13330

South Florida Hardwood Hammock

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Vegetation Type

Forest and Woodland

Map Zones

56

Geographic Range

This system is endemic to south Florida. Tropical hardwood hammocks are found nearly throughout the southern half of south Florida. Large concentrations are found in Miami-Dade County on the Miami Rock Ridge, in Miami-Dade and Monroe counties in the Florida Keys and along the northern shores of Florida Bay, on raised portions of tree islands in the Everglades and in the Pinecrest region of the Big Cypress Swamp.

Hard freezes limit the northward spread of tropical species. Their northern limit roughly coincides with the 12-degree centigrade (53.6-degree Fahrenheit) isotherm for average minimum daily temperature in January (Tomlinson 1980). Analogous communities are also found in the Bahamas and the Greater Antilles (Robertson 1955). Most maritime hammocks on barrier islands in south Florida are similar to this community.

Biophysical Site Description

Soils in tropical hardwood hammocks are primarily composed of organic material which has accumulated directly on top of mineral substrate, and are moist, but rarely inundated. The organic layer, composed mostly of duff, ranges from between 12-15cm (5-6in) thick on Long Pine Key (Olmsted et al. 1983). Tropical hardwood hammock occurs on limestone, sand and shell substrates which are moist, and usually do not flood. Hammocks on limestone substrates, however, are dependent on the underlying water table to keep humidity levels high, especially in limestone sinkholes. Mesic conditions are developed by a combination of the hammock’s rounded profile and densely vegetated edges, which deflect wind and limit the effects of desiccation. The dense canopy minimizes temperature fluctuations by reducing soil warming during the day and heat loss during the night. The litter and duff layer is generally significantly deeper than in surrounding areas. The transition between tidal habitats and hardwood hammocks is abrupt and dependent upon soil salinity (Snyder et al. 1990), although hammocks are slightly more salt-tolerant than pinelands (Ross et al. 1992). Soils are largely organic in matter and have good drainage; they remain saturated only when flooded by high water levels. Due to the high proportion of organic matter, the soils burn easily during drought conditions (Snyder et al. 1990).

Unlike most coastal plain systems, fire is a major threat to South Florida Hardwood Hammock (CES411.287). For this reason, many examples occur alongside natural firebreaks, such as the leeward side of exposed limestone (Robertson 1955), moats created by limestone solution (Duever et al. 1986), and elevated outcrops above marshes, scrub cypress or sometimes mangrove swamps (Snyder et al. 1990).

Vegetation Description

Tropical hardwood hammocks are composed of broad-leafed evergreen species of Antillean-West Indian origin (Gunderson 1994, Snyder et al. 1990). They are closed-canopy forests, dominated by a diverse assemblage of evergreen and semi-deciduous tree and shrub species, mostly of West Indian (and therefore often fire-sensitive) origins. More than 150 species of trees and shrubs are found in this habitat within south Florida. While few tropical hardwood hammock plant species are endemic to south Florida, hammocks are critical habitat for West Indian species where the northernmost portions of their ranges extend into south Florida. Tropical species are found in the Keys more often than on the Florida mainland. Keys vegetation is similar to that of the Bahamas and Greater Antilles. They tend to be depauparate in terrestrial herbaceous species as a result of the lack of light that penetrates the canopy. Most of the herbaceous species found in hammocks are epiphytes, including vines, orchids and ferns.

On the Miami Rock Ridge, a mature hammock will have a closed canopy at 18m (59ft) or less, while those on the Florida Keys have a canopy 9-12m (30-39ft) tall (Snyder et al. 1990). The tropical hardwood hammock shrub and herb layer is typically sparse, mostly consisting of seedlings and saplings of canopy and subcanopy trees and shrubs. In typically more open early-mid successional stages, a species-rich understory of shrubby tropical evergreen hardwoods and palms will dominate, but forbs, and graminoids are typically sparse or entirely absent.

