



National Key Deer Refuge (Monroe County) Photo by Gary Knight

Pine Rockland

Description: Pine rockland is characterized by an open canopy of South Florida slash pine (*Pinus elliotii* var. *densa*) with a patchy understory of tropical and temperate shrubs and palms and a rich herbaceous layer of mostly perennial species including numerous species endemic to South Florida. Outcrops of weathered oolitic limestone, known locally as pinnacle rock, are common, and solution holes may be present. This subtropical, pyrogenic flatland can be mesic or xeric depending on landscape position and associated natural communities. There are differences in species composition between the pine rocklands found in the Florida Keys and the mainland (see Community Variations below).

Pine rockland has an open canopy of South Florida slash pine, generally with multiple age classes. The diverse, open shrub/subcanopy layer is composed of more than 100 species of palms and hardwoods (Gann et al. 2009), most derived from the tropical flora

of the West Indies (Snyder et al. 1990). Many of these species vary in height depending on fire frequency, getting taller with time since fire. These include saw palmetto (*Serenoa repens*), cabbage palm (*Sabal palmetto*), silver palm (*Coccothrinax argentata*), brittle thatch palm (*Thrinax morrisii*), wax myrtle (*Myrica cerifera*), myrsine (*Rapanea punctata*), poisonwood (*Metopium toxiferum*), locustberry (*Byrsonima lucida*), varnishleaf (*Dodonaea viscosa*), tetrazygia (*Tetrazygia bicolor*), rough velvetseed (*Guettarda scabra*), marlberry (*Ardisia escallonioides*), mangrove berry (*Psidium longipes*), willow bustic (*Sideroxylon salicifolium*), winged sumac (*Rhus copallinum*). Short-statured shrubs include running oak (*Quercus elliotii*), white indigoberry (*Randia aculeata*), Christmas berry (*Crossopetalum ilicifolium*), redgal (*Morinda royoc*), and snowberry (*Chiococca alba*). Grasses, forbs, and ferns make up a diverse herbaceous layer ranging from mostly continuous in areas with more soil development and little exposed rock to sparse where more extensive outcroppings of rock occur. Typical herbaceous species include bluestems (*Andropogon* spp.), several species of bluestem (*Schizachyrium gracile*, *S. rhizomatum*, and *S. sanguineum*), arrowleaf threeawn (*Aristida purpurascens*), lopsided indiagrass (*Sorghastrum secundum*), hairawn muhly (*Muhlenbergia capillaris*), Florida white-top sedge (*Rhynchospora floridensis*), pineland noseburn (*Tragia saxicola*), devil's potato (*Echites umbellata*), pineland croton (*Croton linearis*), several species of sandmats (*Chamaesyce* spp.), partridge pea (*Chamaecrista fasciculata*), coontie (*Zamia pumila*), maidenhair pineland fern (*Anemia adiantifolia*), Bahama brake (*Pteris bahamensis*), and lacy bracken (*Pteridium aquilinum* var. *caudatum*).

Pine rockland occurs on relatively flat, moderately to well drained terrain from two to seven meters above sea level (Snyder et al. 1990). The oolitic limestone is at or very near the surface, and there is very little soil development. Soils are generally composed of small accumulations of nutrient-poor sand, marl, clayey loam, and organic debris in depressions and crevices in the rock surface. Organic acids occasionally dissolve the surface limestone causing collapsed depressions in the surface rock called solution holes (Outcalt 1997). Drainage varies according to the porosity of the limestone substrate, but is generally rapid. Consequently, most sites are wet for only short periods following heavy rains. During the rainy season, however, some sites may be shallowly inundated by slow-flowing surface water for up to 60 days each year.

