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july 2005

BIG THICKET NATIONAL PRESERVE

A Resource Assessment

National Parks Conservation Association



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STATE OF THE PARKS® Program

More than a century ago, Congress established Yellowstone as the world's first national park. That single act was the beginning of a remarkable and ongoing effort to protect this nation's natural, historical, and cultural heritage.

Today, Americans are learning that national park designation alone cannot provide full resource protection. Many parks are compromised by development of adjacent lands, air and water pollution, invasive plants and animals, and rapid increases in motorized recreation. Park officials often lack adequate information on the status of and trends in conditions of critical resources. Only 10 percent of the National Park Service's (NPS) budget is earmarked for natural resources management, and less than 6 percent is targeted for cultural resources management. In most years, only about 7 percent of permanent park employees work in jobs directly related to park resource preservation. One consequence of the funding challenges: two-thirds of historic structures across the National Park System are in serious need of repair and maintenance.

The National Parks Conservation Association initiated the State of the Parks® program in 2000 to assess the condition of natural and cultural resources in the parks, and determine how well equipped the National Park Service is to protect the parks—its stewardship capacity. The goal is to provide information that will help policy-makers, the public, and the National Park Service improve conditions in national parks, celebrate successes as models for other parks, and ensure a lasting legacy for future generations.

For more information about the methodology and research used in preparing this report and to learn more about the State of the Parks® program, visit www.npca.org/stateoftheparks or contact: NPCA, State of the Parks®, 230 Cherry Street, Ste. 100, Fort Collins, CO 80521; Phone: 970.493.2545; E-mail: stateoftheparks@npca.org.

Since 1919, the National Parks Conservation Association has been the leading voice of the American people in the fight to safeguard our National Park System. NPCA and its 300,000 members and hundreds of partners work together to protect the park system and preserve our nation's natural, historical, and cultural heritage for generations to come.

- * Nearly 300,000 members
- * 8 regional offices, and 6 field offices
- * 42,000 activists



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REPORT SUMMARY



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Located in southeastern Texas, Big Thicket National Preserve's 97,206 acres are home to a diversity of natural resources and a history of human occupation that dates back at least 8,000 years. The preserve is composed of nine land units and six river and stream corridors that are distributed over seven counties and 1,885 square miles of southeastern Texas. The preserve's unique natural features and species diversity have earned it designation as an

International Biosphere Reserve and Globally Important Bird Area. Big Thicket hosts about 60 mammal species, in addition to 92 reptile and amphibian species, more than 1,800 invertebrate species, 97 fish species, and at least 176 bird species. Archaeological resources, logging mills, oil wells, and homesteads tell the stories of past human inhabitants.

The park is near Beaumont and is just 90 miles from Houston, a major metropolitan area

Red-cockaded woodpeckers were once found throughout the United States, but habitat destruction and fire suppression have severely affected populations and caused the bird to be federally listed as endangered.



JOHN AND KAREN HOLLINGSWORTH/US FISH AND WILDLIFE SERVICE

with a population of 2 million. Increasing development around the park—commercial, industrial, roads, and residential—continues to fragment the Big Thicket region. Big Thicket’s resources are particularly vulnerable to adjacent development because most preserve units are small and isolated from one another. More than 2 million acres of timber company land surrounding the park have been sold or put up for sale in the last four years, and preserve staff are concerned because some of the acreage has already been subdivided and developed. Big Thicket is working to acquire sensitive lands, but funds have been slow in coming, and negotiations with sellers are often complicated.

In addition to development concerns on neighboring land, Big Thicket faces challenges from within its borders. As a result of its establishing legislation and designation as a national preserve, certain consumptive activities are allowed. Oil and gas development is of primary concern because of its effects on wildlife and

sensitive plants, as well as potential contamination of waters and soils from spills.

Logging and fire suppression that occurred for decades before the preserve was created have left behind a legacy of altered landscapes. Longleaf pine forests, critical to the federally endangered red-cockaded woodpecker (*Picoides borealis*), were logged and replanted with other faster-growing pine species. This disruption, combined with fire suppression, allowed a variety of brush species to form a dense, woody understory throughout much of the park. Big Thicket’s fire management team has been conducting prescribed burns since 1982 in efforts to restore some of the preserve’s fire-dependent landscapes. This labor intensive process has shown much success—longleaf pines have become re-established in some burned areas, and brush species have been reduced.

Big Thicket suffers from funding and staffing shortfalls that limit cultural and natu-

ral resources research and protection projects. In addition, staff turnover, which is an issue throughout the Park Service, can result in short-lived projects and a lack of research continuity. In-depth resource knowledge is resident in a few individuals who have lived near the preserve or conducted research there since its establishment or before and in several park staff who have worked in the preserve for many years. Preserve resources would benefit from additional staff who could stay at Big Thicket long enough to know about the resources, develop strategic management plans, and follow through on them.

The preserve does not have any staff to care for cultural resources, which suffer as a result. Archival and museum collections are not cataloged or properly stored, and historic structures are not interpreted for visitors.

Two or three biological technicians are needed to collect essential natural resources data and conduct monitoring, and a geographic information systems specialist is needed to organize the preserve's mapping data. More than 1,300 species of vascular plants exist in the park, and Big Thicket needs a botanist to track the health of preserve flora.

RATINGS

Current overall conditions of Big Thicket's known **natural resources** rated a "fair" score of 69 out of 100. Ratings were assigned through an evaluation of park research and monitoring data using NPCA's State of the Parks comprehensive assessment methodology (see Appendix). Urban encroachment and habitat fragmentation from residential, commercial, industrial, and road development in the region are primary concerns.

Overall conditions of the park's known **cultural resources** rated 42 out of a possible 100, indicating "poor" conditions. Big Thicket lacks any cultural resources specialists. As a result, these resources are not properly cared for or interpreted for visitors.

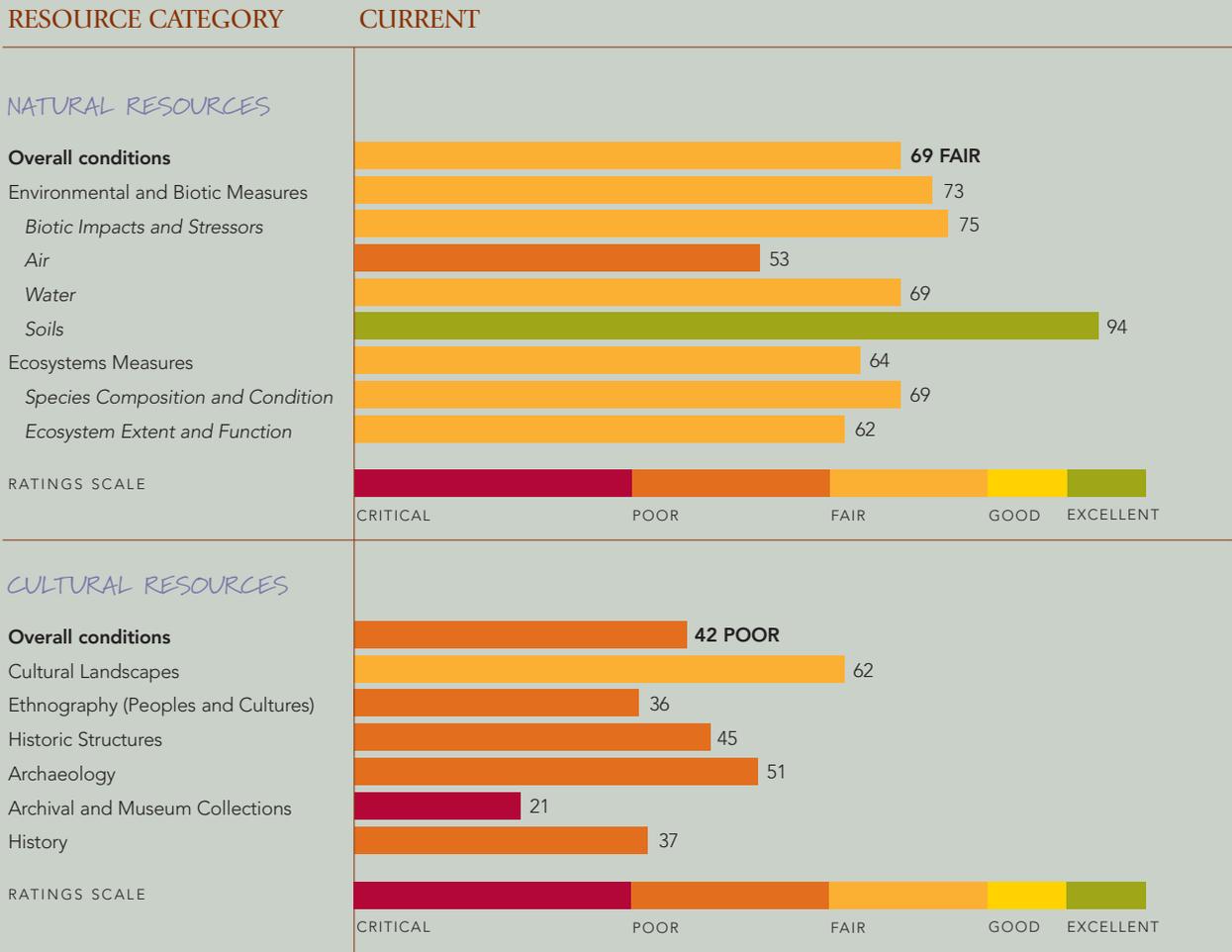
BIG THICKET NATIONAL PRESERVE AT A GLANCE

- In recognition of its unique natural resources and diverse wildlife habitats, the United Nations Education, Scientific, and Cultural Organization (UNESCO) designated Big Thicket National Preserve as an International Biosphere Reserve in 1981. In 2001, The American Bird Conservancy named the preserve as a Globally Important Bird Area.
- Logging and oil and gas production have been major industries in the Big Thicket region since the mid-19th century. Much of the preserve's history is tied to these activities, which had profound effects on the region's resources.
- Big Thicket National Preserve provides economic benefits to local communities. In 2003, about 100,000 visitors to the preserve spent an estimated \$6.25 million and supported 157 jobs. Increasing awareness of preserve resources and recreational opportunities will draw more visitors and provide additional economic benefits to local communities.



JIM NATIONS

Note: When interpreting the scores for natural resource conditions, recognize that critical information upon which the ratings are based is not always available. In this assessment, 80 percent of the information requirements associated with the methods were met, which limits data interpretation to some extent.



The findings in this report do not necessarily reflect past or current park management. Many factors that affect resource conditions are a result of both human and natural influences over long periods of time, in many cases before a park was established. The intent of the State of the Parks® program is to document the current status of park resources and determine which actions can be taken to protect them into the future.

