

Geologic Resources Inventory Scoping Summary

Big Thicket National Preserve, Texas

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October 9, 2008

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The Geologic Resources Inventory (GRI) Program provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this document), a digital geologic map, and a geologic resources inventory report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and monitoring and research needs. Participants at the geologic scoping meeting evaluate the adequacy of existing geologic maps for resource management, discuss park-specific geologic management issues, and if possible, take part in a site visit with geologic experts knowledgeable about the park.

On October 3, 2008, the National Park Service held a GRI scoping meeting for Big Thicket National Preserve (BITH) at the Park Headquarters, near Kountze, Texas. Todd Brindle (BITH - Superintendent) welcomed the group. Dave Roemer (BITH - Chief of Resources) provided background information about the Preserve. Heather Stanton (Colorado State University) facilitated the discussion of geologic map coverage, Eddie Collins (Texas Bureau of Economic Geology) presented an overview of the regional geology, and Lisa Norby (Geologic Resources Division) led the discussion regarding geologic features, processes, and resource management issues. Participants at the meeting included NPS staff from the Preserve, Geologic Resources Division, Gulf Coast Inventory and Monitoring Network, and staff from the Texas Bureau of Economic Geology (BEG). This interim report summarizes the GRI scoping meeting for Big Thicket National Preserve including the geologic setting, the plan for providing digital geologic map coverage, a description of significant geologic features and processes, action items, and a record of GRI scoping meeting attendees (Table 1, follows report).

Preserve and Geologic Setting

Originating in the 1930s, conservation efforts to preserve the rich biological diversity of southeastern Texas ultimately led to the establishment of one of America's first national preserves, Big Thicket National Preserve on October 11, 1974. The Preserve's mission is "to preserve, conserve, and protect the natural, scenic, and recreational values of a significant portion of the Big Thicket with a particular emphasis on maintaining the ecological integrity of the Preserve." Big Thicket National Preserve was later designated an International Biosphere Reserve by the United Nations Education, Scientific and Cultural Organization (UNESCO) Man and the Biosphere Program on December 15, 1981. More recently, the American Bird Conservancy recognized the Preserve as a Globally Important Bird Area on July 26, 2001. The Big Thicket eco-region is estimated to have once occupied over 1 million hectares (3 million acres). About 40,000 hectares (100,000 acres) are managed by the National Park Service at the Preserve.

Big Thicket National Preserve is situated within the relatively flat-lying Gulf Coastal Plain physiographic province. The Preserve lies between the Coastal Salt Dome Province (Spindletop Oil Field) and the East Texas Basin Salt Dome Province (Saratoga and Sour Lake Oil Fields). Fourteen salt domes have been mapped in the vicinity of the Preserve. Detailed geologic field mapping in the

region has been impeded by dense vegetative cover, minimal topographic relief, and few rock outcrops. The vast low-lying coastal plain records a prograding sequence of gently dipping Miocene to Holocene-aged fluvial deposits with numerous fluvial avulsions and channel migrations. From oldest to youngest, the formations include the Fleming, Willis, Lissie (subdivided into the Bentley and the Montgomery), Beaumont, and Deweyville Formations. Older strata generally outcrop farther away from the Gulf of Mexico and younger, overlying strata outcrop seaward. Younger, overlying deposits were incised during times of sea level fall (regressions), exposing terrace deposits, and older, underlying strata. In general, the lithologic units are not well indurated. Minor faulting of the strata occurs at depth and is related to depositional loading and salt diapirism.

Geologic Mapping Plan for Big Thicket National Preserve

During the scoping meeting, Heather Stanton (Colorado State University) showed some of the main features of the GRI Program's digital geologic maps, which reproduce all aspects of paper maps including notes, legend, and cross sections, with the added benefit of GIS compatibility. The NPS GRI Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRI Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRI digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in geodatabase and shapefile formats, layer files with feature symbology, Federal Geographic Data Committee (FGDC) compliant metadata, an Acrobat Reader help document that captures ancillary map data, and an ArcMap map document that displays the data and provides a tool to directly access the help document. Completed digital maps are available from the NPS Data Store at <http://science.nature.nps.gov/nrdata/>. The data model is available at <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>.