Typical canopy species of tropical hardwood hammocks include gumbo-limbo (*Bursera simaruba*), paradise tree (*Simarouba glauca*), pigeon-plum (*Coccoloba diversifolia*), strangler fig (*Ficus aurea*), wild mastic (*Sideroxylon foetidissimum*) and willow-bustic (*Sideroxylon salicifolium*). Although a temperate species, live oak (*Quercus virginiana*) can be found in or on the margins of many tropical hardwood hammocks outside of the Florida Keys. Other canopy trees include short-leaf fig (*Ficus citrifolia*) and wild-tamarind (*Lysiloma latisiliquum*), both associated mostly with rockland hammocks; poisonwood (*Metopium toxiferum*); West Indian mahagony (*Swietenia mahagoni*), which naturally occurs in the northern Florida Keys and in hammocks along the northern shores of Florida Bay; cabbage palm (*Sabal palmetto*): and Gulf licaria (*Licaria triandra*), a tropical species historically known only from a small area near downtown Miami. Some epiphytes also occur in the hammock canopy, including Spanish-moss (*Tillandsia usneoides*) and ballmoss (*T. recurvata*). The overstory sometimes includes remnant south Florida slash pine (*Pinus elliotti* var. *densa*).

Common woody subcanopy and understory trees and shrubs include black ironwood (*Krugiodendron ferreum*), inkwood (*Exothea paniculata*), lancewood (*Ocotea coriacea*), marlberry (*Ardisia escallonoides*), poisonwood (*Metopium toxiferum*), satinleaf (*Chrysophyllum oliviforme*) and white stopper (*Eugenia axillaris*). Additional rockland hammock species include crabwood and spicewood. Coastal hammocks typically include Jamaica-dogwood (*Piscidia piscipula*), saffron-plum (*Sideroxylon celastrinum*), Spanish stopper (*Eugenia foetida*) and sea-grape (*Coccoloba diversifolia*). Buttonwood (*Conocarpus erecta*) can often be found in hammocks along the interface with mangrove swamps and salt marshes. In the Florida Keys and along the northern shores of Florida Bay, additional subcanopy and understory species include Bahama strongbark (*Bourreria succulenta*), beeftree (*Guapira discolor*), darling-plum (*Reynosia septentrionalis*), Florida boxwood, green thatch palm, Jamaica caper (*Capparis cynophallophora)*, Key’s tree cactus, lignum-vitae, limber caper (*Capparis flexuosa*), manchineel, mayten (*Maytenus phyllanthoides*), milkbark, pearlberry, princewood, red stopper, torchwood (*Amyris elemifera*) and wild dilly. Species associated with aboriginal activity include red mulberry (*Morus rubra*) and soapberry (*Sapindus saponaria*), and those associated with wet areas in hammocks (such as sinkholes) include cocoplum (*Chrysobalanus icaco*), hackberry (*Celtis laevigata*) and pond-apple (*Annona glabra*); Bahama tree cactus (*Pilosocereus bahamensis*), cinnecord (*Acacia choriophylla*) and soldierwood (*Colubrina elliptica*), found only in the upper Florida Keys; and cupania (*Cupania glabra*), maidenbush (*Savia bahamensis*), and rough strongback (*Bourreria radula*), found only in the lower Florida Keys. Vines often associated with the hammock subcanopy include pull-and-hold-back (*Pisonia aculeata*), *Tournefortia hirsutissima* and *T. volubilis*. Epiphytes found in the sub-canopy and understory include Florida peperomia (*Peperomia obtusifolia*) and resurrection fern (*Polypodium polypodioides*). In the lower portions of the understory, especially in wetter areas, epiphytes such as strap-leaved guzmania (*Guzmania monostachya*) and soft-leaved tillandsia (*Tillandsia variabilis*), can also be found. Common palms include thatch palm (*Thrinax morrisii, T. radiata*), silver palm (*Coccothrinax argentata*), saw palmetto (*Serenoa repens*) and cabbage palm (*Sabal palmetto*).

