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Fire Management Assessment of the Caribbean Pine *(Pinus caribea)* Forest Ecosystems on Andros and Abaco Islands, Bahamas

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Cover Photo: Caribbean pine forest on Abaco, the Bahamas ©Ronald Myers

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1 introduction

Objectives & Focus

From 2-7 February 2003, a team of fire management and fire ecology experts visited the islands of Andros, Abaco, and New Providence in the Bahamas to gain insight into the fire issues facing the conservation of the Caribbean pine forests, which cover large percentages of each island. The objectives for the assessment were to:

(1) Gather information on fire management needs and issues for the pine forests on the three islands, particularly Andros and Abaco;

(2) Assess current fire regimes and discuss whether they are significantly altered from what is believed to be appropriate to maintain the integrity of the pinelands;

(3) Develop a list of research needs and information gaps;

(4) Evaluate fire management planning and training needs;

(5) Identify managers to participate in training courses, exchanges and mentoring programs;

(6) Identify other threats related to fire, e.g., invasive species and climate change; and

(7) Provide Bahamian conservation managers with recommendations and next steps.

The assessment was conducted as part of the Latin American & Caribbean Fire Management Network funded through The Nature Conservancy by U.S. Forest Service International Programs.

The information in this report is based on observations by, and discussions among, the members of the Assessment Team and their Bahamian hosts during two days in the field on

Team Members

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- Dale Wade, Fire Researcher, U.S. Forest Service (retired), Macon, Georgia

The team was accompanied by

- Christopher Russell, Senior Forest Officer, Bahamas Department of Lands & Surveys
- David Knowles, Assistant Agricultural Officer, Bahamas Department of Agriculture, Abaco
- Randolph Burrows, Bahamas National Trust
- Ron Pagliaro, Abaco Friends of the Environment
- Erin Pagliaro, Abaco Friends of the Environment

Central and North Andros, two days on Abaco, and a brief tour of the pinelands of central New Providence near the airport. This report will focus primarily on Andros and Abaco. The team's observations were limited on both islands to broad transects along primary and secondary roads within the pine forests. These transects do not necessarily represent the conditions of the entire pine-dominated landscape.

Several members of the Team (Bergh, Snyder, Myers, and Wade) are experts in the ecology and management of the pine rocklands in southern Florida and the Florida Keys (see Myers, 2000; Myers & Ewel, 1990; Snyder, 1986; Snyder, 1991; Snyder et al., 1990, Wade et al., 1980). These members consider the Florida pine rocklands to be ecologically very similar to the Bahamian pine forests in terms of forest structure, species composition, pine regeneration, stand dynamics, and responses to fire. Much of this report is based on inferences made about the dynamics of the Bahamian pine forests based on the ecology of the Florida pine rocklands.

This report builds on a fire management assessment of the pinelands of Grand Bahamas and Abaco conducted in 1997 by the fire staff at Everglades National Park, Florida (Segar, 1997) for the Bahamas National Trust.

Caribbean Pine Forest Distribution

Within the Bahamian Archipelago, only four of the islands of the Bahamas support pineland vegetation: Andros, Abaco, Grand Bahamas, and New Providence. Apparently, there were once pines on Berry Island. There are also pine forests in the Turks and Caicos, which are part of the Bahamian Archipelago, but are not part of the Bahamas nation. In the Bahamas, pine forests comprise 23 percent of the terrestrial ecosystems. Andros contains 55 percent of the country's pine forests. Among the four pine

Figure 1. Blue hole on Central Andros surrounded by pyric Caribbean pine forest on limestone substrate. Sediments from blue holes provide pollen and charcoal evidence of the historical dynamics of fire-dependent pine forest vegetation. (Photo: R. Myers)

Figure 2. Fire-maintained wet prairie that grades into salt marsh on North Andros. Pinelands are in the background. (Photo: R. Myers)

islands, most of the remaining intact pinelands, approximately 350,000 acres, occur on government-owned "Crown Lands" which include national parks, national forests, freshwater recharge and supply areas, and unclassified lands.

