



Agroforestry: a Refuge for Tropical Biodiversity after Fire

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During the spring of 1998, Mexico and Central America experienced the most devastating fires in 50 years. In Mexico more than 12,600 fires burned 381,200 ha of land; in Nicaragua 13,000 fires seared nearly 810,000 ha (U.S. Agency for International Development 1998). The enormous extent of these fires was attributed to record drought in conjunction with agricultural expansion in landscapes once covered by tropical forest. According to government officials, including President Ernesto Zedillo of Mexico, most of the fires were begun by peasant farmers who prepare their fields for planting by burning the previous year's stubble or by slashing and burning forest (Dillon 1998). Exacerbated by drought and high temperatures, these agricultural fires burned out of control and swept across rural landscapes and deep into forest reserves. Economic and environmental devastation was enormous.

Government leaders and environmentalists often identify the major culprit for this ecological tragedy as the small, impoverished farmer, who also receives the majority of blame for tropical deforestation (Myers 1996; Food and Agriculture Organization of the United Nations 1997; Rudel & Roper 1997). Yet the rhetoric concerning the socioeconomic causes of tropical deforestation and the 1998 fires often ends there, and the reasons underlying peasant agricultural practices are rarely addressed in depth. Land insecurity, unequal land distribution, lack of financial credit and institutional support, poor market access, and political instability give poor farmers in Mexico and Central America little choice but to practice short-term, subsistence agriculture, which in tropical ecosystems usually results in further degradation of cultivated land or clearing of forest. If tropical forests and all their biodiversity are to be saved, and if the primary agent of tropical deforestation is the landless peasant, then measures to secure land tenure and eliminate rural poverty

should be the highest priorities of tropical-forest conservation. Protected areas, extractive reserves, and ecotourism ventures will be undermined if the fundamental problem of rural poverty in the tropics is not addressed.

A socially and ecologically sustainable alternative to widespread subsistence farming by shifting cultivation methods is more permanent agroforestry. Agroforestry is generally a traditional method of farming that incorporates a mixture of woody perennial crops, annual crops, and sometimes livestock into an integrated production system (Kidd & Pimentel 1992). In the past two decades, evidence of the capacity of agroforestry for sustainable food production as well as biodiversity conservation has grown (Noble & Dirzo 1997; Pimentel et al. 1997). More and more studies show higher biodiversity in agroforestry systems than in other agricultural systems, and in some cases levels of species richness are equivalent to those of forest (Estrada et al. 1993; Perfecto et al. 1996). When farmers possess legally recognized land tenure, access to bank credit, and an agricultural management scheme that includes a complex mosaic of fruit trees, timber trees, and annual crops to offset both ecological and financial risk, they are able to exercise long-term preservation of their farms as well as the biodiversity associated with their farms (Current et al. 1995). An important way that agroforestry farmers contribute to conservation, but one that has received little attention, is through the protection of farms from fire.

The Petén region of Guatemala was one of the most severely burned areas in 1998. The Petén currently receives much attention from the international environmental community because the northern portion contains the 1.4-million-ha Maya Biosphere Reserve, which together with reserves in Mexico and Belize comprises the largest contiguous forest in Central America (Sader et al. 1994). In May 1998 fires burned an estimated 166,650 ha, almost one-twelfth of the forest in the Maya Biosphere Reserve (Arellano 1998). On the southern border of the reserve, a buffer zone that contains cattle

ranching, shifting cultivation, and agroforestry intended to reduce human pressures on the reserve also suffered widespread fires, and many farmers lost their crops. Within this buffer zone I located two adjacent agroforestry farms that had remained intact. I censused the diversity and abundance of birds on the farms to determine the role of agroforestry as a refuge for biodiversity following fire.

Each farm consisted of 45 ha of fruit and timber trees, including oranges, mangos, avocados, allspice, mahogany, and Spanish cedar, interspersed among cornfields and patches of forest. The forest patches within the farms were at various stages of succession, ranging from 1 year to roughly 100 years. According to the farmers Zacarías and Nehemías Quixchán, the fires that burned through the Petén reached the farms near the end of May. For 10 days the farmers repelled the fires by clearing vegetation in a 5-m-wide strip around the perimeters of the farms and rapidly extinguishing fires that penetrated the perimeters. As a result, approximately 95% of the two farms was saved. In contrast, the understory of the forest surrounding the farms burned completely, and only portions of the canopy survived.

Because they contained some of the only intact vegetation in the area, the agroforestry farms may have served as a critical refuge during a habitat bottleneck for many forest species. For a total of 24 hours over 7 days from mid-July to mid-August 1998, I conducted transect counts of birds within the farms and around the perimeters. I encountered 72 species and 318 individuals of birds between the two farms. During casual observations I observed another 11 species, for a total of 83 species. In a study of birds at Tikal, Petén, 11 of these 83 species were considered to be obligate to mature forest or old second growth (over 10 m high) and another 15 to be forest generalists (Whitacre et al. 1995). The farmers said that in 30 years they had never witnessed such high diversity and abundance of birds on their farms. Birds most likely were attracted to the agroforestry farms as refuges by both the intact forest patches, which harbor insects, provide nesting sites, and offer protection from predators, and the cultivated fruit trees, which may have provided some of the only fruit and nectar in the region after fire destroyed most of the surrounding vegetation.

In the context of ecological and socioeconomic devastation by fire, therefore, agroforestry by small farmers may represent an important land use for conservation and development in the tropics. Generally, forest re-

serves and protected areas are considered the most important refuges for biodiversity, but in May 1998 when fires were too extensive to control and forested areas too large to protect, the small agroforestry farmer provided the best strategy for protecting biodiversity. The broad stereotype of small farmers as the primary threat to tropical forests must end. Policymakers and environmentalists should recognize the contribution of small farmers to conservation, especially under the threat of widespread fire, and work to reduce the rural poverty that degrades resources and undermines conservation in the long run. A good model may be agroforestry.

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