The tropical hardwood hammock shrub and herb layer is sparse, mostly consisting of seedlings and saplings of canopy and subcanopy trees and shrubs. However, shiny-leaf wild-coffee (*Psychotria nervosa*) is not infrequently found in this layer, as well as herbs such as rouge plant (*Rivina humilis*) and false mint (*Dicliptera sexangularis*). Two species of native grasses can also be frequently found in this layer: bamboo grass (*Lasiacis divaricata*), and woods grass (*Oplismenus hirtellus*) and seashore ageratum (*Ageratum littorale*), and limestone flatsedge (*Cyperus fuligineus*), found only in the Florida Keys.

The walls of sinkholes in hammocks are either bare or covered by mosses, liverworts and ferns.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| METO3 | *Metopium toxiferum* | Florida poisontree |
| EUGEN | *Eugenia* | Stopper |
| BUSI | *Bursera simaruba* | Gumbo limbo |
| RANDI | *Randia* | Indigoberry |
| RESE | *Reynosia septentrionalis* | Darlingplum |
| COAR | *Coccothrinax argentata* | Florida silver palm |
| THRIN | *Thrinax* | Thatch palm |
| PIELD | *Pinus elliottii var. densa* | Florida slash pine |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

This BpS has a fire regime characterized by moderate frequency fires (35-100yrs+ mean fire return interval) and replacement (although can be low intensity) fires occurring during frequent drought periods.

Tropical hardwood hammocks burn infrequently, although the precise role of fire in tropical hardwood hammocks is poorly understood. Recovery of tropical hardwood hammocks following fire is dependent on the nature of the fire, in particular whether the fire consumes a thick layer of the organic matter containing the tree roots (Loope and Urban 1980). When the organic layer is not consumed, recovery of tropical hardwood trees is rapid and complete forest canopy closure can be achieved in 40yrs or less (Olmsted et al. 1983). The theoretical successional relationship between pine rockland and tropical hardwood hammock has been discussed (see Olmsted et al. 1983). It has been reported that in the absence of fire, pine rockland will succeed to tropical hardwood hammock in 20-50yrs (Alexander 1967, Wade et al. 1980, Loope and Dunevitz 1981, Snyder et al. 1990), with succession taking place over a longer time period in the droughty conditions of the lower Florida Keys. Succession may also be slowed if less hammock is present in the vicinity of the pine rockland (Loope and Dunevitz 1981). Olmsted et al. (1983), however, reported that hammock size and shape stays remarkably constant over time.

The sparse understory, dense shade of the canopy and high humidity of a hammock helps to insulate it from fire. In very dry periods, however, hammocks become more vulnerable to wildland fire, and a major burn can completely destroy a hammock. Under drought conditions, fires can enter hammocks. Great disturbance (replacement) is caused by slow combustion of the organic soil. The trees may be completely killed, but shrubs often re-sprout or coppice from below ground parts (Snyder et al. 1990). In most cases, the site returns to hammock cover, but the process may take decades.

In the absence of fire, herbaceous pineland plants are shaded out by overgrowing hardwood shrubs within 10-15yrs (Alexander and Dickson 1970) and pinelands revert to hardwood hammocks in 20-50yrs (Snyder et al. 1990). The relative cover of pine forests and hardwood hammock on rockland is the direct result of the fire history; pine forests burn more frequently. Although influenced by fire, there are many other environmental components that influence the structure and composition of tropical hardwood hammocks; these include rainfall, temperature, hurricanes, type of adjacent vegetation, elevation, and substrate.

Mixed severity fire events maintain early and open classes (A, C and D), and are more frequent than replacement fire events. All annual fire event probabilities decrease with increasing tropical hardwood tree canopy height and closure. However, in virtually all fire events in closed classes (B and E) deep duff burning will kill >75% of the upper canopy layer, due to root and cambial damage to the fire-prone tropical tree species during the drought conditions usually associated with these types of fire. Anthropogenic fire was considered but is not expected to change reference class composition.

