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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING



Cornell University

HOLLISTER HALL, ITHACA, N. Y. 14850
REMOTE SENSING PROGRAM

December 27, 1973

NASA Scientific and Technical
Information Facility
P.O. Box 33
College Park, Maryland 20740

Subject: NASA Grant NGL 33-010-171
Semi-Annual Status Report

Gentlemen:

In accordance with the provisions of the subject grant, we are transmitting herewith five (5) copies of our Semi-Annual Status Report covering the period June 1, 1973 to November 30, 1973. In addition, two (2) copies of the same report are being sent directly to the University Research and Applications Branch, Office of University Affairs, NASA Headquarters, Washington, D.C. 20546, (Attention: Mr. J.A. Vitale).

Sincerely yours,

Ta Liang
Principal Investigator

TL/js

cc: Mr. J.A. Vitale, NASA Headquarters
Mr. H.S. Snyder, NASA Headquarters

Deans E.T. Cranch and A.R. Seebass
Mr. T.R. Rogers/Mr. P.F. Mather
Director W.R. Lynn

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SEMI-ANNUAL STATUS REPORT
of the
NASA-Sponsored
Cornell University Remote Sensing Program
June 1, 1973 - November 30, 1973

NASA Grant NGL 33-010-171

Principal Investigator: Ta Liang

Co-Investigators: Arthur J. McNair
Donald J. Belcher

Research Associate: Warren R. Philipson

Remote Sensing Program
Hollister Hall
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Ithaca, New York 14850

June 1973

INTRODUCTION

The Cornell University Remote Sensing Program has had continued success in stimulating interest in remote sensing, both within the University community as well as among various State and local agencies. Consultations, instruction, a weekly seminar, and a monthly newsletter have contributed to create the requisite atmosphere and linkages for cooperative research directed at problem-solving applications of remote sensing in New York State and the Northeast.

This third Semi-Annual Status Report contains a summary of Program activities from June 1 to November 30, 1973. The information serves to update two earlier Program status reports, submitted in December 1972 and June 1973.

COMMUNICATION AND INSTRUCTION

Discussion, Contacts and Cooperation--Over the past six months, the Program staff has worked closely or been in contact with a large number of on-campus and off-campus individuals.

In conjunction with ongoing studies, members of the Program staff have worked cooperatively with personnel from the Cornell Departments of Natural Resources, Agronomy, Plant Pathology and Agricultural Engineering, as well as with representatives of the N.Y.S. Cooperative Extension Divisions at Cornell. Off-campus cooperators on specific projects have included representatives of the Environmental Protection Agency, Eastman Kodak, Rome Air Development Center, the N.Y.S. Department of Transportation, the N.Y.S. Geological Survey, several divisions of the N.Y.S. Department of Environmental Conservation, the Cayuga Museum of History and Art in Auburn, N.Y., and the Department of Planning of Tompkins County, N.Y. (Appendix J).

In an effort to initiate new cooperative studies, while drawing upon the broad expertise at Cornell, members of the Program staff have entered into discussions with individuals from the Cornell Departments of Entomology and Geological Sciences, as well as with other colleagues in the Department of Natural Resources and the School of Civil and Environmental Engineering.

Over the past six months, the Program staff has received an increasing number of requests for imagery and consultation. The use of ERTS and aircraft imageries, as well as Program facilities, has been provided to researchers and other interested parties from Cornell and from several public and private agencies, and the Program has served as coordinator to a series of Cornell remote sensing studies, undertaken in conjunction with the Environmental Protection Agency. The Program's review of ice reconnaissance (first Semi-Annual Status Report) has been requested by a private engineering firm from Alaska, and a special report on inventory methods was prepared for the Cornell

Advisory Board to the N.Y.S. Land Use and Natural Resources Inventory (LUNR) User Service.

Newsletter--The Cornell Remote Sensing Newsletter is received monthly by approximately two hundred individuals and groups (Appendices H and I). By highlighting remote sensing activities at Cornell, while reporting other items of general interest, the Newsletter has elicited and retained the interest of the Cornell community, at large, and provided a regular link with the Program's on-campus and off-campus cooperators.

Seminar--The Program-sponsored "Seminar in Remote Sensing" is a one-credit hour course in the School of Civil and Environmental Engineering. During the fall semester 1973, the Seminar brought experts from government, industry and other institutions to Cornell to discuss current research, issues and applications of remote sensing with students, staff and other interested parties (Appendix G). The fall-semester registration in the course totaled 13 students from four Cornell divisions; however, the weekly seminar--publicized in the Newsletter, special announcements and, occasionally, in the local newspaper--attracted audiences ranging from 20 to 40. In all, the fall semester's audiences have had representation from 23 Cornell divisions, local industry and the general public.

Instruction--In addition to instituting the Seminar in Remote Sensing, the Program staff has been actively revising the curriculum in remote sensing. Although primary emphasis had been placed on conventional aerial photographic studies and photogrammetry, greater emphasis is now being placed on non-panchromatic and high altitude photography, as well as on data derived from non-photographic sensors. A new three-credit hour course, "Remote Sensing," will be offered for the first time during the spring semester 1974.

IMAGERY

It is obvious that research and instruction in remote sensing are heavily dependent upon the availability of remote sensing data and, particularly, upon the availability of representative imageries.

With the assistance of the NASA Office of University Affairs, the Program is receiving ERTS imagery of the Northeast, NASA high altitude photography of the Northeast has been obtained from Ames, and NASA-Houston has flown several multisensor missions over Program-selected test sites in New York State. Sample imageries of the Northeast also have been acquired from the Rome Air Development Center, the St. Lawrence Seaway Development Corporation, the U.S. Geological Survey, Environment Canada, the Environmental Protection Agency, and several commercial firms.

In support of planned research, the Program has requested additional NASA missions to be flown during 1974, and to supplement to the existing file of imagery, the Program is also exploring the availability of Skylab data over the Northeast.

The Program has arranged with ERTS investigators at Cornell and elsewhere for cooperative use of imagery and facilities. With these associations, various methods of image enhancement and data extraction are being examined.

RESEARCH COMPLETED

Airphoto inventory of Tompkins County, New York (Appendix A)--Working together with the County Department of Planning, Mr. James Ni performed an aerial photographic inventory of the unique natural resources of Tompkins County. This inventory constitutes the initial phase of the Tompkins County Environmental Conservation Plan and Program, and the County Master Plan will be based on the compiled information. (Mr. Ni's report was submitted in partial fulfillment of his professional master's degree.)

Detection of buried river channels (Appendix B)--Mr. Joseph Krieger completed a pilot study aimed at detecting buried Hudson and Mohawk River channels--possible sources of sand, gravel, and groundwater, as well as areas which are potentially susceptible to groundwater pollution. Working closely with the N.Y.S. Geological Survey, Mr. Krieger was able to demonstrate the kinds of information that can be derived from ERTS, high altitude and other NASA-provided imageries. Although his preliminary findings with respect to buried channels were not encouraging, the Geological Survey has begun to make greater use of remotely sensed data, and future cooperative efforts seem likely; especially, those which the Program deems to be of a benefit-producing nature. A follow-up study, utilizing newly acquired imageries, is now under consideration. (Mr. Krieger's report was submitted in partial fulfillment of his professional master's degree).

ERTS delineation of interconnected waterways (Appendix C)--The existing data on interconnected waterways in New York State are inadequate for comprehensive recreational planning. At the request of the N.Y.S. Department of Parks and Recreation, Mr. Frederick Voigt performed a pilot study, designed to test the feasibility of employing ERTS-derived data to upgrade the existing State map of continuous waterways. Concentrating on inexpensive diazo and density-slicing techniques that could be easily adopted by the State Agency, Mr. Voigt demonstrated that the basic network of State waterways could be sufficiently enhanced on ERTS imagery to provide substantially more waterway information than is presently available.

Mr. Voigt's report is being submitted to the Department of Parks and Recreation at the time of this writing. The extent to which the Program will be called upon to assist in a state-wide waterways mapping project will be discussed with the Agency's Director of Research in the near future.

Miscellaneous Studies--As noted in a previous section, members of the Program staff have been called upon to provide consultation to an increasing number of projects and proposals involving the application of remote sensing. Two studies for which written reports were submitted are described below.

Plant indicators of atmospheric pollution (Appendix D)--At the request of the Division of Air Resources of the N.Y.S. Department of Environmental Conservation, Mr. Joseph Krieger performed a preliminary review of the feasibility of diagnosing levels of atmospheric pollution through spectral analysis of plant indicators. Based on the decision that only known cases of pollution damage might be monitored successfully by remote sensing techniques, no comprehensive report was prepared. Instead, all basic data compiled in the review were submitted to the D.E.C., and the study was terminated.

Techniques for data transfer from photos to base maps (Appendix E)--The State of New York is considering the need and means for updating the N.Y.S. Land Use and Natural Resources Inventory (LUNR), completed by Cornell in 1971. In an effort to provide input to these considerations, members of the Program staff compiled a basic report on techniques for transferring inventory information from aerial photographs to base maps. The report is being submitted to the Cornell LUNR Advisory Board, which is currently discussing the possibility of a LUNR update with the N.Y.S. Office of Planning Services.

RESEARCH IN PROGRESS

Ten projects are presently being carried out by, or in conjunction with, members of the Program staff. Listed in the order of their expected completion date, they are:

1. Time-sequence ice-cover mapping of the St. Lawrence Seaway.
2. Remote sensing input to highway environmental impact statements.
3. Aquatic weedbed studies in Cayuga Lake, New York.
4. Vegetative cover and habitat studies in the Montezuma National Wildlife Refuge, New York.
5. Evaluation of disease infestation in apple orchards.
6. ERTS analysis of earth lineaments.
7. Water quality analysis with multispectral photography.
8. Detection and analysis of sensitive clay soils.
9. ERTS analysis of snow for recreational planning.
10. Detection of historical sites along Great Gully, New York.

Although interim and final reports on each project will be submitted at appropriate stages of project completion, the background and status of each investigation is described briefly, as follows.

1. *Time-sequence ice-cover mapping of St. Lawrence Seaway*

- cooperator: St. Lawrence Seaway Development Corp.
- potential users: St. Lawrence Seaway Dev. Corp.; U.S. Army Corps of Engineers
- potential benefit: Navigation season extension
- expected completion date: Pilot study--January 1974

In an effort to extend the navigation season on the St. Lawrence Seaway into the winter months, the St. Lawrence Seaway Development Corporation has contracted with an engineering firm to evaluate the feasibility of constructing gates in the existing ice control structures. Additionally, the Program was requested to provide any possible data input to the engineering analysis.

A progress report on ice-type classification and time-sequential ice-cover mapping is contained in Appendix F. This report is being submitted to the St. Lawrence Seaway Development Corporation and, with their approval and suggested modifications, final data compilation and analysis will commence.

2. *Remote sensing input to highway environmental impact statements*

- cooperators: N.Y.S. Dept. of Transportation; Cornell Dept. of Agricultural Engineering
- potential users: N.Y.S. Dept. of Transportation; various U.S. Agencies and groups involved or concerned with highway planning.
- potential benefits: More comprehensive and systematic evaluation of highway impact
- expected completion date: January 1974

Many highways being planned today cannot be built without an Environmental Impact Statement (E.I.S.). Commonly, these Statements are neither as extensive nor as accurate as communities and environmental groups would desire.

This project is examining five categories of environmental impact that have been ignored or inadequately treated in the conventional highway E.I.S. The primary objective is to develop a systematic approach to the evaluation of air pollution, noise pollution, aesthetics, neighborhood impact, and displacements. To the extent possible, remotely sensed data will be relied upon as a principal source of information.

The evaluative techniques under study are being tested on a proposed State highway between Horseheads and Watkins Glen, New York. Background data have been supplied by the N.Y.S. Department of Transportation, and much of the impact data is being extracted from the existing panchromatic aerial photographs.

3. *Aquatic weedbed studies in Cayuga Lake, New York*

- cooperators: Cornell Depts. of Agronomy and Natural Resources; E.P.A.; N.Y.S. Dept. of Environmental Conservation
- potential users: N.Y.S. Dept. of Envir. Conservation; Cornell Cooperative Extension Divs.; recreationalists; private & public agencies concerned with weedbed control
- potential benefits: More effective means for mapping weedbeds and assessing their affect on fishing, swimming and boating; documentation and better understanding of seasonal and yearly weedbed changes.
- expected completion data: Pilot studies--March 1974

In 1966, the State Conservation Department (presently, part of the N.Y.S. Department of Environmental Conservation) sponsored a Cornell project in which portions of Cayuga Lake were imaged with color aerial photography, and the general categories of aquatic vegetation were mapped. During the summer of 1973, the Environmental Protection Agency sponsored periodic photographic missions over Cayuga Lake, and the 9-by-9in and 70mm panoramic imagery included color, color infrared, and Kodak's new color film for water penetration.

At the time of the E.P.A. flights, the weedbeds in selected areas of the Lake were sampled by divers and from boats, while other test plots were subjected to a series of weed-control experiments, involving cutting and chemical herbicides. All field work was performed under the ongoing programs of Cornell's Departments of Natural Resources and Agronomy.

The 1973 photographs and ground data will be used to map the present weedbeds and to investigate weedbed changes through the growing season. Additionally, the 1973 and 1966 photographs will be compared to gauge and document major weedbed changes over the 7-year interval.

4. *Vegetative cover and habitat studies in the Montezuma National Wildlife Refuge, New York*

- cooperators: Dept. of Natural Resources and N.Y.S. Cooperative Wildlife Research Unit, Cornell; Manager, Montezuma Refuge; E.P.A.
- potential users: N.Y.S. Cooperative Wildlife Unit; wildlife researchers and refuge managers throughout the Northeast.
- potential benefits: Interpretive techniques for species identification and for analysis of vegetative change and replacements over growing season; vegetative cover map of Montezuma Refuge for planning, management, and habitat studies.
- expected completion date: Pilot studies--March 1974.

In response to requests from the Manager of the Montezuma National Wildlife Refuge and the Head of the N.Y.S. Cooperative

Wildlife Research Unit, the Program arranged for E.P.A.-sponsored flight missions to obtain multispectral, multiscale photographic coverage of the Montezuma Wildlife Refuge, at three dates during the summer.

The initial use of the imagery will be to identify and map the distribution of major types of emergent and submergent vegetation. The cover map will be employed as a base for ongoing vegetative and duck habitat studies, and it will be compared to older Refuge maps to determine significant vegetative changes. The time-sequential E.P.A. photographs will also be analyzed for specific vegetative changes and replacements over the growing season. The overall objective is to assess the extent to which remotely sensed data might provide useful input to wildlife habitat studies, in general, and to studies of the Montezuma Refuge, in particular.

5. *Evaluation of disease infestation in apple orchards*

- cooperators: Depts. of Plant Pathology, Entomology and Agronomy, and Cooperative Extension, Cornell; N.Y.S. Agricultural Experiment Station at Geneva, N.Y.; various apple growers in Wayne Co., N.Y.
- primary sponsor: Eastman Kodak Company
- potential users: Apple growers; private consultants; N.Y.S. Cooperative Extension Bureau; N.Y.S. Dept. of Agriculture and Markets
- potential benefits: To consumer, apple growers, and New York State economy.
- expected completion date: June 1974

Although the project is considering a number of apple diseases, the focus is on fire blight, a common disease that was especially severe in New York State during the 1972 growing season. The objectives are to detect and monitor disease infestation, and to provide techniques or a basis for evaluating orchard management and assessing damage.

In an effort to determine the optimum film-filter combinations for disease detection, spectral readings of leaves and branches from control and artificially infected trees were obtained with a spectrophotometer supplied by Eastman Kodak. The raw data were calibrated on Kodak's IBM 360 computer.

Staff of Cornell's Department of Plant Pathology and their Extension Division selected a number of test orchards in Wayne County, New York, and arrangements were made with the orchard owners to study various management techniques and/or obtain ground data in their orchards throughout the growing season. Field and laboratory assistance has been provided by personnel from the Departments of Agronomy and Entomology at Cornell, as well as from the N.Y.S. Agricultural Experiment Station at Geneva.

Periodic low altitude (500 and 1000 feet) photographic

missions were flown by Kodak, and NASA-Houston has provided thermal and smaller scale photographic coverage of the test orchards. The imagery, together with detailed tree, soil, and climatological data, are currently under analysis.

6. *ERTS analysis of earth lineaments*

- cooperators: N.Y.S. Geological Survey; Cornell Dept. of Geological Sciences
- potential users: N.Y.S. Geological Survey; private and public planning and exploration organizations
- potential benefits: Better understanding of geology of the Northeast; possible correlations between lineaments and seismic or other geologic phenomena (e.g., mineral deposits)
- expected completion date: Map of Northeast lineaments--June 1974

As noted in the second Semi-Annual Report, and as reported by other investigators, ERTS imagery provides an excellent tool for detecting major as well as minor earth lineaments. Preliminary examination of ERTS images of the Northeast revealed the existence of lineaments which appear to be of subcontinental dimensions. An ERTS mosaic of the Northeast is being constructed, and major Northeast lineaments will be identified. Follow-up meetings with staff of the N.Y.S. Geological Survey and Cornell's Department of Geological Sciences are being scheduled.

7. *Water quality analysis with multispectral photography*

- cooperators: E.P.A.; N.Y.S. Dept. of Health; Cornell Dept. of Natural Resources; local power boat owners.
- potential users: E.P.A.; State agencies concerned with water quality
- potential benefits: Rapid means for assessing water quality
- expected completion date: Pilot study---June 1974

With design and coordination provided by the Program staff, the Environmental Protection Agency sponsored a series of multispectral, multiscale photographic missions over four of New York State's Finger Lakes. At the time of these flights, comprehensive lake sampling was carried out by teams from the N.Y.S. Department of Health and Cornell's Department of Natural Resources, the latter being assisted by a local group of power boat owners. All costs for sampling and water quality analysis were covered by the participating groups, at no expense to the Program.

Spectral data derived from the photographs will be compared and correlated with the field and laboratory water measurements in an effort to provide the E.P.A. with an effective, yet economic, means for rapidly assessing water quality.

8. *Detection and analysis of sensitive clay soils*

- cooperators: N.Y.S. Dept. of Transportation; engineering

- soils firms operating in St. Lawrence and Albany regions
- potential users: N.Y.S. Dept. of Transportation; various State, county and Canadian planning and engineering agencies
- potential benefits: Route and site design to accommodate hazardous areas, thus, preventing losses to property and lives.
- expected completion date: September 1974

Various marine and lacustrine soil deposits, occurring throughout the northeastern United States and Canada, are susceptible to catastrophic slides and flows. These deposits are of special interest to engineering and planning agencies, in that knowledge of their precise location would greatly affect route and site selection or design.

A comprehensive review of the literature is being finalized, and the St. Lawrence and Albany districts of New York State--areas with known deposits of sensitive soils--have been selected for concentrated study. With the cooperation of the N.Y.S. Department of Transportation, pertinent engineering soils data are being gathered from the records of the State Agency and private engineering firms. NASA-Houston has flown a multisensor mission over the test sites and, together with ERTS and other available aircraft coverage, the imagery is currently under analysis.

9. *ERTS analysis of snow for recreational planning*

- cooperators: N.Y.S. Dept. of Parks and Recreation
- potential users: N.Y.S. Dept. of Parks and Recreation; various public and private recreational planning groups
- potential benefits: More comprehensive planning for recreational facilities; increased income for facility owners and State
- expected completion date: September 1974

The duration and distribution of snow in New York State directly affect the location and success of winter as well as summer recreational facilities. Reporting that the existing data on snow cover are scattered and insufficient for detailed planning, the N.Y.S. Department of Parks and Recreation requested that a study be performed to determine the extent to which ERTS imagery could provide supplemental information.

The long range objective of this study is to assess the accuracy with which ERTS and other satellite imagery could be used to produce time-sequential maps of snow cover. However, recognizing that many years of data would be required before statistical reliability could be established, and recognizing that cloud-free coverage of the entire State is not regularly available, the immediate aim is to examine the feasibility of using ERTS imagery as a base for evaluating the existing network of snow-measuring stations and the data therefrom.

Toward these ends, the list and records of snow-measuring stations in western New York are being obtained from the State Climatologist, and various techniques for enhancing snow are being applied to selected ERTS scenes.

10. *Detection of historical sites along Great Gully, New York*

- cooperators: Cayuga Museum of History and Art; E.P.A.
- potential user: Cayuga Museum; N.Y.S. and Cayuga County planning and historical societies
- potential benefits: Preservation and better documentation of N.Y.S. historical/archeological sites
- expected completion date: September 1974

At the request of Professor Walter Long, Historian of Cayuga County, New York, and Curator of the Cayuga Museum of History and Art, the Program has undertaken a study to detect and delineate historical/archeological sites in Cayuga County. The area selected for a pilot project is the Great Gully--a five-mile stream, along which Iroquois, and possibly pre-historic, Indians are known to have settled.

To supplement the existing panchromatic aerial photographs of the Great Gully, the Environmental Protection Agency provided color and color infrared aerial coverage, flown during the past summer and early fall. All imagery is being analyzed, and a map of suspected sites will be compiled. Field checking will commence in the spring, and it is expected to extend into the summer months. Based on the existing information, as well as any new information supplied by this study, the Great Gully will likely be designated a "Forever Natural" area of New York State.

FUTURE RESEARCH

Based on preliminary discussions with user groups and cooperators, two topics, not described above, have been selected as potentially rewarding areas of research. During the following months, each topic will be explored more thoroughly, and pilot investigations will likely be initiated.

1. *Evaluation, monitor and selection of solid waste disposal sites*

- cooperators: Environmental Protection Agency; N.Y.S. Dept. of Environmental Conservation; N.Y.S. Dept. of Health; selected counties or municipalities

Both the Environmental Protection Agency and the N.Y.S. Department of Environmental Conservation have ongoing programs concerned with solid waste disposal, and both have indicated interest in examining the extent to which remote sensing might provide useful data. The research would be designed to evaluate and monitor the location, leachate, and management of

existing landfill sites, while providing basic information for selecting new landfill sites. Toward these ends, the Program has requested NASA to fly periodic multisensor missions over a representative corridor of New York State--from Syracuse to Cortland.

2. *Outflow inventory of Canadarago Lake, New York*

-cooperators: Environmental Protection Agency; N.Y.S. Dept. of Environmental Conservation; N.Y.S. Dept. of Health; City of Richfield Springs; Cornell Depts. of Natural Resources and Agronomy

Over the past few years, Canadarago Lake has received a great deal of attention from various New York State agencies. The Lake is being used as a demonstration lake for the pollution-eutrophication programs of the N.Y.S. Departments of Health and Environmental Conservation, and a tertiary treatment plant was recently installed to reduce the pollution entering the Lake from Richfield Springs, the only major population center on the Lake. Current efforts are focusing on other sources of pollution, and to assist these efforts, the Program has requested NASA to fly a series of low altitude, multisensor missions over the Lake. The remotely sensed data would be used to document the number, location and general characteristics of outflows entering the Lake. With this data, the cooperating investigators would undertake field studies to determine the extent to which each outflow constitutes a source of pollution.