KEY FINDINGS

- Big Thicket is composed of nine land units and six water corridors that are separated by miles of privately held lands. The discontinuous nature of the preserve makes its resources more vulnerable to negative effects from adjacent development that fragments the natural landscape.
- About 2 million acres of timber company lands surrounding the preserve have been sold since 2002. This has the potential to have significant negative effects on the preserve as these lands shift from sustainable timber production to other uses such as subdivisions and commercial developments. Sensitive habitats (and visitor experiences) along the boundaries of the preserve have been and will be affected as adjoining lands are cleared for a variety of purposes such as pastures and residential yards or are paved for commercial development. Big Thicket needs the authority to work with willing sellers or cooperators to conserve land along the boundaries of the preserve. At this time, the preserve does not have the authority to buy lands or hold conservation easements outside its boundaries. To maintain the integrity of preserve resources, this must change.
- The Big Thicket National Preserve Addition Act of 1993 authorized the preserve to acquire lands along portions of Village Creek and the Neches River (about 11,000 acres). However, funds to acquire this land have been slow in coming. Recent appropriations have allowed the park to acquire some of this land, but additional funds are needed to buy the rest.
- A 72-mile, four-lane divided highway (U.S. 69) from Lumberton north to Zavalla has the potential to significantly degrade Big Thicket National Preserve's resources. Continued cooperation between the Park Service and the Texas Department of Transportation (TxDOT) is critical to ensure that resources are not affected. In addition to employing a variety of mitigation measures, TxDOT should acquire and donate strategic tracts of land to Big Thicket to reduce urban sprawl adjacent to the preserve.
- New reservoirs that could be built on the Neches River north of Big Thicket could significantly affect preserve resources if water flows are diverted to other basins and the beneficial effects of periodic flooding are eliminated or reduced. At least two new reservoirs are being considered for the Neches River; if built, they could divert water that currently flows through the preserve's 85-mile Neches River corridor. Such diversions could disrupt native plant communities, affect wildlife, and compromise recreational opportunities.
- Big Thicket lacks any cultural resources specialists, and as a result, these resources are not properly cared for or interpreted for visitors.
- Poaching, illegal dumping in the Neches River and other streams, and all-terrain vehicle use are concerns throughout Big Thicket. The preserve has just three full-time field rangers to patrol more than 97,000 acres of parkland that are spread over seven counties and 1,885 square miles of southeastern Texas. Big Thicket's law enforcement needs assessment states that the preserve needs at least 16 rangers to adequately protect visitors and resources. The existing staffing shortfall makes law enforcement, resource protection, and visitor protection difficult if not impossible.
- Big Thicket suffers from funding and staffing shortfalls that limit cultural and natural resources research and protection projects. In addition, staff turnover, an issue throughout the Park Service, can result in short-lived projects and a lack of research continuity.
- Several of the people who played key roles in convincing Congress to establish Big Thicket National Preserve are still active in regional conservation issues. They represent valuable human resources the preserve could tap to complete an administrative history of Big Thicket.



I. ESTABLISHING THE PRESERVE: THE PROTECTION CHALLENGE CONTINUES



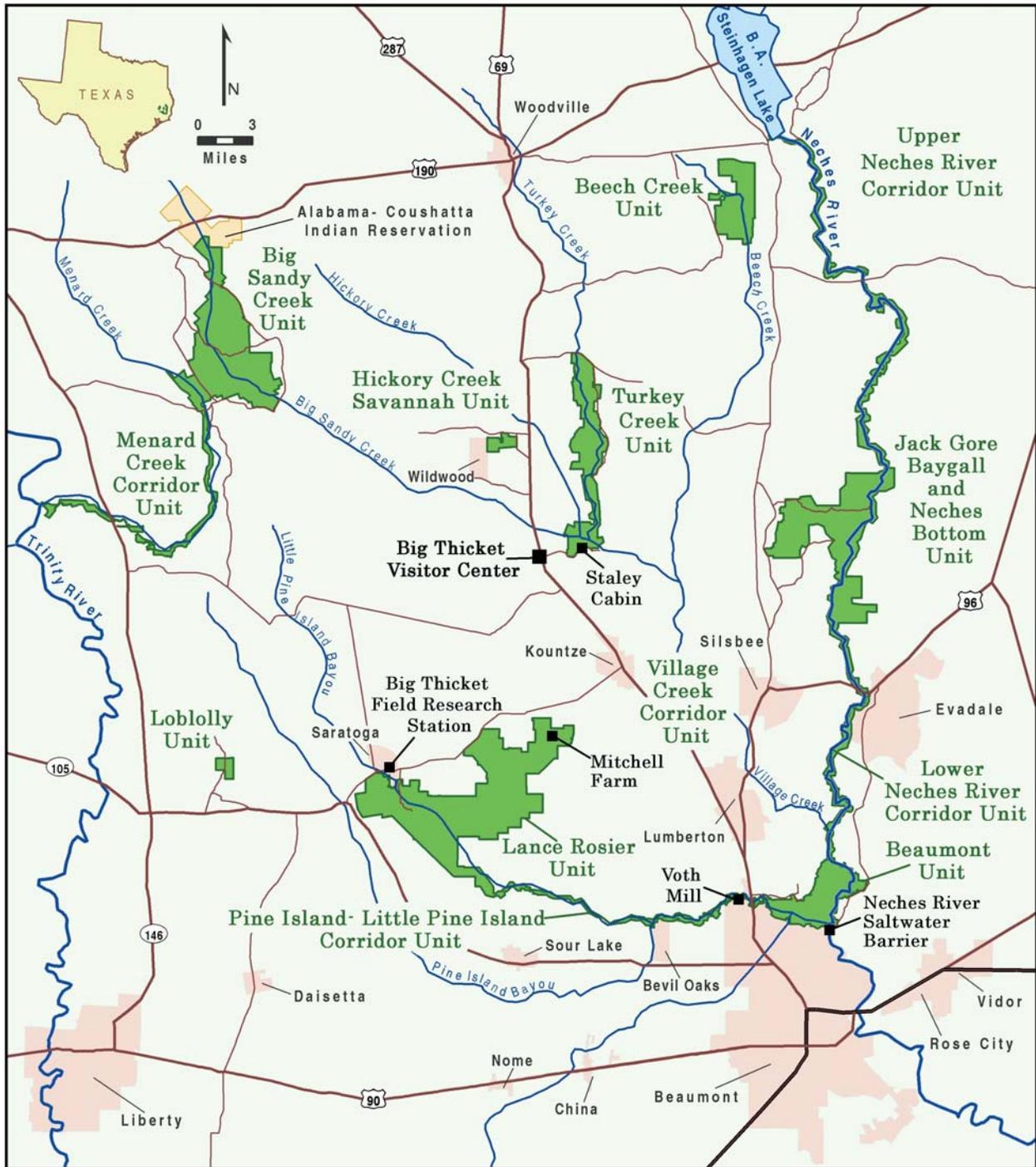
Logging activities over the past century caused major habitat changes that affected other plants and wildlife. Logging continues today, but some companies such as Temple-Inland have demonstrated a commitment to forest conservation.

Big Thicket National Preserve was established to protect the remnants of a vast and unique landscape of incredible biological diversity that once covered more than 3.5 million acres of east Texas. A unique interaction of soils and climate has resulted in a truly remarkable mix of southeastern swamps, eastern deciduous forest, pine savannas, and dry sandhills.

Establishment of the preserve was a long and arduous process. Interest in creating a national

park to protect part of the Big Thicket region from logging and oil production dates back to at least the late 1920s and the formation of the East Texas Big Thicket Association. The National Park Service completed a favorable study of the region in 1939, but the nation's interests turned to World War II. For the next three decades, conservationists continued to fight for protection of the Big Thicket region as timber and oil companies took advantage of the region's resources.

BIG THICKET NATIONAL PRESERVE



RESOURCE MANAGEMENT HIGHLIGHTS

- Big Thicket's fire management team has been conducting prescribed burns throughout the preserve since 1982 in an ambitious effort to restore fire-dependent vegetation communities. As a result of these burns and accompanying restoration activities, some longleaf pine forests are recovering, and brush has been reduced in many areas. However, the fire management team is unable to burn some other areas as often as necessary.
- Big Thicket staff regularly join with regional conservation organizations and Temple-Inland, a forest products company that owns much land around the preserve, to accomplish resource preservation projects. In 2002, the preserve worked with The Nature Conservancy and Temple-Inland to restore longleaf pines to parts of the Turkey Creek Unit of Big Thicket. Big Thicket is currently working with the Conservation Fund and Temple-Inland to establish a 12,000-acre easement through the U.S. Forest Service's Forest Legacy Program. The easement will protect a buffer along the east side of the preserve's Turkey Creek Unit and the southern boundary of the Hickory Creek Savannah Unit.
- In conjunction with Stephen F. Austin State University and Texas A&M University, Big Thicket is reintroducing Texas trailing phlox (*Phlox nivalis* ssp. *texensis*), a federally listed endangered plant, to the Big Sandy Creek and Turkey Creek units of the preserve. In February 2005, 200 phlox were planted in the Big Sandy Creek Unit, and an additional 600 will be planted in winter 2005. The plant had a historic range of only three east Texas Counties; reintroductions in Big Thicket are a vital part of meeting recovery plan goals for this species.
- Preserve staff have started a mist-netting and bird-banding station as part of the Institute for Bird Population's MAPS (monitoring avian productivity and survivorship) program. Data from this project will help resource management staff better understand the population dynamics of its breeding bird populations and better manage preserve resources.
- Researchers at the University of North Texas and Rice University are studying the effects of hydrologic changes in flood pulses along the Neches River that have occurred as a result of upstream dams. They hope to determine the effects of these hydrologic changes on the vegetation communities along the Neches River floodplain—important research, as there are several proposals for more dams upstream of the preserve.

Big Thicket fire management staff teach visitors about how the preserve uses fire as a habitat restoration tool.

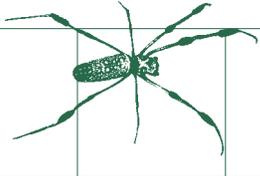
Old growth forests were clearcut, and crude oil once used for medicinal purposes by American Indians was extracted in great quantities.

A renewed effort to establish a national park took shape in 1964 with the formation of a new conservation organization, the Big Thicket Association. For the next ten years until Big Thicket National Preserve's establishment in 1974, members of the association, other conservationists, and conservation-minded politicians such as Sen. Ralph Yarborough (D-TX) fought for a national park. After numerous bills were introduced in Congress, with total park acreages varying from just a few thousand to several hundred thousand, Big Thicket National Preserve was finally established on October 11, 1974.