Tropical cyclones are frequent natural disturbance events. The impact of hurricanes may be more severe in fragmented hammock patches (Strong and Bancroft 1994). Salinization of soils may be the most significant negative impact of hurricanes on hammocks in the Florida Keys (Ross et al. 1992). Winds can create canopy gaps, while the combination of winds and saltwater flooding from storm surge during rarer high intensity (Category 3+ hurricanes) can result in stand replacement over large areas. Inundation may occur only during extremely high water periods (Duever et al. 1986, Gunderson et al. 1982, Olmstead et al. 1980), although forests have been observed with hydroperiods of 10-45 days (Duever et al. 1986).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 176 | 69 |  |  |
| Moderate (Mixed) | 392 | 31 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 122 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

This BpS occurs in patches ranging in size from 1-10,000ac in areas where the soil depth is minimal due to the presence of pinnacle rock. These patches were likely fragmented by the presence of tropical hardwood stands, everglades marsh and cypress domes or savannahs.

Adjacency or Identification Concerns

Tropical hardwood hammock is often found in association with pine rockland (which it readily invades in the absence of fire) and short hydroperiod freshwater wetland communities. On the seaward side tropical hardwood hammock can also contact mangrove and buttonwood forest.

It can also be the dominant community on tree-shrub islands imbedded in the larger landscape matrix dominated by Everglades sawgrass and marl prairies.

One of the most important ecotonal communities associated with tropical hardwood hammocks is the hammock edge where it interfaces with pine rockland, buttonwood wetlands, marl prairie or other communities. The edges of hammocks are floristically very important, and many tropical hardwood hammock species are limited to these ecotones (although they may be found in other communities such as pine rocklands, or in hammock gaps following disturbance).

Issues or Problems

Major limiting factors on tropical hardwood hammock establishment, growth and persistence appear to be (1) regional gradients of rainfall, (2) temperature, (3) fire and hurricanes, (4) local gradients of saline influence, (5) surrounding vegetation types (exotic intrusion), (6) substrate (elevation and composition), and (7) development pressure (Snyder et al. 1990).

The natural fire regime is currently altered by urbanization and artificially controlled water levels. Tropical hardwood hammocks depend upon prevailing fresh water conditions in the rooting zone, which is typically shallow in rockland settings (Ish-Shalom et al.). Where salt water encroachment causes brackish water conditions to develop, tropical hardwoods give way to the more salt-tolerant mangrove forest.

Tropical hardwood hammocks can be created almost anywhere in the built environment, from residential yards, to small spaces between condominium buildings, to roadside swales.

Areas of disturbed substrate within and adjoining Keys hardwood hammocks are however often heavily infested with exotic plants, especially Brazilian pepper. Everglades tree-shrub islands are often infested with *Meleleuca* and or *Lygodium* in addition to Brazilian pepper. Recent GIS mapping of invasive exotics throughout the Florida Keys shows that approximately 2,833ha (7,000ac) of susceptible upland habitat have been invaded by exotic plants, especially Australian pine (*Casuarina equisetifolia*), Brazilian pepper (*Schinus terebinthifolius*), and latherleaf (*Colubrina asiatica*) (Kruer et al. 1998). Areas of disturbed substrate within and adjoining Keys hardwood hammocks are often heavily infested with exotic plants that are rapidly spreading into and displacing the natural plant community.

Native Uncharacteristic Conditions

Comments

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | C | C | C | C | B | B | B | B | B | B |
| Tree | 5-10 | C | C | C | C | B | B | B | B | B | B |
| Tree | 10-25 | D | D | D | D | E | E | E | E | E | E |
| Tree | 25-50 | D | D | D | D | E | E | E | E | E | E |
| Tree | >50 | D | D | D | D | E | E | E | E | E | E |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 4 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| METO3 | Metopium toxiferum | Florida poisontree | Mid-Upper |
| EUGEN | Eugenia | Stopper | Mid-Upper |
| THRIN | Thrinax | Thatch palm | Mid-Upper |
| RANDI | Randia | Indigoberry | Mid-Upper |

