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Title of Project:

APPLICATIONS OF ERTS IMAGERY
TO INVESTIGATING LAND USE AND NATURAL RESOURCES

Contract # NAS5-21886

Progress Report Type I

August 14, 1973 - October 13, 1973

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INTRODUCTION

This Status I Report covers the period from August 14 to October 13, 1973. During this interim, effort has been concentrated on finalizing methodology and proceeding with final interpretation and analysis of ERTS data for several projects. These include photo processing methodology, a computer program to compare land use and soils data, a computer program to store ERTS interpretation data and integrate with LUNR data to demonstrate updating of an existing inventory, and a study to determine the rate of change in LUNR over five years to confirm a relative amount of change which might be interpreted on the ERTS data and a seasonal analysis study.

PROBLEM AREAS

Updating of LUNR with ERTS interpretation data does not seem feasible on a one-to-one category basis because the categories are not directly comparable. Detailed LUNR categories must be grouped for comparison with more generalized ERTS data. The land uses within the spectral categories defined from ERTS imagery do not always correspond with the land uses in the grouped LUNR categories.

The Long Island imagery has a lower contrast and greater density than any other imagery enlarged in the New York State test area. Since Long Island is a relatively small area of land mass surrounded by water, this possibly causes a problem with the scanning system. The lower contrast imagery decreases the spectral breakout in the color enhancement process and interpretation. Currently, a procedure is being investigated to correct the Long Island images to make all test areas comparable.

ACCOMPLISHMENTS

Photo processing techniques. The methodology for balancing and processing the original 70mm film chips has essentially been finalized. A separate report is being prepared which details the steps and materials necessary to balance density relationships between bands as well as improving contrast within each scene. It has already been demonstrated in the Type II Report that such steps are required to maximize the amount of information for interpretation as well as to balance density between bands to maintain color uniformity in the diazo composites.

Each of the three diazo films have been evaluated to determine the relationship between exposure time and density. The resulting curves were then used as a guide to set exposure values comparing the lowest average density on the black and white transparency (excluding water and clouds) to the exposure setting on the diazo film. Table I relates the lighted density on the original to a dial setting on the diazo machine (60 divisions on the dial) for each of the three diazo films. In this way, the equivalent density of the black and white transparency can be maintained on the respective diazo films. Figures 1-3 show the log density curve of the three diazo films. It is felt that this procedure permits equal mixing of the different hues to obtain a consistent color result based on the density in the black and white. Furthermore, it has resulted in much improved color contrast and consistancy in the composites.

COMPUTER ANALYSIS

Correlating land use to soil types. A computer program has been assembled to compare types of land use to underlying types of soils to determine whether there might be some correlation. Correlations were made on 800 hectares between 14 different types of LUNR land use categories and 27 SCS soil mapping units. Soils were categorized according to soil series, drainage, parent material, and capability class. Land use was lumped into three major categories in order to obtain sufficient sample size which include agriculture, forest, and residential. It was reasoned that, should some correlations exist, there might be some justification to investigate the use of ERTS data to relate surficial terrain features such as agriculture, forest, and wetland areas to generalized soil types. Unfortunately, no clear relationship was determined on the sample area which was examined. The area, however, supports mostly marginal agriculture; therefore, our sample probably was too small to warrent drawing any conclusions. These computer programs are being documented and will appear in the Final Report.

A computer program to store the interpretation of ERTS data according to UTM coordinates has been completed and is undergoing final testing with actual data taken from the interpretation of the Central New York test site area documented in the Type II Report. This program will permit cell-by-cell comparison of the ERTS data to the LUNR file system so that it is possible to either update the LUNR file with ERTS data or determine relative accuracy of the ERTS interpretation compared to that of LUNR. In order to establish an index for rate of change, a project was undertaken to update the LUNR file for Cortland County. The data has now been gathered and is currently being analyzed. It is hoped that some contrast can be derived to determine the relative rate of change in LUNR over the test area and thereby determine the accuracy level of the ERTS interpretation category by category. In addition, cells will be chosen at random over all the spectral categories for confirmation with field checking and airphoto analysis.