Big Thicket was the first national preserve to be included in the National Park System. Its primary goals are to preserve, protect, and conserve "the unique natural, scenic, and recreational values and to provide for the enhancement and public enjoyment thereof." As a preserve, Big Thicket allows for certain activities that are not permitted in national parks: Hunting and trapping, as well as oil and gas exploration and extraction, are managed by preserve staff. Aside from these exceptions, management of Big Thicket does not differ from that of other park system units and is directed toward maintaining the preserve's natural and scientific values. In a preserve that is composed of 15 discrete land and water units and faces funding and staffing constraints, as well as increasing fragmentation of the surrounding landscape, fulfilling its mission to protect resources is a growing challenge.



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THE BIG THICKET ASSESSMENT



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NATURAL RESOURCES— REGIONAL DEVELOPMENT AND HABITAT FRAGMENTATION THREATEN DIVERSE RESOURCES

The assessment rated the overall condition of natural resources at Big Thicket National Park a 69 out of 100, which ranks the park in “fair” condition. Habitat fragmentation that is a result of residential, commercial, industrial,

and road development in the region is a key concern at Big Thicket.

ADJACENT LAND USE—URBAN ENCROACHMENT AND FRAGMENTATION ARE KEY CONCERNS

The Big Thicket of southeastern Texas once covered more than 3.5 million acres. Today, just a fraction of that original area remains. Intensive logging, oil and gas production, agriculture, and

Residential and commercial development often occurs directly adjacent to Big Thicket’s boundary. In this photo, a fence separates residential backyards from the Hickory Creek Savannah Unit of the preserve.

human settlement have changed the character of the ecoregion. Some of the last remaining parcels of diverse forests are protected within Big Thicket National Preserve, but activities on adjacent lands continue to threaten the resources the park was created to preserve.

Historically, timber companies owned much of the land surrounding Big Thicket National Preserve. Their lands created a relatively undeveloped buffer around the park that helped protect it, but in 2001 and 2002, two of the largest landowners, Louisiana-Pacific and International Paper Company, sold much of their land. About 2 million acres of land around the preserve have been sold. Much has been clearcut and subdivided, and some is already being developed.

The preserve has acquired some sensitive lands in recent years to help protect them from development. The Big Thicket National Preserve Addition Act of 1993 authorized the preserve to acquire lands along portions of Village Creek and the Neches River (about 11,000 acres). However, funds to acquire these lands have been slow in coming. Recent appropriations have allowed the park to acquire some areas, but additional funds are needed to buy the rest. This acquisition legislation was passed before large land divestitures by timber companies, and could not take into account the effects these changes in ownership would have.

The landscape around Big Thicket is changing as forested lands are clearcut, subdivided, and developed, and these changes are likely to continue as regional populations grow. Protecting additional sensitive lands before they are irreparably altered is critical to maintaining the integrity of the preserve's ecosystems.



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The landscape surrounding the preserve is rapidly changing. Sensitive habitats and visitor experiences along the boundaries of the preserve have been and will be affected as adjoining lands are cleared for a variety of purposes such as pastures and residential yards or are paved for commercial development. At this time, the preserve does not have the authority to purchase lands or hold conservation easements outside its boundaries, severely hampering efforts to protect Big Thicket National Preserve resources and those of the larger (but shrinking as development occurs) Big Thicket region. Park personnel need the authority to work with willing sellers or cooperators to conserve land along the boundaries of the preserve.

In spite of these difficulties, the park has had recent successes. In August 2004, the Conservation Fund, in collaboration with the Brown Foundation and Big Thicket Association, helped Big Thicket acquire almost 400 acres around the preserve's visitor center. Also in 2004, the Big Thicket Natural Heritage Trust donated more than 40 acres along Village Creek to the preserve. Though these acres are now protected from development, the 2 million acres that have been sold by timber companies are still at risk.

One timber company, Temple-Inland, has not sold large pieces of its land and has demonstrated an interest in maintaining much of its forested lands at this time. Big Thicket has a very good working relationship with Temple-Inland and is exploring ways to encourage the company to continue to manage (rather than sell) its lands adjacent to the preserve. As evidence of its land conservation ethic, Temple-Inland has applied to put about 12,000 acres adjacent to Big Thicket into a conservation easement through the U.S. Forest Service's Forest Legacy program. The preserve strongly supports this application and sees it as critical to protecting nearby sensitive habitat such as wetland pine savannahs, longleaf forests, and

pitcher plant bogs. Big Thicket hopes to continue to explore other potential cooperative efforts with Temple-Inland.

The importance of protecting sensitive adjacent lands cannot be overstated. Urban development that occurs right up to the park's borders has particularly profound effects on resource condition and visitor experience, in part, because the park is composed of 15 separate, relatively small units. Many of these units are also long and narrow, with high percentages of edge habitat. For example, the park encompasses little more than narrow corridors of land along the Neches River and Little Pine Island Bayou.

Development often occurs immediately adjacent to the park's border and is clearly visible from within the park, detracting from a sense of solitude and wilderness experience. For example, residential subdivisions occur along 12 miles of preserve boundary, while rural homesite developments occur along about 26 miles of boundary. Such development allows non-native plants and feral animals to move into the preserve; subjects the preserve to the potential drift of herbicides, pesticides, and fertilizers from residential and agricultural use; increases trash on the preserve borders; limits fire management options; further inhibits the natural movements of native animals; and accelerates forest edge effects by altering forested buffer lands.

Residential development of lands adjacent to the park is likely to increase given the continued population growth of the region, further underscoring the need to protect additional sensitive lands. The populations of Tyler, Polk, and Liberty counties, which contain parts of the preserve, increased by 25.4 percent, 34 percent, and 33.1 percent, respectively, between 1990 and 2000. Hardin County's population increased 9.6 to 15.1 percent from 1990 to 2000, with explosive growth occurring in and around Lumberton.

HIGHWAY 69 EXPANSIONS—PROJECT POSES CONCERNS FOR PRESERVE RESOURCES

U.S. Highway 69 runs north-south through east Texas, ending in Port Arthur, south of Big Thicket National Preserve. Near the preserve it is a two-lane highway with one segment that is a divided highway with two lanes of traffic in each direction. In 1997, the Texas Department of Transportation (TxDOT) initiated the U.S. 69 Corridor Study to evaluate designs for the construction of a 72-mile, four-lane divided highway from Lumberton north to Zavalla. Proponents of the new highway claim it will reduce traffic congestion and better provide for hurricane evacuation. The new highway will run through the geographic center of Big Thicket National Preserve and will bisect one unit of the preserve, raising concerns about effects on sensitive resources and visitor experience.

During the planning phase, the Park Service has officially commented on the project through direct communication with TxDOT, and has raised significant concerns about potential effects on preserve resources. The Big Thicket Association, a group devoted to protecting the region's resources, is concerned that the highway project will affect wetlands; impede wildlife movement; be a vector for invasive species; fragment habitat and isolate preserve units, making them ecologically unviable habitat for some species; be a source of noise and light pollution; affect soil quality; affect natural hydrology and water quality; and promote new development adjacent to the preserve.

TxDOT is currently conducting an environmental assessment (EA) to determine how the highway would affect the surrounding resources. The EA is scheduled to be available for public review during the fall of 2005. Should the EA identify significant effects on resources, TxDOT will be required to complete a more intensive environmental impact statement (EIS).

The Park Service has established a good working relationship with TxDOT, and has offered

IT IS ESSENTIAL
THAT TXDOT
THOROUGHLY
ANALYZE AND
MITIGATE ALL
IMPACTS OF
THIS PROJECT,
PARTICULARLY
FROM WILDLIFE
AND INDUCED
SPRAWL
ASPECTS.

Big Thicket is home to four kinds of carnivorous plants, including sundews. A keen eye and slow pace are needed to spot these tiny, brightly-colored plants.



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numerous suggestions for project improvements and alterations that would reduce the short- and long-term consequences of the highway on preserve resources and visitor experience. TxDOT has indicated a willingness to eliminate two harmful interchanges, use longer bridge spans to accommodate wildlife movement, employ low-noise road technology, use building materials that blend with the natural environment, and explore the development of sprawl-resistant interchanges and other project enhancements that may discourage development in sensitive areas adjacent to the preserve (particularly around the Hickory Creek Savannah Unit) and protect (or enhance) the visitor's experience.

The dialogue between TxDOT and Park Service staff is positive and encouraging and has produced a number of concessions that address Park Service concerns. It is essential that TxDOT thoroughly analyze and mitigate all impacts of this project, particularly from wildlife and induced sprawl aspects. TxDOT must carefully

consider the growing body of literature that addresses ways to limit the effects of such projects, and should acquire and donate strategic tracts of land to Big Thicket to reduce urban sprawl adjacent to the preserve.

VEGETATION—ELEVEN DIFFERENT PLANT COMMUNITIES CHARACTERIZE BIG THICKET

The Big Thicket region is home to an impressive array of about 1,300 species of trees, shrubs, forbs, vines, and grasses that are distributed as a function of climate, geography, soils, and land-use history. The preserve flora includes 26 ferns and allies, 20 orchids, and four of the five kinds of carnivorous (insect-eating) plants found in North America.

To understand the plant diversity found in Big Thicket, preserve staff use a classification system that divides the park into vegetation communities based on landscape position and community structure. Although this system is useful,

it was developed in the 1970s and concepts of vegetation classification have changed. The preserve needs new vegetation analysis and mapping to bring the classifications up-to-date.

Until that time, staff continue to use their current system, which identifies 11 vegetation types that reflect natural potential vegetation types, rather than actual vegetation types that are present in the park today. By determining what kinds of vegetation would be present naturally, preserve staff gain a better understanding of how human actions like fire suppression and logging have changed the region. For example, logging during the past century targeted most of the region's old growth forests. Longleaf pines, loblolly pines, and hardwoods were removed, and a different assortment of trees and shrubs replaced them, changing the character of the forest. Determining what the forests were like before logging helps preserve staff to restore them.

Big Thicket's 11 vegetation types are classified according to their upland, slope, floodplain, or flatland locations.