Other research--Depending upon user interest, personnel and available funds, additional research projects may be undertaken. The Program has agreed to provide consultation and partial support to an ongoing study of landsliding caused by tropical storm Agnes, and cooperative investigations of pedological soil mapping, lake recreational planning, and crop disease/insect infestation are being considered with Cornell's Departments of Environmental Engineering, Agronomy, Natural Resources and Entomology.

PROGRAM STAFF

The regular staff of the Program consists of the principal investigator, Prof. T. Liang, two co-investigators, Profs. D.J. Belcher and A.J. McNair, one research associate, Mr. W.R. Philipson, and two graduate research assistants, Messrs. T.L. Erb and F.C. Voigt. Dr. E.E. Hardy, of the Department of Natural Resources, serves as a no-cost consultant to the Program and, for specific projects, assistance has been provided by various Cornell and non-Cornell personnel. Among these, special mention is due Prof. S.V. Beer, of the Department of Plant Pathology, Prof. R.T. Oglesby, of the Department of Natural Resources, Prof. D.A. Sangrey, of the Department of Environmental Engineering, and Mr. C.P. McCabe, special consultant to the Environmental Protection Agency from Eastman Kodak.

Over the past six months, the Program has provided and

received direct and indirect support from a number of graduate and undergraduate students. Among those who have worked most directly with the Program staff are J.J. Krieger, J. Ni, R. Ackley, B. Coskun, W. Teng, T. Jarrett, and M.R. Specht, the latter, a Ph.D. candidate supported by Eastman Kodak.

LIST OF APPENDICES

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APPENDIX A
UNIQUE NATURAL RESOURCES
OF TOMPKINS COUNTY, N.Y.

TOMPKINS COUNTY DEPARTMENT OF PLANNING

FRANK R. LIGUORI, PE
COMMISSIONER
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June 29, 1973

TO: Ta Liang, Professor of Civil & Environmental
Engineering

FROM: George D. Weiner, Tompkins County Department
of Planning

RE: Report by James Fu Ni

I've had an opportunity to read through Jim's report on the unique natural resources of Tompkins County, and I feel that it will be a most useful input to the Environmental Conservation Plan and Program now being prepared by our Department. The report appears complete (particularly in regard to geological and physiographical features), clear and concise. It would be helpful, however, if the technical terms (particularly those relating to geological features and periods) were defined in simpler terms. Perhaps a glossary of technical terms could be appended to the report.

It may be possible to utilize Jim's services again, if his activities can be funded through the NASA Grant. We will keep this in mind during the preparation of this plan, and let either you or him know as soon as possible.

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UNIQUE NATURAL RESOURCES OF TOMPKINS COUNTY, N.Y.

A Project Report

**Presented to the Faculty of the College of Engineering
of Cornell University in Partial Fulfillment
of the Requirement for the Degree of
Master of Engineering(Civil)**

by

James Fu N1

June 1973

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PREFACE

Of major concern to the country today, at the federal, state and local levels, is the improvement of environmental quality. In New York State, this fact is evidenced by the passage of the Environmental Quality Bond Act of 1972. In accordance with this legislation and in the interests of the citizens that it represents, the Tompkins County Department of Planning has become directly involved in the preservation and management of the unique natural resources of Tompkins County.

At the request of the County Department of Planning and in partial fulfillment of his professional masters degree, Mr. James F. Ni performed an aerial photographic inventory of the unique natural resources of Tompkins County. The work was sponsored jointly by the County Department of Planning and the Cornell Remote Sensing Program, under NASA Grant NGL 33-010-171.

The inventory described herein constitutes the initial phase of the County's Environmental Conservation Plan and Program. Future land and water use plans and the Tompkins County Master Plan will be based upon this study, and the information will be input to zoning ordinances and various unique area and wetlands acquisition projects, as described in the bill of particulars, New York State Environmental Quality Bond Act of 1972.

Ta Liang
Professor of Environmental
Engineering
Principal Investigator
Remote Sensing Program

INTRODUCTION

The present and future demand for a quality environment by the people in New York State was translated into state and federal laws which mandate that the state and its communities move forward with necessary measures to better our environment.

To improve our environment, on one hand, the need to abate air, water and land pollution will be provided for by the construction of secondary sewage treatment plants and the management of air pollution and solid waste in environmentally sound ways. On the other hand, unique natural resources left unprotected are subject to development and loss of environmental values. Already in upstate New York, wetlands are disappearing at the rate of five percent annually (DEC, 1972). In the Finger Lakes Region, privately owned land is being sold for development, thus threatening the wilderness character of adjacent public lands. Unique lands, treasured for their natural beauty, and open lands near the county's urban centers are being lost at a rapid pace.

In 1960, 1962, and 1966, the State of New York took a giant step forward by passing legislation which provided funds to acquire additional open space for the purposes of conservation and recreation. On April 26 and 27, 1972, the State Legislature approved the Environmental Quality Bond Act

of 1972 and the bill of particulars. The bond act provides a total \$1.15 billion for urgent pollution fighting or land preservation that cannot be responsibly delayed. About 19 percent of the total funds (\$175 million) will be used to acquire forest preserve lands, wetlands, parks and other unique natural resources that could be lost forever.

Unique natural resources are elements of our physical environment which are considered scarce amenities because of their fragile nature, relatively limited number, and their irreplaceability. Unique natural resources contain beautiful streams and gorges, unusual plants, wildlife, geological landforms, or simply open space.

Within Tompkins County are many such unique natural resources. Cayuga Lake is truly a unique natural resource of the County. Other unique features of the region are beaches and shorelines, wetlands, flood plains, summits and ridges, glens, gorges and waterfalls, rare plant-life, wild life habitats, virgin tree stands, and many physical features of scientific interest.

Some of the well-known landforms that constitute unique natural resources in ^{the} Tompkins County region are Taughannock Falls, Enfield Glen, the Portage Escarpment and the Valley Head Moraines. The shores of Lake Cayuga are nearly all privately owned with limited public access and few undeveloped areas, especially along the west shoreline. Another unique natural

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resource rapidly disappearing as a result of gravel excavation is the Hanging Deltas at Coy Glen(Figure 1).


Preceding any action toward the actual acquisition of unique natural resources it is necessary to evaluate the existing available open land in Tompkins County. The Environmental Conservation Plan and Program of Tompkins County will be based upon this inventory and other related studies in environmental conservation. Information from this report will also be used to establish priorities for the conservation of the County's unique resources.

The primary objective of this study is to present certain unique natural resources -- natural forests, wetlands, geological formations, physiographic features, fishing and white-water canoeing opportunities, and existing scenic views and scenic roads -- in a map form for easy identification of their importance.

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FIGURE 1



Coy Glen Hanging Delta  on the glacially oversteepened slopes of the Inlet Valley. Gravel pit G has destroyed most of both lower deltas. Waterfall W is visible.

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METHODOLOGY

The location of unique natural resource sites is recorded manually via a variety of methods. The base maps are U.S.G.S. 7½-minute topographic maps. Aerial photographs of the same scale flown in April, 1968, are used.

Unique natural resources have various recognition elements (Figure 2). These characteristics can be identified on aerial photographs and further substantiated by selected field observations. The manual techniques used for unique natural resources mapping are:

1. Preliminary scan of imagery. This is accomplished to determine general location of certain landforms such as valleys, Valley Head Moraines, Escarpments.
2. Stereoscopic imagery analysis. Recognition elements such as color, shapes of gully cross-sections, drainage patterns, slope and size are identified from photo to photo and subsequently recorded on the Base Maps.
3. Verification with existing available information. Rock outcrops along gorges and streams mapped in the Tompkins County Soil Survey are verified.
4. Spot field check. Field checking is conducted in selected post-glacial streams to verify the interpretation of rock gorges. Selected Scenic

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Views are also checked to verify interpretation of view angle and obstructions from altitude and the aerial photos.

5. Up-dating maps. Corrections are made to Base Maps and the final map then prepared.

The locations of Igneous Dikes, Faults, Anticlines and Synclines are gathered from geological publications. Cold water fishing streams information is adapted from "Outdoor Recreation Development in Tompkins County". Interviews with Professor Lawrence Hamilton* and Mr. David Rossiter* contributed valuable information concerning scenic views, scenic roads, and white water canoeing.

* Professor Lawrence Hamilton is a professor in the Natural Resources Department, Cornell University. He is also a member of the Sierra Club.

Mr. David Rossiter is a native of Ithaca and a student of soil science at Cornell University.

FIGURE 2



A stereopair showing Kame K, Kettle Ponds P, Kame Terrace KT, Delta D in the West Danby Valley Head Moraine. Truncated Spur S is on the oversteepened valley sides.

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NATURAL FOREST RESOURCES

One third of the county is covered by natural forest, placing it near the middle of New York counties in this respect. Natural forest is the 2nd largest land use in the county but, as urban pressure increases and agriculture continues to decline, it will become the leading land use in the county. In Tompkins County the natural forest is dominated by mixed hardwoods of second and third growth with relatively little original pine and hemlock remaining.

Despite their generally fair commercial value, however, the vital functions the woodlands perform in conserving soil and water resources and producing an attractive landscape demand an identification of those existing natural forests whose importance may warrant protection.

The only information available is a 5-year-old Land Use and Natural Resources Inventory by the New York State Office of Planning Service. On the fringe of the urban area this information is no longer 100% valid but throughout the remainder of the county it can serve as a useful guide. Only one category of the forestland - F_n(forests over 30') - is taken from LUNR inventory and designated as natural forest in this report.

Identification of specific forest areas having outstanding commercial or aesthetic value is not available,

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and it could only be obtained by professional forestry analysis. However, one criteria can serve to indicate forest areas which should be protected from development. Land which is over 25% slope is generally best suited for forest. Certain recommendations are:

1. Extensive steep slope areas now in forest, on the escarpment, bordering the flood plain of major streams, and in the steep valleys, should be kept predominantly in forest land.
2. Those forested areas on steep slope or flat near the urbanized area, and on the watersheds of clean streams, should be considered for forest protection.
3. Extensive steep slope areas not now in forest, especially in small watersheds with flooding problems, should be the first priority for restoration of forest.

The existing heaviest concentration of forest is found in the southern portion of the county and along the stream tributaries, particularly Fall Creek, Six Mile Creek and Salmon Creek.

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WETLAND RESOURCES

Waterfowl, shorebirds, marshbirds and certain furbearers are directly associated with water areas. The lakes and ponds, rivers and streams, swamps and bogs provide the habitat needed by these species. The marshes are considered to be the most important inland waterfowl habitat in the northeast.

By definition wetlands are said to encompass everything between open water and dry upland. The littoral zone of lakes and ponds has been included since it contains certain aquatic plants and associated animals which comprise an important part of the food supply of waterfowl and other wetland species. Two classifications of wetlands are used in this report, they are:

1. Wooded wetlands (swamps), which contain either shrubs or trees. Delineation of wooded wetland boundaries is taken directly from the LUNR inventory, as shown on Map Overlay Set #1.
2. Non-wooded wetlands (marshes) are wetland areas that support such vegetation as cattails, bulrushes, reeds, sedges, arrowhead, and wild rice. Boundaries of marshes are also taken directly from the LUNR inventory, as shown on Map Overlay Set #1.

There ^{are} 19 principle wetlands in Tompkins County and they have a total area of approximately 5,000 acres.

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GEOLOGICAL AND PHYSIOGRAPHICAL FEATURES

General Geology

Tompkins County is situated in the Finger Lakes region. This region during the Paleozoic Era lay in the western part of the Appalachian geosyncline and was continuously covered by a shallow sea into which sediments were carried from the tectonic and volcanic lands to the east. The sediments were dominantly clastic with lesser accumulations of carbonate muds and oozes. The thickness of the Paleozoic rocks in the region is about 8000 feet, following the southerly regional dip of about 50 feet per mile. (Cole, 1959).

These unbroken beds, representing this enormous lapse of ancient geological time, and now largely exposed to view, are one aspect in which the Finger Lakes region is unique.

A vast uplift of the earlier sea bottom occurred at the close of the Paleozoic Era. Gentle folds, small faults, joint systems, and regional dips were developed during this span of time. The igneous dikes (Kimberlite and Peridotite dikes) of the region were intruded at the same time (Cole, 1959).

There ensued a long period during which the rock mass and folded beds were subject to various weathering agencies. This condition proceeded until all the region was worn down

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to an essentially flat plain near sea level. A landform so produced is called a peneplain. Consequently epeirogenic movement elevated the peneplain. The drainage system flowing over this plateau-like country developed valley systems which dissected the uplifted peneplain. The more resistant rock which escaped destruction may be recognized today as a succession of hilltops. At this time there were no gorges or waterfalls. Broad valleys with gentle gradients linked up in completely organized and stable systems comprised the relief (von Engel, 1961).

At the beginning of the Pleistocene Epoch, there came the time of the Ice Age. The eastern North American continental glacier originated as a low mound of ice on the upland of the Labrador Plateau. The ice sheet grew bigger and flowed radially as far southward as Pennsylvania. In the Finger Lakes region the ice was 1.2 km thick at its maximum stage.

The general direction of the advance of the glacier was southward. The flowing glacier found the Cayuga River valley a convenient course and resulted in about 1000 feet of erosion so that the valley bottom is now below sea level. This valley has the U-shaped cross-section typical of all glacial valleys. The tributary streams, flowing perpendicular to the direction of the ice movement, were less eroded. When the ice retreated they were left

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isolated far above the new bottom of the main valley, so that they are now hanging valleys. Post-glacial gorges and waterfalls were cut into the rock while the streams in the tributary valleys reached the steep slopes of the deepened main valley.

The glacial period was interrupted by at least one or more interglacial periods which were warmer and of much longer duration than the present post-glacial period. The interglacial valleys are largely filled with glacial drift and are exposed only locally where the post-glacial streams have partially re-excavated them. The interglacial gorge is generally broader than the post-glacial gorge.

As the ice margin melted back, the glacial water was ponded between the high land to the south and the ice to the north, and overflowed southward into the Susquehanna River. As the ice margin continued to melt northward, it uncovered lower outlets and allowed the lake to drop to successively lower levels. At each level the incoming streams built deltas which are now called hanging deltas. The city of Ithaca is built on a delta which was formed at the present lake level by the loose material brought there by Cascadilla, Fall, Six Mile, and Inlet Creeks.

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Classification

The unique geological and physiographic features of Tompkins County can be divided into two types:

1. The preglacial features (listed in Table 1), of which examples are the east-west trending Portage Escarpment dominating the upland and the Timberlite dikes.
2. The glacially modified features (listed in Table 2), of which the trough valley (Cayuga Valley) is a classic example. A combination of pre-, inter-, and post-glacial features is found in the valleys of Tompkins County.

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Table 1

Preglacial Features in Tompkins County

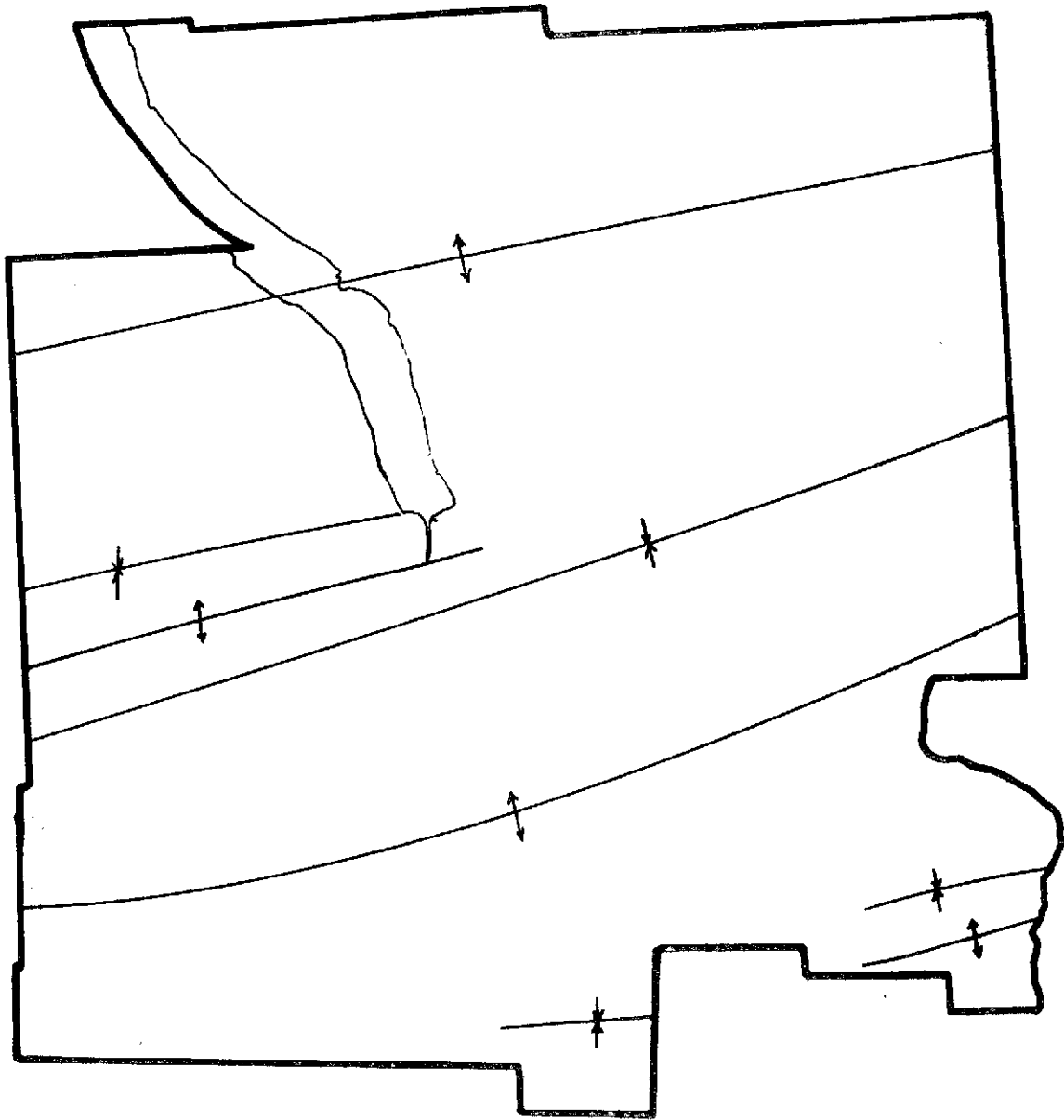
Unique features	Description	Values
Portage Escarpment	<p>The Portage front is 900 to 1000 feet high. Because of its structural make-up it is susceptible to piecemeal destruction and regularly appears as a steep slope, never as a vertical cliff. Location is shown on Map Overlay Set #2.</p>	<p>This escarpment is the dominant relief element of Tompkins County</p>
Igneous Dike	<p>Oxidized dikes vary from cream white to orange brown. In general, the dikes weather more rapidly than Devonian sandstones and shales. in Tompkins County. Location is shown on Map Overlay Set #2.</p>	<p>It has potential value as deep-seated petroleum traps, as moderate depth ground water dams, and as the diamond bearer.</p>
Anticline and Syncline	<p>They have a more or less east-west trend and are superimposed on the regional dip. (see Figure 3)</p>	<p>They represent a major structure in this region.</p>
Faults	<p>Low-angle thrust fault at Portland Point. Opposite the Lake, at the mouth of Taughannock Gorge lies another thrust fault, perhaps a continuation of the quarry fault. Location is shown on Map Overlay Set #2.</p>	<p>The fault zone is generally unstable</p>

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- | | | |
|-------------------------|---|--|
| Joints | Exposed at rock gorges and rock-bottomed streams. | Tompkins County is a classic for the study of joint phenomena. |
| a. Master or Dip Joints | Composed of two conjugated shears intersecting at a very acute angle (10°-30°) arranged with their mean direction swinging progressively from N15-30E eastward from Cayuga Lake to N40-50W to the west. | |
| b. Strike Joints | About perpendicular to the master joints. West of the county is about N60E, shifting centrally to N70E. | |
| c. Tension Joints | Arranged concentrically with a strike in the south of about N84W, and well-developed in the southwestern part of the county. | |

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FIGURE 3



ANTICLINE & SYNCLINE

ANTICLINE AXIS 

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SYNCLINE AXIS 

Table 2

Glacial Modified Features in Tompkins County

Unique	Description	Values
Trough Valley	Cayuga Valley, it has the U-shaped cross section.	Scientific; cascade is associated with it.
Hanging Valley	The "hanging" relationship between tributary valley and Cayuga Trough.	Scenic and scientific.
Through Valley	North-South valleys whose preglacial ridges have been reamed out by glacial erosion. Michigan Hollow, Pony Hollow, Inlet Valley, Danby Creek Valley, Caroline Valley, Six Mile Creek - West Branch Owego Creek Valley, and Virgil Creek Valley are Through Valleys.	Drainage divides, highland swamps and moraine landforms are present Through Valleys
Hanging Delta	A delta whose elevation is high above the valley floor. Ordinarily the deltas join the valley floor at about equal level. The most clearly defined set of Hanging Deltas are those associated with Coy Glen. Location is shown on MapsOverlay Set #2.	Hanging Delta reflect a different stage of Proglacial Lakes, and is a good source of sand and gravel.
Truncated Spur	Long spurs typically extend in alternation from the sides of valleys of gentle gradient created by stream erosion. Massive ice currents moving through such valleys cut off the ends, that is, truncate the spurs.	Scenic and scientific

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Valley Head Moraine	Moraine deposits form ridges and hummocks situated, in general, a short distance from the heads of the Finger Lakes. Location is shown on Map Overlay Set #2.	It represents a drift border of Late Wisconsin Age. Kettle ponds and swamps are important as wildlife habitats.
Kame	Extremely hummocky, commonly massive, deposits of glacial drift. Situated within Valley Head Moraines.	Scenic, contain sand and gravel.
Kettle	A closed depression in a deposit of Moraine.	Ecologic and scenic.
Esker	Gravel deposit forming a linear ice ridge, made on the bottom of a sub-glacial stream flowing under ice stagnated at the front of a glacier. Location is shown on Map Overlay Set #2.	Scientific
Rock Gorge	As used in this report, a stream cutting through rock is considered a Rock Gorge. Location is shown on Map Overlay Set #2.	The scenic glamour of the region.
Waterfall	Two categories were used in this report. 1. Less than 10 feet high. 2. Over 10 feet in height. Location is shown on Map Overlay Set #3.	Scenic
Rapids	A part of stream where the current great swiftness, the surface being broken by obstruction, but without actual waterfall. Location of rapids in major streams is shown on Map Overlay Set #3.	recreational.

