

Central America Southern Pine Beetle / Fire Management Assessment

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for the

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Executive Summary

Two of the most destructive agents affecting forests in Central America are wildfires and pine bark beetles. Wildfires are a common occurrence across Central America from February through May, associated with the region's "dry season." By far, the majority of these fires are caused by agricultural practices. Such practices include clearing and burning forests for shifting agriculture, burning of field stubble in preparation for planting, and burning to rejuvenate pastures for cattle grazing. In recent years, it has become apparent that this high fire frequency is contributing to several environmental and socio-economic problems including insect infestations, reduced water holding capacity, and soil erosion.

Impacts from fire are being compounded by several large outbreaks of southern pine beetle (*Dendroctonus frontalis*), which over the last two years have killed over 60,000 hectares of mature and developing pine stands in Belize, Nicaragua, Honduras and Guatemala. In turn, unmanaged pine stands, particularly those weakened by frequent fires, are prime targets for southern pine beetle attacks.

This document outlines a forest pest and fire management assessment conducted by Dr. Ronald Billings, forest entomologist with the Texas Forest Service, and Paul Schmidtke, a Fire Management Officer with the USDA Forest Service, Lincoln National Forest. This assessment was conducted from March 4 – 22, 2002, under the auspices of the U.S. Agency for International Development (USAID), Guatemala Central America Program (G-CAP), through a technical agreement with the U.S. Department of Agriculture, Foreign Agricultural Service, International Cooperation and Development (USDA/FAS/ICD). To conduct the assessment, the authors met with forestry officials to discuss the status of bark beetle and fire programs at the national and local levels in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.

A key finding of the assessment is that a regional strategy for bark beetle and fire management needs to be developed. The first step towards achieving this goal is to hold a regional workshop under the auspices of the Comisión Centroamericana de Ambiente y Desarrollo (Central American Environment and Development Committee) or CCAD. The workshop would bring together the national fire and pest coordinators from each Central American country (and southern Mexico) and other key personnel representing NGOs, forest industry, etc. to develop the regional strategic plan. It has been proposed that this regional workshop be held at ESNACIFOR in Sigatepeque, Honduras in late-June or July 2002, with financial support from the International Development Bank, Norwegian Trust Fund, the USDA, and others.

As part of the regional workshop, two regional committees would be formed, one for fire management and one for bark beetle issues. The function of each committee would be to review regional issues involving these two subjects, maintain region-wide databases on fire and bark beetle occurrence and impacts, and propose short- and long-term strategies

for resolution of these issues. An objective of the assessment was to identify key players in each country who should participate in the regional workshop and CCAD pest and fire committees.

The U.S. Agency for International Development (USAID) also feels the United States Government (USG) may have a role to play in assisting countries in addressing fire management and forest pest issues at a regional or country specific level. A secondary purpose of this visit was to provide a rapid assessment of the existing conditions within each country and determine what role, if any, the USG could, or should, play in improving the overall situation.

As a result of this assessment, the following recommendations are being made to USAID:

Fire

- 1) As part of the regional workshop, CCAD should form a Regional Fire Management Committee, consisting of the national fire coordinators from each Central American country and southern Mexico. The Regional Fire Committee would continue to foster on-going national level fire management planning efforts, standardize training and prevention programs, identify potential areas for mutual cooperation among countries, and assist in scientific research, data collection and monitoring.
- 2) Local and community level technical capacity should be strengthened. One alternative to accomplish this is to revive existing Sister Forest agreements with the U.S. Forest Service or other USG agencies where possible or create new ones as needed. A second alternative would be to work with Costa Rica, Guatemala, and/or Honduras, which already have well-established fire programs.
- 3) Agricultural extension institutions in each country, along with resource agencies, should increase presence/involvement in teaching farmers basic techniques in prescribed fire.
- 4) Regional fuel models should be developed that would in turn be used in developing a Central American fire danger rating system.
- 5) Each country should establish an emergency fund to be able to respond in a timely manner to wildfires in commercial forests and protected areas. Funding sources for this emergency fund could come from timber sale or forest management receipts, and/or eco-tourism.
- 6) Nicaragua should reinforce and/or update its ability to use real-time satellite data for fire detection and disseminate this information to other countries.

Bark Beetles

- 1) As part of the regional workshop, CCAD should form a Regional Forest Pest Committee, to include the national forest pest coordinators from each country and other key personnel representing NGOs and forest industry. The Regional Forest Pest Committee should meet periodically to identify regional pest problems, coordinate short- and long-range strategic plans for integrated management, identify research needs, and maintain a permanent database of pest outbreaks and associated losses throughout Central America and southern Mexico.
- 2) The importance of protecting Central American pine forests from forest pests, especially *Dendroctonus* bark beetles, needs to be recognized at all levels of government within each country. It is recommended that a national coordination group for forest pest control (Grupo Coordinador de Plagas Forestales) be organized in each country, with key members representing the forest service, park service, NGOs, agroforestry groups, and other national and international organizations with vested interests in forest protection within each country. This group would be responsible for approving, coordinating, and implementing the national strategic plan developed by the CCAD Forest Pest Committee to more effectively deal with forest pest problems. Responsibilities would be identified and assigned at the local, departmental, and national level with regard to detection, evaluation, control, and recovery of damaged areas.
- 3) Each country needs to identify one or more forest pest coordinators at the national level to provide leadership and coordinate bark beetle management programs within the country, as has been done in Honduras. These individuals would serve on the CCAD Forest Pest Committee.
- 4) To more promptly and continuously respond to bark beetle outbreaks, each country should establish an emergency fund. This fund could be financed from salvage sale receipts or other sources.
- 5) A short course on bark beetle detection, evaluation, suppression, and prevention should be offered for Forest Pest Committee members to establish standard approaches for bark beetle management and reporting throughout the region.
- 6) To increase technical capacity in bark beetle management at the department, local, and community level, USAID should support the development of a series of bark beetle training courses, including “train the trainer” programs, similar to those offered by the Office of Foreign Disaster Assistance (OFDA). These courses should initially be offered at the Escuela Nacional de Ciencias Forestales (ESNACIFOR) in Siguatepeque, since Honduras has the most

developed bark beetle program in Central America and the facilities to conduct such training.

- 7) Extension material (posters, brochures, field guides, videos, CDs, etc.) on bark beetle identification, prevention, and suppression should be developed and distributed at the national and local levels, as has been done for fire in most countries. A regional Internet web page on forest pests should be developed to include bark beetle information, names of country pest specialists, entomologists and insect taxonomists at Central American universities and forestry schools, annual bark beetle status reports, and pertinent literature. Pertinent information on bark beetles and other forest pests should be added to the existing forestry web pages currently maintained by forestry departments in Honduras, Nicaragua, Guatemala, and other Central American countries.
- 8) A long-term commitment from all interested national, regional, and international organizations and agencies is needed if a strategic plan for forest protection is to be successful at the regional level in Central America and southern Mexico. Regional training and extension centers for fires and pests need to be identified and provided with financial support.

Central America Southern Pine Beetle/Fire Management Assessment

Ronald F. Billings and Paul J. Schmidtke

I. Introduction

Forests in Central America are impacted periodically by various destructive agents, including wildfires, insect and disease outbreaks, wind storms, and human activities. This report addresses two of the most common and preventable concerns, wildfires and bark beetle outbreaks.

Wildfires are a common occurrence across Central America from February through May, associated with the region's "dry season." By far, the majority of these fires are caused by agricultural practices. Such practices include clearing forestland for shifting agriculture, burning of field stubble in preparation for planting and to rejuvenate pastures for cattle grazing. In recent years, it has become apparent that this high fire frequency is contributing to several environmental and socio-economic problems including insect infestations, reduced water holding capacity, and soil erosion. The death and destruction caused by Hurricane Mitch in late 1998 across the central part of the isthmus occurred, in part, because frequent fires had reduced the ability of local ecosystems to withstand copious amounts of rainfall.

Impacts from fire are being compounded by several large outbreaks of pine bark beetles, particularly those caused by the southern pine beetle, *Dendroctonus frontalis* (Coleoptera: Scolytidae). Over the last two years, severe southern pine beetle outbreaks have occurred throughout much of Central America, killing over 60,000 hectares of mature and developing pine stands in Belize, Nicaragua, and Honduras alone. These extensive areas of dead trees create excessive fuel loads that become subject to severe wildfires for several years following bark beetle outbreaks. Ironically, particularly in unmanaged pine stands, frequent fires are recognized as an important predisposing factor contributing to the initiation of southern pine beetle outbreaks, creating an interdependent cycle.

The following document outlines a forest pest and fire management assessment conducted by Dr. Ronald Billings, forest entomologist with the Texas Forest Service, and Paul Schmidtke, a Fire Management Officer with the U.S. Forest Service, Lincoln National Forest. This assessment was conducted from March 4 – 22, 2002, under the auspices of the U.S. Agency for International Development (USAID) as part of its Guatemala Central America Program (G-CAP), through a technical agreement with the U.S. Department of Agriculture, Foreign Agricultural Service, International Development Program (USDA/FAS/ICD).

