

# The Ecological Role and Management of Fire in Caribbean & Central American Pineland Ecosystems



Highlights of a workshop held at  
Rio Bravo Conservation & Management Area, Belize  
7–9 May 2002

*Cover photo: Prescribed fire in a subtropical pineland ecosystem  
(Pinus elliottii var. densa) at Archbold Biological Station,  
Florida. Photo by Ron Myers.*

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## Background and Introduction

The Nature Conservancy's Global Fire Initiative, with funding from the USDA Forest Service International Programs and the Conservancy's RJ/KOSE Endowment, convened a workshop 7–9 May 2002, at the Rio Bravo Conservation and Management Area in Belize<sup>1</sup>. This meeting focused on the ecological role of fire and fire management planning needs in Caribbean / Central American pineland ecosystems. The workshop was fundamentally an exchange—reserve managers from Belize, the Bahamas, the Dominican Republic, Honduras, and Florida provided Nature Conservancy Fire Initiative staff with an overview of the ecology, conservation status, and threats in the areas where they work, and Fire Initiative staff, researchers, and conservation area managers provided information about the ecology of fire and how to develop and implement fire management plans in nature reserves. There were 30 participants at the workshop, including those representing 12 conservation areas in Belize, the Bahamas, the Dominican Republic, Honduras, and Florida (see Appendix A).

### Workshop Objectives

- Provide an overview of the ecological role of fire in pine forests and savannas of the greater Caribbean region to justify fire actions.
- Begin to identify the best fire management practices for protected natural areas in the region.
- Evaluate fire management planning, training, implementation, and public outreach needs for represented protected natural areas.
- Provide expert & peer review of the fire management situation at key sites.
- Identify strategies/ideas that might be exported to other areas encountering similar issues and needs.
- Identify information sources for fire managers in the region.
- Give participants the opportunity to discuss and develop cooperative fire projects.
- Discuss the establishment of a formal or informal fire management network.

For a number of reasons, The Nature Conservancy (TNC) has up until now focused the majority of its fire management work on conservation areas in the United States. With the recent formation of the Global Fire Initiative, including a mandate to work in all countries where TNC is actively engaged in conservation, a series of scoping meetings are being conducted. The meeting at Rio Bravo was the third such meeting convened as an initial step toward supporting the conservation of places outside the U.S. that contain fire-dependent and fire-sensitive communities and species. Therefore, objectives of the workshop included obtaining as much information as possible about the fire-related needs of conservation area managers in Belize, Honduras, the Bahamas, and the Dominican Republic and a discussion of the need to create a **network** of practitioners and

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<sup>1</sup> The Nature Conservancy's Belize Country Program and **Programme for Belize**, a non-governmental agency that owns and manages the Rio Bravo Conservation and Management Area, also sponsored the workshop.

experts dealing with these systems in the Caribbean and Central America. (The Nature Conservancy presently has a number of **learning networks**, focused on a variety of threats and strategies, that are supporting work at more than 160 conservation areas in eight countries. In addition to promoting on-the-ground conservation at specific places, the networks are advancing the development and dissemination of innovative, organization-wide strategies for abating key biodiversity threats such as altered fire regimes.) The meeting also served as a first step toward getting participating sites under fire management.

## Introduction to Fire Management and Fire-Maintained Ecosystems

To start the workshop, Ron Myers, Joan Walker, Dale Wade, David Mehlman, Dave Ewert, and Carolyn Kindell gave presentations about fire management, fire-adapted ecosystems, fire effects on animals, and pine savanna restoration. The following paragraphs summarize some of the key messages from those talks.



