THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING

1972 REPORT

Dr. C. H. Smith,
Chairman,
Interagency Committee on Remote Sensing,
Department of Energy, Mines and Resources,
Ottawa, Ontario.

Dear Dr. Smith:

I submit herewith the annual report of the Canadian Advisory Committee on Remote Sensing and its working groups for the calendar year 1972.

In this report are a large number of recommendations. Many are of an operational nature and have to do with increasing efficiency. The CCRS will take these in hand directly.

Other recommendations have to do with policy matters. These I will be referring to your committee for direction.

I wish to commend to you the fine work of all the members of CACRS and its working groups for their enthusiastic support of the advisory committee in pushing this national program forward as much as they have. We look forward to another year of achievement in 1973.

Yours sincerely,

L. W. Morley

L. W. Morley,
Chairman,
Canadian Advisory Committee on
Remote Sensing.

TABLE OF CONTENTS

1. Summary Minutes – Canadian Advisory Committee on Remote Sensing 1

2. Resolution from Provincial Representatives to CACRS 8

3. Recommendations 9

4. Report of Activities. 14

5. Reports of Working Groups 42

6. Reports from Provincial Representatives 152

7. Reports from Specialty Centres 205

1. SUMMARY MINUTES,
CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING,
Manoir Papineau, Montebello, P.Q.,
February 22, 1973

1.1 Introductory Meeting (Feb. 19, p.m.)
Chairman: Dr. L.W. Morley

Dr. Morley reviewed the three previous annual sessions at Montebello. He noted that CACRS was responsible for co-ordinating the national program of remote sensing which comprises the separate programs of the provincial governments, the program of the federal government and the programs of universities and industries which are brought to the attention of the Committee.

The objectives of this meeting were: (1) to summarize the highlights of annual reports to CACRS, especially the recommendations; (2) to provide feedback between users and technologists; and (3) to prepare an annual report from CACRS to the Interagency Committee on Remote Sensing.

1.2 General Overview of CCRS and NAPL Activities (Feb. 20, a.m.)
Chairman: Mr. E.A. Godby

Mr. Godby reviewed the progress at CCRS during 1972, noting that difficulties in producing both airborne and ERTS data were largely related to the limited budget and tight scheduling. Delivery times should improve early in 1973. Increase emphasis will be placed on development of applications.

1.2.1 - Airborne Program (see 4.2 for details)
Mr. R.C. Baker introduced the following briefings:

Airborne Projects (see 4.2.2) - Mr. E. McLaren reported that 128 projects were tasked in 1972, of which 18 were cancelled. The major users of airborne data were: Forest Management Institute, Manitoba Committee for Remote Sensing, universities, Canada Centre for Inland Waters and other branches of the Department of the Environment. The airborne program incurred 37% down-time, which resulted mainly from weather and unserviceability of equipment. Delivery of imagery suffered substantial delays of up to 3 months which alienated many users, particularly those concerned with temporal variations. Improvements in delivery, control of exposure and annotation are essential.

Flight Operations (see 4.2.3) - Major E. Gardiner noted that close communication with the principal investigator was essential if the user's requirements were to be considered in the timely decisions involved in planning and carrying out the mission. Without close contact, image quality and user satisfaction often degrade. Considerable lead-time is required to schedule aircraft across the country.

Sensors and Ancillary Equipment (see 4.2.4) - Dr. N. de Villiers reported on sensors and navigational aids in use and being planned. Experiments with laser bathymetry will attempt to measure water depths up to about 10 metres. Concurrent annotation and coordination of all data acquired in a remote sensing mission is being planned with the proposed Airborne Data Acquisition System. A quick-look facility was proposed for quality control, calibration and sensor tests in the hangar.

1.2.2 - ERTS Program (see 4.3 for details)
Dr. Strome reviewed the Canadian ERTS program noting significant differences between the Canadian and U.S. facilities for handling data and in the products of the two systems. The planned time of 10 calendar days for responding to standing orders in the Canadian system has not been achieved and CCRS has a severe back-log. CCRS hopes to achieve the planned time by mid-1973 and will begin reducing the backlog as soon as possible. More manpower is required for quality control, photographic processing and distribution.

Transparencies are radiometrically faithful but prints are dodged. Prints of Quick-look images are available to regional centres only.

NASA has stretched out the ERTS-1 experiment to 1976 and delayed ERTS-B with its thermal-IR channel until that time.

Mr. L. Chouinard (see 5.13) described the proposed indexing system for ERTS images using microfilm. He noted the low cost and wide applicability of the system.

Dr. J. Kruus (see 5.5) reported on Canadian experiments utilizing the data relay system on ERTS. Fourteen ground platforms were established in Canada and the relevant data are obtained through NASA/Goddard by mail or TWX. Additional proposals for participation in dcs experiments will be considered. D.O.C. is funding a study of Canadian needs for dcs.

Dr. A. McQuillan (see 4.4) reported on optical and digital equipment for processing and interpreting MSS data, noting the trend toward complex automated methods.

1.3 Reports of Working Groups
(Feb. 20, p.m.)
Chairman: Mr. E.A. Godby

1.3.1 - Working Group on Cartography and Photogrammetry (see 5.3 for details) -
Mr. G. Falconer reviewed four aspects studied by the working group: accurate height determination, spectral analysis for cartographic purposes, photomaps from satellite images and cartographic experiments with Skylab.

Mr. A. Stewart reviewed Canadian participation in Skylab, noting that Canada might receive some of the earliest data soon after the May 1973 launch. The manned space laboratory will not orbit north of 50°. Most experiments are biomedical and observation of the Earth is limited, in part, because Skylab must be rotated for such purposes.

1.3.2 - Working Group on Sensors (see 5.14 for details) -
Dr. P. Lapp reviewed progress in sensor development, noting the major setback as a result of the budget cut in 1972 and the poor prospects for adequate funding in 1973. The sensor survey previously completed by CARED needs to be supplemented. A subcommittee on reflection spectroscopy was established.

1.3.3 - Working Group on Data Handling and Satellite Technology (see 5.4 for details) -
Dr. M. Strome reviewed the needs to extend and augment the current US/Canadian agreement, to expand development of sensors and attitude controls and for design studies relevant to possible future Canadian satellites.

1.3.4 - Working Group on Photo Reproduction and Distribution (see 5.13 for details) -
Mr. E. Dixon reviewed aspects of the photographic reproduction system at NAPL and made recommendations for priorities in processing various types of data, as follows: (1) ERTS, (2) airborne remote sensing, (3) aerial photography (80% of customers). Subsequent discussion resulted in the recommendation that ERTS and airborne data receive equal priority.

Mr. S. Zelitt reviewed marketing aspects and recommended that CCRS should have a marketing officer to interface with NAPL.

Mr. P. Andrews (see 4.5) noted a 95% increase in demand for the services of NAPL over the past year. He stated that telex and phone orders are possible and faster than mail. Remote sensing is currently about 25% of NAPL business but a much greater effort is put into this area.

Mr. G. Nitschky (see 4.6) reported on photo processing at NAPL/RC. The composite printer is now operational. A two-shift operation produces ERTS images using 3 crews (2 in daytime). Additional staff are required to meet current demand.

Mr. L. Chouinard noted needs for improving the index for airborne remote sensing and for adding flight log data to the index.

1.3.5 - Working Group on Geosciences (see 5.8 for details) -
Dr. A.F. Gregory reviewed highlights of the report noting that few members had received ERTS data and that no results had been reported. One member reported dissatisfaction with the quality of some airborne data and noted a need for closer liaison during the remote sensing mission.

1.3.6 - Working Group on Forestry, Wildlife and Wildlands (see 5.6 for details) -
Mr. A. Bickerstaff and Mr. B. Smith reviewed highlights of the report noting that few ERTS images had been received by investigators and that no results had been reported. Mr. A. Buys was seconded to CCRS from FMI. The working group recommended that screening of proposals for remote sensing be removed from its terms of reference.

1.3.7 - Working Group on Agriculture (see 5.1 for details) -
Dr. A. Mack reviewed the report noting the lack of ERTS data and the very slow delivery of airborne data. He observed that CCRS must reestablish credibility for quick delivery of data if agricultural use is to cease declining. Airborne surveys should be integrated into common multidisciplinary blocks. Increased experimentation with radar and microwave was recommended because of agricultural requirements for all-weather capability and cloud penetration. Soil moisture sensing requires further research.

1.3.8 - Ice Reconnaissance and Glaciology (see 5.10 for details) -
Dr. D. Terroux noted that, although their major focus was on sea ice in the Gulf of St. Lawrence, Strait of Belle Isle and the Beaufort Sea, there was much overlap with interests of the Working Groups on Hydrology (snow) and Limnology (lake ice). Many of their interests are in areas presently beyond the range of aircraft available to CCRS. Further experiment and research is needed to assess the potential of radar and microwave for measuring ice thickness, strength and structure of ice and rate and direction of movement of icebergs.

1.3.9 - Working Group on Limnology (see 5.11 for details) -
Dr. R. Lane noted that no interpretations of ERTS data had been completed. He indicated inadequate funding for interpretation of remote sensing by user agencies and recommended the provision of "seed money" by Treasury Board for this purpose.

1.3.10 - Working Group on Hydrology (see 5.9 for details) -
Dr. J. Kruus noted that snowpack, water content of snow and soil moisture were all important concerns of their working group. He also reported on airborne studies of natural gamma radiation in selected test areas with the objective of measuring the water content of snow.

1.3.11 - Working Group on Oceanography (see 5.12 for details) -
Dr. W. English reported that positioning and attitudes of aircraft during aerial missions were special problems of concern to them because standard solutions were not feasible. He noted a major interest in measuring chlorophyll in the ocean. More attention should be directed to the oceans by improving acquisition of both ERTS and airborne data over the coastal waters within several hundred miles of the shore. All-weather sensors should be developed.

1.3.12 - Working Group on Atmospheric Sciences (see 5.2 for details) -
Dr. C.L. Mateer reported on the recent initiation of the group and on efforts in inform atmospheric specialists about remote sensing.

1.3.13 - Discussion of Working Group Reports -
Dr. R.K. Lane noted that the CCIW Skylab project had been accepted by NASA and that the Ontario Department of Highways would be working with some of the data obtained for the EMR Skylab project.

Mr. J. Thie asked about the use of microwave methods for detecting permafrost. Several bands of e.m. radiation are being investigated for this application and further details can be obtained from Mr. L.S. Collett, Geological Survey of Canada.

A number of members raised the question of support for regional interpretation centres. It was concluded that local funding was essential and that sole support through federal-provincial cost sharing programs was unlikely.

Mr. A. Bickerstaff discussed the need to select several integrated test areas rather than many separate discipline-oriented test areas for ERTS, airborne and ground investigations. Subsequent discussion revealed that some, though not complete, integration had been achieved by provincial committees but that greater effort was required.

Other discussion was concerned with obtaining details about remote sensing projects (e.g. their location, type of sensor, survey parameters, investigator and relative success) but no solution to this information problem was recognized.

1.4 Invited Lectures

1.4.1 - Mr. J. Thie, Chairman of the Manitoba Remote Sensing Committee, described his methods for interpreting ERTS images and reviewed the results of his interpretations for the Winnipeg images.

1.4.2 - Mr. R. Lewis, E.M.R. Planning and Evaluation Office, reported on a departmental review of the remote sensing program which had been completed by his office. Priorities recommended by the study group were: (1) development of applications and markets, (2) definition of benefits by March 1974, and (3) familiarization of potential users with operational remote sensing. Integration of projects with main departmental thrusts was also recommended.

1.5 Review of Policy Consideration
(Feb. 21, a.m.)
Chairman: Dr. L.W. Morley

1.5.1 - Policy Direction - Dr. Morley reviewed the terms of reference and the membership of the Interagency Committee on Remote Sensing.