II. Objectives

The three desired outcomes of this assessment were as follows:

- 1) Identify common issues among the various countries in the area of fire management and forest pest management.
- 2) Identify key resource professionals in each country who could represent their countries in a workshop to develop a regional strategy for bark beetles and fire, under auspices of the Comisión Centroamericana de Ambiente y Desarrollo (CCAD).
- 3) Make short- and long-term recommendations to USAID for the integrated management of bark beetles and wildfires at the regional level (Central America) and suggest how USAID and other USG agencies can best support the recommended protection program in the next five years.

Dr. Billings visited with resource professionals and forest technicians at national and local levels in Belize, El Salvador, Guatemala, Honduras, and Nicaragua. Mr. Schmidtke visited forestry leaders in Belize, Costa Rica, El Salvador, Guatemala, Nicaragua, and Panama (see Appendix A). Visits were conducted from March 4 through March 22, 2002. A draft of this report was presented to USAID officials in Guatemala on March 22.

III. Country Overviews

The following section briefly describes the present situation in each country as it relates to forest pest management and fire management. Information concerning forest pest management is summarized in Table 1. Fire information is summarized in Table 2.

A. Belize

The situation in Belize is much different from that of its neighbors. Four main differences include:

- 1) Low population pressure – Population density in Belize is approximately 11 people per square kilometer. Contrast this with El Salvador, which has a population density of approximately 290 people per square kilometer.
- 2) Public land ownership/clear land tenure/few pine forests– About 45% of Belize has been designated as some sort of protected area. The Government of Belize owns a majority of these areas. The remainder is owned almost entirely by the NGOs that manage those particular reserves. Almost all lands within the country have clear tenure and squatting is nearly non-existent. Only about 6% of the forested area is in conifer forests, the latter consisting primarily of the *Pinus caribaea* stands of the Mountain Pine Ridge Forest Reserve (MPRFR) and coastal pine savanna in southern Belize.

Table 1. Forest and Pest Summary for Central American Countries.

Country	Total area of forest cover (1000 ha.) (from Sharma 1992)	Total area of pine forest (1000 ha.) (Sharma 1992)	Area (and % of pine) affected by <i>D. frontalis</i> in 2000 & 2001 (1000ha.)	Major forest pests	Primary Issues
Belize	1,446	89 (30 in MPRFR)	25 in MPRFR (28% overall; 83% of pine forests in MPRFR)	<i>D. frontalis</i>	Need to control remaining SPB spots and utilize dead timber; fire protection for pine regeneration. Need for national forest pest coordinator.
Costa Rica	1,798	0	0 (0%)	<i>Scolytodes alni</i> on alder <i>Hypsypilla grandella</i> on mahogany	Need to prevent and control <i>Scolytodes alni</i> in alder plantations.
El Salvador	141	25	0.214 (1%)	<i>D. frontalis</i>	Need to identify national forest pest coordinator; place SPB detection and control responsibilities under same agency. Need more SPB training of field technicians. Need a permanent record-keeping system for forest pests.
Guatemala	4,542	602 (7.5 in Petén Region)	3.0 in Petén Region (40% of pines in Petén Region)	<i>D. adjunctus</i> <i>D. frontalis</i> <i>Atta</i> spp. Mistletoes Various defoliators and other pests	Need to identify national forest pest coordinator(s) for INAB and CONAP; need more SPB training, permanent pest record-keeping system.
Honduras	5,680 (Silviagro S.de R.L. 1996)	2,781 (Silviagro S.de R.L. 1996)	10.8 (0.4%)	<i>D. frontalis</i> <i>Rhyacionia</i> spp. <i>Atta</i> spp. <i>Tropidacris dux</i> <i>Ips</i> spp. Mistletoes	Need to continue control of the worst bark beetle outbreak since 1982. Need more operating funds in certain forest regions.
Nicaragua	4,496	318	31 (9.7%) (47% in Dept. of Nueva Segovia)	<i>D. frontalis</i> <i>Ips</i> spp. <i>Tropidacris dux</i>	Need to complete control of the worst bark beetle outbreak in the country's history. Need to select national forest pest coordinator.
Panama	4,165	30	0 (0%)	<i>Ips</i> spp. Various pests of teak plantations	Need to prevent and control other forest pests such as <i>Ips</i> and those that attack teak.

Table 2. Fire Management Overview*

* Data on number of fires, causes, and hectare burned, etc. is limited in some countries and will not be presented in this report.

Country	Values at Risk	Major ignition sources	High Hazard Areas	Primary Issues
Belize	Pine regeneration in MPRFR. Broadleaf forests in South.	Lightning Milpa burning Hunters	MPRFR Areas affected by Hurricane Iris	Lack of funding. Need to train more personnel in fire suppression and incident management. Need to improve monitoring system/fire database, including GIS.
Costa Rica	Protected areas and watersheds Forest restoration areas	Revenge Pyromania Carelessness	No significant areas	No significant crisis exists.
El Salvador	Small areas of productive pine forests Fledgling protected areas	Agricultural burning for a variety of objectives	No significant fuel hazards have been identified.	Complex bureaucracy. Lack of funding. Need for increased training in fire management planning and suppression at the local level. Prescribed fire is not used as a management tool. Need to develop a fire data base and monitoring system.
Guatemala	Regeneration in commercial forests Protected areas Watersheds	Agricultural burning for a variety of objectives Hunters	Areas affected by bark beetles in Petén Region. Isolated pockets of fuel but no major threats in other regions.	Need to strengthen SINIFOR, including establishment of fire database. Need to increase local capacity to plan for and initially attack fires. Prescribed fire is not being used to the extent possible.
Honduras	Regeneration in commercial forests Protected areas Watersheds	Agricultural burning for a variety of objectives	Isolated areas of beetle kill.	Lack of funding Need to strengthen local capacity to plan for and initially attack fires. Prescribed fire is not being used to the extent possible.
Nicaragua	Pine regeneration Watersheds	Agricultural burning for a variety of objectives	Areas affected by pine beetle in the Department of Nueva Segovia.	Reduced role of INAFOR in fire management actions. Lack of funding. Need to improve existing fire plans. Need to fortify local capacity to plan for and fight fires.
Panama	Pine and teak plantations Protected areas in the canal zone	Agricultural burning Carelessness Hunting	Thick grass stands planted in the canal zone to stabilize deforested banks.	Need to increase local capacity to plan for and suppress fires.

- 3) Single agency management – The Forestry Department manages all aspects of publicly held reserves. Most of them are managed directly by government-employed natural resource managers, with some smaller reserves being managed by NGOs supervised by the Forestry Department.
- 4) The British legacy – Up until the early 1970s, Belize was known as British Honduras and was a colony of Great Britain. The British created an extensive infrastructure for management of pine forests that remains relatively intact today.

Until recently, fires, while occurring with regular frequency in some areas, were not considered a major threat to the ecology or the socio-economic landscape of Belize. Two recent events have changed this situation dramatically.

Mountain Pine Ridge Forest Reserve (MPRFR) Beetle Outbreak

From early in 2000 until late in 2001, over 25,000 hectares of mature pine stands (*Pinus caribaea* and *Pinus patula* var. *tecumumanii*) suffered near 100% mortality from an outbreak of southern pine beetle (*Dendroctonus frontalis*). This area represents about 60% of the entire Mountain Pine Ridge Reserve and about 80% of the pine ecosystem within the Reserve. In 2001, the outbreak spread to the *P. caribaea* stands along the southern coastal savannas near the town of Independence, impacting about 30% of these stands. By March 2002, the beetle outbreak had largely subsided and, while beetle activity remains in isolated areas, it is not likely that another significant outbreak will occur in the near future.

A large percentage of the decimated stands did have enough seed trees left to produce adequate natural regeneration that is taking hold in many areas. The principal threat to this regeneration and the re-establishment of another pine forest is wildfires. Between 5-10 fires/year occur in the MPRFR, primarily caused by lightning. Until the sapling trees reach the height of about 4-5 meters (which will take 6-8 years), they are highly susceptible to mortality from fires. A recent fire was visited on the trip and although fire behavior was considered to be low in intensity, it was still hot enough to kill almost all the regeneration within the burned area. To exacerbate the problem, heavy fuel loading created by falling snags could lead to fires that have the potential to grow very large and burn with very high intensity, potentially impacting the residual seed trees and adjacent forests.

Hurricane Iris

In October 2001, Hurricane Iris made landfall near the town of Monkey River and proceeded to destroy over 243,000 hectares of coastal pine

savannas and tropical broadleaf forests. Fuel loading created by this tropical storm is very heavy in many areas. These areas have traditionally seen more fires than in the MPRFR, because many indigenous people living in the area use fire in the production of corn and other crops. Many of these fires escape control and move into what once were forested areas. Under normal circumstances, these fires have rarely grown large, except during periods of drought. However, with the creation of heavy fuel loading by Hurricane Iris, these fires now have the potential to impact large areas that could include isolated homes, small settlements, and steep erosive slopes in the foothills of the Maya Mountains.

