Conserving Neotropical Biodiversity: The Role of Dry Forests in Western Mexico

Introduction

Neotropical dry forests occur from Mexico to northern Argentina (Bullock et al. in press; Ceballos & Sánchez in press). Unfortunately, most dry forests have been highly affected by human activities and have practically disappeared from Central America and certain regions in South America (Mares et al. 1985; Janzen 1988; Bullock et al. in press). The largest remaining dry forests north of the Equator are found in western Mexico. Such forests are diverse and rich in endemic species (Ceballos et al. 1994; Ceballos in press) but are threatened by high deforestation rates from tourism development, cattle ranching, and agriculture.

A major step to protect dry forests in Mexico has been the recent creation of the Chamela-Cuixmala Biosphere Reserve in Jalisco, an endeavor of the National University of Mexico and Cuixmala Ecological Foundation (Ceballos et al. 1994). The area was threatened by a tourism development scheme promoted by one of the most powerful banks and construction companies in Mexico, but the area was effectively protected by a legal and public campaign that used the information about the biological value and uniqueness of the Chamela-Cuixmala region to support preservation. The reserve is becoming a model in Mexico because it has solved the main problems that limit the efficiency of nature reserves in the country, including land tenure, financial support, and social problems. To evaluate the importance of the Chamela-Cuixmala reserve and the conservation of western Mexico dry forests to maintain Neotropical biodiversity, we present an analysis of the area's biodiversity and summarize the efforts to protect them.

Mexican Dry Forests

Tropical dry forests are found in small areas in eastern Mexico but cover extensive areas in the Pacific lowland of western Mexico from southern Sonora to northern and central Chiapas (Rzedowski 1978). Pacific dry forests are geographically and ecologically isolated from other tropical forests because they are only tenuously connected to more southerly tropical moist forests and are usually in contact with temperate dry (e.g., scrub) or humid (e.g., pine and oak) forests (Ceballos in press).

The Pacific dry forests are found from sea level to 1500 m, and climatic features that determine their distribution include temperature and rainfall (Rzedowski 1978). Specifically, annual average temperature ranges from 20 to 29°C, and the lowest extreme is never lower than 0°C. With respect to rainfall, a key feature is the strong annual seasonality, with a 5- to 8-month dry season and an annual average rainfall from 600 to 1200 mm (highest values at the lowest latitudes [Rzedowski 1978]).

Vertebrate Species Richness

Mexico is considered a megadiversity country (Mittermeier 1988) be-

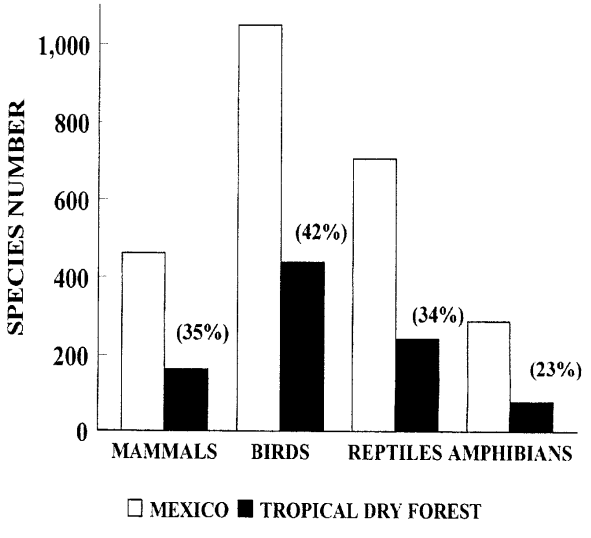

Figure 1. Vertebrate species in Mexico and Mexican tropical dry forests. Note that dry forests have relatively similar proportions of the country's mammals, birds, and reptiles.

Conservation Biology, Pages 1349-1356
Volume 9, No. 6, December 1995

Table 1. Species diversity and composition among terrestrial vertebrates in Mexico and Mexican tropical dry forests (Mexico/dry forests) and the proportion of dry forest taxa with respect to the country's total number of taxa (%).