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FISHERIES RESOURCES

The sport fisheries in Tompkins County are of great recreational and economic importance. The following varieties of fish can be caught in this area:

Species	Area
Lake Trout	Cayuga Lake
Atlantic salmon	Cayuga Lake and tributaries
Rainbow trout	Cayuga Lake and tributaries, farm ponds
Brown trout	Most streams and farm ponds
Brook trout	Headwater of streams
Smallmouth bass	Cayuga Lake, Fall Creek
Largemouth bass	Dryden Lake, Treman Lake, Beebe Lake, Danby Pond, farm ponds
Northern pike	Cayuga Lake
Chain pickerel	Dryden Lake, Cayuga Lake
Channel Catfish	Cayuga Lake, farm ponds
Brown Bullhead	Cayuga Lake, Dryden Lake, Treman Lake, Danby Pond
Yellow perch	Cayuga Lake, Dryden Lake, Danby Pond
Rock bass	Cayuga Lake
Bluegill	Cayuga Lake, Treman Lake, Dryden Lake, farm ponds
American smelt	Tributaries of Cayuga Lake

Fishing waters are generally divided into "warm" and "cold", with trout and salmon found in cold waters and bass, perch, etc. in warm waters. Accelerated urbanization has contributed thermal pollution to many cold streams. At present cold water stream fishing is limited, ^{and} hence is considered unique. Since Cayuga Lake is not comparable to the regular stream fishing, cold water fishing was divided into colder streams and lake as separate classes. It was reported that 85% of the cold water fishing was provided

by the Lake and spring spawning runs in the streams from the Lake to the "fall line" (Howard, Brown, Cole, 1967). Cold water fishing streams, during other seasons, are shown on Map #1.

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WHITE WATER CANOEING

Tompkins County offers very special opportunities for white water canoeing (see Map #1). The most impressive run is situated on Fall Creek between Malloryville and Varna. It is lined with beautiful, deep hemlock-lined ravines, and it has continuous rapids, final stretches of which challenge one's maneuverability. During high water in spring, canoeing may begin north of McLean and extend downstream to Forest Home bridge below Flat Rock. Another canoeable waterway is located at Salmon Creek between the mouth and the waterfalls at Ludlowville. However, this section is only maneuverable during high water in the spring.

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SCENIC VIEWS AND SCENIC DRIVES

Tompkins County as part of the Finger Lakes region is scenically unique. The geographical environment has, as its general expression, wide farm acres and level upland pastures, ice-molded valleys and reach-like hills in the southern part of the county. The southern end of Cayuga Lake has high, almost cliff-steep shores. Associated with Cayuga Lake are narrow, deep gorges, with cascading and plunging waterfalls. From many roadsides one views the trough and through valleys, the wide farmlands and scenic Cayuga Lake.

Scenic drives have been selected in an attempt to produce quality views. In most cases these drives are situated in areas not influenced by urbanization. Although several scenic drives were selected from which spectacular views could be obtained, the scenic environment was continuously interrupted by signs, telephone and power lines, junk automobiles, and piles of litter.

The existing scenic views are grouped into two major groups:

1. The Panoramic Landscape View (Figure 4) consists of an unobstructed 120° or better angle of vision, minimum of one mile in distance.
2. The Distance Landscape View (Figure 5) has a minimum

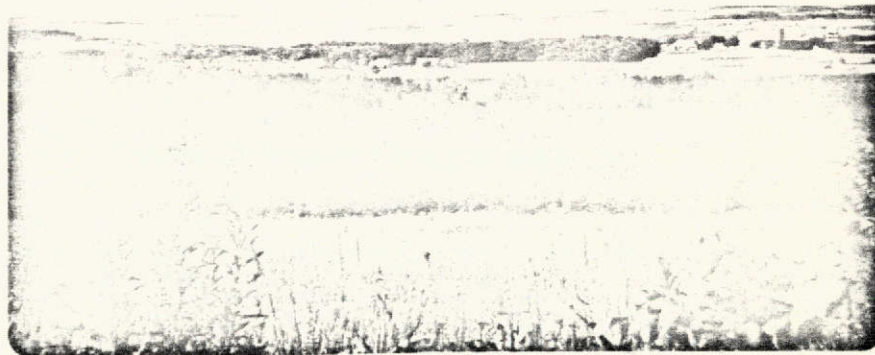
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10° view angle with a minimum of 3 miles unobstructed view.

Scenic Drives include drives with roadside interest either in spectacular views, along a quiet stream, and/or drives under a crown cover or through a forest at least one-half mile.

Scenic Views and Drives are documented in Map Overlay Set #3. All views are along present roads.

FIGURE 4



Panoromic Landscape View, from Turkey Hill Road, Town of Dryden. Cornell University, Ithaca College and West hill can be seen in this view.

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FIGURE 5



Distance Landscape View, from Buffalo Road,
Town of Caroline. Mt. Pleasant at a distance
of more than 8 miles is shown in this picture.

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AUTHOR'S RECOMMENDATIONS

It is the author's idea that major emphasis should be placed on the selection of unique natural resources with the following categories to be given top priority:

1. All major wetlands in the county should be included in this category because these lands reflect the roles of flood and water storage, wildlife habitats, and fish spawning.
2. Rock gorges, regardless of their size, should receive top priority to prevent their further destruction; the one requiring immediate attention is Coy Glen which is facing destruction by gravel excavation.
3. The wooded slopes of Inlet Valley and the East and West Shores of Cayuga Lake.









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MAP OVERLAY SET #2

	ESCARPMENT
	PALISADE
	ROCK GORGE
	FAULT
	IGNEOUS DIKE
	HANGING DELTA
	VALLEY HEAD MORaine
	ESKER

MAP OVERLAY SET #3

	WATERFALL MORE THAN 10' HIGH
	LESS THAN 10' HIGH
	RAPID
	PANAROMIC LANDSCAPE VIEW
	DISTANCE LANDSCAPE VIEW
	SCENIC ROAD

APPENDIX B
DETECTION OF BURIED
HUDSON-MOHAWK RIVER CHANNELS

NOTE: The initial phase of this study has been completed by Mr. Joseph J. Krieger; however, because of the Program's commitments to the N.Y.S. Geological Survey--the cooperating agency that provided confidential geological information, the formal report must be reviewed and cleared by this agency before submission. The following pages contain excerpts from Mr. Krieger's report, and they serve to indicate the scope of the study.

Feasibility of Detecting
and
Delineating Preglacial
Buried Channels

-Albany-Schenectady Area-

Joseph J. Krieger
M. Eng. Project
Prof. Ta Liang-Advisor
9/73

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1.0. INTRODUCTION

As a result of Pleistocene glaciation, the Albany-Schenectady area of New York State, as well as many other parts of the United States, has been covered with considerable amounts of glacial debris. An important aspect of these glacially covered regions is that the buried, preglacial valleys are often sources of substantial volumes of groundwater and granular materials. Susceptibility to ground water pollution is also a major consideration.

In many parts of the country, cities utilize buried valleys as their primary source of water (Thornbury, 1969), and in the Albany-Schenectady area, one such town is Latham (Halberg et al., 1964). The population of the Albany-Schenectady area is projected to increase from 748,000 in 1975 to 922,000 by the year 2,000 (N.Y.S. Office of Planning Services, 1972). With the continually growing need for water in this area, as well as in other areas of the United States, buried valleys will become increasingly important.

The purpose of this study is to determine whether remotely sensed data can be used to detect and delineate major buried valleys, using the Albany-Schenectady area of New York State as the test site. Simpson (1949) gives an introductory account of the buried topography in this area, and he presents a contour map of the buried bedrock which he constructed using well data. Since that time, a more detailed map has been compiled by the New York State Geological Survey, and it will be published in the near future (Dineen, 1973).

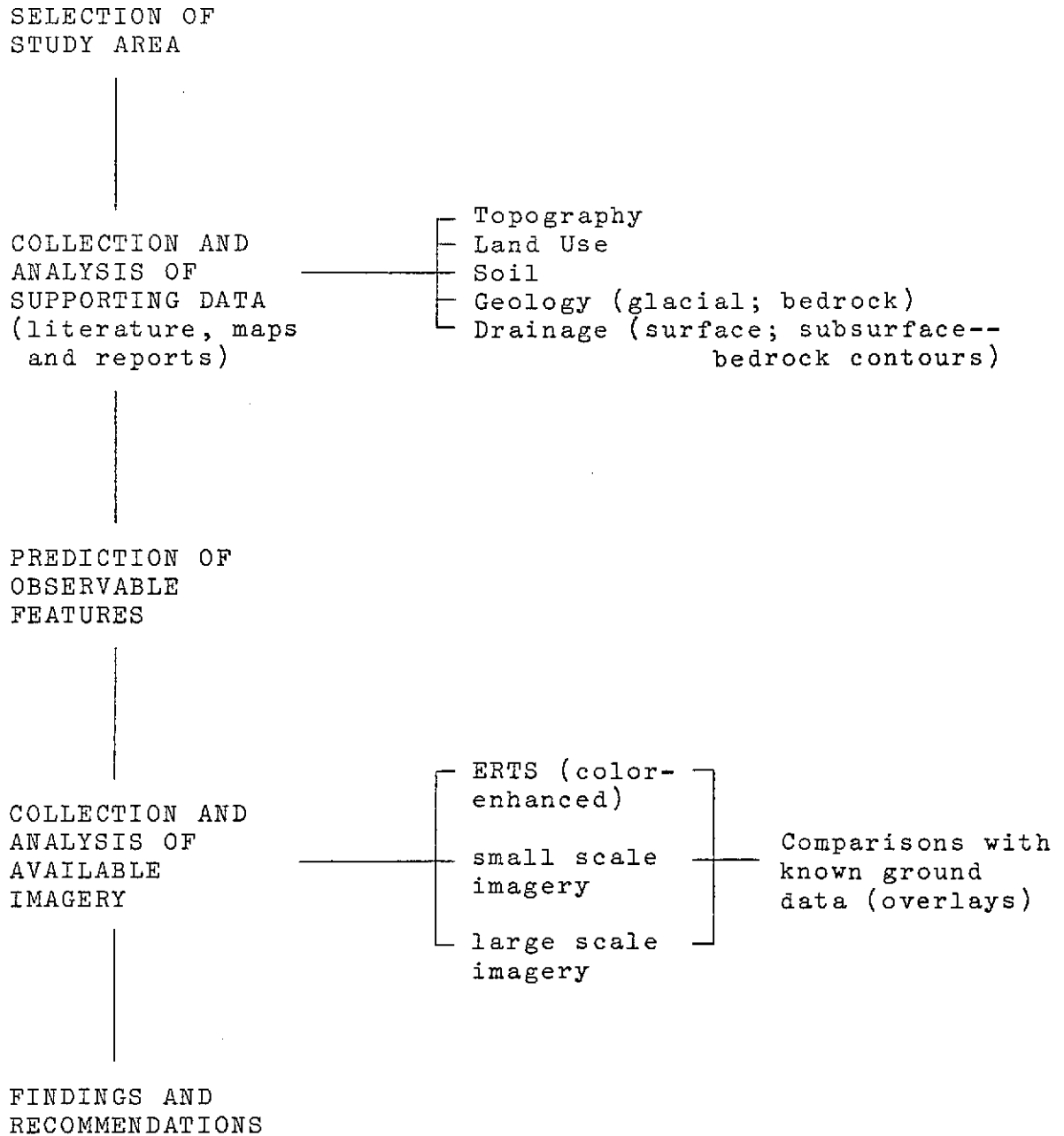
In this report "preglacial valleys," in which the preglacial streams flowed, is used synonymously with "preglacial channels." Detection was considered feasible if one or more portions of the buried valley network could be identified on the surface by distinctive features. For the delineation of the channels to be judged feasible, the buried valleys had to be manifested to the extent that the entire network could be constructed with reasonable accuracy.

Table 1. Imageries used for analysis of buried Hudson-Mohawk River channels.

IMAGERY	SCALE 1:X,000	DATE	QUALITY	TYPE	SOURCE
Pan- chromatic	24	4/68	Good	Print	Lockwood Mapping
	40	10/69	Good	Print	USDA
	100	8/71	Poor	Print	USAF (Rome, N.Y.)
Color	20	6/73	Poor	Film	NASA-Houston ^{1/}
	40	6/73	Poor	Film	NASA-Houston
	40	(Winter)	Good	Print	USAF (Rome, N.Y.)
B&W IR	40	6/73	Poor	Film	NASA-Houston
Color IR	20	6/73	Poor	Film	NASA-Houston
	130	4/73	Good	Film	NASA-Ames ^{2/}
Thermal ^{3/}	40	6/73	Poor	Film	NASA-Houston
ERTS (1079- 15122)	1000	10/73	Good	Film	NASA-Goddard
	250 ^{4/}	10/73			

- 1/ All NASA-Houston imagery was obtained under SRT Project X163, Mission 235
- 2/ ERTS-1 A/C support mission FSR-273 (Flight 73-065B)
- 3/ Daytime flight with RS-14 scanner; only 8-14µm, onboard film available for analysis
- 4/ ERTS images enlarged to 1:250,000 for color enhancement with diazo and density-slicing

Figure 9. Approach to the detection of buried channels with remotely sensed data.



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APPENDIX C
ERTS DELINEATION OF
INTERCONNECTED WATERWAYS

ERTS DELINEATION
OF
INTERCONNECTED WATERWAYS

-A Pilot Study-

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14850

December 1973

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PREFACE

This pilot study was performed by Mr. Frederick C. Voigt at the request of Mr. Ivan Vamos, Director of Research of the New York State Department of Parks and Recreation. The work was supported by NASA Grant NGL 33-010-171.

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INTRODUCTION

Recreation accounts for a substantial share of the economy of New York State. Comprehensive planning for recreation and recreational facilities is based on available data, and in the case of water-related recreation, and specifically canoeing, the existing data are inadequate.

The present method for inventorying continuous waterways--interconnected creeks, streams, rivers, ponds or lakes, which might be used for canoeing--is through reports of individuals or groups that participate in the sport. This information is compiled and published in New York State leaflets, where reference is made to U.S. Geological Survey topographic maps for more detailed information. On the other hand, because the obvious priority of topographic mapping is topography and not waterways, and because waterways may have changed subsequent to the date of the mapping, topographic maps should not be relied upon for more than the major waterways.

This study was undertaken to determine whether ERTS-derived data could be used to produce a more detailed map of interconnected waterways in New York State than is presently available.

MATERIALS AND METHODS

Test Sites

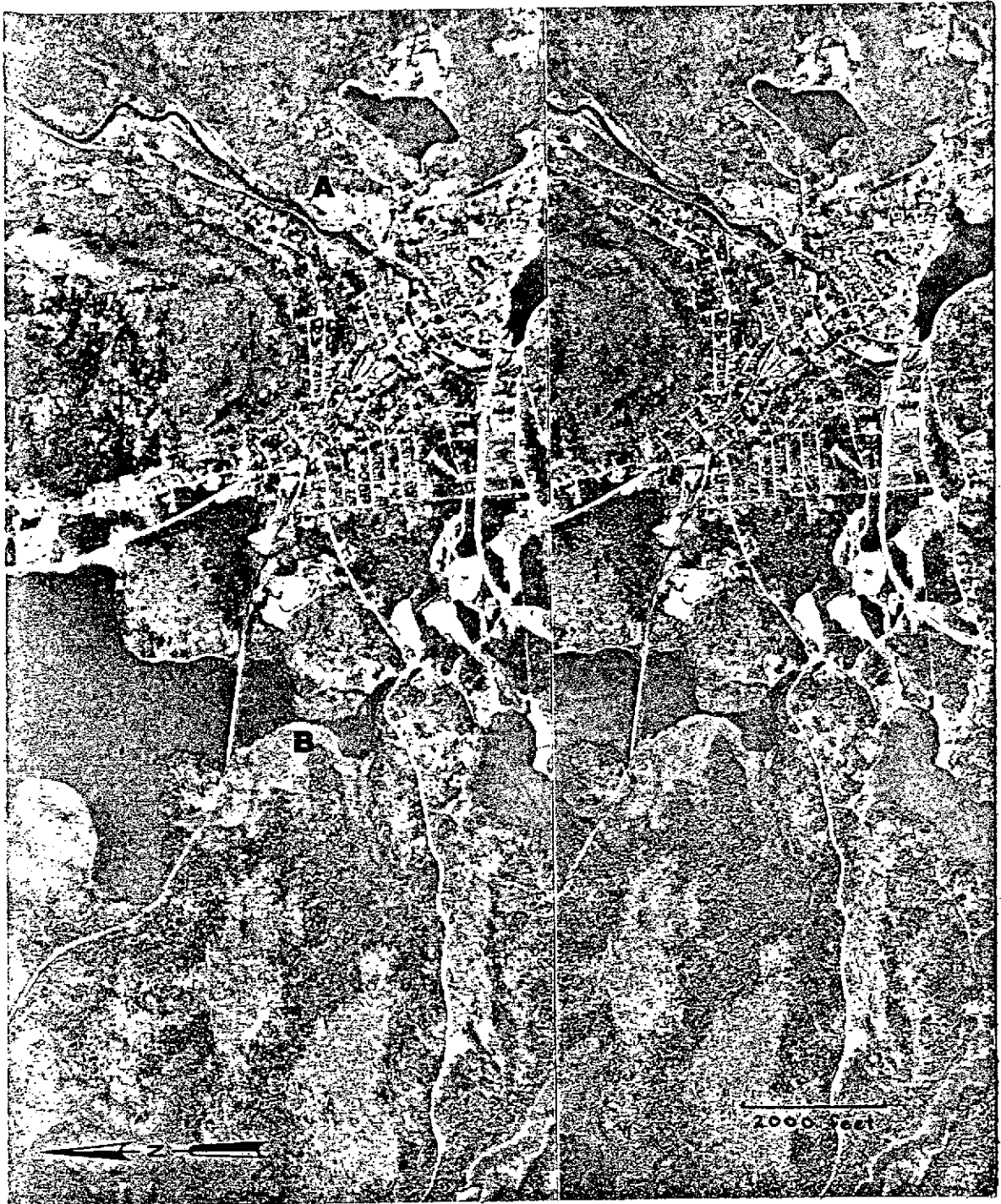
A relatively wide sampling of streams, ponds and lakes are found in the Saranac region of the Adirondack Mountains, and this region was deemed a suitable test area (Fig. 1). Four specific waterways in the test area were selected for analysis, and these are noted at points A, B, C and D in Figures 1 through 4.

Imagery

All investigations were confined to the multispectral scanner (MSS) data obtained during a single ERTS pass over the test area (image id: E1260-15183; date: 9 April 1973). In order to facilitate feature identification, the image from each of the four MSS channels (spectral bands) was photographically enlarged from its original scale (1:3,369,000) to the scale of a U.S.G.S. topographic map (1:250,000). That portion of each image which contained the test area was then printed as both a positive and negative film transparency.



Figure 1. U.S.G.S. topographic map showing points A, B, C and D. SARANAC LAKE, N.Y. 1955 AMS 6172 I-SERIES V721



5-1550-1169

5-1550-1170
4-19-68

Figure 2. Stereogram of points A and B as seen from conventional black and white aerial photography.

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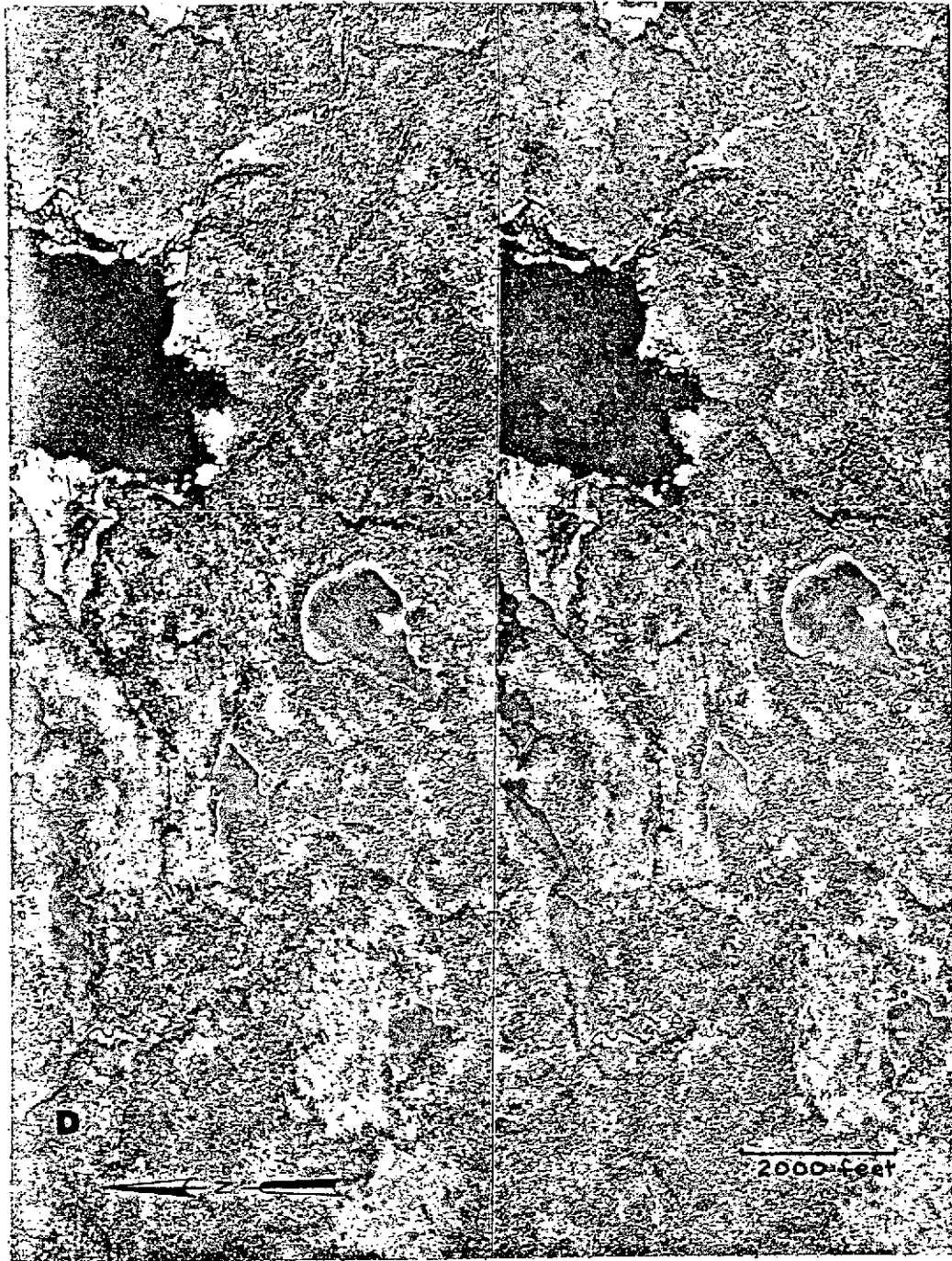


5-1550-1171

5-1550-1172
4-19-68

Figure 3. Stereogram of point C as seen from conventional black and white aerial photography.