When possible, the GRI Program provides large scale (1:24,000) digital geologic map coverage for each unit's area of interest, which is generally composed of the 7.5-minute quadrangles that contain NPS-managed lands. Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 40 ft. The process of selecting maps for management use begins with the identification of existing geologic maps in the vicinity of the park unit. During project scoping, meeting participants discuss mapping needs and select appropriate source maps for the digital geologic data to be derived by GRI staff; or, if necessary, develop a plan to obtain new mapping.

Several unique characteristics of Big Thicket National Preserve that warrant consideration during the creation of GRI maps include the large areal extent and broad geographic distribution of the narrow river corridor units, channel migration and related effects on management issues and unit boundaries, and proposed legislation (H.R. 5891) that could eventually add substantially to the size of the Preserve.

The mapping area for Big Thicket National Preserve includes 35 7.5-minute quadrangles of interest—Beech Grove, Magnolia Springs, Potato Patch Lake, Franklin Lake, Evadale, Pine Forest, Beaumont East, Town Bluff, Spurger, Fred, Deserter Baygall, Silsbee, Voth, Birdwell Lake, Kirkpatrick Lake, Hicksbaugh, Kountze North, Kountze South, Bevil Oaks, Hillister, Warren, Village Mills, Kountze Southwest, Sour Lake, Jack's Creek North, Jack's Creek South, Bragg, Saratoga, Thorson Gully, Dallardsville, Segno, Votaw, Arizona Creek, Schwab City, and Romayor

quadrangles (Figure 1). During GRI scoping, Preserve staff determined that the content and coverage of the *Geologic Atlas of Texas* (GAT sheets) is sufficient for resource management needs. Although the map was published at the 1:250,000 scale, the publication's original work maps were produced at 1:24,000 scale. The work maps will be compared with the digital data from the GAT sheets and will be digitized if they exceed the quality of the existing vector-based 1:250,000 scale GIS data. If the quality of the GAT sheets digital data is sufficient, the data will be converted to the GRI geodatabase data model. According to Dusty Pate (BITH), detailed geological maps created by Saul Aronow (Lamar University) exist for 12 of 15 of the Preserve's units. Where there is overlap with the work maps, the Aronow maps will be digitized if they are higher quality than the *Geologic Atlas of Texas* maps.

Also of interest, is the *Land Resources of Texas* volume and maps, by R.S. Kier, L.E. Garner, and L.F. Brown, Jr., produced by the Texas Bureau of Economic Geology as part of the Land Resources Laboratory Series, 1977. GRI staff will digitize useful maps issued with *Land Resources of Texas*, 1977; although published at a 1:500,000 scale (work maps have not been located at the time this report was written), the small scale information can still serve as a useful reference layer to accompany Big Thicket National Preserve-GRI products. On this map, relevant information includes groundwater recharge areas, significant mineral resources, limiting physical properties, unique landscapes, critical biological habitats, dynamic physical processes, submerged coastal environments, and environments altered or created by humans.

Preserve staff also indicated an interest in obtaining a GIS layer showing oil and gas field boundaries. The Texas Railroad Commission regulates oil and gas operations, and according to Dusty Pate (BITH), the data are fairly well attributed from the 1980s to the present. Big Thicket National Preserve is currently developing an inventory of oil and gas operations which will provide more accurate and thorough data pertaining to well sites. This will be supplemented by datasets obtained from the Texas Railroad Commission. Information on historical sand and gravel mining may be useful to include in the GRI digital product. Soil inventories and SSURGO (Soil Survey Geographic) maps and reports once contained such information, but that is no longer the standard. For additional information pertaining to soils, contact Pete Biggam, Soil Resource Inventory Coordinator, Pete_Biggam@nps.gov, (303) 987-6948.

