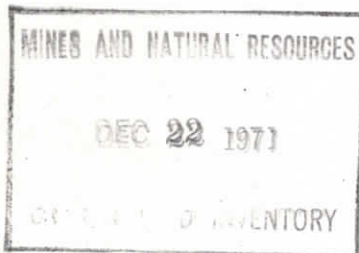




Department of Energy, Mines and Resources
 Ministère de l'Énergie, des Mines et des Ressources

File Number 1165-3
 No. à rappeler

Canadian Centre for
 Remote Sensing,
 Room G-320,
 No. 8 Temporary Bldg.,
 Ottawa, Ontario.
 K1A 0E4



December 6, 1971

Mr. Jean Thie, Chief,
 Forestry Sector,
 Canada Land Inventory Project,
 Department of Mines, Resources and
 Environmental Management,
 Winnipeg, -Manitoba.
 R3G 0G1

Dear Mr. Thie:

Re: The First Canadian Remote Sensing Symposium

At a recent meeting of the Program Committee, the following paper was accepted for presentation at the Symposium sponsored by the Canadian Centre for Remote Sensing and the Canadian Institute of Surveying to be held in Ottawa, February 7, 8, 9, 1972.

Author(s)	Title
<u>J. Thie</u>	<u>Evaluation of the Usefulness of High</u>
	<u>Altitude Multiband Photography for Forest</u>
	<u>Site Classification, Forest Ecological</u>
	<u>Studies, and Bio-physical Land Classifi-</u>
	<u>cation</u>

It was assigned for presentation at:

Session: 1 Date: 7/2/72 Time: 1615

Projectors for 35 mm., 70 mm. and overhead display will be available. Adequate space for display is available. For any special display requirement, please contact: Mr. Peter Andrews, National Air Photo Library, 615 Booth Street, Ottawa, Ontario.

The presentation of a paper and direct discussion on it will be limited to 15 MINUTES. After each session of five papers, a 15 minute discussion period related to the group has been provided followed by a short break before the next session.

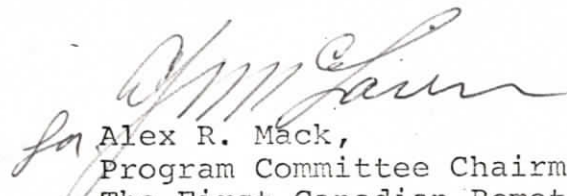
On Tuesday, February 8, papers will be presented at two concurrent sessions. It is important that a 15 MINUTE limit be adopted to enable presentation of all accepted papers with time for discussion afterwards.

Papers may be given in either English or French and they will be reproduced in the Proceedings in the language presented by the author. Simultaneous translation of the papers is being arranged for the meeting.

Information on publication of the paper in the Proceedings of the Symposium will be forwarded from Dr. L. Sayn-Wittgenstein.

Yours truly,

/hr


Alex R. Mack,
Program Committee Chairman,
The First Canadian Remote
Sensing Symposium.

FIRST CANADIAN SYMPOSIUM ON REMOTE SENSING

Monday, February 7, 1972

- 0800 Registration
to Viewing of Exhibits
0915
0915 Call to Order—A. Mack, *Canada Dept. of Agriculture*
0920 Welcome by Canadian Institute of Surveying
—L. Sayn-Wittgenstein
0925 Welcome by Department of Energy, Mines and Resources
—J. M. Harrison
0930 Introduction of Guest Speaker

- 0935 Guest Speaker —J. Austin, Deputy Minister
1000 L. Morley, E. A. Godby, P. A. Lapp, *Canada Centre for Remote Sensing, Ottawa*
“General Program of the Canada Centre for Remote Sensing”
1030 A. Gregory, *Canada Centre for Remote Sensing*
“What do we mean by remote sensing?”
1045 J. MacDowell, *Canada Centre for Inland Waters*
“A review of satellite and aircraft remote sensing instrumentation”
1100 Exhibitors' Hour
1200
to Lunch
1330

AGRICULTURAL CROPS, FORESTRY AND WILDLIFE (A)