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5-1550-1172

5-1550-1173
4-19-68

Figure 4. Stereogram of point D as seen from conventional black and white aerial photography.

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Image Enhancement

In an effort to further facilitate the identification of the test site waterways, the enlarged images were color-enhanced with various combinations of diazo (Figs. 5, 6, 7 and 8) and through density slicing (Figs. 9, 10 and 11).

Diazo

The first enhancement technique involved the use of color diazo foils--Mylar or clear acetate, coated with a sensitized diazonium-based compound (Appendix). Diazo foils of different colors were printed in contact with the enlarged images of the four spectral scenes, with various colors being "assigned" to each positive and negative image. The diazo foils were then overlaid in selected color-spectral band combinations to produce a series of color composite images. Each color composite, in turn, served to enhance different scene features with various colors and to various degrees.

Density Slicing

The second enhancement technique involved the use of a specialized instrument that electronically color-codes the tone densities of a single image. In brief, a gray-tone image is centered on the instrument's light table, where it is scanned with a vidicon camera. The analog signal from the vidicon is then converted to a digital signal which can be divided into 32 possible levels, with each level being assigned a unique color or color intensity. The color-coded levels, corresponding to levels of image density, are converted back to analog form and displayed on a t.v. monitor. The processed image can then be photographed or studied directly on the monitor.

All work on the density slicer was performed with the enlarged image from MSS band 7 (infrared), since this image is known to provide the greatest tonal contrast between water and vegetation.

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Figure 5. Color
Composite I
-5 yellow
+6 green
+7 magenta



Figure 6. Color
Composite II
-5 yellow
+7 green
+7 magenta

-65-



Figure 7. Color Composite III

- 5 yellow
- 5 magenta
- 7 green

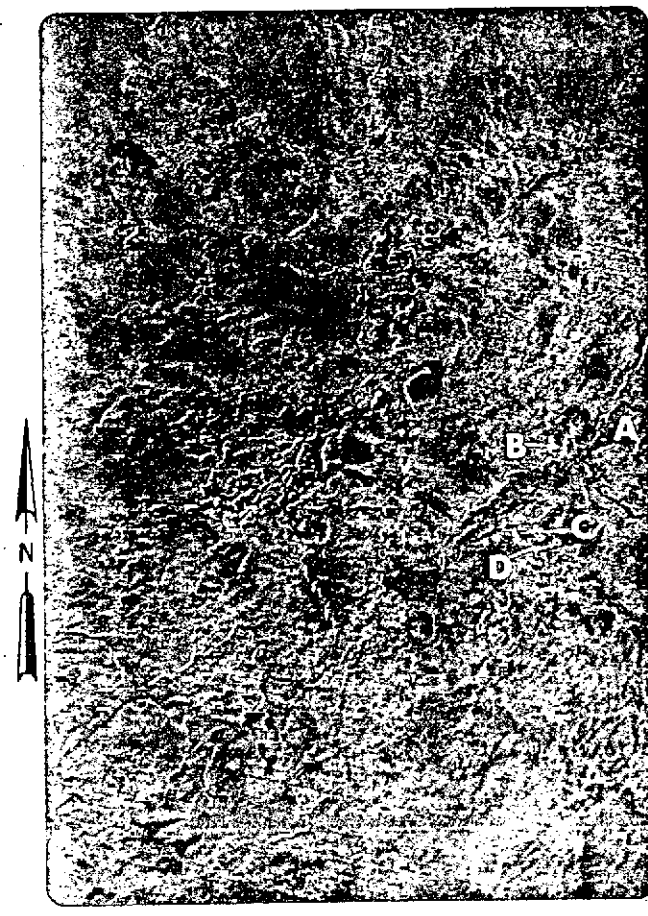


Figure 8. Color Composite IV

- 4 green
- +7 magenta
- 7 cyan

-60-

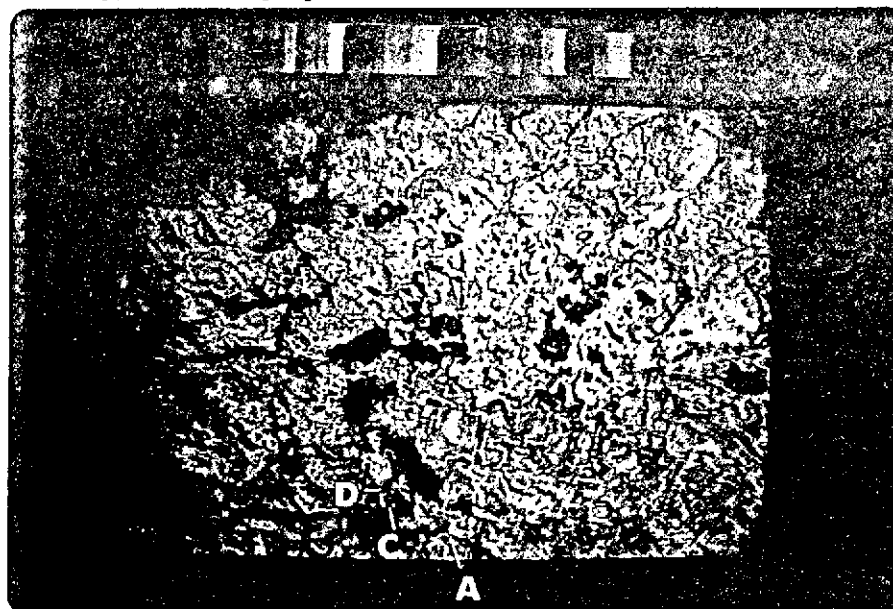


Figure 9. Density-sliced image of the Saranac Lake region showing points A, C, and D as black or blue-black in color.

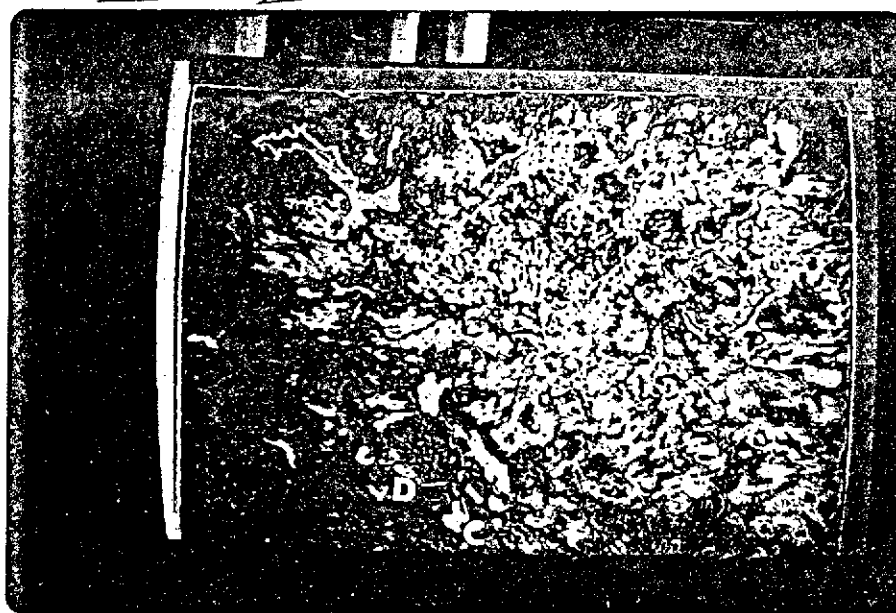


Figure 10. Density-sliced image of the Saranac Lake region showing only points: C and D as faint red lines.

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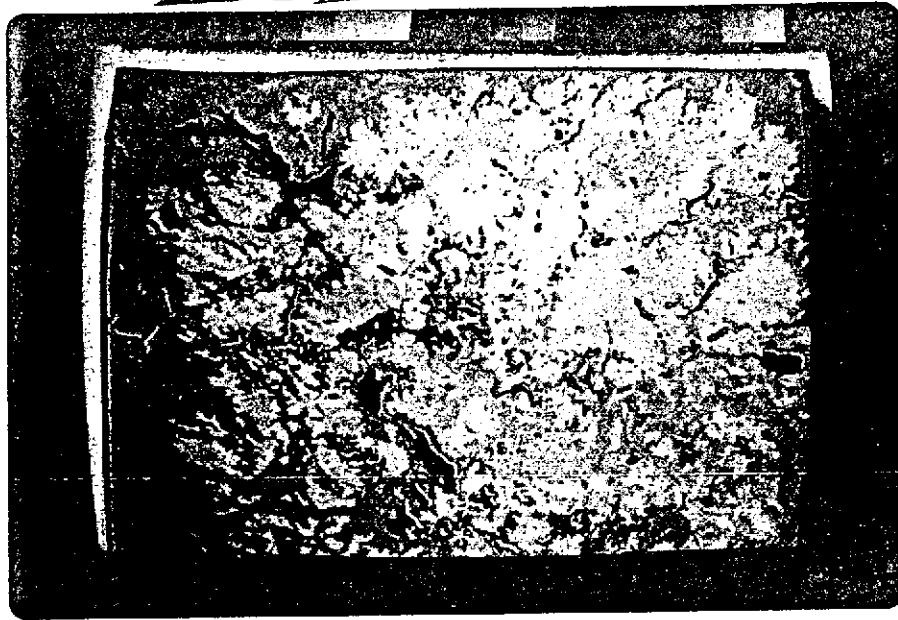


Figure 11. Density-sliced image of Saranač Lake Region showing only the major lakes and waterways, with points A, B, C, and D not being visible.

RESULTS AND DISCUSSION

The Saranac region test area is shown on the 15 minute, U.S.G.S. topographic map in Figure 1. The four waterways of interest--A through D--are indicated on the map as well as on three stereograms, enlarged from 1968, 1:24,000 scale, panchromatic aerial photographs (Fig. 2, 3 and 4). Measurements on the photographs determined that the channel widths were approximately 70 feet at A, 50 feet at B, and 125 feet at C and D.

Diazo

Four color composites of different diazo-spectral band combinations are presented in Figures 5, 6, 7 and 8. These are but four examples of the many combinations investigated, and they are included to provide some indication of the range of enhancement possible. As reported in Table 1, each of these color composites was formed with three diazo foils, two of subtractive colors (yellow, magenta or cyan) and a third of the primary color green.

In general, Color Composites I and II provide the most detailed view of waterways (Figs, 5 and 6). The assignment of green to the infrared images (bands 6 or 7) caused the water to appear dark and, thus, distinguishable from the lighter background. The channels at C and D are easily seen on either composite, and while the channels at A and B require closer examination, they can be identified.

As with Color Composites I and II, the assignment of green to an infrared image in Color Composite III caused the waterways to appear very dark (dark green); however, unlike Composites I and II, the background colors of Composite III are such that the narrower waterways at A and B are not easily distinguished (Fig. 7).

The contrast between water and background, while insufficient in Color Composite III, has been provided in Color Composite IV (Fig. 8). The waterways appear light red, and the background, blue or bluish green. It is apparent, however, that excessive contrast can also result in loss of detail--even the wider test channels at C and D require close examination before they can be identified on Color Composite IV.

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Table 1. Combinations of color diazo and spectral bands used to form color composites.

<u>COMPOSITE</u>	<u>ERTS BAND</u>	<u>IMAGE</u>	<u>DIAZO</u>
I	5	negative	yellow
	6	positive	green
	7	positive	magenta
II	5	negative	yellow
	7	positive	green
	7	positive	magenta
III	5	negative	yellow
	5	negative	magenta
	7	positive	green
IV	4	negative	green
	7	positive	magenta
	7	negative	cyan

Density Slicing

Slight adjustment of the density slicer's gain or color offset controls can produce major variations in the assignment of color to image density. Three examples of a density-colored MSS band 7 image of the test area are presented in Figures 9, 10 and 11.

In the first density-sliced image (Fig. 9), the lakes and interconnected waterways appear a black or dark blue, which contrasts sufficiently with their light blue surroundings. Three of the four test site waterways are visible (A, C, and D), and only the narrowest channel at B cannot be detected.

Although the second density-sliced image (Fig. 10) contains a greater number of colors than the first image (Fig. 9), it provides less waterway detail. The yellow lakes are easily distinguished; however, the wider test channels at C and D can only be seen as faint red lines, and the narrower test channels at A and B cannot be seen.

The third density-sliced image (Fig. 11) contains the

fewest colors, and the specific image densities selected for color-coding are such that only the lakes and major waterways are detectable. None of the four test channels can be discriminated.

CONCLUSIONS

In the course of this study, it was found that color-enhancing enlarged (1:250,000) ERTS images with diazo or density slicing proved a valuable aid toward defining interconnected waterways. No experimentation was conducted to determine whether increased image enlargements would provide additional information, nor were any experiments conducted with color-additive viewing or computer techniques. While either of these methods are considered worthy alternatives, a color-additive viewer was not immediately available, and data extraction by computer was judged to be too costly for an operational mapping program.

To be navigable to canoeists, a waterway need only be slightly wider than the canoe, with water depths of only several inches. The resolution of ERTS data (roughly 60 meters) as well as other limiting factors (e.g., overhanging vegetation, obstructing terrain and weather conditions) point to the obvious conclusion that ERTS imagery cannot be used to define all canoeable waterways.

As demonstrated in this study, however, ERTS imagery can assist in identifying and delineating waterways as narrow as 50 feet, and finer detail is likely possible. Overall, it is concluded that ERTS data could provide substantially more information on interconnected waterways than is presently available.

ACKNOWLEDGMENTS

The initial arrangements for this study were made by Dr. Ernest E. Hardy of Cornell's Department of Natural Resources. Diazo work was performed on a GAF #240 Diazo Printer, with the cooperation of Cornell's Department of Agricultural Engineering, and density slicing was performed on an International Imaging Systems (I²S) Digicol System, with the cooperation of Cornell's Division of Atmospheric Sciences. Prof. Warren W. Knapp assisted in the density-slicing operations.

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APPENDIX

Color Diazo Processing

A color diazo foil consists of a diazonium-based emulsion, coated on a sheet of clear Mylar or acetate. If the diazo is exposed to alkaline ammonia vapor (the developing agent), the diazonium salts will couple with the vapor to form a visible color. In contrast, if the diazo is exposed to ultraviolet (uv) light, the diazonium salts will decompose in proportion to the length or intensity of exposure. Development of a uv-exposed diazo will produce a diazo foil of lighter color; and, if the uv exposure has been sufficient, the foil will be clear (colorless).

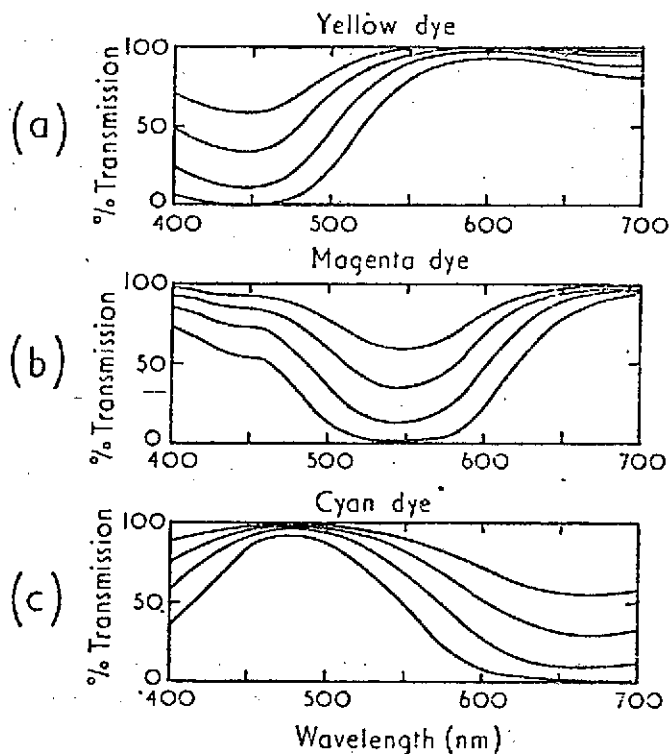
A single color representation of a gray-toned image transparency can be obtained by exposing a diazo foil to uv light; passed through the original image. The diazonium salts will decompose in proportion to the amount of uv light which is not filtered out by the gray-toned image. Upon subsequent development, the diazo foil becomes a single-colored image, in which the color densities correspond to the gray-toned densities of the original image transparency.

On a diazo printer, the two principal adjustments control exposure and development. The degree of exposure, which is controlled by the speed of printing, is more critical than the amount of alkaline ammonia present for development. The faster the printing speed, the shorter the time of exposure to uv light and, thus, the darker the resultant diazo foil.

Subtractive Color

The capacity to obtain a range of colors by overlaying two or more color diazo foils of the same image scene is basically a result of color subtraction.

White light is an additive mixture of blue (390 to 490 nm) green (490 to 580 nm) and red (580 to 780 nm) light. The subtractive colors--yellow, magenta and cyan--represent white light minus one of the primary additive colors. As shown in the figure, a yellow filter will absorb (subtract) blue light, while transmitting red and green; a magenta filter will absorb green, while transmitting red and blue; and a cyan filter will absorb red, while transmitting blue and green. If, in



Spectral transmission curves for (a) yellow, (b) magenta, and (c) cyan, dyes at four different concentrations. (Hunt, 1967)

projecting white light, the proportions of blue, green and red are varied with color subtractive filters, of various dye concentrations, a wide range of colors can be produced.

SELECTED REFERENCES

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- Denstman, H. and M.J. Schultz. 1963. Photographic reproduction; Methods, techniques, and applications for engineering and the graphic arts. McGraw-Hill Book Co., Inc. N.Y. 181 p.
- Eastman Kodak Company. 1972. Color as seen and photographed. Kodak Pub. No. E-74. Rochester, N.Y. 68 p.
- Hunt, R.W.G. 1967. The reproduction of color. John Wiley & Sons, N.Y. 470 p.

APPENDIX D
PLANT SENSITIVITY
TO ATMOSPHERIC POLLUTION

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PLANT SENSITIVITY TO
ATMOSPHERIC POLLUTION

Sensitivity Tables
and
Selected References

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September 1973

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ACKNOWLEDGMENTS

This information on vegetative indicators of air pollution was compiled by Mr. Joseph J. Krieger under the direction of Mr. Warren R. Philipson. The work was sponsored by NASA Grant NGL 33-010-171 and performed for Mr. David J. Romano, Chief, Special Projects Section, Division of Air Resources, New York State Department of Environmental Conservation.

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The relative sensitivity of various forms of vegetation to ozone (O₃), sulphur dioxide (SO₂), fluoride (HF), nitrogen oxides (NO_x), peroxyacetyl nitrate (PAN), ethylene (ETH), 2,4-dichlorophenoxyacetic acid (2,4D), chlorine (Cl), hydrogen chloride (HCl), mercury (Hg), ammonia (NH₃), and hydrogen sulfide (H₂S) have been compiled from four references:

1. Magill, P.L., F.R. Holden, and C. Ackley. 1956. Air pollution handbook. McGraw-Hill Book Co., N.Y. 670 p.
2. Forest Service, U.S. Dept. of Agr. 1972. Our air: Unfit for trees. 20 p.
3. Treshow, M. 1970. Environment and plant response. McGraw-Hill Book Co., N.Y. 422 p.
4. Jacobson, J.S., and A.C. Hill (eds.). 1970. Recognition of air pollution injury to vegetation: A pictorial atlas. Air Poll. Control Assoc., Pittsburgh, Pa. 100 p.

The sensitivity ratings are listed as follows:

S--plant is sensitive

I--plant is intermediate in sensitivity

R--plant is resistant or tolerant

As evidenced by the numerous blank spaces in the tables, the sensitivity data are incomplete. Moreover, in certain cases, different sensitivity ratings were encountered. For these cases, both ratings are recorded, together with the numerical citations of the conflicting references. In every case, sensitivities are recorded at the taxonomic level of available information; ratings for a genus may not apply to all species and, similarly, ratings for a species may not be applicable to all varieties.