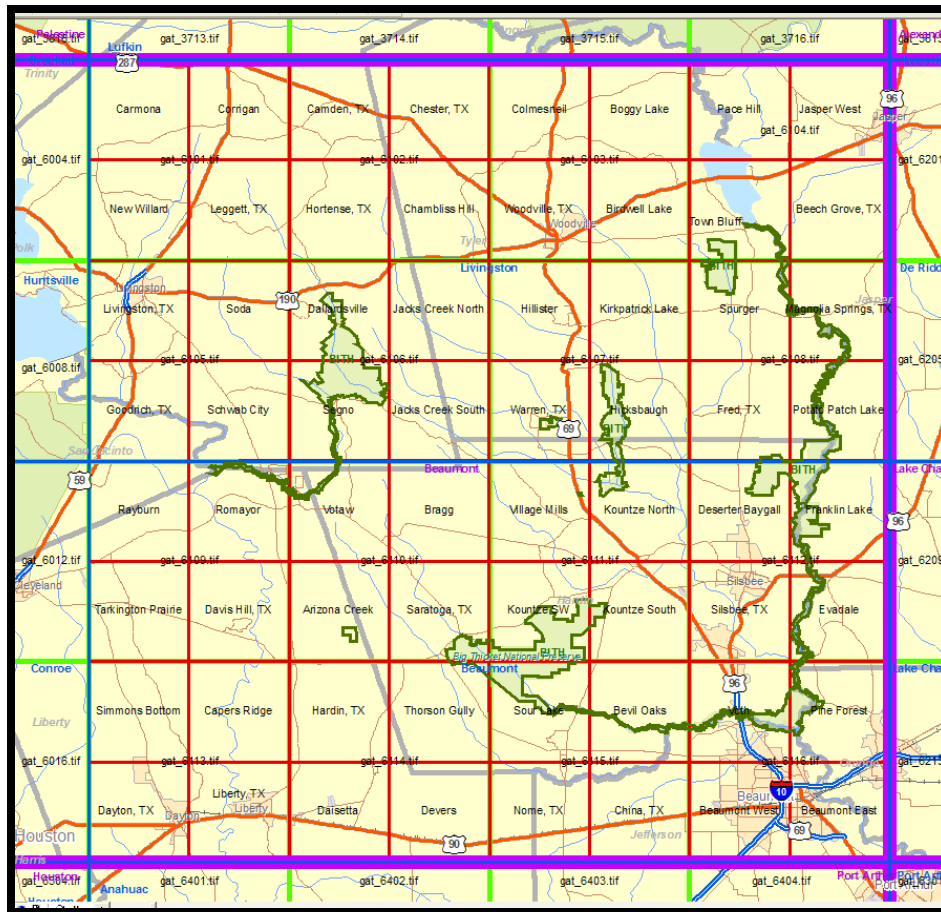


Figure 1. Quadrangles of Interest for Big Thicket National Preserve. Big Thicket National Preserve (outlined and shaded in green) is situated within the 1° x 2° Beaumont Sheet (outlined in purple). The 7.5-minute quadrangles surrounding the Preserve are outlined in red and labeled in black.

Table 2. Source Maps for Big Thicket National Preserve GRI Mapping Plan

GMAP ID*	Reference	GRI appraisal	GRI Action	Scale
72509	Texas Commission on Environmental Quality. 2004. <i>Geologic atlas of Texas</i> (GAT sheets). Scale 1:250,000. Austin, TX: Texas Commission on Environmental Quality.	Beaumont 1x2 Sheet covers the area of interest with sufficient detail for management	Locate and digitize 1:24,000 work maps if higher quality; filed with Texas BEG and used to produce the 1:250,000 publication.	1:250,000
68693	Kier, R.S.; Garner, L.E.; Brown, L.F. 1977. <i>Land resources of Texas</i> . Scale 1:500,000. Austin, TX: University of Texas, Bureau of Economic Geology.	Information useful for management, but as a <i>reference layer only</i> .	Digitize larger scale work maps, if locatable (Should be filed with TX BEG). Otherwise, digitize at 1:500,000 scale for <i>reference only</i> .	1:500,000
75018	Aronow, S. 1982. <i>Geologic map of Menard Creek Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 1 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75019	Aronow, S. 1982. <i>Geologic map of Lance Rosier Unit, Big Thicket National Preserve and vicinity</i> (sheet 1 of 4). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75020	Aronow, S. 1982. <i>Geologic map of Lance Rosier Unit, Big Thicket National Preserve and vicinity</i> (sheet 2 of 4). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75021	Aronow, S. 1982. <i>Geologic map of Lance Rosier Unit, Big Thicket National Preserve and vicinity</i> (sheet 3 of 4). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75022	Aronow, S. 1982. <i>Geologic map of Lance Rosier</i>	Evaluate for inclusion	Digitize if higher quality than BEG maps	1:24,000