- Chairman: L. Sayn-Wittgenstein, *Canadian Forestry Service*
1330 P. A. Murtha, *Canadian Forestry Service, Ottawa*
“Sulfur dioxide damage delineation on high-altitude photographs”
1345 E. H. Halstead and D. A. Rennie, *University of Saskatchewan, Saskatoon*
“Crop identification and detection of atmospheric potash damage from multi-stage photography”
1400 V. R. Wallen, L. E. Philpotts, and H. R. Jackson, *Canada Dept. of Agriculture, Ottawa*
“Detection, interpretation and assessment of aphid infestation in field corn by colour-I.R. aerial photography”

- 1415 L. V. Busch¹, L. E. Philpotts², and J. Law³
¹ *Guelph University, Guelph*
² *Canada Dept. of Agriculture*
“Assessment of Verticillium wilt within a potato crop by colour-I.R. photography”
1430 E. J. Brach and A. R. Mack, *Canada Dept. of Agriculture, Ottawa*
“Difference in reflectance properties of diseased plants grown under different environments”
1445 Discussion
1500 Break

AGRICULTURE, FORESTRY AND WILDLIFE (B)

- Chairman: P. A. Murtha, *Canadian Forestry Service, Ottawa*
1515 R. B. B. Dickison¹, and D. O. Greenbank²
¹ *University of New Brunswick*
² *Canadian Forestry Service, Fredericton, New Brunswick*
“Topographic variation of forest canopy temperature as measured by an airborne radiometer”
1530 J. D. Heyland, *Quebec Wildlife Service, Quebec, P.Q.*
“Vertical aerial photography as an aid in wildlife population studies”
1545 J. M. Wightman, *Canadian Forestry Service, Ottawa, Ontario*
“High-altitude photography records and monitors logging operations”
1600 J. W. E. Harris, *Canadian Forestry Service, Victoria, British Columbia*
“High-level photography for forest insect damage surveillance in British Columbia”
1615 J. Thie, *Manitoba Dept. of Mines, Resources and Environment Management, Winnipeg, Manitoba*
“Use of aerial photographs in forest site classification, forest ecology, soil survey and geomorphology”
1630 Discussion
1700 Break
1730 Social Hour, Cocktails and Buffet
to Conference Centre Lounge
1900 (*ladies and gentlemen*)

good opening session. cliff

good

good visuals

Tuesday, February 8, 1972, Concurrent Sessions I and II

SESSION I

OCEANOGRAPHY AND LIMNOLOGY (A)

- Chairman: J. Kruus, *Inland Waters Branch, Ottawa*
0830 K. P. B. Thomson, *Canada Centre for Inland Waters*
“Infrared scanner observations on Lake Ontario”
0845 H. Gross¹ and P. Holman²
¹ *Inland Waters Branch*
² *Geological Survey of Canada*
“Infrared investigations in Southern Ontario”
0900 J. G. Irbe, *Atmospheric Environment Service, Downsview, Ontario*
“Operational program measuring surface water temperature by airborne radiation thermometer (ART) survey”
0915 G. L. Nielson, *Alberta Dept. of Environment, Edmonton*
“Thermal pollution investigation at Wabumum Lake, Alberta”
0930 W. C. Moore, *Canadian Forestry Service, Ottawa*
“Remote airborne sensing of water pollution: Rideau River Drainage Basin”
0945 Discussion
1000 Break

OCEANOGRAPHY AND LIMNOLOGY (B)

- Chairman: K. P. B. Thomson, *Canada Centre for Inland Waters, Burlington*
1015 B. C. Kenny, *Fisheries Research Board, Winnipeg*
“Circulation and diffusion in a small lake”
1030 T. S. Murty and F. G. Barber, *Marine Sciences Branch, Ottawa*
“Rip current patterns in oil slicks”
1045 H. L. Ferguson and H. F. Cork, *Atmospheric Environment Service, Downsview, Ontario*
“The use of satellite photographs to determine the time of freeze-up and break-up of Canadian lakes”
1100 W. D. Bruce and P. J. Howarth, *McMaster University, Hamilton*
“Geomorphic significance of drainage characteristics interpreted from ERTS, A simulation imagery”
1115 A. W. Adey, R. E. Barrington T. R. Hartz, *Communication Research Centre, Ottawa*
“Theory and field tests of a UHF radiometer for determining sea-ice thickness”
1130 Discussion
1200 Lunch