*Fire-maintained South Florida slash pine (Pinus elliottii var. densa) ecosystem on limestone rock substrate, Big Pine Key, Florida. Structure, function and fire regime are similar to the Bahamian pinelands.*

Altered fire regimes (too much or too little fire) are a global threat to biodiversity. **Fire-maintained ecosystems** are those in which fire is essential; significant changes to the natural fire regime will result in the loss of that system. Examples of fire-maintained ecosystems include the pine forests and savannas of Belize and the pinelands of Cuba, the Bahamas, and the Florida Keys. **Fire-influenced ecosystems** are those where fire influences the structure and/or the abundance or extent of species in that system. Often there is a relationship between fire-maintained and fire-influenced ecosystems. Although fire plays a role in influencing the structure and species composition of fire-influenced ecosystems, they are in fact quite fire-sensitive, and too much fire may quickly lead to ecosystem conversion and species loss.

There are six components of a fire regime: fire type, fire frequency, fire behavior, burn severity, timing, and size and pattern. It is important to understand that variation in these six

## Designing, Implementing and Managing for Ecologically Appropriate Fire Regimes

- Remember, fire is not the end product.
- Set fire management goals by identifying “critical elements,” i.e. ...what are the targets of conservation.
- If goals are not compatible, compromise may not be possible, i.e. it may not be possible to maintain all targets.
- Base goals on both knowledge and *inferences* about the life histories and dynamics of the conservation targets.
- Determine if you are in a maintenance phase or if you need a period of restoration burning.
- Determine if exotic species control or have altered the fire regime, and whether targets can persist under this new regime.
- Direct management actions, e.g., prescribed burning or suppression efforts, toward restoring or maintaining the ecological integrity of targets, not necessarily toward recreating a historical landscape.
- Use historical information as a reference to gain insight into the origin of current ecosystem states and to understand ecosystem potential.
- Because management actions are based on inferences rather than complete knowledge, those actions must be monitored.
- Feedback from monitored trends should drive future management actions (in other works, practice adaptive management).
- There is no single protocol for designing, applying, or managing fire regimes. There are likely manifold routes to desired outcomes.
- Expect to make compromises because of safety and liability concerns and due to capacity constraints.
- Regarding our understanding of fire effects and fire regimes, be humble ... remember we are ignorant.

components may be more important ecologically than each component’s average property. Managing the fire regimes of conservation areas through prescribed burning, fire suppression, or fire prevention may lead to less variation. Therefore, we must avoid applying fire regimes that are too narrow.

**Restoration burns** involve focused burning with specific objectives for each burn. These are designed to alter the existing structure and composition of a given ecosystem in order to advance specific conservation objectives. **Maintenance burns** call for variable fire applications within the normal ranges for a given ecosystem.

Because the groundcover layer typically contains most of the botanical biodiversity of pine savanna ecosystems, it is important to understand how fire affects herbaceous



vegetation in addition to how it affects woody vegetation in the overstory. Different fire frequencies, seasons, intensities, and extent can affect vegetation in a variety of ways. Therefore, fire managers should vary fire regime components within their normal range of variability during all periods when fuels are available to burn. Specific burn objectives may dictate narrowing certain regimes for the benefit of specific targets of conservation. Fire effects must be monitored in order to refine the fire management plan.

**Table 1. Expected changes in tropical pinelands and savannas under managed fire regimes.**

<b>Suppression/Prevention</b>	<b>Prescribed Burning</b>
– Increased fuel loads	– Decreased fuel loads
– More large fires	– Fewer large fires
– More high intensity fires	– More low intensity fires
– More high severity fires	– More low severity fires
– More fires under extremes	– Shifts in burn season
– Loss of groundcover diversity	– Maintenance of groundcover diversity
– Loss of overstory pines	– Maintenance of mixed-age pine stands

Although we typically focus on the vegetation component of fire-maintained ecosystems, many of these systems have vertebrate animals associated with them, either wholly or partially. Fires can directly injure or kill animals at the same time as it preserves their habitat. Of particular concern for conservationists are the short- and long-term needs of rare or endangered specialist or obligate species such as the red-cockaded woodpecker in the southeastern U.S., the Kirtlands Warbler in Michigan and the Bahamas, and the yellow-headed parrot of Belize. Fire managers must consider these conflicting factors along with their conservation objectives before they implement fire management plans. In general, managers should try to leave refugia of unburned habitats and “escape routes” within large burn units, time burns so that they will have the least impact on breeding animals, and leave intact critical habitat features such as trees with nest cavities.