	<i>Unit, Big Thicket National Preserve and vicinity</i> (sheet 4 of 4). Scale 1:24,000. Unpublished.	in final map product		
75023	Aronow, S. 1982. <i>Geologic map of Neches Bottom and Jack Gore Baygall Unit, Big Thicket National Preserve and vicinity</i> (sheet 1 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75024	Aronow, S. 1982. <i>Geologic map of Neches Bottom and Jack Gore Baygall Unit, Big Thicket National Preserve and vicinity</i> (sheet 2 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75025	Aronow, S. 1982. <i>Geologic map of Big Sandy Creek Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75078	Aronow, S. 1982. <i>Geologic map of Beaumont Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75079	Aronow, S. 1982. <i>Geologic map of Beech Creek Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75080	Aronow, S. 1982. <i>Geologic map of Hickory Creek Savannah Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75081	Aronow, S. 1982. <i>Geologic map of Little Pine Island Bayou Corridor Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75082	Aronow, S. 1982. <i>Geologic map of Loblolly Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75083	Aronow, S. 1982. <i>Geologic map of Lower Neches River Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 1 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75084	Aronow, S. 1982. <i>Geologic map of Lower Neches River Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 2 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75085	Aronow, S. 1982. <i>Geologic map of Menard Creek Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 2 of 2). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75086	Aronow, S. 1982. <i>Geologic map of Turkey Creek Unit, Big Thicket National Preserve and vicinity</i> . Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75087	Aronow, S. 1982. <i>Geologic map of Upper Neches River Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 1 of 3). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75088	Aronow, S. 1982. <i>Geologic map of Upper Neches River Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 2 of 3). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75089	Aronow, S. 1982. <i>Geologic map of Upper Neches River Corridor Unit, Big Thicket National Preserve and vicinity</i> (sheet 3 of 3). Scale 1:24,000. Unpublished.	Evaluate for inclusion in final map product	Digitize if higher quality than BEG maps	1:24,000
75069	Bureau of Economic Geology. 1992. <i>Jack's Creek South quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75070	Bureau of Economic Geology. 1992. <i>Kountze South quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000

75071	Bureau of Economic Geology. 1992. <i>Pine Forest quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75072	Bureau of Economic Geology. 1992. <i>Segno quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75073	Bureau of Economic Geology. 1992. <i>Silsbee quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75074	Bureau of Economic Geology. 1992. <i>Sour Lake quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75075	Bureau of Economic Geology. 1992. <i>Spurger quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75076	Bureau of Economic Geology. 1992. <i>Voth quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000
75077	Bureau of Economic Geology. 1992. <i>Warren quadrangle</i> . Scale 1:24,000. Unpublished work map for <i>Geologic Atlas of Texas</i> , Beaumont sheet. Austin, TX: University of Texas, Bureau of Economic Geology.	Evaluate for inclusion in final map product	Digitize if higher quality than Aronow maps and GAT	1:24,000

*GMAP numbers are identification codes for the GRI Program's database

Geologic Features and Processes and Related Management Issues

The scoping session for Big Thicket National Preserve provided the opportunity to develop a list of geologic features and processes, which will be further explained in the final GRI report. During the scoping meeting, participants did not prioritize the issues, which are given below in the order they were discussed.

Fluvial Features and Processes

Fluvial features dominate the landscape at Big Thicket National Preserve. Fluvial processes such as channel migration, erosion, and flooding create a number of management issues. The Preserve is particularly vulnerable to impacts from adjacent land uses because it covers a large area bounded by private lands and but does not manage the entire watershed for the rivers that flow through the park. The major river systems in the Preserve include the Neches River and its tributaries, Little Pine Island Bayou and Village Creek; the latter is fed by Turkey Creek and Big Sandy Creek.

Stream channel migration complicates resource management for the Preserve. This natural process causes rivers to meander in and out of the park's jurisdiction.