Pine Vegetation History (Andros)

Information on the long-term vegetation history of Andros is available from a pollen/charcoal analysis of the sediments from Church's Blue Hole, a deep, water-filled, solution hole in the limestone bedrock (Kjellmark, 1996) (Figure 1). The analysis indicates that pyric pine forests expanded and charcoal increased coincidentally with the arrival of humans on Andros about 1,200 yrs bp. Prior to that, the climate may have been drier, limiting human settlement because of lack of water. The pine forests contracted around 500 yrs bp coincidentally with the introduction of European diseases, and forced removal of the population by slave traders from Cuba and Hispaniola. The island remained depopulated for 200 years. Since then, there has been an increase in pine concomitant with re-settlement and population growth. The assumption is that there has been a dynamic relationship between extent of pine forest and human burning. The competing vegetation in this dynamic waxing and waning of the pine forest (known locally as pineyard) is coppice—the Bahamian equivalent of subtropical hammocks in southern Florida—moist-to-dry subtropical hardwood forest on limestone substrate.

Other Pyric Vegetation

Co-occurring with the pine forests are fire-maintained freshwater marshes, wet prairies, palm savannas, and salt marsh (Figure 2). These are most abundant on the lee (west) side of the islands grading into mangrove, but are also found elsewhere. Periodic fire is needed to maintain the herbaceous dominance of these areas. Without fire, salt marshes become mangrove, and freshwater marshes become dominated by woody species such as coco plum (*Chrysobalanus icacao*) and bays.

2 observations

Fire Ecology & Fire Regimes

The Bahamian pineyards are fire-maintained, i.e. they depend on fire for their persistence and characteristics; a specific fire regime is required. A fire regime is defined as a set of recurring conditions of fire that characterize a given ecosystem and include the components of fire frequency, fire intensity, burn severity, seasonality, and pattern of burning. The fire regime required to maintain the biodiversity of the pineland ecosystem can be generally described as frequent (perhaps within the range of 1 to 7-10 years), low-intensity, surface fires (i.e. fuels are on or just above the ground surface; the fire burns through these fuels), that have little impact on the overstory or on the soil/substrate. The fuel is probably capable of burning at any time of the year, provided there is a day or two of drying, but a predictable protracted dry season runs from about January through May and most of the burning each year occurs during this period. The fuel—pine needle litter, combined with grasses—mediates the nature of the fire regime. Where present, scattered-to-dense shrubs and palms contribute to fire intensity and may affect the overstory pines.

Whether a given area burns or not depends on the presence of fuels, whether those fuels are available to burn (i.e. they are dry), and an ignition source. Historically, ignitions were caused by humans and lightning. The vegetation history suggests that human ignitions may have been very important in creating the current extent of the pine forests. Lightning can occur during summer-season convectional storms and during winter-season frontal storms. Lightning fires probably had their greatest impact during the transition between the drought season and the summer wet season, probably in April, May, and June. This is the same period when human caused fires would be most extensive. Humans have probably had the effect of shifting and expanding the window of burning to times when lightning was unlikely to occur and cause fires, e.g., early- to mid-dry season.

Today, the majority of fires on both islands appear to be of human origin. Because they occur earlier in the dry season, they tend to pre-empt most lightning season fires. Few records are kept, so the role and incidence of lightning-ignited fires is not known, but lightning-struck and killed pine trees were evident. Human ignition sources are escaped fires from around homes and from agricultural burning, set fires by people hunting wild pigs, inadvertent ignitions from people using torches to hunt for land crabs at night, other inadvertent ignitions, and arson. Large portions of the pinelands are probably burned prior to the onset of the lightning season. It is likely that little of the pinelands escapes burning for more than 3 years. A huge proportion probably burns every 1-2 years.

The biota of the pine forest, particularly the plants, have evolved adaptations to fire. These adaptations include those that: (1) allow species to survive fire (e.g., the thick bark of mature pines; clusters of needles that protect buds from the heat; high, open crowns that allow heat from a surface fire to dissipate; resprouting ability of shrubs and herbs); and (2) allow the species to respond favorably to the fire (e.g., fire prepares the seed bed for pine regeneration by creating an open, sunny, exposed mineral substrate; it also stimulates flowering and regeneration by seed of many

species). Animals in fire prone environments develop behavioral adaptations to fire. For example, the endemic Bahamas parrot on Abaco nests on ledges in solution holes in the limestone substrate, which presumably provides the nest with some protection from surface fires.

Under the fire regime just described and given the known responses of the pines, an unmanaged, unharvested pine forest would probably be all-aged, made up of small- to mid-sized stands or clumps of trees of the same age. These even-aged clumps or groves would represent areas that at one time were open and remained fire-free long enough for regeneration to take place and for the trees to become established.