<u>TABLE</u>	<u>PAGE</u>
Trees	1
Softwoods	1
Hardwoods	2
Crops	6
Ornamentals	8
Shrubs	9
Weeds	10
Herbs	10

TREES

1

SOFTWOODS	O ₃	SO ₂	HF	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
FIR												
Balsam	R	I							R			
Big Cone Douglas	I											
Douglas	R	I	S2R1		R							
Grand			R									
Silver		I										
White	I	I										
PINE												
Austrian	S	R		S	R				R			
Coulter	I	R										
Digger	R											
Knob Mugo		R	S	S								
Eastern White	S	S	S	S	R			S	R	I4S2		
Jack	S	S			R			I				
Jeffrey	S											
Knobcane	I											
Loblolly			S					I				
Lodgepole		I	S2R1									
Monterey	S	R										
Pitch	S				R							
Ponderosa	S	I3S2	R1S2									
Red	R											
Scotch	S		S									
Shortleaf								I				
Singleleaf Pinyon	R											
Slash								I				
Sugar	R											
Torrey	R											
Virginia	S											
Western White		S2R1										
LARCH		S	S						S			
European	S			I	R							
Japanese	S				R							
Western		S	S									
SPRUCE									I4R4			
Black Hills	R											
Blue			S									
Colorado	R		S	S	R		I					
Engelmann		S	R									
Norway	R								R			
White	R	R	I3R2	S	R							

SOFTWOODS	O ₃	SO ₂	H ₂ F	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
HEMLOCK			R				I	R				
Eastern	S				R							
Mountain		S										
CEDAR												
Eastern White	R	R	I			I4S2			R			
Incense	I											
Western Red		R										
JUNIPER		R	R									
Western	R											
YEW			I				I	R				
Japanese			I									

HARDWOODS	O ₃	SO ₂	H ₂ F	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
MAPLE		R							S4R4			
Hedge		R	I									
Japanese				S						I		
Manitoba	S	R	S				S	S				
Mountain		R										
Norway	R			S			S		R			
Red	R	R										
Silver	S		I									
Sugar	R	R			R			S	R			
OAK									R	I		
Black							S					
Bur	R											
English	R	R	I									
Gambel	S											
Pin	S						I	S				
Red	R	R					I	R	R			
Scarlet	S											
Shingle	R											
White	S											
POPLAR		I										
Balsam Poplar		I										
Bitooth Aspen		I										
Eastern Cottonwood		R										
Eugene Poplar			I									

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HARDBOODS	O ₃	SO ₂	HF	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
POPLAR												
Lombardy Poplar		S	I									
Quaking Aspen	S	S	I									
Yellow Poplar	S	R			S							
BIRCH		IIS2	IIR5				S		R			
Cutleaf European			R									
European Filbert			I									
European White	R		I									
White		S										
WILLOW		S	R							S		
Weeping	S											
Yellow			I									
LINDEN		I					S			I		
American	R		R									
European			I									
Large Leaf				S								
Little Leaf	S		R	S	S							
ASH							R					
American Mt.			R									
European			I									
European Mt.	R	S	R									
Green	S	R	I									
Modesto			R									
Mountain			I									
White	S											
APPLE		IIS2	I	S			S	S			R	R
Crab	S							S				
Delicious			I									
Red Jonathan			R									
CHERRY							I		S			R
Bing	S		I									
Black								I	R			
Choke			I				I					
Cornelian			R									
Flowering			R									
Jerusalem										R		
Oriental			R									
Royal Ann			I									
Sweet		R										

HARDWOODS	O ₃	SO ₂	HF	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
PLANETREE	S		IIR2									
American	S	R										
California	S											
London							S					
Oriental		R	I									
APRICOT		I	S									
Chinese	I		S									
Flowering			S									
Moorpark			I3S1									
Royal			S									
Tilton			I									
PEAR		S	R	S			R		R			
Bartlett	R											
ELM		I										
American		S	R									
Siberian	R											
MULBERRY		S	I				I					
Marie, Leaf	S											
Red			I									
Texas		S										
DOGWOOD			R				S					
White	R	R										
PLUM		I										
Bradshaw			S									
Flowering			R									
BEECH									R			
European	R	R	I	S								
ELDERBERRY			R				S					
European			R	S								
European Red			R									
LOCUST												
Black	S	R	I	S								
Honey	S											
Thornless Honey	S											

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HARDWOODS	O ₃	SO ₂	HF	NO _x	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
ALDER	S											
European, Black			R									
PEACH		I	S4I1			S	S	I		I	R	R
Elberta Lovell			S									
CHESTNUT												
Horse								S				
Spanish			I									
SUMAC												
Chinese			R				S	S				
Smooth			I									
WALNUT												
Black	R		I									
English	S	S	I									
HOLLY												
American											I	
Chinese								R			R	
English		R	I									
Japanese						S2I4						
LAUREL												
Sassafras								S				
CITRUS		R	I4R1									
Grapefruit			I									
Orange			I	I								
TUPELO												
Black Gum		R						I				
Sweet Gum	S							I				
HORNBEAM												
European		R	I	S								
SERVICEBERRY			I									
CATALPA	S	S2I1										

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	O ₃	SO ₂	HF	NO ₂	PAN	ETH 2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Alfalfa	S	S	I		I		S				
Asparagus			R	R							
Barley	S	S	I		I						
BEANS	S	S	R		S				S		
Black Valentine						S					
Bush				R			R				
Castor		R									I
Field		S									
Kidney											S
Lima					R						
Pinto				S	S			I			
Scotia								I			
BEETS											
Sugar		I	I		I			S			
Table	R	S			I4S3	R					
Broccoli	S	S			R						
Brussels Sprouts		S									
Buckwheat		S	I1S1				S			I	S
Cabbage		I	R		R	R	R				
Carrot	I	S	I		I4R3	I					
Clover		S	I		S	R					S
CORN	S	R	S		S3R4		I	S			
Field							R				
Sweet	S		S								
Cotton	R	S	R		R	S					
Cowpea						S		I			
Cucumber	R	R	R		R	S		I			S
Eggplant		I	R				R	R			
Endive	I	S			S	R					

CROPS	O ₃	SO ₂	HF	NO ₂	PAN	ETH 2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Grass											
Annual Blue	R			I	S		I			I	R
Bent	S										
Broome	S										
Crab	S		I								
Johnson			S				S				
Kentucky Blue				R			R			I	I
Orchard	S										
Lettuce	R	S	I	S	S						
Muskmelon	S										
Mustard				S	S		S			S	R
Oat	S	S	I		S	R					
Okra		S									
Onion	S	R	R		R	R	S				
Pea		I	I								
Peanut	S										
Pepper		S	R		S		R				I
Potato	S		I					I			
Potato, Sweet		S	SIII			S					
Pumpkin		S									
Radish	S	S			R	R	S				S
Rhubarb		S	I		R	R					
Rye	S	S	I	I		R					
Safflower		S									
Sorghum			I		R	R	R				
Sorrel							S				
Soybean		S	R		I	I	R				S
Spinach	S	S	I		I						
Squash		S	R		R	I	I				
Strawberry			R		R				I		R
Swiss Chard		S			S						
Tobacco	S		R	S	I4S3		S	SIR4	I	I	S
Tomato	S	I	R		S	S	S	I	S	I	S
Turnip	I	S									
Wheat	S	S	R4II								

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ORNAMENTALS

	O ₃	SO ₂	HF	NO _x	PAN	ETH 2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Aster		S4I1	I		S		I				S
Bachelor's Button		S									
Basil, Sweet					S						
Begonia		I	I		R		R	I	I		
Camellia					R				I		
Carnation	S				R	S					R
Chrysanthemum	S	R	R		R						
Coleus					R		S			I	R
Cornflower											I
Cosmos		S					S		I		S
Croton				R					R		
Cyclamen					R						
Dahlia			I		S		I				
Fuchsia					S				I		
Geranium	R		I				I		I		
Gladiolus		S3R1	S				I				I
Hydrangea		I							S		
Impatiens					S						
Ivy					R				R		
Lilac	S	R	I								
Lilly, Calla									I		
Lilly, Easter									I		
Marigold		I	R								
Marigold, African						S					
Narcissus			I		R						
Nasturtium		I					I				I
Orchid					R	S					
Peony			I				R				
Petunia	S				S		I				
Philodendron						S					
Saxifrage									I		
Snapdragon			R		S						
Tulip			S				S				

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SUBSTR

	O ₃	SO ₂	HF	NO ₂	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Azalea			SIII	S	R	I		I		I		
Blackberry								S				
Blueberry			S									
Bridalwreath	S		IIR									
Forsythia							S			I		
Gardenia						I						
Grape	S	IIRI					S	I				
Grape, Oregon			S									
Grape, Concord			I									
Heath				R								
Hibiscus		R		S								
Lilac	S	R RII										
Mimosa										S		
Oxalis			I					R		S		
Periwinkle					R							
Privet	S	R	R			S	I	S		S4I4		
Pyracantha	I		R									
Raspberry			I									
Rhododendron			I				I					
Rose		R RII4				S	I	S	I			I
Salvia										I		S
Snowberry	S											
Virginia Creeper	R	R	R					S				
Wandering Jew								I				
Wisteria							S					
Witch Hazel								S				

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WEEDS

	O ₃	SO ₂	HF	NO ₂	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Bindweed		S										
Burdock			R									
Careless Weed		S										
Chickweed			I	I	S			S			R	I
Curly Dock		S			S							
Dandelion		I	R	I				I			R	I
Fleabane		S										
Jimson Weed					S							
Lettuce, Prickly		S										
Mallow		S										
Pigweed			R4II	R	S			R			R	R
Plantain		S	R									
Ragweed		S					I					
Sunflower		S	R3I4	S				S		S	S	I
Velvet Weed		S										
Wild Oat					S							

HERBS

	O ₃	SO ₂	HF	NO ₂	PAN	ETH	2,4D	Cl	HCl	Hg	NH ₃	H ₂ S
Butterfly weed										S		
Columbine										I		
Golden Rod			I									
Johnny Jump Up								S				
Polygonum								R				
Poppy												S
Purslane		R	R									R
Violet		S	I									

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APPENDIX E
TECHNIQUES FOR TRANSFERRING
AIRPHOTO DATA TO BASE MAPS

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TECHNIQUES FOR TRANSFERRING
AIRPHOTO DATA TO BASE MAPS

-An Internal Report-

Remote Sensing Program
Cornell University
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December 1973

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PREFACE

This report focuses on the accuracy of airphoto-derived inventories. It makes no attempt to assess or minimize the usefulness of existing inventories, but instead, calls for future attention to those errors which arise independently of the photographic interpretation. The effects of these errors vary with the inventory cell size, as well as with the types of data (area, line or point) and complexity of the region being inventoried. Overall, however, their number and magnitude can be reduced to the extent that one is willing to pay for increased photogrammetric accuracy.

This study was performed by Messrs. W.R. Philipson and B. Coskun. It was supported, in part, by NASA Grant NGL 33-010-171.

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1. INTRODUCTION

Today, resource analysts are storing and analyzing land use and natural resource information relative to the earth's surface by computer. One approach to inventory is to identify and delineate the thematic data on aerial photographs and subsequently transfer this data to geodetic base maps. Once recorded on the base maps, the existence and areal data can be located, measured, stored and retrieved with respect to cells, whose sides form a geodetic, Cartesian grid.

2. ACCURACY

The accuracy with which data can be inventoried in this manner is related to: the scale and accuracy of the base map; the size of the grid cell; the quality, scale, and tilt of the photography; the nature and amount of terrain relief; and the manner in which thematic boundaries are delineated, transferred, and measured.

2.1. Accuracy Achievable

Since the thematic data are recorded and measured on existing base maps, the ultimate accuracy that could possibly be achieved is governed by the scale and accuracy of the base map. If the base map conforms to U.S. National Map Accuracy Standards, the horizontal accuracy is defined as follows: for maps at scales of 1:20,000 or smaller, not more than 10% of the well-defined points shall be in error by more than 1/50 inch; for larger scale maps, the error shall be no more than 1/30 inch.

Hence, if an inventory were referenced to a U.S.G.S. 7-1/2 minute quadrangle map, at 1:24,000, the positional accuracy of the inventoried data could be no better than 90% of the well-defined features located within 12 meters of their true ground position. On the other hand, because the inventory is compiled from thematic data and reference grid lines that have been added to an existing base map, this accuracy is virtually impossible to achieve. Even

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with error-free feature identification, delineation and transfer, plotting inaccuracies are such that errors contained in the gridded thematic display will exceed those errors contained in the base map; rarely, would these errors compensate. At a map scale of 1:24,000, a plotting error as small as 1 mm would result in a ground positional error of 24 meters.

If accuracy were viewed as the reliability of referencing thematic data to their appropriate geodetic grid cell, the size of the cell would have a direct bearing on the expected and attained reliability. Enlarging the cell will have no effect on the accuracy of the thematic data, as plotted, but it will increase the reliability of the computer-stored data by decreasing the relative effect of any positional error; although the absolute error within a cell will remain constant, the error as a proportion of the total area of the cell will decrease. Moreover, the larger the cell, the higher the probability that the inventoried data will, at least, be referenced to the proper cell.

As an illustration, consider a thematic display whose horizontal accuracy is such that 90% of the well-defined features are plotted within 1 mm (1/25 inch) of their true map position (i.e., one half the accuracy required by the National Map Accuracy Standards). Intuitively, the reliability with which thematic data could be assigned or referenced to their correct grid cell would be substantially lower for a cell of, say, 1 mm-by-1 mm than it would be for a cell of 10 mm-by-10 mm. By assuming a thematic display of this accuracy, Colvocoresses (1973) has determined that a cell of, at least, 20 mm-by-20 mm would be required if data reliability were to approach 97%.

2.1 Increased Reliability

The positional accuracy of thematic data can be increased by increasing the accuracy of the base map. In effect, this is synonymous with increasing the base map scale. With a map of 1:10,000, for example, 90% of the well-defined map points would be located within 8.5 meters of their true

ground position, or about 3.5 meters more accurately than with a base map of 1:24,000. This approach is, of course, limited by the availability of base maps and, in general, the larger the scale of the base map, the greater the cost of the inventory.

As described, data reliability could also be improved by employing larger cell sizes; however, this is normally an undesirable approach. Although the statistical reliability of data stored on the computer is improved, the positional accuracy of data recorded on the thematic displays is not. In addition, the larger the cell, the greater the generalization afforded to and by computer-stored data.

3. INFORMATION TRANSFER

Although the errors associated with the base map are unavoidable and, seemingly, appreciable, seldom would they represent more than a small portion of the total inventory error. Until such time as the transfer of information from the photographs to the base map can be automated or eliminated, the greatest portion of inventory error will likely arise in the transfer process.

3.1 Potential Errors

Assuming accurate feature identification and precise, stereoscopic feature delineation, the principal sources of error affecting information transfer are considered to be inherent to the photography; namely, relief and tilt displacements.

3.1.1. Scale Variation

Aerial photography is normally flown at a relatively constant height above a defined datum (generally, mean sea level or mean terrain), and the nominal or average scale of the photography is, thus, based on this datum. However, because aerial photographs are central perspective views and not orthogonal projections (maps), ground features occurring at elevations that differ from the elevation of the datum will be imaged at scales which differ from the

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scale at datum. Consequently, even if the average scale of the photography were identical to the scale of the base map, thematic data could not be transferred accurately from the photographs to the base map without adjusting for scale variation--the only exception being for a perfectly flat terrain.

To illustrate, the average scale of a photograph taken with a 152 mm (6 in) focal length camera at 3,660 m (12,000 ft) above mean terrain would be 1:24,000. If this scale were applied in measuring the image of a 50 m-by-50 m field that occurred at 100 m above mean terrain, the field would be reported as having an area of 2,650 m² rather than 2,500 m². In brief, the closer the object is to the camera, the larger it will appear. Unless all objects fall on a single datum, that is equivalent or scaled to the base map datum, some objects will appear larger and some smaller than their actual map size.

3.1.2. Relief Displacement

Scale variation is one effect of relief displacement. For a truly vertical photograph taken with a perfectly aligned camera, the image of any ground point that does not fall on the datum will be displaced from its true datum position, in a direction which is radial from the center of the photograph. The amount of displacement can be computed from the equation, $d=rh/H$; where r is the photographic distance between the center of the photograph and the image of the ground point, h is the elevation difference between the ground point and the datum, and H is the height of the aircraft above datum.

Sample values of relief displacement and corresponding ground distances are listed below for a point imaged at 3 inches from the center of a 1:24,000 scale photograph taken at 3,660 m above datum. For example, a ground point whose elevation is 25 m above datum will be imaged at 0.521 mm from its true position on the 1:24,000 datum or corresponding base map, or 12.5 m from its true ground position. -101-

h (meters)	d (mm)	Ground Displacement (meters)
5	0.104	2.5
10	0.208	5.0
25	0.521	12.5
50	1.04	25.0
100	2.08	50.0
150	3.13	75.0

3.1.3 Tilt Displacement

In addition to accounting for the effects of relief, the transfer process must also allow for any tilt displacements. Although a thorough discussion of tilt is beyond the scope of this report, it will suffice to note that an aerial photograph is generally considered to be "vertical" if it contains less than 3 degrees tilt. While 3 degrees tilt might seem an acceptable amount, a point imaged approximately 3 inches from the center of a 1:24,000 photograph would be displaced as much as 17m if tilt were 1 degree, 36 m if tilt were 2 degrees, and over 50 m if the angle of tilt were, in fact, 3 degrees. Moreover, image displacements due to tilt and relief arise independently, and they may add or subtract (compensate). As a rough approximation, these displacements will tend to compensate over one half of the photograph and add on the opposite half.

3.2. Elimination of Potential Errors

3.2.1. Photographic Processing

The effects of relief and tilt can be removed during the photographic processing. Tilt displacements are eliminated through rectification, and tilt as well as relief displacements are eliminated through orthophotographic processing.

Rectifying photographs for an airphoto-derived inventory consists of printing photographs which have been transformed from their negative plane onto the datum plane of the base map. Since rectification requires ground control and special orientation for each photograph, the cost of a

rectified print will obviously exceed that of a conventional contact print. Moreover, although rectification can be employed to remove tilt and set the average photographic scale to the scale of the base map, rectification will not eliminate the effects of relief--displacements that can be removed only through orthophotographic processing.

The production of an orthophotograph is essentially the same as the production of a topographic map on a stereoscopic plotter. The model formed by the projection of two overlapping photographs is scanned, but scanned electro-optically to produce a photograph which is equivalent to a line-contour map insofar as tilt and relief displacements have been eliminated and the model scaled to a desired datum.

The primary drawback of orthophotography is cost. At present the minimum cost of a single orthophotograph is on the order of thirty to forty dollars. A secondary drawback is that, unless parallax is "built-in" artificially, orthophotographs cannot be used by themselves to provide stereoscopic information. Although a three dimensional scene could be obtained by viewing an orthophotograph together with an overlapping perspective photograph of the same scale, orthophotographs are normally printed at a scale which is larger than that of the original photography. For orthophotography, the original photographs are commonly obtained at scales of 1:40,000 or smaller in order to reduce the effects of relief and, thus, overcome any technical difficulties that may arise in orthogonalizing sharp, vertical discontinuities (e.g., in steep mountainous regions or in urban areas where buildings exceed several stories in height). As such, unless the original negatives are also printed at an enlarged scale, the interpreter would have to obtain any stereoscopic information from smaller scale prints, independently of the orthophotographs.

3.2.2. Photogrammetric Instruments

As described, tilt and relief displacements can be removed in the photographic processing, but it is also possible to account for those potential sources of error

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without actually removing them from the photographic products. By employing any of several available photogrammetric instruments, the photo-analyst has the capacity to correct for tilt, relief or both.

A number of single photograph, non-stereoscopic instruments have mechanisms to adjust for tilt (e.g., Aero-Sketchmaster by Zeiss, Rectoplanigraph by Fairchild, Map-O-Graph by Art-O-Graph and various reflecting projectors), yet only one, the Bausch & Lomb Zoom Transfer Scope, has the capacity to correct for both tilt and relief. On the other hand, correcting for image displacements with this instrument is a time-consuming task, and the Transfer Scope is not considered a practical tool for more than a local inventory.

Similarly, although any instrument that couples a stereoscope with a parallax measurement device can provide elevations and perspective contours of relief, not all can provide an orthographic projection at a uniform scale--as would be required for transferring photo-information to the base map. In general, those instruments which do have this capacity include paper print plotters and double projection type plotters which employ glass diapositives.

The advantages of performing the inventory with the aid of a double projection, stereoscopic plotter are clear (i.e., simultaneous interpretation, plotting and data takeoff, with maximum possible accuracy); however, the cost of diapositives and the requirement that the photo interpreter must also be a qualified plotter operator, would likely outweigh the advantages.

Of the available paper print plotters, only the K.E.K. Stereoscopic Plotter by Kail and the Stereotope by Zeiss have the capacity to correct for all image displacements while, simultaneously, providing a uniform scale, orthographic projection. Although several other paper print plotters could be employed successfully with near vertical photographs (e.g., the Cartographic Stereomicrometer, the Stereoflex and radial line plotters), the K.E.K. Plotter

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and the Stereotope would generally provide greater accuracy; especially, with larger angles of photographic tilt.

3.3. Transfer Techniques

3.3.1. Non-Instrumental

The quickest, easiest and, by far, the cheapest method of transferring photo-information to the base map is by eye. If performed by a skilled photo-analyst, some amount of compensation or correction for relief and tilt displacements, as well as for scale differences, could be expected. In general, however, there is no way to gauge either the amount of error compensation or the resultant accuracy of the inventory without testing the final results; no estimate of error can be provided beforehand.

In an effort to improve the accuracy of data transfer, the photo-analyst might attempt to trace the photo-data on acetate overlays and, subsequently, transfer the overlay data onto the base map. It is probable, however, that the accuracy resulting from this approach would be lower than that of the unaided data transfer. Photographic displacements and scale differences would be "fixed" on the overlays, thus, confusing the analyst and hindering any attempt at error compensation.

The least costly means of upgrading the accuracy obtainable with data transfer by eye is to perform the inventory with rectified photographic prints. As described, the average scale of the photographs would be identical, or nearly identical, to the scale of the base map, and tilt displacements will have been removed. The photo-analyst would still have to contend with relief displacements, but by working only with the center portion of each photograph and by interpretive resections these errors can be held to a minimum.

A second alternative is to perform the inventory with orthophotographs. Although the cost would increase substantially, the potential benefits in terms of accuracy

and subsequent applications are manifold. This alternative should be studied in detail, with considerations including data transfer from photographs to orthophotographs to base maps, as well as the more interesting possibility of substituting orthophotographs for line-contour base maps.

3.3.2. Instrumental

If the inventory is to be performed with conventional contact prints, it is recommended that the use of a K.E.K. Stereoscopic Plotter or a Zeiss Stereotope be considered. In contrast, if the inventory were performed with rectified photographic prints, several other lower cost, paper print plotters would also suffice. The initial cost of a suitable instrument might well be justified by the resulting increase in accuracy.

One advantage to performing the inventory with a stereoscopic plotter is that thematic boundaries need not be drawn on the photographs. Thus, the errors that arise in plotting, as well as in transferring a penciled line rather than a thematic boundary, can be eliminated.

4. SUMMARY

This report has considered the accuracy of airphoto-derived, land use and natural resource inventories, while focusing on the major errors that arise in transferring thematic data from the photographs to the base map. Secondary errors associated with photographic quality have not been treated, nor have errors that arise in data takeoff or subsequent phases of inventory compilation and processing.

In line with the objective of this report, alternative methods for increasing the accuracy of data transfer have been selected and recommended for further study.

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APPENDIX F
TIME-SEQUENCE ICE-COVER
MAPPING OF ST. LAWRENCE SEAWAY

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TIME-SEQUENCE ICE-COVER
MAPPING OF ST. LAWRENCE SEAWAY

-A Progress Report-

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14850

December 1973

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ACKNOWLEDGMENTS

This pilot study was supported by NASA Grant NGL 33-010-171 and performed at the request of Mr. David Robb, Chief, Special Projects Planning of the Office of Comprehensive Planning, St. Lawrence Seaway Development Corporation.

All aerial photographs employed for this study were obtained by Dickerson, Czerwinski & Warneck of Watertown, New York, under contract with the St. Lawrence Seaway Development Corporation.

The study was carried out by Mr. Thomas L. Erb with assistance provided by Messrs. William Teng and Thomas Jarrett.

Ta Liang
Professor of Environmental
Engineering and
Principal Investigator,
Remote Sensing Program

INTRODUCTION

During the winter season, the power companies along the St. Lawrence River employ ice control structures, or "ice booms", to reduce the amount of free-floating ice that would block the power plant intakes. These booms consist of large timbers fastened with steel cables which, when strung from shore to shore, stabilize the ice cover but prevent ship passage through the Seaway channels. From 1962 to 1970, for example, all Seaway commerce was halted for periods ranging from mid- or late-December to late-March or early April.

In an effort to extend the navigation season into the winter months, the St. Lawrence Seaway Development Corporation is investigating the feasibility of modifying the existing ice booms. This study was undertaken to determine the extent to which aerial photography could be employed to provide input data to the ongoing studies.