Stream bank erosion and channel migration threatens infrastructure (e.g., roads, buildings, pipelines, well-casings, well sites, directional drilling sites on adjacent land, etc.), may cause property damage,

present navigational hazards, and can increase the risk of exposing park resources to contamination. Private homes in the vicinity of Four Oaks Subdivision which are adjacent to the Village Creek Corridor Unit are currently being impacted by channel migration. Near the Edgewater Day Use Area, a homeowner is using fill dirt to prevent river encroachment; in other areas, private residents are haphazardly armoring stream banks with tires, concrete, and other materials in an attempt to minimize property damage. Abandoned well sites in the Beaumont and Neches Bottom & Jack Gore Baygall Units have eroded, exposing park resources to contaminated soils and previously buried blow-down pits. In the northern part of the Jack Gore Baygall Unit, the Neches River has migrated, exposing plugged well casings that pose navigational hazards for vessels. Oil and gas pipelines installed using conventional trenching/dredging methods have also become exposed by streambank erosion and channel migration of the Neches River. Exposed pipe suspended within the river represents a hazard to navigation, potentially violates the operating standards for the industry, and increases the chances of a hydrocarbon release. Currently, exposed pipelines are typically replaced using horizontal directional drilling techniques which reduces impacts on the resources of the Preserve, and limits the chances of future exposure of the buried pipelines.

Flooding occurs most commonly in the summer during tropical storms and creates problems throughout the area. The severity of flood events may be exacerbated by river aggradation and debris loading of the rivers during storm events. Water releases from B.A. Steinhagen Reservoir (controlled by the US Army Corps of Engineers) are done intermittently and without notice to the NPS, resulting in incised channels, downstream aggradation, and flooding of the Neches River.

The Lower Neches Valley Authority (LNVA) has installed a permanent saltwater barrier downstream of the confluence of Pine Island Bayou and Neches River which allows the LNVA to protect its intakes that supply freshwater for municipal and agricultural uses from saltwater intrusion. The facility completed in November of 2003 replaced temporary steel sheet-pile barriers that were installed 36 times from 1940 to 2000 and remained in place for a few weeks to several years. These temporary barriers created environmental problems including shoreline erosion in the Preserve.

Hillslope Features and Processes

Slope failures occur most commonly along riverbanks, especially in the units with more topographic relief - the Upper Neches River Corridor Unit and in the newly acquired Canyonlands Unit. If the Rush Creek area is acquired by the federal government, the Preserve will likely have additional hillslope issues due to the area's varied terrain. Erosion is also occurring along bluffs overlooking the Trinity River at Menard Creek. Erosion and hillslope processes are of particular concern where pipelines or roads are adjacent to or cross streams.

Lacustrine Features and Processes

Oxbow lakes form in abandoned meanders of rivers and are an integral part of the hydrologic system in the Preserve. An oxbow lake is currently forming in the Lower Neches River Corridor Unit, just north of Weiss Bluff.

Coastal Features and Processes

A portion of the Beaumont and Little Pine Island-Pine Island Bayou Corridor Units include tidally influenced wetlands. Anticipated land acquisition will bring more tidally influenced areas into Big Thicket National Preserve. The original vegetative cover in these areas included cypress and tupelo, but is now dominated by marsh vegetation. These low-lying areas are expected to be particularly vulnerable to climate change and sea level rise. Storm surges associated with Hurricane Ike in 2008 caused water to over-top the saltwater barrier for the first time.

Seismicity

Minor faulting occurs at depth in southeast Texas, but the USGS has classified the southeast Texas region as a low risk for hazards associated with seismicity. The last earthquake “felt” in the region occurred in the mid-1960s (<http://earthquake.usgs.gov/regional/states/?region=Texas>). Eddie Collins (BEG) knows of no confirmed earthquakes in the area in historic times.

Paleontological Resources

Fossils have been identified in all strata that outcrop in the Preserve, making it a high probability area for finding paleontological resources. The Rush Creek area, which has not yet been acquired, is expected to be a high probability area for paleontological resources. The Preserve is at risk for unauthorized collection of fossils and archeological resources. The brief description that follows has been adapted from the NPS report, *Paleontological Resource Inventory and Monitoring, Gulf Coast Network*, which contains a more thorough description of fossil occurrences and significance, as well as management recommendations.