TERRAIN ANALYSES (A)

- Chairman: S. Pawluk, *University of Alberta*
1330 D. F. Acton, *University of Saskatchewan, Saskatoon*
“Experimental program on the application of remote sensing for soil surveys in Saskatchewan”
1345 G. J. Beke, *University of Manitoba, Winnipeg*
“Evaluation of multi-band data for resource inventories”
1400 P. H. Crown, *University of Alberta, Edmonton*
“Remote sensing for soil resource inventories”
1415 C. Tarnocai, *University of Manitoba, Winnipeg*
“The use of remote sensing techniques to study peatland and vegetation types, organic soils and permafrost in the Boreal region of Manitoba”
1430 H. J. Dirschl¹ and D. L. Dabbs²
¹ *Canada Wildlife Service, Saskatoon*
² *Williams Brothers Canada, Limited, Calgary*
“The role of remote sensing in wildland ecology and environmental impact studies”
1445 Discussion
1500 Break

SESSION II

METHODOLOGY (A)

- Chairman: V. Smith, *Defence Research Establishment, Ottawa*
M. M. Taylor, *Defence Research Board, Downsview, Ontario*
“Perceptual principles related to remote sensing”
V. Kratky, *National Research Council, Ottawa*
“Photogrammetric aspects of precision processing of ERTS imagery”
R. Barrington¹ R. Hutchinson¹, J. S. MacDonald², D. S. Sloan²
¹ *Communications Research Centre*
² *MacDonald, Dettwiler and Associates Limited, Vancouver*
“A quick-look read out for ERTS multi-spectral scanner imagery”
M. A. Underhill, *Dept. of National Defence, Dartmouth, Nova Scotia*
“Problems in relating user-requirements to quantitative parameters of imagery quality”
G. E. Derenyi, *University of New Brunswick, Fredericton*
“Geometric considerations in remote sensing”
Discussion
Break

METHODOLOGY (B)

- Chairman: M. G. Tanguay, *École Polytechnique, Montreal*
I. Henderson, *Defence Research Establishment, Ottawa*
“Interpretation of Arctic imagery”
T. Kasvand, *National Research Council, Ottawa*
“Can we teach computers to see?”
S. H. Collins, *University of Guelph, Guelph, Ontario*
“The block adjustment of colour in high-altitude photography”
A. G. Wacker, *University of Saskatchewan*
“Minimum distance classification in remote sensing”
D. Steiner, *University of Waterloo, Waterloo, Ontario*
“Multi-spectral photography and automatic terrain recognition”
Discussion
Lunch

SENSORS AND INSTRUMENTATION (A)

- Chairman: P. Lapp, *Consultant*
A. W. Adey, *Communications Research Centre, Ottawa*
“Microwave radiometry for remote sensing from aircraft and spacecraft”
M. A. K. Hamid, J. Hunter, M. A. Rzepecka and A. H. Soliman, *University of Manitoba, Winnipeg*
“Remote sensing by microwave radiometry”
R. L. Grasty and P. B. Holman, *Geological Survey of Canada, Ottawa*
“The measurement of snow-water equivalent using natural gamma radiation”
A. I. Carswell, *York University, Toronto, Ontario*
“Remote probing by laser radar”
J. H. Davies and J. D. McNeill, *Barringer Research Limited, Rexdale, Ontario*
“Airborne remote sensing of resistivity through the use of E-PHASE techniques”
J. Davies, *Barringer Research Limited, Rexdale*
“Detection of atmospheric constituents”
Discussion
Break

Tuesday, February 8, 1972 (cont.)

SESSION I (cont.)