A seasonal analysis has been completed for the Central New York area. A literature survey indicated that seasonal changes in foliage reflectance should result in relatively uniform, low vegetative reflectance in early spring and late fall when deciduous trees are bare and most vegetation brown. It was hoped that urban and residential areas would show up well then. In early summer, vegetative reflectance would be higher, but relatively uniform. Late summer and early autumn were expected to have the greatest spectral variation due to a mixture of green, gold, and scenescent vegetation.

This analysis was attempted first using a single composite for the months of March (1973), May (1973), August (1972), and October (1972). The results of this were inconclusive. The study was repeated using four composites for each season, since these would contain more spectral information than one composite. A residential area near Syracuse and a rural area in the Otisco Valley were studied. ERTS categories were compared with LUNR totals to determine classsification accuracy. The imagery was interpreted at a scale of 1:250,000 and 1:24,000. The larger scale was more accurate so that data was used in the final analysis.

August and October were most closely comparable to LUNR data. For example, in the urban area, urban and residential categories were interpreted with 79.9% and 98.0% accuracy in August, and forest and agricultural areas defined with 94.5% and 91.9% accuracy in October. Apparently, the spectral diversity at these seasons aids in defining land use categories. Snow masked all categories in March, and in May only early greening areas such as golf courses were most accurately defined. Combining the most accurate composites from several seasons resulted in less accurate interpretation than use of single season composites. It was concluded that greatest interpretation accuracy could be achieved using either August or October imagery.

Rural hamlets were difficult to define, probably due to their many trees. Urban areas and water are difficult to separate at some seasons.

INTERPRETATION

Interpretation of the ERTS data for each of three separate geographical areas of New York State has now begun. These include Central New York (including the test site described in the Type II Report), St. Lawrence County in the Adirondacks and St. Lawrence River Valley region, and the northern end of Long Island. Composites have been constructed for at least two seasons for each of the areas based on the latest photo diazo processing steps discussed above. Comparisons will be made between the different areas as to accuracy of interpretation, type and number of spectral classes, and the type of composites required to determine the different spectral classes within and among the different geographical regions.

PREDICTION MODEL TO DERIVE COLOR COMPOSITES

Work has slowed on the project during this interim due to the lack of an adequate light transmission densitometer and the need to consult with some recognized experts in color theory. A new MacBeth TD-518 densitometer has been procured and plans are now progressing to try to establish the density and hue relationships necessary to construct the prediction model.

CONFERENCES

Dr. Ernest E. Hardy and James Skaley traveled to Purdue University to attend the Annual Conference on Machine Processing of Remotely Sensed Data held from October 16-18, 1973. Dr. Hardy presented a paper co-authored by Dr. James R. Anderson entitled "A Land Use Classification System for Use With Remote Sensor Data". The paper is published in the conference proceedings.

SIGNIFICANT RESULTS

1. Completion of the photo processing steps necessary to balance density and contrast within and between ERTS scenes.
2. Matching of density values of the enlarged black and white transparencies to the exposure curve of the different diazo films, thus producing composites with better color contrast and more consistent reproduction.
3. Completion of a computer program to store the ERTS data. This program is undergoing final testing prior to running correlations between ERTS and LUNR data banks.
4. Studying seasonal changes in two small test sites--one urban and the other rural to determine what changes occur in the ERTS scenes according to season. Final analysis is still incomplete.

PROJECTED ACTIVITIES

Completion of interpretation of ERTS data for the three geographical areas mentioned earlier. Comparison between areas in regard to accuracy of interpretation and repeatability of interpretation between regions.

Completion of a prediction model to derive composites with optimum interpretability.

