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# Study of Recreational Land and Open Space Using SKYLAB Imagery
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CURRENT ACTIVITY

During the reporting period, work continued on the analysis of signatures for 35 training sets extracted from both S-192 and ERTS-1 data sets which cover the Gratiot-Saginaw State Game Area. These signatures had been extracted from training sets established with the aid of high altitude color-infrared photography collected during the previous growing season. Many of the scene classes identified on the photography had been acknowledged as significant for game management purposes by the Michigan Department of Natural Resources. The large number of signatures extracted from the S-192 and ERTS-1 data sets constituted an effort to encompass the inherent variability of the scene classes.

An analysis of the statistical uniqueness of each of the signatures was made by computing a matrix of probabilities of misclassification for all possible signature pairs. Within each data set, the 35 signatures were then aggregated into a smaller set of composite signatures by combining groups of signatures having high probabilities of misclassification.

Table 1 lists the resulting composite signatures for the S-192 and ERTS-1 data sets along with scene classes identified on the high-altitude, color-infrared photography. Note that computer separation of scene classes identified on photography of 10 June 1972 was possible with ERTS-1 data collected on 8 June 1973. Of particular importance is the separation of three forest density classes. The separation of only two wetland classes with ERTS data was not disturbing since such scene classes are of limited areal extent in the test site, making accurate establishment of training sets difficult. In addition, because the extent and physical characteristics of wetlands can vary dramatically from year to year, the separation of only two wetland classes by ERTS data may be indicative of the actual situation that existed a year after the photography had been collected.

Computer separation of forest density classes was poor with S-192 data collected on 5 August 1973. High probabilities of misclassification were noted to occur for all forest signatures regardless of tree density. Thus, signatures which had been aggregated into three forest density classes for ERTS data were more appropriately combined into a single forest signature.

Signatures from the S-192 data were further analyzed to determine the ranking of spectral channels for computer separation of the scene classes. Although the separation of forest density classes was poor, optimum channel selection was performed separately for two groups of signatures as shown in Table 2: (a) a set of 4 signatures corresponding to herbaceous brush, cutover forest having less than 25 percent crown cover, sparse forest with 50-70 percent crown cover, and dense forest with greater than 70 percent crown cover, and (b) a set of all major separable signatures, with the three forest density classes listed in (a) as a single signature. The resulting channel selections are shown in Table 3. The first two optimum channels are the same for both sets of signatures, 0.78-0.88 μm and 1.55-1.75 μm. The third and fourth channels differ, but fall in the spectral range of the ERTS system.

Finally, probabilities of misclassification were computed for composite signatures using four separate combinations of data source and channel selection:

1. Four channels of ERTS data acquired on 8 June 1973.

2. Four channels of S-192 data (acquired on 5 August 1973) most nearly corresponding to the ERTS channels (see Table 3).

3. Four channels of S-192 data shown in Table 3 as optimum channels for the 7 major categories.

4. Twelve channels of S-192 data.

In order for the resutls to be comparable, the single forest signature from S-192 data was replaced with the three signatures from Table 2 that represented the three forest density classes for which ERTS signatures had been derived. For each of these four combinations of data, probabilities of misclassification were computed for each of the possible pairs of 9 signatures. From a comparison of the results, the conclusions listed below were reached. It should be recognized that these conclusions are based on study of an area dominated by wetlands, brush, and woodlands, and do not necessarily apply to other combinations of land use and land cover.

1. The ERTS June data give consistently lower probabilities of misclassification than the four ERTS equivalent channels of S-192 August data. This improvement may result from one of two basic causes. Either the vegetation signatures are more easily discriminated in June than in August, or the quality of the S-192 data is lower than that of the ERTS data. This lower quality may be due either to higher signal-to-noise ratios or to misregistration of individual pixels. It seems likely that all these factors have some effect, but the exact contribution of each cause cannot be determined. Another difference in the two sets of data is the fact that the S-192 equivalent channels are narrower in bandwidth than the ERTS channels. It is unlikely that this would explain any of the poorer performance of the S-192 data.

2. The optimum four channels of S-192 data gave consistently better results than the ERTS-equivalent channels. Since the 1.55-1.75 μm band

constitutes the major difference of the optimum channels from the ERTS bands, the indication is that this channel is the major factor in improving performance.