The effect of fire regime and changes in fire frequency on ecosystem structure are illustrated in the diagram in Figure 3. Frequent fires favor an herbaceous ground cover. Annual fires prevent sufficient pine regeneration to maintain the pine forest over the long term. Slightly less frequent fires stimulate pine regeneration, which maintains pine dominance. With an interval of several decades between fires, pine regeneration is again limited and favors the development of a hardwood understory. Without fire, the pines will eventually disappear as hardwoods take their place.

Role & Impact of Forest Exploitation

The current structure and dynamics of the pinelands on both Andros and Abaco have been strongly influenced by previous logging events. Commercial logging began on Abaco in the early 1900's. The last commercial harvesting for pulp and timber was conducted by Owen-Illinois in the late 1950's through the 1960's. Abaco was cut before Andros. Cutting

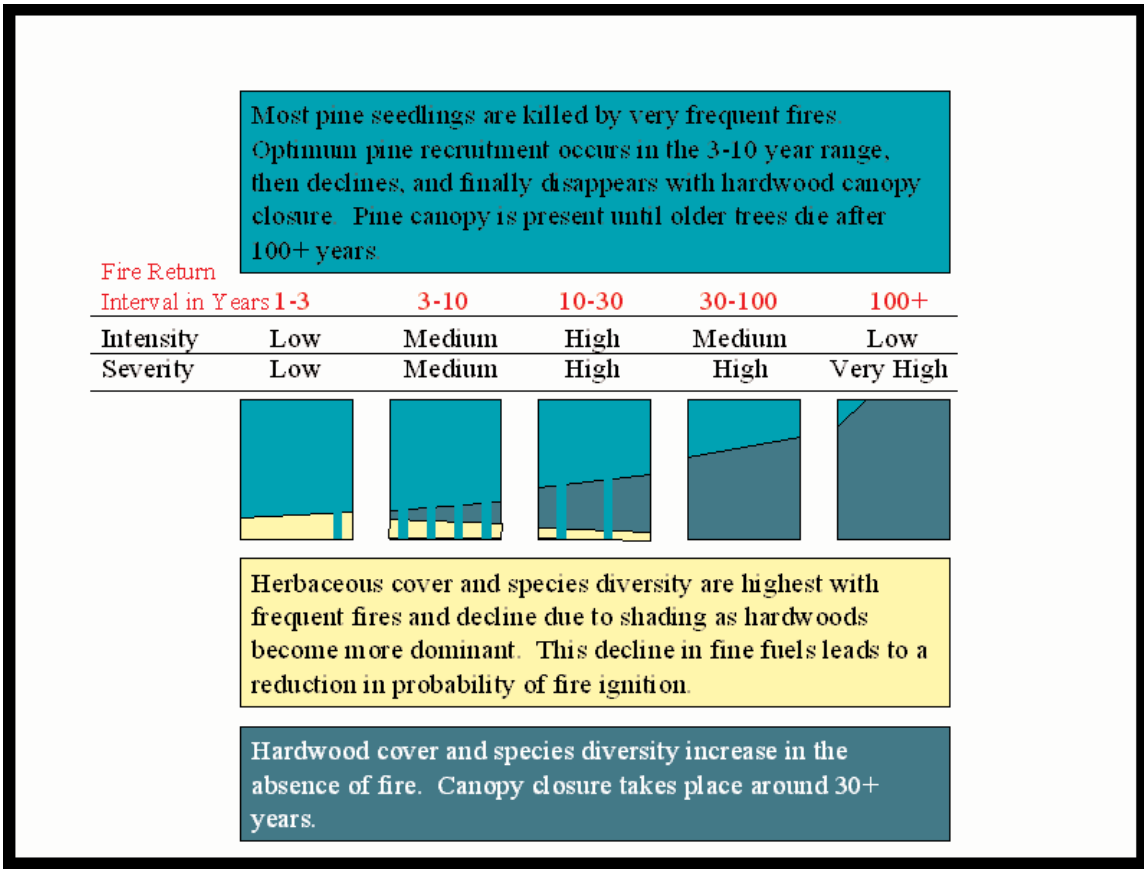

Figure 3. Changes in vegetation structure, fire intensity, and burn severity with increasing interval between fires.

ended on Abaco in 1964 when a hurricane damaged the logging operation and the company moved on to Andros. This abrupt cessation of operations on Abaco spared a last remaining area of old-growth pine at the north end of Little Abaco.