Belize's Department of Forestry has done a good job in analyzing the current fire situation, has made appropriate plans to address the concerns and issues in these two areas, and has the trained personnel to implement these plans. What is lacking is funding. Current appropriations from the Belize legislature are being reduced annually. The MPRFR, for example has a budget of \$125,000 (US), which is sufficient to pay its 50 or so employees, but leaves very little to pay for fuel, vehicle maintenance, materials, or supplies.

The Reserve is heavily dependant on the Pine Lumber Company (the logging company who holds the rights to harvest timber in the MPRFR) to provide needed equipment, manpower, and supplies to attack both the beetle outbreak and wildfire. While the company has a vested interest in maintaining the valuable timber, they can only provide so much before their assistance starts eating into profits. Recently, with assistance from the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA), the Department of Forestry published a color-illustrated leaflet describing the biology and control of the southern pine beetle for use in Belize.

The extensive loss of pine resources in Belize to an unprecedented outbreak of southern pine beetle can be attributed to several factors: 1) an abundance of dense, susceptible pine stands, particularly in the MPRFR, 2) failure to recognize and respond to the beetle outbreak in early stages of development (there was no SPB monitoring system and control measures were not begun until more than 15,000 hectares had become infested), and 3) a severe reduction in forestry personnel (in 1995, the work force of 120 forestry personnel was reduced by government mandate to just 8 permanent forest officers and 36 others, including forest guards).

Containment of the SPB outbreak was eventually achieved by creating large buffer zones along the leading edge of expanding infestations. In a unique approach, a heavy 100-foot long chain was pulled between two D-8 bulldozers to fell freshly-attacked trees and adjacent uninfested trees. By making two passes in opposite directions with the chain, not only were the trees felled in the buffer strips, but much infested bark was removed in the process which may have reduced brood survival. Harvest and utilization of beetle-killed trees in the

MPRFR and other infested areas are still in progress, but no doubt much of the affected resource will go to waste. As with other countries in Central America, no water sprinkler systems or chemical treatment facilities are available to store logs for long duration without losses to fungi and wood-boring insects.

Clearly, the Belize Forestry Department is severely undermanned, especially considering that the department not only has responsibility for protection of pine forests against fires and pests, but also for protection of protected areas throughout the country from fire, illegal logging, squatting, and hunting.

In the Iris-impacted areas, the Forestry Department has a well-developed strategy for community-based fire prevention planning, fuels management, and community fire brigades. The current proposal, as written, will cost over \$400,000 US, and to date has not been funded.

Recently, the German Forestry Agency (GTZ) conducted a fire assessment of Central America, including Belize, following the massive southern pine beetle outbreaks. The results of this assessment have yet to be released.

B. Costa Rica

Costa Rica has a well-developed environmental management program. The entire country is divided into conservation areas. In each area, national parks, forest reserves, wildlife refuges, and other public lands are managed in an interdisciplinary fashion. Additionally, each conservation area is responsible for environmental protection on all lands for issues such as watershed and riparian management, hazardous waste, etc. Within each area, the federal government also has a series of what are known in the U.S. as conservation easements, where private landowners are paid by the government to protect or enhance important natural areas. All of these actions are administered through the Ministry of Energy and the Environment (Ministerio del Ambiente y Energía or MINAE).

In terms of wildland fire, each conservation area has an established fire management plan that functions under the direction of the “National Fire Management Strategy,” an interagency plan that has been accepted as national policy. One interesting feature of this plan is that volunteer firefighters are provided a life insurance and workman’s compensation policy should an injury or fatality occur in the line of duty. To date, Costa Rica has 862 wildland firefighters enrolled in this program.

The fire management program is co-funded by a variety of institutions across the country including that national insurance organization, which operates all the fire departments in the country. The average annual appropriation for the wildland fire program is approximately \$300,000. The program also takes advantage of private donations from a variety of sources. Costa Rica has a well-developed data collection system, infrastructure, training program, and sufficient material and supplies to implement fire management programs across the country. The Costa

Rican program is a model program for Central America and includes certain aspects that could be applied in the U.S. to improve program delivery.

Costa Rica's ability to develop this level of environmental program is based on its large eco-tourism program, the number one industry in the country. As eco-tourism and other economic developments have increased, cattle ranching and subsistence agriculture have all but disappeared.

One issue currently facing Costa Rica is in the area of forest pest management. For many years, MINAE supported and led an interagency forest pest organization. This group has been dissolved and no longer functions across the country. However, several forest pest problems have recently occurred that should be addressed. (Southern pine beetle or other species of *Dendroctonus* bark beetles are not found in Costa Rica and pine is not managed as a commercial species).

The most critical forest pest is the wasp *Scolytodes alni*. This wasp lays its eggs in a species of alder (*Alnus acuminata*), known locally as "jaul." This tree is considered to be native and grows at mid-range elevations in many parts of the country. It has recently become an important species for reforestation and watershed protection projects because of its fast growth and adaptation to the local area. It is currently being planted in watersheds surrounding the densely populated central valley to protect potable water sources, hydroelectric dams, and restore abandoned dairy farms. Part of this farm restoration is being conducted through a reforestation incentives program which provides government and private subsidies to landowners who re-establish forests. Some subsidies are also provided through a carbon sequestration project with a Norwegian group.

Many of these alder plantations are suffering significant mortality due to the appearance of this wasp. Little is known about the wasp's life history or what measures can be taken to prevent or control infestations. MINAE officials are concerned that a widespread outbreak of this pest could jeopardize these important reforestation programs.

C. El Salvador

El Salvador has the smallest amount of forest cover remaining among the seven countries and one of the highest population densities (290 persons/square kilometer). It has a complex set of bureaucratic departments that maintain a variety of responsibilities concerning fire and forest pest management. The following is a brief description of each agency and its role in natural resource management and protection.

Ministry of the Environment and Natural Resources (Ministerio del Medio Ambiente y Recursos Naturales (MARN))

MARN manages El Salvador's protected area system, which is the youngest and least developed in Central America. Currently, only one protected area (Montecristo) has been officially declared by legislative act. Several other areas have been identified by the executive branch and fall under the jurisdiction of MARN to be managed as protected areas. A few areas are being managed privately by NGOs such as SalvaNatura, which has acquired lands through various donations and outright purchases. The majority of the country's protected areas are small forests within community cooperatives that were created as a result of sweeping land reform, which took place in 1992. These small community forests are being transferred little by little from the country's land reform agency to MARN. They will become property of the Salvadoran government and will be managed as protected areas.

Although MARN has the responsibility to oversee management of protected areas, they do not have any legal mandate to implement management actions within these areas. Even those areas that are in public ownership are having the implementation responsibilities shifted to NGOs where possible. On non-public lands, final responsibility lies with the landowner or community cooperative, who must consult with MARN before taking management actions. MARN plays no active role in fire management or forest pest management other than as a consultant to other agencies. They do, however, take the lead in fire prevention and produce a variety of prevention materials.

The Salvadoran Forest and Wildlife Service (Servicio Forestal y de Fauna)

This agency, organized under the Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganaderia or MAG) has the legislative mandate (1973 forestry law) to manage all forested lands within El Salvador, including providing fire protection and taking actions to suppress forest pest outbreaks. Unfortunately, this agency is significantly under staffed, under trained, and under funded to accomplish this mandate. A majority of time and effort is concentrated on evaluating, approving and supervising the implementation of harvesting plans that occur on privately-held forest lands. No fuels management or hazard reduction for pine bark beetles of any kind occurs within the country.

Unfortunately, this agency does not have the responsibility for monitoring or identifying forest pest outbreaks. However, they do have several field foresters and technicians who have been trained (in Honduras) to identify and manage beetle outbreaks and have done a fairly good job in suppressing infestations as they occur, using the cut-and-leave method,

primarily. Recently, a bark beetle control plan has been developed, but to implement it would require additional forestry technicians and funding that have not been provided to date.

The Plant and Animal Health Department (Dirección General de Sanidad Vegetal y Animal)

This agency, along with the Forest and Wildlife Service, falls within MAG. Its primary role in forest management is to monitor and identify forest pest outbreaks, along with addressing other plant health issues across the country. Based on a survey of 8% of the pine-forested areas, this agency has identified a series of small bark beetle outbreaks and has reported these to the Forest and Wildlife Service. The Forest and Wildlife Service maintains ultimate responsibility for suppressing these outbreaks. To date, no major outbreaks such as those in Belize, Honduras or Nicaragua have occurred, no doubt due to the paucity of extensive pine forests.

The Salvadoran Disaster Committee (Comité de Emergencias Nacionales (COEN))/Fire Corps (Cuerpo de Bomberos Salvadoreño)/Military

These three agencies combine to form the backbone of the Salvadoran wildfire suppression organization. These agencies are fairly well trained and organized to suppress fires and have been assisted in the past by the Office of Foreign Disaster Assistance (OFDA). They work under a national fire management strategy developed in conjunction with land management agencies such as MARN, the Forest Service, and other Salvadoran environmental agencies. This plan does describe in detail the role of each agency and the mobilization process for fire suppression. On scene incident management is coordinated by the Fire Corps. Logistics are coordinated through the COEN. This suppression organization is fairly good at managing large incidents, but local communities still lack equipment and training to respond to incidents before they become large. The natural resource agencies play no role in prioritization of fires and no resource management plans exist which would help suppression managers make decisions based on resource values at risk.