The Fleming Formation (lower-middle Miocene) outcrops in steep gullies in and around the Preserve. The Fleming Formation is widely known for its abundant and diverse faunal assemblage, primarily representing vertebrates such as fish, reptiles, amphibians, and mammals. Although the fossils of the Fleming Formation tend to be poorly preserved, they are significant for their use in paleoenvironmental reconstructions and in establishing stratigraphic relationships. Some of the more productive sites include fossil localities near Moscow, around Livingston Dam, near Goodrich, west of Doucette, near Woodville, at Saratoga Field, along Push Creek, and near Town Bluff. A Pleistocene-age mammoth tooth was found among reworked sediments of the Miocene Fleming Formation along the bank of the Trinity River in the Menard Creek Unit of the park. The specimen is maintained in the park’s museum collection (BITH Accession 006). A mammoth or mastodon bone fragment was discovered in February of 2009 in the same general area. It will be accessioned into the Preserve’s museum collection as well. This site of the 2009 discovery also produced several small pieces of petrified wood (Dusty Pate, NPS biologist, written communication, March 5, 2009).

Although all strata have the potential to yield petrified wood, the basal gravels of the Willis Formation (Pliocene-Pleistocene) are known to contain most of the petrified wood in the Preserve.

The Bentley Formation (Pleistocene) includes some marine invertebrates in small, isolated deposits. The undivided Lissie Formation is regionally known to preserve ice-age megafauna such as ancestral horse, mastodon, giant ground sloth, turtle, and sabre-tooth cat -material. The holotype

(name bearer for the species), *Smilodon fatalis*, originated from Pleistocene deposits near Sour Lake.

The Beaumont Formation (Pleistocene) produces fresh, marine, and brackish water local fauna, including invertebrates, vertebrates, as well as flora such as cypress logs.

Late Pleistocene Trinity River Terraces have produced an abundance of fossil material including vertebrates, aquatic invertebrates, insects, and logs. Especially interesting are the rare and well-preserved skulls of *Megalonyx* and *Tapirus* that have come from the terrace deposits.

The Deweyville Formation (Late Pleistocene? - Recent) is not known for paleontological resources, but it has produced petrified wood.

Recent alluvial deposits contain a small amount of reworked older fossil material.

Unique or Culturally Significant Features

Sand mounds (also referred to as “pimple mounds” or “Mima mounds”) occur in the Preserve and throughout the Texas Gulf Coast Plain. All known mounds of this region occur in-and-on sandy surficial deposits. Despite the widespread continental (and even global) distribution of these features, their origin and mode of formation is uncertain. Some scientists ascribe an aeolian origin, or an aeolian-bioturbation origin. Sand mounds, river terraces, and other high grounds are high probability areas for finding cultural artifacts and commonly contain evidence of camps and ancient inhabitants. If a bioturbation mode of genesis is assumed for these sand mounds, then any associated cultural artifacts may “lack context” and are therefore not considered to be “significant cultural sites” or have scientific integrity, per state law. A different and unrelated type of mound-feature occurs to the northwest of the Preserve and is the work of the Caddoan Mound Builder Culture (Dusty Pate, NPS biologist, personal communication, October 9, 2008). These mound-features are approximately 3 m (10 ft) high.

Salt domes are important features for a variety of reasons: unique topographic highs tend to be significant in a cultural context, salt domes can produce salt licks which attract wildlife, and the features are associated with the occurrence of historically curative sulfurous water. Salt domes are historically significant and provide an excellent opportunity to interpret their origin and uses (e.g., oil and gas development in the area). Salt domes are hydrologically significant because the topographic highs influence surface drainage, High Island near the Preserve, is a good example of this. Hall Dome has a pronounced topographic expression and may have experienced movement during the Pleistocene. Sour Lake has a distinct topographic expression and its movement could have been influenced by oil and gas drilling (e.g., Spindletop, Saratoga, and Sour Lake oil and gas fields). According to Eddie Collins (BEG), “Salt dome growth is a tricky thing to constrain and can be variously influenced by geochemistry, caprocks, false caprocks, and deposition.”

Geochemistry

Sour Lake is known to have “curative” sulfur-bearing waters.

Type Sections

The type section of the Beaumont Formation occurs in the subsurface near the town of Beaumont, Jefferson County, Texas (Kennedy, 1903).

