Fire and Vegetation In the Everglades

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TO BEGIN WITH, I'd like to limit the area and topic. I'll be dealing with the vegetation of that part of southern Florida which has some affinities with the West Indies. You can think of it, if you wish, mainly as the area south of the Tamiami Trail, realizing that some of the vegetation types, such as the mangroves and tropical hardwood forests, extend considerably north of that line on particular sites, especially those that have some natural protection from frost.

Of the vegetation that occurs within this area, I will ignore cypress, and also the vegetation of acid sandy sites. These types are more typical of places farther north in the Southeast and perhaps someone else will be tackling them. The acid sand vegetation within this area includes some pine flatwoods that reach northern Monroe County and about to Miami, some sand pine scrub that once occurred south to Miami, and some peculiar scrub-like vegetation without sand pine that is found on Marco Island and at a few other places on the Gulf coast. These I will omit entirely.

I intend to describe in a brief, generalized way the five or six major kinds of vegetation that occur in this area which, in many ways, can be described as "south of the South." It's surprising to note the number of treatments concerning aspects of the biology of the southeastern United States that come to a confused halt somewhere around Lake Okeechobee. Southern Florida gets mentioned, if at all, in a footnote. I will try to describe the

major kinds of plant cover in this area and indicate some of the things that seem to govern their occurrence, emphasizing, of course, the place of fire in the picture. Along the way I'll show some slides that may make more sense than my discourse.

At the beginning I'd like to make two points. These are important because they establish the context that may justify my appearance on this program. The first is that the vegetation of southern Florida is not well understood. In any modern ecological sense, it could be called almost unknown. Even in a natural history sense published information is very inadequate. Several factors help to explain this. Much of the area has been difficult of access until fairly recently. Its flora is unfamiliar to most American botanists. And its timber resources were too limited or too remote to justify much attention from the Forest Service.

I'm aware that a several-page bibliography of titles (including one or two that I'm guilty of myself) dealing with the vegetation of southern Florida could be compiled, but the sum of all of these contributions leaves a great deal unsaid. It is just my bad luck, I suppose, that a small group like this should include two men who have contributed notably to what literature there is. Perhaps, however, it will illustrate the state of affairs to point out that after 35 years Dr. Roland Harper's paper is still perhaps the most useful comprehensive account of southern Florida vegetation; and, twenty years later, Dr. Phillips' paper on Castellow Hammock is still one of the few in print from which one can learn what plants actually occur in a given stand.

My companion point is: although present information is poor, in many cases it will have to suffice, because the natural vegetation is disappearing so rapidly. The imminent obliteration of the native plant cover of southern Florida has been proclaimed periodically for at least 50 years. When you think of what they still had in those happy times before the bulldozers, it seems quaint to read Charles Torrey Simpson and John K. Small prophesying doom *circa* 1910. However, they weren't wrong. The straws that they saw in the wind have become haystacks in the last few years.

At least two vegetation types that probably were unique

on earth, the Custard Apple swamps of the south side of Lake Okeechobee and the cypress-Royal Palm forest of Collier County, either have disappeared or are so mangled that it's doubtful that any sort of ecological reconstruction can be made. The information in print about these vegetation types is so poor that it is difficult to determine even what they looked like. The rockland pine forests of southern Dade County, and the tropical hammocks of the Upper Florida Keys are rapidly headed in the same direction. In the Keys, the course of development seems likely to leave not only few native plants, but very little of the original land forms. The people that inhabit such places can scarcely be said to live in southern Florida. They occupy the space where southern Florida used to be.

It's true that sizable areas held as sanctuaries by the State and Federal Governments, the Audubon Society, and others presumably will always bear natural vegetation. As most of you know, however, much of this area is affected by some unsolved, and perhaps unsolvable, problems of water supply which make it hazardous to predict what sort of vegetation may be there fifty or a hundred years from now.

Having thus disposed of southern Florida vegetation, I'll proceed to try to interpret it. I have part of a speech prepared, and will read it. After that I must make do with sketchy notes. It will be merciful and humane if you interrupt me with questions whenever you feel like it.

I also should say that I came to the study of vegetation by a somewhat devious route and my route, for better or worse, didn't include any very telling indoctrination in the orthodoxy of plant ecology which, I think, may be evident.