Description

Includes a dense low shrub layer dominated by tropical hardwood shrubs and palms. The shrub layer can also include seedlings, saplings and poles of south Florida slash pine or grasses and forbs may be present, but are subordinate to woody shrubs and palms (together comprise <41%). Individual tree gaps and clusters interspersed throughout the landscape result from mortality from wind or lightning.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class B 7 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| METO3 | Metopium toxiferum | Florida poisontree | Upper |
| BUSI | Bursera simaruba | Gumbo limbo | Mid-Upper |
| THRIN | Thrinax | Thatch palm | Middle |
| QUVI | Quercus virginiana | Live oak | Mid-Upper |

Description

Includes development of a closed tropical hardwood tree canopy layer emerging from the still dense, but declining tropical hardwood shrub and palm layer. A few scattered, remnant slash pine trees may be evident in the overstory. Herbaceous plants are sparse to absent, and a distinct litter layer has developed over the limestone substrate.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class C 4 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| METO3 | Metopium toxiferum | Florida poisontree | Mid-Upper |
| QUVI | Quercus virginiana | Live oak | Mid-Upper |
| EUGEN | Eugenia | Stopper | Lower |
| RANDI | Randia | Indigoberry | Lower |

Description

Patches of tropical hardwood and slash pine trees provide <40% tree canopy closure. The site remains dominated by a tropical hardwood shrub and palm understory mixed with small isolated patches of tropical hardwood trees or herbs. Small patches of grasses and forbs may also be evident but comprise <20% cover.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class D 3 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| METO3 | Metopium toxiferum | Florida poisontree | Mid-Upper |
| QUVI | Quercus virginiana | Live oak | Mid-Upper |
| EUGEN | Eugenia | Stopper | Lower |
| SIDER2 | Sideroxylon | Bully | Lower |

Description

Tropical hardwood and slash pine tree canopy over the tropical hardwood shrub and palm understory. The site remains dominated by a tropical hardwood shrub and palm understory however in the numerous gaps between tree patches. Small patches of grasses and forbs may also be evident but comprise <10% cover.

*Maximum Tree Size Class*  
Medium 9-21"DBH

Class E 82 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| METO3 | Metopium toxiferum | Florida poisontree | Mid-Upper |
| BUSI | Bursera simaruba | Gumbo limbo | Mid-Upper |
| SIDER2 | Sideroxylon | Bully | Mid-Upper |
| QUVI | Quercus virginiana | Live oak | Upper |

Description

The tree canopy layer of tropical hardwood and slash pine trees is clearly dominant over the declining to absent understory shrub and palm layer. Herbs are sparse or absent. Epiphytes (lichens and bromeliads) may be common. A well developed, often compact litter and duff layer has accumulated over the limestone substrate when compared with adjoining areas.

*Maximum Tree Size Class*  
Medium 9-21"DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:OPN | 10 |
| Mid1:OPN | 11 | Late1:OPN | 29 |
| Mid1:CLS | 11 | Late1:CLS | 29 |
| Late1:OPN | 30 | Late1:OPN | 999 |
| Late1:CLS | 30 | Late1:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Alternative Succession | Early1:ALL | Mid1:CLS | 1 | 1 | Yes | 8 |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.05 | 20 | Yes | 0 |
| Replacement Fire | Mid1:OPN | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Mid1:OPN | Mid1:OPN | 0.033 | 30 | No | 0 |
| Mixed Fire | Mid1:OPN | Mid1:OPN | 0.04 | 25 | No | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early1:ALL | 0.0015 | 667 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid1:OPN | 0.033 | 30 | Yes | 0 |
| Alternative Succession | Late1:OPN | Late1:CLS | 1 | 1 | Yes | 25 |
| Wind or Weather or Stress | Late1:OPN | Early1:ALL | 0.0015 | 667 | Yes | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Late1:OPN | Late1:OPN | 0.033 | 30 | No | 0 |
| Mixed Fire | Late1:OPN | Late1:OPN | 0.033 | 30 | No | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.0015 | 667 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:OPN | 0.0033 | 303 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.004 | 250 | Yes | 0 |

References

Alexander, T.R. 1967. A tropical hammock on the Miami (Florida) Limestone -- A twenty-five-year study. Ecology 48: 863-867.