**Table 2. General effects of fire in tropical pinelands and savannas.**

<b>Frequently Burned</b>	<b>Infrequently Burned</b>
– Sparse shrub layers and limited hardwoods	– Woody species increase
– Woody patches localized	– Continuous trees and shrubs
– High light at surface	– Reduced light
– Exposed mineral soil after burns facilitates regeneration	– Litter covers soil
– Abundant flowering	– Reduced flowering
– Relatively high species richness at small scales	– Reduced species richness
– Seedling establishment	– Limited regeneration of pines and herbs
	– Increased risk of insect and disease outbreaks
	– Increased risk of damaging fires

## Fire Management Planning and Implementation

A fire management plan is a document that contains ecological and technical information about the desired role and effect of fire in and around a conservation area. It establishes the justification for a fire management program. Although the fire management plan is part of the overall management plan for a conservation area, it is generally best as a stand-alone document. The plan should establish fire management goals and serve as a guide for fire suppression, prevention, and fire use actions.

**Managers will always have incomplete information; this should not be a barrier to developing and implementing a plan.** As new information is obtained, management practices are adjusted, and the plan is updated.

Each prescribed burn is conducted under a “prescribed burn plan” that spells out ecological and other objectives, safety considerations, smoke management, monitoring procedures, and operations procedures. It is also a good idea to list suppression resources, ignition procedures, and contingency plans. For burns conducted by The Nature Conservancy, each burn plan must be signed by an authorized, experienced staff member.

## Regional Fire Management Issues

### **Belize: Rio Bravo Conservation and Management Area**

Belize is a Central American country of 350,000 people spanning just under 8,900 square miles. Programme for Belize is a private, Belizean, non-governmental organization that is dedicated to preserving the natural heritage and biological diversity of Belize. Programme for Belize owns and manages the Rio Bravo Conservation and Management area (Rio Bravo), encompassing 105,200 hectares (260,000 acres) of lush sub-tropical forest. This reserve is part of a major biological corridor that is key to biodiversity conservation in Central America.

Programme for Belize is presently engaged in a number of activities within and around Rio Bravo that are consistent with the organization’s mission, including:

- carbon sequestration,
- biodiversity research,
- protection of biodiversity,
- sustainable timber extraction,
- extraction of non-timber forest products,
- ecotourism,



*Ecotone between Caribbean pine savanna and hardwoods. The presence of pines among the hardwoods indicates encroachment of hardwoods into the savanna. This site was last burned seven years ago.*

- environmental education, and
- community outreach.

Rio Bravo contains approximately 10,000 hectares of lowland pine (*Pinus caribea*) savanna and lowland pine forest (Figure 1). During the workshop, participants created a draft conceptual ecological model for this fire-maintained ecosystem (Figure 2). The model, which will be revised as new information becomes available, will help inform fire management of this system at Rio Bravo.

Management objectives for the pine savanna ecosystem within Rio Bravo include promoting tree growth as part of a larger carbon sequestration project, and protecting populations of the endangered yellow-headed parrot, which nests in pine tree cavities. Managers here have been grappling with the issue of fire for some time; the savannas are prone to both natural fires and human-set fires, particularly during the dry season from February to May. Programme for Belize has fire-fighting equipment and actively suppresses fires deemed harmful to the reserve.

For the Rio Bravo pine savannas, the immediate needs identified during the workshop include drawing up a fire management plan for the reserve, training staff in the