Although large parts of southern Florida are still wilderness of sorts, one does not find the pristine simplicity of vegetation usually associated with concepts of the "natural area." There is instead a vegetational mosaic in which stands of greatly different physiognomy and composition are juxtaposed in bewildering fashion, often with sharp junctions between the various plant cover types. The tendency has been to regard the area as "recovering" and to attribute the present pattern to the

effects of human disturbance upon an originally more uniform plant cover. I cannot agree with this view. It's true that the nature of the country permitted both the Indian and white man to disturb areas far beyond his zone of effective cultural occupation. I believe, however, that the mosaic occurrence of plant communities in southern Florida truly reflects an equilibrium reached through interaction of the available flora with an unusual array of natural environmental factors, and that man-caused disturbances have been merely additional elements exerted against an already established pattern of vegetation. Man-caused fires have modified the pattern to some extent. Drainage, through its indirect effects upon fire and salt-water encroachment, and its direct effect in altering the plant cover potentialities of lowland sites, may have disturbed the original conditions enough to set vegetation in motion toward some new equilibrium. These effects, however, have developed gradually over the past fifty years. Clear evidence that vegetation is responding to the new conditions exists, but as yet this has only blurred the original pattern, not obliterated it.

In some regions the available flora may be free to establish its own balances and major natural environmental disturbances may be too infrequent or local to be of much significance. Under such conditions plant communities are species-groups selected by competition with regard to the regional range of climate and edaphic conditions. Insofar as these conditions can be modified toward uniformity by the effects of the stand upon the site, the communities may tend to form seres that converge toward some more or less uniform terminal stage. It is soon evident that vegetation in southern Florida is far less in control of the situation.

The mosaic pattern of southern Florida vegetation cannot be explained by reference to variations in soil or climate. Vegetation in southern Florida was never able to exploit its potentialities for establishment of a more uniform terminal plant cover to the point where development was impeded by edaphic or climatic factors. Instead, the progress of plant succession was regularly checked by forces that are features of the natural

environment. The most effective of these are fire and hurricane. To some extent they complement one another in relative importance at inland and coastal sites respectively. The natural mosaic of vegetation in southern Florida resulted from the interplay of tendencies for plant succession and the succession-retarding influences of factors in the natural environment.

Two points of view are possible in an ecological consideration of this sort of situation. One would emphasize the observed or inferred evidence of successional relations between various elements of the mosaic. The other would emphasize the controlling role of natural disturbances.

Dr. John Davis, in his various studies, has stressed the potentialities of vegetation in an undisturbed southern Florida environment. He finds evidence that without disturbances, succession would result in a convergence of seres to the familiar regional monoclimax. Some of the successional tendencies that Dr. Davis presents can be seen clearly in present stands. Others are almost entirely inferred. The point that seems important to me is that one can find little indication that plant succession in southern Florida can now or ever did establish any sort of uniform climax vegetation in the face of the existing environment.

Although southern Florida is an area of extremely low relief, elevation as it affects the extent, periodicity, and duration of flooding is the primary factor determining the type of plant cover that can develop at any site. Vegetation within the region may be divided into upland and lowland types despite the fact that the topographic scale embraces a total range of no more than twenty-five to thirty feet. The upland types are those whose occurrence depends upon adequate elevation above tidally or seasonally flooded areas which are occupied respectively by mangrove swamps and by sawgrass and other freshwater marshes.

The upland types are pine forests, tropical hammock forests, and bayheads. The elevations necessary for their occurrence may be features of the original topography such as the Miami limestone ridge, the marl soil hurricane rampart along

parts of the south coast, and some of the shell-beach ridges. They may be vegetation-induced elevations built up by peat deposits. Or, they may be anthropic features such as Indian shell mounds, road shoulders, and spoil banks.

Elevation as it affects flooding exercises primary control over plant cover potentialities of a given site in southern Florida. Within the upland and lowland vegetation groups, the potential plant cover is affected additionally by the position of the site in relation to climatic gradients of increasing frequency of destructive frosts northwestward, and decreasing rainfall southwestward; and also by the location of the site relative to the coast. Within all of these limits the actual plant cover at a given place and time is largely determined by the history of disturbance by fires and hurricanes.

In my opinion plant succession in southern Florida can't be discussed usefully without clear recognition of the controlling role of elevation in determining the potentialities of a site. I can see little relation between upland versus lowland sites and upland versus lowland vegetation. It's possible, of course, to deduce logical relationships and to construct a long-time pattern of succession which will unite all vegetation types and bring a uniform climax to all sites. No matter how logical such a structure may be, however, it seems meaningless if the necessary conditions never, or but rarely, occur in nature.