Taxa	*Mammals (%)*	*Birds (%)*	*Reptiles (%)*	*Amphibians (%)*
Order	10/9 (90)	22/14 (64)	3/2 (64)	3/3 (100)
Family	34/27 (79)	76/51 (67)	37/23 (73)	14/10 (71)
Genera	156/86 (55)	462/179 (39)	155/94 (61)	47/22 (47)
Species	462/164 (35)	1050/340* (33)	707/243 (34)	288/77 (23)
Endemic species	146/40 (27)	101/38 (38)	376/124 (33)	173/44 (25)

**Estimated.*

cause it maintains around 10% of the world's biota (McNeely et al. 1990), including many endemic species (Ceballos & Navarro 1991; Rzedowski 1993), and tropical dry forests are among the richest ecosystems in Mexico. For example, the total number of terrestrial vertebrate species found in Mexico is 2507; 11% of the world's total (Ceballos & Navarro 1991; Escalante et al. 1993; Flores Villela 1993). Impressively, at least 33% (824 spp) of such species have been recorded in dry forests (Table 1; Fig. 1). Dry forest's vertebrate species represent 80% of all orders, 73% of all families, and 51% of all genera from Mexico, and the contribution of the four classes of vertebrates is remarkably similar (Table 1).

At a continental scale the vertebrate diversity of Mexican dry forests is generally lower than Costa Rican and South American dry forests (e.g., Ceballos in press). Mexican dry forests are geographically and ecologically isolated from wetter/moister forests. In contrast, Central and South American dry forests are usually connected to rain forests, so there is a frequent interchange of species among such forests which increases dry forest species richness (Mares et al. 1985; Redford & da Fonseca 1986; Ceballos in press).

Endemicity

Superficially, terrestrial vertebrate faunas found in the dry forests of western Mexico can be characterized as a subset of rain forest faunas. However, this is a misinterpretation because they are unique for their high levels of endemicity and because the populations of many widespread species have biological adaptations, specific to dry forests, to cope with the strong environmental seasonality (Lister & Garcia-Aguayo 1992; Ceballos in press).

At a continental scale Mexican dry forests maintain the highest levels of endemicity of all Neotropical dry forests (Short 1974; Gallardo 1979; Janzen 1983; Vanzolini et al. 1980; Mares et al. 1981; Redford et al. 1990; Ceballos in press). In Mexico dry forests harbor a high number of endemic species, comparable to only cloud and conifer forests (Flores Villela & Gerez 1988; Ceballos & Navarro 1991; Ceballos & Rodriguez 1993; Escalante et al. 1993). For example, of the 796 endemic species from Mexico (Table 1; Fig. 2) 31% (246) are found in dry forests and 11% (90) are exclusively distributed in such ecosystems. At supraspecific taxonomic levels endemic species represent 72% of all categories, with the highest percentage in amphibians (79%), lowest in reptiles (64%), and intermediate values for mammals (75%) and birds (68%).

Interestingly, at least one vertebrate family, Bipedidae (two-legged lizards, Amphisbaenia:Reptilian), is endemic to the dry forest (Flores Villela 1993). At the generic level 60% of all the endemic mammalian taxa, including several rodents (*Xenomys, Hodomys*, and *Osgoodomys*), an insectivore (*Megasorex*), and a bat (*Musonycteris*), are mostly or exclusively found in dry forests (Ceballos & Navarro 1991; Ceballos & Rodriguez 1993). In other classes levels of generic endemicity are lower and include two colubrid snakes (*Geagras* and *Pseudoleptodeira*), the Blue-rumped Parrotlet (*Forpus*), and the Flammulated Flycatcher (*Deltarhyn-*