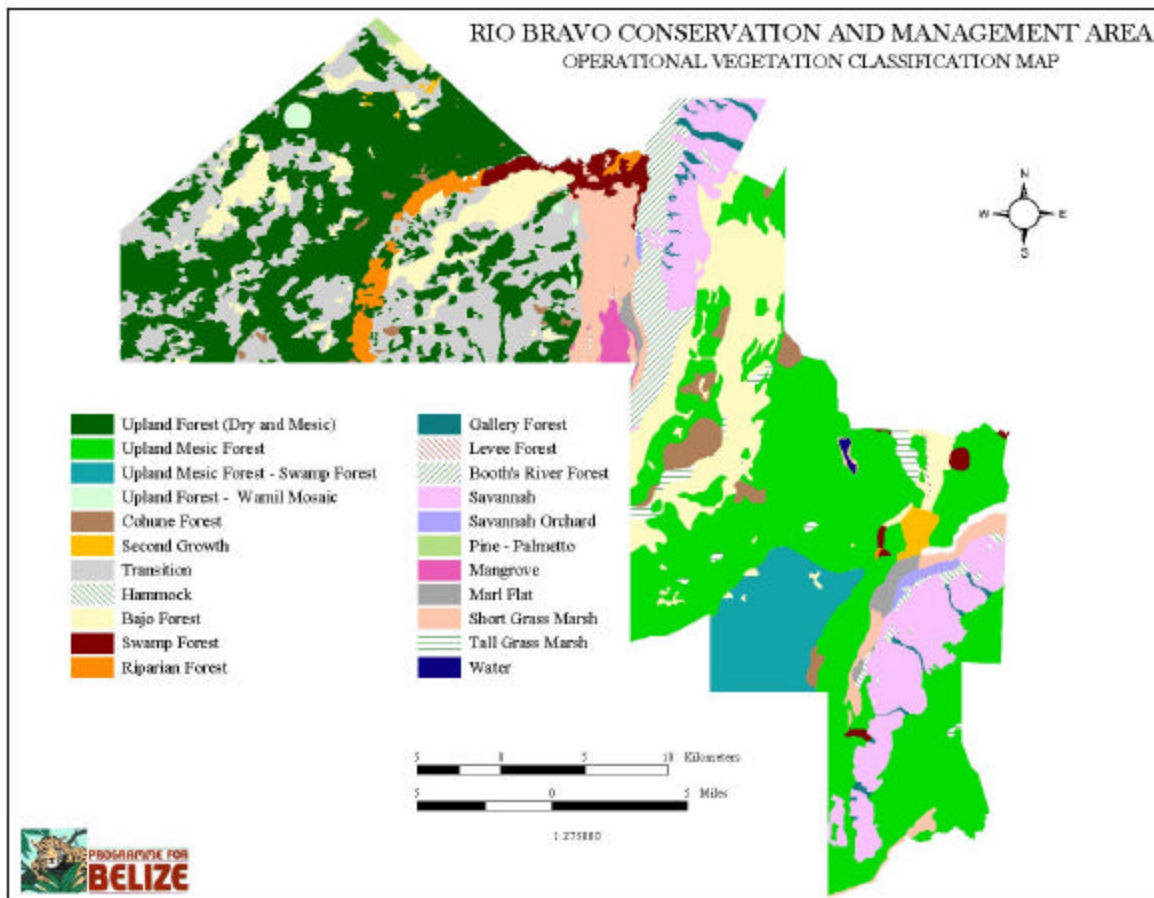


Figure 1. Vegetation map for the Rio Bravo Conservation and Management Area, Belize. (Lowland pine savanna shown in pink.)

