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APPLICATIONS OF AERIAL PHOTOGRAPHY AND REMOTE SENSING TO HYDROBIOLOGICAL RESEARCH IN SOUTH FLORIDA

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Recent technological developments in remote sensing instruments and aerial photographic techniques have opened a broad field for the study of hydrobiology and other natural sciences.

The U.S. Geological Survey in Miami is currently evaluating airborne data collected over south Florida including the Everglades. The research program, conducted in cooperation with the National Aeronautics and Space Administration and the National Park Service, has two goals:

1. The interpretation of airborne data to determine the relations between water conditions and biological populations in Everglades National Park, and
2. The development of new applications in natural resources research for data from remote sensors.

A preliminary scrutiny of airborne data, including infrared color, standard color, panchromatic and multispectral photography, and ultraviolet, infrared and radar imagery, has already led to some meaningful findings in Florida. For example, infrared imagery was used successfully to locate new submarine springs (F. Kohout, U.S.G.S., personal communication).

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PANCHROMATIC AERIAL PHOTOGRAPHY IN HYDROBIOLOGICAL RESEARCH

Panchromatic aerial photography has been suitable as an aid in solving certain hydrobiological problems. For instance, the authors have developed a practical and rapid technique for determining quantitatively the acreage occupied by various plant communities by using standard black-and-white photographs. This technique has been used successfully in the Shark River Slough of the Everglades National Park. Models, as illustrated in Figure 1, were compiled with a stereoplotter from aerial photography of the Slough taken in 1940, 1952, and 1964. Change occurred in the percentages of the forest (tree islands and river bank trees), sawgrass marshes, and shallow intermittent pond communities (Figure 2) in many portions of the Slough. A study of the causes of the plant community changes is underway, and factors under consideration are fire, drought, frost, variation of water levels in the Slough, and coastal salt-water intrusion.

This technique can be applied in other areas for use in such fields as ecology, forestry, and agriculture.

INFRARED COLOR PHOTOGRAPHY IN HYDROBIOLOGICAL RESEARCH

Infrared color photography seems to have considerable potential for use in hydrobiological studies. Brief experience has already shown that infrared color aerial photographs, taken at an elevation of 5,000 feet, aid in the delineation of fresh-water and salt-water marshes and red mangrove shorelines over large areas along the coast of Florida Bay (Figure 3).