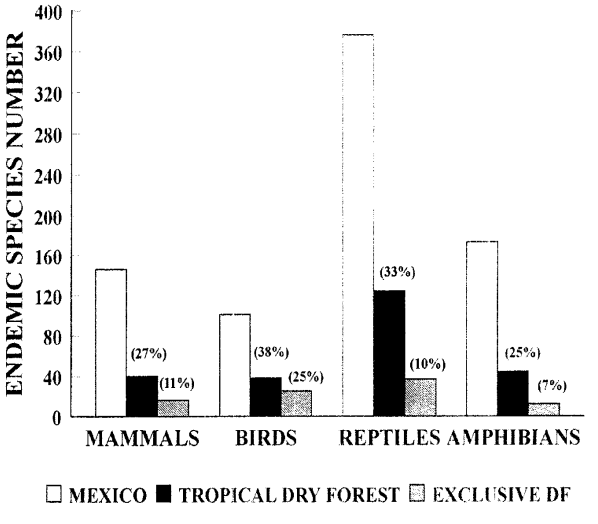

Figure 2. Vertebrate endemic species from Mexico. Note that the proportion of dry forest endemic species of mammals, reptiles, and amphibians is very similar.

Table 2. Vertebrate diversity in the Chamela-Cuixmala Biosphere Reserve (modified from Ceballos et al. 1994).*

Class	*Order*	*Family*	*Genera*	*Species*	*Endemic species*
Mammalia	8	21	59	70	15
Aves	21	50	172	265	23
Reptilia	3	21	57	66	31
Amphibia	1	5	12	19	11
Total	33	97	300	420	80

**The number of orders, families, genera, species, and species endemic to Mexico are given in each major vertebrate Class.*

chus); there are no endemic amphibian genus restricted to the dry forests (Flores Villela 1993).

It is becoming clear that Neotropical dry forests in general, and Mexican dry forests in particular, make substantial contributions to the region's biological diversity because of their species richness and endemicity at species and higher taxonomic categories (Janzen & Wilson 1983; Redford et al. 1990; Mares 1992; Ceballos in press).

Dry Forests Conservation Problems

Presently there is no doubt that deforestation is the major threat for the long-term conservation of dry forests in Western Mexico and other regions in the Neotropics (Lugo 1988; Bullock et al. in press). There is not a consensus about rates of deforestation in the Neotropics, but all estimates tend to be relatively high and indicate that this is an acute problem (Lugo 1988). In Mexico deforestation rates of dry forests, estimated at 300,000 ha/year (2% year), are the highest among the different ecosystems in the country (Masera et al. 1992). Large dry forest tracts have disappeared in recent years mainly to support agriculture and cattle ranching activities. Unfortunately, this scenario is also prevalent in other regions in the Neotropics. Dry forests have almost disappeared from Central America (Janzen 1988), Venezuela and Colombia, and the Caatinga in Brazil, and they have been severely disturbed in the Chaco (Roig 1991; Bullock et al. in press; Ceballos in press).

Vertebrate dry forest species in western Mexico are being decimated mainly by the destruction of their habitat but also by other anthropogenic factors such as sport and subsistence hunting and illegal trade. Although there is no precise information, it is known that at least 47 vertebrate dry forest species are at risk of global extinction, and many more are becoming locally extirpated (Ceballos in press; Ceballos & Sanchez in press).

The Chamela-Cuixmala Biosphere Reserve

Extensive, well preserved dry forests are still found in western Mexico. The 13,200 ha of the Chamela-Cuixmala biosphere reserve are privately owned by the major university of Mexico, nongovernmental organizations, and several private companies. The reserve protects nine major vegetation types, including dry and semidry forests and the associated wetlands to the northern bank of the Cuixmala river. The reserve has been very successful in protecting more than 1100 species of vascular plants (Lott 1993), 85 reptiles and amphibians (García & Ceballos 1994), 265 bird species (Arizmendi et al. 1991), and 70 mammal species (Ceballos & Miranda 1986). Despite a lack of complete inventories, several species of plants (Lott 1993), a snake (García & Ceballos 1994), and more than 80 invertebrate (Noguera & Ayala 1994) species have been described through the intensive taxonomic research carried out mainly at the Chamela Biological Station which is part of the reserve.