1.5.2 - Cost Recovery - Dr. Morley noted that CCRS was committed to a graduated program of cost recovery because Treasury Board had adopted the concept that users should now be willing to pay for remote sensing. Accordingly, during fiscal year 1973-74, all federal agencies will be charged at the rate of $2 per line mile of useable airborne data. During fiscal year 1974-75, the rate will increase to 50% cost recovery for all users and thereafter to 100% cost recovery. No viable market for remote sensing (other than conventional aerial photography) has yet developed, not even within the agencies with the greatest experience.

1.5.3 - Industrial Participation - Dr. Morley reported that under official federal policy ("Make or Buy"), CCRS was contracting research and operational projects to industry e.g.

Prince Albert Satellite Station was built by SED Systems Ltd. of Saskatoon under the direction of the Department of Communications and the Data Handling Centre by Computing Devices of Canada in Ottawa. CCRS is committed to turning over the airborne operations to industry by 1975.

1.5.4 - Long Range Patrol Aircraft - Dr. Morley noted that CCRS has been instructed by Treasury Board to investigate civilian requirements for remote sensing in the Arctic and offshore areas. Recommendations about sensors and operational requirements will be made to DND who have their own requirements for LRPA.

Lt. Col. D.P. Wightman noted that DND hoped to contract for detailed studies of proposals for LRPA in September 1973. The aircraft, which are to begin operations in 1977, will have 3 or 4 jet or turbo-prop engines plus sophisticated systems for navigation and data acquisition. The basic requirement is for peace-time surveillance and regulation of fishing, dumping of wastes, etc. The remote-sensing role remains to be defined.

Subsequent discussion agreed that national interests might best be served by including in LRPA a capability for remote sensing of offshore and Arctic areas.

1.5.5 - Regional Interpretation Centres - Dr. Morley outlined the need to plan for regional centres in order to attain practical benefits from remote sensing.

1.5.6 - International Aspects - Dr. A. F. Gregory reviewed the background paper being prepared by the UN Working Group on Remote Remote Sensing of the Earth by Satellites and outlined some of the legal and organizational aspects. National viewpoints about remote sensing from space and the dissemination of data range from permissive through "laissez-faire" to very restrictive.

1.6 Reports from Provincial Representatives (Feb. 21 a.m, p.m.)
Chairman: Dr. L.W. Morley

1.6.1 Alberta (see 6.1 for details) -

Mr. C.D. Bricker reported that the Alberta government was coordinating, at present through one department, the procurement of imagery and the operation of remote sensing projects. Interpretation will continue to be done by many users, both within and outside the government service. Twelve projects were proposed in 1972 and 10 were completed. An integrated, multidisciplinary approach is favoured with block surveys serving as a focus for requests for airborne data.

Related discussion about the use of commercial contractors emphasized requirements for very precise controls during storage, exposure and processing of the films.

1.6.2 British Columbia (see 6.2 for details) -

Mr. A. Kinnear reported that a provincial committee coordinates requests for remote sensing. Current planning does not include an interpretation centre or colour processing facilities. Four "Winter Works" staff are involved but no one is presently committed full time to remote sensing (excluding aerial photography). Remote sensing projects were related to forest management and studies of forest growth, logging practices, stream fisheries, wildlife habitats and landforms. Only one ERTS image had been received, hence there was no report about this imagery. A new indexing system for remote sensing was demonstrated and further details are available from Mr. Kinnear.

1.6.3 Saskatchewan (see 6.9 for details) -

Dr. Morley read a telex reporting that the value of the 1972 Saskatchewan airborne program was nullified by severe problems of liaison during the acquisition of data. Non-delivery of ERTS images was hampering plans for 1973 field programs.

Subsequent discussion revealed that there were few problems in sensing a large area in Saskatchewan in 1971 but that, in 1972, the aircrew spent more time on the ground in Saskatchewan than in any other province. Much of the downtime was attributed to inadequate coordination and poor contacts with investigators.

1.6.4 Manitoba (see 6.3 for details) -

Mr. J. Thie reported that the Manitoba Remote Sensing Committee comprises over 110 members representing provincial, federal, academic and private interests. A proposal for a Regional Interpretation Centre was not supported by the federal government. Four alternatives were considered and Manitoba is now proceeding with a smaller-scale provincial centre, costing about $110,000, which is expected to provide a benefit-cost ratio of about 3. Despite a number of problems, MRSC was pleased overall with the CCRS program. The major problem was a severe delay in delivery of images and the consequent loss of interest on the part of users.

Subsequent discussion centred on funding problems for regional centres and the possibility of combining the program in the Prairie Provinces in a truly regional centre such as the Maritime Provinces are considering.

In response to Dr. Bruneau's question about the reality of immediate benefits totalling $315,000 for 1973-74, Mr. Thie explained how the list of benefits was developed with the aid of user agencies.

Extensive discussion was related to the inadequate delivery times for imagery and the possibility that CCRS couldn't meet its objectives unless delivery requirements were met.

1.6.5 Ontario (see 6.6 for details) -

Mr. V. Zsilinszky reported that Ontario was studying the concept of a production-oriented regional centre and was discussing the means of funding and of obtaining support from users. At present, all provincial sensing is handled through the Ministry of Natural Resources which has representation on the Ontario Association for Remote Sensing. He noted that the public impression of remote sensing was largely one of research and emphasized the need for concrete results, training lists, general articles on practical applications and the involvement of experienced users in the marketing program. He questioned the value of temporary "Winter Works" staff in achieving these objectives.

Subsequent discussion clarified the role of "Winter Works" staff as technical salesmen rather than expert interpreters.

1.6.6 Quebec (see 6.8 for details) -

Dr. J.G. Bernier reported on the formation of the Quebec Committee on Remote Sensing (CQPD: Le Comite Quebecois de la Perception a Distance), with members representing 12 provincial ministries. The establishment of a remote sensing centre is under consideration. In 1972, projects related to forestry, agriculture and hydrology were undertaken. A list of projects for 1973 was tabled. Dr. Bernier noted that few ERTS images had been received for Quebec and recommended that the delivery time for both ERTS and airborne data be improved as soon as possible.

1.6.7 New Brunswick (see 6.4 for details) -

Mr. B.M. Smith reported on the formation of a provincial committee on remote sensing which will coordinate the remote sensing requirements of users in the province. Several projects were hindered by slow delivery of airborne imagery in 1972. A comprehensive program is planned for 1973 with interest in flooding, land use, crop health, water quality, tidal flow patterns and ecological base lines.

1.6.8 Prince Edward Island (see 6.7 for details) -

Dr. A. Raad reported on the formation of a provincial committee and noted that there were no current programs of remote sensing in P.E.I. He expressed concern about the costs of remote sensing, especially for new programs which had not received federal support in earlier phases. Recommendations included: greater involvement by CCRS in interpretation and development of practical applications, improved training programs and regional interpretation centres.

Subsequent discussion brought suggestions that federal-provincial cost sharing programs should involve remote sensing where feasible and that CCRS was prepared to assist with training.

1.6.9 Newfoundland (see 6.5 for details) -

Dr. A.A. Bruneau reported that a provincial committee was being planned to coordinate the projects of some 30 persons currently involved with remote sensing in the province. No ERTS images had been received. He recommended greater emphasis on remote sensing of the ocean and especially of its ice cover, a normal state for much of the year. A request was made for CCRS/NAPL to produce negative transparencies as standard products.

1.7 Reports of Specialy Centres
(Feb. 21, p.m.)
Chairman: Dr. L.W. Morley

1.7.1 Canada Centre for Inland Waters D.O.E. (see 7.1 for details) -

Dr. K. Thomson noted that much of the CCIW work was described in the report of the W.G. on Limnology (see 5.11). CCIW has an ERTS program involving 2 staff members. Six contracts were let for interpretation of ERTS images. CCIW is involved in the ERTS data collection system and also has a Skylab project. Some sensor development is supported including research with underwater lidar.

1.7.2 Forest Management Institute D.O.E. (see 7.2 for details) -

Dr. L. Sayn-Wittgenstein reviewed the involvement of FMI in remote sensing and noted that he would discuss ERTS in particular during his lecture. He referred to the published "FMI Program Review, 1969-72" and outlined experiments utilizing thermal imagery, SLAR, image enhancement, radar altimeters and aerial photographs of both large and small scale. An assessment of damage resulting from smelter fumes was completed. An interpretive key for forest damage was published.

1.7.3 Remote Sensing and Instrumentation Section, Glaciology Division, D.O.E. (see 7.3 for details) -

Dr. J. Kruus reported that the section was testing a laser fluorosensor for detecting oil films, weed beds, ice and chlorophyll. False parallax studies were completed with CIR photography to measure velocity of movement of ice, foam and debris in rivers. Four contracts were let for hydrologic interpretation of ERTS imagery. The section coordinated the Canadian involvement in the ERTS data collection system. Colour display and enhancement equipment may be available to assist interpretation by other investigators.

1.8 Reports of Working Groups (cont'd.) (Feb. 21, p.m.) -
Chairman: Dr. L.W. Morley

1.8.1 Working Group on Geography (see 5.7 for details) -

Dr. D. Steiner reviewed geographical aspects of remote sensing and described a number of relevant activities which were organized in three categories: national inventory, regional analysis and urban studies. He suggested that regional depositories for ERTS data should be established, that interpretation should be assisted by the preparation of manuals, keys and other aids and that there should be closer liaison between working groups. He was particularly concerned about the scarcity of funds to support the development of practical applications.

Subsequent discussion affirmed that support for development of applications (except methodology) must be obtained from sources other than CCRS. The lack of "seed money" for innovations in the development of applications appears to be a major weakness in the national program.

1.9 General Overview of CCRS Activities (cont'd.) (Feb. 21, p.m.) -
Chairman: Dr. L.W. Morley

1.9.1 Applications Division (see 4.4 for details) -

Mr. J. MacDowall reported on progress in staffing the division and on the acquisition of equipment. He noted that an investigator had been seconded to CCRS by FMI and that there were similar opportunities for secondment from other agencies and from industry. The division is concerned with the development of new techniques for image analysis and of new sensors for quantitative measurements. In the coming year, major emphasis will be placed on defining cornerstone projects which will serve to illustrate practical benefits from remote sensing.

Subsequent discussion centred on the means of selecting cornerstone projects. The consensus of the meeting was that such projects should be related to the main thrusts of federal and provincial departments and that, therefore, the planning groups of these departments should be involved at an early stage. Cost sharing would be worked out for each project. CCRS will provide data and make their facilities as widely available as is feasible.

1.10 Invited Lectures (Feb. 21, evening) -

1.10.1 Dr. L. Sayn-Wittgenstein (FMI), Chairman of the Working Group on Forestry, Wildlife and Wildlands, described his methods for interpreting ERTS images and reviewed the results of his work in support of forest investigations.

1.10.2 Dr. A.F. Gregory (consultant), Chairman of the Working Group on Geoscience, reviewed the results of his interpretation of geological formations and structures. A light cover of snow and a low sun angle serve to enhance the textural and structural features.

1.11 Study Groups (Feb. 22, a.m.) -
Chairman: Dr. L.W. Morley

Five study groups were organized to consider and formulate recommendations that would be included in the annual report of CACRS. The following groups met at various times during the morning:

1. discipline-oriented working groups:
   Dr. W.M. English, chairman;

2. provincial representatives:
   Mr. V. Zsilinszky, chairman;

3. airborne program:
   Mr. R. Baker, chairman;

4. ERTS program:
   Dr. M. Strome, chairman;

5. Cornerstone projects:
   Mr. J. MacDowall, chairman.

1.12 Recommendations and Discussion
(Feb. 22, p.m.) -
Chairman: Dr. L.W. Morley

The study groups reported to the plenary session. Several recommendations and a resolution were formulated and approved by members of CACRS. After considerable discussion, the secretary was requested by the membership to compile and consolidate the numerous recommendations that had not been assessed and to circulate these by mail for consideration by them. Recommendations receiving a majority of support were to be included in the CACRS report.

1.13 Adjournment -

The meeting adjourned at 3:40 p.m., February 22/73.

Alen F. Gregory,
Secretary.

2. RESOLUTION

From Provincial Representatives to CACRS

The Canada Centre for Remote Sensing and associated facilities are commended for their positive accomplishments, for their assistance to the provincial programs of remote sensing and for their contribution to the management of resources and environment.