Upland Plant Communities

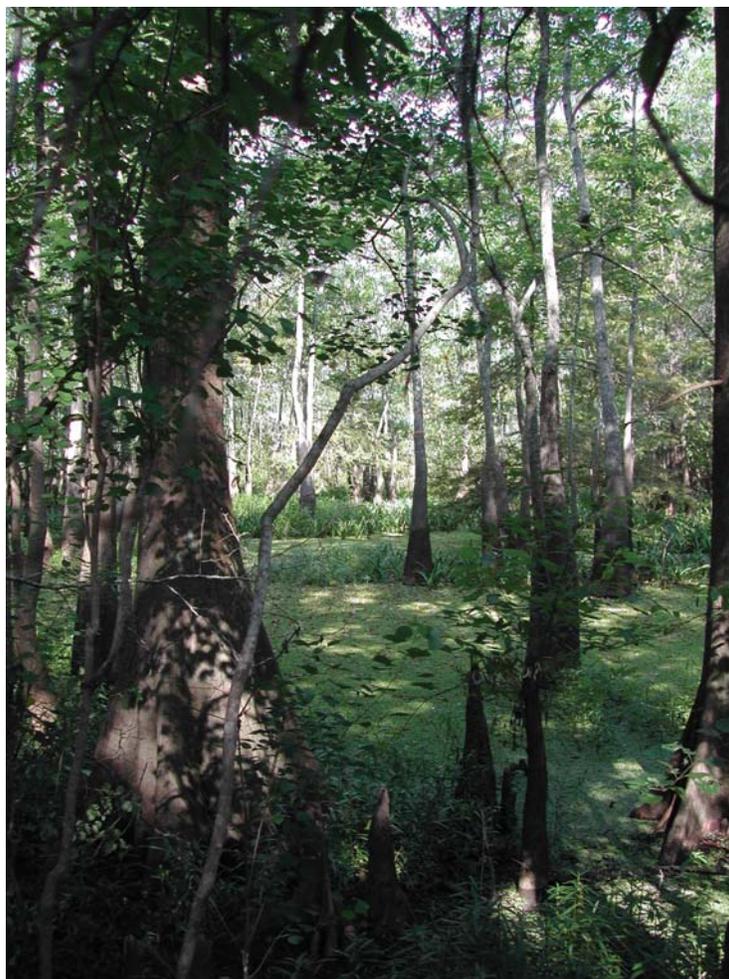
Upland communities include upland pine forest, sandhill pine forest, and wetland pine savannah. Well-drained uplands and ridges in the northern part of the Big Sandy Creek Unit are home to upland pine forests of longleaf pine (*Pinus palustris*), mixed with shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), blackjack oak (*Quercus marilandica*), bluejack oak (*Quercus incana*), and post oak (*Quercus stellata*). Grasses and forbs form an herbaceous understory in this fire-dependent community when fires occur at frequent intervals. Logging and fire suppression have compromised this system, resulting in the loss of many longleaf pines and the growth of shrubs that form a dense, woody understory.

Sandhill pine forests are rare, occurring along creeks and rivers. These low, open woodlands are characterized by an indistinct shrub layer;

exposed sand; and bluejack oak and post oak, with scattered longleaf, shortleaf, and loblolly pines. Because of low soil moisture, this community also supports a number of species adapted to dry conditions, including cacti and yucca.

Wetland pine savannahs contain the richest botanical diversity in the preserve with approximately 100 species of forbs per acre. These communities occur on poorly drained soils where water ponds seasonally, an environmental circumstance that is thought to inhibit tree growth. Scattered longleaf pines form the overstory, while shrubs include sweetbay magnolia (*Magnolia virginiana*), gallberry holly (*Ilex coriacea*), wax myrtle (*Myrica cerifera*), and titi (*Cyrilla racemiflora*). Orchids and insectivorous plants are usually common in the herbaceous layer along with sedges. Human settlement and fire suppression have dramatically altered the vegetation in wetland pine savannahs, and less

Cypress swamps were once found throughout the Big Thicket region, but now are extremely rare because of logging.



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than 3 percent of the original extent of this community type exists today. Preserve staff use prescribed burns and mechanical thinning to restore and maintain wetland pine savannas.

Slope Plant Communities

Increased soil moisture on slopes gives rise to three distinct vegetation communities: upper slope pine oak forest, middle slope pine oak forest, and lower slope hardwood pine forest. Moving down slope, longleaf pine increasingly gives way to loblolly and shortleaf pines, and southern red oak (*Quercus falcata*) is replaced by white oak (*Quercus alba*) on lower and wetter slopes. The herbaceous layer is sparse because of the well-developed canopies of the slope forests. Dominant shrubs are yaupon (*Ilex vomitoria*), flowering dogwood (*Cornus florida*), and beautyberry (*Callicarpa Americana*), with American holly (*Ilex opaca*), American hornbeam (*Carpinus caroliniana*), and horse sugar (*Symplocos tinctoria*) prevalent on middle and lower slopes. The understory on moister, lower slopes also includes sweetgum (*Liquidambar styraciflua*) and blackgum (*Nyssa sylvatica*).

These slope vegetation types are alternatively referred to as beech-magnolia-loblolly forests because of the presence of not only oak and pine species, but also abundant hardwoods like southern magnolia (*Magnolia grandiflora*) and

American beech (*Fagus grandiflora*). Because of the rarity of these forest types, the Texas Natural Heritage Program considers them imperiled. There is also new evidence that beech-magnolia-loblolly forests are declining, perhaps because of increasing summer temperatures that could be related to global climate change.

Floodplain Plant Communities

Big Thicket's four floodplain plant communities are: floodplain hardwood pine forest, floodplain hardwood forest, wetland baygall shrub thicket, and swamp cypress tupelo forest. Floodplain hardwood pine forests feature loblolly pine and American beech, with American hornbeam prominent in the understory. As floodplains increase in size, this vegetation type gives way to floodplain hardwood forests that include sweetgum and water oak (*Quercus nigra*) as the dominant tree species. This community type is found along the Neches River floodplain, most notably in the Jack Gore Baygall and Neches Bottom units.

Baldcypress (*Taxodium distichum*) and tupelo (*Nyssa aquatica*) are the dominant tree species of the swamp cypress tupelo forests found in secondary river and creek channels and along the edges of oxbow lakes and sloughs throughout the preserve. These primordial forested swamps were once found throughout the Big Thicket region, but now are extremely rare because of extensive cypress logging during the last century. A few stands of this forest type still exist in the preserve, representing much of the only remaining old-growth cypress in the region. Visitors can see this unique habitat along the cypress loop of the Kirby Nature Trail.

Wetland baygall shrub thickets are most extensive along the broad floodplain of the Neches River. Baygalls can also be found in wetland pine savannas and areas containing springs, seeps, and ponds. The term "baygall" is derived from sweetbay magnolia and gallberry holly, two dominant plants in these communities.

Dwarf palmettos lend a jungle-like feel to this hardwood forest in the Lance Rosier Unit.



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Flatland Plant Community

The flatland hardwood forest is also referred to as bottomland hardwood forest, and it may be endemic to the Big Thicket region. It occurs in flat, poorly drained areas where water forms ponds for significant periods of time. Dominant deciduous tree species include overcup oak (*Quercus lyrata*), willow oak (*Quercus phellos*), and laurel oak (*Quercus laurifolia*). Abundant sandy mounds also characterize this vegetation type and represent small, drier “islands” that often support loblolly pine. Dense thickets of jungle-like dwarf palmetto (*Sabal minor*) frequently dominate the understory.

FIRE MANAGEMENT—PRESERVE WORKS TO RESTORE VEGETATION COMMUNITIES

Fire played an important role historically in shaping the vegetation communities of the Big Thicket region. Regular fires and dense pine canopies prevented brush from becoming established in the forest understory, creating an open, park-like atmosphere of grasses and flowering plants beneath tall longleaf pines. Pine savannahs and sandhill communities relied on fires to prevent dense brush from becoming established and to prevent transition to hardwood species.

As Euro-American settlers moved to the region, some took advantage of the value of the tall, straight trees. Areas were clear-cut and left to regenerate, but the forests’ species composition changed as shortleaf and loblolly pines grew in faster than longleaf pines, and brush species filled the understory. Timber companies planted loblolly and slash pines instead of longleaf pines because they grew faster and could be harvested sooner, further changing the forests’ composition.

Fire suppression became common practice as settlement of the Big Thicket region increased. Regular fires no longer influenced vegetation communities, and natural succession processes were disrupted. Because of logging



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and fire suppression, longleaf pines have largely been replaced by loblolly pines, yaupon and other brush species are common, and the diversity of plant and animal species has declined. Today’s longleaf pine forests represent less than 3 percent of the acreage that was present historically, and this forest type is considered to be globally threatened.

Within Big Thicket National Preserve, there are about 13,500 acres that contain fire dependent communities. In efforts to return fire to the region and help restore natural vegetation in these communities, Big Thicket initiated a fire management program and began conducting prescribed burns in 1982. Staff have burned 25 treatment areas, some as many as nine times in

Park staff use prescribed burns to help restore forests to more natural conditions.

PARTNERS HELP RESTORE HABITAT

In an innovative partnership, the preserve worked with The Nature Conservancy and Temple-Inland, a forest products company, to restore longleaf pine to 51 acres of a former slash pine plantation in the Turkey Creek Unit of Big Thicket. The Nature Conservancy and Temple-Inland removed about 80 percent of the existing non-native slash pines and sold the timber, with sale proceeds assisting additional restoration work. Big Thicket staff burned the site after the slash pine was removed, and The Nature Conservancy and AmeriCorps volunteers planted longleaf seedlings. Preserve staff hope to expand this partnership project to include other areas within the preserve suitable for restoration.

Big Thicket continues to partner with Temple-Inland on a number of other projects. The company participated on an interdisciplinary team that helped develop the preserve's new fire management plan; provided input on the management of feral hogs; converted another slash pine plantation next to the preserve to longleaf pine; has proposed conservation easements; and routinely seeks preserve staff input on the desired condition of forest stands along Village Creek and Big Sandy Creek. Temple-Inland's conservation-minded assistance has proven critical to protecting lands within and outside the preserve boundary.



Before restoring native longleaf pines to part of the Turkey Creek Unit, Big Thicket partnered with Temple-Inland and The Nature Conservancy to remove non-native slash pines.

the last 23 years. The Big Thicket fire management team's hard work has resulted in some longleaf pine regeneration, brush control, and the initial return of a limited array of grasses and forbs to the forest understory. Preserve staff have done a remarkable job, particularly considering the lack of support for the fire management program during its early years, but there is still much restoration work to be done. Big Thicket is in critical need of staff botanists and restoration specialists to assist with continued efforts.

Regular fires and longleaf pine restoration are also important for the continued survival of the federally listed endangered red-cockaded woodpecker (*Picoides borealis*), which prefers to nest in longleaf pines in mature forests. These birds were once found throughout the southeastern United States, but logging, conversion of forests to agriculture, and fire suppression have dramatically reduced the amount of suitable habitat. Now an estimated 12,500 red-cockaded woodpeckers live in forested areas that represent just 1 percent of the species' original range.

NATIVE SPECIES—REINTRODUCTIONS COULD HELP RESTORE EXTIRPATED SPECIES

By virtue of its diverse habitats that range from sandhills to swamps, Big Thicket National Preserve is home to a wide array of wildlife. About 60 mammal species are found in the park, in addition to 92 reptile and amphibian species, more than 1,800 invertebrate species, 97 fish species, and 176 bird species. The park probably hosts even more bird species because of its position along a migratory flyway; a comprehensive study is needed to determine the actual number of bird species that use park resources. Big Thicket is also home to a number of state and federally listed threatened and endangered species, as well as species of concern.