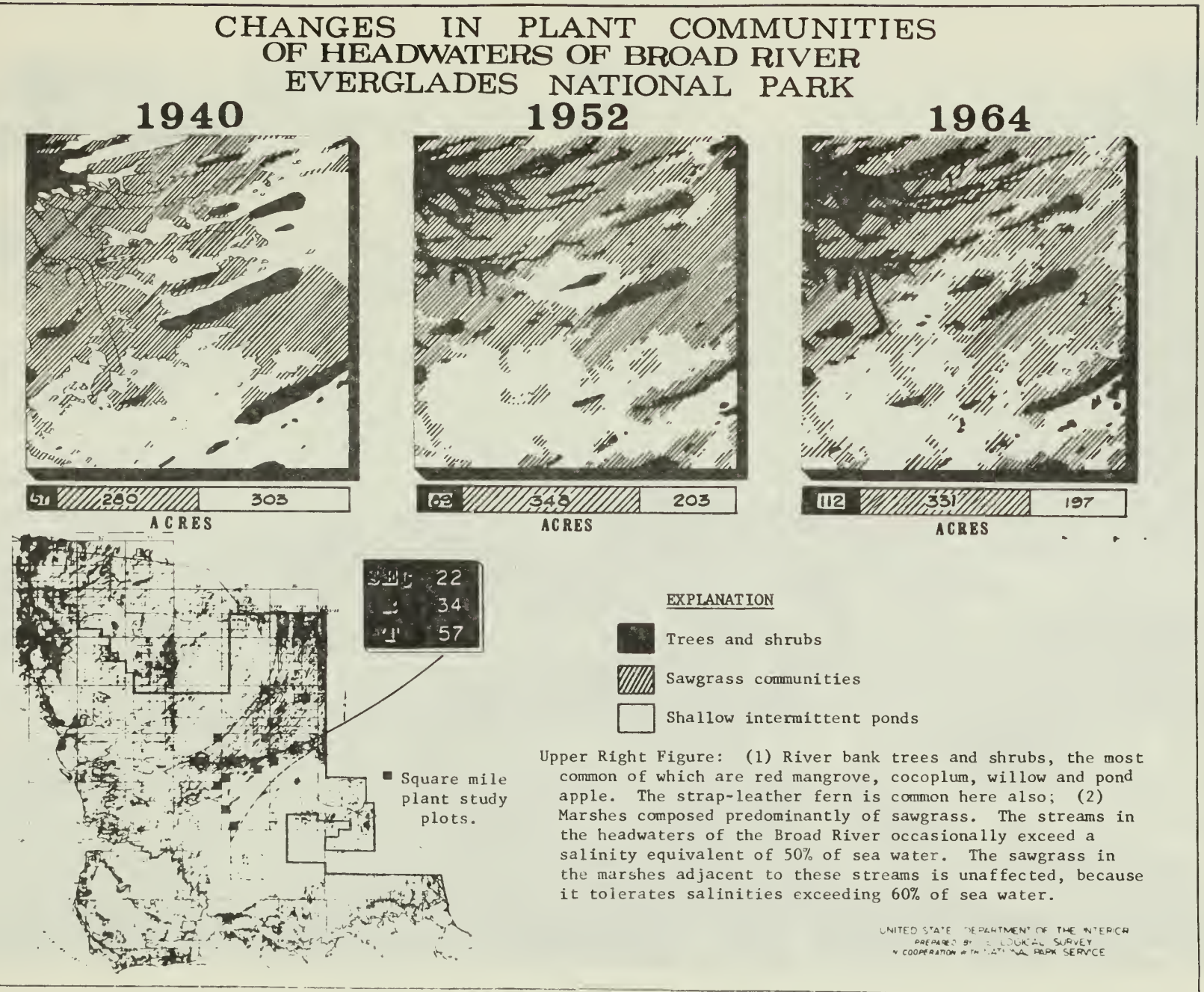


Figure 1. MODELS PREPARED ON A STEREOPLOTTER FROM PANCHROMATIC AERIAL PHOTOGRAPHS DEPICTING VEGETATIVE CHANGES IN THE HEADWATERS OF THE BROAD RIVER, EVERGLADES NATIONAL PARK.

Figure 2. AERIAL VIEW OF THE FRESH-WATER EVERGLADES DURING THE WET OR RAINY SEASON. THE DARKER AND ELEVATED AREAS ARE TREE ISLANDS OR "HEADS" THAT ARE INTERSPERSED AMONG THE SHALLOW INTERMITTENT PONDS AND SAWGRASS COMMUNITIES.