Based on a review of ice reconnaissance (Erb et al., 1972), and based on the availability of photography and supporting data, the work was defined as having two objectives: (1) to classify photo-distinguishable ice types, and (2) to provide time-sequential maps depicting their spatial distribution.

MATERIALS AND METHODS

Study Area

The area selected for study comprises a 17-mile stretch of the International Section of the St. Lawrence Seaway, from Nevins Point to the Iroquois Control Dam. This portion of the Seaway contains a number of ice control booms and is thus of prime concern to the navigation season extension program.

Aerial Photography

The analyses were based on 428 contact prints from 22 panchromatic aerial photographic missions over the study area. Each mission consisted of one flight line along the Seaway, with 12 missions being flown between 8 January and 7 April 1972, and 10 between 2 January and 8 March 1973. The time intervals between missions, as well as the flight heights during each

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mission, were largely controlled by weather conditions. Photographic scales ranged from 1:4,000 to 1:24,000.

During the 1973 winter season, a single mission was also flown with color infrared photography. Although this coverage was not employed for the pilot work reported here, it will be analyzed in subsequent investigations.

Supporting Ground Data

All ice data obtained at the nine ice-measuring stations along the Seaway during the 1972 and 1973 winter seasons were supplied by the St. Lawrence Seaway Development Corporation and the Canadian St. Lawrence Seaway Authority. Four ice-measuring stations are located within the immediate study area.

Ice Type Classification

The system for classifying river ice types with panchromatic aerial photographs was devised from photographic lake and sea ice classifications developed by Black (1957) and Marshall (1966), from various ground studies of river ice phenomena (e.g., Michel, 1969), and through analysis of the available photography and ice measurement data in the study area. The classification system was designed such that ice-type designations would be applicable over the entire range of available photographic scales, as well as throughout the winter season.

Ice Mapping

The overlapping contact prints from each flight were laid out in their respective flight line and overlaid with a single sheet of matte acetate. The contact prints were then analyzed stereoscopically, and all ice information was traced directly onto the overlay. In order to rectify and reduce the ice cover data to a common scale, each flight line overlay was optically projected onto a 1:30,000 scale nautical chart, and the information was re-compiled on a map overlay. This operation was accomplished with a Bausch & Lomb Zoom Transfer Scope.

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RESULTS AND DISCUSSION

The study area and ice-measuring stations are shown in Figure 1, a section of the 1:125,000 scale chart of the St. Lawrence Seaway, compiled by the Canadian Hydrographic Service in 1963. In general, because the dates of ice measurements did not correspond well to the dates of photography, the ground data obtained at these stations were of limited value to the present analysis.

The classification system developed for identifying and mapping ice types on panchromatic aerial photographs recognized eight classes of ice cover, two ice features, and open water (Table 1). Using this system, the river ice imaged during each flight was traced from the contact prints onto a single acetate overlay, and the information was subsequently re-compiled on a 1:30,000 scale nautical chart overlay (Fig. 2).


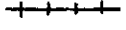
Where combinations of the recognized ice types were found to occur in a matrix fashion, these areas were designated by a composite ice-type symbol. For example, if refrozen brash (RB) and refrozen floes (RF) were near-equally distributed within a single ice mass, the mapping unit would be "RB-RF". In addition, if snow cover was observed on an otherwise classifiable ice type, the ice-type symbol was prefixed by "S/". Snow over refrozen brash, for example, would be designated "S/RB".

By transferring all ice cover data onto a series of acetate overlays, at the scale of a standard nautical chart, the ice information is referenced to a readily available base map, and it can be analyzed for a given flight date or for any combination of flight dates (Fig. 3). Overlaying the acetate sheets provides a visual display of time-sequential ice cover.

To date, the ice-type mapping from the contact prints has been completed for the 1972 photography, and work on the 1973 photography is in progress. The transfer of ice data to the nautical chart base has been completed for several of the 1972 flights.

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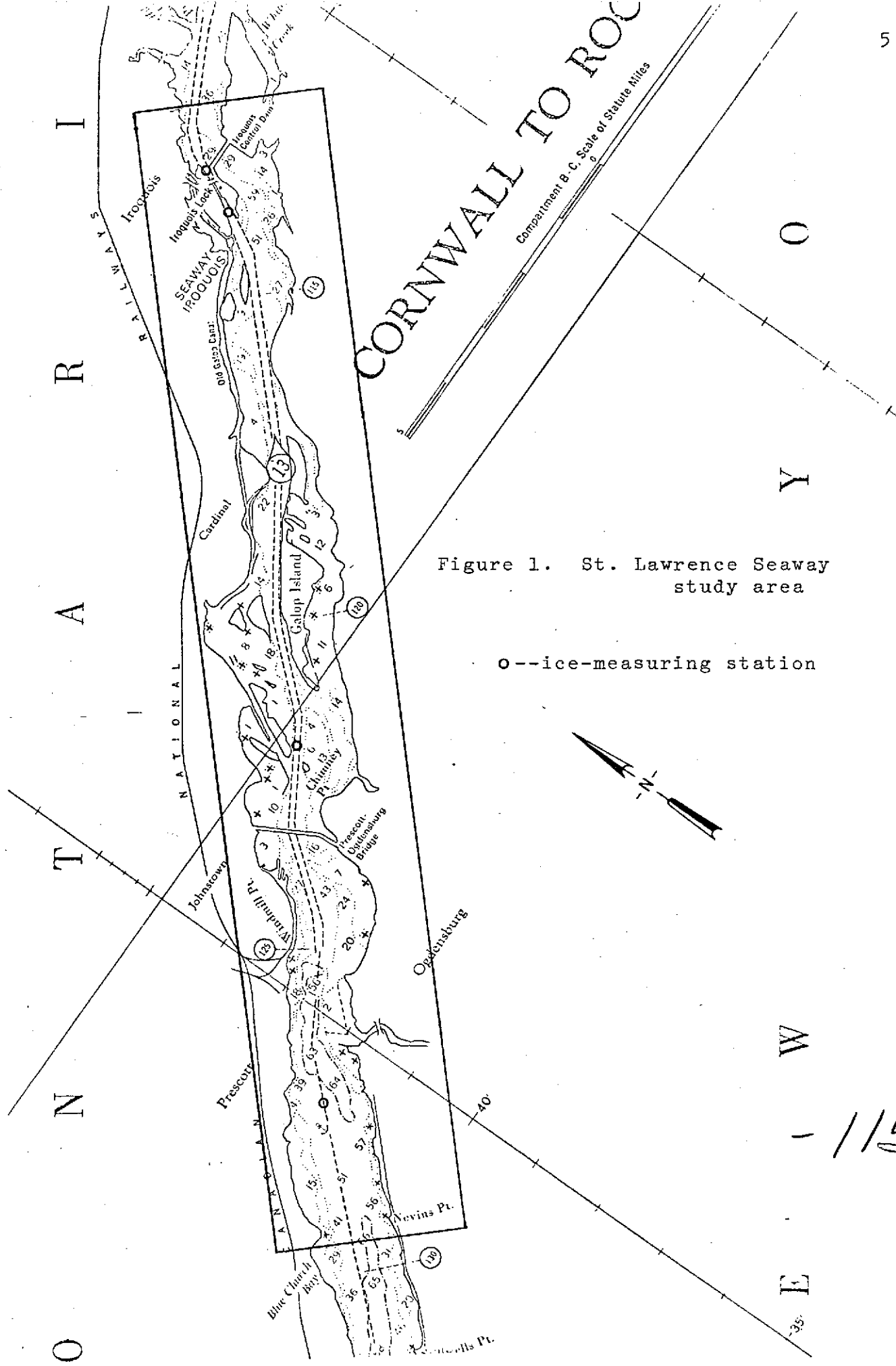
Table 1. Units used for panchromatic airphoto-mapping of ice cover on St. Lawrence Seaway.

<u>MAPPING UNIT</u>	<u>SYMBOL</u>
Uniform Ice	U
Brash (<6' max. dimension)	B
Floe(s) (>6' max. dimension)	F
Frazil Slush	Z
Refrozen Brash	RB
Refrozen Floe(s)	RF
Shore Fast Ice	SH
Snow-Covered Ice	S
Ice Ridge	
Ice Crack	
Open Water	W

All ice mapping should be completed over the next two months. Possible methods for facilitating the portrayal of time-sequential ice cover are currently being examined, and the analysis of the color infrared photography will be initiated in the near future.

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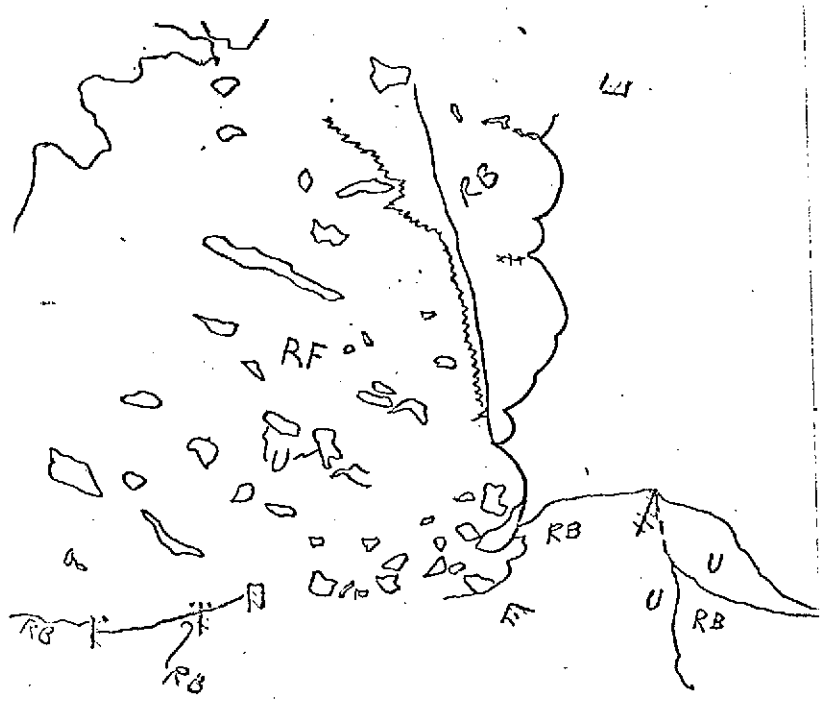
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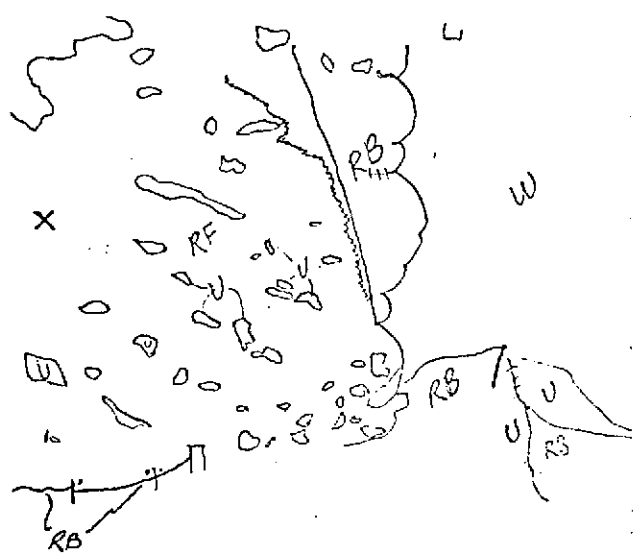
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Contact print



Ice cover map--
photo overlay



Ice cover map--
nautical chart overlay

Figure 2. Contact
print and ice cover
as mapped on print
and transferred to
nautical chart overlay

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APPENDIX G
SEMINAR IN REMOTE SENSING
(CEE 2496)

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SEMINAR IN REMOTE SENSING

LIST OF SEMINARS

Fall Term 1973

<u>Date</u>	<u>Speaker</u>	<u>Topic</u>
Sept 5	Organizational Meeting	Movie on the Brazilian Radam Project
Sept 12	Mr. Homer Jensen Director of Development Aero Service Corp. Philadelphia, Pa.	Surveying with Synthetic Aperture, Side-Looking Airborne Radar
Sept 19	Prof. Donald J. Belcher School of Civil and Environ- mental Eng'g. Cornell University	Status of Remote Sensing in South Africa
Sept 26	Mr. S.A. Raje Systems Development Engineer General Electric Space Div. Valley Forge, Pa.	ERTS Data Handling and Applications
Oct 3	Mr. Roger C. Haas Environmental Sciences Dept. Calspan Corp. Buffalo, N.Y.	Calspan's Operations with Thermal Scanners
Oct 10	Prof. Elmer S. Phillips College of Agriculture and Life Sciences Cornell University	Photographic Enhancement of Satellite Imagery
Oct 17	Mr. Lester E. Garvin Principal Scientist Raytheon/Autometric Wayland, Mass.	Development of a Natural Resource Information System
Oct 24	Dr. J. Colin Jones Chief, EREP Integration Martin Marietta Corp. Denver, Colorado	Earth Resources from Skylab
Nov 7	Dr. Paul A. Mohr Smithsonian Astrophysical Observatory Cambridge, Mass.	ERTS-1 Imagery and the Structural Geology of the African Rift System
Nov 14	Dr. Peter A. Murtha Forest Management Institute Canadian Forestry Service Environment Canada Ottawa, Ontario	A Train Wreck, SO ₂ and Spruce Budworm: Image ² Inter- pretation of Forest Damage

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<u>Date</u>	<u>Speaker</u>	<u>Topic</u>
Nov 28	Mr. Merrill Conitz Office of Science and Technology U.S.A.I.D. Washington, D.C.	Remote Sensing in Developing Countries
Dec 5	Dr. Robert K. Vincent Environmental Research Institute of Michigan Ann Arbor, Mich.	Spectral Ratio Imaging Methods for Geological Remote Sensing from Aircraft and Satellites

APPENDIX H
NEWSLETTER RECIPIENTS

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CORNELL REMOTE SENSING NEWSLETTER
LIST OF RECIPIENTS

A. CAMPUS GROUPS AND INDIVIDUALS*

1. Aerospace Studies (Air Force R.O.T.C.)

2. Agricultural Economics

B.F. Stanton (Chairman; Prof.)
D.J. Allee (Prof., Resource Economics; Assoc. Dir.,
Water Resources and Marine Sciences Center)
H.E. Conklin (Prof., Land Economics)
G.L. Casler (Assoc. Prof.)
J.J. Jacobs (Research Assoc.)
A.G. Colmenares (Research Asst.)

3. Agricultural Engineering

E.S. Shepardson (Chairman; Prof.)
G. Levine (Prof.)
R.C. Loehr (Dir., Environmental Studies; Prof., Civil
and Envir. Eng'g. and Agr. Eng'g.)
D.C. Ludington (Assoc. Prof.)
D.A. Haith (Asst. Prof., Civil and Envir. Eng'g. and
Agr. Eng'g.)
L.H. Irwin (Asst. Prof.)
E.G. Srinath (Research Assoc.)

4. N.Y.S. Agricultural Experiment Station (Ithaca)

J.F. Metz, Jr. (Assoc. Dir. of Research, N.Y.S. College
of Agr.; Assoc. Dir., Agr. Exp. Station; Prof.)

5. Agronomy

M.J. Wright (Chairman; Prof.)
M. Drosdoff (Prof., Soil Science)
M.G. Cline (Prof., Soil Science)
D.R. Bouldin (Prof., Soil Science)
E.R. Lemon (Prof., Soil Science; Supervisory Soil
Scientist, U.S.D.A.)
P.J. Zwerman (Prof., Soil Conservation)
R.W. Arnold (Assoc. Prof., Soil Science)
W.B. Duke (Assoc. Prof., Soil Science)
G.W. Olson (Assoc. Prof., Soil Science)

* Newsletters are sent to the main office of each department listed, as well as to various individuals within the department. In addition, Newsletters are provided to graduate and undergraduate students, upon request.

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Agronomy (Cont)

- L.H. Allen Jr. (Soil Scientist, U.S.D.A.)
- J.H. Peverly (Asst. Prof., Eutrophication)
- D.A. Lauer (Research Assoc.)
- G.F. Kling (Research Asst.)
- L.A. Daugherty (Research Asst.)

6. Anthropology

- R. Ascher (Prof., Anthropology and Archaeology)

7. Applied and Engineering Physics

- A.F. Kuckes (Prof., Applied Engineering Physics)

8. Architecture

- H.W. Richardson (Asst. Prof.)

9. Astronomy

- M.O. Harwit (Chairman; Prof.)
- F.D. Drake (Dir., Nat'l. Astronomy and Ionosphere Center; Assoc. Dir., Center for Radiophysics and Space Research; Prof.)
- Y. Terzian (Asst. Dir., Center for Radiophysics and Space Research; Assoc. Prof.)
- C. Sagan (Acting Dir., Center for Radiophysics and Space Research; Prof.)
- J. Berger (Sr. Computer Programmer)

10. Atmospheric Sciences

- B.E. Dethier (Prof.)
- W.W. Knapp (Assoc. Prof.)
- A.B. Pack (Climatologist, National Weather Service, N.O.A.A., U.S.D.C.; Asst. Prof.)

11. Biological Sciences

12. College of Agriculture and Life Sciences

- W.K. Kennedy (Dean; Prof., Agronomy)
- J.W. Spencer (Assoc. Dean; Prof., Agr. Eng'g.)

13. College of Engineering

- E.T. Cranch (Dean; Prof., Theoretical and Applied Mechanics)
- A.R. Seebass (Assoc. Dean; Asst. Prof., Mech, and Aerospace Eng'g.)
- F.J. Ahimaz (Asst. Dean; Asst. Dir., Program on Science and Technology)

14. Communication Arts
15. Computer Science
16. Cornell Energy Project
17. Design and Environmental Analysis
G.J. Coates (Asst. Prof.)
18. Ecology and Systematics
L.C. Cole (Prof., Ecology)
G.D. Likens (Prof., Ecology)
J.P. Barlow (Assoc. Prof., Oceanography)
P.F. Brussard (Asst. Prof., Ecology)
P.L. Marks (Asst. Prof., Biology)
19. Economics
20. Education
V.N. Rockcastle (Prof.)
R.B. Fischer (Prof.)
21. Electrical Engineering
N.M. Brice (Prof.)
S. Linke (Asst. Dir., Lab. of Plasma Studies; Prof.)
G.J. Wolga (Prof.)
R.A. McFarlane (Assoc. Prof.)
J.M. Ballantyne (Assoc. Prof.)
22. Entomology
D. Sliwa (Survey Entomologist)
A. York (Research Asst.)
23. Floriculture and Ornamental Horticulture
R.J. Scannell (Assoc. Prof., Landscape Architecture)
M.I. Adleman (Assoc. Prof., Landscape Architecture)
A.S. Lieberman (Assoc. Prof., Landscape Architecture)
P. Tresch (Asst. Prof., Landscape Architecture)
24. Geological Sciences
J.E. Oliver (Chairman, Prof.)
J.M. Bird (Prof.)
G.A. Kiersch (Prof.)
S.S. Philbrick (Prof.)
J.W. Wells (Prof.)
A.L. Bloom (Assoc. Prof.)
B.L. Isacks (Assoc. Prof.)
W.B. Travers (Asst. Prof.)
B. Bonnicksen (Asst. Prof.)

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25. Human Development and Family Studies
26. Industrial Engineering and Operations Research
27. International Agricultural Development
28. Center for International Studies
 - N.T. Uphoff (Asst. Prof., Govt.; Chairman, Rural Development Committee, Gov't)
29. Material Science and Engineering
30. Mechanical and Aerospace Engineering
31. Military Science (Army R.O.T.C.)
32. Natural Resources
 - W.H. Everhart (Chairman, Prof.)
 - L.S. Hamilton (Prof.)
 - R.J. McNeil (Assoc. Prof.)
 - R.R. Morrow (Assoc. Prof.)
 - H.B. Brumsted (Assoc. Prof.)
 - B.T. Wilkins (Asst. Prof.; Program Leader, Sea Grant Advisory Service)
 - A. Dickson (Assoc. Prof.)
 - A.W. Eipper (Assoc. Prof., Fishery Biology; Leader, N.Y.S. Cooperative Fishery Unit)
 - A.N. Moen (Assoc. Prof.)
 - R.T. Oglesby (Assoc. Prof.)
 - D.Q. Thompson (Assoc. Prof.; Head, N.Y. Cooperative Wildlife Research Unit)
 - J.W. Kelley (Asst. Prof.)
 - G. Reetz (Asst. Prof.)
 - E.E. Hardy (Sr. Research Assoc.)
 - C.S. Hunt, Jr. (Research Assoc.)
 - W.R. Schaffner (Research Assoc.)
 - J. Skaley (Research Assoc.)
 - J.W. Caslick (Extension Assoc.)
 - J. Glaser (Research Asst.)
 - R. Wulff (Research Asst.)
 - J. McKenna (Research Aide)
33. Naval Science (Navy R.O.T.C.)
34. Plant Pathology
 - D.F. Bateman (Chairman; Prof.)
 - H.D. Thurston (Prof.)
 - S.V. Beer (Assoc. Prof.)
 - O.E. Schultz (Assoc. Prof.)
 - P.A. Arneson (Asst. Prof.)

35. Policy Planning and Regional Analysis

B.G. Jones (Chairman; Prof.)
S. Saltzman (Prof.)
W.W. Goldsmith (Asst. Prof.)
L. Caplan (Research Asst.)

36. Pomology

37. Poultry Science

R.J. Young (Chairman; Prof., Animal Nutrition)

38. Rural Sociology

H.R. Capener (Prof., and Head, Rural Sociology)
F.W. Young (Prof.)
W. Saint (Research Asst.)
P.H. Gore (Research Specialist)

39. Sociology

P.S.K. Chi (Assoc. Prof., Program Assoc., Int'l. Population Program)

40. Thermal Engineering

F.K. Moore (Prof.)
T.A. Cool (Assoc. Prof.)

41. U.S. Plant, Soil and Nutrition Laboratory

42. Urban Planning & Development

S.W. Stein (Chairman, Prof.)
H.M. Hammerman (Asst. Prof.)

43. Civil and Environmental Engineering

W.R. Lynn (Dir., School of C.E.E.; Dir., Center for Environmental Quality Management; Prof., Envir. Eng'g.)
G.B. Lyon (Acting Asst. Dir.; Assoc. Prof., Envir. Eng'g.)
R.H. Gallagher (Prof. and Chairman, Structural Eng'g.)
C.D. Gates (Prof. and Acting Chairman, Envir. Eng'g.)
V.C. Behn (Assoc. Prof., Envir. Eng'g.)
D.J. Belcher (Prof., Envir. Eng'g.)
P.L. Bereano (Assoc. Prof., Envir. Eng'g.; Exec. Secy., Program on Science, Technology, and Society)
J.J. Bisogni (Asst. Prof., Envir. Eng'g.)
W.H. Brutsaert (Assoc. Prof., Envir. Eng'g.)
L.B. Dworsky (Dir., Water Resources and Marine Sciences Center; Prof., Envir. Eng'g.)
G.P. Fisher (Prof., Envir. Eng'g.)
R. Gergely (Assoc. Prof., Structural Eng'g.)
J.N. Kay (Asst. Prof., Envir. Eng'g.)
A.W. Lawrence (Assoc. Prof., Envir. Eng'g.)