Overall, El Salvador experiences a large fire load. Over twenty active fires were seen in one afternoon trip to the country, with many more acres having recently been burned. Most of the burning occurs in the densely populated agricultural lands that are spread throughout the country. These agricultural lands are susceptible to erosion during heavy rains. Potable water shortages, due to lack of moisture holding capacity of watersheds caused by deforestation, are a common occurrence. Fire, however, is an unfortunate necessity in El Salvador's agricultural system and does not significantly contribute to damage already done.

A few intact forest systems remain, primarily pine-oak associations located at higher elevations along the border with Guatemala and Honduras, and tropical broadleaf forests located near the top of high volcanic peaks. Both insect outbreaks and fires threaten these forests. The Forest and Wildlife Service has done a good job in reacting to bark beetle outbreaks in areas where the few trained field foresters or technicians are working. However, during suppression actions, there have been cases where the news media, general public, private landowners, and local political officials have protested against the extensive tree felling that is needed to quell these outbreaks. In some cases, active treatments were halted due to public and political pressure, resulting in increased timber losses.

Guatemala

Fire management in Guatemala is operated through the Forest Fire Prevention and Control System (Sistema para la Prevención y Control de Incendios Forestales or SIPECIF), an interagency committee represented by several natural resource agencies, the Guatemalan military, and the National Emergency and Disasters Council (Consejo Nacional de Reducción de Desastres (CONRED)). Similar groups have been formed at the department and local levels (e.g., Consejo Departamental de Reducción de Desastres (CODRED) y Consejo Local de Reducción de Desastres (COLRED)).

SIPECIF has done an outstanding job in creating a national fire management structure, fashioned after the National Interagency Fire Center in Boise, Idaho. It has also been proactive in adapting OFDA and other training materials to fit Guatemala's unique cultural situation, including fire leaflets in Ketchí, the common Mayan language. They have conducted a national-level fire risk analysis and are developing agreements with Mexico to provide satellite imagery for fire detection. They have made significant investments in tools and other materials and supplies and have a rigid accounting system to reduce loss and theft of equipment. Finally, they have been aggressive in producing fire prevention material.

Two government agencies take the primary role in natural resource management in Guatemala. First is the Guatemalan National Forest Institute (Instituto Nacional de Bosques (INAB)). INAB is responsible for all forest management actions, including fire and forest pest management, on forested lands within Guatemala, except those found in declared parks, reserves and other protected areas. They also manage an aggressive incentives-based reforestation program (PINFOR) that is quite successful. Forest protection activities in parks and reserves fall under the jurisdiction of the National Parks Council (Consejo Nacional de Areas Protegidas (CONAP)).

A third group of players in the forest management field are a small number of NGOs, such as Fundación Defensores de la Naturaleza (FDN) and Fundación de

Ecología (FUNDAECO). These groups have been given legislative authority to manage certain parks and reserves in coordination with CONAP. They receive little financial support from legislative appropriation to accomplish this mission, but are well established and have been able to develop comprehensive, sustainable programs in various locations with private donations. The Ministry of the Environment and Natural Resources (Ministerio de Ambiente y Recursos Naturales) also forms part of SIPECIF and is primarily involved in prevention and community extension programs. Finally, the Guatemalan military has been trained to combat large wildfires and support the land management agencies at critical times.

Guatemala has received substantial involvement from donor countries since the devastating fires in 1998. OFDA, the USDA Forest Service, and the Department of Interior, through USAID, have assisted in developing national level fire management programs and site-specific programs in the Petén Region. SIPECIF and CONAP have been the primary players in establishing a fire organization in the area. Also, depending on the level of financial commitment, available resources, and institutional development, other portions of the country have been able to develop fairly advanced plans for fire management and forest pest control. Sierra de las Minas Biosphere Reserve and surrounding areas are well on their way to implementing a sustainable forest management program that includes fire and forest pest management (see Billings 2001c).

On the other end of the spectrum, several forested areas exist that do not have comprehensive forest management plans or well-established local fire control committees. In many cases, field level personnel in both CONAP and INAB lack the necessary skills to serve as initial attack incident commanders and the turnover rate among trained volunteer fire fighters is high. This lack of local level capacity is slowly being addressed, but inter-institutional competition and recent political turmoil are causing setbacks. Agricultural activities account for the majority of fire starts within Guatemala, and forests, especially pine and pine/oak forests, located along the agriculture/ forest interface are most susceptible to damage from fires.

In 2000 and 2001, the pine forests in the Petén Region of Guatemala suffered a severe outbreak of southern pine beetle, *Dendroctonus frontalis*. Nearly 3,000 ha. or 40% of the existing 7,500 ha. of *Pinus caribaea* forests were killed. A total of 341 individual infestations (spots) were detected and average spot size after containment was ca. 9 ha. Of these, 305 spots were addressed by CONAP and the remainder by INAB. CONAP and INAB were slow to respond to the rapidly-developing SPB outbreak and many infestations were larger than 10 ha. prior to initiation of control action. Once the decision to control was made, a variety of control methods were used, ranging from salvage, chemical control, cut-and-leave, and cut-and-remove.

In certain areas around the town of Poptún, standing trees were treated with an agricultural systemic insecticide (active ingredient = oxamyl 24SL), a highly toxic, carbamate, restricted use insecticide produced by DuPont. Effectiveness of this insecticide for bark beetle prevention and/or control remains inconclusive. Currently, no new active beetle infestations are known to occur in the Departments of Poptún or Delores (Petén Region), but salvage operations are continuing in beetle-affected areas. No plans have been made to reforest the area. A few live pines per hectare remain standing as seed trees, but natural regeneration is scarce to date. There is need for more training in bark beetle prevention and control measures, although the Texas Forest Service field manuals in Spanish (Billings et al. 1990, 1996a, b) and other information have been received via the forest technician school (ESNACIFOR) in Honduras.

The National Park at Tikal has a small acreage of pine forests, but to date, these have escaped bark beetle infestation and the major forest protection issue within the park is fire. However, various isolated young plantations of *Pinus caribaea* established near Flores, at least 80 km from the major bark beetle outbreak near Poptún, had been attacked and eliminated by *D. frontalis* during the 2000-2001 outbreak.

Historically, the most severe bark beetle problems in Guatemala have occurred in the Altiplano Region and have involved *Dendroctonus adjunctus*, rather than *D. frontalis* (Schwerdtfeger 1955). The principal pine host has been *Pinus hartwegii* (= *P. rudis*). An estimated 100,000 ha. of *P. hartwegii* were killed by *D. adjunctus* from 1975 – 1980 (Petoni et al. 1980). During the last decade, several small infestations of *Dendroctonus* have been detected and controlled in the Sierra de las Minas, without causing major resource losses.

During this trip, an infestation of *Dendroctonus* spp. was observed killing 35-40 year-old trees of *Pinus pseudostobus* within Iximche Archeological Park near Chemaltenango, at an elevation of 2,600 m. At least two species of *Dendroctonus* were involved; the principal attacking species was characterized by “S”-shaped parent galleries, suggesting possibly *D. mexicanus* (and/or *D. vitei*), while the bases of certain trees were attacked by the red turpentine beetle, *D. valens*. The elevation is outside the known range for *D. frontalis*, which is limited to elevations below 2,000 m. Several adult bark beetles were collected from the Iximche site and sent to Dr. John Moser, USDA Forest Service, Pineville, Louisiana to verify the species involved.

In most cases, bark beetle infestations in Guatemala are identified as *Dendroctonus* spp., with no attempt to identify species. In 2001, at the request of INAB, Guatemalan entomology consultant César Casteñeda S. prepared a literature review of *Dendroctonus* bark beetles and a plan for integrated management of bark beetles in Guatemala (Casteñeda S. 2001). This plan, which includes recommendations for short- medium- and long-range actions to suppress

and prevent bark beetle outbreaks, has yet to be approved, funded, or implemented by INAB.

Honduras

Honduras has a long history of forest health problems involving wild fires and *Dendroctonus frontalis* outbreaks. One of the worst southern pine beetle outbreaks on record occurred in Honduras in 1962-1964. Due to the lack of control, at its peak the outbreak was expanding at an estimated 162,000 trees per day, ultimately destroying 28% of Honduras' extensive pine forests (Ketcham and Bennett 1964, Hernandez Paz 1975).

Since 1982, the Honduran Forestry Corporation (Corporación Hondureña de Desarrollo Forestal or COHDEFOR) has implemented a comprehensive SPB management program, with technical assistance from Dr. Ronald Billings, Texas Forest Service, and financial support from US AID and other international organizations (Billings 1982, 1988, 1998, 1999, 2001a). As a result, Honduras has the most advanced bark beetle management program in Central America. This program consists of a national pest coordinator (role fulfilled by Ing. Vicente Espino Mendoza since 1982) and forest protection coordinators in each forest region. The latter are trained foresters or technicians that coordinate detection and control programs for both fires and bark beetles.

