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Detecting Melaleuca Trees and Stands in South Florida

Individual trees and a variety of melaleuca stands can be identified on color infrared transparencies in sufficient detail for subsequent mapping.

Abstract: *The results of a pilot study designed to determine the feasibility of using photographic remote sensing to delineate* Melaleuca quinquenervia *in south Florida are presented. Three film types and several photo scales have been evaluated on two test sites. Preliminary results indicate that individual trees and a variety of melaleuca stands can be identified on color infrared transparencies in sufficient detail for subsequent mapping.*

Introduction

Melaleuca quinquenervia, commonly known as cajuput punk tree or paper tree, was first introduced to south Florida from its native Australia in the early 1900's. During the elapsed period of time, melaleuca has become a naturalized species of south Florida. The initial expectation was that melaleuca could be used as a resource base for a new forest products industry. This objective has not as yet been realized. Its use is limited to windbreaks and living fences. Because of its distinctive bark and tree form, melaleuca has long been used as an ornamental. It is considered a desirable plant by Florida beekeepers because it provides an abundant year-round source of nectar for their bees.

Under certain ecological conditions, melaleuca tends to grow faster than its common associates such as slash pine (*Pinus elliottii*, var. densa, Lit. & Dor.), live oak (*Quercus virginiana*, Mill.), and pond cypress (*Taxodium asscendens*, Brong.). Beyond the juvenile stage, melaleuca is very resistant to pests, frost, and fire. As a result, it has dominated or is threatening a significant part of the south Florida ecosystems. In addition, some residents of the surrounding areas have complained that vapor form melaleuca causes allergic effects.

There are no precise estimates of the land areas occupied by melaleuca in south Florida. Its spatial distribution pattern over time is also unknown. Past attempts to use satellite digital data to detect melaleuca stands on the ground have not been very successful (Capehart *et al.*, 1977).

The main objective of this study has been to explore the feasibility of photographic remote sensing in delineating melaleuca stands in sufficient detail for subsequent mapping.

Study Procedures

Description of Test Sites

Two test sites were selected to represent distinct ecotypes within the range of melaleuca (Figure 1). One site is located on the west coast of Florida, south of Ft. Myers; it includes a wide variation of vegetative cover in which melaleuca is present in gradients from none to pure stands. There are also residential areas, improved pastures, canals, burned areas, and land-fill pits. The second test site is located on the east coast of Florida near Hialeah

Photogrammetric Engineering and Remote Sensing,
Vol. 50, No. 1, January 1984, pp. 95-98.

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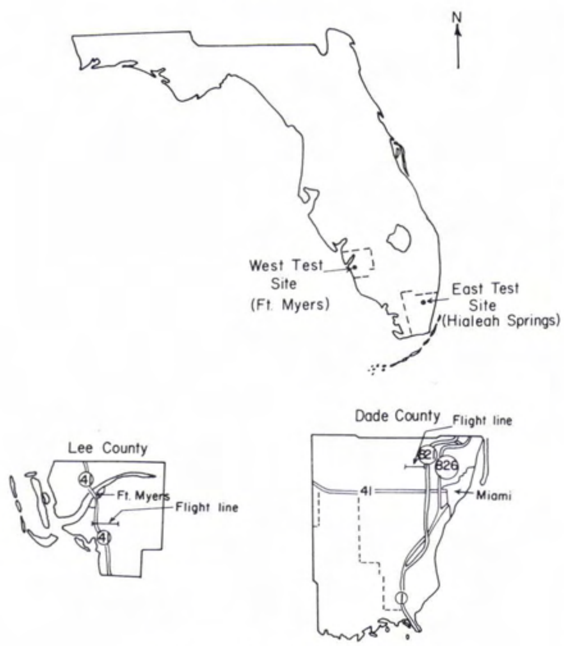

FIG. 1. The two test sites.

Springs. The east coast test site is characterized by sawgrass, interspersed by tree islands of willow, ficus, melaleuca, and various other types of lesser vegetation.

SPECTRAL REFLECTANCE READINGS

Airborne spectral reflectance data were gathered with portable spectroradiometers in the vicinity of the test sites. Measurements were made from an altitude of 500 feet above ground with a Cessna* 172 aircraft. Reflectance readings were taken on the sunny side of trees in pure stands of pine, cypress, melaleuca, and sawgrass.

During the same flights, 35-mm photographs were taken with Konica and Minolta cameras. The Konica (55-mm lens) was used to take color infrared photos with a Kodak ASA 100 film. The Minolta camera (lenses of 21 mm and 55 mm) was used for natural color photos (with Kodak Ektachrome 200 film and a polarizing filter) as well as black-and-white photos (with Kodak Panchromatic X 125 film).

Additional spectral reflectance measurements were made on the ground with a Beckman DK-2A Spectroreflectometer on branches and leaves of melaleuca, slash pine, palmetto, maple, oak, and elm.

AERIAL PHOTOGRAPHIC SENSING

A detailed study of 35-mm aerial photographs and transparencies along with information derived from spectral analysis data has provided helpful guidelines for planning the photo missions of the two test sites.