Characteristic Set of Species: South Florida slash pine, Christmas berry, maidenhair pineland fern, Florida silver palm, Florida white-top sedge

Rare Species: Pine rocklands are rich with rare and endemic plants (Table 1). Numerous plants endemic to South Florida are found in pine rockland, including 18 species that are restricted to this community such as Carter's small-flowered flax (*Linum carteri* var. *carteri*; Bradley and Gann 1999). Some rare plant species of pine rocklands occur throughout the range of pine rockland, such as pineland noseburn and Christmas berry, while other species such as Big Pine partridge pea (*Chamaecrista lineata* var. *keyensis*) and few-flowered fingergrass (*Digitaria pauciflora*) have more restricted distributions (Table 1).

Five federally listed animals, Florida panther (*Puma concolor coryi*), key deer (*Odocoileus virginianus clavium*), key rice rat (*Oryzomys palustris* pop. 1), eastern indigo

snake (*Drymarchon couperi*), key ringneck snake (*Diadophis punctatus acricus*), and lower keys rabbit (*Sylvilagus palustris hefneri*), use pine rocklands either for foraging or nesting (Bradley and Gann 1999). Pine rocklands are particularly important foraging habitat for key deer (Carlson et al. 1993). Florida leafwing (*Anaea troglodyta floridalis*), lesser wasp moth (*Pseudocharis minima*), Bartram's scrub-hairstreak (*Strymon acis bartrami*), and two species of rare katydid (*Belocephalus micanopy* and *Belocephalus sleighti*) are among the many rare invertebrates found in pine rockland.

Range: Pine rockland is globally imperiled and extremely limited in distribution. In Florida, pine rockland occurs along the southern extreme of the Atlantic Coastal Ridge, or the Miami Rock Ridge, which extends from around downtown Miami southwest to Long Pine Key in Everglades National Park (Miami-Dade County); in scattered locations in the lower Florida Keys, most notably and extensively on Big Pine Key (Monroe County); and in a small isolated area in the Big Cypress National Preserve (Monroe and Collier counties). Pine rockland historically occurred in the upper Florida Keys; pine stumps and remnant species characteristic of pine rockland have been found in one area of Key Largo (Alexander 1953).

Similar physiognomic pinelands occur in the Caribbean, particularly in the eastern Bahama Archipelago on Grand Bahama, Abaco, New Providence, and Andros, with disjunct pinelands in the Caicos Islands (Correll and Correll 1982). These communities, while dominated by Caribbean pine (*Pinus caribaea*), are otherwise quite similar in species composition to Florida pine rockland (Correll and Correll 1982).

Urban development and agriculture have greatly reduced the extent of pine rockland. The condition of some extant pine rocklands has declined because of inadequate management or because they are isolated and confined by surrounding development that restricts the use of prescribed fire, a principal management tool. Everglades National Park supports 80 percent of Florida's remaining pine rocklands in Florida (Loope et al. 1979). Only about two percent (2,273 acres) of the original Miami-Dade County pine rockland (approximately 126,500 acres) remains outside Everglades National Park (URS Corporation Southern et al. 2007).

Natural Processes: Pine rockland is maintained by regular fire, and susceptible to other natural disturbances such as hurricanes, frost events, and sea-level rise (Ross et al. 1994). Fires historically burned on an interval of around 3 to 7 years (Wade et al. 1980; Snyder et al. 1990; URS Corporation Southern et al. 2007) and was typically started by lightning strikes during the frequent summer thunderstorms.

Presently, prescribed fire must be periodically introduced into pine rocklands to sustain community structure, prevent invasion by woody species, maintain high herbaceous diversity (Loope and Dunevitz 1981), and prevent succession to rockland hammock. The degree of woody understory growth is directly related to the length of time since the last fire. The ecotone between pine rockland and rockland hammock is abrupt when regular fire is present in the system. However when fire is removed the ecotone becomes more gradual and subtle as hammock hardwoods encroach into the pineland (Wade et al. 1980).