In the reserve there are approximately 81 endemic vertebrate species and 72 species considered at risk of extinction (Ceballos et al. 1994). It is the only known locality of *Xenomys nelsoni*, an arboreal rodent endemic to Western Mexico (Ceballos & Rodríguez 1993). There are viable populations of endangered species such as sea turtles (*Lepidochelys olivacea, Dermochelys coriacea, Chelonia agassizi*), American crocodile (*Crocodylus* acutus), California Least Tern (*Sterna antillarum*), Yellow-headed Amazon (*Amazona orathryx*), ocelot (*Leopardus pardalis*), and (possibly) jaguar (*Panthera onca;* Ceballos et al. 1994).

Perspectives for Conservation and Management

Despite the speed at which Mexican dry forests are disappearing, there is no comprehensive plan in the country (or the continent) to properly preserve them. To maintain a substantial proportion of dry forest biodiversity, a strategy that considers the preservation of the most important areas in reserves and the sustainable uses of dry forests outside the reserves in a "seminatural matrix" (J. H. Brown) is urgently needed.

To protect the whole range of species and habitats found in western Mexico's dry forest, several reserves have to be set aside in a latitudinal gradient from Sinaloa to Chiapas. Such reserves (including Chamela-Cuixmala) will be complementary to the Guanacaste National Park, which protects the last remnants of Costa Rican (and Central American) dry forests (Janzen 1988). However, even in the best scenarios, reserves will not be sufficient to maintain all species of fauna and flora (Noss & Harris 1986; Scott et al. 1987). So, to

avoid the isolation of the reserves and to increase the number of surviving species, the dry forest resources outside reserves must be used to increase the welfare of the local human populations. To have any real chance of success such a strategy must be based on solid scientific knowledge and shaped into a regional socioeconomic perspective.

From a management point of view perhaps the most acute problem for the "sustainable" use of dry forests and their faunas is the lack of basic research and techniques for the long-term use of natural resources in general and wildlife in particular. Knowledge of the proper uses of dry forest species and resources is very limited. There is almost no information, for example, about forestry, harvesting, trade, or hunting quotas. Such information is critically needed to increase the value of the forest for local people and to stop or reverse deforestation rates. That should be a priority in the research agenda of the scientific and conservation communities.

Acknowledgments

We would like to express our deepest gratitude to the Fundación Ecologica de Cuixmala, the Centro de Ecología of the National University of Mexico, and the National Council of Science and Technology (CONACyT) for having provided financial and logistic support. Our warmest appreciation to our friends James Goldsmith, José Sarukhán, Luis de Rivera, Alberto Szekely, Cristina Olivier, Luis Bustamente, and Efrén Campos for their critical role on behalf of the creation of the reserve. We would like to thank Guadalupe Téllez and Cuauhtemoc Chávez for their help in gathering the data and drawing the final figures, respectively. Brian Miller and Rodrigo Medellín kindly reviewed the manuscript and made helpful comments for improving it.

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ANNOUNCEMENTS

New Protected Areas

Two New Parks in Bolivia

On September 22, 1995 Bolivian President Gonzalo Sánchez de Lozada signed decrees establishing the Kaa-Iya del Gran Chaco National Park and Integrated Management Area and the Madidi National Park and Integrated Management Area. These two protected areas total over 5 million hectares.

The Kaa-Iya ("spirit masters" in Guaraní) del Gran Chaco in eastern Santa Cruz Department consists of 34,411 km^2 of dry and thorny tropical forest. It is the traditional home of the Izoceño and Ayoreo people and represents about 5% of the Gran Chaco, which covers 1 million km^2 of Bolivia, Paraguay, and Argentina. The Kaa-Iya reserve is now the largest terrestrial protected area in tropical America and is the most significant reserve of tropical dry forest anywhere. Preliminary ecological surveys suggest that Kaa-Iya has high diversity in nonflying mammals and probably more large and medium-sized mammal species than any reserve in South America. The protected area was proposed by the National Biodiversity Conservation Directorate and the Capitania of the Upper and Lower Izozog (CABI), a grassroots organization for Izoceño Indians, with technical help from the Wildlife Conservation Society. The Izoceños will play a leading role in the reserve's management.