Three different films and several photo scales, ranging from 1:2400 to 1:24000, have been evaluated in order to determine their effectiveness in identifying melaleuca trees and stands. For stereovision purposes, there was a 60 percent endlap between photos along the flight lines. All aerial photos were along two six-mile east-west flight lines designed to include the widest possible diversity of ground cover conditions and ecotypes, among which melaleuca is found either in pure or mixed stands of all sizes. Only two flights were completed in the east site (Hialeah Springs) due to its proximity to Miami airport and the existing air traffic restrictions.

The following Kodak aerial films have been used:

Black-and-white panchromatic No. 2402
Natural color No. 2448
Color infrared No. 2443

Standard size (9 by 9 inch) prints were made from the black-and-white panchromatic film, while the natural and false color films were processed to positive transparencies of the same 9 by 9 inch size.

PHOTOINTERPRETATION

All black-and-white prints and the transparencies for natural and color infrared were carefully studied in the laboratory for preliminary assessment of the resulting images. Sharpness, texture, tone, shadow, and color were some of the characteristics considered.

The following photointerpretation devices have been used in this study: a small hand lens (4×), a pocket stereoscope (2×), an Old Delft scanning mirror stereoscope (4.5×), and a (1× to 20×) Bausch & Lomb zoom stereoscope.

Preliminary photointerpretation was checked thoroughly in the field. Ground observations led to corrections of the office work and improvement of the photointerpreters' ability to delineate associations of species found in melaleuca areas. Although not directly proportional, the ability of a trained photointerpreter to correctly identify features on aerial photographs of acceptable quality is affected by the photo scale.

RESULTS AND DISCUSSION

The results of this feasibility study indicate that melaleuca trees and stands can be identified on color infrared transparencies. The ability of photo interpreters to relate photo images to ground truth improves with their familiarity with field conditions. Color infrared film, originally designed to detect differences between live and dead vegetation, has exceptionally good haze-penetrating capabilities. It has been used successfully by others in forestry, agriculture, and horticulture to detect loss of vigor in plants due to various stresses such as pests, water, soil, and atmospheric conditions before they are ap-

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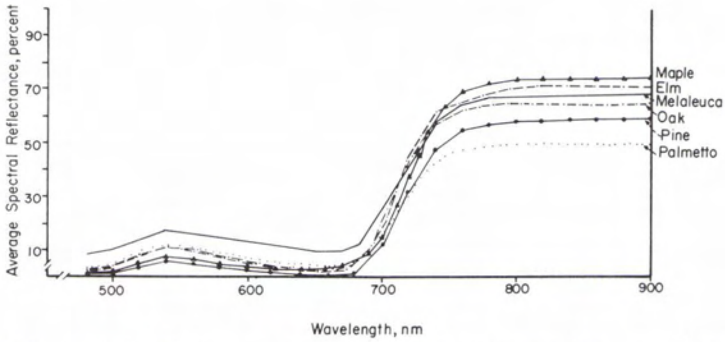

FIG. 2. Average spectral reflectance curves for six different species from ground measurements.

parent to the naked eye (Heller, 1971; Colwell, 1970).

Mean spectral reflectance values by species and wavelength from the raw data of this study are plotted in Figures 2 and 3. Results indicate that, for the visible portion of the electromagnetic spectrum (400 to 700 nm), spectral reflectance values for melaleuca were slightly higher than those for the other five species. In the photographic infrared region of the spectrum (700 to 900 nm), melaleuca reflects approximately the same energy as maple and elm, but it registers higher than palmetto, pine, and oak. A rather typical spectral reflectance curve for melaleuca is depicted in Figures 4 and 5.

Overall, color infrared photography proved to be much more effective than black-and-white and natural color in identifying melaleuca trees and stands. However, because the resulting transparencies depict false colors for most species, photointerpretation using this type of film must be thoroughly checked on the ground.

From the results of this study, it appears that, for tree species like melaleuca with a wide diversity of size and spatial distribution, a scale of about 1:12,000 may serve a multitude of needs. To take full advantage of color infrared film and possibly other remote sensing approaches, there is a need to study a wide array of spectral reflectance values obtained from diverse ecological conditions and alternative times of the year.

Both spectral reflectance values and resulting images of plants change with the time of the year (Hardisky *et al.*, 1983). Therefore, the extrapolation of specific results may be misleading without adequate verification on the ground. Detailed comparisons between 1:12,000 scale color infrared transparencies taken in February and those of April in the Ft. Myers test site indicate that winter photography is preferable for identifying melaleuca. The vigorous spring foliage of the various other species minimizes the winter contrast of melaleuca. In addition, during the winter in the areas where melaleuca grows the water level is relatively low, if not completely absent from the ground surface. Thus, the resultant winter image contrasts are much sharper and easier to interpret than those of other seasons.

Stereovision of color infrared images may annoy some interpreters because of minor color differences between the two images which interfere with proper focusing. In addition, field use of transparencies is restricted because, to interpret them, one needs a supporting table with fluorescent light. Thus, prints are more suitable for field use than are diapositives.