3. RECOMMENDATIONS

3.1 Operation of the National* Program of Remote Sensing

3.1.1 Data Distribution

3.1.1.1 Fast turn-around between acquisition of data by the sensor and receipt of the product for interpretation by the user should be recognized as an essential aspect of the timely use of remote sensing. High priority should be assigned to the processing and distribution of data for which timeliness is important. Delivery schedules must be met for those data which have been assigned a timeliness priority.

3.1.1.2 The establishment of regional libraries or depositories should be encouraged. These should be co-ordinated with regional and provincial centres to catalogue--and possibly provide--remotely sensed data pertinent to the region.

3.1.1.3 Immediate steps should be taken to improve the current sales and information system and to plan for a future system.

3.1.2 Data Reproduction

3.1.2.1 Imagery from both ERTS and airborne surveys should be assigned equal priority for processing and reproduction.

3.1.2.2 The priority schedule proposed by the Working Group on Photo Reproduction and Marketing, including turn-around times of 3, 5, 10 and 21 days, should be accepted and supported by the necessary staff and funding. Users should be involved in relevant priority decisions and changes in schedule should be well publicized.

3.1.2.3 Research should be undertaken to improve image quality by ensuring adequate control of exposure and uniform processing of film and by establishing standards for quality control. The R & D resources of NAPL-RC/CCRS should be sufficient to upgrade current photographic products and introduce new products in response to market demands.

3.1.2.4 Plans should be made to handle an imminent increase in demand for remotely-sensed products. The B.C. report, for example, suggests that users in that province will double their requirements in 1973-74.

3.1.3 Airborne Sensing

3.1.3.1 Priorities for airborne operations should be defined by the regional or provincial working groups well in advance of proposed flights.

3.1.3.2 The airborne program should be particularly responsive to seasonal priorities such as those related to the growing season. Special consideration should be given to problems of attaining simultaneous field surveys on the ground in remote areas.

3.1.3.3 Project priorities should be periodically reviewed in light of seasonal aspects, on-site capabilities and personnel, and availability of aircraft and sensors.

3.1.3.4 Improved lines of communication should be established during the planning of airborne projects so that close liaison is maintained during the scheduling of the aircraft, operation of sensors and recording of field data. Such scheduling might be done on a quarterly basis requiring prior submission of requests except for special and urgent requests.

3.1.3.5 A mission managing team should be established to make timely contacts and decisions with respect to airborne surveys. This team should develop principles governing the acquisition of data considering both the needs of users and the operational requirements.

3.1.3.6 Discipline-orineted working groups should not screen requests for airborne sensing but should provide, on request, guidelines re priorities as well as technical advice.

3.1.3.7 An in-camera annotation system should be developed to place as much information as possible about the flight on the photographic data base.

3.1.3.8 Calibration, preflight checking of sensors and control of forward overlap should be improve.

*The National Program of Remote Sensing is the integration of provincial, academic, industrial and federal programs as reviewed by the Canadian Advisory Committee on Remote Sensing. The National Program should not be equated solely to the program of the federal government.

3.1.3.9 The capability for conducting airborne sensing should be improved by acquiring long-range aircraft that make feasibile the survey of remote coastal waters and the Arctic archipelago. Such regions are now not accessible using CCRS/CFASU aircraft.

3.1.3.10 Users should be encouraged to provide whenever feasible, one observer in the aircraft for all flights in their areas.

3.1.3.11 In view of the recurring availability of aircraft in the vicinity of urban areas, the need to acquire high altitude photography (CIR) on an opportunity basis should be assessed as an aid to investigations of urban growth.

3.1.4 ERTS

3.1.4.1 Despite the experimental nature and indefinite future of ERTS, staffing and support should be sufficient to enable the assessment of the temporal aspects of remote sensing from satellites. It is essential that the turn-around time for ERTS data be markedly decreased to the planned maximum of 10 calendar days after acquisition. Otherwise, a substantial proportion of the Canadian ERTS experiments will be in jeopardy.

3.1.4.2 Negatives of all MSS bands should be made available as standard products.

3.1.5 User Liaison

3.1.5.1 More effective liaison between the users and the various operational units of the national program (e.g. NAPL, CFASU, CCRS, Provincial Centres etc.) should be established. Some of the ways in which this might be achieved include:

- regional assignments for federal staff to provide personal contact with regional co-ordinators and possibly to work part time in the region;
- prompt feedback in case of delayed or unfilled orders;
- appointment of discipline-oriented contacts;

3.1.5.1 Con't

- regular regional meetings of users at which current investigators would be expected to report on their work. These might be the source of papers for a national symposium (see 3.3.2);
- a series of interim and final reports to be prepared by the principal investigators for limited circulation as warranted, but publication in scientific and technical journals should be encouraged also;
- clear and prompt statements of system capabilities and problems.

3.1.5.2 A means of improving interdisciplinary liaison should be sought. Working Groups on CACRS might exchange information between themselves and also with regional co-ordinators. Exchange of representatives should be supported where meetings involve overlapping concerns. Reports of the Working Groups might be summarized in the CCRS Newsletter (see 1.5.3).

3.1.5.3 The CCRS Newsletter should be published on a more regular basis (see 3.3.1) and might include highlights of remote sensing activities, notices of relevant meetings, possibly reviews of significant books, information about new projects such as ERTS-B, Skylab, EOS, changes in planning and summaries of reports (see 1.5.1 and 1.5.2).

3.1.5.4 Users should be encouraged to report to CCRS all problems in format, annotation, coverage, quality and delivery of images.

3.1.5.5 CCRS, with the assistance of CACRS, should produce an annual inventory and periodic forecasts of remote sensing projects in Canada.

3.1.5.6 A committee should be established to consider prior access and exclusive rights in data for various users and types of data. The committee should make recommendations for future policy, as soon as possible. As a temporary measure, investigators who pay for their data should be permitted to negotiate with CCRS for exclusive rights for a period not exceeding three months after receipt of data.

3.1.6 Cornerstone Projects

Identification of cornerstone projects should continue with the objective of recognizing and where necessary supporting, the most promising short and long term projects.

3.1.7 Interpretation

CCRS should play a more active role in interpretation and relevant research, and in assisting the regional centres with ongoing programs of interpretation at the same time avoiding unnecessary duplication of effort.

3.1.8 Make-or-Buy Policy

In supporting the federal government's "Make-or-Buy" principle, at least as much effort should be devoted to fostering the effective purchase of remote sensing services as is presently devoted to controlling in-house "Make" activities.

3.2 Policy Relating to Intergovernmental Arrangements

3.2.1 International

3.2.1.1 Canada should review policies relevant to remote sensing of Canadian territory from space platforms launched by other states.

3.2.1.2 Provincial and federal policies governing the foreign sponsorship of remote sensing programs in Canada should be reviewed, especially with respect to the need to report to relevant authorities and to the need to involve Canadians.

3.2.1.3 Data retransmission experiments should be co-ordinated with relevant international programs.

3.2.2 United States of America

3.2.2.1 Negotiations should be initiated now to prepare US/Canada agreements covering observation satellites that may be launched after the present ERTS/Skylab agreement terminates in 1975.

3.2.3 Provinces

3.2.3.1 The federal government should encourage and support the development of regional interpretation centres by:

- developing federal-provincial cost-sharing arrangements;
- providing capital assistance for the purchase of basic equipment by regional centres;
- providing regional contacts in CCRS (see 1.5.1);
- facilitating the secondment of staff from CCRS and line departments to regional centres and vice-versa.

3.2.3.2 Cost-sharing arrangements for airborne remote sensing should be extended to the regional centres on the basis of the time at which they were established rather than on the basis of a specific calendar year. Thus recently established centres would obtain introductory low-cost data in 1974 and subsequently would continue on the cost-recovery basis.

3.2.3.3 If the Winter Works Program is warranted next year, remote sensing projects should be supported by such funding.

3.3 Policy Relating to Applications

3.3.1 Development of Applications

3.3.1.1 Regionally representative, multi-disciplinary test sites should be established and given priority for intensive studies utilizing field investigations by responsible agencies and remote sensing from both ERTS and the airborne program. Where feasible, these applications studies should be tied in to projects with current socio-economic priorities (e.g. St. John River Basin, Sudbury area, Churchill-Nelson drainage basin, urban development, etc.).

3.3.1.2 Spectral characteristics of selected surficial materials should be defined to assist both interpretation and sensor development. Particular attention should be directed to fresh and salt water, rocks and soils and vegetation.

3.3.1.3 A study should be undertaken to relate the capabilities of current and foreseeable sensing systems to the current requirements of users for data about resources and the environment (see 4.2.1 and 4.4.1).

3.3.1.4 Greater effort should be made to involve resource and environmental managers in developing practical applications of remote sensing from both aircraft and satellites. Applications that are related to land use (in the broadest sense) appear to have high potential for imminent benefits.

3.3.2 Interpretive Methodology

3.3.2.1 Pilot studies utilizing semi-automatic and automatic techniques of data extraction should focus on areas where imminent success appears likely, e.g. measurement of areas (lakes, fields, etc.), delineation of boundaries and easily identified materials (water, snow, etc.). The usefulness of the selected image parameters should be evaluated by operational agencies using calibration data from test sites.

3.3.2.2 Similar, though more experimental, studies of automated data extraction should be undertaken in other areas where potential benefits appear great, e.g. identification of crops and soils; (semi-) quantitative assessment of density and quality of urban buildings.

3.3.3 Information and Training

3.3.3.1 A comprehensive program for providing information and training at three levels - specialists, planners and managers, and the public - should be initiated as soon as possible in order to broaden Canadian capabilities to utilize remote sensing. Such a program should be co-ordinated with provincial agencies and should support:

- co-operative training programs and workshops directed to specific user problems (e.g. urban planning, mineral exploration, forest management, etc.) and utilizing regional experts and facilities whenever feasible.

3.3.3.1 Con't

- a credible public relations effort including publication of examples of practical applications of remote sensing.

3.3.3.2 A Canadian symposium on remote sensing should be organized, possibly alternating with the Michigan symposium.

3.4 Policy Relating to Technology

3.4.1 Development of Sensors and Ancillary Equipment

3.4.1.1 A strong program of sensor development should be established (with a minimum budget of about $250,000 per annum) in order to:

(a) advance selected Canadian sensors into the pilot operational phase which is necessary to define practical applications;

(b) develop sensors to meet specific requirements established by Canadian users;

(c) maintain Canadian competence in state-of-the-art technology.

3.4.1.2 Sensor development should focus on a multi-spectral scanner suitable for both airborne and space use and on all-weather sensing systems. High priority should be given to sensors for the measurement of groundwater, soil moisture, terrain heights (to meet photogrammetric standards) and water equivalence of snow cover.

3.4.1.3 In developing ancillary equipment, high priority should be given to a system for in-flight annotation and correlation of data. Immediate needs are for in-camera annotation but the ultimate requirement may be for a complete and integrated system for annotating film, magnetic tapes and video tapes.

3.4.1.4 Summaries of new sensing systems and their capabilities should be widely circulated among the user groups.

3.4.2 Development of Platforms and Ancillary Equipment

3.4.2.1 Further study is required to define specific Canadian requirements for a variety of platforms to facilitate remote sensing operations including, among others, stationary platforms (e.g. balloons) for repetitive sensing of prime local sites, long-range patrol aircraft for operations in the Arctic, over coastal waters and the oceans and satellites for repetitive orbital sensing of temporal changes in the regional environment (see 4.4.1 in the latter case).

3.4.2 Development of Data Retransmission System

3.4.3.1 The need for further development of a system for relaying data from remote ground platforms via satellite to a data acquisition centre should be studied with emphasis on meteorology and hydrology where the needs for real-time data have been most clearly identified. Such a study should be closely co-ordinated with the Department of Communications and responsible user agencies.

3.4.3.2 High priority should be given to the development of reliable sensors and compact, long-lived power supplies for data collection platforms in remote locations. Such development should co-ordinate the needs of interested user agencies.