The Madidi reserve consists of nearly 20 thousand km^2 adjacent to the Tambopata reserve of Peru. In Bolivia it links up with the Ulla Ulla reserve in the Altiplano and the Pilan Lajas Biosphere Reserve. The new park contains an altitudinal range from snow-covered peaks at 5500 m down to lowland tropical rain forest and savannas. The Madidi reserve is the result of a proposal developed by the National Biodiversity Conservation Directorate in consultation with the local Tacana and Chimane people, with technical help from the Ecology Institute in La Paz, EcoBolivia, and the Wildlife Conservation Society. Conservation International's RAP team conducted key surveys that identified the region's ecological significance. (*Source:* Wildlife Conservation Society)

Rio Negro State Park in Brazil

The Rio Negro State park, covering over 436,000 ha, was decreed by the Governor of the State of Amazonas in April 1995. It is located on both sides of the Rio Negro, northwest of Manaus, and adjacent to the giant, 2.3 million hectare Jaú National Park. At the same time two Environmental Protection Areas were created, on the left bank (741,000 ha) and on the right bank (554,000 ha) of the Rio Negro which surround the state park and will act as buffer zones. The state park itself surrounds the Anavilhanas Ecological Station (350,000 ha). This complex of protected areas covers over 3 million hectares, with a further 1.23 ha of buffer zone. (*Source:* Neotropical Primates)

El Taray Reserve in Mexico

In August, 1995 negotiations were completed for the preservation of a 300 ha parcel of pine forest in the state of Coahuila, Mexico. This small reserve hosts the largest known nesting colony of the endangered Maroon-fronted Parrot (*Rhynachopsitta terrisi*). The site, the El Taray nesting cliff, was discovered in the fall of 1994 by scientists from Monterrey Tech, Wildlife Preservation Trust International, Profauna, and Antonio Narro University. With support from DUMAC (Ducks Unlimited in Mexico), the San Diego Zoological Society, and the U.S. Fish and Wildlife Service, CONABIO, Mexico's national commission for biodiversity, was able to arrange for the purchase of the area. Administra-

tive control of the reserve will be held in trust by the Museo de las Aves de Mexico in Saltillo, and it will be managed for conservation, research, education, and tourism. The El Taray nest cliff lies near the center of the known breeding range of the Maroon-fronted Parrot, which consists of a strip of land about 100 km long and 20 km wide. The current population of Maroon-fronted Parrots is estimated to be between 2000 and 4000 individuals. (*Source:* Wildlife Preservation Trust International)

Bhembe/Dongala National Park

The first piece of what is expected to be a very large new wildlife park in South Africa, Botswana, and Zimbabwe was opened in June. The total area of the Vhembe/Dongala National Park will be 1552 km^2 when completed. Management of the park will be overseen by a committee of representatives of the Northern Transvaal provincial government and the National Parks board in South Africa. (*Source:* Conservation Digest)

Collapsing Fisheries in the U.S. Northeast, Pacific Northwest, and Gulf of Mexico

In response to collapsing fisheries, on August 3, 1995, U.S. President Bill Clinton approved $53 million in emergency aid to fishermen. In the Northeast and Pacific Northwest the bulk of the funds will be used to buy out fishing boats to diminish the number of vessels fishing the areas. (*Source:* Conservation Digest)

New Australian Coastal Policy and Action Program

On May 28, 1995 the Australian government launched a $53 million Coastal Action Program as one of its 30 initiatives in its new "Living on the Coast" policy. The policy aims to build cooperation between national, state, and local governments, industry, and communities to ensure ecologically sustainable activities in coastal zones. The program includes Coastalcare, a community-based set of activities including protection work, rehabilitation of sensitive areas, identification of natural and cultural heritage resources, monitoring, and implementation of management plans. Implementation of the new policy and program will be based on agreements now being drafted between the federal government and individual states in Australia.

