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Dear Bob:

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INTERAGENCY REPORT NASA-148

VEGETATIVE CHANGES CAUSED BY FIRE IN THE FLORIDA FLATWOODS AS OBSERVED BY REMOTE SENSING*

by

W. T. Mealor, Jr.**

and

Merle C. Prunty, Jr.**

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Sincerely yours,

W A Fischer

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Research Coordinator
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**Department of Geography, University of Georgia

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ABSTRACT

VEGETATIVE CHANGES CAUSED BY FIRE IN THE
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W. T. Mealor, Jr. and Merle C. Prunty, Jr.

Fire as a modifying agent used to suppress the growth of some vegetation and promote the growth of other plants has been recognized and studied for many years. The flatwoods of Florida are no exception; they have been subjected to repeated burning since before the arrival of the white man.

The purpose of this paper is to discuss the nature of the flatwoods and the role that ground fires have played in maintaining them. Emphasis is placed on the areal and temporal extent of burns as recorded uniformly by remote sensors.

Thermal infrared, color infrared, and ektachrome imagery were obtained from sensors flown by a NASA aircraft at 15,000 feet over a test site in Osceola County, Florida, in March 1968. The overall pattern of burning can be sequenced and mapped uniformly from the imagery. By comparing the various imagery, areal and temporal extent of burned areas can be determined. The authors believe that remote sensed imagery provides more accurate and areally comprehensive media for assessing the impact of ground fires on the landscape of the flatwoods region than are available from any other data source.

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W. T. Mealor, Jr. and Merle C. Prunty*

Fire as a modifying agent used to suppress the growth of some vegetation and promote the growth of other plants has been recognized and studied for many years. The flatwoods of Florida are no exception; they have been subjected to repeated burning since before the arrival of the white man.[1] The use of fire in the flatwoods is still important and, as Garren has stated, "In many parts of this region present-day fires seem to exert an influence as great as that of climate and soil in determining the persistent type of vegetation."[2] It is the concensus of ecologists and botanists that the flatwoods would not be in existence if it were not for ground fires. If fires were eliminated, a climax forest of evergreen and deciduous hardwoods would become dominant in less than twenty years.[3] Thus the flatwoods of Florida can be considered as a pyromorphic sub-climax type, held in this state by fires of cultural origin.

The purpose of this paper is to discuss briefly the nature of the flatwoods and the role that ground fires have played in maintaining them. It must be noted that the fires under discussion are <u>ground</u> fires, not tree-crown or forest fires. Although the relationship of fire with flatwoods has been studied by many scholars from many disciplines, the areal and temporal extent of the burns as recorded uniformly be remote sensors have not been studied. Therefore, this discussion stresses remote sensed imagery and its use in determining the areal and temporal extent of fire in relation to vegetative changes in the Florida flatwoods.

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The Flatwoods

The flatwoods cover approximately 50 per cent of peninsular Florida.[4] They are characterized by a relatively open canopy composed of one or more of three pine species, which are long leaf, pond, and slash pines.[5] Ground cover is primarily an association of palmetto (Serenoa repens) and wiregrass (Aristada stricta) with various other grass and brush scattered throughout. Interspersed within this typical and areally dominant vegetation complex are a variety of other phytomorphic types, including: 1) hammocks: a cluster of broadleaf deciduous and evergreen hardwoods that form a closed canopy and are located on slightly elevated and better drained sites; 2) scrub vegetation: including various small oaks, gallberry bushes, and numerous other brush usually not in excess of twelve feet in height; 3) bayheads: occupying slightly depressed areas that are subjected to periodic flooding, they contain bay trees, some cypress, and moisture tolerant hardwoods; 4) cypress domes: occupying sites similar to bayheads, but containing only cypress; 5) strands: located along stream courses and containing hardwoods and cypress; 6) swamps: much larger areas of standing water than bayheads and strands and containing hydrophytes.[6]

Soils of the flatwoods are somewhat poorly drained, predominantly thick acid sands with organic pans. These soils are not known for their fertility but, under proper management, can and do produce excellent forage.[7] Little cropping is done on them and grazing of cattle is, areally, the main economic enterprise.