Predators such as ocelots, black bears, jaguars, and red wolves used to inhabit the Big Thicket region, but habitat fragmentation and hunting contributed to their extirpation. Regional



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resource managers have been studying the possibility of reintroducing the Louisiana subspecies of the American black bear (*Ursus americanus luteolus*) to the area. Although the preserve is probably too small to act as a primary reintroduction site, bears brought to the region could use parts of the preserve and its resources. However, a lack of funds has stalled reintroduction efforts in east Texas for now. In addition, not enough individuals of this subspecies of bears are available to support reintroduction efforts at this time. In the meantime, resource managers are working to educate the public about the bears and possibly garner additional support for reintroduction efforts in the future.

The Texas Parks and Wildlife Department reintroduced eastern wild turkeys to the Turkey Creek, Big Sandy Creek, and Lance Rosier units

of Big Thicket in 1994. The birds had been nearly extirpated from the region by hunting by 1900. Park staff do not know how many turkeys survived and are now living in the preserve.

Texas trailing phlox (*Phlox nivalis* ssp. *texasensis*), a federally listed endangered plant, had a historic range of only three east Texas counties. Habitat destruction as a result of logging decimated phlox populations. In conjunction with Stephen F. Austin State University and Texas A&M University, Big Thicket is reintroducing the plant to the Big Sandy Creek and Turkey Creek units of the preserve. In February 2005, 200 phlox were planted in the Big Sandy Creek Unit, and an additional 600 plants will be planted in winter 2005. Reintroductions in Big Thicket are a vital part of meeting recovery plan goals for this species.

In conjunction with Stephen F. Austin State University and Texas A&M University, Big Thicket is reintroducing Texas trailing phlox, a federally listed endangered plant, to the Big Sandy Creek and Turkey Creek units of the preserve.

NON-NATIVE SPECIES—DAMAGE TO PRESERVE RESOURCES DOCUMENTED

Non-native species that pose threats to Big Thicket's natural resources range from aggressive plants to highly destructive feral hogs, and also include insects and invasive aquatic plants. Invasive non-native vegetation has increased in the past years because of the highly fragmented nature of the preserve, which is crossed by numerous pipelines, road corridors, and river channels. Invasives are among the greatest threats to the ecological integrity of the preserve. Problematic species include Chinese tallow tree (*Sapium sebiferum*), Japanese honeysuckle (*Lonicera japonica*), Chinese wisteria (*Wisteria sinensis*), and Japanese climbing fern (*Lygodium japonicum*). New non-natives recently found in the preserve include Chinaberry (*Melia azedarach*) and coral ardisia (*Ardisia crenata*). Water hyacinths (*Eichornia crassipes*), aquatic invasives of particular concern, are prolific and getting worse. Also near the preserve, but not yet found within the boundaries, is giant salvinia (*Salvinia molesta*).

The Park Service's Gulf Coast Exotic Plant Management Team is based at Big Thicket National Preserve, and is active in locating and working to control non-native plants. However, the team is also responsible for non-native plant management in seven other

Japanese climbing ferns are one of Big Thicket's problematic non-native species.



TED BOONER/SOUTHERN WEED SCIENCE SOCIETY/INVASIVE PLANTS OF THE EASTERN UNITED STATES CD-ROM

regional parks, and has limited time to spend on projects in Big Thicket.

One of the most damaging non-native animals is feral hogs (*Sus scrofa*)—both in terms of their raw habitat-altering impact and the challenge to control them. An estimated 2 million feral hogs range over the state of Texas—nearly half of the entire U.S. population of feral hogs. The term “feral hog” applies to domestic hogs that were released or escaped to the wild (feral), Eurasian wild boars, and hybrids of the two. Brought to the United States with early explorers and settlers and first introduced to Texas in the 1680s, Eurasian wild boars are now quite rare, but hybrids resulting from mating with feral domestic hogs and their descendants are prolific, and their numbers have increased dramatically in the past decade. Although their total population in Big Thicket National Preserve is uncertain, feral hogs are now estimated to directly affect 5 percent of parklands, with some individual park units having as much as 8 percent of their acreages disturbed.

Feral hogs are omnivorous and have voracious appetites. They compete with native wildlife for food, and they can root-up large areas literally overnight. Feral hogs are known to eat acorns, tubers, fruits, insect grubs, carrion, amphibians, reptiles, eggs, birds, and arthropods (especially beetles) and can prey on the young of many mammals. Because they can be carriers of a host of diseases and parasites such as brucellosis, tuberculosis, plague, and anthrax they also represent a health hazard to native wildlife, domestic animals, and even humans. Control efforts for feral hogs in the preserve include permitted hunting. Preserve staff are currently in the process of preparing a feral hog management plan that will include more options for the control of these non-native threats.

Feral cats and dogs—strays or abandoned animals that have entered the preserve from adjacent lands and become self-sufficient—are

also of some concern at Big Thicket National Preserve because of competition for resources and habitat degradation.

Fire ants, another non-native species, have become well established in southeast Texas and invaded the preserve about 20 years ago. But because much of Big Thicket is wet, fire ants are not a major concern. When present, they directly affect native ants, other insects, reptiles, and ground-dwelling birds by swarming, biting, and often killing. They also represent a hazard to humans as their bites are highly painful and can cause serious reactions. Although pesticides can temporarily reduce fire ant populations, control is not effective unless the chemicals are used frequently over large areas.

Southern pine beetles (*Dendroctonus frontalis*) are cyclic forest pests that can kill mature trees. During the 1990s, infestations of southern pine beetles in Big Thicket totaled more than 2,500 acres.

OIL AND GAS DEVELOPMENT— ACTIVITIES MUST NOT IMPAIR PRESERVE'S RESOURCES

Oil and gas production in the Big Thicket region dates back to the beginning of the 20th century, when oil was discovered at Spindletop, Sour Lake, Saratoga, and Batson. By 1902, 285 active oil wells were operating at Spindletop, and oil companies were being formed seemingly overnight. Several of them such as the Texas Company (Texaco), J.M. Guffey Petroleum Company (Gulf), Magnolia Petroleum Company (Mobil), and Sun Oil Company (Sunoco) are industry giants today.

Early oil exploration initially concentrated at the southern edge of the Big Thicket region, pushed north and east in the 1930s, and by the 1950s much of the future national preserve was home to some level of oil and gas activity. Between 125 and 155 wells were drilled within the boundary of the future preserve. When the preserve was established, subsurface mineral rights were privately-held and the federal gov-



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ernment did not acquire these rights. Oil and gas exploration and extraction are still allowed in the preserve, under the management of preserve staff who are required to ensure that such activities will not compromise the values for which the preserve was established.

Today there are nine non-federal oil and gas operations within the preserve, 34 directional wells that were drilled from outside the preserve to locations beneath the preserve, and 57 oil and gas pipeline segments that run through the preserve. Big Thicket continues to get requests for oil and gas activities within the preserve, and staff recently drafted an Oil and Gas Management Plan to comprehensively address these activities.

Continued oil and gas exploration and production within the preserve are of concern for multiple reasons. Spills can contaminate waters and soils; air quality can be affected by increased vehicle traffic and accidental releases of volatile chemicals; vehicle and foot traffic can compact soil and change natural drainage patterns; wildlife movements and feeding and nesting activities can be disrupted; and vegetation must be cut or cleared along survey or seismic lines and pipelines and on drilling pads. Visitor

Water hyacinth, an invasive species that is a problem throughout the southeastern United States, is prolific at Big Thicket and getting worse.

ELIZABETH MEYERS



Evidence of illegal dumping in the Neches River and other preserve waterways is prevalent, but apprehending and prosecuting offenders is difficult, in part, because the preserve does not have enough law enforcement staff.

experiences and natural quiet can also be negatively affected by oil and gas activities within the preserve. First and foremost, preserve staff are obligated to protect “preserve resources, visitor use and experience, and human health and safety” and prevent “impairment to preserve resources and values.”

PROHIBITED ACTIVITIES—POACHING, ILLEGAL DUMPING, AND ALL-TERRAIN VEHICLE USE DIFFICULT TO CONTROL
 Because of the shape and distribution of Big Thicket’s 15 separate units, the preserve has about 530 miles of boundary—more than Yellowstone National Park. This allows easy access to park resources, and poaching, illegal dumping in the Neches River, and off-road vehicle use are common problems.

Hunting is allowed in six of the preserve’s units, but hunters must first obtain a free permit and register to hunt in just one of the units. The only animals that can be taken are white-tailed deer, squirrel, rabbit, wild/feral hog, and waterfowl. Though plenty of permits are available, park staff frequently discover hunters with deer and other animals that they have taken without a park permit or that they have taken illegally from private land without a hunting lease. In addition to wildlife poaching, illegal fishing is a problem along the Neches River. Two main infractions involve using electric shocks to immobilize fish and taking more fish than allowed.

Curbing poaching is difficult for many reasons: the preserve does not have the funds to continually re-mark its boundary, leading to

confusion about what lands are within the preserve; illegal hunting fines within the preserve are low compared to state fines; and the preserve has just four law enforcement officers, with only three of them available to patrol all 15 units. These units are located in parts of seven counties and are dispersed over 1,885 square miles of southeast Texas. Big Thicket used to have 11 law enforcement rangers and could work on special projects aimed at halting illegal activities, but staff reductions means these efforts are no longer possible. According to Big Thicket's law enforcement needs assessment, the preserve needs at least 16 law enforcement rangers to adequately protect visitors and resources. Increased funding for additional rangers to patrol the preserve and heftier poaching fines would go far in deterring people from illegal hunting.

Plant poaching is a problem in many national parks where sensitive species like ginseng and ornamental cacti are targeted, but Big Thicket does not have any evidence of plant poaching within its borders. However, the preserve is home to many mushroom species that could be potential targets.

In addition to poaching, illegal dumping in the Neches River and preserve streams is also a primary concern. Appliances, old cars, trash, and household items are often stored on the riverbank by people who live nearby and erosion causes them to fall into the river. Sometimes these items are intentionally dumped into the river. Though evidence of illegal dumping is present, catching offenders is difficult because most dumping occurs at night or in secluded areas. Prosecuting cases is also a challenge. Preserve staff partner with investigators from the Texas Parks and Wildlife Department, the Texas Commission on Environmental Quality, and county law enforcement officers, but these agencies have limited staff and must be selective about which dumping cases to pursue.

Local media recently helped the preserve

publicize the importance of the issue by focusing attention on a case where construction materials from a local remodeling project were intentionally dumped into the river. This coverage made local residents more aware of the problem and the consequences of illegal dumping.

All terrain vehicles (ATVs) are not allowed in Big Thicket, but evidence of illegal use is found in the Lance Rosier Unit of the preserve. It is difficult to catch offenders, and the \$100 fine is too low to effectively deter repeat offenses.

