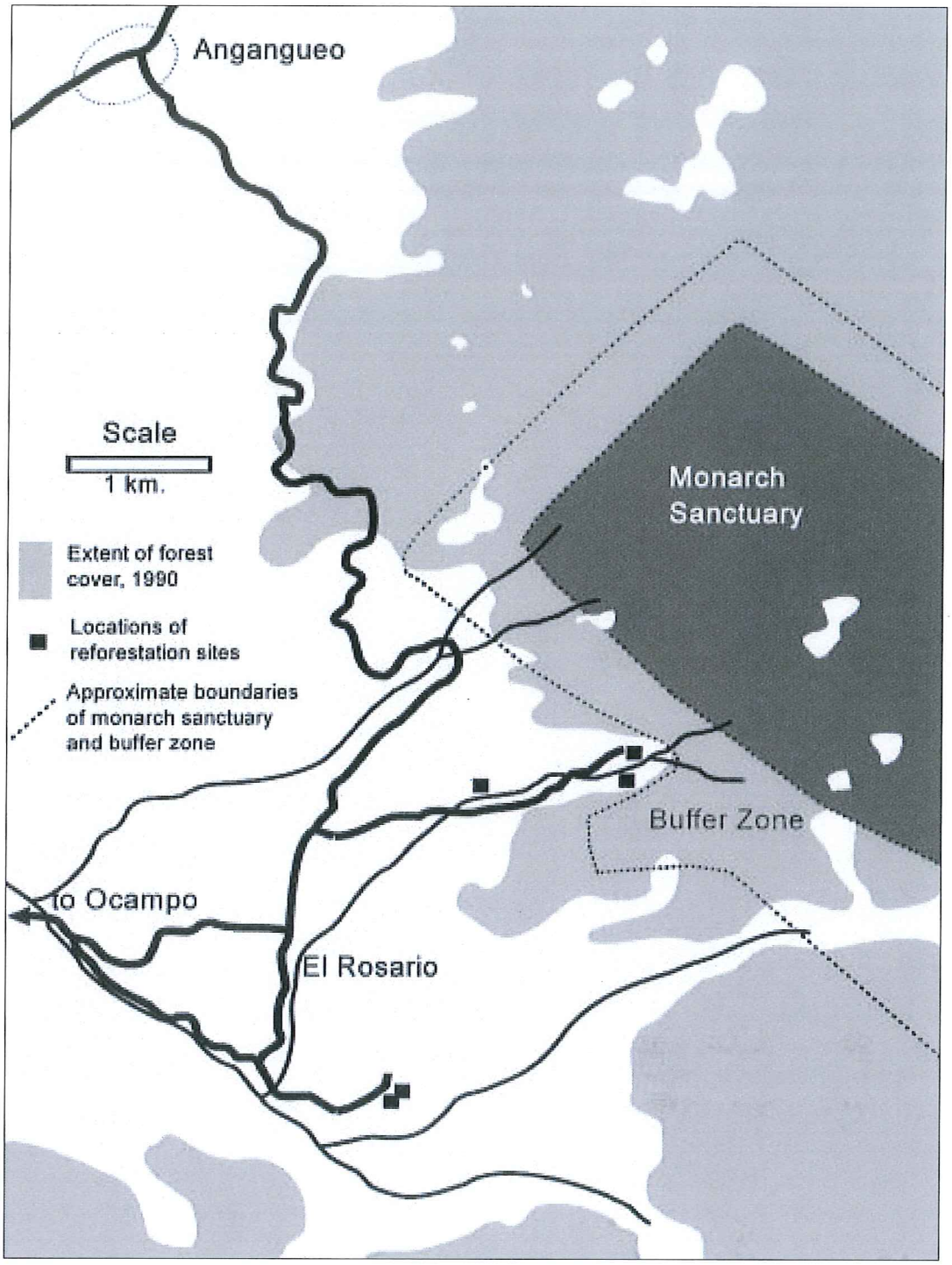

Figure 1. Map of El Rosario area, showing reforestation sites planted in 1997.