TERRAIN ANALYSES (B)

- Chairman: A. C. Darnley, *Geological Survey of Canada, Ottawa*
- 1515 L. S. Crosson and R. Protz, *University of Guelph, Ontario*
"The use of orthophotos in terrain analyses"
- 1530 A. Kesik, *University of Waterloo, Ontario*
"Supplementary reconnaissance air photographs as an aid for detailed geomorphological mapping"
- 1545 P. Gimbarzevsky, *Canadian Forestry Service, Ottawa*
"Terrain analysis from high-altitude aerial photographs"

- 1600 P. J. Howarth, *McMaster University, Hamilton, Ontario*
"Film and filter combinations for the study of the periglacial landscape of the high Arctic"
- 1615 M. G. Tanguay¹ and J. Chagnon²
¹ *École Polytechnique, Montréal*
² *Ministère des Richesses Naturelles, Québec*
"Thermal infrared imagery at the St. Jean Vianney landslide"
- 1630 Discussion
1700 Break
2000
to Dinner, Entertainment, Dancing
2400

Wednesday, February 9, 1972

For delegates wishing to examine several sensor-equipped aircraft at Canadian Forces Base, Uplands, a bus will leave the Conference Centre at 1000, 1300 and 1500 hours, returning to the same point at 1200, 1500 and 1700 hours.

SENSORS AND INSTRUMENTATION (B)

- Chairman: N. de Villiers, *Canada Centre for Remote Sensing*
- 0830 W. B. McCoy, *University of Saskatchewan, Saskatoon*
"A poor man's remote sensing system"
- 0845 U. Nielsen, *Canadian Forestry Service, Ottawa*
"Effects of spectral filtration and atmospheric conditions on aerial photography in 1970-1971"
- 0900 Lt. Worsfold, *Canadian Forces Airborne Sensing Unit, Ottawa*
"A qualitative study of Kodak Aerochrome Infrared Aero film 2443 and the effect produced by Kodak compensating filters relating to data interpretation"
- 0915 V. R. Slaney, *Geological Survey of Canada, Ottawa*
"Getting better photography for geologists"
- 0930 V. Zsilinszky, *Ontario Dept. of Lands and Forests, Toronto*
"Camera mounts for 35 mm. mono- and multi-spectral photography"
- 0945 Discussion
1000 Break

TERRAIN ANALYSES (C)

- Chairman: D. F. Page, *Communications Research Centre*
- 1015 F. Bonn, P. Clement, B. Bareille, C. Trudel, Y. Leblanc, C. Jalbert, *Université de Sherbrooke, Québec*
"Étalonnage au sol sur parcelles expérimentales de radiomètre Barnes PRT-5 dans la fenêtre 9.5-11.5 microns"
- 1030 G. Morley and D. McKinnon, *Defence Research Board, Ottawa*
"Use of ground calibration array with infrared line-scanners"
- 1045 J. W. Locke, *University of Toronto, Ontario*
"A colour laser beam image recorder for Canada's remote sensing program"
- 1100 G. Hasslin and D. F. Page, *Communications Research Centre*
"Principles of SLAR systems"
- 1115 P. M. Addison, *Consultant, Ottawa*
"SLAR imagery interpretation techniques and procedures for reconnaissance forestry and soils mapping of remote tropical regions"
- 1130 Discussion
1200 Lunch

ECONOMIC ANALYSES, PROGRAMS AND PLANS (A)

- Chairman: L. Philpotts, *Canada Dept. of Agriculture, Ottawa*
- 1330 C. D. Bricker, *Dept. of Highways and Transport, Edmonton*
"Experiments in aerial remote sensing for highway engineering"
- 1345 A. N. Aldred, *Canadian Forestry Service, Ottawa*
"Economics of combining remote sensing data collected at several scales"
- 1400 R. Grinnell, *Canadian Forestry Service, Ottawa*
"The economics of remote sensing in forest land use"
- 1415 W. M. Strome, *Canada Centre for Remote Sensing, Ottawa*
"The data handling facility of the remote sensing centre"
- 1430 L. Sayn-Wittgenstein and W. C. Moore, *Canadian Forestry Service, Ottawa*
"The ERTS experiments of the Canadian Forestry Service"
- 1445 Discussion
1500 Break