3.4.3.3 Canadian involvement in data retransmission should be more closely co-ordinated to optimize benefits and bring users together with technologists.

3.4.4 Systems Study for Canadian Remote Sensing Satellite

In view of the long lead time (about ten years) required to design and develop a satellite system, preliminary studies should be initiated now with the aim of defining specific Canadian requirements for sensors, data retransmission, satellites and attitude control systems. Such studies, estimated to cost about $40,000 by the Working Group on Data

3.4.4 Con't

Handling and Satellite Technology should be completed without jeopardizing the current CCRS program.

4. REPORT OF ACTIVITIES

CANADA CENTRE FOR REMOTE SENSING AND NATIONAL AIR PHOTO LIBRARY

4.1 Historical Highlights

4.2 Report of Airborne Program

4.3 Report on the ERTS Receiving, Data Handling and Photo Reproduction System

4.4 Report of the Applications Division

4.5 Report of the National Air Photo Library (NAPL)

4.6 Report of the NAPL-Reproduction Centre

4.1 HISTORICAL HIGHLIGHTS

CANADA CENTRE FOR REMOTE SENSING

1967

May 27: Meeting of representatives from E.M.R., N.R.C., Forestry and R.P., D.R.B., Agriculture, to discuss Canadian Participation in the EROS Project. The following "tentative" costs were estimated:

Feasibility Study	$ 20,000
Modification to Prince Albert Facility	250,000
Operating Costs - $100,000/year	300,000
Tape Recorder and Tapes	75,000
Lease Scanner for printing pictures	90,000
Extra staff to print and distribute photos	30,000
Cost over 3 years	$765,000

1968

May 23: Meeting of Interdepartmental Committee on Remote Sensing of Earth Resources from Aircraft and Satellites covered by Dr. L.W. Morley to discuss advantages of joint programs in remote sensing. 16 representatives from 8 government agencies attended.

May-July: Preparation of first draft of background paper "Satellite Observation of Canadian Resources".

Sept: Report on U.S. earth resources satellite programs by Dr. A.F. Gregory (consultant) following intensive reviews and discussions in Washington.

Nov. 20: Meeting of Interdepartmental Committee on Remote Sensing chaired by Dr. L.W. Morley to initiate planning for a Canadian program of remote sensing.

1969

Feb. 26: Completion of final draft of background paper for memorandum to Cabinet.

1969 Con't

June 20: Liaison meeting to hear and discuss briefs from representatives of government, industry and universities concerned with organizing a Canadian program of remote sensing. 14 briefs were received, comprising 6 from federal government agencies, 7 from industries and consultants and 1 from a university.

July 22: Cabinet Committee on Scientific and Industrial Research recommended that EMR should be the responsible agency for co-ordination and funding of "Resource Satellites - Canadian Research Program" and should establish an ad hoc Interdepartmental Commitee to steer the program. The Program Planning Office was officially established with Dr. L.W. Morley as Director.

Oct. 8: First meeting of "Interdepartmental Committee on Resource Satellites and Remote Airborne Sensing", chaired by ADM, Science and Technology, EMR.

Oct. 28: Second meeting of the Interdepartmental Committee, at which it endorsed a program of participation with the U.S.A. in the NASA Earth Resources Technology Satellite (ERTS) Program.

Nov. 24: Memorandum to Cabinet from EMR re: "Proposed Projects for Resource Satellites and Remote Airborne Sensing for 1970-71", requesting that the Cabinet Committee on Science and Technology consider four urgent projects: (1) hyper-attitude aircraft experimental earth sensor operation, (2) R and D on remote sensors, (3) study of incidence of cloud-free areas, (4) study of data reproduction system for resource satellite data. Total funding: $550,000.

Nov. 28: Cabinet Committee on Science Policy and Technology agreed that $550,000 funding to be made available, as per memorandum on November 24, 1969.

Dec. 11: Cabinet confirmed decision of November 28, 1969.

1969 Con't

Dec. 24: Third meeting of Interdepartmental Committee approved appointments of Chairmen of seven ad hoc working groups in (1) Forestry, (2) Hydrology, Oceanography, Limnology, Fisheries and Meteorology, (3) Data Reproduction and Distribution, (4) International Co-operation, (5) Sensor and Data Systems, (6) Remote Airborne Sensing, and (7) Geology.

1970

Feb. 14: First Montebello meeting to form the Working Groups of the Program Planning Office.

March 5: Fourth meeting of Interdepartmental Committee set (1) the functions of a Program Planning Office (PPO) to serve as its secretariat, (2) terms of reference for user groups, and (3) the membership of 14 working groups (extending the 7 groups of the December 24, 1969 meeting). These working groups are sub-committees of what is now called the Canada Advisory Committee on Remote Sensing (CACRS), as described under ORGANIZATION, COMMITTEE STRUCTURES.

April 3: Fifth meeting of Interdepartmental Committee considered the next submission to Cabinet (April 18, below).

April 18: Memorandum to Cabinet from EMR re: "Resource Satellites and Remote Sensing: Collaborative Program with the United States", proposing a 3-year experimental program of remote sensing from aircraft and satellites, related to the ERTS (A) satellite to be launched on March 22, 1972. A proposed Memorandum of Agreement between EMR and NASA was appended to the Memorandum. The proposed program included (a) ground receiving station at Churchill, Manitoba, (b) continuation of experimental airborne remote sensing program, (c) continuation of sensor development, (d) facilities in Ottawa for computer-correcting, reproduction and distribution of data, (e) partial financing of

1970 Con't

April 18 (Con't): regional interpretation centres. A three-year forecast of expenditures was included.

May 1: Cabinet Committee on Science Policy and Technology gave approval for EMR to negotiate a Memorandum of Understanding between EMR and NASA, as requested in the April 18 Memorandum.

May 7: Cabinet confirmed the May 1 decision.

May 20: External Affairs transmitted tex of proposed Memorandum of Understanding to State Department (U.S.), and informally to NASA

1971

Jan. 16-20: Second Montebello meeting to review reports of the Working Groups.

Feb. 1: Beginning of "Systems Integration Contract" with Computing Devices of Canada to produce a data processing facility to process the data from the ERTS-1 Satellite.

Feb. 1: Treasury Board Memorandum re: "Change in Organization", authorizing the establishment of the Remote Sensing Centre as a new organizational element of EMR, as proposed in the paper "Organization for a Program in Remote Sensing of the Surface Environment", by Dr. L.W. Morley, October 16, 1970. (The Centre was subsequently re-named Canada Centre for Remote Sensing, with Dr. Morley appointed as its founding Director).

March 31: Submission of Working Group Reports. (2) Agriculture and Geography. (3) Atmospheric Constituents. (4) Cartography and Photogrammetry. (5) Forestry and Wildlife. (6) Geology. (7) Ice Reconnaissance and Glaciology. (8) Water Resources. (9) Satellite and Ground Station Engineering. (10) Sensors.

April 1: Canada Centre for Remote Sensing officially established.

1971 Con't

April 21: Memorandum to Cabinet from EMR re: "Earth Resources Survey (ERS) Agreement" reviewing international policy aspects of the proposed agreement with the U.S. (April 18, 1970). Included were drafts of a proposed exchange of diplomatic notes, with annexed arrangements between EMR and NASA.

May 14: Letter from Deputy Minister, DND, to Deputy Minister, EMR, constituting an agreement in principle fro DND to provide flying support for the Earth Resources Survey program, with the proviso that the cost of this support must be recovered by DND.

May 14: Agreement with NASA signed.

June 23: Memorandum to Cabinet from EMR re: "A Program for Remote Sensing of Earth Resources and the Surface Environment", seeking approval for (a) an increase of capacity for the Air Photo Production Unit (APPU) and the National Air Photo Library (NAPL) of the Surveys and Mapping Branch of EMR, to handle the additional load of the Remote Sensing Centre, (b) an airborne remote sensing program, (c) conceptual studies of an internationally shared resource satellite system and other remote sensing systems. The memorandum recommended a supplementary budget to cover item (a) and a "B" Budget for FY 1972-73 to cover the other items as "an integrated remote sensing program" to be undertaken in 1972-73. It also recommended the replacement of the ad hoc Interdepartmental Committee by a senior Inter Agency Committee to be chaired by the ADM, Science and Technology, EMR. It also contained forecasts of expenditures for three alternative optional programs.

July 1: CFASU formed and became operational.

July 28: Record of Cabinet Decision, approving (a) the supplementary budget to increase the capacity of the APPU/NAPL; (b) the FY 1972-73 "B" Budget for the integrated remote sensing program (including

1971 Con't

July 28: (Con't) an expansion of the airborne sensing part of the program); (c) the new Inter Agency Committee on Remote Sensing (IACRS); and suggesting (d) shifting the temporary Prince Albert Receiving Station (PASS) from Prince Albert to Churchill.

Nov. 30: Purchase of Falcon Fanjet Aircraft.

1972

Jan. 4: Meeting of the Inter Agency Committee on Remote Sensing (IACRS) at which terms of reference for the Canada Advisory Committee on Remote Sensing (CACRS) were approved, and at which the first partial "cost recovery" or "shared funding" formula was approved (whereby CCRS may charge Federal government user agencies for airborne remote sensing).

Jan. 17: Submission of an "A" Budget for FY 1973-74, establishing the CCRS "A" Budget activity level at about $6.5 million, and 104 man years, a minimal datum for on-going activities.

March: "A" level budget of $5,431,000 and 60 man years approved by Treasury Board.

May 1-22: Tests of the HISS Radar in the Arctic.

July 6: Treasury Board Memorandum entitled: "The Canada Centre for Remote Sensing" submitted providing III options.

Option I: $6.916 million and 104 man years, the amount recommended by Cabinet in June, 1971 and requested by DEMR as its "A" level budget which includes $450,000 in grants for regional centres, and 3 man years and $35,000 to provide personnel to supervise the operation of PASS.

Option II: $5.431 million and 60 man years, the amount suggested by Treasury Board Staff. As mentioned previously, this option is considered non-workable in terms of the

1972 Con't

July 6 (Con't): Option II con't

limit of 60 man years and will, therefore, not be considered further.

Option III: $5.431 million and 84 man years. This option, though workable, does not include grants for regional centres, is technology frozen and does not attain the objectives outlined in the Cabinet Memorandum of June, 1971.

July 23: ERTS Satellite launched.

July 26: First imagery of Canada received

July 27: First ERTS image presented to Hon. Robert Stanbury, Ministry of Communications, at the International Society of Photogrammetry Conference held in Ottawa.

Aug. 24: Submission considered and approved on the following basis:

1. The program should concentrate on the collection and dissemination of remotely-sensed data to public and private sector users.

2. A strong effort should be made to develop performance indicators as the basis for an evaluation of the program prior to any consideration being given to continue the the program beyond its current level of activities and, in particular, prior to the termination of the ERTS experiment in 1975-76.

3. The 1973-74 budgetary level to be $5.943M (84 man years) and serve as the "A" Budget bases for the 1974-75 Program Forecast.

4. An amount of $338,000 and 12 man years to be included in Supplementary Estimates, 1972-73, subject to confirmation by Cabinet through the monthly expenditure process.

5. An accelerated, limited cost recovery plan be implemented, as per the submission.

6. Co-ordination of remote sensing activities among Federal govern-

Aug. 24 (Con't): 6. Con't

ment departments is required, particularly vis-a-vis, the civilian aspects of DND's Long-Range Patrol Aircraft Program and the Inter-Agency Committee on Remote Sensing is the appropriate vehicle for this purpose.

7. A review to be undertaken by the Treasury Board Secretariat with respect to the organizational location of CCRS.

It is recognized that the Board's decision on the 1973-74 budget will necessitate hard choices and priorities for CCRS, particularly with respect to the development of remote sensing applications and development of sensor technology. In this connection, the Board noted that sensor development is being carried out by other Federal government departments and considered that users should play a greater role in the development of remote sensing applications suited to their particular missions.

1973

Jan. 29: "Preliminary Assessment of the Remote Sensing Program" by the Program and Evaluation Office, E.M.R.