Some of the reforestation sites are located in close proximity to existing areas of mature forest stands within the buffer zone established around the monarch sanctuary (Figure 1). Although planting sites within or adjacent to mature forests and established buffer zones may eventually play a role in ecosystem restoration, the focus of the La Cruz Habitat Protection Project is not on directly restoring the ecosystem functions of the sanctuaries or buffer areas. Its focus is on reducing the pressure on these areas to supply the local demand for wood. The philosophy of the project is to provide reforestation assistance to any *ejidatario* who is interested in reforesting lands which have been previously cleared. It is our belief that by maximizing the number of people who realize benefits from reforestation, other landowners from other *ejidos* in the area will be encouraged to reforest their lands. Landscape-scale changes may be achieved over time if enough landowners participate. As an indication of the level of interest, it is encouraging to note that during the first planting season, the demand for seedlings exceeded the amount that the La Cruz Project could supply.

Conclusions: Reforestation as a strategy for forest conservation and ecosystem restoration

The La Cruz Project is not intended to be an attempt to recreate natural forests. Once natural forests are cleared by logging or severely altered by thinning, re-establishment of these complex ecosystems through human intervention may not be an achievable goal. Reforestation, as practiced in this project, is a strategy for conserving the remaining natural oyamel and mixed fir-pine forests by establishing alternative sites for extractive forest uses by local residents, who are also the landowners of the monarch sanctuaries and buffer areas. The intent is to assist the *ejidatarios* by involving them in saving the forest that provides a buffer for the overwintering monarchs, a biological heritage they are committed to preserving. Cooperative preservation of their forests and the monarch habitat will be facilitated when the local people, who are heavily reliant on wood from forest trees and who have historically used the oyamel forest, see that they have a viable alternative to continuing to log and thin the forest.

In addition to conserving remaining forests and butterfly habitat, reforestation will indirectly contribute to ecosystem restoration on a landscape scale, if extensive areas are planted and maintained as woodlots. This includes restoration of the hydrologic balance and soil conditions within the drainage basin, as well as restoration of some elements of the natural vegetation communities. However, these aspects of ecosystem recovery will require a high level of participation by local landowners over many years. Stewardship values, which have been instilled in the farming culture of the *ejidatarios* over generations, will be strengthened and given a means of expression through learning a new way to meet their needs for forest resources. Expression of these deep-seated cultural values will make ecosystem restoration possible.

How will it be possible to achieve the high level of participation among local landowners that will be necessary to advance forest conservation and ecosystem restoration goals? We believe that reforestation offers direct economic benefits to the *ejido* members who participate. The establishment and sustainable management of woodlots provides a long-term source of forest products for subsistence needs and opportunities for income for those families who invest in reforestation. A system of integrated sustainable forest management is illustrated in Figure 2. This system provides for both subsistence wood uses and a continuing source of income from forest products.

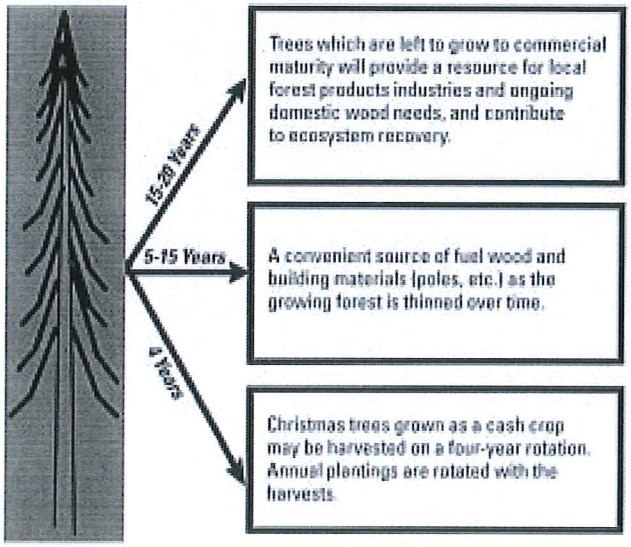

Figure 2. Integrated sustainable forest management of reforestation sites is the long-term goal.