Biodiversity Crisis in Southwestern Ghana

Surveys of wildlife in the three forest national parks (Bia, Ankasa, and Kakum) of southwestern Ghana indicate that the forests have become increasingly isolated by expanding agriculture and have been seriously degraded through excessive logging and hunting. Their biodiversity is being simplified through the loss of species adapted to old-growth, mature forest, and the persistence or increase of species that are adapted to secondary or colonizing forests. For the past 15 years primate species dependent on tall, mature forest and susceptible to hunting have been nearing extinction. The three species for which the crisis seems most acute are Miss Waldron's red colobus (*Procolobus badius waldroni*), the Roloway monkey (*Cercopithecus diana roluay*), and the white-naped mangabey (*Cercocebus atys lunulatus*). When large, highly vocal and conspicuous mammals disappear, one cannot help but wonder how many other, less conspicuous species are going extinct. (*Source:* African Primates Newsletter)

Suriname Forests under Threat

Conservationists in Suriname are working to convince the Suriname government to reject or modify requests from three Asian timber companies that want to log millions of forested acres. The Indonesian investment group MUSA has already been granted a concession to remove trees from 141,645 ha. Suriname now has intact rain forest covering more than 90% of the land area of the country. Only 20,000 people live in the country's interior in scattered villages along three major rivers. Timber concessions, according to a World Resources Institute analysis, would be financially a bad deal for Suriname, environmentally a serious threat to the forests, and socially a threat to indigenous people. Efforts are also being made in Indonesia to modify MUSA's logging plans. (*Source:* Eco-Exchange; Conservation International)

Species News

Taking Rules Upheld by U.S. Supreme Court

On June 29, 1995 the U.S. Supreme Court upheld the rule of the Fish and Wildlife Service that "significant habitat modification or degradation" that actually kills or injures endangered or threatened wildlife is a "taking." A coalition of logging interests argued for a narrow interpretation in which only direct killing or capturing of listed animals on private land would be affected by the Endangered Species Act (ESA). The ESA specifically prohibits "taking" with severe penalties for violation. The Supreme Court's decision confirmed that the ESA covers the use of private property that affects wildlife habitat. The decision has provoked reaction from Congressional opponents of the ESA who vowed to include a narrow definition of harm in any reauthorization of the law. *Sources:* Conservation Digest, Endangered Species Update)

Waterbird and Curlew Conservation Agreements Signed

The African-Eurasian Waterbird Agreement was signed in Europe on June 16, 1995, under the umbrella of the Bonn Convention on Migratory Species. The new accord covers species that are ecologically dependent on wetlands for at least part of their annual cycle and includes many species of pelicans, storks, flamingos, ducks, and geese. The agreement

covers a geographic area from northern Canada and Russia across Europe to southernmost Africa and requires the 60 signatory countries to enact an action plan of species and habitat conservation, management of human activities, biological research and monitoring, and education programs. (*Source*: Conservation Digest)

Conferences

Conservation of the Southwestern Atlantic

On September 27, 1995 Britain and Argentina signed an agreement on oil exploration in the Falkland Islands, also known in Argentina as the Islas Malvinas. International analysts hailed it as the most important diplomatic move since the two countries fought a 10-week war over the Islands in 1982. Despite the attention given to the 160-year-old sovereignty dispute and now the potential oil bonanza, little notice has been given to the biology of this southwest corner of the Atlantic Ocean.

The southwestern Atlantic is one of the world's most productive marine ecosystems, including over 3000 km of coastline along Argentina and a continental shelf extending into the Falklands and South Georgia archipelagos. The convergence of the cold nutrient-rich Antarctic current and the warm coastal South American waters results in a bountiful upwelling system hosting a rich diversity of seabirds and marine mammals. Despite low human density, threats to this diversity are coming from rapidly expanding fisheries, oil exploration and extraction, and tourism.

From May 18–20, 1995, 20 conservationists from the Falkland Islands, Argentina, and Great Britain gathered in New York at a workshop organized by the Wildlife Conservation Society and the British Antarctic Survey to discuss the region's wildlife and their management.