Owen-Illinois reported in 1961 that most of their harvesting was in second growth forest with some even-aged stands of 50-year-old trees, and other even-aged stands of 25-year-old-trees. Stand density was 196 and 180 stems per acre respectively (Owen-Illinois, 1961). They also reported cutting some old-growth stands where the trees ranged from 125-150 years with a density of 115 trees per acre (average diameter 8.5 inches, range 5-13 inches). Their report did not include stems less than 5 inches dbh. Harvesting left five or more seed trees per acre. This seed source has been largely responsible for the regeneration of the extant pine forests. It is apparent that the forest has been able to successfully regenerate and maintain itself after at least two intensive harvests over the past century.

At present, there is an active, small-scale, pine harvesting permit on Andros for furniture and other specialty forest products. On Abaco, there was a salvage logging permit issued following Hurricane Floyd in 1998, but no extraction took place.

Current Conditions

The current condition of the pineyards strongly reflects the past harvesting and the frequency of burning. On both Andros and Abaco the forests are uniformly monotonous, with all of the trees virtually the same age. Some of the seed trees have persisted. There is little or no pine regeneration within the forest. The lack of regeneration is due to two factors:

(1) The canopy is too dense and uniform to provide the sunlight for successful regeneration.

(2) Where canopy gaps do occur, fires may be too frequent in most cases to allow seedlings to reach a size to survive fires.

These beg the question: why didn't the frequency of burning inhibit regeneration after successive timber harvests? There is little to suggest that fires may have been less frequent prior to past logging events. A more likely scenario is that fires immediately post-logging removed the pine litter fuel that is the primary carrier of fire in the pinelands. Without a pine canopy to provide needle cast to replenish the fuel, fires were less frequent for awhile, of lower intensity, and less uniform, allowing time for the pines to re-establish. Assuming the fire regime has not changed appreciably, this suggests that intensive logging every 50 years or so, with seed trees left, would continue to perpetuate the forest in a condition similar to what it is today.

In 1998, Hurricane Floyd damaged portions of the pine forest on Abaco. The storm damage led to abnormally high fuel loads. During a protracted drought in the dry season of 1999, many of these storm-damaged areas burned severely, killing stands of pine of hundreds of acres in extent (Figure 4).

Regeneration of these severely burned areas will likely follow the same pathway as regeneration following logging and fire, i.e. pine needle fuel inputs have been cut off, allowing re-establishment from mature seed trees that surround the burned areas. This pattern of disturbance involving hurricanes + fire has probably been part of the endemic disturbance regime in the pine forests throughout their history and may be responsible for creating relatively large even-aged tracts of pine.

The pine forests of both Andros and Abaco have very little regeneration. This is partly due to the lack of light gaps. Where gaps in the

Figure 4. Pine stand in central Abaco killed after severe fire in 1999. This was after Hurricane Floyd-damage led to large fuel accumulations. (Photo: R. Myers)

canopy occur, regeneration, ranging from seedling to sapling to pole sized trees, is frequently present. Instances where this regeneration had recently been killed by fire are also common. There is likely to be little significant regeneration and a trend toward a more natural uneven aged forest until the forest becomes more open. How detrimental the frequent fires are to this trend is unknown. It may be that the natural development of larger canopy gaps will create fuel situations similar to what occurred following logging, but on a smaller scale, i.e. larger gaps would lack pine needle cast and would more likely escape frequent burning until the trees re-establish. However, the fact that the relatively open stand of old-growth pine on Little Abaco has few young trees points to a regime of fire that has been preventing successful regeneration. If this regime persists, there will be a gradual thinning of the forest, eventually creating a savanna-like aspect.

A viable Caribbean pine forest would probably have trees of all ages clumped into small to mid-sized groves or stands that represent areas that were open when regeneration occurred and escaped severe fire until the trees where large enough to survive. Openings would occur when groves of older trees died or where hurricanes, drought, disease, or fire happened to kill clumps of trees. A subsequent fire would prepare a suitable seed bed. Abaco appears to have more patches of regeneration than the forest on Andros. This may be due to the hurricane history of the island.