As shown in Figure 2, income will be produced in four years from oyamels and pines that are planted for Christmas trees. Ideally, a system of harvesting Christmas trees on a four-year rotation can be established, whereby a portion of the trees is harvested each year. The trees that are harvested are replaced by annual supplemental plantings of new seedlings. In this way, a continuous income stream can be established. After about five years, wood will be available for subsistence harvesting to supply needs for domestic firewood uses and charcoal production. The convenience of having a source of wood for domestic uses on their own property, rather than having to continually go up into the forest to harvest wood, is an additional incentive for landowners to participate in reforestation. Over a period of five to fifteen years after the initial planting, necessary thinning of trees will provide a source of poles, fence posts, and small dimension lumber. In fifteen to twenty years, trees that are allowed to grow to a more mature size will be available for lumber production. Where pines are planted, there will be opportunities for resin extraction as an additional source of income. The establishment of mixed-age stands and understory vegetation on reforestation sites may also provide important genetic resources for ecosystem restoration, and over time will promote recovery of healthy soil conditions and hydrologic balance. It is a long-term goal of the project that participating landowners will take an integrated approach such as this to managing their reforestation sites.

Effective community organization will be the key to developing ways to market Christmas trees and other forest products, in order to optimize income production as a benefit to landowners who invest in reforestation. The pre-Christmas tourists that annually come to the monarch preserve at El Rosario can be provided with opportunities to buy sustainably-produced Christmas trees as a way to support forest conservation. Woodlot owners who manage part of their trees for longer rotations and produce commercial size timber can eventually develop local forest products industries to supply local needs for building materials, and promote a value-added approach to using trees for income.

Although most of the *ejidatarios* at El Rosario practice small-scale farming to feed their families, sites targeted for reforestation are not well-suited to producing corn or other crops for income or subsistence needs, due to climatic conditions, steep slopes, and highly erodible soils with marginal agricultural productivity. The need to use chemical fertilizers for agricultural crops further reduces the economic viability of farming these lands. Yet these same lands are ideally suited to growing native species of forest trees. Given the inherent limitations for agricultural production, government incentives to plant trees and production of Christmas trees as a cash crop can provide several times as much income as a corn crops grown on the same land (Soto pers. comm. 1997; Contreras Telles pers. comm. 1997). However, because the beginning of a sustainable income stream from forest products will be delayed a few years, the shift to growing trees is a long-term investment and a major decision for landowners. It will be necessary to use some of this income to replace the food previously obtained from subsistence farming, and many families will continue growing food crops on part of their land, no matter how marginal the productivity. At the same time, flatter lands in the area that are more suited to growing corn and other crops will need to be farmed more intensively, suggesting the need for a more strategic approach to establishing agricultural fields and systems for distributing the agricultural production. Such organizing and planning at the community level can only serve to advance the goals of forest conservation and ecosystem restoration.

The La Cruz Habitat Protection Project is made possible by the support of the people of El Rosario and outside volunteers and contributors. The project has the capacity to provide tens of thousands of seedlings for reforestation. The Michoacán Reforestation Fund is a volunteer-based, non-profit corporation that has recently been established to support forest conservation activities, and is providing administrative and fund-raising support for the La Cruz Project. The objective for future years is to greatly increase the level of participation by *ejido* members and to expand the ability of this volunteer-based project to support reforestation through enhanced fund-raising efforts. The goal of the La Cruz Habitat Protection Project and the Michoacán Reforestation Fund is quite simple. Any *ejidatario* who has decided to reforest his or her land should be provided with the seedlings and other support needed to make reforestation a reality.

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