NATURAL RESOURCES RESEARCH— FUNDING LIMITS WORK

Bird watching is a popular activity at Big Thicket, drawing thousands to the preserve each year to spot migrants and local favorites such as Bachman's sparrow (*Aimophila aestivalis*). Though birds are some of the preserve's most visible wildlife, they have not been extensively studied. Preserve staff recently initiated a mist-netting and bird-banding station as part of the Institute for Bird Population's MAPS program. Data from this project will help resource management staff better understand the population dynamics of the preserve's breeding bird populations and better manage preserve resources. Big Thicket is borrowing research equipment from San Antonio Missions National Historical Park this year, but funds to buy equipment for the preserve are needed to continue the project.

If funds were available, a number of other natural resource projects would yield useful information for resource managers. For example, Big Thicket has diverse vegetation communities, but there are no maps that accurately depict vegetation types throughout the park. Feral hogs roam the park and are known to eat just about anything, but staff do not have quantitative data showing how hogs affect rare plants and orchids. Between 125 and 155 oil wells have been drilled in the preserve, most of which were plugged and abandoned before the preserve was established, yet staff do not know the extent of soil and water

contamination at most of these sites. Only four of the abandoned sites have been tested, and all four showed metal and lead contamination exceeding state of Texas standards.

In addition to funding constraints that limit research projects, the preserve suffers from a staff shortage. The natural resources staff includes a chief of natural resources, an oil and gas specialist, and a newly hired biologist. Seven or eight full-time staff and about four seasonal staff work with the park's fire management program. The Gulf Coast Exotic Plant Management Team is based at Big Thicket, but works at a number of other regional parks. A staff person with experience in geographic information systems is needed to organize, maintain, and make accessible the park's digital data, and two or three biological technicians are needed to do monitoring, bird counts, and collect other data. In addition, the park needs a botanist to ensure the diversity of flora is adequately protected and managed.

Although the preserve does not have the funds or staff needed to conduct all the research necessary to fully understand resources, it benefits from work done by researchers from Rice, Lamar, Texas A&M, and Stephen F. Austin State universities. In particular, studies of Big Thicket's forest vegetation and rivers and streams have helped staff identify management concerns and provided the information needed to shape management strategies. Two long-term study plots in the Turkey Creek and Neches

Bottom units are the preserve's oldest such plots, and are among the oldest active permanent study plots in the National Park System.

The preserve should continue to encourage researchers and graduate students from local universities and other organizations to take advantage of the many research opportunities available at Big Thicket. In cooperation with the Big Thicket Association, the preserve operates a research station in Saratoga that includes accommodations for individuals and teams conducting research or making field observations in the preserve. The facility is currently under-used, as the preserve only receives about six to ten research requests each year. The preserve must boost its visibility and market the countless research opportunities available to maximize use of the research station. Graduate student research projects in the preserve have the potential to provide learning experiences for students and valuable resource information for preserve managers.

WATER RESOURCES—RENEWED MONITORING EFFORTS IMPORTANT

Rivers, streams, creeks, and other waterways are at the heart of Big Thicket. The Neches River flows through several preserve units, and much of Little Pine Island Bayou is part of the preserve, as are parts of Turkey, Village, Menard, Beech, Little Beech, and Big Sandy creeks. In sum, the preserve contains more than 250 miles of waterways. The health of these waterways is critical to the condition of park resources, including vegetation communities and dependent wildlife. Big Thicket's waters are affected by activities both outside and inside the preserve. As mentioned previously, illegal trash dumping is a problem, and so are contamination from sewage discharge, oil and gas production, timber harvesting, and agricultural runoff.

The preserve initiated a water quality monitoring program in 1984 that included sampling at 21 stations. Data was regularly collected until 1994, but Big Thicket staff have not measured

This research station, located near the Lance Rosier Unit, is available to researchers working in Big Thicket.



MAXINE JOHNSTON

PROPOSED DAMS THREATEN PRESERVE RESOURCES

The Neches River, which flows for 85 miles through Big Thicket National Preserve, is critically important to the health of wildlife and preserve habitat. Two dams upstream of the park have altered the flow of the Neches River and changed its flood regime, causing changes in floodplain forest communities.

New reservoirs proposed for the Neches River north of Big Thicket could significantly affect the preserve if water is diverted and the beneficial effects of periodic flooding are eliminated or reduced. At least two new reservoirs are being considered for the Neches River; if built, they could divert water that currently flows through the preserve, disrupting native plant communities, affecting wildlife, and compromising recreational opportunities.

The City of Dallas is considering building a new dam and reservoir to supply water to the city. The proposed Fastrill Reservoir would compromise water flows and habitat quality in Big Thicket National Preserve, and it would also inundate an estimated 27,000 to 32,000 acres of prime hardwood bottomland habitat currently being studied for inclusion in the proposed Neches River National Wildlife Refuge.

The land that would be flooded by the new dam also provides potential habitat for the threatened Louisiana black bear, which some wildlife managers hope to reintroduce to parts of east Texas. A new reservoir would further reduce already limited bear habitat. In addition, the reservoir would flood the debris field of the wreckage of the space shuttle *Columbia*.

A coalition of groups led by the Texas Committee on Natural Resources opposes the new reservoir and has been working to convince Dallas City Council members to focus on water conservation and existing



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water sources to satisfy the future needs of the city.

Discussion concerning the Rockland Dam, which was first proposed in the 1940s, also continues to surface. This project would flood at least 125,000 acres along the Neches River about 25 miles upstream of Big Thicket National Preserve. In 2001, the Park Service contacted the Texas Water Development Board to express concerns about how the proposed Rockland Dam would affect Big Thicket's resources. The Park Service cited potential effects related to changes in the timing and volume of river flows, floodplain contraction, changes in species composition within the river and floodplain, loss of natural areas that would be inundated by the new reservoir, and the loss of recreational opportunities.

New reservoirs proposed for the Neches River upstream of Big Thicket would disrupt vegetation communities, affect wildlife, and compromise recreational opportunities.

RECENTLY COMPLETED PERMANENT SALT WATER BARRIER HELPS PROTECT NECHES RIVER AND PINE ISLAND BAYOU

Water quality in Big Thicket was degraded historically by saltwater that flowed upstream from the Gulf of Mexico when flows in the Neches River and Pine Island Bayou systems were reduced by drought and increased water demands for agriculture and other uses upstream. To prevent saltwater contamination, the Lower Neches Valley Authority periodically constructed temporary saltwater barriers. However, these barriers presented new problems.

Saltwater from the Gulf of Mexico and waste effluents from downstream backed up against the barriers, creating a large effluent holding lake where saltwater and pollutants were concentrated. These pollutants included discharges from petrochemical plants and a large paper mill as well as poorly treated municipal sewage. The waste-laden waters would readily become deoxygenated over the dry season, killing most organisms trapped there. In 1976, the tidal Neches River was designated as the second-most polluted waterway in the state and the estuary was considered highly stressed because of the extremely low density and diversity of common estuarine species. Federal and state regulatory authorities in the 1970s ordered significant wastewater and municipal upgrades and a 96 percent reduction in the permitted waste load. Conditions improved dramatically, and in 1986 the designation of the Neches was changed from non-contact recreation to contact recreation.

Even with improvements in water quality, the temporary barriers were expensive, obstructed boat navigation, prevented fish migration, and caused shoreline to erode in Big Thicket. To address these issues, in 2003 the Lower Neches Valley Authority completed a permanent saltwater barrier with a navigation lock just downstream of Big Thicket, below the confluence of Pine Island Bayou and the Neches River. The new barrier prevents saltwater from traveling upstream, while ensuring that enough freshwater is allowed to flow downstream.

water quality parameters regularly since that time because of funding and staffing shortages.

In 1995, the Park Service Water Resources Division (NPS-WRD) issued a baseline water quality report for Big Thicket that presented surface water quality data obtained from the Environmental Protection Agency's (EPA) databases. This study analyzed and summarized 40,043 observations for 493 parameters collected from 41 monitoring stations in and around Big Thicket over the period 1959 to 1993. Of the nine stations where long-term, multiple observations were made, only two were within preserve boundaries, both on the Neches River at Evadale and at U.S. Highway 96, east of Silsbee.

Collectively, the baseline analysis yielded 15 parameters that exceeded screening criteria (EPA and NPS-WRD threshold standards) at least once within the study area. Those parameters found to exceed EPA chronic or acute criteria for the protection of freshwater aquatic life included dissolved oxygen, pH, chloride, and several metals (cadmium, copper, lead, silver, zinc and mercury). EPA standards for drinking water were exceeded for sulfate, cadmium, chromium, lead, nickel, silver, and mercury. In addition, total and fecal coliform concentrations and turbidity exceeded the NPS-WRD screening limits for primary-body contact recreation and aquatic life. Although discrete water quality concerns and some exceeded pollutant criteria were observed at multiple stations within and outside the park, the most consistent and chronic problems were associated with the Pine Island Bayou system and to a much lesser extent the Sabine-Neches Estuary and the Neches River, east of Silsbee at Highway 96.

Rather than indicating widespread general conditions, these findings and the bulk of surface water quality concerns observed reflect localized impacts of human activities within the watershed but outside the preserve. Sewage treatment plant discharge and septic tank



usage, oil and gas production, timber harvesting, and agricultural practices on surrounding and upstream lands were all cited as potential pollution sources.

Another more recent study that focused on Big Thicket's major drainages found that water quality in Big Sandy Creek, Turkey Creek, Village Creek, and the Neches River was generally good, but that water quality in Pine Island Bayou was impaired for much of the year. Elevated nutrient levels in Pine Island Bayou, primarily nitrates and ammonium that likely came from agricultural practices, led to plankton blooms followed by chronically low levels of oxygen in the water, especially during periods of low water flow. The study also indicated that the chronically low dissolved oxygen condition in the Pine Island Bayou system has worsened

over time, and that ammonium concentrations have increased significantly throughout the preserve since the 1995 NPS-WRD baseline study, likely as a result of accelerating agriculture and the associated increased use of fertilizers. Although modest by comparison to the Pine Island Bayou, algal blooms also occur on the Neches River. However, higher flow through this large alluvial system coupled with considerably lower nitrate and ammonium levels prevent severe lowering of dissolved oxygen.

Because large portions of the preserve are centered around rivers and streams, a renewed effort to establish a long-term water quality monitoring program is critical. Big Thicket will likely resume a water quality monitoring program as part of the Park Service inventory and monitoring network's vital signs monitoring program.

Water quality in the Neches River is affected the most by human activities such as sewage treatment plant discharge and septic tank usage, oil and gas production, timber harvesting, and agricultural practices that occur outside the preserve.