It is logical, for example, to assume that peat deposits by a mangrove forest will elevate the site until it is enough above the influence of tidal flooding to support tropical hammock. The actual occurrence of such a successional shift is indefinitely delayed at most sites, however, by the effects of slowly rising sea level. Depth of mangrove peat exceeding fourteen feet occur at some sites that are still occupied by mangrove forest. That such a succession could logically occur seems of very little importance in the face of the strong probability that it will not occur on any sizable scale in southern Florida under present conditions. I conceive my present objective to be the thumbnail description of existing vegetations, and of observable relations between them.

The vegetation of southern Florida can be divided into about six broad, general types: four forests—pine woods, hardwood hammocks, bayheads, and mangrove swamps; and two grasslands—the marshes of the Everglades and the coastal prairies. These six cover most all the area that still has natural vegetation, and most present stands can be put without much strain into one of these pigeonholes. I wish to emphasize that these are merely convenient categories for discussion rather than plant communities in the usual sense. In most cases fairly distinct subtypes can be recognized.

I will make no attempt to analyze the vegetation types distinguished in terms of theories of plant association. In fact, I wouldn't know how to approach it because every existing stand in southern Florida has a long and complex history of natural disturbance and we know very little about even the recent part of these histories.

I think the slides can be started now.

The first thing I wish to do is dispose of types that have little relation to fire so far as we know. One of these is the mangrove swamp forest. This is a picture of the mature mangrove forest on the Gulf coast at the mouth of Shark River as it was before Hurricane Donna. It is a mixed forest, not a zoned forest—all three species of mangrove occur in it. It's a forest of big single-stemmed trees that reach about four feet d.b.h. and eighty to ninety feet in height.

The next slide shows the south edge of the Everglades where it meets the coastal mangrove belt, scattered shrubs of Red Mangrove in a marsh that is largely *Eleocharis*. This is one place where fire may affect the relations of mangrove vegetation to other vegetation tyes of southern Florida. Egler has suggested that Glades fires burning down toward the mangrove edge may be one factor that limits inland extension of Red Mangrove. Possibly that is true, but within the years of the Everglades National Park, which include some extremely bad fire years, we have no record of a fire that burned that far toward the coast. It may happen, but we are yet to see it.

QUESTION FROM THE AUDIENCE: Is this a peat deposit?

No. The little tree island at the left-hand side of the slide may occupy a peat elevation. The general level of the marsh is shallow marl over Miami Oolite limestone.

The main control upon what mangrove vegetation can do in southern Florida is provided by occasional intense hurricanes. This slide shows what plant succession has accomplished at a site on Cape Sable in the twenty-five years since the hurricane of 1935. Before the storm this was an open, orchard-like forest of Black Mangrove. In the quarter century since almost no vegetation recovery has occurred.

Here is another area devastated by the 1935 storm in which you can see the standing dead snags of the pre-'35 *Avicennia* forest, and the new growth of *Rhizophora* that had come up by 1960. Since that time this area has been slugged again, by Hurricane Donna, and again no living vegetation exists here.

This is a view of the creek into Cuthbert Lake taken several months after Hurricane Donna. I don't know how generally appreciated it is that Donna caused a tremendous kill of mangroves on the south and southwest coasts of Florida. We have something of the order of 50 square miles of mangrove swamp on the Park which is presently in this condition, at least several hundred square miles in addition where the mortality of mangroves amounted to 50 per cent or more of the stand.

The other vegetation, that I'd like to dispose of now, is also a coastal type, the so-called coastal prairie. It is found on Cape Sable, in the interior of some of the islands in Florida Bay, and as a belt behind the mangrove farther north along the Gulf coast. It is a mosaic within a mosaic, so to speak, including stands of tall *Spartina* bunch grasses, low mats of *Sporobolus* and other grasses of that type, patches of yucca, patches of various shrubs, and areas of *Batis* and *Salicornia* and other halophytes such as are shown here. One would immediately assume that this was a recently disturbed area, that such a mess could scarcely be natural vegetation.

I don't have much idea how these coastal prairies may have originated. Pretty good evidence exists, however, that, odd and mixed-up as they appear, they have been there for a long

time. A fairly distinct subspecies, or perhaps species, of bird, the Cape Sable Sparrow, is closely associated with this vegetation. This suggests that the habitat is old enough for this sort of evolution to occur.