ECONOMIC ANALYSES, PROGRAMS AND PLANS (B)

- Chairman: R. Goulden, *Manitoba Department of Mines, Resources and Environment, Winnipeg*
- 1515 H. W. Thiessen, *Alberta Dept. of Environment, Edmonton*
"A proposed organization for the efficient interpretation of remote sensing data"
- 1530 E. M. Sugimoto, *Canadian Forces Headquarters, Ottawa*
"The Canadian forces airborne sensors familiarization program (CF ASE Program)"
- 1545 G. Jenkins, *Dept. of Mines and Natural Resources, Winnipeg*
AGRICULTURE
"The application of remote sensing to the study of soil erosion"
- 1600 R. W. Higgs, *Canada Dept. of Public Works, Ottawa*
"High flying hardware and the common man"
- 1615 S. J. G. Bird, *University of Toronto, Ontario*
"Remote sensing evaluation of environmental factors affecting the developmental capacity of inland lakes"
- 1630 Discussion
1645 Conclusion
1700 Break

Mark
Sevens
Consult.
to CCERS

Novak
Am 206
1:30 - 4:00 pm

Mr. Glen Bird

Cal Bricker
Dept. Hws. EDMT

Mr. Gordon Hills

announce questionnaire

GENERAL INFORMATION

Pre-registration

Please pre-register early by mail if possible in order to assist the committee in making arrangements. This will also save you time in registering at the Symposium. A pre-registration desk will also be available Sunday evening, February 6, 1972, in the lobby of the Chateau Laurier Hotel.

Hotels

It would be advisable to make early reservations at the hotel of your choice. The committee cannot assume responsibility for reserving such accommodation.

The Chateau Laurier is directly across the street from the Conference Centre, and the Lord Elgin Hotel is just a few hundred yards away; neither need entail use of taxis. The Skyline Hotel and Holiday Inn are within easy walking distance in fine weather. Many other fine hotels and

motel are linked by public transport to downtown Ottawa.

Parking

Four large covered parking garages are located near the Conference Centre, as well as several open parking lots.

Entertainment

Chiefly for the ladies, on Monday afternoon from 2 to 4, the committee will host an afternoon's entertainment by Jack McPartlin in the Colonel By Lounge of the Chateau Laurier. Cash bar.

On Monday evening, from 5:30 to 7:00 p.m. there will be a social hour with cocktails and buffet in the lounge of the Conference Centre. Admission for one is included in the registration.

On Tuesday evening, February 8, from 8:00 p.m. until midnight there will be a dinner dance at the Chateau Laurier.

Government Conference Centre, 2 Rideau St., Ottawa
February 7, 8 and 9, 1972

Sponsored by the Department of Energy, Mines and Resources, the Canada Centre for Remote Sensing, and the Canadian Institute of Surveying

Sous les auspices du Ministère de l'Énergie, des Mines et des Ressources, du Centre canadien de Télédétection, et de l'Association canadienne des Sciences géodésiques

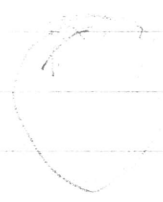
Inst Environ Sci & Engineering

APPLICATION OF REMOTE SENSING TECHNIQUES FOR
DESCRIPTION AND MAPPING OF FOREST ECOSYSTEMS

Slide: ~~app~~ title (1)

Since the second World War the use of aerial photographs has played a major role in the management of forest resources. Applications in the fields of mapping, forest typing and volume mensuration were soon perfected and we can say that much of our merchantable forest area has been inventoried at least once. The development of the camouflage detection film, introduced plant disease surveys. More recently stress symptoms in plants as result of environmental factors have been studied. The question is no longer just where, but also why?

In the early 1950's Hills recognized the value of aerial photographs for his forest site (~~physiographic site~~) classification system. He stressed landform and surface geology as the integrating framework for vegetation, soils, local climate and "site".