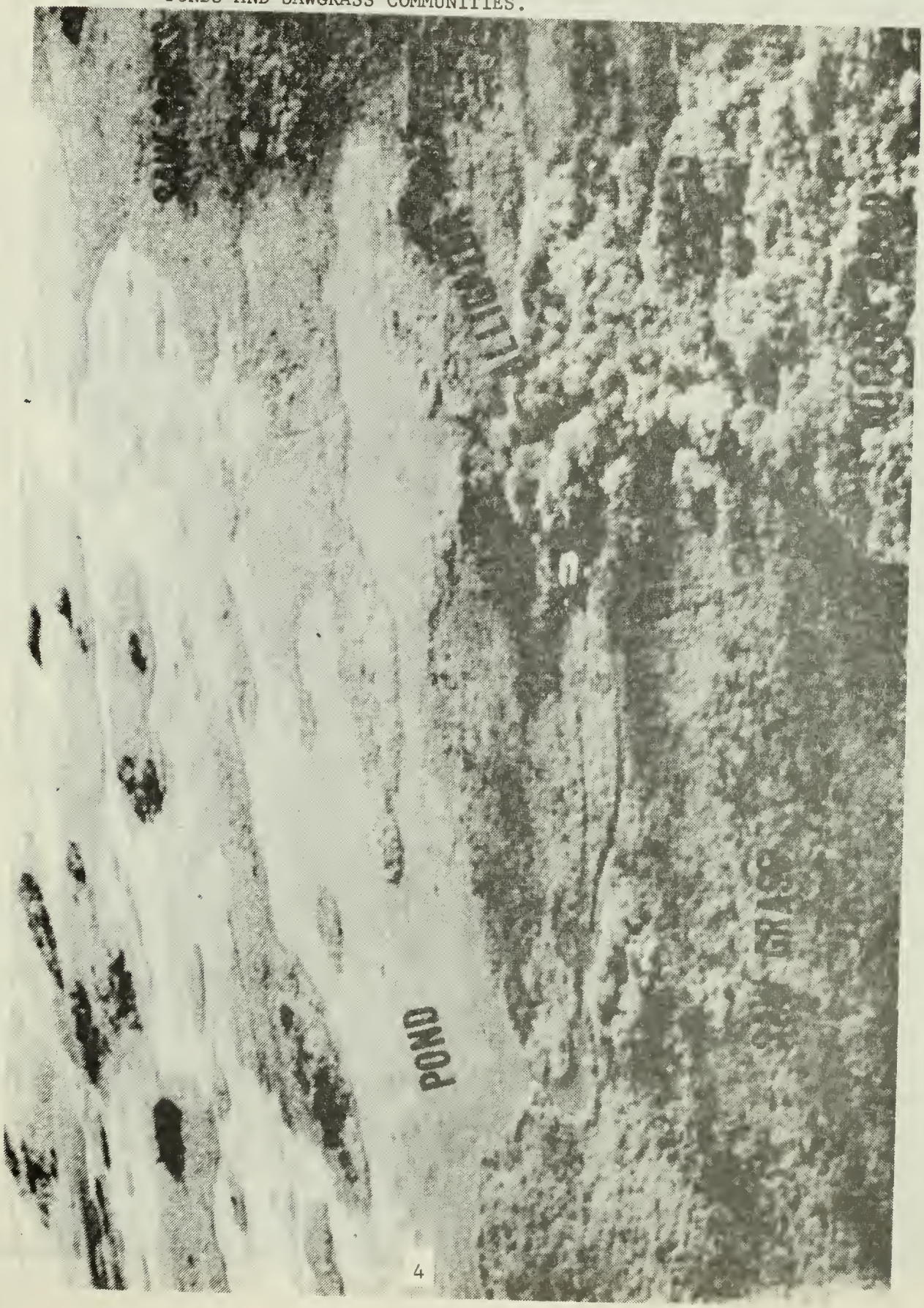
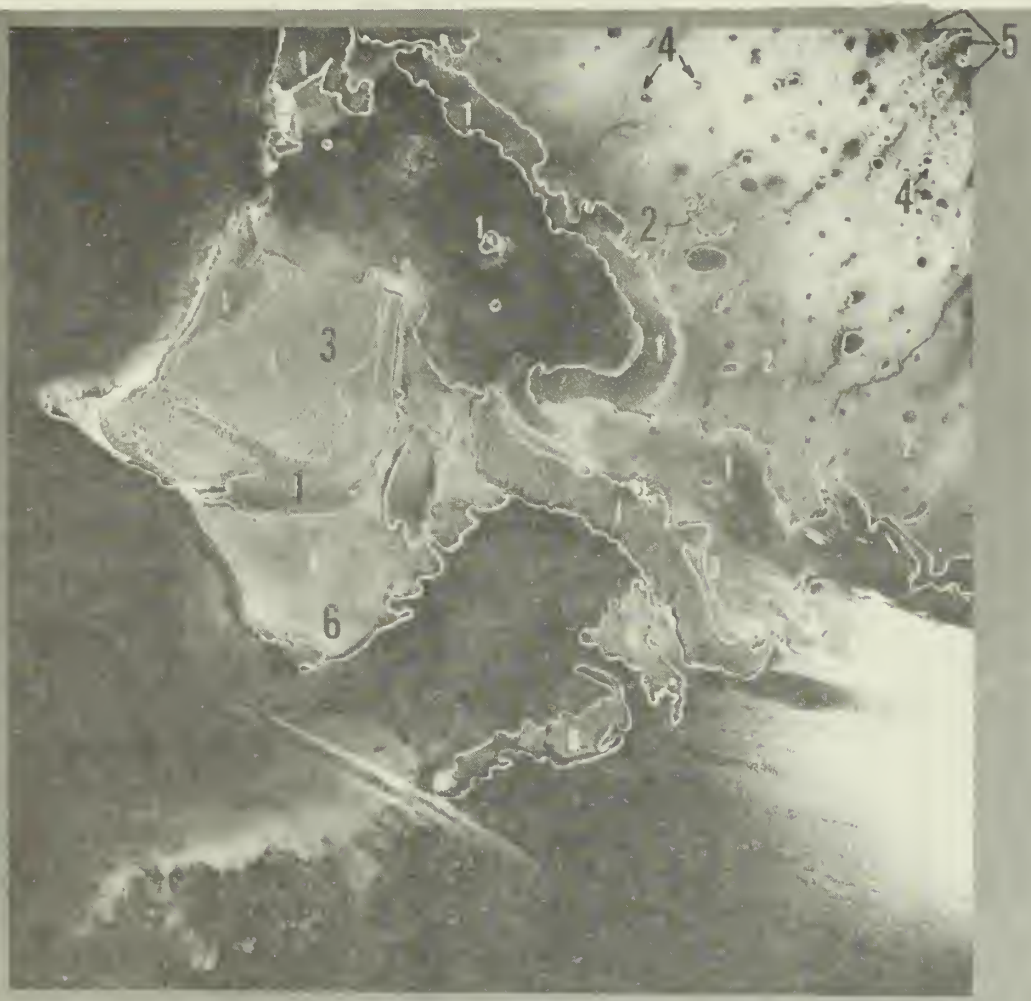


Figure 3. COASTAL VEGETATION IN THE FLORIDA EVERGLADES. VEGETATION IN THE INFRARED COLOR PHOTO AIDS IN DELINEATION OF FRESH AND SALINE WATER ENVIRONMENTS. THE HIGH INFRARED REFLECTIVITY FROM THE RED MANGROVE FORESTS (1, 2, AND 3) INDICATES MARINE AND BRACKISH WATER CONDITIONS. INLAND, THE LOW INFRARED REFLECTIVITY FROM SPARSER VEGETATION AND MARL SUBSTRATE (4) INDICATES A FRESH WATER HABITAT.