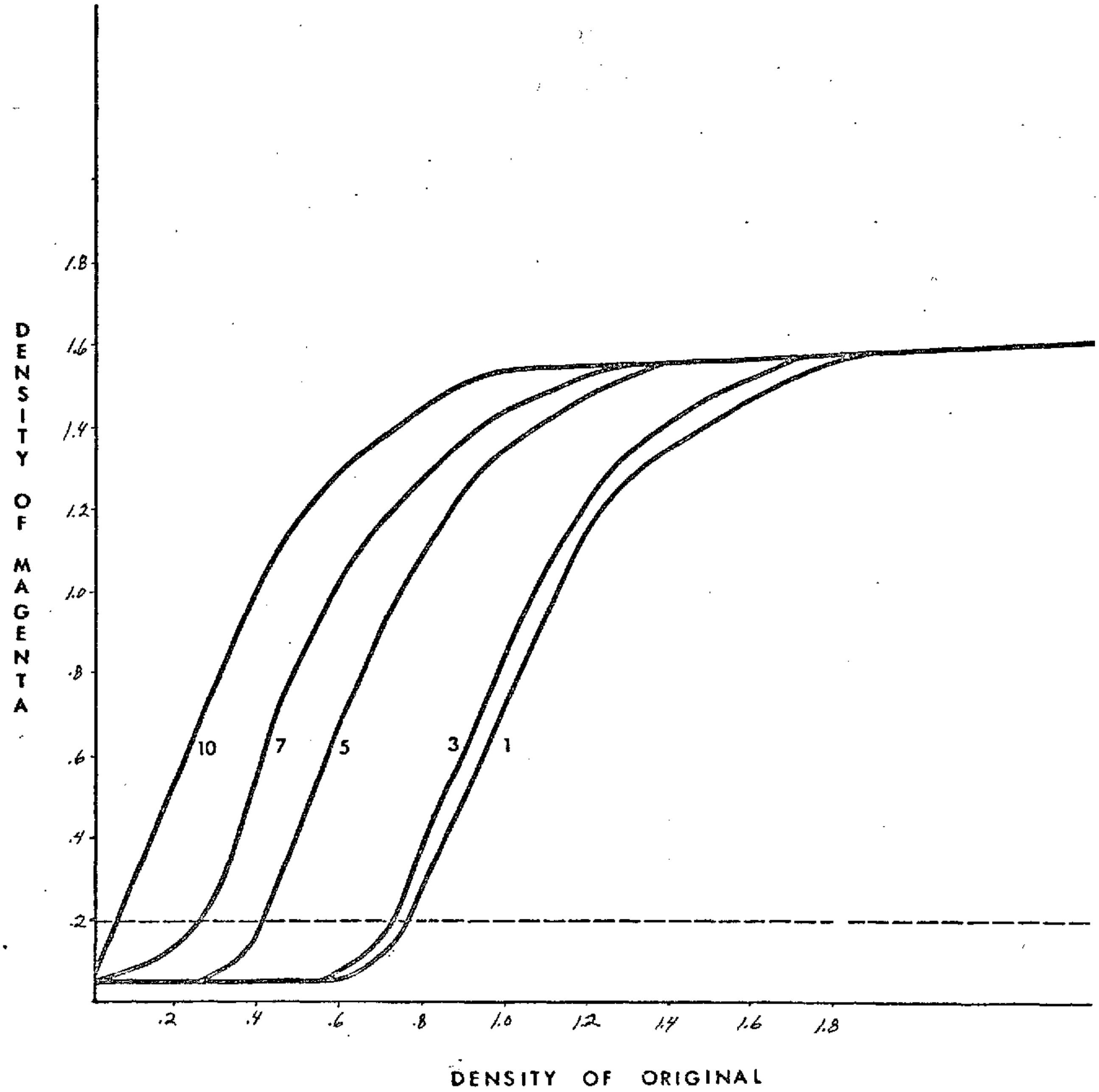
Completion of analysis of the effect of seasonal spectral changes on ERTS interpretation.