"Summary of Program Priorities"

"Priorities within the current phase of the Remote Sensing Program should be:

1. Develop applications or uses of the Remote Sensing data and markets for their uses. This can be done on the basis of projects to define individual application/market; or as a package of applications for a single market.

2. Estimate potential benefits at each phase of the program; the first of these estimates is required by March, 1974.

1973 Con't

Jan. 29: (Con't)

3. Maintain satellite and airborne data to support the studies required, and to familiarize users with the data obtainable.

4. Develop sensors and platform, primarily for airborne sensing, related to acquisition of data for uses having potential benefits in new and existing programs.

5. Investigate long-term alternative system configurations."

Feb. 19-22: Second CACRS (fourth "Montebello") meeting at Montebello, Quebec.

4.2 REPORT OF THE AIRBORNE PROGRAM

4.2.1 Introduction

The CCRS airborne program is developed around the Data Acquisition Division - in fact the word acquisition applies here to airborne data since CCRS' only other field data, the ERTS data, is acquired directly by the Data Processing Division. Certain ground truth data could be the responsibility of the Data Acquisition Division.

The elements of the airborne program are:

(1) Aircraft and flying services provided under contract by the DND through CFASU, commanded by Major E.W. Gardiner.

(2) Engineering, installations and aircraft modification provided by the Airborne Systems Section of DAD. This is a combination of in-house and contracted work with considerable assistance from CFASU.

(3) Sensor Development and calibration partly by the Sensor Section under Dr. de Villiers and through contracts with industry and universities for special sensor development.

(4) The Airborne Operations Section headed by Mr. McLaren, which ties together the user requirements, the tasking of CFASU and the scheduling of all aircraft flights, modifications and installations.

Beginning with the 73-74 year we will be attempting a more organized division of the so-called "production" remote sensing using photographic and scanner techniques from the experimental remote sensing with active lasers, microwave systems and other new devices.

The Falcon aircraft, the CF-100 and one C-47 will be used chiefly for production work and the remaining C-47 for experimental work. Both C-47's are being similarly equipped with sensor bays and windows as well as standard equipment racks so that one can back up the other. Experimental projects can be initiated internally by CCRS or by users with a project requiring an experimental setup.

4.2.2 Review of 1972-73 Program

Introduction

The CCRS Airborne Program has been in operation for three years and all members of this group are probably aware of the past and present capabilities of the program with respect to equipment, materials and procedures. This briefing will, therefore, consist of a rapid statistical review of flying operations during the 1972 season. Each failure or deficiency noted will be discussed and a solution to the problem will be proposed. In this way the concept of the 1973 program will be revealed.

AIRBORNE OPERATIONS SUMMARY

Period: 1 January to 31 December, 1972

Aircraft Utilized: *1 Falcon
1 CF-100
*2 C-47

1. Projects Tasked: 128

2. Projects complete or Partially complete: 110

3. Projects not flown:

   18 projects cancelled due to time frame: 18

4. Non-programmed reflights: 5

   Imagery unacceptable

5. Aircraft down times:

   Equipment - 60.5 days
   Weather - 67.0 days
   Personnel - 9.5 days

6. Total Lines Miles to Date: 34,668

7. Total Transit Miles to Date: 71,900

8. Line Miles by Agency:

Environment	4,104
DND	389
Trans. and Comm. (Ontario)	2,802
Universities	4,565
MOT	84
AES	40
CCRS	84
CCIW	3,799
CFASU	707
FMI	7,530

8. Con't

National Resources (Ontario)	15
Bedford Institute	965
CDA	2,391
MRSC (Manitoba)	4,799
Environment (Alberta)	150
Highways	95
Ontario Water Resources Comm.	1,200
CWS	555
Agriculture	144
INRS (Quebec)	250

SUMMARY

1. 85% of tasks received were completed or partially completed.
2. 15% of tasks were cancelled due to time frame.
3. A total of 137 flying days were lost due to aircraft/sensor unserviceability, unsuitable weather, and unavailability of personnel.

*4. Falcon available from mid-April only.
C-47 931 available from August only.
C-47 942 available to mid-October only.

5. As a result of cancellations and only partial coverage on some projects, 57.5% of the original tasked-line mileage was flown.

The above statistics shown that the program encountered problems in three major areas:

(a) Weather
(b) Equipment deficiencies
(c) Non availability of personnel

WEATHER

1972 The loss of 67 project flying days due to weather should need little explanation to Canadian residents. Atmospheric Environment Services records reveal that across Canada, periods of zero to two-tenths cloud cover were from 10% to 30% less frequent than normal.

1973 There is little we can do about weather other than to urge requestors to provide maximum flexibility in their requests in altitude, time period, etc. In addition we have divided Canada into three operations areas and through grouping of projects and careful scheduling, ensure that deployment bases are located in such a way that crews have a wide choice of project areas within one or two hours transit time.

EQUIPMENT DEFICIENCIES

Sensors

1. Vinten Cameras -- 1972 operations were conducted with 12 cameras held on loan from DND. These cameras had been subject to approximately 10 times the use normally expected between overhaul. Lack of servicing personnel and time prevented proper servicing and this resulted in both inferior quality and lost imagery.

   For 1973 we have obtained 20 overhauled Vinten cameras on a long-term loan basis and have modified them to exacting standards. Changes included:

   a) Purchase and fitment of vacuum backed magazines. This will increase spatial resolution.

   b) Selection and focussing of four sets of four lenses to the ERTS bands. i.e. each lens in each set is focussed for a specific band; images from each camera in a set will register exactly with any other camera image in that set.

   c) Purchase of permanent coated glass filters to match the ERTS bands.

   d) Purchase of four matched six inch lens cones c/w ERTS band filters.

2. RC10 Cameras -- Few problems were encountered. Several flights were cancelled due to the failure of a switch in the vacuum system. Some delays and inferior imagery resulted from the late delivery of a 540 3.3 anti vignetting filter for the second camera.

   The faulty switch system is now stocked as a standard servicing item and two technicians have attended a three-week servicing course at Wild in Hurbrugg, Switzerland. A 4.4 AV filter will be used on an experimental basis to further even illumination on the super wide angle image plans; 3.3 AV clear glass filters have been obtained to permit the use of any standard gelatine filter between the lens and film. This system provides superior results to the use of glass-sandwich filter in front of the lens. A six-inch, SAG II lens has been purchased. This allows greater versatility in our RC10 package and will produce superior imagery in some instances.

Sensors Con't

3. RC8 Camera -- Lack of time and personnel prevented the use of the RC8 camera during the 1972 season.

   This camera has now been overhauled, a second magazine and a complete set of filters have been purchased. This camera, in company with the RC10 equipped with a standard cone will give us a capability of flying two six-inch cones simultaneously in one aircraft, or singly with other sensors in two different aircraft at the same time.

4. Zeiss RMK 8.5 Camera -- A serious fault in the control system resulted in the loss of some imagery from this camera. Lack of filters and a second magazine also caused some delays and inferior quality imagery.

   The system is now serviceable; a second magazine, filters and spares have been purchased.

5. Daedalus Scanner -- Although few serious problems were encountered with the actual scanner, a number of flights were lost, imagery was lost or was inferior on many sorties and a number of missions were not flown due to continued unserviceability of the Lockheed tape recorder system.

   The complete system including the scanner head, tape recorders and field printer will be overhauled prior to 1 April, 1973; the substitution of a Mincom recorder system in May or June should prevent the re-occurrence of problems. A signal processing device has been purchased and this will greatly increase the value of imagery supplied to users. A number of technicians have been trained by the manufacturer in the use of this device.

6. RS14 Scanner -- Lack of time precluded extensive training of operators and lack of experience produced some imagery of inferior quality. Several mechanical failures also necessitated the return of the scanner to Texas Instruments Limited for repair -- hence some flights were lost. The full capability of the system was not utilized due to an unserviceable tape recording system and the availability of the 8 - 14 micron head only.

   The system has undergone a complete overhaul at the factory and is now capable of recordong on film in either the NV, visual, 3 - 5 or 8 - 14 micron bands.

6. Con't

   With the installation of the Mincom recorders in May or June, two channels may be recorded simultaneously on tape and in addition, one of these channels may be recorded on film. Operators have obtained extensive experience in the use of the system and have received additional training at the factory.

Aircraft

1. Falcon -- The urgent requirement for immediate use resulted in lash-up construction of mounts for the camera and CCTV system in the aircraft. A camera drift and levelling capability was not available throughout the flying season.

   Proper mounts with drift and level control have been fabricated for the Wild RC10, Wild RC8 and the Vinten 70 mm, four camera package. The CCTV is correctly mounted and has been fitted with a wide-angle lens to provide an improved navigation and track recovery capability. Video recording of the CCTV will be incorporated prior to 1 April, 1973.

2. CF100 -- No serious problems were encountered. The lack of an IR scanner for this aircraft did make scheduling difficult. The necessity for reliance on the Falcon to do all the high level scanning caused a number of delays.

   No change is planned for the configuration or operation of the CF100 in 1973.

3. C47 (Dakota) #12942 -- This aircraft operated until 1 October with a limited package consisting of the Daedalus scanner and two 70 mm Vinten cameras. Its use was, therefore, extremely restricted.

   It has now undergone a major overhaul and is presently being modified to the same configuration as 12931. i.e. four large sensor bays and standard equipment racks. On completion in May, this aircraft will be dedicated to sensor test and experimental flights.

4. C47 (Dakota) #12931 -- Due to a delay in modification, this aircraft did not become available until 1 August, 1972. At that time it was pressed into service with sensor mounts that did not provide drift and level control. Some inferior imagery resulted but few failures resulted in lost missions.

4. Con't

Mounting systems have been re-built, the CCTV has been fitted with a wide-angle lens and a video recording system has been added and tested successfully.

PERSONNEL

There has been a shortage of trained personnel in all areas of the Airborne Program. This has resulted in inadequate scheduling and tasking, lost missions and lost or inferior quality imagery.

Personnel establishments have now been filled to limits imposed by budgetary restrictions and although this is still inadequate, training and increased efficiency should prevent many of the previous failures. The Data Acquisition Division must still rely heavily on Winter Works and Summer Students; Major Gardiner will brief you on plans for ASU operations.

GENERAL

A number of other problems have been encountered and these are detailed as follows:

1. Delivery of imagery. Due to a series of difficulties, users in 1972 were forced to wait delivery of imagery for excessively long periods. The flood of complaints from users places serious reservations on the probable success of the future airborne program unless this problem can be solved.

   Plans have been made to decrease the time between the flight and delivery of film to NAPL for processing. Some film will be wasted, overtime will be necessary and some expenses for air express delivery will be incurred. Air Operations will allot priorities reached in agreement with requestors at the time of project acceptance; NAPL have promised the following delivery schedule:

   a) If imagery is required within 3 working days of the flight, the project will be allotted a #1 priority. Original unannotated imagery will be shipped air-express collect to the user (at the discretion of CCRS) or it will be made available at 2464 Sheffield Road for perusal by the user. A #1 priority will only be allotted under very special circumstances and, as with all priorities, will be established at the time the project is accepted.

   b) Priority #2 will provide a package consisting of a roll print from each requested roll within 5 working days. Imagery will not be annotated or indexed, quality of colour printing will be inferior to that normally produced by the step and repeat system as control is limited on the roll printer.

   c) Priority #3 will indicate return of reproductions within 10 working days, annotation and indexing will be completed; a "standard package" only will be provided, i.e. one roll continuous contact print from each black and white roll and selected contact stereo pairs, beginning, middle and end from each colour roll.

   d) Minimum priority will be #4. This will provide all reproductions requested from annotated and indexed rolls within 21 working days.

2. Exposure. Exposure of the various film/filter combinations, under varying atmospheric conditions and at altitudes between 500 and 40,000 feet has been determined by the visual evaluation of sensor operators. Although much improved over 1971, a considerable amount of imagery has been lost or been inferior in quality.

   An air exposure meter has been designed and is being built. This is a new concept in photometers and should result in a vast improvement to image quality. It is hoped to have one system available for test by April; timing of fleet fitment will depend on test results.