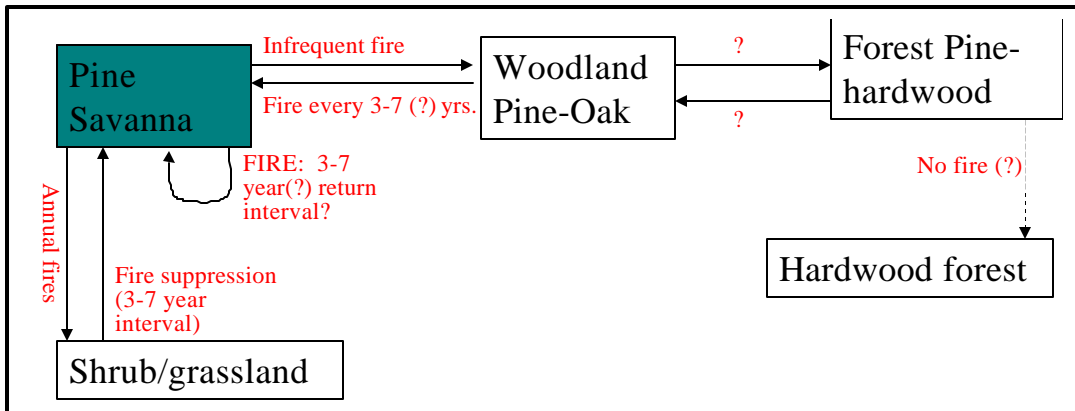


Figure 2. Draft ecological model for the *Pinus caribea* savanna ecosystem at Rio Bravo Conservation and Management Area, Belize. Different transitions and species composition can be expected depending on depth to water.

ecological application of fire, and obtaining additional equipment needed for prescribed burning operations. Fire training was also identified as an important need for conservation area managers throughout Belize. To maintain a healthy savanna and multi-aged woodland of Caribbean pine, the expert consensus was an initial burn frequency of five to seven years, varying season of burn and fire intensity depending on specific burn objectives. Careful monitoring would allow for the refinement of this regime.

### Dominican Republic: Madre de las Aguas Conservation Area

The Madre de las Aguas Conservation Area is in the Central Highlands of Hispaniola. This is a multi-site conservation area composed of five protected areas: Armando Bermúdez, Juan B. Pérez Rancier (Valle Nuevo), José del Carmen Ramírez, Ebano Verde, and Nalga de Maco, covering a total area of more than 200,000 hectares (over 494,000 acres). The landscape is a high conservation priority because of the richness and endemism of its species assemblages. More than 90 percent of amphibians and reptiles, close to 50 percent of butterflies, approximately 35 percent of birds, and almost 40 percent of this area's plant species (excluding ferns) are found nowhere else in the world. The region contains the best representations of coniferous pine (*Pinus occidentalis*), montane broadleaf, and cloud forest on the island, and its high altitude reaches (Pico Duarte, up to 10,125 feet or 3,086 meters) represent the greatest elevation and ecological diversity in the entire Caribbean. The site provides the headwaters for the majority of the island's rivers. Moreover, the quality and quantity of water that originates from the region benefits approximately 80 percent of the people of the Dominican Republic through agricultural irrigation, energy production, and/or water consumption.

The biodiversity values of the area are threatened by deforestation, soil erosion, alien species, and contamination and sedimentation of aquatic systems. Illegal commercial logging and intensive agriculture are common in the reserve. Fire is generally considered to be a destructive force; its influence on rare endemic species, and its role in