Aerial photographs with a three dimensional image provide a way to separate significantly different units, to define or describe these by field sampling and to extrapolate information to non similar ^{and unrepresentative} sampled areas. The total number of field investigations is therefore considerably less than in conventional surveys. The value of each field observation is much greater, therefore both its choice and location, and its description and classification are of more critical nature. (Vink, 1964).

show
Fig 2



Recently

A greater interest in Forest Ecosystems is being shown based on the increasing awareness that manipulating and planning of our resources should be based on sound ecological knowledge rather than exploitation or primitive sustained yield management. *ad in Forestry*

odum defined

↓ Ecosystems are defined as "any area of nature that includes living organisms and non living substances to produce an exchange of materials between living and non-living parts (Odum,

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Aerial photographs with a three dimensional image provide a way to separate significantly different units, to define or describe these by field sampling ^{and interpretation} and to extrapolate information to non similar sampled areas. The total number of field investigations is therefore considerably less than in conventional surveys. The value of each field observation is much greater, therefore both its choice and location, and its description and classification are of more critical nature. (Vink, 1964).

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FIG 2



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A description of ~~forest~~ ^{an} ecosystems ~~is~~ ^{is} has to be based on a study of the environmental and biotic factors.

Slide: (2)

The interaction

Time-lapse photography or sensing provides us with the fourth dimension and enables us to study the dynamic aspects of an ecosystem over long or short time intervals.

time concept
-melting permafrost.

yes

The development of passive and active imaging techniques in the various portions of the electromagnetic spectrum, from ultra-violet to microwave provide us with a new kind of information related to the surface of the earth and vegetation and its environment. Many of environmental parameters can only be feasibly studied and mapped with these remote sensing techniques.

I will discuss these

Photo interpretational elements of an ecosystem.

in more detail with some examples

Relief: Changes in slope and relief usually indicate a change in ecosystem.

perhaps the most indicative element and a most easy to interpret as the human eye is very sensitive to depth in a 3 dimensional modal

slide (3) -
relief interpretation.

Relief exaggeration of the stereomodal can be influenced by changing the base-height ratio (airbase between points were consecutive pictures were taken over flying height). A normal angle lens will provide little exaggeration, the super wide angle about three times as much. The latter lens might provide more easily interpretable images in areas with a extremely flat topography.

- macro relief.
- micro relief.

Believation on this slide is based on almost only macro and micro relief; classification is based on landform knowledge

Landforms and parent material:

Identification of landforms on aerial photographs is based on specific relief and surface configuration, while drainage pattern may be of assistance. Knowledge of the geomorphology of an area provides us with

- ester

(For landform and Relief interpretation)
we cannot expect too much from scanning type images which do not provide a three dimensional model.

Drainage: Changes in drainage conditions are reflected by changes in vegetation and soil development. Analysis of drainage systems, the structure and composition of rivers, creeks and gullies can be very indicative of the underlying bedrock and the type of surface and sub-surface materials, textures and landforms.



slide (4) -
Sask delta area

The development of peatland ecosystems is closely linked to drainage conditions and flow. As these areas are usually extremely flat and relief cannot be analysed on smaller scale imageries we have to depend more on drainage and vegetation analysis for mapping of ecosystems.



- A - weakly microtophic
- B - microtophic
- C - Highly microtophic
- D - almost ombrotrophic.

On the basis of shape and configuration of peat landforms, like (A) palsas, (B) ribbed fens and black spruce islands a very detailed drainage flow map often can be made and unknown water divides mapped.



slide (5)
drainage interpretation.



slide 6 - drainage flow map.

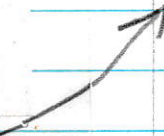
Vegetation: If properly analysed, vegetation can be an important indicator of an ecosystem, since soil type

Vegetation composition is strongly influenced by such parameters as climate, microclimate, slope, drainage conditions, soil profile development, nutrient status and also very sensitive to disturbances by human beings (e.g. logging, air pollution), animals (grazing, browsing), diseases and, especially, fire.