The group reviewed current information on the ecology and population dynamics of seabirds, the status of migratory shorebird ecology, the lack of solid knowledge on the size of fishing fleets and their catch, an updated atlas of breeding birds of the Falkland Islands, the status of sea mammals along the Patagonian coast and the Falkland and South Georgia Islands, the dynamics of penguin populations, the effects of chronic oil pollution on wildlife, studies of wildlife health and pathology, and the impact of tourism on wildlife.

The group produced a list of priorities for conservation in the southwest Atlantic that include research on several vulnerable endemic species of birds and marine mammals, such as the Dolphin Gull and the southern elephant seal; measures on the effects of chronic oil pollution along the Patagonian coast; development of reliable information on fisheries; and expansion of the current system of protected areas.

Despite still frosty relations between Great Britain and Argentina, scientists agree that the region must be treated as a biogeographic unit for integrated management. The United Nations Development Program, through the Global Environmental Facility, is supporting a Patagonian Coastal Management Plan, and scientists of both countries have started collaborative research projects.

Ironically, as this note went to press in late September, a fishing boat sank near Puerto Deseado producing a significant oil spill in this unique, fjord-like coastal region of southern Patagonia threatening thousands of seabirds and marine life. (*Source:* Wildlife Conservation Society)

EECONET and the Wildlands Project

The European Ecological Network (EECONET) and the U.S.-based Wildlands Project conducted a joint workshop on establishing systems of protected areas on July 6 and 7, 1995. The meeting was held at the Luso-American Development Foundation (FLAD) in Lisbon, Portugal. The two groups were initiated independently in 1991 based on the concept of the "ecological network," and this was the first time the two organizations met to share strategies and technical information. Representatives from Portugal, Spain, Italy, Estonia, Lithuania, Japan, Costa Rica, The Netherlands, and Great Britain attended, along with staff members from EECONET and The Wildlands Project.

Graham Bennett of EECONET opened the workshop by noting that despite efforts in recent years to protect the environment, the biological diversity of Europe and North America is still declining. Coastal and marine ecosystem, rivers, wetlands, grasslands, forests, and mountain ecosystems have all suffered serious and extensive damage, and threats are increasing in many areas. Both EECONET and The Wildlands Project are working on measures to promote biological diversity. The "ecological network" concept offers the opportunity to improve the application of ecological theory to the task of conserving ecosystems.

Even though Europe and North America have different governments, cultures, and a wide diversity of situations, an exchange of strategies can be helpful. The convergence of strategies in Europe and North America is an encouraging sign. However, EECONET is working from a top-down or government-driven approach, whereas The Wildlands Project uses a bottom-up or grassroots strategy. Nevertheless, both groups agreed that to accomplish their mutual goals, it is necessary to: (1) change land use, (2) break down administrative and psychological boundaries, (3) integrate biological diversity conservation into many policies, (4) engage broad public support, (5) set ground rules for a wide variety of approaches by different grassroots organizations, (6) learn from the experiences of all organizations in the field by exchanging information, and (7) form

an international organizational network. (*Source:* Gilbert Leo Wells, Lisbon, Portugal)

First Regional Community Forestry User's Group Workshop

A 5-day workshop was held May 23–27, 1995 at the Budhani-kantha School near Kathmandu, Nepal, to bring together leading implementors of community forestry in Asia. Rural women from India, Nepal, Pakistan, Thailand, the Philippines, and Bhutan gathered to share experiences in protecting and managing the environment through changes in local land use practices. The meeting was sponsored by the International Centre for Integrated Mountain Development (ICIMOD), in collaboration with the FAO and Women Acting Together for Change. The meeting was one of the first where villagers from different regions were able to compare goals and methods. The State Minister for Forests and Soil Conservation, who attended the meeting, noted that because women and poor people are the main users of forest products, strengthening their groups will enable his government to incorporate user's views in future forest management policy. (*Source:* Down to Earth [New Delhi])

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