Hurricanes and storms can have a major impact on pine rocklands. High winds can significantly affect plant structure or composition by causing canopy and subcanopy mortality (Platt et al. 2000), resulting in subsequent stimulation of shrub or herbaceous growth. Pine rocklands near the coast may be temporarily inundated by saltwater during severe storm events which can kill or damage vegetation (Snyder et al. 1990; URS Corporation Southern et al. 2007). Rare frost events bringing below-freezing temperatures can reduce tropical hardwoods. Because tropical and subtropical plants in pine rocklands are more exposed to below-freezing temperatures in the relatively open understory, they are more likely to succumb to freeze damage than their counterparts in sheltered rockland hammocks. The area of pine rockland in the Florida Keys has been reduced since the 1930s (Ross et al. 1994). This is at least partially due to increased ground and soil salinity resulting from a 15 centimeters local rise in sea-level that has occurred since that time (Ross et al. 1994).

Community Variations: Pine rockland occurs in three distinct areas: the Miami Rock Ridge, the Florida Keys, and the Big Cypress area. The woody understory varies across this range. Big Cypress pine rockland contains more temperate species and is generally wetter than pine rockland on the Miami Rock Ridge or Florida Keys (Snyder et al. 1990). The Florida Keys pine rockland is more xeric due to lower rainfall and has a well developed subcanopy of silver palm, brittle thatch palm, and a higher percentage of tropical shrub species since many temperate species, such as running oak and coontie, reach their southern limits on the mainland. Many tropical shrub species such as devil's smooth-claw (*Pisonia rotundata*) do not extend to the mainland. The mainland pine rockland has a more diverse herbaceous layer due to a mixture of temperate species that do not reach the Florida Keys and tropical species not present in the Florida Keys such as tetrazygia.

Associated Communities: Pine rockland occurs mainly in a mosaic with two other natural community types: rockland hammock and marl prairie. Pine rockland grades into and, in the absence of fire, succeeds to rockland hammock. Many species occur in both habitats; these include locustberry, Florida thatch palm, and poisonwood. Pine rockland differs from rockland hammock in having an open pine canopy rather than a closed, hardwood canopy. Pine rockland can also occur within lower, seasonally flooded marl prairies on the Miami Rock Ridge. These marl prairies differ from pine rockland in having no pines, and an understory dominated by grasses and sedges, typically hairawn muhly (*Muhlenbergia capillaris*) and sawgrass (*Cladium jamaicense*), and a minimal cover of shrubs. In areas where pine rockland is close to the ocean it may be bordered by mangrove swamp or salt marsh and can receive flooding by extremely high tides.

Pine rocklands on the northern Miami Rock Ridge grade into scrub and sandhill vegetation where the three communities intermix in areas with deep sands and rock outcrops (Snyder et al. 1990). On the northwestern edge of the pine rockland range, in Big Cypress National Preserve, pine rocklands occur in a mosaic with wet flatwoods. Pine rocklands can be distinguished from wet flatwoods, scrub, and sandhills by the presence of exposed limestone rock and the presence of rare plant species characteristic of pine rockland (Table 1).

Management Considerations: Prescribed fire is the most important consideration in pine rockland management and should be administered every 3 to 7 years to maintain community structure and to prevent the community from succeeding to rockland hammock. Although hardwood species are a natural component of pine rockland, without fire they tend to increase in cover and reduce the amount of light penetrating the forest floor (Wade et al. 1980). Over time, shading from hardwoods will reduce herbaceous diversity, and a period of just 10 years without fire may result in a marked decrease in number of herbaceous species. Exclusion of fire for 25 years will result in gradual hammock development over that time period, leaving a system that is very fire resistant (Robertson, Jr. 1953; Wade et al. 1980).

Prescribed fire can be difficult to administer because of urban interface issues related to public perception and smoke management. Alternatives to prescribed fire, such as mechanical removal of woody vegetation are less ecologically effective, as they do not mimic post-fire nutrient cycling processes (URS Corporation Southern et al. 2007) and the woody debris generated must be removed to prevent organic soil development (URS Corporation Southern et al. 2007). Use of heavy equipment can damage soils and herbaceous vegetation, and large-scale removal of vegetation debris could inadvertently include removal of non-target species and propagules.