Alexander, T.R. and J.D. Dickson. 1972. Vegetational changes in the National Key Deer Refuge - II. Quarterly Journal of the Florida Academy of Sciences 35: 85-96.

Alexander, T.R. and J.H. Dickson. 1970. Vegetational changes in the National Key Deer Refuge. Quarterly Journal of the Florida Academy of Science, 33: 81-89.

Brown, J.K. and J. Kapler-Smith, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42. vol 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Duever, M.J., J.E. Carlson, J.F. Meeder, L.C. Duever, L.H. Gunderson, L.A. Riopelle, T.R. Alexander, R.L. Myers and D.P. Spangler. 1986. The Big Cypress National Preserve. National Audubon Society Research Report No. 8. National Audubon Society, New York. 444 pp.

Everglades National Park Fire Management plan and Environmental Assessment (Draft 2003). Everglades National Park.

Ish-Shalom, N., L. Sternberg, M. Ross, J. O'Brien and L. Flynn. 1992. Water utilization of tropical hardwood hammocks of the Lower Florida Keys. Oecologia 92: 108-112.

Loope, L.L. and N.H. Urban. 1980. A survey of fire history and impact in tropical hardwood hammocks in the East Everglades and adjacent portions of Everglades National Park. Report T-592, South Florida Research Center, Everglades National Park; Homestead, FL.

Loope, L.L. and V.L. Dunevitz. 1981. Impact of fire exclusion and invasion of Schinus terebinthifolius on limestone rockland pine forests of southeastern Florida. Report T-645, South Florida Research Center, Everglades National Park; Homestead, FL.

Myers, Ronald L. and Ewel, John J., eds. 1990. Ecosystems of Florida. Orlando, FL: University of Central Florida Press. 765 pp.

Myers, R.L. [editor]. 2002. The ecological role and management of fire in Caribbean and Central American pineland ecosystems: highlights of a workshop held at Rio Bravo Conservation and Management Area, Belize May 7-9, 2002. The Nature Conservancy Global Fire Initiative. http://www.tnc-ecomanagement.org.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Olmsted I., Loope L. and Russell R. 1981. Vegetation of the Southern Coastal Region of Everglades National Park Between Flamingo and Joe Bay. Homestead, FL: South Florida Research Center, Everglades National Park. Report T-260. 18 pp.

Robertson, W.B., Jr. 1955. An analysis of the breeding-bird populations of tropical Florida in relation to the vegetation. Ph.D. thesis, University of Illinois, Urbana, IL.

Ross, M.S., S. Koptur and J.R. Snyder. Developing Ecological Criteria for Prescribed Fire in South Florida Pine Rockland Ecosystems.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann and D.L. Bunnell. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 41 pp. + CD.

Snyder, J.R. 1986. The impact of wet season and dry season prescribed fires on Miami Rock Ridge pineland, Everglades National Park. National Park Service South Florida Research Center, Everglades National Park, Homestead, FL.

Snyder, J.R., A. Herndon and W.B. Robertson, Jr. 1990. South Florida Rockland. Pages 230–277 in R.L. Myers and J.J. Ewel, editors. Ecosystems of Florida. University of Central Florida Press.

Snyder, J.R. 1991. Fire regimes in subtropical south Florida. Tall Timbers Fire Ecology Conference Proceedings 17: 303-319.

USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online]. Available:

http://www.fs.fed.us/database/feis/.

USFWS. Tropical Hardwood Hammock. In: Multi-Species Recovery Plan for South Florida.

Wade, D., J. Ewel and R. Hofstetter. 1980. Fire in South Florida Ecosystems. General Technical Report SE-17. Asheville, NC: USDA Forest Service, Southeastern Forest Experiment Station. 125 pp.