For the purpose of mapping and understanding ecosystems we therefore need to analyse and map the disturbance history. In the boreal forest zone, forest fires have influenced most of the vegetation types.

(7)
slide: burn interpretation

On the basis of photointerpretation of small panchromatic images (Fig. 5) and limited fieldwork, we can estimate the age of burns and map fire boundaries. as is done on this slide



(8)
slide with forest fire map.

In some areas we are able to reconstruct the fire history over a period of 100 to 200 years.



As our photographic data of the environment do not go back much further than 1920, we have to depend on other techniques to approximate forest succession ~~in the boreal ecosystem.~~

talk to slides

It is as if we have a cross section of maybe 100 to 300 years of forest succession.

like this soil map

A common mistake in many land surveys is the indiscriminate use of vegetation boundaries, as soil or site boundaries. If the difference in vegetation is not supported by relief or drainage ~~difference~~ the boundary must be checked carefully as it often has been introduced by old forest fires.

This was the case on this slide

slide (12) Soil map
misinterpretation

talk to slide
delineate fire

Climate: is characterized on the basis of parameters which are usually measured above the surface near weather stations. There are also other climatic indicators in the form of ecosystems and the changes taken place in these as reaction on climatic changes.

Zoltai (1971) mapped for example the southern occurrences of ribbed fens and collapse scars of wooded palsas and peat plateaus in Manitoba and Saskatchewan with small scale aerial photographs and found high correlation with the 0°C mean annual isotherm.

Zoltai and Tarnocai (1969) mapped different permafrost zones in Manitoba and strong climatic significance is expected.

slide (13) Manitoba
Permafrost

Some micro climatic conditions can easily be mapped on aerial photographs such as the difference between north and south facing slopes, the influence of water bodies on vegetation. To study micro climate the infrared scanner flown at low altitude can provide excellent information. Murtha (1971) examined the temperature fluctuations of a planted area by means of repetitive infrared scanner imagery. Frost pockets could be related to poor growth.

Climatic inferences over a period of about 300 years based on time-lapse interpretation of permafrost are discussed in detail later in this paper.

Living organisms: Animals, insects, ~~man~~ operate as a part of an ecosystem. Man however tends to change the ecosystems for the production of energy in a form he desires. Influence of man therefore tends to be abrupt and destructive. His practises, like cropping, grazing, logging, transportation etc. can therefore easily be mapped and studied by aerial photographs or remote sensing techniques even on ultra small scale imagery.

slide 141 - (Ridgely mountain)

The study of organisms living in balance with nature is far more difficult with remote sensing techniques and to obtain results very large scale imagery seems to be necessary.

1:20000

ecosystem

Time plays an important role in the complex interactions of an ecosystem.

To understand these changes adequately, time-lapse remote sensing is essential from high and low altitudes.

Without repetitive aerial photography or ERTS imagery, long term and widespread change would be difficult to assess.

Comparison of repetitive daily flight imagery from infrared scanners has already proven to be very useful for the study of forest and soil ecosystems.

Elem. Analysis
+ time laps photo.

CASE STUDIES

During 1971, three areas in Manitoba were studied. Areas No. 1 and 2 are in the Mid Boreal, area No. 3 in the North Boreal

Area 1: Limestone Bay - Warren's Landing Area (about 400 sq. miles)

Objective of Study: 1) To map and measure the occurrence and melting of permafrost and to relate it to environmental factors. 2)

To evaluate the usefulness of careful element analysis of all available photographic material for the description of ecosystems and ecoregions.

Methods: A detailed evaluation and mapping of the elements of the landscape was done by means of ^(small scale) airphoto-interpretation and limited selective field sampling.

5 maps were made up:

- drainage flow (Fig. 3)
- vegetation
- fire history (Fig. 5 and 6)
- permafrost occurrence
- geomorphology

A comparison of 1947, 1967 panchromatic photography, at scales approximately 1:15,000 and 1926 oblique photographs was made to evaluate and measure the changes in vegetation and permafrost bodies. These results were mapped and related to the above maps.

areas in red were melted during the last 20 years.