The forestry school (Escuela Nacional de Ciencias Forestales or ESNACIFOR), located in Siguatepeque, is recognized throughout Central America for its forestry curricula and training programs. Most of the forest technicians involved in bark beetle control programs have either graduated from ESNACIFOR or received at least one training course in bark beetle biology, evaluation, and control at the school.

A record-keeping system, established in 1982 and operated continuously since then, provides detailed records of infestations detected, evaluated, and controlled, acreages affected, volumes of timber killed and salvaged, and costs of control. Regional records are summarized in periodic reports at the national level. Extension and training efforts in bark beetle identification, biology and control are offered at the local level, to involve communities, NGOs, agroforestry groups, forest industries, and private landowners.

From 1984 through 1993, a total of 6,233 SPB infestations were detected in Honduras and 73% were controlled, primarily with cut-and-leave or cut-and-remove. The average size of controlled spots was 2.1 ha/infestation (Silviago S. de R.L. 1996), emphasizing the effectiveness of the bark beetle protection program. This track record suggests that Honduras should serve as the model for development of pest management programs in other countries of Central America.

Despite progress made to date, Honduras' bark beetle protection program is not without problems. A severe SPB outbreak developed in 2000 and 2001 when 1,691 and 3,297 infestations, respectively, were detected. The total area affected was the greatest since 1983, amounting to 1,743 ha. in 2000 and 9,078 ha. in 2001. Drought conditions and an abundance of dense, unmanaged pine stands frequently weakened by wildfires and resin extraction have been identified as contributing factors. The outbreak has been addressed adequately in most regions by means of cut-and-leave and cut-and-remove operations (Billings et al. 1996b), but certain regions require increased attention in 2002. These include the forest regions of El Paraíso, Francisco Morazán, and Copán. From January 1 through February 8, 2002, a total of 844 new infestations had been detected and only about 50% had been controlled.

In response to the alarming bark beetle situation, the Honduran government passed an emergency law for the control of the pine beetle in December, 2001. This new law not only brought national attention to the current pine beetle outbreak, but more importantly, provided the financial resources and incentives to carry out an intensified control program. One of the limiting factors believed to have contributed to the outbreak is that the national forest pest coordinator, Vicente Espino, took leave from COHDEFOR from July through December, 2001, to pursue a forestry degree at ESNACIFOR. This left no trained person in charge to administer the pest program at the national level. Not until Mr. Espino was encouraged to return to COHDEFOR in December and conducted aerial detection flights over the more infested regions (accompanied by regional pest coordinators) did the severity of the current outbreak become realized. This emphasizes the need to maintain strong leadership in forest pest control at the national level to assure adequate and prompt response to bark beetle outbreaks.

Presidential elections in October 2001 and associated changes in the administration of COHDEFOR also may have hampered the extent and continuity of control operations. The new General Director (Gustavo Morales) for COHDEFOR is a forester and seems supportive of a more aggressive pest control program. Field foresters in the regions, however, have devoted long hours and weekends on pest and fire programs, sacrificing their vacations for 3 years with no compensation. Thus, morale in the field is low at present. Another major problem is the rapid turnover of trained personnel.

Most of the current regional protection specialists have less than 2 years of experience, while many of the COHDEFOR foresters and technicians trained in bark beetle control since 1982 no longer work for COHDEFOR. The need for training in pest- and fire protection is a continuous one. In this regard, Dogaberto Núñez H. (2001), with support from PROCAFOR, has published a literature review in Spanish on the integrated management of southern pine beetle. AFE-COHDEFOR also has published a color poster showing the life cycles and attack symptoms of *Dendroctonus frontalis* and *Ips* spp. in Honduras, as well as leaflets on bark beetle control methods.

Fire programs in Honduras appear to attract more support and attention, even though fires cause much less damage than bark beetles. COHDEFOR has a fairly well developed fire prevention and control program, operated as part of the Department of Forest Protection (which also includes the pest program). An annual forest protection plan has been prepared that describes both fire and bark beetle management activities at the national, department, and local levels. In Honduras, land is divided among three groups, with approximately 50% being privately owned, 25% community owned (ejidales), and the remainder government land. Private landowners must prepare and file a management plan with COHDEFOR that includes protection from fire and pests. Honduran forest law gives the government the right to charge private landowners if they do not control fires or pests on their property, but this is seldom enforced.

COHDEFOR's national fire plan, which includes some prescribed burning and prevention activities, is mostly focused on fire suppression. Several COHDEFOR personnel have completed the courses in fire and instructor training offered by OFDA. Priorities for fire control are: 1) managed forests on government lands with regeneration of 6 years or less; water sources in protected areas; 2) young pine forests; 3) mature pine forests. Fire breaks are used around protected areas and fire prevention information and short courses are offered at the local level. There is some overlap in fire and SPB control programs, with the same crews performing both operations in some cases. Occasionally, a chainsaw operator with saw is assigned to a fire crew to treat small beetle infestations upon detection.

Among needs identified in the fire program in Honduras are methods for evaluating losses and the cost:benefits of control and prevention programs. No new equipment has been purchased in the last 5 years. No fire hazard or warning system is available and the number of fire towers has been reduced from 100 in 1986 to 40 in 2002. The average acreage damaged by fires per year has remained relatively constant since 1980 at ca. 2,300 ha./year or 31 ha. per fire, despite increased prevention efforts. Fires are fought with hand tools. Only one tractor is available (in La Mosquitia Region) and it is not in working order. No safety program has been implemented and fire fighters lack training in safety and safety gear. There are no methods used to monitor fuel loads.

D. Nicaragua

Several agencies are involved with protection of managed forests and protected areas in Nicaragua. These include the Ministry of Agriculture and Forestry (Ministerio Agropecuario y Forestal o MAGFOR), of which the National Forestry Institute (Instituto Nacional Forestal or INAFOR) is a part, and Ministry of Environment and Natural Resources (Ministerio del Ambiente y los Recursos Naturales or MARENA). Both MAGFOR and MARENA coordinate the sustainable use of natural resources and protected areas. Forest management and

protection programs are administered directly by INAFOR. In addition, several governmental agencies, including MARENA and MAGFOR, form part of the National Disaster Committee (Comité Nacional del Sistema Nacional or CNSN) to address prevention and mitigation of national disasters. At the National University (Universidad Nacional Agraria or UNA), forest entomologist Alberto Sediles has begun some research studies on southern pine beetle and other forest pests.

Nicaragua has been significantly impacted by natural disasters over the last several years. Since 1998, over 30,000 hectares of pine forest (*P. caribaea* and *P. oocarpa*) were killed by southern pine beetle in Nicaragua, primarily in the municipality of Jalapa within the northern province of Nueva Segovia. In May 2001, with emergency funds and technical assistance provided by the USDA Hurricane Mitch Project and subsequently by the Nicaraguan government, an organized control effort was initiated. As a result, potential losses were reduced by application of extensive buffer strips to slow the spread of massive infestations and use of cut-and-leave to treat smaller infestations as they were detected (Billings 2001 b, d).

According to INAFOR data, within the Department of Nueva Segovia, 855 infestations were detected during the course of the 1999 – 2001 outbreak and 615 were controlled (the remainder either went inactive or merged with other infestations prior to control). Some 5,600 ha were treated as of December 31, 2001, involving the felling of 1.4 million trees having an estimated volume of 575,421 cubic meters. As a result of the aggressive, albeit delayed, control effort, over 35,000 ha (53%) of the pine resource in the Department of Nueva Segovia have been saved from potential destruction. The beetle outbreak has now been largely contained, although less than 30% of the felled timber and 5% of all the dead trees have been salvaged to date (December 31, 2001). The standing dead trees and those felled for purposes of control are rapidly losing commercial value due to degrade from wood-boring insects and wood-rotting fungi. Nicaragua lacks facilities for storing logs under sprinkler systems or by other means. Local markets for beetle-killed trees are largely saturated, even in neighboring El Salvador and Honduras. These beetle-affected trees have increased the risk of wildfires throughout the outbreak area.

In addition to U.S. agencies, several international forestry organizations were involved with addressing the massive southern pine beetle outbreak in the Department of Nueva Segovia. Among these was the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA), with headquarters in El Salvador, which has published a literature review of *Dendroctonus* bark beetles in Central America (Landaverde Toruño 2001) and provided training to field crews. Also, the Central American Forestry Project (Proyecto Regional Forestal para Centro América or PROCAFOR), with financial support from Finland, has financed SPB training sessions and provided logistical support for control efforts.

As with Belize and the Petén Region of Guatemala, the extensive bark beetle losses in Nicaragua can be attributed to initial lack of experience and forestry personnel trained to address SPB outbreaks. Inadequate financial and logistical support (vehicles and fuel) were contributing factors that allowed many small infestations to enlarge and merge, before an adequate control program was initiated. In Nicaragua, control programs also were hindered by poor access, lack of initial inter-institutional coordination, negative responses by certain landowners that prohibited felling trees on their property, and presence of anti-personnel mines along the Nicaragua/Honduras border (left from the 1980s Contra-Sandinista conflict).