Rainfall, although abundant and occurring in every month, is seasonally concentrated. Approximately 26 per cent of the total annual precipitation occurs from October through March. Normally, six inches or less of rain occurs from November through January compared with a total annual rainfall of greater than 50 inches.[8] It is during this season of reduced precipitation that the flatwoods are burned.

Because of the relatively warm winter season and adequate moisture, the native grass regrows rapidly after it is burned. Herein lies the rationale behind burning the flatwoods. Grass two years old and older is not palatable nor nutritious for cattle. The tops of the grass are dead and little green forage is available. In order to stimulate new growth of nutritious grass, ground fire is used to remove the dead grass in order to permit the new shoots to grow. Ash from the burn provides a quick "shot" of fertilizer. Usually the new grass has sprouted and can be grazed in at least six weeks after burning. In most areas of the flatwoods burning occurs on a given plot only every other year. The result of ground fires in the flatwoods is relatively nutritious forage for cattle during a season when, otherwise, feed would have to be supplied in another manner or from another source, such as hay.

Remote Sensing Rationale

The overall pattern of burning in a given area can be sequenced and mapped uniformly from remote sensed imagery. Also, vegetative changes subsequent to burning can be observed areally and temporally. By employing several types of remote sensors it is possible to compile relatively accurate information regarding the effects of burning by comparing the respective images. Thermal infrared, color infrared, and ektachrome color imagery were obtained from sensors flown by a NASA aircraft at altitudes of 3,000 and 15,000 feet in January and March of 1968 in order to study fire effects in the flatwoods. This imagery has proven satisfactory for the purpose of determining areal and temporal extents of burns.

The color infrared film, operating in a wavelength band of 0.5 to 0.9 microns, has proven to be highly useful. Its ability to penetrate haze makes it superior to the ektachrome. The red-producing of the color infrared film is sensitive to reflectance governed primarily by the structural characteristics of the plant mesophyll, thus giving excellent imagery in response to the growth and health conditions of the plant.[9] Plants in a growth stage are recorded in red tones while those that are dormant, unhealthy, or dead appear in tones of green or brown. This property makes the color infrared surprisingly accurate in determining age of grass regrowth, thus making it possible to calculate time lapse since the last fire.

Although the thermal infrared, operative at 8.0 to 14.0 microns, is usable in determining extent of recent burns, it is not accurate in determining extent or age of burns older than about three months. Being sensitive to the energy (heat) emitted from the plant, the thermal infrared will record recently burned areas in light tones (hot) while older burned areas of flatwoods will report in darker tones (cool) and strands, bayheads, and other unburned areas will report even darker (cooler).[10]

The ektachrome, sensitive to visible light reflectance and limited in its ability to penetrate haze, has not produced as good imagery contrast as has the color infrared film.

Imagery Analysis: A Case Study

The imagery presented as Figures I and II is from NASA Mission 67 of Test Site 165 flown March, 1968, at an altitude of 15,000 feet over an area in northeastern Osceola County, Florida, approximately 35 miles southeast of Orlando. Figure I is color infrared and ektachrome color is Figure II.

To the right center of both transparencies, showing in white, is a Corps of Engineer's drainage project. Traversing the imagery from bottom left to upper right is a stream. A highway is visible to the far right.

On the color infrared imagery the strand along the stream appears in shades of red (hardwoods in a growth state) interspersed with points of green (dormant cypress). It is nearly impossible to discern these differences on the ektachrome.

The area appearing in dark green in the center of the color infrared imagery is flatwoods that were burned during the third week of October, 1967. The overstory of pines registers in red. In comparing this area with the burned flatwoods north of the stream, one can discern differences in green tones. The northern area was burned in February, 1968, and thus has a greater accumulation of ash and less vegetative cover, cause it to reflect less light; thus it appears darker than the southern area.