Shading from and competition with invasive exotic plants for limited resources can be a problem in pine rocklands. Brazilian pepper (*Schinus terebinthifolius*), Burma reed (*Neyraudia reynaudiana*), natal grass (*Melinis repens*), and more than 100 other non-native plant species have invaded many pine rocklands (Possley and Maschinski 2006; URS Corporation Southern et al. 2007). Prescribed fire, herbicide application, and manual removal are all useful tools to remove invasive exotic species. The fragmentation of pine rockland in the Miami area and the Florida Keys increases the risk of invasion by exotic plants along the interface with disturbed or developed areas.

Exemplary Sites: Ludlam Pineland (Miami-Dade County), Navy Wells Park (Miami-Dade County), Long Pine Key in Everglades National Park (Miami-Dade County), National Key Deer Refuge on Big Pine Key (Monroe County)

Global and State Rank: G1/S1

Crosswalk and Synonyms:

Kuchler	105/Mangrove 16/Subtropical Pine Forest
Davis	3/Southern Slash Pine Forests 1/Coastal Strand
SCS	2/South Florida Coastal Strand 9/Everglades Flatwoods
Myers and Ewel	Subtropical Forests - subtropical pinelands
SAF	111/South Florida Slash Pine 74/Cabbage palmetto
FLUCCS	411/Pine Flatwoods 419/Other Pines

Table 1. Rare plant species (FNAI Tracked) in Florida pine rockland.

Species Occurring on Both the Mainland and Florida Keys	Species Restricted to the Mainland
<i>Argythamnia blodgettii</i>	<i>Alvaradoa amorphoides</i>
<i>Basiphyllaea corallicola</i>	<i>Amorpha herbacea</i> var. <i>crenulata</i>
<i>Bourreria cassinifolia</i>	<i>Brickellia mosieri</i>
<i>Byrsonima lucida</i>	<i>Chamaesyce deltoidea</i> ssp. <i>adhaerens</i>
<i>Chamaesyce garberi</i>	<i>Chamaesyce deltoidea</i> ssp. <i>deltoidea</i>
<i>Chamaesyce porteriana</i>	<i>Chamaesyce deltoidea</i> ssp. <i>pinetorum</i>
<i>Coccothrinax argentata</i>	<i>Colubrina cubensis</i> var. <i>floridana</i>
<i>Crossopetalum ilicifolium</i>	<i>Digitaria pauciflora</i>
<i>Forestiera segregata</i> var. <i>pinetorum</i>	<i>Eupatorium villosum</i>
<i>Hypelate trifolia</i>	<i>Galactia pinetorum</i>
<i>Jacquemontia curtissii</i>	<i>Galactia smallii</i>
<i>Jacquinia keyensis</i>	<i>Ilex krugiana</i>
<i>Linum arenicola</i>	<i>Ipomoea microdactyla</i>
<i>Phyllanthus pentaphyllus</i> var. <i>floridanus</i>	<i>Lantana depressa</i> var. <i>depressa</i>
<i>Pteris bahamensis</i>	<i>Linum carteri</i> var. <i>carteri</i>
<i>Sachsia polycephala</i>	<i>Linum carteri</i> var. <i>smallii</i>
<i>Spiranthes torta</i>	<i>Polygala smallii</i>
<i>Stylosanthes calcicola</i>	<i>Ponthieva brittoniae</i>
<i>Thrinax morrisii</i>	<i>Selaginella eatonii</i>
<i>Tragia saxicola</i>	<i>Tephrosia angustissima</i> var. <i>corallicola</i>
<i>Tripsacum floridanum</i>	
Species Restricted to the Florida Keys	
<i>Caesalpinia pauciflora</i>	
<i>Catesbaea parviflora</i>	
<i>Chamaecrista lineata</i> var. <i>keyensis</i>	
<i>Chamaesyce deltoidea</i> ssp. <i>serpyllum</i>	
<i>Odontosoria clavata</i>	
<i>Pisonia rotundata</i>	
<i>Savia bahamensis</i>	
<i>Strumpfia maritima</i>	

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Ludlam Pineland (Miami-Dade County)

Photo by Gary Knight