Pine forests in this area are at high risk due to grazing and agricultural pressure and lack of silvicultural treatments such as thinning. Surrounding areas have almost systematically been deforested over the last 20 years. This area experiences severe soil erosion, low productivity, shortages of potable water, and even periods of food shortages. The area was severely impacted by Hurricane Mitch and recent soil movement has subsequently damaged some rehabilitated infrastructure. There has been little investment in upper watershed restoration, reforestation, or other long-term solutions to these environmental problems.

Pine stands that have been impacted by bark beetles are at risk of following the same path as surrounding areas. First, natural regeneration and superior seed trees are not common in many areas. Second, active use of fire for agricultural purposes is common throughout the zone. To their credit, the Nicaraguan government has developed an emergency action plan to address the current fire risk. While this plan is more of a funding request than a strategic approach, it is at least an attempt to recognize the gravity of the situation.

A notable success is a municipal executive order banning all agricultural burning in the Jalapa municipality. This order is being enforced by military patrols in the area. To date, several fines have been levied and one arrest has been made. Continued enforcement of this policy represents the best chance for protection of this forest and restoration of healthy pine stands. However, local fire fighting capacity is almost non-existent, and the National Forestry Institute (INAFOR) currently plays only a minor role in the overall situation. It also is likely that local leaders who to date have shown proactive leadership may not have the political will to extend burning bans into the future.

There is serious concern that the large areas of felled trees will be converted from forestry uses to other land uses (grazing, agriculture) in the outbreak area, before they can be regenerated with pines. This land use conversion following bark beetle control is a problem also in Honduras and other Central American countries.

Protecting impacted forestlands from fires and establishing pine regeneration, while avoiding conversion of cut-over forestland to other uses, are INAFOR's

primary concerns for the next few years. INAFOR once had a Department of Forest Protection, originally to respond to wildfires and more recently to forest pests, but this department was eliminated in 2001. Ramiro Saboria, the new sub-director of INAFOR, promises to re-establish this department, which is considered essential to properly address both wildfires and bark beetle outbreaks at the national level. Nicaragua also needs a forest pest coordinator at the national level and regional protection coordinators in all forestry departments with protection problems.

E. Panama

Panama has a much different situation than that of its neighbors. First, pine is not native to Panama, and grows entirely in plantations. Second, because of its climate and topography, a majority of its remaining forest lands are located in areas that are not subject to significant impacts by fires except during droughts. Third, subsistence agriculture is much less common than it is in other countries further north. As such, the burning practices associated with this activity are also far less common. Finally, a great deal of infrastructure and forested land was transferred to Panama by the USG as part of the divestiture of the canal zone and military installations. This infrastructure, combined with a much stronger economy, provide the Panamanian National Environmental Authority (Autoridad Nacional del Ambiente (ANAM)) with a better foundation for forest and protected area management than some other countries. Organized within the ANAM is the Dirección Nacional de Patrimonio Natural or Panamanian Forest Service.

The major success story in Panama is its reforestation program. All expenses associated with reforestation are tax deductible. Corporations and individuals interested in reforesting their own property or leasing government-owned lands for reforestation are allowed to deduct 100% of their expenses for seed, preparation of land, fertilizer, fire protection, pest control, and other silvicultural treatments. Public land concessions are granted for 20 years. Reforestation of native species within protected areas also is being attempted by requiring those who harvest forests to manage reforestation plots of similar size in protected areas. All reforestation projects are managed under the direction of foresters from ANAM.

This plan costs the public next to nothing. All expenses are borne by the group or individual doing the reforestation. Primary species include Caribbean pine (*Pinus caribaea*) and teak (*Tectona grandis*). Native species are planted in protected areas. Over 45,000 ha have been reforested since 1992.

The major concern of these tree farms is forest pests. Although no species of *Dendroctonus* are known to occur in Panama, engraver beetles (*Ips* spp.) and other pests and diseases have affected these farms over the last few years. There

has been some institutional support from various people in the entomology field but these individuals primarily deal with agricultural pests and are not experts in the forest arena. Both ANAM officials and farmers feel it is critical both for the short-term success of existing farms and long-term success of the program, that regional officials and local foresters get training in forest pest management. They also would like increased training in incident management to assist farmers in the initial attack phase of fire suppression.

Panama has nearly completed its national fire management strategy and most of its protected areas have established fire management plans. Lack of funding and incident management experience at the local level are severe hindrances to success.

III. Conclusions

A. Common Themes in Fire Management

Common themes across the Central American region are very difficult to discern, principally because a great diversity of socio-economic conditions exists among the various countries. For example, Costa Rica has not suffered the political and social unrest that many of its neighbors experienced during the last century. Belize has a much more recent colonial legacy and a population density that is significantly less than its neighbors. El Salvador, Honduras and Nicaragua are culturally and politically similar and are experiencing many environmental problems not found in Panama or Costa Rica, for example. In turn, Guatemala supports a diversity of forests and pests that vary greatly with altitude; also, the Mayan culture and practices in Guatemala are distinct from those of its neighbors.

Therefore, the following themes with regard to fire are generalizations that may not exactly describe the specific situation in each country. They do, however, present an overview of some issues that seemed to be common in most countries at least to a certain degree.

1. Presence of OFDA – For nearly 20 years, the USAID Office of Foreign Disaster Assistance (OFDA) has been working in Central America in the area of disaster planning. This work includes wildfire training and preparedness. After the disastrous 1998 fire season, this program has dramatically expanded. OFDA works with natural resource and disaster management agencies in 11 countries within Latin America, including all of Central America. They currently have a well-developed regional fire management strategy that seeks to support national level fire management planning and wildfire management training for participating agencies.

One consideration worth noting is that, while OFDA has been the lead agency, communications between OFDA, USAID missions, and Guatemala/Central American Programs (G-CAP) have been less than stellar at times. As such,

delivery of USG fire management assistance has not been coordinated as well as it could have been.

2. Lack of stable funding – A common denominator among most forest management and protected area management agencies within each country is a lack of stable and sustainable funding. One glaring reason for this situation is that there are few mechanisms to re-invest timber income, eco-tourism taxes, and payments for environmental services such as watershed protection back into the forests and protected areas. Payments for timber sold, management plans implemented, or other taxes are normally sent directly back into the county's general fund. In many countries, this situation is compounded by rampant corruption. Lack of stable appropriations leads to instability in the workforce, inability to purchase or maintain equipment, disincentive for private or cooperate investment, and dependence on donations, grants, and foreign aid.
3. Lack of a holistic approach to fire – Each country falls within a spectrum in terms of how they approach fire management. In general, some countries have not done sufficient work to determine what values they are trying to protect at a national level, where the greatest sources of ignition lie in relations to those values, and if opportunities exist to manage fuels to reduce potential impacts. Some that have done this level of analysis have not developed sustainable funding to implement these plans. Furthermore, a system to predict fire severity, monitor fire impacts, or prioritize suppression actions based on values does not exist. Finally, prescribed fire is not being used to the extent it could be used to reduce potential impacts.
4. Lack of field-level proficiency in fire suppression tactics and incident management – All countries have participated in fire training courses sponsored by OFDA, other USG agencies, or other international groups. The OFDA material is considered to be the standard by all Central American countries and includes both basic and advanced training material. However, depending on the country specific issues such as turn-over rate of personnel and the dedication of the forest management agencies, there are varying levels to which this training has been disseminated to the field and community level. Also, in-country political situations often leave resource agencies on the sidelines, where they have a legal mandate to protect forests but little funding or training to accomplish this mission. Furthermore, fireline leadership skills are not being developed in all countries to the extent necessary to manage both initial attack and large incidents. Many fires are suppressed by a group of individuals, not a coordinated team and, usually, little action is taken until the fire becomes a conflagration.
5. Agricultural burning is a fact of life – Most small farmers have developed the mind set/tradition that fire is the best management tool to remove field stubble, prepare land for planting, and regenerate pasture grass. Traditional extension and prevention programs have done little to overcome this attitude. Until a cheaper or simpler alternative becomes available, or economic conditions change so that

rural farmers no longer have to depend on subsistence agriculture, fires will continue to occur, especially along the agricultural/forest interface in counties such as Nicaragua, Honduras, Guatemala, and El Salvador.

B. Common Themes in Pest Management

As with fire, common themes in pest management throughout Central America are difficult to identify. The seven Central American countries vary greatly in the make-up of their forests and the extent of their forest pest problems. In certain countries, *Dendroctonus* bark beetles have been the dominate problem historically (e.g., Guatemala, Honduras), whereas these same pests have become a problem only recently in others (Belize, Nicaragua, El Salvador), or are not present (e.g., Panama and Costa Rica). The latter two countries are experiencing different pest problems that often result from establishment of single-species plantations.