AIR QUALITY—PRESERVE LACKS MONITORING PROGRAM

Big Thicket National Preserve is northeast of the Houston/Galveston airshed and just north of the Beaumont/Port Arthur/Orange airshed, two of the most polluted airsheds in Texas and among the state's five non-attainment areas where pollutant levels exceed National Ambient Air Quality Standards. The prevailing air flow is from the southeast and the Gulf of Mexico, placing the preserve immediately downwind of the heavily industrialized Port Arthur area. It shifts to a westerly flow during the winter months. Inshore/offshore flows from the Gulf of Mexico affect the southern portions of the preserve and are of particular concern because they carry atmospheric pollutants from the industrial and urban areas immediately to the

south. Pollutants that originate at the Lake Charles, Louisiana, petrochemical complex some 60 miles east of the preserve might also affect Big Thicket.

Ground-level ozone is a concern at Big Thicket, which is within the ozone non-attainment area of Hardin, Liberty, Orange, and Jefferson counties. Sunlight causes pollutants like nitrous oxides to react and form ground-level ozone, which damages some plants and is a health hazard for humans and wildlife. While ozone is not measured at any sites within the preserve, data from a monitoring station in nearby Beaumont indicate that Environmental Protection Agency standards are commonly exceeded during the summer months. New or expanded oil and gas production near Big Thicket is a concern because this industry emits sulfur dioxide, nitrous oxides, and volatile organic compounds that further contribute to ground-level ozone formation and are transformed to fine particulate matter, which scatters light and reduces visibility.

Although Big Thicket has no ongoing air quality monitoring program, it participated in a special study conducted by the Texas Commission on Environmental Quality in 1996 aimed at defining atmospheric pollution vectors and associated visibility reduction for the Big Bend area of southwest Texas. Of the 18 sites in the United States and Mexico that were monitored in this study, Big Thicket had the highest levels of fine particulate matter.

Big Thicket needs funds to establish an air quality monitoring program to measure levels of particulate matter, sulfur dioxide, ozone, and nitrous oxides, and to collect visibility and climatological data. This information is critical to an understanding of air pollution and associated impacts at the preserve. Data from established monitoring locations outside Big Thicket may not provide an accurate representation of air quality within the preserve. Instead, multiple monitoring stations located throughout the preserve would provide more reliable data.



JIM NATIONS



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CULTURAL RESOURCES— RESOURCES SUFFER FROM LACK OF STAFF

Big Thicket scored an overall 42 out of 100 for **cultural resource** conditions, including archaeology, cultural landscapes, history, historic structures, archival and museum collections, and ethnography (peoples and cultures). This score indicates that the preserve’s cultural resources are in “poor” condition. The scores for cultural resources are based on the results of indicator questions that reflect the National Park Service’s own Cultural Resource Management Guideline and other policies

related to cultural and historical resources.

The primary challenge to cultural resources stewardship at Big Thicket is the preserve’s lack of any cultural resource specialists. As a result, cultural resources do not get adequate attention, and many are at risk of deteriorating. For example, some museum collection items are inappropriately stored in cardboard boxes in several locations within preserve facilities, while the exact locations and conditions of others are unknown. Until the preserve has funds to hire a staff person with cultural resources training, these resources will not receive proper care and they will not be adequately interpreted for visitors.

Preserve staff would like to study recently discovered mounds, which could be pre-historic, but funds have been denied so far.

BIG THICKET
DOES NOT HAVE
A CULTURAL
ANTHROPOLOGIST
ON STAFF,
AND FUNDING
SHORTAGES MAKE
IT NEARLY
IMPOSSIBLE FOR
REGIONAL PARK
SERVICE STAFF
TO PROVIDE
TRAINING AND
CONSULTATION ON
A REGULAR
BASIS.

ETHNOGRAPHY (PEOPLES AND
CULTURES)—ETHNOGRAPHIC
OVERVIEW AND ASSESSMENT NEEDED

Before Big Thicket became a national preserve, many groups of people lived on and used the resources of the land, including the Atakapa, Caddo, Creek, Alabama, and Coushatta American Indian tribes; Euro-American settlers; and people associated with the creation of the preserve. Now that the Park Service manages the land, staff have a responsibility to foster relationships with people who were traditionally associated with the land and protect the resources that are important to them.

Big Thicket staff have identified and built relationships with associated ethnographic communities, but staff have not identified associated ethnographic resources within the preserve. In order to identify cultural and natural resources that have special importance for associated peoples, the preserve needs an ethnographic overview and assessment. This research would help Big Thicket and regional Park Service staff ensure that important resources are not being degraded and would guide management priorities.

Big Thicket does not have a cultural anthropologist on staff, and funding shortages make it nearly impossible for regional Park Service staff to provide training and consultation on a regular basis. As a result, the preserve is unable to meet most Park Service ethnographic management guidelines and provide full protection for ethnographic resources.

ARCHAEOLOGY—PRESERVE LACKS
SYSTEMATIC STUDIES

Both prehistoric and historic archaeological resources have been unearthed at Big Thicket to date, and they include lithic scatters, homesteads, cabins, shipwrecks, ferry sites, and mill locations. Some of the sites are potentially eligible for the National Register of Historic Places, but none have been for-

mally nominated. Evaluation for the National Register is a two-part process: first there is an initial field appraisal, and then there is a more formal evaluation involving the state historic preservation office. Funding and staffing shortages at Big Thicket have prevented the preserve from completing the second part of the process.

According to Big Thicket's "Gazetteer" of archaeology—a compilation of all known archaeological work that has been done in the park—there are 91 known archaeological sites, but the Park Service's Archaeological Sites Management Information System (ASMIS) only lists 21 sites in the preserve. Work is needed to update ASMIS with all known sites, and condition assessments are needed for all identified sites.

Most archaeological work in Big Thicket is conducted in conjunction with oil and gas exploration and production. Although oil and gas development is allowed in Big Thicket according to certain guidelines, preserve staff must first ensure that these activities will not damage cultural resources. Research is done to locate archaeological sites so that they can be avoided during oil and gas exploration and production. As a result of this compliance work, additional archaeological sites are frequently discovered. However, new discoveries are limited to areas where oil and gas development will occur, and research is not directed at answering specific questions or developing the prehistoric and historic archaeological context of the preserve. To gain a full understanding of the breadth of archaeological resources in Big Thicket, the preserve needs an archaeological overview and assessment.

Big Thicket does not have funding to support permanent on-site archaeological staff. Instead, the Park Service's regional office handles research and planning, and consultants do some work. Consultants recently created a model to predict the locations of archaeological



MAXINE JOHNSTON

sites throughout the preserve. This model could be used to build a sample survey of Big Thicket, and along with an archaeological overview and assessment, would aid in overall project planning. The preserve has applied for funding to complete these projects from the System-Wide Archaeological Inventory Program (SAIP), but only \$350,000 is available each year for projects in the region. There are nearly 90 parks competing for these funds, and just two or three receive funding at any one time.

Big Thicket recently requested funding to investigate newly discovered mounds, which are likely prehistoric and could hold rich archaeological information. No funds were awarded in the most recent funding cycle, but the preserve will likely continue to pursue opportunities to investigate these mounds.

CULTURAL LANDSCAPES—ADJACENT DEVELOPMENT THREATENS LANDSCAPES

Cultural landscapes tell the stories of how people lived on the land and used its resources. Evidence of human occupation of the Big Thicket region dates back at least 8,000 years. Several American Indian Tribes are tied to the region, including the Atakapa, Caddo, and Creek tribes, and the Alabama and Coushatta tribes have a reservation next to the preserve's Big Sandy Creek Unit. Both French and Spanish explorers had influence in the area, and logging camps, mills, homesteads, ferry crossings, and trails remain from the mid-19th century "Americanization" of the region.

Big Thicket has not been inventoried for cultural landscapes, and the number of land-

Early oil and gas development is a major part of the human history of the preserve region and needs to be interpreted, yet this type of development poses a significant threat to the landscapes and other resources of the preserve today.

A Park Service team photographed this abandoned farmhouse in the late 1960s during a study of lands suggested for inclusion in the proposed new national park.

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scapes is unknown. The Park Service Cultural Landscape Inventory indicates that there could be as many as 15 potential cultural landscapes in the preserve that have not been comprehensively identified. A cultural landscape inventory is needed, but funding and staffing constraints at the preserve and at the Park Service regional office limit work.

Early oil and gas development and timber harvesting practices form a significant portion of the human history of the preserve region and need to be interpreted, yet these same activities pose the most significant threat to the landscapes and other resources of the preserve today. Residential, commercial, and industrial development on adjacent lands also threaten park resources. As land within the preserve is altered by oil and gas development and land next to the preserve is developed, cultural and natural resources are affected. Acquiring sensitive lands next to Big Thicket is necessary to help protect the historic landscape and its associated resources.

*HISTORIC STRUCTURES—
INTERPRETATION OF THE PRESERVE'S
FEW REMAINING STRUCTURES NEEDED*
Pioneer homesteads, mills, and railroad routes are examples of the kinds of historic structures

that remain in the preserve and the surrounding Big Thicket region. A preserve survey done in the late-1970s documented about 150 existing structures and determined that none was eligible for the National Register of Historic Places. Very little work on historic structures has been done since this initial survey, and as a result, it appears that many structures have either been removed or have completely deteriorated.

Remaining structures include the Staley Cabin, the Voth Mill, and the Mitchell Farm. The Staley Cabin, the former home of Jimmy and Elda Staley, served as the preserve's visitor center until the completion of a new visitor center in 2001. Today the cabin serves as the preserve's Environmental Education Center. Schoolchildren have the opportunity to participate in natural resource programs, and they can learn about the preserve's human history by handling items such as a spinning wheel and logging, farming, and oil field implements. Although the Staley Cabin is likely Big Thicket's best-preserved historic structure, renovations have compromised its character.

The Voth Mill was a very large early-20th century lumber mill located near the town of Beaumont. Today only a few structures remain. The Mitchell Farm, located in the Lance Rosier unit, was home to the Mitchell family and their African-American slaves. The site was evaluated by cultural resources consultants in 1999 and was determined to be eligible for the National Register of Historic Places. This homestead is now considered a historical archaeological site, and should be formally nominated to the National Register.

Other historic structures and a potential cultural landscape located near Big Thicket but outside its boundaries, is a historic railroad route along "Ghost Road." The road got its name from unexplained floating lights sometimes seen by visitors. The Big Thicket Association has expended considerable time and effort working with local officials to secure the area from logging, which has preserved the

cultural landscape. The association also has worked on interpreting and organizing tours of the area.

*ARCHIVAL AND MUSEUM
COLLECTIONS—LACK OF STORAGE
SPACE AND TRAINED STAFF PUT
RESOURCES AT RISK*

Big Thicket's modest archival and museum collections contain 2,159 items, of which just 182 are catalogued. Items are mostly historic in nature and include clothing, household objects, photographs, and other archival materials, as well as a small number of natural history specimens, archaeology collections, and associated records. Displaying some of these items in the preserve's new visitor center would help teach visitors about Big Thicket's human history and natural resources.