3. Annotation. Other than the recording of limited instrumentation in the Zeiss and Wild cameras, all film must now be identified by hand annotation. Experiments have shown that the Vintens can now be fitted with a 12 digit identification system for in-flight recording. All parts are on order and at least one set of cameras should be equipped by May.

4. Equipment Servicing. During 1972, sensor were, through necessity, operated to the limits of their capability without adequate servicing and maintenance.

   A maintenance committee has been formed and has outlined a complete overhaul, maintenance and servicing procedure for all operational sensors. Suggested spares have

been obtained and will be maintained at specific levels; personnel have been designated for full-time maintenance and servicing duties.

4.2.3 The Role of CFASU

Quality vs Quantity

In order to provide the user with the best possible product, it is essential that the Canadian Forces Airborne Sensing Unit know exactly what the investigator wants and the minimum conditions acceptable in terms of weather, equipment status and sun angle.[1] The original request form contains this information, however, many factors come into play which can make strict adherence to the user's request impossible. With the advent of cost recovery policies the question of who bears the responsibility when the end product does not exactly match the original request must be answered. Prior to issuing a task request to the CFASU the staff of CCRS have been able to discuss the pros and cons of a project with the user. It is the next step in Data Acquisition, the gathering of data that affects the CFASU.

Communications and Decisions

The operational aircrews of the Canadian Forces Airborne Sensing Unit face many unpredictable problems each time a mission or deployment is carried out. Equipment failures, adverse weather conditions and high velocity winds are prime examples. It is not possible to establish operating procedures which will cover every eventuality, however, there are a number of areas where the chief investigator can assist the flight crews to minimize delay and improve results. These areas are:

1. Communication between Operational Crews and the Chief Investigator

There have been many instances during the past two years where the CFASU crew flying a project have been unable to contact the chief investigator or his representative. Once an aircraft has been deployed away from Ottawa, the communications gap widens and the only reliable method of updating user requirements is through direct contact in the field. Three situations exist:

a) Where the user is present

This is normally true for flights out of and returning to Ottawa or from main centres where airport facilities are in close proximity to the investigator's headquarters. In this instance face to face discussions on equipment and weather conditions can be carried out.

b) Where the user is contacted by telephone

This method of co-ordination is possible only when the operational crews can discuss the project with either the chief investigator or his representative.

c) Where the aircraft is airborne

Contact with the investigator in this situation is next to impossible.

In order to ensure direct contact between crews and those in the field it is desirable that a central point of contact be established for each region, i.e. Winnipeg for Manitoba, Edmonton for Alberta, etc. Once in contact the flight crews must be able to discuss weather conditions, equipment conditions, and sun angles to determine the minimum acceptable to the user. Unless otherwise directed flight crews will not attempt to fly any projects unless conditions outlined in the CCRS task form prevail. In the case where the aircraft is already airborne the aircraft commander will attempt to assess the situation and the go-no go decision will be discussed with the user after the landing.

2. Navigation and Weather

Accurate navigation is essential to the production of high quality data. New techniques and equipment are being introduced, however, the problems associated with flying a predeterminined track are many. For example:

a) High level winds which vary from 30 to 150 MPH;

b) Low level winds which vary according to terrain;

c) Inaccurate wind forecasting;

d) Inaccurate maps;

e) Few if any large geographical features.

Investigators can help minimize the navigational problems by selecting areas to be overflown which contain an identifiable geographical signature, i.e. a river, lakes, main roads or large tree patterns.

1. Users Handbook, Airborne Program, CCRS.

2. Navigation and Weather Con't

Weather conditions in the target area cannot be controlled; the presence of cloud or reduced visibility in an area is vital information to the flight crew involved. Present day forecasting methods will give the crews the broad weather picture but in many instances area weather conditions do not agree with the forecast. If ground truth parties or someone in the area could be contacted prior to take off, the actual "out the window" weather conditions could be confirmed, thus avoiding weather aborted flights. If ground truth parties are not involved in a particular project, it is suggested that the chief investigator make arrangements with local authorities, i.e. RCMP, OPP or QPP to provide this information on request.

Mission Manager Concept

In order to provide improved co-ordination and supervision on all remote sensing flights, it is planned to introduce what is known as the "Mission Manager" concept. In the past, the aircraft commander has been responsible for aircraft operation and the co-ordination and supervision of the sensor operators. If additional manpower can be made available all future remote sensing flights will include a highly trained supervisor who will monitor each operator during flight co-ordination. With the multi-sensor packages presently in use this "team" concept is considered essential to ensure data obtained is of the highest possible quality.

4.2.4 Future Capabilities

Introduction

The airborne program has expanded from a single aircraft with photographic sensors in 1970 to a four aircraft program utilizing in the main photographic sensors, line scanners and radiometers. In the coming years new generation sensors will be, and are being, added which will measure parameters of more direct use to users. No longer can each sensor produce its own output data on film, tape, charts or other recording medium unrelated and unregistered with respect to the other sensor outputs. A systems appraoch is being adopted in which, not only will as few separate recording mediums be used as possible, but all data outputs will be tagged and annotated so that the data can be automatically registered and related to all the other sensor outputs.

Future Sensors

New generation sensors will be added to enhance the airborne capability. These will include:

1. Microwave Devices - A microwave scatterometer and radiometer are being commissioned this year, and will have applications in ice type identification, in sea-state measuring, and in the investigation and detection of oil spills on water. U.S. Government laboratories would be interested in obtaining further microwave data in a co-operative program to evaluate real time automatic data reduction techniques for ice type identification.

2. Spectroscopic Devices - Several spectroscopic devices are being developed under contract. One such imaging sensor (SPAR Multispectral Camera) and one profiling sensor (York Photometer) have been flight tested and evaluated. They will be useful for making detailed spectroscopic measurements of user targets and other areas of interest. Such measurements are often the precursors to more extensive measurements with multispectral scanners.

3. Multispectral Scanner - It is planned to acquire a multispectral scanner in the not too distant future. This should enable users to identify and quantify parameters of significance in agriculture, forestry, oceanography, hydrology, etc. The scanner will also be able to acquire data in the ERTS bands to provide an ERTS underflight capability.

4. Laser Devices - An active "laser fluorosensor" developed under a sensor development contract will be test flown shortly. The device has application to detection and classification of oil spills, to coastal bathymetry measurements and will be of use in performing other active airborne spectroscopic measurements.

5. Low Light Level T.V. (L^3TV) - Flight line navigation at night is extremely difficult even when the moon is full. A low light level T.V. camera is being acquired which will be used, in part, for night time navigation and track recovery. It will be equipped with filters so that it can be used as a night time sensor such as a filtered photographic sensor is used during the day.

To support these new generation sensors (as well as the existing ones) appropriate calibration and test facilities are being established to improve the quality of acquired data.

Further sensors being developed under contract or by other agencies will be test flown, evaluated and made available operationally as appropriate. One such sensor, DOE's laser fluorometer, has been flown and is already showing promising results in detecting oil on water at night.

The area of accurate flight line navigation and track recovery will receive continuing effort. Closed circuit TV systems are presently used for this purpose during the day with much success. The low light level TV camera will add a similar night time capability. For those projects being undertaken which require very accurate monitoring and recording of aircraft attitude, position and track, a high grade inertial navigation system has been acquired which will be fully interfaced to the ADAS described in the next section.

Data Gathering and Annotation Systems

The Airborne Data Acquisition System (ADAS) under development is an initial attempt to institute a data gathering and annotation system capable of centralizing the information gathered from a multitude of sensors.

The ADAS system consists of a minicomputer, interface units, keyboard, display and tape systems. Developed software will be available to perform tasks such as:

1. Collecting data from sensors, time code generators, "on top" indicators, navigation systems, etc.

2. Formatting the data and subsequently recording it on tape.

3. Monitoring and recording of sensor performance.

4. Annotating film with required parameters.

The ADAS system will be installed in A/C 942 and after an initial integration period will be used for special programs using integrated sensor systems. A Wide-band multi-track tape recorder is employed by the ADAS system as the storage media. Both analogue and digital data can be recordered on the tape in time synchronism. Pre-programmed operator information can be provided by the ADAS system, and the keyboard allows the operator to provide annotation on the tape system of aircraft housekeeping parameters.

The ADAS system is being developed as a versatile data collection system by modular techniques in both hardware and software.

"Quick Look" Facility

With the introduction of an airborne data acquisition system, a complimentary "Quick Look" facility is required on the ground for the following reasons:

1. On a daily basis examination of a sample of imagery is required to evaluate quality of data and ensure no degradation in sensor performance has occurred.

2. Malfunctioning or intermittent sensor operation will be quickly evident on this facility.

3. If the Quick Look system is compatible with the airborne system, components of the airborne system can be tested by substitution in the ground facility and repaired or adjusted.

The computer system for this facility has been ordered and system definition has commenced.

Special Projects

Aircraft 942 is being configured as an experimental test platform. The ADAS will be installed in it so that it will be possible to operate the aircraft with integrated sensor systems:

1. To evaluate and optimize sensing techniques to be used in operational aircraft.

2. To test and evaluate new sensors, data recording systems and in flight data processing.

3. To conduct special projects to develop new techniques requiring a fully integrated aircraft sensor system.

A typical special project of the type in 3 above is the Aerial Hydrography

proposed by the Marine Sciences Directorate of DOE.

An important and time consuming part of every hydrographic survey is the surveying of the intertidal and shallow water subtidal zones along the coasts. In these areas the sounding launch must operate at slow speeds and manoeuvre around drying and subsurface rocks and shoals. Heights of the above surface rocks and depths over the subsurface shoals must be obtained, however, in areas of complicated bottom topography, it is impossible to locate and measure all of these hazards to navigation. Obviously aerial photography offers a possible alternative method of surveying these areas.

A method of mapping from aerial photographs is by stereo-compilation. However, unlike photo interpretation, this method requires accurate knowledge of the attitude and altitude of the camera at the time of each exposure, in addition to the position. Overland these photo control parameters are indirectly obtained by aerotriangulation of photo identifiable ground points. Over water this facility does not exist, hence, other methods of determining the photo control parameters must be developed. One method is to directly measure these parameters with an inertial platform and a radar altimeter. If the accuracy of the attitude information that can be derived from the inertial platform is sufficient and stereo-compilation could be used, all of the other hydrographic data in the shallow water areas could be obtained in addition to the depth contours.

DOE is seconding two persons to work with CCRS in developing this new hydrographic technique. Aircraft 942 will be fitted with a special inertial navigation system (INS) which will provide relative position information to an accuracy of a few feet and relative attitude information to an accuracy better than one minute of arc to the on-board radar altimeter and pulsed laser bathymeter. The outputs of all the sensors will be read by ADAS and recorded on tape together with the time of each camera exposure. The camera frames will be annotated directly by ADAS with appropriate parameters for data reduction.

4.2.5 Recommendations for the Airborne Program

1. It is recommended that the NAPL priority schedule be accepted. NAPL to advise users and CCRS of status on each project and deviations. If any deviation is foreseen, all users and CCRS to be informed.

   It is recommended that CCRS must establish an in-camera annotation system which should eliminate the time consuming hand annotation. CCRS should place a high priority on developing this in-camera annotation for all cameras.

2. It is recommended that project requests be submitted as far ahead of the proposed flight as possible. Project requests to reach CCRS at least 3 months prior to the proposed flight date. Projects of an urgent or emergency nature to be considered for acceptance at any time prior to the proposed flight date but must be fully supported in writing.

3. It is recommended that the names, numbers and committed availability of the P.I.'s and ground truth contact be made available to CCRS. Also CCRS to provide contact numbers and locations of mission manager and operations control prior to each project being flown.

   If weather or any other conditions preclude flying the project as tasked, and a P.I. or ground truth contact cannot be reached, the project may not be flown.

4. It is recommended that there be an Arctic, coastal and offshore capability for remote sensing.

   It is recommended that a proposal be submitted to IACRS suggesting the formation of a CCRS Task Force to study the subject of the potential use of the proposed DND LRPA for civilian remote sensing in the Arctic and coastal areas. This Task Force will specifically, by soliciting inputs from the relevant Working Groups on the uses of this concept, develop the rationale for the feasibility and possible implementation of such an approach to increase the scope of airborne remote sensing capabilities in Canada.