Sand and Gravel

No administrative sand or gravel pits exist inside the park. Saul Aronow (Lamar University) would likely have recorded historical sand and gravel pits when he mapped the geology of the Preserve, and none are shown on his original geologic maps. Fine washed sand, occurring in the Village Creek Corridor Unit, is thought to be more marketable than other sand and gravel deposits, and is more likely to have been mined outside of the Preserve. Sand and gravel mining operations are scattered outside of the Preserve, including a large sand mining operation at Ross Ridge, a smaller one off FM-787 near the Menard Creek Unit, and several in the vicinity of Village Creek.

Oil and Gas Development

The best current estimate of the number of well sites on the Preserve is 217, although Radian Corporation identified 125 sites in a previous oil and gas inventory in 1985. The Preserve recently initiated a new inventory of oil and gas operations to gather more accurate and detailed data pertaining to the well sites. Field work has been completed in that effort. Ten operations are active within the Preserve. More difficult to track is the number of directional drilling operations located just outside the boundary that are producing hydrocarbons from reservoirs beneath the Preserve. An estimated 30 directionally drilled wells are active adjacent to the Preserve's boundary (Dusty Pate, NPS biologist, personal communication). Due to recent 3-D seismic surveys that have been completed in and adjacent to the Preserve (five 3-D surveys have been completed since 2006), it is reasonable to expect delineation of additional oil and gas drilling prospects and the continuation of oil and gas drilling in the future.

Abandoned oil and gas sites are scattered throughout the Preserve and will increase as new lands are acquired. These sites often contain fill material, well and production pads, access roads, mud pits, and small blow-down pits. Information on these sites will be included in the new oil and gas inventory. Vegetation has been impacted at some of these sites, particularly where there has been groundwater contamination or brine spills from oil and gas operations. While contamination associated with abandoned sites tends to be minimal, the abundance of fill materials affects hydrologic and fluvial processes, including erosion and deposition.

Oil and gas operations are a management concern for Preserve staff. Spills originating from in-park and adjacent operations have affected and continue to affect park resources. The park occupies a number of low-lying river corridors making it particularly vulnerable to a variety of contamination threats, and water quality and benthic macroinvertebrate systems in the Preserve have been shown to be vulnerable to crude oil spills (Harrel 1985). Hydrocarbon spills are damaging, but their remediation is a relatively straight-forward process. Brine (saltwater) spills can be more problematic because salt destroys virtually all of the vegetation exposed to it, and is difficult to remediate. Saltwater readily moves through the groundwater system and can emerge in the root zone of vegetation at some distance from the site of a spill, damaging and killing vegetation. Until the 1960s, the traditional disposal process at Saratoga Field was to drain saltwater into a large lagoon

that was “dammed” by asphalt-hardened sand. A large portion of the now breached levee system that separated the lagoon from Little Pine Island Bayou is located within the Lance Rosier Unit of the Preserve. This disposal method left behind a large plume of saltwater contamination. The area is described on soil maps as “oil wasteland.”

Other adverse affects associated with oil and gas operations include vegetation removal, soil compaction, increased erosion, and the introduction of invasive species, especially at wellpads and along access roads. Additionally, easements, rights-of-way, and access roads open pathways into the Preserve for illegal activities such as off-road vehicle (ORV) use, and poaching of wildlife and cultural artifacts.

Hydrogen sulfide, a toxic and flammable gas, is naturally associated with a small percentage of oil and gas reservoirs. The gas is lethal at relatively low levels, and because it is heavier than air, the gas tends to accumulate in low areas such as pits, ditches, and gullies. However, hydrogen sulfide is not associated with most of the reservoirs in and around Big Thicket National Preserve with the possible exception of the area around Sour Lake (Patrick O’Dell, NPS Geologic Resources Division, written communication, February 24, 2009). Where hydrogen sulfide is naturally present, the gas is not released during drilling operations unless there is a well control problem emanating from the zone that contains the gas. Monitoring for hydrogen sulfide is a standard operating procedure during for oil and gas drilling operations.