At least until recently, most Central American foresters and forest technicians lacked training in pest identification and management and methods used to confront bark beetle outbreaks have varied widely. On the positive side, the three Spanish field guides for southern pine beetle management (Billings et al. 1990, 1996a, b) have been distributed to various degrees in every country visited, with the exception of Panama and Costa Rica. Based on these guidelines, standardized methods of detection, ground evaluation, and direct control are being adopted in those countries where *D. frontalis* is a problem. Also, many foresters and/or technicians have received training in bark beetle biology and control from the forestry school (ESNACIFOR) in Honduras.

There are very few University professors with professional training in forest entomology in Central America. To date, most of the training offered to forestry personnel on forest pests has come from short courses offered at ESNACIFOR or CURLA (Centro Universitario Regional del Litoral Atlántida) in Honduras or CATIE (Centro Agronómico Tropical de Investigación y Enseñanza) in Costa Rica. The diversity of landownership, the periodic change in political parties and government positions with resultant turnover of technical personnel, and the lack of sufficient financial resources are common problems facing forest protection programs in Central America.

The severity of southern pine beetle outbreaks in Belize, Nicaragua, Guatemala, and, to a certain extent, Honduras in 2000 and 2001 can be attributed to 1) favorable environmental and host conditions (dense, unmanaged pine stands weakened by frequent fires, wind, and/or resin extraction) that favored rapid build-ups of local beetle populations, 2) lack of leadership at the national level and trained pest coordinators at the local level to detect new infestations and recognize the severity of the problem at an early stage of development, 3) inability of the responsible forestry agency to make timely decisions or secure the necessary funds to control infestations while they were small, 4) insufficient education of news media, landowners, and others having vested interests with regard to need for prompt control and effectiveness of control methods, 5) lack of access, equipment, and markets to permit rapid harvest and utilization of infested trees as a means of control.

In 1998, Hurricane Mitch delivered high winds and extensive rainfall and flooding to Central America, particularly to Nicaragua and Honduras. The extent to which this event was responsible for predisposing pine forests and fostering the extensive multi-country SPB outbreaks in the following years remains unclear.

Among specific common needs in forest pest control are the following:

1. Increased governmental and public awareness of forest pests. There is need to increase the level of awareness and understanding of bark beetle outbreaks and control methods at all levels of the government and within the general population within each country so that bark beetle outbreaks can be identified and addressed promptly while infestations are relatively small.
2. Pest management training. Due to the high rate of turnover in field forestry staffs in Central America, the need for training is a continuous one. A program to train trainers in forest pest control in each country (similar to the OFDA training provided for forest fires) is needed. A manual in Spanish for trainers needs to be developed with classroom materials on bark beetle biology, behavior, prevention and control, with particular reference to Central America.
3. Operating funds. All Central American forestry departments are operating protection programs with a shortage of operating funds. There is need for more 4-wheel drive vehicles, fuel, and safety equipment.
4. Department of Protection and field coordinators. Several countries (Nicaragua, El Salvador, Belize) lack a department of forest protection with a national coordinator for forest fires and a coordinator for forest pests. Honduras has the most advanced forest pest protection program and should serve as a model for other countries; in addition to national pest and fire coordinators, a trained individual is assigned to each forest region within the country to coordinate fire- and pest programs at the local level and to provide periodic accomplishment reports to the national fire and pest coordinators.
5. Record-keeping system. With the exception of Honduras, where bark beetle data have been maintained since 1982, most countries lack a permanent record-keeping system for collecting, evaluating, and maintaining pest information at the field and national level. A standardized record-keeping and reporting procedure for forest pests is needed throughout Central America.
6. Incentives for forestry personnel. Many dedicated foresters and technicians are asked to work long hours and on weekends on fire and pest control projects with little or no compensation or incentives. In Honduras, for example, some foresters have had no vacations in three years. There is need to recognize and reward those individuals who have done an outstanding job in carrying out the protection programs within their designated areas.

7. Information and technology transfer. There is need for a practical means to share information among Central American forestry protection personnel regarding the status and location of fire and pest problems (particularly in the vicinity of shared borders), names and addresses of protection personnel, scientific literature, available training materials, etc.
8. Coordination among organizations. There is need for improved coordination among the various national and international agencies, NGOs, and other groups involved in the protection of Central American forests from fire and pests.
9. Prevention programs. Little attention has been paid to prevention of bark beetle outbreaks. Programs need to be initiated to recognize and reduce those conditions that render Central American pine forests susceptible to outbreaks of bark beetles and other pests. More education materials in Spanish (or English in case of Belize) are needed to increase public awareness of forest pest problems and their solutions (e.g., posters, flyers, CDs, videos, handbooks, etc.).
10. Forest pest research. Much remains to be learned about the biology, seasonal behavior and population dynamics of the southern pine beetle and other bark beetle pests in Central America. Entomologists in Central American forestry schools and universities having research capabilities and interest in bark beetles (e.g., Alberto Sediles with the Universidad Nacional Agraria in Nicaragua, Dr. Jorge Macias-Sámano with ECOSUR in Chiapas, Mexico and Mario Molina with CURLA in Honduras) should be identified and provided with financial support to carry out needed research studies. Among suggested studies are the development of effective use of pheromone traps for monitoring seasonal dispersal patterns and prediction of infestation trends, evaluation of the efficacy of current control methods (cut-and-leave, cut-and-burn) on brood survival, seasonal variation in patterns of new spot initiation, identification of natural enemies of bark beetles and their contributions to control, evaluation of new control methods (verbenone, aerial application of systemic chemicals, etc.). Other forest pests that warrant research include the alder wasp, *Scolytodes alni*, in Costa Rica, leaf-cutting ants, pine tip moths, mistletoes, and the mahogany shoot borer (*Hypsypilla grandella*) in mahogany and cedar (*Cedrus*) plantations.

IV. **Recommendations for Immediate Implementation**

The U.S. Department of Agriculture, through its interagency agreement with the U.S. Agency for International Development/Guatemala-Central America Program, should support and be an active participant in the regional fire and pest management workshop tentatively being sponsored by the International Development Bank and the Norwegian Trust Fund. It has been proposed that this regional workshop be held at ESNACIFOR at Sigatepeque, Honduras in late-June or July 2002. The primary objective of this workshop should be to identify concrete steps that can be taken to establish a regional fire and pest management strategy for Central America and analyze the feasibility of implementing the

recommendations listed below. Participants in the workshop should include members of the fire and pest management committees as described below. Other possible participants could include Mexican fire and pest management specialists, representatives from forest industry, NGOs, and U.S. partners, including the U.S. Forest Service, Department of Interior, and Texas Forest Service.

A. Fire

1. Foster on-going national level fire management planning efforts. CCAD should form a Regional Fire Management Committee, consisting of the national fire coordinators from each Central American country and southern Mexico. Through this Regional Fire Management Committee, and in conjunction with OFDA, CCAD should foster on-going national level fire management planning efforts. This committee can also be useful in leveraging funding sources, standardizing training, materials and supplies, developing inter-country agreements, and supporting needed research, data collection, and monitoring programs. The following persons have been identified as possible representatives for their respective countries on the Fire Management Committee:

Oswaldo Sabido – Belize
Current Director, Salvadoran Forest Service – El Salvador
Miguel Salazar (or Lucky Medina) – Honduras
Roberto Alvarez – Nicaragua
Helvesia Bonilla – Panama
Wilfran Murillo – Costa Rica
Guillermo Orosco – Guatemala
Maria Luisa Alfaro – OFDA
TBD – Southern Mexico representative
TBD - NGO representative
TBD – Forest industry representative

2. Strengthen training and technical capacity at local and community level. Although OFDA has provided outstanding support to host countries in the area of disaster management planning and wildfire training, this information is not being transferred to local resource officials or community disaster groups on a wide scale. One possible way to bridge this gap is to revive or expand the Sister Forest Program with the U.S. Forest Service, or Department of Interior. Both Belizean and Guatemalan officials have expressed a strong desire to re-activate this program and consider it to be one of the more successful interactions they have had with the USG in fire management. These existing or created Sister Forest Programs should be managed through, or closely associated with, existing OFDA programs to ensure that

Sister Forests provide a fortification of existing programs rather than duplication. Costa Rica, Honduras, or Mexico would be other sources of field level technical experience that could be used to assist in fostering local program development.

3. Training farmers to prescribe burn. Agricultural extension institutions in each country along with resource agencies should increase presence/involvement in teaching farmers basic techniques in prescribed fire. Along with this, forestry laws should be created and/or enforced which sanction illegal burning and penalize those responsible for allowing fires to escape.
4. Satellite data for fire detection. Nicaragua should reinforce and/or update its ability to use real-time satellite data for fire detection. A system should be developed to share this information with all other Central American countries on a daily basis during periods of high fire danger/activity.
5. Provide emergency funds for forest and protected area management. To assure prompt response to wild fire incidents, each country should establish an emergency disaster fund, possibly generated from timber sale, forest management, and/or eco-tourism receipts. Private sector responsibility for forest protection is considered by many to be an alternative worth exploring.