Anything that would limit height growth of the smaller pines limits successful regeneration. We observed that a tip moth was causing death of the terminal leader of many seedlings and small trees. The longer it takes for pine seedlings to get their terminal shoots above the flame zone, the longer the young pines are susceptible to fire injury and death. The incidence of this moth is probably endemic and of little

concern; however, there may be some environmental factors, like excessive shade under the even-aged stand, that create conditions favorable for the moth.

Even though the pine stands are very uniform throughout much of both islands, there is considerable variation in understory and groundcover vegetation. These differences are probably due to some combination of fire history, substrate characteristics, and depth to water table. In places, particularly on Abaco, grasses dominate the ground cover (Figure 5).

In other places, like the old-growth forest on Abaco, bracken fern dominates the understory. It was suggested that frequent burning might be responsible for the aspect dominance of the ferns (Figure 6). (Aspect dominance means that a single species appears to dominate the vegetation, but no judgment can be made about the diversity of species of the vegetation.) It has also been suggested that the fern-dominated ground cover in the old-growth forest is species depauperate, or that species diversity may be declining. This has not been documented. The fern dominance may be the result of season of burn. Winter (January-March) burns in Florida pine forests produce a dominance of bracken fern. When these areas are burned later in the dry season (April-June) grasses dominate the aspect. The shift can occur after a single late-season burn.

Some of the differences observed in ground cover may be a function of substrate characteristics and depth to water table combined with fire history. The general consensus is that palms are abundant on substrates that are saturated with water during the wet season (Figure 7). What separates the habitat of the three species of palms is unknown. Although the substrate is uniformly oolitic limestone, its gross morphology varies from sharp "pinnacle" rock to smooth pavement pitted with solution holes. Substrates with deep fissures may allow a

Figure 5. Grass-dominated ground cover in Abaco National Park. The aspect of grasses may be due to a regime of very frequent fire. (Photo: R. Myers)

Figure 6. Bracken fern-dominated ground cover in Abaco's remnant old-growth pine forest may be a response to frequent dormant season burns. Soil characteristics may also contribute to the dominance of bracken fern after a fire. Note the lack of both age diversity and regeneration in the stand. (Photo: R. Myers)

Figure 7. Pine forest on Andros with abundant thatch palm possibly indicating a high water table. (Photo: R. Myers)

Figure 8. Diverse shrub-dominated understory on Andros may reflect fire history and/or substrate conditions. Note young pines and dead small stems in gap. (Photo: R. Myers)

greater accumulation of organic matter and clays. Deep burns may remove this organic accumulation in some areas, affecting species composition. Forests with a diverse woody understory may be the result of some unknown combination of substrate and fire history (Figure 8).

Shrub-dominated understories reflect the dynamic relationship between pine forest and coppice vegetation. Coppice will develop anyplace where pines occur that has become fire-free for a sufficient period of time. Coppice tends to occur in areas that are protected from fire. Once established, coppice is less likely to burn than pineland vegetation because of differences in fuel characteristics. That is, there is less fine fuel, higher dead and live fuel moisture, and the fuel is more compact. The most dynamic areas of coppice are those that have an overstory of pines with pine needle litter. These situations tend to result in more severe fires with more damage to the pine overstory. Coppice predominates on the windward (east) side of the islands, frequently on the windward side of rock ridges that run parallel to the windward coast (Figure 9). The dry season winds are the consistent easterly trade winds, thus wind-driven head fires would rarely affect coppice on the east coast. Fires backing into the winds would tend to go out when fuels change from pineland fuels to coppice fuels. Coppice also develops in areas pocketed by deep solution holes, which provide moist central habitats for coppice species (Figures 10 & 11). These coppice areas can expand during fire-free periods. Conversely, they contract during periods of drought accompanied by frequent fire. There was a general observation that there were fewer pockets of coppice on Abaco than on Andros. This would have to be verified on a vegetation map or on aerial photographs.

Figure 9. Abrupt transition between pine and coppice along windward side of Abaco. Fires backing into the wind will generally go out when they reach coppice fuels. (Photo: R.Myers)

Figure 10. Coppice-pineland transition on Andros. These zones wax and wane in response to the occurrence of fire. (Photo: R. Myers)

Figure 11. Pineland burn on Andros that went out when it reached coppice fuels. (Photo: R. Myers)

Invasive Species & Land Conversion

Several of the troublesome non-native invasive species in Florida's pine rocklands and freshwater marshes were observed on both Andros and Abaco. They include Brazilian pepper (*Schinus terebinthefolious*) and several aggressive grasses, notably Napier grass (*Pennisetum purpureum*). Burma reed (*Neyraudia reynaudiana*) was not observed, but is reported as occurring on North Andros. Generally, these invasive species are only abundant in or near rockland areas that have been converted to agriculture, and they are probably restricted from the pineyards proper by the frequent burning and the lack of rock substrate disturbance. Scattered melaleuca (*Melalueca quinquenervia*) were observed in freshwater marshes on North Andros. This aggressive, fire-adapted species from Australia has the potential to convert the marshlands and wet prairies to forest. It generally does not do well in pine forests on limestone substrates.