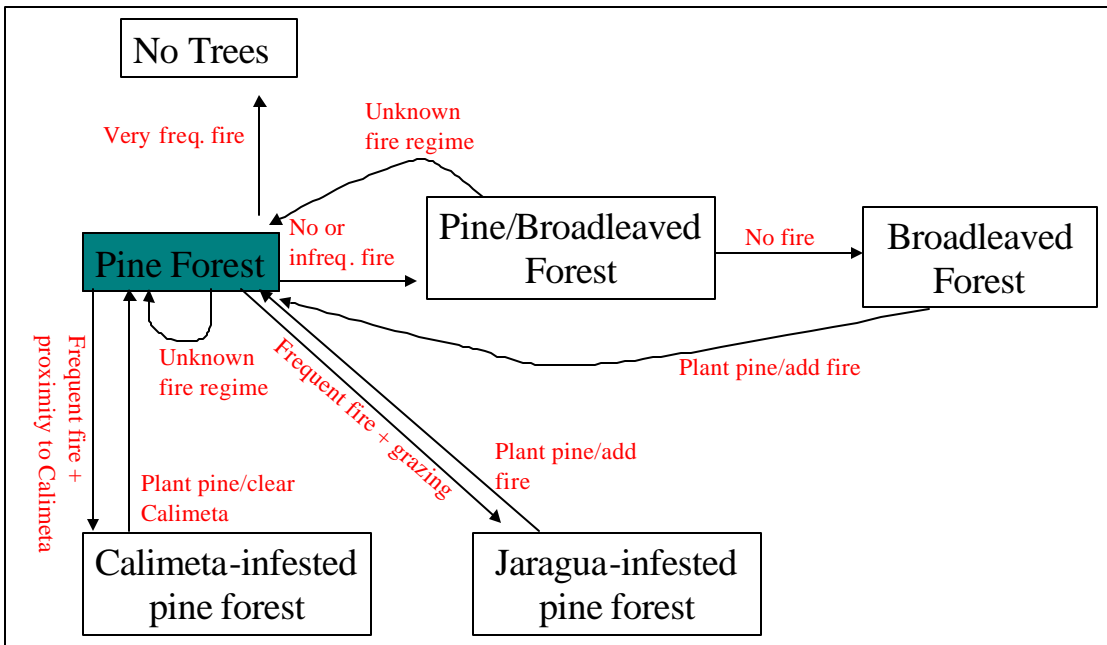


Figure 3. Draft ecological model for the *Pinus occidentalis* ecosystem at Madre de las Aguas Conservation Area, Dominican Republic. The model illustrates that research is needed to determine appropriate maintenance fire regime.

maintaining pine forest ecosystems are not well understood.<sup>2</sup> As a result, several components of the ecological model created for the pine forest ecosystem of Madre de las Aguas (Figure 3) will need to be tested. Fire, however, undoubtedly plays a role in the maintenance of these pine forests. The appropriate regime is unknown.

The Dominican Republic has developed an effective wildland fire suppression system that depends upon the rapid mobilization of local communities to put out human-caused fires. This system works well even in the most remote regions of the country. It is presently illegal to start fires of any type within protected natural areas. As a result, the first action identified during the workshop was to gather data and educate governmental decision-makers about the importance of fire in maintaining pine forest ecosystems, particularly their watershed qualities. Government support will be key to instituting fire management in the pine forests of Madre de las Aguas. Public outreach and education are also needed. Finally, drafting a fire management plan is another high-priority action item.

### **Bahamas: The Pine Forests of Andros, Abaco, and Grand Bahama Islands**

Pine forests dominated by *Pinus caribea* are one of nine terrestrial communities in the Bahamas. These forests differ from those in Belize because they grow on a carbonate rockland substrate rather than sand. They are structurally and functionally similar to the pine rocklands in southern Florida and the Florida Keys.

<sup>2</sup> Dr. Sally Horn, who attended this meeting, is investigating the fire history in Madre de las Aguas using tree rings and by studying vegetation recovery after fire. See references in Appendix C.

Although pines have been commercially exploited in the Bahamas region for more than a century, a 1986 inventory showed that pine forests cover approximately 23% of the land area of the country. Unlike many other terrestrial ecosystems in the Caribbean and Central America, the role of fire in Bahamian pine forests is fairly well understood. With prolonged absence of fire, pine regeneration is halted and the forest eventually converts to a hardwood coppice (see Figure 4). A number of endemic plant and animal species are also affected by fires in this ecosystem. In recent years, considerable attention has been paid to the pine forests, in part because of the plight of the Kirtlands Warbler, a species that breeds in Michigan in the U.S. and overwinters in the Bahamas. The warbler, which has very narrow habitat requirements and a narrow geographic range, is critically endangered. International efforts are underway to improve the species' chances of survival.

The Bahamas National Trust, established by Act of Parliament in 1959, is a unique collaboration of governmental, private sector, and scientific interests dedicated to the conservation of the natural and historic resources of the Bahamas for the enjoyment and benefit of the Bahamian people. One of the primary functions of the Bahamas National Trust is to build and manage the National Park/Protected Area System of the Bahamas. The Trust manages four national parks containing pine forests:

- Abaco National Park,
- Rand Nature Centre,
- Lucayan National Parks, and
- Central Andros Park System.