B. Insects

Recommendations for improved forest pest management are as follows:

1. As part of the regional workshop, CCAD should form a Regional Forest Pest Committee, to include the national forest pest coordinators from each country and other key personnel representing NGOs and forest industry. The Forest Pest Committee would meet periodically to identify regional pest problems, standardize pest-reporting systems, coordinate short- and long-range strategic plans for integrated management, and maintain a database of pest outbreaks and associated losses. Suggested representatives for the Forest Pest Committee are as follows:

David Perera	Belize Forestry Department
Luís Quiros	MINAE – Costa Rica
Salvador Arteaga	Servicio Forestal – El Salvador
TBD (2)	INAB and CONAP - Guatemala
Vicente Espino M.	COHDEFOR - Honduras
Carlos Hernandez	INAFOR – Nicaragua
Manuel Hurtado	ANAM – Panama

TBD	Southern Mexico
TBD	NGO representative
TBD	Forest industry representative

2. The importance of protecting Central American pine forests from forest pests, especially *Dendroctonus* bark beetles, needs to be recognized at all levels of government within each country. It is recommended that a national coordination group for forest pest control (Grupo Coordinador de Plagas Forestales) be organized in each country, with key members representing the forest service, park service, NGOs, agroforestry groups, and other national and international organizations with vested interests in forest protection within each country. This group would be responsible for approving, coordinating, and implementing the national strategic plan developed by the CCAD Regional Forest Pest Committee to more effectively deal with forest pest problems. Responsibilities would be identified and assigned at the local, departmental, and national level with regard to detection, evaluation, control, prevention, and recover of damaged areas.
3. Each country needs to identify one or more forest pest coordinators at the national level to coordinate bark beetle management programs within the country, as has been done in Honduras. These individuals would serve on the CCAD Regional Forest Pest Committee described above.
4. Funding sources for bark beetle detection, prevention and control should be stabilized within each country, including the establishment of emergency funds for prompt response to bark beetle outbreaks. An emergency or disaster fund to accommodate rapid and continuous control programs for pests and fires should be established, possibly with revenues generated from sale of salvaged timber.
5. A short course on southern pine beetle detection, evaluation, suppression, prevention, and record-keeping systems should be offered to Forest Pest Committee members as an integral part of the Fire and Pest Workshop proposed for June or July 2002 at ESNACIFOR in Siguatepeque, Honduras. At this first meeting, the CCAD Forest Pest Committee members will have the opportunity to develop a region-wide strategy for the integrated management of southern pine beetle in Central America. The short course on pine bark beetle management previously proposed by Luko Hilje (CATIE), Jorge Macias-Sámamo (ECOSUR), and Ronald Billings (TFS) should be incorporated into this regional workshop.

V. Long Term Recommendations at the Regional Level (2003-2008)

The following recommendations for the Central American Region are made for the five-year period 2003-2008:

1. A long-term commitment from all interested national, regional, and international organizations and agencies is needed if a strategic plan for forest protection is to be successful at the regional level in Central America and southern Mexico. Regional training and extension centers for fires and pests need to be identified and provided with financial support. ESNACIFOR appears to be a logical candidate for forest pests, particularly bark beetles, while OFDA in Costa Rica could assume this role for wild fires.
2. Extension material (posters, brochures, field guides, videos, CDs, etc.) on bark beetle identification, prevention, and suppression should be developed and distributed at the national and local levels, as has been done for fire in most countries. A regional Internet web page on forest pests should be developed, perhaps in conjunction with the Extension Service, University of Georgia to include bark beetle information and diagnostic keys, names of country pest specialists, entomologists at Central American universities and forestry schools with experience in forest pests, annual bark beetle status reports, scientific and technical publications on pest management, announcements of available training sessions offered at the regional level, and other news related to forest protection in Central America. Pertinent information on bark beetles and other forest pests should be added to the existing forestry web pages currently maintained by forestry departments in Honduras, Guatemala, Nicaragua and other Central American countries.
3. To increase technical capacity in bark beetle management at the department, local, and community level, USAID and other organizations such as CATIE in Costa Rica or OIRSA, with offices in various Central American countries, should support the development and implementation of a series of bark beetle training courses, including “train the trainer” programs, similar to those offered by the Office of Foreign Disaster Assistance (OFDA). These courses should initially be offered at the Escuela Nacional de Ciencias Forestales (ESNACIFOR) in Siguatepeque, since Honduras has the most developed bark beetle program in Central America.
4. The U.S. Peace Corps should become involved in regional forest protection programs by assigning Volunteers to key areas and training centers to facilitate establishment of national pest and fire programs.

5. Regional fuel models should be developed as a means to create a Central American fire danger rating system. This predictive system is used to efficiently determine appropriate level of preparedness, preposition fire fighting resources in critical areas and assisting managers in making incident management decisions. As part of this project, significant improvement in fire related data collection and coordination with in-country meteorological agencies is needed. The US Forest Service could be used as a mechanism for this research and development. However, this commitment will involve a significant number of technical assistance visits from the Fire Science Laboratory in Missoula, Montana over a period of several years and should only be undertaken if it can be determined that significant commitment exists on the part of in-country cooperators.

In summary, to improve forest protection programs, the authors recommend that measures be taken to establish pest and fire committees under CCAD as a means to develop and implement strategic plans for improved forest protection and training at regional, national and local levels. If each country supports such a commitment, Central America will be better prepared to confront or prevent forest health disasters in the future.

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VIII. Appendix A Contact List

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IX. Appendix B - Country Specific Recommendations (in addition to regional recommendations)

A. Belize

1. Detect, evaluate on ground, prioritize and apply direct control to active SPB infestations remaining in Mountain Pine Ridge.
2. Establish a forest pest coordinator at the national level to provide leadership in forest pest programs.
3. Increase monitoring and surveys of forest regeneration and SPB outbreaks.
4. Incorporate prescribed fire training into agricultural extension program in areas impacted by Hurricane Iris.
5. Increase use of prescribed fire in MPRFR to reduce fuel loading and create fire breaks.
6. Provide basic silvicultural and SPB training to technicians.
7. Establish a permanent system for reporting and recording SPB detection, evaluation, control and loss records.

B. Costa Rica

1. Develop funding sources for local fire program development by charging natural resource beneficiaries.
2. Re-establish the national forest pest committee and identify a forest pest coordinator at the national level to provide leadership in forest pest programs.
3. Search for Master's degree candidates interested in researching the relationship between local alder trees and wasps.

C. El Salvador

1. Consider placing responsibilities for detection and control of bark beetle infestations under a single agency (e.g., Servicio Forestal).
2. Identify and/or create a national forest pest coordinator to provide leadership in forest pest programs.
3. Improve media and local political awareness of importance and treatment strategies for SPB.
4. Encourage the thinning of dense pine stands to reduce susceptibility to bark beetle outbreaks.
5. Improve utilization and/or disposal of sawmill waste products left in forested stands.
6. Update the national fire strategy to include a more active role for the Forest Service and MARN.

D. Guatemala

1. Improve coordination among agencies, NGOs and political leaders, especially at the regional and local level.

2. Identify the various species of bark beetles affecting pine stands in Guatemala and develop identification guides for the more common *Dendroctonus* and *Ips* species.
3. Establish a permanent record-keeping system within INAB and CONAP for recording bark beetle detection, control, and loss records at the local (department) and national level.
4. Identify a national forest pest coordinator(s) to provide leadership in forest pest programs within INAB and CONAP.
5. Increase the availability of bark beetle field guides for detection, ground evaluation, prevention and control at the department and local level.

E. Honduras

1. CODEFOR needs to place increased emphasis on prompt control of bark beetle infestations in certain forest regions (El Paraíso, Francisco Morazan, Copán) to better address the current outbreak. Redirect forest inventory crews and provide logistical support (vehicles, operating expenses) to treat more infestations in these high priority areas.
2. Increase use of prescribed burns to protect high value regeneration and protected areas.
3. Re-establish the goal of controlling all SPB spots before they enlarge beyond 1 hectare in size.
4. Provide incentives to those COHDEFOR field personnel who have demonstrated outstanding performance in control of SPB infestations in their forest regions.

F. Nicaragua

1. INAFOR should assist in strengthening local disaster committees in order to make use of possible emergency funds that may be available from USAID.
2. INAFOR should work directly with municipal governments and local landowners to establish grazing strategies that will protect areas with high regeneration.
3. INAFOR should work with local municipal governments and farmers to implement a strong community prescribed fire program for burning of agricultural lands.
4. INAFOR should re-establish a Department of Forest Protection, with at least two national coordinators, one for fires and one for forest pests.
5. INAFOR should establish a permanent record-keeping system for recording SPB detection, control and loss records at the Department and national levels.
6. INAFOR foresters should be given more training in the proper use of pheromone traps for monitoring SPB populations.

G. Panama

1. Organize a forest insect and disease workshop for field level professionals.
2. Provide field guides in Spanish for identifying pine bark beetles and evaluating, treating, and preventing bark beetle infestations in pine plantations.