3. The use of twelve channels of data further improved the performance substantially over that of the four optimum channels, indicating that the classification process should not arbitrarily be limited to four channels.

4. The 10.5-12.5 μm thermal infrared channel had a low rating in the choice of optimum channels. This is probably due to the fact that the pass over the test site occurred at 9:00 AM, which is not a favorable time for thermal discrimination. Therefore, no general conclusion about the utility of the thermal channel should be reached on the basis of this analysis.

The ERIM computer was shut down on 8 May so that it could be moved from the Willow Run Airport laboratories to its location in ERIM's new laboratories in Ann Arbor. During the shutdown, project effort was concentrated on analysis of the computer data obtained before the shutdown. By 1 June, the computer system was again in operation.

FUTURE WORK

It is planned to make a field trip to the test site during June in order to take ground photographs of the training areas with summer foliage and to resolve several uncertainties about type and density of vegetation for some of the selected training sets. If necessary, the nine training sets will be recombined into a different grouping of training sets which accurately represent homogeneous types of land cover.

Computer processing of the S-192 data and ERTS data will then proceed. The conclusions reached on the basis of the work reported under Current Activity are based on examination of values for probabilities of misclassification derived for all the pairs of individual and composite signatures used. The results for various pairs of signatures are not mutually exclusive; therefore, the specific probabilities cannot be combined to determine total accuracy of classification for the simultaneous recognition of more than two signatures. We intend to repeat this study during June using a new computer program which will give probabilities of misclassification for more than two signatures at a time.

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TABLE 1.

MANUALLY IDENTIFIED SCENE CLASSES AND STATISTICALLY AGGREGATED COMPOSITE SIGNATURES FOR THE GRATIOT-SAGINAW STATE GAME AREA

| Scene classes identified on color-infrared photography collected 10 June 72 | Composite signatures of S-192 data collected 5 August 73 | Composite signatures of ERTS-1 data collected 8 June 73 |
|---|---|---|
| Wetlands 1 | Wetlands 1 | Wetlands 1 |
| Wetlands 2 | Wetlands 2 | Wetlands 2 |
| Wetlands 3 | Aspen regeneration | Aspen regeneration |
| Aspen regeneration | Herbaceous brush | Herbaceous brush |
| Herbaceous brush | All forest | Cutover forest[1] |
| Cutover forest[1] | Flooded timber | Sparse forest[2] |
| Sparse forest[2] | Pine plantation | Dense forest[3] |
| Dense forest[3] | | Flooded timber |
| Flooded timber | | Pine plantation |
| Pine plantation | | |

[1] <25% crown cover

[2] 50-70% crown cover

[3] >70% crown cover

TABLE 2.

COMPOSITE SIGNATURES FROM S-192 DATA USED FOR THE DETERMINATION OF OPTIMUM SPECTRAL CHANNELS

| Signature Name | 4 Brush and Tree Signatures | 7 Major Signatures |
|---|---|---|
| Wetlands 1 | | X |
| Wetlands 2 | | X |
| Aspen regeneration | | X |
| Herbaceous brush | X | X |
| Cutover forest | X | |
| Sparse forest | X | X |
| Dense forest | X | |
| Flooded timber | | X |
| Pine plantation | | X |

TABLE 3.

SELECTION OF OPTIMUM CHANNELS FOR
COMPOSITE SIGNATURES FROM S-192 DATA

| Spectral Band (μm) | Ranking of Channels: 7 Major Signatures | Ranking of Channels: 4 Brush and Tree Signatures | ERTS Band Simulated by S-192 Channel |
|---|---|---|---|
| 0.41-0.46 | 9 | 6 | |
| 0.52-0.56 | 4 | 8 | Band 4 |
| 0.56-0.61 | 11 | 12 | |
| 0.62-0.67 | 10 | 4 | Band 5 |
| 0.68-0.76 | 7 | 3 | Band 6 |
| 0.78-0.88 | 1 | 1 | |
| 0.98-1.03 | 3 | 5 | Band 7 |
| 1.09-1.19 | 5 | 10 | |
| 1.20-1.30 | 6 | 11 | |
| 1.55-1.75 | 2 | 2 | |
| 2.10-2.35 | 8 | 7 | |
| 10.20-12.50 | 12 | 9 | |