TABLE I

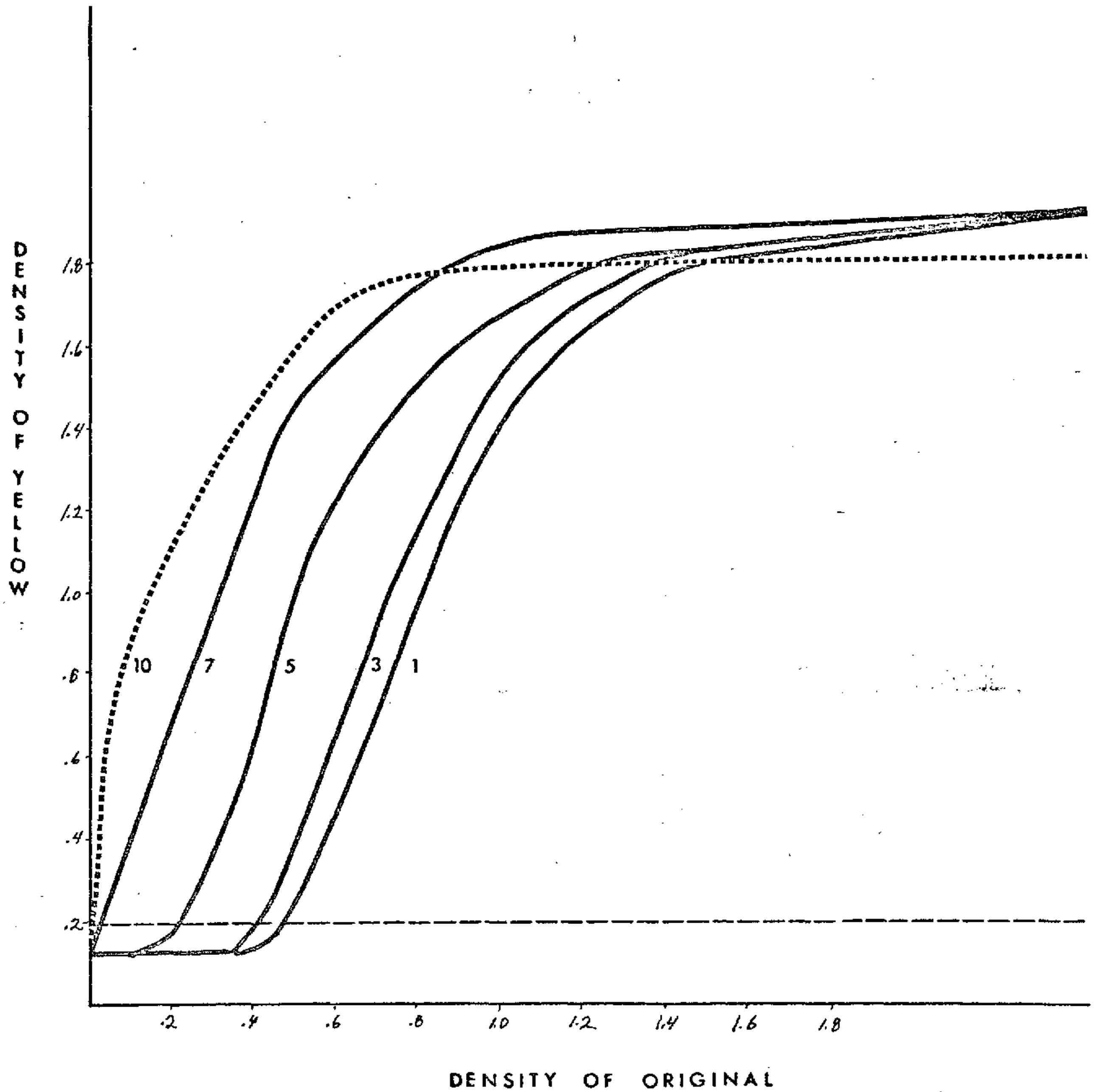
	Diazo Setting
Magenta	
$D > .72$	3
$.71 > D > .58$	4
$.57 > D > .42$	5
$.41 > D > .34$	6
$.33 > D > .26$	7
$.25 > D > .00$	8
Yellow	
$D > .40$	3
$.39 > D > .32$	4
$.31 > D > .22$	5
$.21 > D > .00$	6
Cyan	
$D > .60$	3
$.59 > D > .52$	4
$.51 > D > .44$	5
$.43 > D > .32$	6
$.31 > D > .18$	7
$.17 > D > .00$	8

The light density feature of the original black and white film (excluding water and clouds) are measured and recorded. This density is located in the appropriate color column, and the corresponding density bracket shows the correct diazo setting to use on a 60-step calibration dial (feet/second).