Grazing and Logging

In the early days of historic settlement in the Big Thicket region, the inhabitants were widely scattered and practiced small-scale subsistence farming that included raising pigs and cattle. These animals were typically allowed to range freely. In order to study historic land use activities, the Preserve recently purchased a series of aerial photos from P2 Energy Solutions that were taken during the 1930s and 1950s. Based on a review of that photography, small portions of several units, primarily the Big Sandy Creek and Lance Rosier Units were apparently grazed and/or used to cultivate hay or other crops. These developments likely occurred in the late nineteenth or early twentieth centuries following the boom in logging created by the arrival of railroads, which cleared large tracts of land. Many of these small farms remained until at least the 1950s, and most contained 12 hectares (30 acres) or less of land maintained for agricultural production. This was not a particularly widespread practice in the Big Thicket area, and as the United States began acquiring land in the 1970s, the cleared areas were allowed to return to forested vegetation communities. Most of the grazing in the area appears to have occurred on prairies outside of park boundaries around the town of Sour Lake and State Highway 105 between Sour Lake and the Batson/Saratoga area, as well as on small farmsteads adjacent to many park units. Many of these surrounding areas are still being grazed today.

A majority of the Preserve has been logged at least once. Most large-scale logging occurred subsequent to the construction of the first railroads in the area in the mid-1870s and ended by the 1930s, although logging continued within some areas of the Preserve until the government acquired the land. Some portions of the Preserve that are still in private ownership face logging pressure. Evidence of historic logging tram roads and canals persists today within the Preserve. Tram roads were temporary narrow gauge rail lines that were used to bring logs to the main rail line or rivers for

transport to the lumber mill. Many tram and mainline railroad routes subsequently became roads and highways. A phase I cultural landscape inventory of these features in the Beech Creek Unit has been completed, but there are no current plans to build on that work or survey other parts of the Preserve.

Disturbed Lands

Disturbed lands are parklands where the natural conditions and processes have been directly impacted by mining, oil and gas exploration and production, development (e.g., facilities, roads, dams, abandoned campgrounds, and user trails), agricultural practices (e.g., farming, grazing, timber harvest, and abandoned irrigation ditches), overuse, or inappropriate use. The NPS Disturbed Lands Restoration Program, administered by the Geologic Resources Division, usually does not consider lands disturbed by natural phenomena (e.g., landslides, earthquakes, floods, hurricanes, tornadoes, and fires) for restoration unless the areas are influenced by human activities.

Additional issues associated with disturbed lands that have not already been covered in previous sections of this scoping summary include unauthorized uses in the Preserve and impacts associated with construction activities. ORV use in the Preserve denudes or crushes vegetation, impacts saturated and hydric soils, and causes compaction which results in accelerated erosion. If not designed and maintained properly, access roads, electrical transmission lines, and pipeline right-of-ways are also sources of erosion. A proposed route for the TransCanada oil pipeline crosses through the Preserve. Interest in constructing and operating oil and natural gas pipelines within the Preserve remains high, but the NPS currently does not have the statutory authority to grant new rights-of-way for such pipelines, therefore limiting access for potential operators. The NPS also sporadically receives permitting requests regarding electrical transmission lines, and other linear infrastructure projects such as fiber optic networks. Mitigation measures are required by the NPS as part of the permit to reduce or eliminate erosion, sedimentation, contamination, and other impacts that could affect geologic resources.

Action Items

- (1) Dusty Pate will send Heather Stanton a map reflecting recent boundary changes and additions.
- (2) Heather Stanton will revise index map of quadrangles to be included in mapping, and submit it for review.
- (3) Eddie Collins will attempt to locate original 1:24k work maps used to create the Geologic Atlas of Texas.
- (4) Eddie Collins will scan a work map and send it through Amanda Mastersen, to see if it will be adequate for digitizing.
- (5) Eddie Collins will attempt to locate original work maps used to create Land Resources of Texas, 1:500k.
- (6) Report author will locate Decade of North American Geology - Volume on Gulf of Mexico; Decade of North American Geology - Volume on Quaternary deposits of the US; Map explanation for Geologic Atlas of Texas, Beaumont Sheet; Geologic cross-sections from well logs, available on Water Development Board websites.
- (7) Martha Segura will follow up on USGS accretion and erosion monitoring along the Neches River.

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