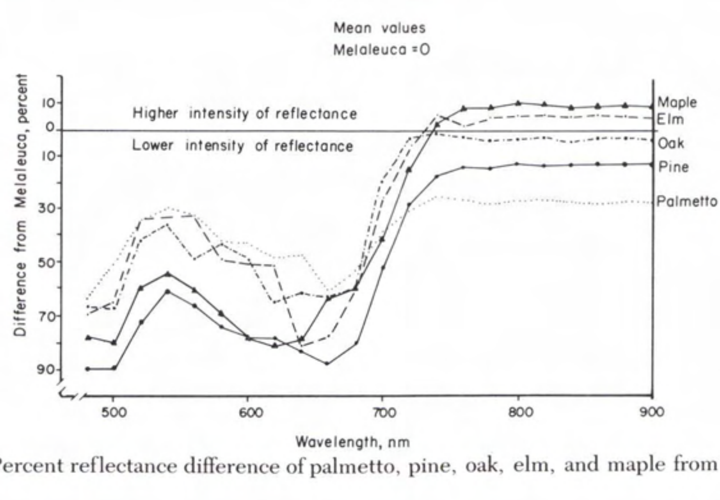

FIG. 3. Percent reflectance difference of palmetto, pine, oak, elm, and maple from melaleuca.

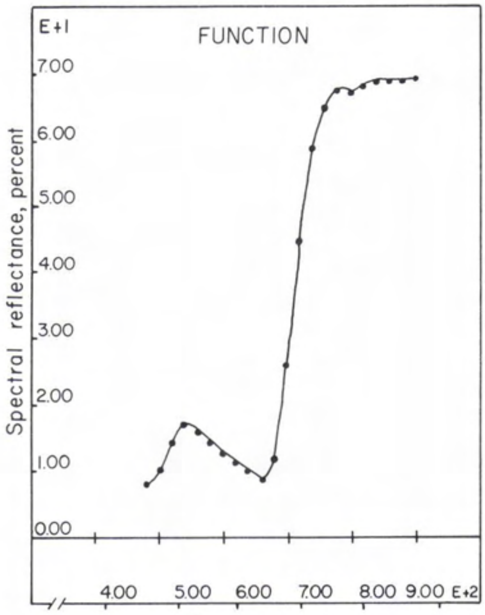

FIG. 4. Spectral reflectance curve for *Melaleuca quinquenervia* from ground samples.

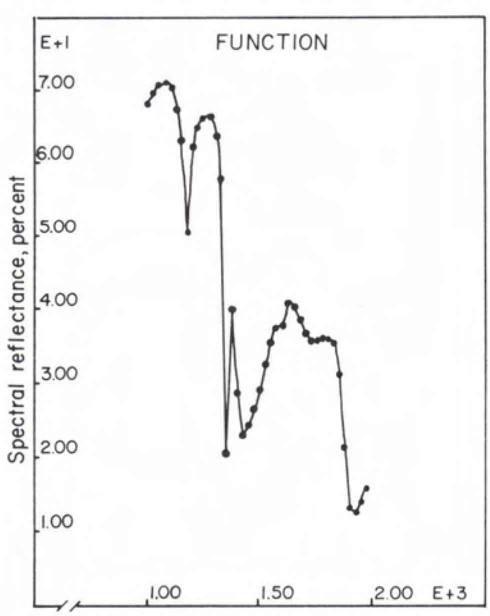

FIG. 5. Spectral reflectance curve for *Melaleuca quinquenervia* from ground samples.

Most of the aerial photography has been completed with a 6-inch focal length camera. For two flight lines of the east test site (scales 1:6,000 and 1:12,000), a narrow angle, 12-inch focal length camera has been used. The latter has produced sharper images with less edge distortions than those obtained with the 6-inch camera. However, to cover the same ground area a plane must fly at a higher altitude, in which case images on photos may be affected by larger layers of atmospheric haze, a common problem in the study area. On the other hand, use of a 6-inch focal length camera will increase the displacement of trees on the photographs, which may be desirable when height measurements are needed on a relatively flat terrain.

There have been speculations that uncontrolled growth and spread of melaleuca may seriously threaten the fresh water reservoirs of south Florida's wetlands. It is known that water and wet ground absorb infrared light to a high degree and produce sharp contrasting images on aerial photos. Thus, multidate aerial photography could provide a continuing record of changes in wetland ground conditions, which will document the rate and extent of melaleuca spread in the areas of concern. The frequency of coverage will depend on the objectives and the available resources.

Although recommendations for the most desirable photo scale will depend on specific objectives, it appears that, for melaleuca with a wide diversity of size and spatial distribution, a scale of about 1:12,000 may serve a multitude of needs.

Acknowledgments

Financial support for this study was provided by the State of Florida Division of Forestry through the U.S. Forest Service, Southeastern Forest Experiment Station. Spectral reflectance measurements from ground samples were analyzed at the University of Florida's Agricultural Research and Education Center, Lake Alfred.

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(Received 7 February 1981; revised and accepted 11 September 1983)