Hurricane Donna put eight to ten feet of water over some island stands of Buttonwood. You might think that would make it saltier than ever, and perhaps it should have. The major vegetation change following Donna that we've been able to see, however, is that some sites previously barren because of high salt concentration began to produce vegetation for the first time since anybody has been much aware of the area.

This shows one of the small stands of coastal prairie in the center of a key in Florida Bay, and I like the picture because it proves the only case I know of a brood of three young Bald Eagles being fledged from a single nest in southern Florida. This slide was taken in central Florida Bay. The vegetation of the centers of these keys closely resembles the so-called Flamingo or Cape Sable prairie.

We can proceed now to the hinterlands of southern Florida and look at some of the places where fire has been and is important.

This, of course, is a pine forest, the sort of pine woods typical of the northern part of the Miami Rock Ridge from just below Miami to Homestead. Here, perhaps because of more frequent fire, most pine stands lack the dense and floristically complicated shrub understory typical of the southern parts of the mainland pine ridge, and also of pine woods in the Lower Florida Keys. Let's see the next slide, please.

Here is a fairly typical pineland view on Long Pine Key where the hardwood understory is well developed. This shrub understory is a sampling nightmare. It contains about 75 species of woody plants of which some 20 species are dominant locally, and it varies enormously from place to place with no logic that I have been able to fathom. The short-term effects of fire on such a type are to burn back the palmettos and fire-prune the hardwoods, killing very few of them. Most of the woody plants

that occur as a shrub stratum in the Long Pine Key pine woods grow as trees in the adjacent hardwood hammocks. A relatively small proportion of them are naturally of shrub stature. The other isolated bit of rockland pine forest occurs in the Lower Florida Keys. A large part of the pine forest in the Lower Keys has a fairly continuous 10- to 25-foot understory of two kinds of fan palms. It is actually a pine-palm forest.

The rockland pine vegetation of southern Florida has sometimes been connected rather tenuously with the rest of the long-needle pine forests of the Southeast. I presume it has some relation, but it should be pointed out that the closest facsimile occurs not in the U.S. but on the northern islands of the Bahamas. The vegetation type that Bahamians call "the pineyard" is almost identical with the single exception that it lacks Saw Palmetto.

Limestone outcrops at the surface in all of the pine areas of far southern Florida. John K. Small, in trying to describe the area on his first visit to Long Pine Key, remarked that the surface consisted chiefly of holes. I don't think that description can be much improved upon.

In the pine rocklands, the intensity of the fire depends almost altogether upon the length of time since the previous fires. Fires can be fairly low and innocuous or they can be hot enough to kill most of the overstory pines.

The first noticeable vegetational event on new pineland burns in southern Florida is an outburst of bloom by the native herbaceous flora. In areas unburned for as little as three or four years, most of the low pineland flora is subdued and inconspicuous. Within a few weeks after a late winter or spring burn, however, a tremendous show of bloom occurs in the pinewoods. Burns about a year old typically have stands of tall grasses. Some of the principal grasses that follow fire in southern Florida are *Andropogon glomeratus*, *A. cabanisii*, *Muhlenbergia filifera*, and *Sorghastrum secundum*. This grass stage emerges into prominence typically for only one season. After two or three years the shrub understory has largely recovered,

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Fig. 3. Typical growth of fall bunch grasses in pine rockland on Long Pine Key, Everglades National Park, during the first year following winter control burn. Area to the right of the road has pre-fire understory of West Indian hardwoods.

perhaps with even more stems than before, and the pineland looks just about as it did before the fire.

This slide gets us into the tropical hammock forest, the interior of a Long Pine Key hammock. When I say hammock I mean merely a mixed forest of hardwoods, particularly as it occurs in southern Florida, and imply nothing else. Several things are important in considering this forest type. In the first place, most of the plants that enter into it are West Indian. They represent a rather haphazard assortment of West Indian plants, the ones that became naturalized in southern Florida being those whose propagules were most able to traverse the water barrier. Some of the confusing distribution patterns of individual species of hammock hardwoods in southern Florida may be related simply to the length of time that the species has been established.