5. It is recommended that CCRS be provided with additional sensor platforms that will more readily meet specific requirements of investigations, e.g. surveillance under adverse weather conditions, sequential surveillance, water equivalence of snow cover, soil moisture content.

6. It is recommended that CCRS offer to fly special interest projects at special

6. Con't

   times of year that are of high priority.

7. It is recommended that CCRS advertise more widely that an observer can be carried on all but CF-100.

8. It is recommended that CCRS/NAPL be provided with necessary funds and people to stick to the priority schedule and that users are prepared to justify this.

9. It is recommended that CCRS and ASU be commended for excellent work done under adverse conditions.

10. It is recommended that Working Groups provide a priority framework to CCRS. Working Groups to give technical advice on certain projects to CCRS. That Working Groups do not screen requests.

11. It is recommended that user meetings, which users should definitely attend, be held in regions at opportune times and be announced well in advance.

12. It is recommended that ERTS and Airborne priorities for imagery processing be equal.

13. It is recommended that resources to provide better calibration and pre-flight checkout of aircraft systems be provided by CCRS. Forward overlap of cameras to be more strictly controlled.

14. It is recommended that there should be more feedback from users to CCRS.

    - Interim report after 30 days (make up a standard form)
    - Final report within 2 years

15. It is recommended that there should be a strong sensor development program.

4.3 REPORT ON THE ERTS RECEIVING, DATA HANDLING AND PHOTO REPRODUCTION SYSTEM

4.3.1 Introduction

A fairly detailed description of the receiving station (1) and the data handling system (2) have been published. Detailed information on the photo reproduction system is contained in the report by the Working Group on Photographic Reproduction and Distribution.

The Prince Albert Satellite Station is now capable of producing "quick-look" imagery from both MSS and RBV in near-real time. The imagery is not corrected, but does have nearly the full resolution.

4.3.2 Philosophy of the Canadian ERTS System

In July 1969, it was decided that Canada should build read-out and processing facilities for data from the N.A.S.A. Earth Resources Technology Satellites. At that time, two approaches to the system were considered. The "safe" approach would have been to buy a carbon copy of the U.S. system from Bendix Aerospace Division. This would have had the advantage that we would have almost certainly been fully operational at the time of the ERTS-A launch. The implementation cost of this approach would have been about $25 million, and the resulting system would have been incapable of dealing with data other than from ERTS. Virtually all the development and manufacturing would have taken place in the U.S.

The second approach, which was the one adopted, was to design a completely new system using a Canadian design, development and implementation team. By taking this approach, we knew at the outset that it would be almost impossible to have the system complete by launch of ERTS-A. The Canadian system design was to start about five months after the NASA design had been completed, and implementation contracts had been awarded. The advantages of this approach were a) the majority of the system design, development and manufacture could be done in Canada, with Canadian talent, b) it was felt that an alternate approach could provide a better system for Canadian needs, and c) we were certain that the task could be accomplished for a fraction of the cost of the U.S. system.

The fundamental differences in philosophy between the Canadian and U.S. system are outlined in the table on the following pages:

Item	U.S.	Canada
Emphasis	MSS and RBV received equal emphasis in the U.S. System. All products available for one are available for the other.	MSS received much higher priority since it was our belief that the scanner system was generally superior, except for marginally better RBV resolution.
Radiometric Correction - MSS	Radiometric corrections are applied as a function of the onboard calibration signals.	Same as U.S. except that special hardware utilized scent data to improve sensor-to-sensor relative calibration.
Radiometric Correction - RBV	Complex gain-offset function generated as a function of position on basis of a 9 x 9 matrix.	Same as U.S. except 18 x 18 matrix employed.
Geometric Correction - MSS	All systematic errors are corrected for on all images. This imagery has good radiometric fidelity. Full geometric correction is done on approximately 5% of all images using optical correlation techniques.	All images which contain any identifiable ground control points are geometrically corrected to the degree to which it is possible. Manual correlation techniques are used.
	Fully corrected images are produced by digitizing radiance values of an uncorrected image and re-creating a new image photo-electronically. This imagery has poor radiometric fidelity.	Fully corrected images are produced directly from magnetic tape, resulting in good radiometric fidelity.

Item	U.S.	Canada
	Accuracy on fully corrected data is better than a resolution element.	Accuracy on some scenes approaches a resolution element.
Geometric Correction - RBV	Same as MSS	It will be possible to perform full geometric correction of RBV data in the same manner as is done for MSS, but manpower loading may not permit this. In any event, systematic errors will be removed.
MSS Colour	Only 5% of all scenes can be used to produce colour composites, and virtually none of these are geometrically corrected. Composites are produced by hand-registering 9½" format transparencies and hand exposing the negatives.	Approximately 35-40% of all scenes will be used to produce colour composites. All will be geometrically corrected. Composite 9½" negatives are produced directly and automatically from 70mm transparencies with composite printer. Later 9½" negatives will be produced directly with Laser Beam Recorder (LBR).
RBV Colour	Same as MSS	5-10% of RBV images could be produced in colour when LBR is operational. These could either be fully corrected or with systematic errors only removed.
System Capacity	188 scenes/day 3 shift operation.	70 scenea/day 2 shift operation.

Item	U.S.	Canada
Standard Products available on Standing Orders	70mm transparency B&W 70mm negative B&W 9½" transparency B&W 9½" print B&W Only uncorrected B&W images are available on Standing Orders.	9½" transparency (B&W or Colour) 9½" print (B&W or Colour) All MSS images are precision geometrically corrected where possible. Only B&W images are available for RBV, probably only system corrected, unless MSS satellite system fails.
Standing Orders response time	From the time a satellite pass occurs until data on standing order is shipped will be two to three weeks when system design goal is achieved.	From the time a satellite pass occurs until data on standing order is shipped will be 10 days maximum.
Products available through data requests	70mm transparency B&W 70mm negative B&W 9½" transparency B&W or Colour 9½" print B&W or Colour 9½" negative B&W	70mm transparency B&W 70mm print B&W 9½" transparency B&W or Colour 9½" print B&W or Colour 10x10 enlargement (print) B&W or Colour 15x15 enlargement (print) B&W or Colour 30x30 40x40 40x60 Note: All MSS images geometrically corrected. Only 35-40% available in colour.
	Note: only 5% of scenes will be available in colour or corrected.	

Item	U.S.	Canada
	MSS computer compatible tape uncorrected but radiometric correction data only present.	MSS computer compatible tape - uncorrected but with all geometric correction data present.
	RBV computer compatible tape - same as MSS.	No "raw" RBV digital tape available.
	Corrected computer compatible tape produced by scanning photographic image.	Corrected computer compatible tape produced by scanning photographic image.
Photographic Quality	Extremely tight photographic quality control in effect. However, the user can at best expect to receive fifth generation photographic products. This results in considerable degradation.	At present, dust control and processing controls do not match NASA standards. In particular, the recorders used in our system have failed to give satisfactory radiometric repeatability. However, the enlarging lens system is perhaps the finest in existence for the purpose, and the colour registration system is unique and provides the best possible, consistent performance available. The user can depend at worst upon receiving third generation imagery.
Cost	All items are supplied free of charge to NASA principal investigators.	Nominal charge to all users covers the cost of photographic reproduction and distribution.
Data Availability	Data is available from NASA to NASA principal investigators ONLY.	Data is available to anyone at the same charge.
	All data may be ordered through the U.S. Department of the I Interior (EROS Data Centre) by anyone. A nominal charge is made for all products supplied by EROS, and delivery times will be at least three weeks from satellite pass.	Generally, the NAPL charges are lower than EROS for 9½" contact products, but considerably higher for enlargements. NAPL cannot produce large size transparencies.
Systems Status	NASA System is currently keeping up with data flow and has almost eliminated backlog. The system would be in some difficulty if RBV data had not stopped.	CCRS has just reached the point of keeping up with the data flow. The backlog is enormous and will not be eliminated for at lease 9 months.
	System is fully operational.	The MSS system is essentially fully operational, except for software refinements.
		The RBV system checkout has just begun.
		Digital computer compatible tape system is operational, but problems with tape formats will likely crop up.
System Generality	The system is designed specifically for ERTS and can only handle this data.	The system was designed to be flexible so that it can be easily expanded to process aircraft scanner data.

Item	U.S.	Canada
		In addition, provision has been made for use of the system for research into automatic interpretation methods.

4.3.3 ERTS Milestones

History

ERTS-1 was successfully launched from California on July 23/72. First sensor coverage occurred on July 25/72 and first coverage of Canada was on July 26/72. Both RBV and MSS data were recorded until August 3/72 when a tape recorder malfunction aboard the spacecraft caused a system shut-down. On August 6/72 a malfunction in the power sequence system for the RBV camera system forced temporary abandonment of this system.

PASS was essentially fully operational at the time of ERTS-1 launch and, in fact, the observers at PASS were undoubtedly the first in the world to see ERTS imagery since NASA does not have a quick-look capability comparable to that at PASS. The first data tapes arrived at Ottawa at 10:oo p.m. on July 26 and, by 5:00 p.m. July 27, the first MSS Canadian data was released to the press. By July 30, the first Canadian false colour image had been produced for display at the XIIth I.S.P. Conference. Although the system was capable of producing very crude uncorrected images at that time, it was completely incapable of production quantities of imagery. Also, the quality of the images produced was unacceptable. No radiometric or geometric correction could be applied at that time and serious uncontrolled distortions were present. There was virtually no exposure control, making large scale photographic reproduction impractical.

August to November was an extremely difficult time for those involved in the data handling system. There were serious difficulties encountered in reading data tapes from PASS. However, all test tapes seemed acceptable. It was almost impossible at this time to determine whether the difficulty was with the equipment at PASS or at CCRS. Finally, a data tape was received from NASA which was read successfully, indicating clearly that the problem was with the PASS equipment. Within a few days, the fault was located and repaired. All data recorded prior to orbit 459 are therefore difficult to process.

During this time, CCRS also experienced drastic reliability problems with the electron beam image recorders (EBIR'S). Typically 8-12 hours maintenance was required in order to obtain 4-8 hours of operation before another failure occurred. These problems were not discovered during the testing phases, as it had not been necessary or practical to operate the machines to capacity.

By mid-November, the most serious problems in the CCRS system had been solved. However, a key element in the NAPL system, the Composite Printer Enlarger (CPE) was still not operational. This meant that a very crude enlarger had to be used for the production of master negatives, and colour composites had to be produced using a very laborious hand registration technique. The illumination from this enlarger was highly non-uniform, and dust control was next to impossible. Quality control procedures were very poorly organized. This resulted in completely unacceptable data being shipped for the first standing orders processed.

Finally, the standing order processor itself (a software system) was in a very poor state, resulting in mammoth manual clerical work being required to reduce the orders to a form acceptable to NAPL.

From mid-November to mid-January, the most serious problems in ERTS production shifted to the NAPL reproduction system. When the CPE finally became usable, a problem in film delivery resulted in a virtual half of 9½" negative production. When the film arrived, serious problems were encountered in duplicating the wide dynamic range of the EBIR output into negative form. This problem necessitated a large number of tests culminating in a complete change in the photographic processing chemistry.

By mid-January, the standing order software had evolved into a workable, although highly inefficient, automatic system. The CCRS facility was producing EBIR imagery at rates approaching the design goal, and the CPE production was increasing at a satisfactory rate. By the end of January, its production rates were also approaching the design goal. Problems in the quality control and inventory procedures had been ironed out to the extent that the total system throughput was beginning to reach the desired levels.

Present Status

The system has still not reached its planned production capacity. The performance is

improving weekly, although both equipment and procedural problems continue to result in lost effort. Basically, each element of the system has exceeded its required daily production on many occasions. However, a smooth, reliable and consistent record has not been achieved over a full week. Since the system is so complex, a single operator error or machine malfunction can wipe out the total efforts of a full shift of operations. This cuts drastically into the total throughput figures. While the problems are being eliminated, the effort required is considerable, and the time required is frustratingly long.