Although severely understaffed, the Bahamas National Trust has instituted a number of strategies to protect pine forests, including:

- Controlled burning,
- Agricultural restrictions,

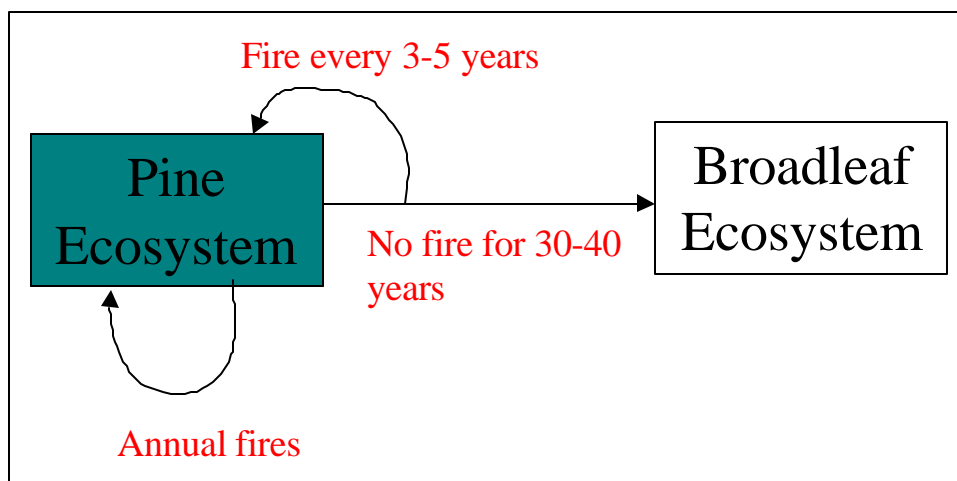


Figure 4. Draft ecological model for the *Pinus caribea* ecosystem in the Bahamas. There should be a transitional state of hardwoods overtopped by pines. Fire intensity and frequency largely determine the fate of this state.

- Hunter education,
- Public awareness and education,
- Forest hunting estates,
- Ecotourism (bird watching), and
- Appropriate forest management programs.

Next steps identified during the workshop include identifying appropriate fire regimes and developing fire management skills.

## Key Findings and Next Steps

The most important finding of the meeting was that all Caribbean and Central American conservation areas represented at the meeting need fire management plans, but staff generally do not have enough information to identify appropriate fire regimes, and they lack fire behavior and fire effects knowledge to make critical decisions. If they had plans, the conservation area managers present at the meeting would not have the skills and experience to implement them.

This finding, coupled with focused discussions during the workshop, generated a number of recommendations that can be considered “next steps” to be taken by workshop participants and TNC’s Global Fire Initiative.

1. Create a formal network that will serve as a forum for training, discussion, and information exchange, i.e. the **Caribbean/Central America Fire Management Network**. Initially, the Network includes participants from the Bahamas, the Dominican Republic, Belize, Honduras, and the U.S. The network will also include additional countries in the region and address other fire-affected ecosystems.
2. The next workshop should focus on planning and fire applications. We have tentatively scheduled this for January 2003 at Rio Bravo.
3. Develop Spanish-language training materials and conduct some workshops exclusively in Spanish.
4. To maintain contact and information flow, a website and listserv will be developed and moderated by TNC’s Landscape Conservation Network Program and Global Fire Initiative.
5. Develop a fire mentoring and exchange program to help key country staff obtain training and experience in the U.S., and planning and implementation help from U.S.-based mentors. These mentorships and training programs will target people who will become future trainers not only for their own programs but also throughout the network. As expertise develops, much of the mentoring effort can be shifted to model conservation area programs outside the U.S. (Since the workshop, Darrel Novelo, a forester at Rio Bravo, participated in the first planned mentoring session. During the week he spent with TNC fire staff, Darrel gained valuable prescribed fire experience and also attended a formal fire behavior course.) A