The other point of importance is that the two climatic gradients within southern Florida strongly affect the composition and appearance of this forest type. As mentioned earlier,

these are the roughly northwestward gradient of increasing frequency of damaging frost, and the southwestward gradient, toward Cape Sable and out the Keys, of decreasing annual rainfall. At the north end of southern Florida mixed stands of south-temperate and tropical hardwoods occur. In the Miami and Long Pine areas, for example, such plants as Live Oak, Hackberry, Red Mulberry and Persimmon enter the hammock stands.

Another thing to be said about the tropical components of this forest type is that they are principally species that in the West Indies occur in the coastal dry forests. Tropical hardwood forests of southern Florida do not closely resemble the West Indian source stands except in the central and western Florida Keys. There one finds open stands of hardwoods that are mostly deciduous in the dry season and some of the hammocks include cacti. The Lower Keys hammocks closely resemble stands that occur in the south coast dry belts of Cuba, Jamaica, Puerto Rico, and the Virgin Islands, and throughout the Bahamas.

Hammocks in the area of higher rainfall around Miami and on Long Pine Key, however, are much more luxuriant than the West Indian source stands. You would seldom see a West Indian forest containing Gumbo-limbo that presented so luxuriant an aspect as this. The West Indian forests that have the closest botanical relations to southern Florida hammocks are open stands with low, spreading trees, leafless for much of the dry season. In southeastern Florida stands that include many of the same species are moist, closed forests, and their trees tend to be evergreen. I don't know just now what sort of relationship can be shown in ecological classification.

I might say a word about what little is known of succession within the southern Florida hammock forest type. Several of the trees involved seem definitely to be pioneers. Live Oak, Wild Tamarind (*Lysiloma*), and Mahogany are examples. These species are prominent in most of the present stands and do not reproduce well in their own shade. Given enough time without disturbance some of the more tolerant West Indian hardwoods, such perhaps as Mastic, might replace the pioneer

species. This may have occurred to some extent in the big hammocks along the east coast in the Miami area, which had probably been free of fire for longer than any other hardwood forests of southern Florida. On most sites, however, succession is regularly interrupted by fire at the Live Oak or *Lysiloma* stage, and the process starts over again.

Let's go rapidly through the rest of the slides and I'll make only a few brief comments.

This is the outside of one of the Mahogany hammocks in the southern Everglades. The palm is *Paurotis wrightii,* or Tree Saw Palmetto. The next picture shows the interior of the same hammock with one of the big Mahogany trees that measures close to five feet d.b.h. This particular stand and most of the others of this type was badly mauled by Hurricane Donna.

This is a view of the interior of Paradise Key about fifteen years after the 1945 fire. Long-established hammocks have a considerable depth of organic soil. Once the soil is ignited, fire creeps through it until put out by rain and the trees are either windthrown or killed by roots being burned off. The snags in the picture are dead Live Oaks.

This hammock west of Homestead formerly was surrounded by pine forest. The slide conveys some impression of the way hammocks occurred, and it also shows what has happened to most of the rockland pine forest of southern Florida.

This is a typical hammock pineland junction. The cliff-like edges appear to be due to the repeated pruning of hammock encroachment by fire.

This is the same contact zone in an area free of fire for about seven years. Speaking very generally, a period of ten to fifty years without fire, depending upon site differences, is sufficient for the establishment of a continuous hardwood understory in any of the southern Florida pinelands. The next slide shows the way in which tree islands, or bayheads, occur in some parts of the glades. Here, too, the character of the contact zone appears to be determined mainly by fire.

Glades fires in areas where the substrate is marl rather than peat have no very obvious effects. In some of the higher

glades a considerable show of grasses occurs on one-year old burns. By the next season, the site looks about as it did before the fire.

I guess that all that remains is to try to point out why I think the southern Florida vegetation mosaic is a natural pattern produced and maintained by periodic disturbance. Until a few years ago, some doubt existed about the occurrence of natural fires in the Everglades, although many bits of evidence suggested it. Ash layers interbedded with Everglades peat have been reported but little definite information is available. These certainly suggest the occurrence of intense fires in the distant past. The concentration of endemic herbaceous plants and small shrubs in fire-maintained vegetation types is strong indirect evidence for long ages of periodic burning. Since 1951 when lookout towers overlooking large areas of the glades were established in the Park, we have logged some fifty fires as lightning caused. In a number of cases the strikes and subsequent fires were observed.

Fires have undoubtedly become more frequent in southern Florida since the country was settled by Indians and then by white man. I think there can be little doubt, however, before the first white man, enough lightning fires occurred to maintain large areas of fire-adapted vegetation.