3 recommendations & next steps

Current Recommendations

(1) The Bahamian pineyards are the largest and most intact examples of subtropical pine rockland ecosystem in the world and they support a wide array of globally imperiled and rare species. Several are endemic to the ecosystem and/or the Bahamas. These unique pine rocklands are the only examples with Caribbean pine (Florida's rocklands have the south Florida variety of slash pine [*Pinus elliotii* var. *densa*], which was once classed as Caribbean pine). The Caribbean pine in the Bahamas is an endemic variety (*Pinus caribea* var. *bahamensis*). Florida's pine rocklands have largely succumbed to urban development or have been rock plowed for agriculture. Difficult-to-manage remnants remain in urban settings. Because of the small size of Florida's pine rocklands they are susceptible to invasive non-native plant species, prescribed burning is difficult and limited, and in the long term many are probably not viable. The largest and most viable tract in Florida is Long Pine Key in Everglades National Park. There are also pine rocklands on several of the Florida Keys. Because of their uniqueness, rarity, and extensive intact condition, the Bahamian pineland/coppice landscape on all four islands should be a conservation priority for the Bahamian government, Bahamian conservation organizations, and The Nature Conservancy. Any significant fragmentation of the Bahamian pinelands will lead to a degradation similar to what has occurred in Florida.

(2) Except for the lack of age diversity, the pinelands on both Andros and Abaco are in good condition. The current fire regime has served to keep fuel loads low and maintain an intermix of coppice. This fire regime could probably continue for 5 or maybe 10 years or more without any adverse effect on the ecosystem. In other words, due to the current structure of the forest, which is the result of regeneration after logging, there is no immediate need to change or manage the fire regime.

(3) That said (in #2), the fires in these forests will eventually have to be managed to allow the development of a viable forest. More variability in the fire regime may also be needed to maintain the biotic diversity of the ecosystem.

(4) In order to accomplish #3, steps should be taken soon to develop fire management capacity, as this takes a number of years to develop.

(5) Concomitant with #4 should be the development of a fire management plan and overall management plan for the pinelands. Planning should not precede the development of fire management capacity. If it does, there will be a plan but no capacity to implement it.

(6) Fire management priority should be given to the national parks on Andros and Abaco, and to the remnant old growth forest on Little Abaco. Other priority areas should be identified, particularly the water recharge areas.

(7) Public education about fire should be a priority. Most Androsians and Abaconians view the annual dry season fires as destructive to the forest and dangerous to their lives and livelihood. People need to hear about the ecological and economic value of their pineyards, the beneficial role of fire, and the value of integrated fire management. This message is particularly important to include in school curricula. Chris Russell's "The Bahamian Pine

Forest—Anything but Barren!" poster is an excellent start.

(8) The volunteer fire departments on both islands need to be educated on the role of fire, and trained in using fire to reduce fuels in the pineyard-urban interface and in areas where smoke from wildfires is a problem. For example, the Marsh Harbor Airport on Abaco has been closed at times due to smoke from fires. The incidence and quantity of smoke could be managed with prescribed burns.

(9) The pineyards on both islands offer a significant economic timber resource. To ensure a sustainable resource and long-term ecosystem viability, an ecologically-based pine management plan needs to be developed and implemented in areas designated for future harvesting. The economic value of the forests should be promoted as a strategy to limit conversion of pineland to other uses.

(10) Some of the pinelands on both Andros and Abaco have been rock plowed and converted to agriculture. Once rock plowed, a new soil is created that will no longer support the pineland ecosystem. The experience in Florida is that abandoned rock plowed farmland leads to a new ecosystem dominated by non-native species. Some assessment of the future threat of agricultural conversion of Crown Lands should be made. Abandoned agricultural lands might serve as suitable sites for pine plantations (of native Caribbean pine) that could take some of the extraction pressure off the higher quality pinelands.