43. Civil and Environmental Engineering (Cont)

- T. Liang (Prof., Envir. Eng'g.)
- J.A. Liggett (Prof., Envir. Eng'g.)
- D.P. Loucks (Assoc. Prof., Envir. Eng'g.)
- A.J. McNair (Prof., Envir. Eng'g.)
- W. McGuire (Prof., Structural Eng'g.)
- A.H. Meyburg (Asst. Prof., Envir. Eng'g.)
- A.H. Nilson (Prof., Structural Eng'g.)
- C.S. Orloff (Asst. Prof., Envir. Eng'g. and Eng'g. Basic Studies)
- T. Pekoz (Asst. Prof., Mgr. Structural Research, Structural Eng'g.)
- D.A. Sangrey (Assoc. Prof., Envir. Eng'g.)
- R.E. Schuler (Asst. Prof., Envir. Eng'g. and Economics)
- R.G. Sexsmith (Assoc. Prof., Structural Eng'g.)
- C.A. Shoemaker (Asst. Prof., Envir. Eng'g. and Entomology)
- F.O. Slate (Prof., Structural Eng'g.)
- S. Stidham, Jr. (Asst. Prof., Operations Research and Envir. Eng'g.)
- P.R. Stopher (Asst. Prof., Envir. Eng'g.)
- H.M. Taylor (Assoc. Prof., Envir. Eng'g. and Operations Research)
- R.N. White (Prof., Structural Eng'g.)
- G. Winter (Prof., Structural Eng'g.)
- S.C. Hollister (Emeritus Prof., Civil and Envir. Eng'g.)
- W.R. Philipson (Research Assoc., Envir. Eng'g.)
- L.S. Zall (Teaching Asst., Envir. Eng'g.)
- B. Coskun (Teaching Asst., Envir. Eng'g.)
- B.J. Tucker (Research Asst., Envir. Eng'g.)
- M.F. Layese (Research Asst., Envir. Eng'g.)
- T.L. Erb (Research Asst., Envir. Eng'g.)
- F.C. Voigt (Research Asst., Envir. Eng'g.)

B. OFF-CAMPUS GROUPS AND INDIVIDUALS

- | | |
|--|--|
| 1. Mr. James C. Barnes
Manager, Earth Resources Studies
Environmental Research and
Technology, Inc.
Lexington, Mass. | 4. Calspan Corporation
Buffalo, N.Y.
a) K.R. Piech
b) J.E. Walker
c) R.C. Ziegler
d) R.C. Haas
e) B. McMichael |
| 2. Mr. Jack L. Barrick
State Resource Conservationist
S.C.S., U.S.D.A.
Syracuse, N.Y. | 5. Canada Center for Remote
Sensing
Ottawa, Ontario. |
| 3. Prof. Robert H. Brock
N.Y.S. College of Forestry
Syracuse University
Syracuse, N.Y. | 6. Prof. Robert N. Colwell
School of Forestry and
Conservation
University of California
Berkeley, Calif. |

7. Mr. Merrill Conitz
Office of Science and Technology
U.S. Agency for International
Development
Washington, D.C.
8. Mr. Robert Crowder
N.Y.S. Office of Planning Services
Albany, New York
9. Dr. Wolfram Drewes
International Bank for Recon-
struction & Development
Washington, D.C.
10. Environmental Research Institute
of Michigan
Ann Arbor, Mich.
a) Dr. R.K. Vincent
b) Mr. T.W. Wagner
11. Dr. Murray Felsher
Office of Technical Analysis
Environmental Protection Agency
Washington, D.C.
12. Dr. Robert B. Forrest
Bendix Research Labs.
Southfield, Mich.
13. Mr. Lester E. Garvin
Raytheon/Automatric
Wayland, Mass.
14. Dr. Clifford W. Greve
Raytheon/Autometric
Arlington, Va.
15. Mr. Philip Guss
Project Manager, Ecological Services
Lockwood, Kessler & Bartlett, Inc.
Syosset, N.Y.
16. Ithaco, Inc.
Ithaca, N.Y.
17. Mr. Homer Jensen
Aero Service Corp.
Philadelphia, Pa.
18. Dr. Jack D. Johnson
Office of Arid Lands Studies
University of Arizona
Tucson, Arizona
19. Mr. Raymond Krieg
R & M Engineering and
Geological Consultants
Fairbanks, Alaska
20. Dr. John E. Lukens
Consultant in Remote
Sensing and Lecturer
Rhode Island School of
Design
21. Mr. C. Philip McCabe
Eastman Kodak Co.
Rochester, N.Y.
22. Dr. Robert B. McEwen
U.S. Geological Survey
Washington, D.C.
23. Dr. Robert H. Miller
National Program Staff
A.R.S., U.S.D.A.
Washington, D.C.
24. Dr. Paul A. Mohr
Smithsonian Astro-
physical Observatory
Cambridge, Mass.
25. N.Y.S. Agricultural
Experiment Station
Geneva, N.Y.
26. N.Y.S. Dept. of Environ-
mental Conservation
Albany, New York
a) R. Pedersen
b) J. Harmon
c) C. Mason
d) D. Romano
e) S. Schwartz
27. N.Y.S. Geological Survey
Museum and Science
Service
Albany, N.Y.
a) J.D. Davis
b) R. Dineen
c) R.H. Fakundiny
d) D.W. Fisher
e) S. Forster
f) Y.W. Isachsen
g) L.V. Richard

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28. Prof. Neville A. Parker
Dept. of Civil Engineering
Howard University
Washington, D.C.
29. Dr. Charles K. Paul
Advanced Projects Group
Jet Propulsion Laboratory
Pasadena, Calif.
30. Dr. Eugene L. Peck
Asst. Dir., Hydrologic Research
Lab.
NOAA/NWS
Washington, D.C.
31. Purdue University
School of Civil Engineering
W. Lafayette; Ind.
a) Prof. E.M. Mikhail
b) Prof. G.W. Marks
32. Mr. S.A. Raje
Systems Design Engineer
General Electric Space Division
Valley Forge, Pa.
33. Dr. Rene O. Ramseier
Inland Waters Directorate
Environment Canada
Ottawa, Ontario
34. Dr. Harold T. Rib
U.S. Dept. of Transportation
Washington, D.C.
35. Mr. David Robb
Office of Comprehensive Planning
St. Lawrence Seaway Dev. Corp.
Washington, D.C.
36. Rome Air Development Center
Griffis Air Force Base
Rome, N.Y.
a) E. Hicks
b) A.J. Stringham
37. Dr. L. Sayn-Wittgenstein
Program Coordinator
Canadian Forestry Service
Ottawa, Ontario
38. Dr. Ronald L. Shelton
Michigan State Univ.
East Lansing, Mich.
39. Dr. Clifford A. Spohn
Director, Office of
Operations
NOAA/NESS
Suitland, Md.
40. Dr. Dieter Steiner
Univ. of Waterloo
Waterloo, Ontario
41. Dr. Paul G. Teleki
Coastal Eng'g. Research
Center
Fort Belvoir, Va.
42. U.S. Coast Guard
Dept. of Transportation
Pollution Prevention
Projects Branch
43. Mr. Ivan Vamos
Director of Research
N.Y.S. Dept. of Parks
and Recreation
Albany, New York
44. Mr. Joseph A. Vitale
Office of Univeristy
Affairs
NASA Headquarters
Washington, D.C.
45. Dr. Roy A. Welch
Univ. of Georgia
Athens, Ga.
46. Dr. Janice M. Whipple
U.S. Geological Survey
Albany, N.Y.
47. Prof. Edward F. Yost, Jr.
Science Eng'g. Research
Center
Long Island Univ.
Greenvale, N.Y.

APPENDIX I
RECENT NEWSLETTERS

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The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

THE SECOND YEAR

The NASA-sponsored Remote Sensing Program, of the School of Civil and Environmental Engineering, enters its second year of operation, following established Program directions and priorities. The weekly Seminar and monthly Newsletter will be continued, as will the emphasis on soliciting user input to interdisciplinary, remote sensing research.

Two studies were completed during the summer months: a pilot project aimed at detecting shoreline encroachment with time-sequence, aerial photography was performed by Fred Voigt, at the request of the N.Y.S. Department of Environmental Conservation; and James Ni compiled an airphoto inventory of unique natural resources of Tompkins County, for the County Department of Planning.

A number of other studies should be finalized over the next few months. Working with the N.Y.S. Geological Survey, Joe Krieger is concluding an analysis of ERTS, high altitude and other imagery for delineating pre-glacial Hudson and Mohawk River channels; and although Dick Specht has returned to Eastman Kodak, his photographic, lab and field work on apple disease detection are nearing completion, and he remains in close contact with his advisory committee, Profs. D.J. Belcher, T. Liang, G.W. Olson and S.V. Beer. Tom Erb is completing a photographic evaluation of ice, for the St. Lawrence Seaway Development Corporation; and, with assistance from the N.Y.S. Department of Transportation and Prof. L.H. Irwin, Rich Ackley is investigating the value of remote sensing for highway environmental impact statements. In addition, Bahattin Coskun and Prof. R.W. Arnold are assessing the potential of ERTS imagery as a base for delineating New York State soil associations.

Several other research endeavors are at preliminary stages of investigation, and these will be described in subsequent Newsletters. In brief, they include a multispectral analysis of sensitive clay soils, an examination of ERTS data for snow belt determination, a photographic evaluation of historical/archeological sites, and a series of cooperative studies on water quality in selected Finger Lakes, weed beds in Cayuga Lake, and vegetative cover of the Montezuma Wildlife Refuge.

The regular staff of the Program consists of Prof. T. Liang, principal investigator, Profs. D.J. Belcher and A.J. McNair, co-investigators, W.R. Philipson, research associate, and T.L. Erb and F.C. Voigt, research assistants. Dr. E.E. Hardy is a general consultant to the Program and, for specific projects, the advice and cooperation of various Cornell and non-Cornell personnel have been and continue to be sought.

CALL FOR PAPERS-ASIA

The 40th Annual Convention of the American Society of Photogrammetry will be held from March 10 to 15, 1974, in St. Louis, Missouri. Proposals for papers on photogrammetry, remote sensing or photography should be submitted to: Ray Helmering, 5074 Kirkey Court, St. Louis, Mo. 63128, before 17 September. Authors should include their name, address, telephone number and affiliation, and a titled abstract of less than 200 words.

MEETINGS AND SYMPOSIA

Fall Technical Convention, Amer. Soc. of Photogram.-Amer. Cong. on Surveying and Mapping; 2-5 Oct; Walt Disney World, Orlando, Florida; Convention will include a symposium on remote sensing in oceanography: A. Aguilar, Florida Dept. of Transportation, Tallahassee, Fla. 32304, or P. Teleki, Coastal Research Center, 5201 Little Falls Rd., N.W. Washington, D.C. 20016.

Conference on Machine Processing of Remotely Sensed Data; 16-18 Oct; Purdue Univ.: Prof. C.D. McGillem, L.A.R.S., Purdue Univ., West Lafayette, Ind. 47907.

National Environmental Engineering Meeting and Product Exposition, Amer. Soc. of Civil Engineers; 29 Oct-1 Nov; Americana Hotel, New York, N.Y.: see August issue of "Civil Engineering" for program and details.

Symposium on Management and Utilization of Remotely Sensed Data; 29 Oct-2 Nov; Sioux Falls, So. Dakota; Hosted by Dept. of Interior EROS Program Data Center and City of Sioux Falls, and co-sponsored by various federal agencies and professional societies: A. Anson, Program Chairman, 6066 Munson Hill Rd; Falls Church, Va. 22044, or R. McEwen, Program Coordinator, 3512 Wilson St., Fairfax, Va. 22030.

CALL FOR PAPERS-CANADA

Papers reporting on projects that demonstrate either the benefits of remote sensing to Canada, useful applications of ERTS, or applications of new sensors are being sought for the 2nd Canadian Symposium on Remote Sensing. Sponsored by the Canada Centre for Remote Sensing, the Ontario Association for Remote Sensing, the Ontario Ministry of Natural Resources, the Canadian Aeronautics and Space Institute, the Canadian Institute of Forestry, and the Canadian Institute of Surveying, the Symposium will be held at the University of Guelph, from April 29 to May 1, 1974. Abstracts of 200 words, preferably, in both English and French, should be submitted to: J. MacDowall, Canada Centre for Remote Sensing, 2464 Sheffield Rd., Ottawa, Ont., K1A 0E4, by 31 October. Preference will be given to multi-disciplinary-group presentations or joint presentations covering a single discipline or application. Further information can be obtained from Mr. MacDowall, at the CCRS, or from Prof. S. Collins, School of Engineering, Univ. of Guelph, Guelph, Ont., N1G 2W1.

USGS QUAD SHEETS

The Resource Information Laboratory, under Dr. E.E. Hardy of the Department of Natural Resources, has been appointed a distributor for USGS topographic maps of New York State. The Laboratory, on Judd Falls Road, maintains a complete stock of the available 1:24,000, 1:62,000 and 1:250,000 scale maps of New York, and these may be purchased with cash or through departmental accounts. Any other USGS map may also be ordered through the Laboratory.

CEE 2496 NOW IIA696

The Seminar in Remote Sensing (IIA696), a one-credit hour course in the School of Civil and Environmental Engineering, is held on Wednesdays, at 4:30 P.M., in 162 Hollister Hall. Students from any discipline may register (or re-register) for credit, and other interested parties are welcome to attend at any time. Each week, an invited speaker from government, industry, Cornell or another institution will cover a different topic on current research, developments or applications in remote sensing.

Tentative speakers and topics for the month of September are as follows:

- | | |
|-----------------|---|
| Wed,
5 Sept | Organizational meeting and presentation of a film on the Brazilian RADAM Project--Amazon resource surveys with radar. |
| Wed,
12 Sept | Surveying with synthetic aperture, side-looking airborne radar: Mr. Homer Jensen, Director of Development, Aero Service Corp., Litton Indus., Philadelphia, Pa. |
| Wed,
19 Sept | Status of remote sensing in South Africa: Prof. Donald J. Belcher, School of Civil and Environmental Engineering, Cornell University |
| Wed,
26 Sept | Image processing techniques: Dr. Richard Economy, Manager, Advanced Image Processing, General Electric Space Division, Valley Forge, Pa. |

ERTS STUDIES IN SOUTH AFRICA

Prof. Donald Belcher, who recently returned from a sabbatical leave in South Africa, reports that the South African Air Force is flying high altitude, 70 mm color-infrared photography, simultaneously with ERTS overpasses. Data derived from the satellite and aircraft imagery are being analyzed, in conjunction with detailed field sampling, to support country-wide surveys of botany, land use, soils and forestry. Prof. Belcher will discuss this topic in the Sept. 19 Seminar in Remote Sensing.

SENSING IN THE SUPERMARKETS
(from "Laser Focus" August, 1973)

Over the next few years, most supermarkets are expected to speed their checkout service by replacing cash registers with lasers. Each item in the store will be stamped with a uniform product code which, when passed over the laser, will be scanned and the information transmitted to a computer. The computer will tabulate the data into inventory information, prices and taxes, and provide the customer with the totals, change and, of course, the required number of trading stamps.

MARS AT 1:250,000,000

The U.S. Geological Survey's photomap of Mars, compiled from Mariner 9 imagery, contains no feature names. The light and dark markings, that were identified and named on the basis of telescopic observations, offer little correspondence to the mapped topographic features. New designations will be devised, and these must be approved by the International Astronomical Union.

SELECTED ARTICLES AND PUBLICATIONS

- El-Biek, A.H.A. 1973. Photogrammetry in centrifugal testing of soil models. Photogrammetric Record. 7:41:538-554.
- Johnson, T.V., C. Pieters, and T.B. McCord. 1973. Mare Humororum: An integrated study of spectral reflectivity. Icarus. 19:2:224-229.
- Lewis, A.J. and H.C. MacDonald. 1972. Mapping of mangrove and perpendicular-oriented shell reefs in southeastern Panama with side-looking radar. Photogrammetria. 28:6:187-199.
- NASA publications; Gov't. Print. Office, Wash., D.C. 20402.
 EP-107. Skylab; A guidebook. Stock No. 2200-00508. (\$2.10)
 EP-110. Skylab experiments; Vol. 1: Physical Science, solar astronomy. Stock No. 3300-00510. (\$1.25)
 EP-111. Skylab experiments; Vol. 2: Remote sensing of earth resources. (\$1.25)
 SP-327. Symposium on significant results obtained from the ERTS-1. 2 volumes. Stock No. 3300-00515. (\$13.65 set)
- Photogrammetric Engineering. Aug 1973. 34:8.
 Schmitt, H.H. The measure of the moon.
 Kedar, E.Y. et al. Earthquake-risk mapping.
 Sabins Jr., F.F. Recording and processing thermal ir imagery.
 Masry, S.E. and J.G. Gibbons. Distortion & rectification of ir.
 Wong, K.W. et al. Analysis of RBV television system.

The NEWSLETTER is made possible through a grant from the NASA Office of University Affairs. If you wish to be included on or removed from the mailing list, or if you know of any item or article that may be of interest to our readers, please contact Mr. Warren R. Philipson, Remote Sensing Program, 462 Hollister Hall, Cornell University, Ithaca, N.Y. - (607) 256-4330.

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

LAND USE INVENTORY WITH ERTS

The feasibility of accomplishing or updating general land use inventories, based on spectral characterization of satellite-derived data, has been demonstrated in an ERTS experiment directed by Dr. Ernest E. Hardy of Cornell's Department of Natural Resources.

In a pilot study of 6300 square kilometers in Central New York, eight spectrally identified categories of land use were delineated from photographically enhanced ERTS images, referenced to the Universal Transverse Mercator grid, and subsequently compared to equivalent categories in the N.Y.S. Land Use and Natural Resources Inventory (LUNR). The maximum area interpreted was 25 hectares, and the minimum area referenced was one square kilometer. Based on field checking and sampling techniques, ERTS data interpretations and referencing were found to be approximately 88% accurate when compared to LUNR.

In order to achieve this accuracy, special photographic processing was employed to improve and balance image contrast and density, such that each of the four spectral bands of each image scene would be consistent with an acceptable standard for scene interpretation. Various combinations of color diazo transparencies, made from positive and negative, 1:250,000 transparencies of each spectral band, were overlaid to enhance the different spectral features. Interpretation and data take-off were performed manually by transferring interpreted areas onto an overlay spectral map.

The pilot study and numerous other studies relating to the development of a computer file system, the effects of temporal changes, interpretations in different areas of the State, improved photographic processing, and a statistical model for predicting the optimum spectral/hue combinations required to enhance spectral-land use categories, are being coordinated by Mr. J.E. Skaley. Prof. E.S. Phillips serves as a photographic consultant, and computer assistance is provided by Messrs. R. Fisher and E. Segal. The technical staff consists of Dr. D. Stevens, D. Payne, C. Selvarajah, L. Hunt, R. Barnes and C. Dawson.

LAST CALL FOR PAPERS

As noted in the April Newsletter (1:8), the 9th International Symposium on Remote Sensing of Environment will be held at the University of Michigan on 15-19 April 1974. Prospective speakers should submit 20 copies of a comprehensive summary (300-1000 words) to: J.J. Cook, Environmental Research Institute of Michigan, P.O. Box 618, Ann Arbor, Mich. 48107, before 15 November 1973.

CORNELL-EPA REMOTE SENSING STUDIES

Mr. C.P. McCabe, special consultant to the Environmental Protection Agency from Eastman Kodak and the Remote Sensing Program, headed by Prof. T. Liang, are coordinating a series of EPA-sponsored aircraft missions which are designed to provide photographic data input to three ongoing Cornell projects. The projects and their principal investigators are: water quality in the Finger Lakes, Prof. R.T. Oglesby; weedbed mapping in Cayuga Lake, Prof. J.H. Peverly; and vegetative cover studies in the Montezuma National Wildlife Refuge, Prof. D.Q. Thompson.

In brief, the primary focus of the photographic missions has been Cayuga Lake, where water sampling teams from Cornell have been aided by local power boat owners, coordinated by Prof. J.H. Whitlock. For comparison study, Owasco, Skaneateles and Canadarago Lakes have also been flown, with Canadarago being sampled by the N.Y.S. Health Department, and Owasco and Skaneateles by Cornell teams.

The missions will terminate in September, and data analyses should be completed over the next few months. Further details and findings from the specific projects will be reported in future Newsletters.

MEETINGS AND SYMPOSIA

Conference on Machine Processing of Remotely Sensed Data; 16-18 Oct; Purdue Univ.: Prof. C.D. McGillem, L.A.R.S., Purdue Univ., West Lafayette, Indiana 47907.

National Environmental Engineering Meeting and Product Exposition, Amer. Soc. of Civil Engineers; 29 Oct-1 Nov; Americana Hotel, New York, N.Y.: see August issue of "Civil Engineering" for program and details.

Symposium on Management and Utilization of Remotely Sensed Data; 29 Oct-2 Nov; Sioux Falls, So. Dakota; Hosted by Dept. of Interior EROS Program Data Center and City of Sioux Falls, and co-sponsored by various federal agencies and professional societies: A. Anson, Program Chairman, 6066 Munson Hill Rd; Falls Church, Va. 22044, or R. McEwen, Program Coordinator, 3512 Wilson St., Fairfax, Va. 22030.

Annual Meetings, Amer. Soc. of Agronomy, Crop Science Soc. of Amer., and Soil Science Soc. of Amer.; 11-16 Nov; Las Vegas, Nevada.

Fourth Annual Conference on the Application of Remote Sensing of Arid Land Resources and Environment; 14-16 Nov; Office of Arid Lands Studies, University of Arizona and American Society of Photogrammetry: Director, Conferences and Institutes, Div. of Continuing Education, Univ. of Arizona, Tucson, Arizona 85721.

SHORT COURSE

A five-day short course on image processing will be held from 12 to 16 November, at the Campus Inn, West Lafayette, Indiana. The objective of the course is to familiarize engineers and scientists with the state of the art of optical and digital image processing. The course fee of \$375 will cover tuition and course materials. Additional information can be obtained from P.A. Wintz, Wintek Corp., 605 Lingle Ave., Lafayette, Indiana 47901 (317-742-5650).