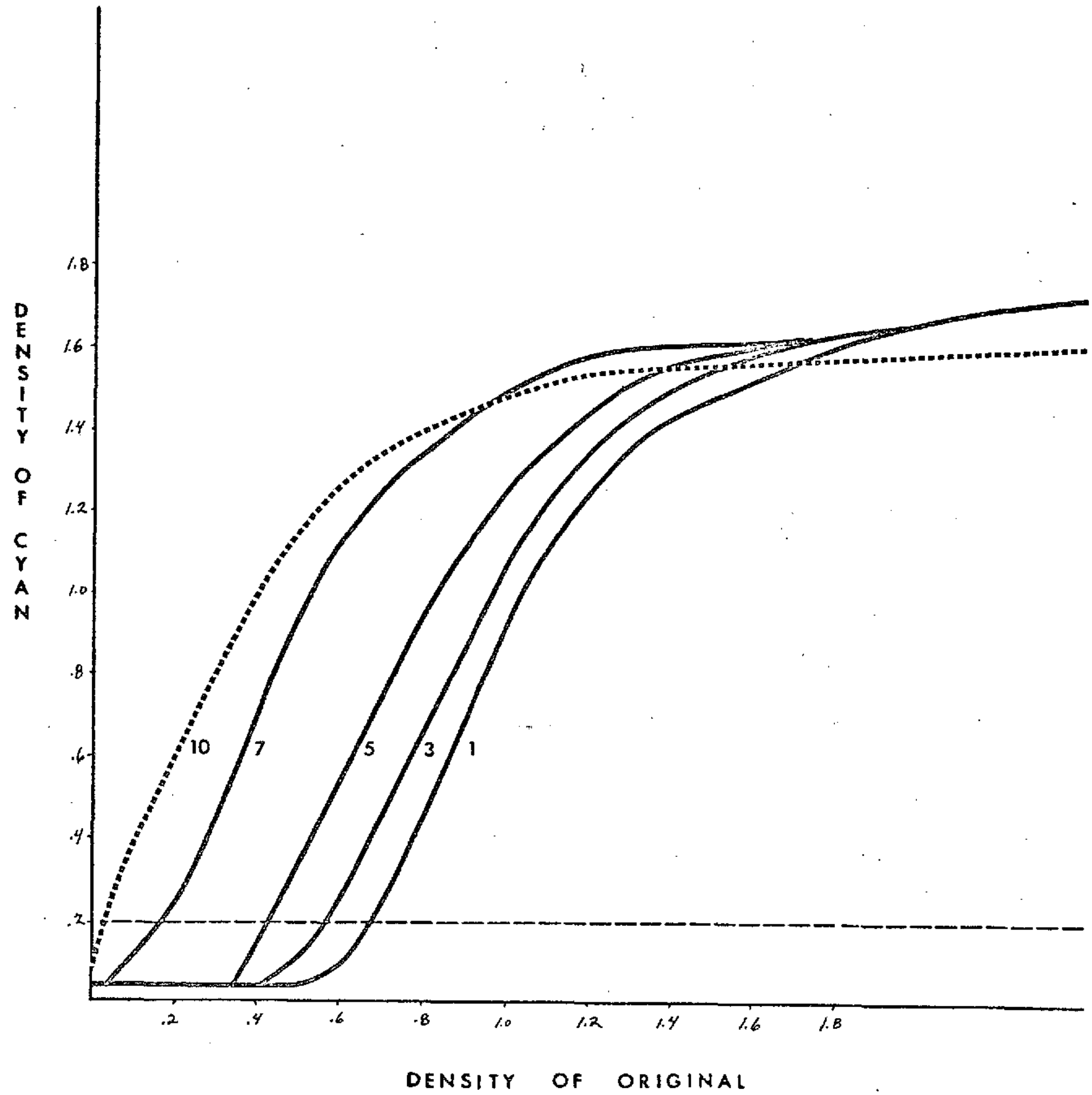
MAGENTA


DENSITY OF MAGENTA
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
10
7
5
3
1
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
DENSITY OF ORIGINAL

YELLOW


DENSITY OF YELLOW
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
10
7
5
3
1
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
DENSITY OF ORIGINAL

CYAN


1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
DENSITY OF CYAN
10
7
5
3
1
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
DENSITY OF ORIGINAL