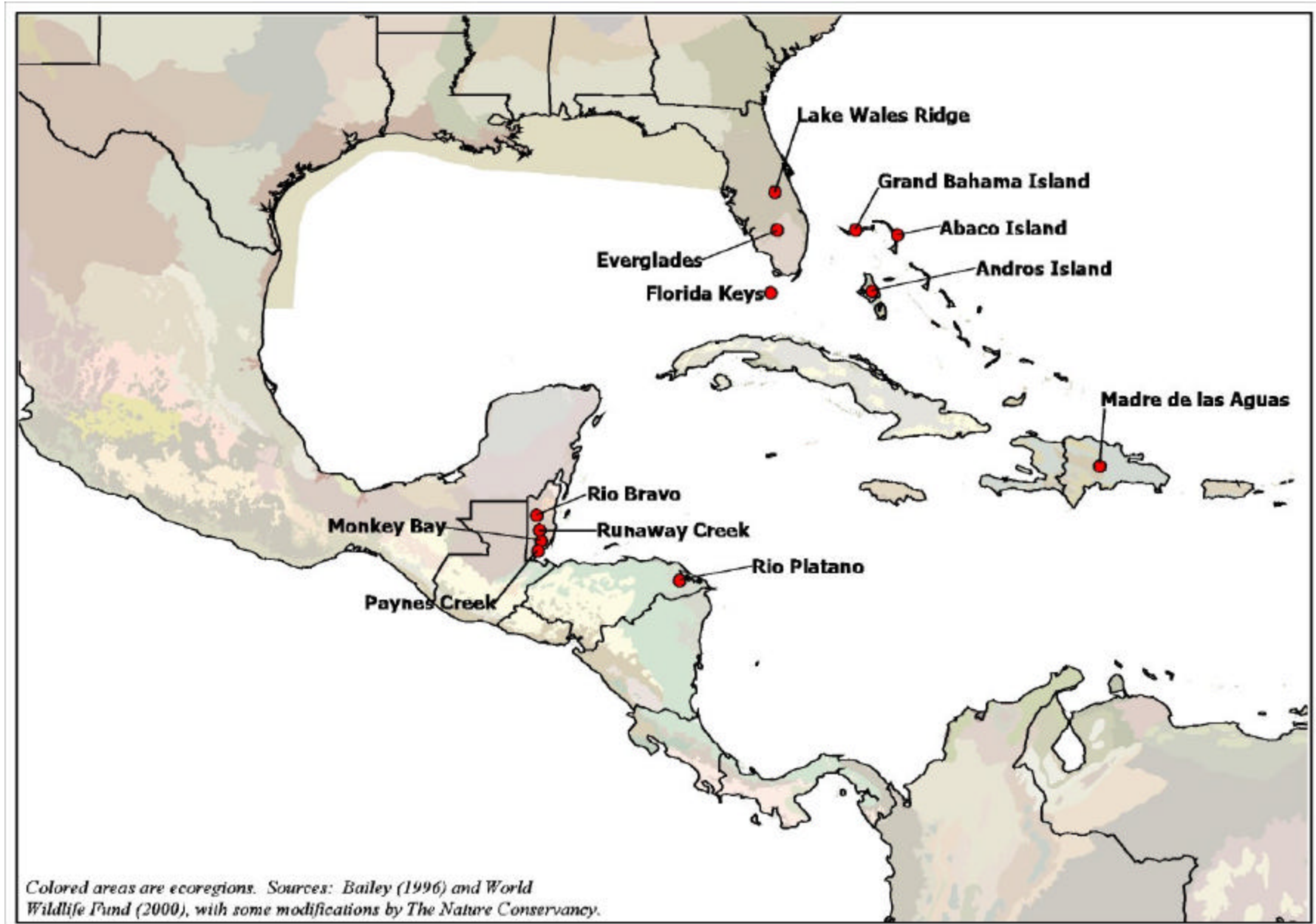
prescribed fire training course is being planned for Rio Bravo in early 2003.

6. Site consultations and country-based workshops are needed in the Dominican Republic and the Bahamas, and perhaps elsewhere in the region. The Dominican Republic representatives specifically requested assistance in dealing with a fire policy issue.



**Appendix A**  
**Conservation Areas Represented at the Workshop**

## Conservation Areas Represented at the Workshop.



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## Appendix C

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