(11) Some basic information about the pinelands and the fire regime should be obtained:

- From a series of aerial photographs that probably go back to the 1940's, an assessment should be made of changes, if any, in the relative proportion of coppice and pineyard. Has it been stable, or has there been an increase in one at the expense of the other under the fire regime that has existed over that period?

- Basic fire information should be obtained, e.g., number of fires, area burned, and date or dates of burn should be documented and roughly mapped to get better documentation of the current fire regime and as a baseline for changes to come under fire management.

(12) Key staff members of Bahamian government agencies, local conservation organizations, and The Nature Conservancy ideally should have some of their time dedicated to the conservation, monitoring, and management of the pineyard ecosystem.

(13) Some of these people in #12 should be trained in fire management planning and fire management implementation. These people could be responsible for further developing capacity within their organizations and local communities. In response to this recommendation, three individuals from Abaco representing the Friends of the Environment, the Marsh Harbor Volunteer Fire Department, and the Bahamas Department of Agriculture, and one person from Grand Bahamas representing the Bahamas National Trust, participated in a week-long workshop in Belize on fire planning, fire behavior, and prescribed burning that was organized by TNC as part of the Latin America & Caribbean Fire Management Network. USDA Forest Service International Programs funds covered their participation. Additional training and exchanges are encouraged, including building partnerships with US agencies in Florida that are managing fire in these ecosystems.

(14) The occurrence of non-native invasive species, including melalueca and the grasses, which can strongly influence fire regimes and

thereby drastically and negatively impact biodiversity, both directly and indirectly, should be documented. A plan for their eradication and/or control should be developed and implemented as soon as possible to minimize costs of this effort and to maximize success probability. Melaleuca has been successfully controlled in some natural areas in southern Florida (Myers et al., 2001).

(15) Research needs include:

- Fire history studies; e.g., proposal of Dr. Sally Horn, University of Tennessee, to look at fire history on Abaco;
- Fire regime studies, particularly season and frequency of burn on biodiversity of ground cover and pine regeneration;
- Effects of fire on Bahamas parrot habitat and population dynamics;
- Relative importance of pine forest cover to freshwater recharge and supply (TNC's Sustainable Waters Program); and
- The potential impact of climate change on the pineland ecosystem (TNC's Climate Change Initiative).

Previous Recommendations

Our recommendations are consistent with those provided by the US National Park Service to the Bahamas National Trust in 1997. The NPS focused on fire operations needs; our recommendations have expanded upon those needs to include the ecosystem function of fire, the conservation of the pinelands values, and research needs. The NPS Action Plan included the following:

Short-Term:

- Identify values at risk;
- Create defensible space around values at risk;
- Begin collection of weather data;
- Begin collection of fire occurrence data;
- Begin repair and/or procurement of fire equipment;
- Begin consultation & coordination with cooperators (fire department, forestry, landowners);
- Begin planning for response to high-risk fire conditions; and
- Begin fire education and prevention efforts.

Medium-Term:

- Begin prescribed burning on simple, low risk sites; and
- Begin organization of an interagency wildland fire management presence (Forest Warden, wildland fire engine, volunteer firefighters) on each pine island.

Long-Term:

- Re-evaluate burn program and revise prescriptions as needed to meet objectives;
- Expand prescribed burn program to include all sites; and
- Support a capable interagency wildland fire management crew on each pine island.

Next Steps

(1) Designate lead for TNC Bahamas to identify and address fire threats and strategies/actions to mitigate those threats.

(2) Lead (identified above), working with TNC Bahamas, Global Fire Initiative, and Bahamas partners, develops a strategy and action plan focusing on Abaco and Andros National Parks.

(3) Follow up on fire training completed in 2003 by Bahamians by identifying other needs and opportunities.

(4) Develop a mentoring/exchange program that will assist in developing fire management plans for priority sites in the Bahamas.

(5) Identify staff and partners who will focus on pineland conservation threats that are fire-related, e.g., invasives species, inappropriate forestry, and land conversion.

(6) Identify and assist individuals on Andros and Abaco to develop and implement a fire occurrence monitoring system.

(7) Pursue opportunities to integrate training burns with fire regime research burns on both Abaco and Andros.

(8) Develop a model fire management plan for Abaco National Park.

(9) Transfer lessons learned in the Bahamas to help address fire management needs elsewhere in the English-speaking Caribbean.

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