* Some results found.

Present permafrost occurrences were most abundant in the medium deep peats.

About 25% of the once occurring permafrost in the area, is still present. Most of the melting occurred since 100-150 years before present (B.P.).

(15)
slide with studie areas.

(16)
oblique of area.

slide (17) - 4 maps

slide

slide.

slide of area (18).

Two types of collapses were noticed: a circular collapse around very small permafrost bodies, a central collapse for the larger bodies. The rate of collapsing varied from 0-30 meters per 20 years; collapse edges showed a rate of 15-25 meters per 20 years. // Forest fires did not influence the rate of collapsing measurably; only on two occasions complete and sudden collapses were noticed after a burn.

without the 20-year time lapse most inferences would have been impossible

Area 2: Wekusko Area (about 9 sq. miles)

ground slide - 19.

Objective of the study: To evaluate high altitude multi-band photography for forest site classification and bio-physical land classification.

Methods and Materials: The study area was flown in the summer of 1971 by CF-100 aircraft at 21,000 ft. with 4, 70 mm. Vinten cameras with 3" focal length. Film-filter combinations used were:

Color infrared with W-12 filter
Black and white I.R. with 89-B filter
Black and white Tri-X with W12+44 filter
9" x 9" aerial color with NAV filter

slide 20
3-films

The photo-interpretational elements of the landscape were analysed for three film, filter combinations

slide 21
results of analysis

it is obvious from this figure that

color I.R. provides superior results //

// And looking at the imagery in detail on these 3 slides the difference is rather conspicuous

slide 22 (color IR)

slide 23 (B.W. TRI)

slide 24 (B.W. Green)

The effectiveness of the different films was expressed as a percentage of success of the final forest site map. Especially the drainage and vegetation

- slide 24 (site map)

interpretation ^{on color I.R.} showed high relation //

slide 25 (analysis results)

// while relief was less successful.

The imagery in this text site at 21,000ft is not at all that exciting. The Canoll lake area shows better quality photography taken from 32,000ft.

I believe that even smaller scale imagery (1:150,000) would be very useful for bio-physical land classification of Northern Canada.

slide. Canoll lake
color I.R. (26)

(27)

b.w. Slide. Canoll lake

Area 3: Southern Indian Lake; Missi Rapid - South Bay - 60 line miles

Objective: Evaluation of infrared scanner imagery (3-5 μ) for interpretation of forest sites with special reference to permafrost ecosystems on mineral and organic soils.

(28) Slide ground.

Two flights were made at midday; at 2000ft and 500ft above ground level.

(29) Slide. 3 strips.

Tonal distribution is very similar to the panchromatic image, and permafrost delineation was easier on the small scale panchromatic because of relief and landform recognition.

fall rocks

- continuous permafrost

Vegetation differentiation was again superior on the panchromatic. For example at the 2000ft I.R. imagery black spruce and trembling aspen on well drained clay could not be separated.

slide (30)

Forest fire boundaries appeared (light/warm) on the scan image especially in moist areas (slow regeneration). Again for fire interpretation panchromatic was considered superior.

In summary:

1) I have tried to express my feeling that detailed analysis of the elements of ecosystems by means of small scale aerial photography can provide a hell of a lot of information.

2) I believe strongly that very high-altitude multi-band photography especially the color-infrared (W-12 filter), can be used as basis for a fast and accurate forest site classification. This material would be very useful for large northern ecological surveys like a biophysical land classification.

3) Thermal-infrared imagery (3-5 μ) proved to be of relative little value in mapping of permafrost and better results were obtained with panchromatic imagery.

4) Time lapse information - with conventional photographs, I.R. scanners ~~or~~ multispectral on a diurnal or seasonal basis will give new dimensions to forest ecological studies.

5) The results, to my feeling, strongly support the ERTS experiment, which will provide us with ultra small scale, repetitive coverages of ^{large} areas for which we need so much information.