The same areas appear in shades of gray and brown on the ektachrome. There is a definite distinction between the two areas, yet the contrast is not as great as on the infrared.

Compare these burns with the area between the highway and the October burn and with the area west of the February burn. All areas are flatwoods; however, the area along the highway experienced fire during the burn season of 1965 while the western area was burned one year later. Note on the infrared that the ground cover of the older burn responds in more greenish tones than does the 1966 burn. This is due to the greater amount of dead vegetation. The 1966 burn still shows in tones of red, due to the growth state of the ground vegetation.

Comparison of one and two year old burns on ektachrome color film is most difficult. There is insufficient contrast to allow accurate determination of the age of burns. All that can be noted is that the areas were not burned during the most recent burn season.

To the northwest of the stream is an open area containing broomsedge (Andropogon virginicus). Fire swept part of this area in January, 1968, and the remainder one year earlier. The boundary between the two burns is distinguishable on both frames. However, the contrast on the infrared is more vivid.

One problem with the ektachrome imagery is that burned areas, showing in gray and black, can be confused with moist areas. Although the infrared will record some moist areas in tones of green and blue, they tend to be much darker than the burned areas.

The use of ground fires is a definite hinderance to the propagation of trees, especially hardwoods. Repeated burning on a two or three year rotation will prohibit even the fire tolerant south Florida slash pine (Pinus elliottii densa) from propagating.[11] Usually ground fires do not invade excessively moist sites such as bayheads or strands. However, fire will burn along the edges of these types and prevent them from spreading to more mesic sites. Note on the infrared imagery the contrast between the burned and unburned areas along the fringe of the strand. This contrast is not as evident on the ektachrome. Over a period of years fire has encroached on the hardwoods and has permitted wiregrass, palmetto, and pine to become established in these enclaves.[12]

The conical shapes of cypress domes are a result of fire retarding the growth of thos trees on the outer fringes of such stands. Those trees in the center are seldom reached by fires, thus they attain greater heights.[13]

Conclusions

Remote sensors have provided imagery capable of recording the areal and temporal extent of burns in the flatwoods of Florida. To date, the authors believe that remote sensed imagery provides more accurate and areally comprehensive media for assessing the impact of ground fires on the landscape of the flatwoods region than are available from any other data source. Color infrared film has proven to be highly effective in providing contrast between burns of different ages. Also, identification of phytomorphic types is relatively clear-cut on the color infrared film.

Color ektachrome, recording objects in their "true color", is helpful in providing a check for the infrared. The main drawbacks to the ektachrome have been its inability to penetrate haze and its lack of tonal contrast among older burn areas.

The ability of thermal infrared to distinguish "hot" and "cold" spots is helpful in determining the extent of recent burns. Ground fires in progress are recorded in remarkedly sharp areal detail on thermal infrared. Unfortunately, thermal infrared sensors presently available do not have great powers of resolution and, therefore, cannot record clear-cut boundaries for burned areas of different ages unless employed at quite low altitudes.

In using remote sensing to observe the influences of ground fire on vegetation, one must be cognizant of the seasonal growth characteristics of plants, their response to fire, and how they will record on the imagery. At this stage in the use of remote sensed imagery, in other words, a certain amount of ground control data is essential. When additional imagery from the spring, summer, and fall season becomes available, as expected, the role of ground fire on the annual growth patterns of vegetation in the flatwoods can be better analyzed. From this knowledge of fire patterns and vegetative responses, it may be possible to develop recommendations for more efficient and extensive use of the native Florida flatwood rangeland.

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FIGURE 1

Color Infrared Imagery, NASA Mission 67, Site 165, Flown March 1968.

FIGURE 2

Ektachrome Color Imagery, NASA Mission 67, Site 165, Flown March 1968.