ALTITUDE 5000 FEET

EXPLANATION

1

DENSE MANGROVE JUNGLE. TREES UP TO 40' TALL. SYSTEMATICALLY FLOODED BY TIDES.

2

BRACKISH-WATER MARSH WITH SCATTERED DWARF RED MANGROVE UP TO 5' TALL. EACH SMALL DOT REPRESENTS AN INDIVIDUAL MANGROVE. WATER VARIES FROM ALMOST FRESH DURING HIGH RUNOFF IN AUTUMN TO SALTY IN SPRING.

3

MANGROVES LESS DENSE THAN (1). OCCASIONALLY FLOODED BY ABNORMAL HIGH TIDES.

4

ISOLATED GROUPS OF TREES INCLUDING MANGROVES AND FRESH WATER SPECIES.

5

EVERGLADES SAWGRASS ENVIRONMENT. PERENNIAL FRESH WATER ENVIRONMENT.

6

MUDFLAT EXPOSED AT LOW TIDE

NOTE: MANY VERY SMALL AREAS NOT DELINEATED FOR CLARITY.

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It is important to note that the appearance of each hydrologic environment on the photograph is based on the integrated infrared and other reflectances from an indicator vegetative community rather than on the salt content of the water. That is, the chloride, sodium, potassium and other ions that contribute to the total salinity of the water are undetectable by infrared color film. Our understanding is that if an ionic species selectively reflects, transmits, absorbs, or re-emits radiant energy, it occurs in one or more extremely narrow spectral bands. Even if some of the ionic spectral bands should fall within the broader sensitivity zone of the infrared color film, it is unrealistic to expect the low energy yield from the ions to act on the film emulsion.

SUMMARY AND CONCLUSIONS

Aerial photographs and remote sensing data can be valuable in hydrological and biological studies, especially where generalizations for large areas are required from limited field data and observations. In this connection infrared color film has the following desirable and undesirable qualities in relation to other films:

1. Infrared color photographs often permit the distinct delineation of plant community types. Along coastlines and in marshes land-water interfaces are sharply portrayed.
2. Infrared color photography taken at low altitudes, for example from a hovering helicopter, is considerably inferior to standard color photography for taxonomic identification in a plant community in the Everglades. The false colors of vegetation on the infrared color photograph make it difficult to distinguish ordinarily recognizable genera or species.

3. Ions and gases in water are generally unidentifiable by infrared color photography. However, the presence of an identifiable indicator can serve as a concentration index of a dissolved substance. For example, stenohaline fresh-water vegetation in an area indicates the presence of an extremely low chloride content in the water. Similarly, high turbidity in the water probably points to a low dissolved oxygen content. There is no substitute for data collection on the ground or in the water concurrently with the collection of the photographic data.
4. Infrared color photography used in conjunction with standard color photography greatly reinforces the skill of the researcher in the aerial photo-interpretation of aquatic and biological features.

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Organization	Branch, Section or Division
U.S. Department of Agriculture	Agricultural Research Service Entomology Laboratory Nematology Laboratory Plant Pest Control Forest Insect and Disease Control Forest Service Soil and Water Conservation
U.S. Department of the Interior	Geological Survey Water Resources Division
U.S. Department of the Army	Electronics Command Cold Regions Research and Engineering Lab
Canadian Department of Forestry	Forest Management and Services Inst.
Florida Department Agriculture	Division of Plant Industry
Florida State Road Department	Photogrammetry Section
State of Georgia	Georgia Forestry Commission
University of Maine	Department of Botany and Plant Pathology
University of Minnesota	Inst. of Agriculture, Department of Plant Pathology and Physiology
Cornell University	School of Forestry Department of Conservation
University of Florida	Inst. of Food and Agricultural Sciences
University of Georgia	Department of Botany
Eastman Kodak Company	Research Laboratories Sales and Service Division
Kocera and Associates, Inc. U.S. Sugar Corporation Color Technique, Inc. Data Corporation Itek Corporation Mark Systems Florida Crop and Livestock	Reporting Service