WETLANDS STUDY BY HELICOPTER
(from "Machine Design" 6 Sept 1973)

Among the various wetlands projects in the United States is a cooperative study by the Virginia Institute of Marine Science (VIMS) and NASA's Langley Research Center. Two marsh areas in Virginia are being photographed each month, with four helicopter-borne cameras from several different altitudes. The multi-spectral images are being studied to characterize the unique seasonal signatures of field-checked plant communities. Ultimately, the VIMS researchers hope to arrive at a method for classifying plant life in specific marshes, in order that they can advise other agencies in decisions concerning marshland use.

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 P.M., in 162 Hollister Hall. Any interested party is welcome to attend. Tentative speakers and topics for the month of October are as follows:

- Wed, Calspan's operations with thermal scanners: Mr.
3 Oct Roger C. Haas, Engineer, Environmental Sciences
 Dept., Calspan Corp., Buffalo, New York.
- Wed, Photographic enhancement of satellite imagery:
10 Oct Elmer S. Phillips, Prof. Emeritus, College of
 Agriculture and Life Sciences, Cornell University.
- Wed Natural resource information system: Mr. Lester
17 Oct Garvin, Principal Scientist, Autometric Operation,
 Raytheon Co., Wayland, Mass.
- Wed, Earth resources from Skylab: Dr. J. Colin Jones,
24 Oct Chief, EREP Integration, Martin Marietta Corp.,
 Denver, Colorado.
- Wed, NO SEMINAR--(Remote Sensing Symposium in Sioux
31 Oct Falls, So. Dakota)

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ERTS-1 COVERAGE

During its first year of operation, NASA's Earth Resources Technology Satellite has collected over 60,000 scenes of the earth's surface. All of the United States and more than 3/4 of all continents have been imaged at least once--and parts, as many as 10 times--in cloud-free conditions.

The September issue of "Astronautics & Aeronautics" (11:9) devotes over 35 pages to ERTS, including a summary of ERTS experiments on: environmental impact; agriculture, forestry and range; marine resources and ocean surveys; geographical applications; water resources; and multidisciplinary and regional resource investigations. The various articles contain a number of images and color composites of the United States as well as of selected foreign areas (e.g., China and U.S.S.R.).

This issue also devotes 9 pages to the early results obtained with the Earth Resources Experimental Package (EREP) and other systems aboard Skylab I. As scheduled, Dr. J. Colin Jones, who is Chief of the EREP Integration Program at Martin Marietta, will discuss this topic during the October 24th Seminar in Remote Sensing.

RECENT ARTICLES

Griffiths, J.F. and E.F. Kolczynski. 1973. Estimation of radiation from satellite data. Int. Jour. Environ. Studies. 4:4:257-260.

Mausel, P.W. and C.J. Johannsen. 1973. An application of remotely-sensed data to agricultural land use distribution analysis. The Professional Geographer. 25:3:242-248.

Pichel, W., C.L. Bristor, and R. Brower. 1973. Artificial stereo: A technique for combining multi-channel satellite image data. Bull. of Amer. Meteorological Soc. 54:7:688-691.

Vonder Haar, S.P. and R.O. Stone. 1973. Oceanographic analysis of orbital photographs of the upper Gulf of California. Photogrammetria. 29:2:45-61.

The NEWSLETTER is made possible through a grant from the NASA Office of Univeristy Affairs. If you wish to be included on or removed from the mailing list, or if you know of any item or article that may be of interest to our readers, please contact Mr. Warren R. Philipson, Remote Sensing Program, 464 Hollister Hall, Cornell University, Ithaca, N.Y. - (607) 256-4330.

The NEWSLETTER, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

ERTS ANALYSIS OF LOWLAND RICE

As described in the November 1972 Newsletter (I:3), Professor Arthur J. McNair of the School of Civil and Environmental Engineering is principal investigator on a NASA-sponsored project, designed to establish the value of ERTS data for discriminating areas of lowland rice and assessing the crop and site status.

The basic approach has been to extract reliable spectral signatures from ERTS images of selected Philippine test sites, analyzing each of the four ERTS bands separately and in combinations of three (color composites); correlate the spectral data with ground observations; and, based on the results of correlation, develop algorithms for crop recognition. To date, ground data and ERTS imagery covering approximately 80% of a rice growth cycle have been analyzed and, although the results are encouraging, additional passes and test sites must still be examined.

The basis for recognizing and evaluating rice through spectral characterizations is provided by the temporal changes that occur in both the crop and water status, from the time that the site is prepared to the time that the mature rice is harvested. In preparing a paddy for rice, the farmer puddles (floods and plows) the soil, resulting in a spectral response which will be low in all ERTS bands, and lowest when the paddy is completely flooded just prior to planting. As the rice plants grow, they increasingly mask the flooded soil, reflecting greater amounts of radiation in all bands and, particularly, in Bands 6 and 7 (infrared). Just prior to harvest, the paddy flooding is stopped, and the rice plants become drier. At this time, there may be a further rise in the responses of Bands 4 (green) and 5 (red), accompanied by a slight decrease in Bands 6 and 7. Finally, as the bare soil becomes exposed during harvest, the response in all bands drops.

Ground data to support these investigations are being supplied by Prof. S. Miranda of the University of the Philippines at Los Banos and by Dr. T. Wickham of the International Rice Research Institute. The spectral and geometric analyses are being performed at the General Electric Valley Forge Space Center, using G.E.'s Multispectral Image Extraction System--a unique hybrid analog-digital system, which provides near-real-time image scanning with a 3-channel TV sensor, a variety of electronic processing and display functions, and direct interface with a digital computer to assure position. The project supervision at G.E. is provided by Mr. H. Heydt, Dr. R. Economy and Mr. S. Raje. Other investigators at Cornell include Profs. T. Liang and G. Levine and, the research assistants, Ms. M.F. Layese and Mr. B. Tucker.

AGNES LANDSLIDES

One of the many Cornell projects relating to tropical storm Agnes is an aerial photographic study of storm-induced landsliding. Headed by Professor Dwight A. Sangrey, of the School of Civil and Environmental Engineering, the project will attempt to: (1) inventory landslides attributed to Agnes; (2) arrive at cost estimates for the associated losses; (3) establish risk criteria for landsliding caused by abnormally high rainfall; and (4) define areas where decision-making should be influenced by the above.

The rainfall and flooding resulting from Agnes produced landsliding in southern New York State at a rate which was unprecedented for at least two decades. Landsliding occurred during and immediately after the storm due to stream erosion; but, in addition, landsliding also occurred the following spring, when seasonally high groundwater was superimposed on the high residual groundwater levels. Both types of sliding caused extensive losses in land and property as well as disruption of communication.

Messrs. Richard Ackley and John Nieber are conducting the airphoto inventory using pre- and post-Agnes panchromatic photography. The project activities are being supported by the Economic Development Administration of the U.S. Department of Commerce and the NASA-sponsored Remote Sensing Program.

CALL FOR PAPERS

An international symposium on Ocean Wave Measurement and Analysis will be held in New Orleans, from September 9 to 11, 1974. Sponsored by the Waterways, Harbors and Coastal Engineering Division of the American Society of Civil Engineers, the symposium is designed to establish the state-of-the-art of wave measurement and analysis and to provide a forum for presentation of recent research in ocean wave instrumentation, wave-record analysis, and interpretation of wave-record information. Requests for additional information should be directed to: International Symposium on Ocean Wave Measurement and Analysis, 110 Lowry Hall, Clemson University, Clemson, S. C. 29631.

CALL FOR PAPERS

The 3rd Annual Remote Sensing of Earth Resources Conference will be held at the University of Tennessee Space Institute, from March 25 to 27, 1974. The purpose of the conference is to examine the need for environmental observation, the existing techniques, and the data handling requirements of resource management activity. Emphasis will be placed on the existing sensor technology and data interpretation techniques; however, information applications, data flow schemes, and social and political factors will be covered. Prospective speakers should submit the tentative title of their paper to: Dr. F. Shahrokhi, The University of Tennessee Space Inst., Tullahoma, Tenn. 37388, by 15 December. The full-length papers will be due by 25 February 1974.

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AVAILABLE IMAGERY

As a result of the Cornell-EPA remote sensing studies, reported in the October Newsletter (II:2), the Remote Sensing Program will have on file at least two dates of multispectral photographic coverage of most of Cayuga Lake and its shorelines (south of Sheldrake and north of Farleys), the Great Gully tributary, and the Montezuma National Wildlife Refuge. In addition, the Program has a near-complete file of 10-by-10in and 70mm ERTS images of the northeastern United States and adjoining parts of Canada; selected high altitude, multispectral photographic coverage obtained during the 1972 and 1973 NASA flights in the Northeast; and multispectral photographic and thermal imagery obtained during Program-requested NASA flights over the Albany-Schenectady region, the St. Lawrence River Valley, and parts of Wayne County.

The use of Program imagery and facilities is offered to researchers who would like to undertake specific projects. To a limited extent, funding and personnel to support approved projects can be supplied by the Program. Further information can be obtained from Prof. Ta Liang (208 Hollister, 256-5074) or Warren Philipson (464 Hollister, 256-4330).

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in 162 Hollister Hall. Any interested party is welcome to attend. Tentative speakers and topics for the month of November are as follows:

- Wed.,
7 Nov ERTS-1 imagery and the structural geology of the African rift system: Dr. Paul A. Mohr, Geologist, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts.
- Wed.,
14 Nov A train wreck, SO₂, and spruce budworm--Image interpretation of forest damage: Dr. Peter A. Murtha, Research Scientist, Forest Management Institute, Canadian Forestry Service, Ottawa, Ontario.
- Wed.,
28 Nov Remote sensing in developing countries: Merrill Conitz, Office of Science and Technology, U.S. Agency for International Development, Washington, D.C.

ERTS IMAGES FOR CHRISTMAS

The EROS Data Center is offering color composites of selected ERTS scenes of the United States and foreign areas. Single-image prints of film transparencies may be purchased in sizes ranging from 10-by-10in (contact) to 40-by-40in, at prices ranging from \$7 to \$25 per print or \$10 to \$60 per transparency. Substantial price reductions are available when two or more copies of the same image are ordered. Among the available color composites of New York State are scenes of Rochester, Syracuse, New York City and the Long Island area. Requests for additional information should be directed to the EROS Data Center, Sioux Falls, South Dakota 57198 (tel. 605-339-2270). - 141-

INWARD SENSING OR SENSING INNARDS

NASA has developed a pill-sized radio transmitter, capable of monitoring deep body temperatures by means of an FM receiver and associated electronics. When swallowed, the unit can detect very small temperature variations in the alimentary tract, thus providing a new aid for medical diagnosis. Other applications of the pill-transmitter concept are being examined, as NASA engineers are confident that as many as five internal phenomena (e.g., stomach acidity) can be monitored simultaneously by a device the size of an aspirin.

RECENT ARTICLES

Carlson, G.E. 1973. An improved single flight technique for radar stereo. IEEE Transac. on Geoscience Electronics. GE-11:4:199-204.

Harney, B.M., D.H. McCrea and A.J. Forney. 1973. Aerial detection of vegetation damage utilizing a simple 35-mm camera system. Jour. of the Air Pollution Control Assoc. 23:9:788-790.

Kiefer, R.W. and M.L. Robbins. 1973. Computer-based land use suitability maps. Jour. of the Surveying and Mapping Div., A.S.C.E., 99:SU1:39-62.

Photogrammetric Engineering. Sept 1973. 34:9.

-Mairs, R.L. and D.K. Clark. Remote sensing of estuarine circulation.

-Bernath, H.J. Radiometric calibration of a multispectral camera.

Photogrammetric Engineering. Oct 1973. 34:10.

-Ryerson, J.M., R.R. Thaman, and J.E. Estes. Marine oil accumulations.

-Wellar, B.S. Remote sensing and urban information systems.

-Moore, R.K. and W.P. Waite. Octave bandwidth microwave spectral response.

-Newton, A.R. Pseudostereoscopy with radar imagery.

-Veign, J.L. and F.B. Reeves. A case for orthophoto mapping.

Remote Sensing of Environment. 1973. v.2, n.4

-Klemas, V., J.F. Burchardt and W.M. Treasure. Suspended sediment observations from ERTS-1.

-Platt, C.M.R. and A.J. Troup. A direct comparison of satellite and aircraft infrared remote measurements of surface temperature.

-Thomann, G.C. Remote measurement of salinity in an estuarine environment.

-Tooma Jr., S.G. and W.B. Tucker. Statistical comparison of airborne laser and stereophotogrammetric sea ice profiles.

The NEWSLETTER is made possible through a grant from the NASA Office of University Affairs. If you wish to be included on or removed from the mailing list, or if you know of any item or article that may be of interest to our readers, please contact Mr. Warren R. Philipson, Remote Sensing Program, 464 Hollister Hall, Cornell University, Ithaca, N.Y. - (607) 256-4330.

The NEWSLETTER, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

NEW COURSE IN REMOTE SENSING

The Remote Sensing Program of the School of Civil and Environmental Engineering is currently planning a 3-credit hour course in remote sensing that will be offered for the first time during the spring semester, 1974.

The course, CEE 2489 (IIA689), is intended to cover the fundamentals of sensing in the electromagnetic spectrum. Although photographic sensing will be discussed, emphasis will be placed on non-photographic forms, such as thermal, multispectral, and active and passive microwave. Lectures and laboratories will be conducted by staff and invited speakers, and the coverage will include sensors, sensor and ground data acquisition, data geometry, analysis and interpretation, and mission planning. As scheduled, the course lectures will meet on Tuesdays and Thursdays, at 10:10, and the laboratory will be held on Thursday afternoons. The course prerequisite is permission of the instructor, and co-registration in the Program's Seminar in Remote Sensing (CEE 2496) is strongly urged. Interested students should contact Mr. W. R. Philipson (464 Hollister) prior to the first class meeting.

CALL FOR PAPERS-ISP SYMPOSIUM

Commission VII of the International Society for Photogrammetry will hold a Symposium on Remote Sensing and Photo Interpretation at the Banff School of Fine Arts, Banff, Alberta, Canada, from 7 to 11 October 1974.

Commission VII is concerned with the interpretation of aerial photographs and other remotely sensed data, and the Banff Symposium will deal with environmental monitoring, vegetation surveys, photo interpretation methods, the value of satellite imagery, and resource inventories--including tropical resource inventories. Papers must be original, and they may focus on past developments, the state of the art, or new findings which will lead to future applications and developments. Persons wishing to present a paper at the Symposium should submit an abstract, of less than 200 words, to: Dr. L. Sayn-Wittgenstein, Canadian Forestry Service, Department of the Environment, Ottawa, Ontario K1A 0H3, before 15 January 1974.

The Symposium is being hosted by the Canadian Institute of Surveying and sponsored by the Government of Canada, the Government of Alberta and the University of Alberta (Department of Extension). Additional information can be obtained by contacting: University of Alberta, Department of Extension, Corbett Hall, 82 Ave.-112 St., Edmonton, Alberta T6G 2G4.

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CONFERENCE ON ENVIRONMENTAL POLLUTANTS

As reported in the February 1973 Newsletter (I:6), the Second Joint Conference on Sensing of Environmental Pollutants will be held from 10 to 12 December, 1973, at the Sheraton Park Hotel and Motor Inn, in Washington, D. C. The co-sponsors of the Conference include the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Meteorological Society, the Institute of Electrical and Electronic Engineers, the Instrument Society of America, the Department of Transportation, the Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration.

The three-day Conference will be divided into 13 sessions, focusing on such topics as: active and passive remote sensing of atmospheric and water pollutants; radiological, electromagnetic and acoustic pollution monitoring; in-situ sensing of acoustic, chemical and biological pollutants; extension of laboratory techniques to field use; instrument quality and measurement standardization; stationary source setting; air quality standards and measurement accuracy; new methods in particulate analysis; measurement and impact of meteorological parameters on pollutants and pollution analysis; and global pollution monitoring.

Further information can be obtained from: P. N. Meade, Instrument Society of America, 400 Stanwix St., Pittsburgh, Pennsylvania 15222 (Tel: 412-281-3171).

CALL FOR PAPERS-GLACIOLOGY

A Symposium on Remote Sensing in Glaciology will be held in Cambridge, England, from 15 to 21 September 1974. Organized by the International Glaciological Society, the Symposium will be concerned with the application of non-photographic remote sensing to glaciological parameter measurement. Topics for discussion will include radio echo sounding, active and passive microwave, infrared techniques and laser profilometry of glaciers, ice sheets, snow, ice and ground ice.

Those wishing to contribute to the Symposium should submit a detailed summary, of less than three pages, to: The Secretary, International Glaciological Society, Cambridge CB2 1ER, England, before 15 January 1974.

MEETINGS

National Meeting on Water Resources Engineering; 21-25 Jan; Los Angeles; Sponsored by the Amer. Soc. of Civil Engrs. and various other societies and hosted by the Los Angeles Section of A.S.C.E. (see Nov. issue of "Civil Engineering" for details and scheduled papers, several of which are on remote sensing).

Annual Conference, Highway Research Board: 21-25 Jan; Washington, D. C.: H.R.B., 2101 Constitution Ave., N.W., Washington, D.C. 20418.

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SEMINAR IN REMOTE SENSING

The final seminar of the fall semester will be held on Wednesday, 5 December, at 4:30 P.M., in 162 Hollister Hall. Any interested party is welcome to attend. The speaker, Dr. Robert K. Vincent, is an Associate Research Geophysicist at the Environmental Research Institute of Michigan (formerly Willow Run Laboratories), and his topic is "Spectral Ratio Imaging Methods for Geological Remote Sensing from Aircraft and Satellites."

Dr. Vincent will describe the production of ratio images, presenting examples derived from aircraft and ERTS scanner data, and focusing on the application of ratio imaging techniques to terrestrial geologic exploration and mapping. In general, because a ratio image, produced from visible, reflective infrared or thermal infrared wavelengths, is less dependent upon variations in atmospheric and solar illumination than either a single channel image or an aerial photograph, it is considerably more amenable to photogrammetric analysis. In addition, the application of photogrammetric techniques to ratio images--ratio scannergrammetry--is further aided by the proportionality between the ratios of a target deduced from ratio images and the ratios of reflectances calculated from laboratory spectra of samples from the target area. Consequently, laboratory-determined ratios can be used to predict which ratios are best for detecting and discriminating a given rock or mineral, and to place ratio scannergrammetry on an absolute basis, with an estimated standard error of approximately 5 to 10%.

RATIOING WITH PHOTOGRAPHS

As reported in the previous item, ratio techniques can be applied with scanner-derived data; but, in addition, because a color photograph consists of three emulsion layers, each sensitive to a different wavelength, ratio techniques can also be applied in conjunction with conventional aerial photography. Calspan Corporation (formerly Cornell Aeronautical Laboratory), for example, has developed a specialized photo interpreter's console which measures the response of each emulsion layer to the light of a photographed object (see Nov. issue of "Optical Spectra"). This information is then input to a programmable calculator which applies a series of corrections and determines the true-energy ratios among the three readings of the object. As with scanner-derived ratios, the ratioed photographic data allow the interpreter to perceive otherwise undetectable patterns.

ARTICLES AND PUBLICATIONS

Cathey, W.T., J.F. Hadwin, and J.D. Pace. 1973. Imaging through turbulent water using speckle reference holography. Applied Optics. 12:11:2683-2685.

Richardus, P. 1973. The precision of contour lines and contour intervals of large and medium-scale maps. Photogrammetria 29:81-107.

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-continued, p. 4-

ARTICLES AND PUBLICATIONS...

American Society of Photogrammetry (105 N. Virginia Ave., Falls Church, Va. 22046)

- "Management and Utilization of Remote Sensing Data": Proceedings of symposium held in Sioux Falls, So. Dakota, 29 Oct-1 Nov. 1973. 677 pp. (members \$7.50/non-members \$12.50).
- "Remote Sensing in Oceanography": Proceedings of special symposium held in Orlando, Fla., 2-5 Oct 1973. approx. 475 pp. (members \$5/non-members \$10).
- "Orthophoto Workshop II": Proceedings of workshop held in San Jose, Calif. 18-20 Jan 1973. 188 pp. (members \$5/non-members \$10).

Highway Research Record. No. 452 (Highway Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418--\$2.20).

- Melhorn, W.N. and E.A. Keller. Landscape aesthetics numerically determined: Applications to highway corridor selection.
- Hawkes, T.W. and D.A. Brown. Application of aerial mapping to development of highways.
- Bird, S.J. Environmental criteria for recreationally oriented highway planning.
- DeLoach, W.C. Remote-sensing applications to environmental analysis.
- MacLeod, M.H. and J.B. Turner. Semiautomated large-scale mapping.
- Norell, W. Measuring and depicting trouble areas in stereo-models.
- Turner, F.W. Aerial surveys for highways in North America.

Photogrammetric Engineering. Nov 1973. v. 34, no. 11.

- Fleming, E.A. Quality of production orthophotos.
- Danko Jr., J.A. A new concept in orthophotography.
- Benesh, M. Mariner Mars 9 stereophotogrammetry.
- Ghosh, S.K. Image quality versus metric capability.
- Leachtenauer, J.C. Photo interpretation test development.
- Rochford, D.S. et al. Northeast reconnaissance test area.
- Heath, G.R. Hot spot determination.

SEASONS GREETINGS

from the staff of the

Remote Sensing Program

The NEWSLETTER is made possible through a grant from the NASA Office of University Affairs. If you wish to be included on or removed from the mailing list, or if you know of any item or article that may be of interest to our readers, please contact Mr. Warren R. Philipson, Remote Sensing Program, 464 Hollister Hall, Cornell University, Ithaca, N.Y. - (607) 256-4330.

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APPENDIX J
TRAVEL SPONSORED
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TRAVEL SPONSORED BY NASA GRANT*

June 1, 1973-November 30, 1973

DESTINATION	PURPOSE	NBR. DAYS	NBR. PERSONS/ NATURE OF EXPENSES
Albany, New York	Discuss possible cooperative studies with N.Y.S. Dept. of Environ. Conservation and N.Y.S. Dept. of Transportation	1	2/road mileage and meals
Albany, New York	Discuss progress of cooperative study and obtain data from N.Y.S. Geological Survey	1	1/car rental and meals
Albany, New York	Discuss cooperative studies with N.Y.S. Dept. of Parks and Recreation, N.Y.S. Dept. of Transportation, and N.Y.S. Geological Survey	2	3/road mileage, lodging and meals
Hornell, New York	Discuss cooperative study and obtain data from Regional Office of N.Y.S. Dept. of Transportation	1	1/road mileage, and meals
Auburn, New York	Discuss possible cooperative studies with Cayuga Museum of History and Art	1/2	3/road mileage
Great Gully, New York	Field check for archeological study	1/2	3/road mileage
Sioux Falls, So. Dakota	Attend Remote Sensing Symposium; visit EROS Data Center	4-1/2	1/airfare, lodging and meals

* List does not include travel funds for seminar speakers

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