A lack of trained staff and appropriate storage and work space place the collections at risk. For example, some items donated to the preserve by the Big Thicket Association—including items from Lance Rosier, a devoted conservationist for whom a unit of the preserve is named—have been lost, damaged, or stored inappropriately in cardboard boxes in a variety of locations within the preserve's facilities. In addition, the exact locations of some collection items are unknown. Some items are housed at the preserve, while herbarium and a few natural history specimens are stored at Louisiana State University. Archaeology and associated records are stored at the Texas Archaeological Research Center.

Preserve staff are not properly trained in the handling, preservation, or use of artifacts or archives, a controlled area in which to store or conserve items is not available, and no funding exists for museum collection and archive training. More funding and staffing at the regional level would allow for greater training at the park unit level. Because of these shortfalls, the preserve is unable to properly maintain its collections and interpret them for visitors.



JIM JENKS

*HISTORY—ADMINISTRATIVE HISTORY
WOULD BE A USEFUL TOOL*

The creation of Big Thicket National Preserve was a tremendous accomplishment that would not have been possible without the dedication of countless local conservationists and various political figures. Documentation of the history of preserve establishment and its management since that time would provide an important tool for preserve managers today and in the future.

There are resources resident at Big Thicket and within the Big Thicket Association that could be consulted in the preparation of an administrative history of the preserve. Some of the people who were instrumental in creating the preserve are still active in regional resource protection issues and could contribute valuable information to an administrative history document.

Big Thicket has never had a historian on staff, and the preserve has completed no new historical studies since the early-1980s. A document detailing the administrative past of the preserve is needed to foster management continuity.

Visitors who tour the Staley Cabin, the former home of Jimmy and Elda Staley, can learn about pioneer life, logging, farming, and early oil development.



In 2001, the park opened a new visitor center without benefit of new personnel or increased funds to cover operating costs.

STEWARDSHIP CAPACITY— PARTNERSHIPS AND CONGRESSIONAL SUPPORT CRITICAL TO PARK'S SUCCESS

FUNDING AND STAFFING—LAW ENFORCEMENT AND RESOURCE MANAGEMENT STAFF NEEDED

The most significant factor affecting a park's ability to protect and steward its resources is the congressional funding it receives. In fiscal year 2004, Big Thicket had an annual operating budget of \$2.25 million to support staff and fund resource protection projects. This is \$14,000 less than the preserve had in fiscal year

2003. Even when budget increases are given, they are generally not enough to cover mandated salary increases and increasing operating costs. This situation is present not only at Big Thicket, but also throughout the National Park System, and results in critical understaffing and limited resource protection capabilities.

Big Thicket continues to grow, but staff size does not. In 2001, the park opened a new visitor center without benefit of new personnel or increased funds to cover operating costs. The Big Thicket Addition Act of 1993 authorized the preserve to grow by about 11,000 acres, yet funds to hire staff to manage the new lands have not been forthcoming.

The preserve is short-staffed in nearly all departments. There are no cultural resources specialists at Big Thicket, and cultural resources are neglected as a result. The preserve has just four law enforcement rangers to ensure resources are protected and visitors are safe, though a recent law enforcement needs assessment indicated that Big Thicket actually needs at least four times that number of rangers to adequately protect resources and provide visitor services. A geographic information systems specialist is needed to organize the preserve's digital data and make it accessible to resource managers; biological technicians are needed to monitor resources, conduct bird counts, and collect other data; and a botanist is needed to adequately assess and make management recommendations on the preserve's diverse flora.

In addition to being short-staffed, the preserve faces staff turnover, which is an issue throughout the Park Service and can result in short-lived projects and a lack of research continuity. In-depth resource knowledge is resident in a few individuals who have lived near the preserve or conducted research there since its establishment or before and in several park staff who have worked at the preserve for many years. But preserve resources would benefit from additional staff who could stay at Big Thicket long enough to know about the resources, develop strategic management plans, and follow through on them.

PLANNING—NEW PLANS RECENTLY RELEASED

In a preserve with such a diversity of resources and management issues, a collection of planning documents is needed to guide management activities. Big Thicket recently developed two plans that describe the preserve's resources and management considerations: the 2004 Revised Fire Management Plan and the 2004 Draft Oil and Gas Management Plan/Environmental Impact Statement. While these two plans contain up-to-date resource information and man-

agement strategies, the preserve needs a number of new or updated plans.

Big Thicket's general management plan was written in 1981 and is no longer relevant as a management guide. The 1996 resource management plan is relatively recent, but is too generic to be of much use and should be expanded to address more cultural resource issues.

Staff are working on a feral hog management plan to guide control efforts. The preserve has never had an administrative history, archaeological overview and assessment, or ethnographic overview and assessment, and a preserve-wide plan is needed to identify sites suitable for habitat restoration.

Most park planning activities are a function of available funds. At this time, Big Thicket does not have the funds to complete additional management plans. Without these plans, staff are forced to address resource management issues on a case-by-case basis without a long-term strategy.

Big Thicket's visitor center features exhibits and orientation films that teach visitors about the preserve's resources.



Big Thicket National Preserve provides a variety of recreational opportunities for visitors, including canoeing, hiking, swimming, fishing, and hunting.



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RESOURCE EDUCATION—PARK IS EXCELLENT RESOURCE FOR STUDENTS

Big Thicket's varied landscape—from sandhill pine forests and wetland pine savannahs to swamp cypress tupelo forests and baygall shrub thickets—provides endless opportunities for natural history and environmental education. Teaching visitors about Big Thicket's significant resources and human history helps to instill an appreciation and understanding of the preserve and its importance to American heritage. Providing high-quality information is also critical to long-term public support for resource protection.

Big Thicket staff offer a variety of activities to engage visitors in the preserve's diverse resources and recreational opportunities.

Naturalist programs, workshops, seminars, and nature walks teach visitors about everything from insects to wildflowers, and orienteering to preserve history. The preserve's new visitor center, which opened in 2001, features a Discovery Room with interactive exhibits.

The preserve has an outstanding opportunity to reach thousands of schoolchildren. About 116 independent school districts (not counting those in the Houston area) that educate more than 800,000 children are within 100 miles of the preserve. Staff work with more than 4,000 schoolchildren each year, both in the preserve and in the classroom. All resources education programs are designed to meet the Texas Education Agency's Essential Knowledge and Skills (TEKS) and the Texas Assessment of Academic Skills requirements (TAAS). With

additional staff and increased promotion of the opportunities available, Big Thicket could potentially reach even more schoolchildren.

Although Big Thicket currently offers a wide variety of resource education opportunities for all ages, additional programs and interpretation would further benefit visitors and preserve resources. For example, just one of the preserve's programs teaches visitors about the human history of the region. To expand on this topic, the preserve could rehabilitate the Staley Cabin to resemble its original condition and initiate a living history program to teach visitors about the lives of pioneers.

EXTERNAL SUPPORT—IMPORTANT PARTNERSHIPS BENEFIT PRESERVE RESOURCES

Big Thicket staff alone cannot fully achieve resource protection without help from others. Partnerships, park support groups, and Congress make enormous contributions to this ongoing work.

The Big Thicket Association is a significant asset and strong ally for Big Thicket National Preserve. The association and the preserve enjoy a long history of mutual support and partnership. The association led the original charge to create Big Thicket National Preserve and has been one of the preserve's leading advocates since then. The association has donated both land and funds to the preserve; sought and received grants for projects such as renovation of the preserve research station and acquisition of land for the new visitor center; and initiated projects outside the boundaries of the preserve itself, such as land acquisition and interpretation.

Other organizations, agencies, and institutions valuable in the preservation of the Big Thicket include: The Conservation Fund; The Nature Conservancy of Texas; Western National Parks Association; Houston Wilderness; Kountze, Texas Economical Development Corporation; Rice University, Department of

Ecology and Evolutionary Biology; Texas Parks and Wildlife Department; USGS Biological Resources Division and Water Resources Division; Lamar University, Department of Geology and Department of Biology; Texas A&M University; Stephen F. Austin State University; Golden Triangle Audubon; Temple-Inland; and National Parks Conservation Association.

Congressional support for Big Thicket includes passage of the Big Thicket Addition Act of 1993, which authorized the preserve to grow by more than 11,000 acres. In fiscal years 2003 and 2004, Congress appropriated about \$6.5 million for land acquisition, and in November 2004, Congress appropriated \$4.5 million more. Sen. Kay Bailey Hutchison (R-TX) has played a critical role in these appropriations, and continues to work to provide funds to Big Thicket for land acquisition. Rep. Kevin Brady (R-TX) is new to the region but has demonstrated a significant interest in the welfare of the preserve. He is considering legislation that would provide greater protection to the preserve, increase the public's awareness and use of the preserve, and improve administrative facilities. If Brady's legislation is introduced, it will aid the preserve in its efforts to teach visitors about Big Thicket's unique resources and its educational and recreational opportunities.

WHAT YOU CAN DO TO HELP

- Support or become a member of groups helping to protect the park: Big Thicket Association (www.btatx.org), The Conservation Fund (www.conservationfund.org), NPCA (www.npca.org/support_npca), and other regional organizations.
- Volunteer in the Parks. Many parks are looking for dedicated people who can lend a helping hand. To learn about opportunities at Big Thicket National Preserve, contact the park at 409-951-6700.
- Become an NPCA activist. When you join our activist network, you will receive *Park Lines*, a biweekly electronic newsletter with the latest park news and ways you can help. Join by visiting www.npca.org/takeaction.



APPENDIX METHODOLOGY

To determine the condition of known natural and cultural resources at Big Thicket National Preserve and other national parks, the National Parks Conservation Association developed a resource assessment and ratings process. It examines current resource conditions and evaluates the park staff's capacity to fully care for the resources. The assessment methodology can be found online at NPCA's State of the Parks® web site (www.npca.org/stateoftheparks/).

Researchers gather available information from a variety of research, monitoring, and background sources in a number of critical categories. The natural resources rating reflects assessment of more than 120 discrete elements associated with environmental quality, biotic health, and ecosystem integrity. Environmental quality and biotic health measures address air, water, soils, and climatic change conditions as well as their influences and human-related influences on plants and animals. Ecosystems Measures address the extent, species composition, and interrelationships of organisms with each other and the physical environment for indicator, representative, or all terrestrial and freshwater communities.

The scores for cultural resources are determined based on the results of indicator questions that reflect the National Park Service's own Cultural Resource Management Guideline and other Park Service resource management policies.

Stewardship capacity refers to the Park Service's ability to protect park resources, and

includes discussion of funding and staffing levels, park planning documents, resource education, and external support.

For this report, researchers collected data and prepared a paper that summarized the results. The draft underwent peer review and was also reviewed by staff at Big Thicket National Preserve.

NPCA's State of the Parks program represents the first time that such assessments have been undertaken for units of the National Park System. Comments on the program's methods are welcome.



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For more information about the **State of the Parks® Program** and this and other program reports, contact:

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