Future Expectations

A new standing order system is being implemented which will make more efficient use of the computers and require less operator interaction. This system is scheduled to come into operation by March 31/73.

By March 31, the full production capacity of the system will be reached, and the goal of shipping standing order data within 10 calendar days of PASS recording will be in effect for all data which does not suffer recording problems.

By March 31, reduction of the backlog will have gotten underway. The priority at that time will be:

1) process all data as it comes in from PASS

2) process one or two priority orbits prior to orbit 459

3) process orbits after orbit 459 in forward order, starting at orbit 459.

Priorities for early orbits will be established on the basis of responses to a questionnaire recently sent to all holders of standing orders.

It will take at least nine months to eliminate the backlog. At the end of that time, it is expected that a few pre-459 orbits will still be unprocessed due to the difficulties experienced in reading the tapes. We believe that eventually, even the most difficult data will be processed.

The NASA ERTS program has been stretched out, so that ERTS-B will not be launched until 1976. It will have the thermal IR MSS channel. It is hoped that, at least in direct mode, ERTS-1 will last until that time. It is highly unlikely that the RBV system will be activated unless the MSS system should fail. All evidence indicates that the RBV system can be used, but one level of redundancy in the power sequencing system has failed, making the operation of the system risky.

4.3.4 Service to the Users

CCRS is currently producing two types of catalogue for holders of standing orders. The first is a computer listing of all images currently on file. The second is also a complete listing, but with comments concerning the images including information on location, types of imperfections and descriptions of the cloud cover where applicable.

As a winter works project, CCRS has hired a number of people at Prince Albert to assess all the quick-look imagery and produce a "Quick-Look Newsletter". In addition, single copies of paper prints are being distributed to five regional centres where the imagery can be viewed. Copies of these images may only be obtained by submitting standing orders to NAPL, which will be processed in the normal manner. Data and centre position derived from the quick-look data will enable the system to generate orders for the data as soon as it becomes available.

In the report on Photo Reproduction and Marketing, the microfilm catalogue, ERTS orbit map, ERTS coverage maps and NAPL enquiry services are described.

Users may submit either standing orders for repeated or specific coverage of an area by location, or data requests for specific scenes.

4.3.5 Interpretation Facilities

Multispectral Analyzer Display

This is a computer driven, full colour display system designed for use in multispectral interpretation studies. Considerable high speed processing logic has been incorporated into the system to allow video mixing, thresholding and colour density slicing.

The specifications for the MAD and for other analysis equipment of CCRS are included in the report by the Applications Division.

4.3.6 References

1. Satellite and Ground Station Engineering, Report #9, Resource Satellites and Remote Airborne Sensing for Canada, CCRS, Ottawa (1971).

References (continued)

2. (a) Canadian ERTS Data Handling System, W.M. Strome, Canadian Computer Conference, Montreal (1972), available from CCRS.

(b) Data Handling Facility of the Canada Centre for Remote Sensing, W.M. Strome, Proceedings of the First Canadian Symposium on Remote Sensing, CCRS (1972).

4.4 REPORT OF THE APPLICATIONS DIVISION

4.4.1 Introduction

The Division Chief, J. MacDowall, commenced duties on January 8, 1973. The Division is now being staffed in two sections viz. an Applications Development Section of environmental scientists, and a Methodology Section of research scientists. Both sections will work closely with scientists seconded from "user" agencies, forming the third aspect of the Division. These three facets bring a wide range of interlocking skills to the development of remote sensing applications. The environmental and seconded staff will have interpretive skills and a knowledge of remote sensing techniques. The researh scientists in Methodology have complementary skills in the use of physical and mathematical techniques to solve problems and provide numeric solutions by computer techniques.

The Division's Multispectral Analyser Display Unit was operational in February 1973; eight additional major pieces of analysis equipment are due for delivery in March 1973 for use by CCRS and secondees. An equipment familiarization course will be run for secondees.

Amongst the first projects to be tackled by the Division will be the Cornerstone Projects.

4.4.2 Cornerstone Projects

The Working Groups of CACRS, and others, have assisted in defining a number of projects which are attractive in that they may have high benefit to cost ratios. Technologically they are attractive to CCRS in offering an opportunity to develop some of those techniques of remote sensing which could have application to several disciplines, in the environmental and earth resource field.

4.4.3 Seconded Personnel and Facilities Available

The first secondee to CCRS was A.A. Buys from the Canadian Forestry Service. Space and facilities will be available for a total of eight investigators. Image analysis equipment will be placed at the disposal of seconded staff and their efforts will be supported by Methodologists (computer oriented physicists) and environmental scientists.

When sufficient secondees are appointed a familiarization course will be run for their benefit to provide a detailed working knowledge of CCRS facilities and staff capabilities. A list of available special equipment is given in Appendix 1. In addition access will be given to one of the PDP 10 Computers held by the Data Processing Division of CCRS.

4.4.4 CCRS Technical Information Section

The Applications Division provides functional guidance to this section which reports to the Chief of Administrative Services.

Accurate up-to-date information on remote sensing techniques and the computer system is called the REmote Sensing On-line Retrieval System, abbreviated RESORS. RESORS was developed under contract to CCRS by the Systems Engineering Division of Carleton University. RESORS contained 1280 documents on February 1, 1973; the acquisition rate was 100 documents per week. Computer searches are requested 10-15 times per week, other types of public requests average 15-20 per week.

The RESORS system has put the power and speed of computer techniques at the disposal of the user. In the near future, direct access and conversation is planned using a terminal coupled to the CCRS computer via the public telephone system. The basis for storage and retrieval is a 649 Key Word Directory and a Category Structure for both applications and techniques of remote sensing. A User's Manual is available. Fuller details are given in Appendix 2.

4.4.5 CCRS Newsletter

This 5-10 page report was published in July and October of 1972; issue number 3 is being written. Its aim is to provide information, "on the activities of the Centre as well as on meetings, publications, and other items of interest to the Remote Sensing Community in Canada". Any contributions to the Newsletter will be greatly appreciated. Items of particular interest which have not yet been covered are:

News from Provincial Centres;
Discipline Oriented Specialty Centres;
Sensor Trials;
Working Group Activities.

4.4.6 Conclusions

The Applications Division is being staffed and equipped to develop the scientific and technological basis of numeric remote sensing. The initial impetus of work will be along guidelines developed by the user interest in Cornerstone Project and in cooperation with seconded staff.

CCRS APPLICATIONS DIVISION

APPENDIX 1

List of facilities available for Application Studies and Methods Development.

Equipment Name	Delivery Date	Function
1. Bausch and Lomb Zoom Transfer Scope	March 31	Instrument for transferring photographic information onto a map or similar data base.
2. Bausch and Lomb Zoon 70 and 240 Stereoscopes	March 31	Stereoscopes with continuously variable magnification capability.
3. Richards Multiple Track Light Table	March 31	Permits Simultaneous viewing of 4 70mm rolls or 2 9" rolls.
4. Richards Light Table	March 31	High quality light table with vacuum surface.
5. Zeiss/Jena Interpretoscope II	March 20	Versatile instrument for stereoscopic photo interpretation.
6. Multispectral Photographic Viewer	March 15	Superimposes four multiband images of the same scene into a single colour image.
7. Density Slicer	March 31	Displays photographic density contours on a coloured television picture tube.
8. Microdensitometer	March 15	Scanning function for digital conversion of data on transparencies and writing mode for plotting of digital data onto film.
9. Bendix Multispectral Analyzer Display	Operational	Displays digitally encoded multiband data on a TV monitor.

CCRS APPLICATIONS DIVISION

APPENDIX 2

RESORS
(REmote Sensing On-line Retrieval System)

The Canada Centre for Remote Sensing has established a Scientific Information Retrieval Section (SIRS), whose function is to acquire, catalogue and disseminate technical literature associated with Remote Sensing. Because of the wide variety of journals and other information sources, documentation tends to be scattered and unorganized. This difficulty, together with the need to serve a large scientific community scattered at various centres throughout Canada, has led to the decision to develop a simple, "hands-on" document retrieval system tailored to the needs of Remote Sensing. The result is RESORS: REmote Sensing On-line Retrieval System, developed by the Division of Systems Engineering of Carleton University.

RESORS provides an integrated approach to the problems of acquisition, indexing, storage and retrieval of technical information in the area of Remote Sensing. Potential sources of documentation are scanned by manual and computerized methods. Selected items are then indexed and catalogued by the SIRS indexing staff. This process includes the selection of keywords from the RESORS controlled vocabulary of Remote Sensing terms, and the selection of one or two subject categories into which the paper should be placed. This process of document acquisition and indexing is proceeding on a continuous basis, thus building up an organized data base of titles and other bibliographic information. At this time, it consists of approximately 1400 selected Remote Sensing references and, with the help of the Canadian Winter Works program, is growing at a rate of at least 200 items per month.

The subject categorization provides the structure upon which a periodical complete catalogue of holdings is organized and printed. The keywords, however, are the basis of the highly selective retrieval process which is the heart of the RESORS system. The keywords selected in the indexing process are assigned weights 3,2, or 1 according to their relevance to the particular document. Weight 3 specifies a keyword concept of primary importance; weight 2, one of secondary importance; and weight 1, a concept which is mentioned but not discussed in detail.

A simple, but powerful, conversational search program allows the on-line user to interact with the data base stored in the computer

to obtain an immediate print-out of references to papers having the desired coordination and association of concepts to meet his information requirement.

The RESORS controlled dictionary provides a common language used by the indexer, the computer and the information user. The computer compares the user's description of the required documentation with all available articles and selects items having some relevance to his request. For each of these, a correlation between the request and indexer's description is calculated, and the selected items are sorted in order of correlation for output to the user. Keyword concepts of particular importance may be emphasized by the user. These will automatically have a greater effect on the correlation function calculation thus giving extra priority to these papers in the output list. The computer provides ordered lists of titles with complete bibliographic references. The full text of each article is available from the CCRS Scientific Information Retrieval Section.

The RESORS search program is designed to operate in two modes. In mode I, the information user communicates his requirement to the Canada Centre for Remote Sensing, Scientific Information Retrieval Section by mail or telephone. Members of the TIS staff will then relay this description to the computerized retrieval system and send the results by mail to the user.

It is hoped in the near future to establish the hardware facility to operate RESORS in mode II. The inherent delays in the present system will be avoided. In mode II operation, users will be given direct access, on-line, to the conversational computerized system using a standard low speed communications terminal coupled to the CCRS computer through the public telephone system. The required equipment (a Teletype, for example) is already available in most research and educational organizations, however mode I operation will continue to be available in case such facility does not exist.

Detailed instructions for the use of RESORS under mode I (and later mode II), as well as copies of the controlled dictionary of Remote Sensing terms and a service price schedule, may be obtained by writing:

Canada Centre for Remote Sensing,
Scientific Information Retrieval Section,
2464 Sheffield Road,
Ottawa, Ontario. K1A 0E4

Tel: 1-613-993-3350 (Ottawa).

4.5 REPORT OF THE NATIONAL AIR PHOTO LIBRARY

The National Air Photo Library (NAPL) has the responsibility for the annotation, indexing, documentation, archival of reference prints, and the ordering of Airborne Remote Sensing imagery; the ordering indexing, archival of reference prints, and the provision of general information concerning the Earth Resources Technology Satellite program; and is the federal agency responsible for the indexing, documentation, storage of reference prints and ordering of the federal mapping photography obtained by or for the federal government. The NAPL receives an average of 50 to 60 requests per day for photographic reproduction, technical information, available coverage or index maps, etc. In order to provide a more efficient service to it's users, and to meet the increased demands placed on it, the NAPL is undergoing an expansion of facilities and an increase in staff. During the 1971-72 fiscal year, the NAPL had only two staff members devoting their full time to the Airborne Remote Sensing program. As of April 1, 1973, the NAPL Remote Sensing Section will be staffed by a Section Head, a Supervisor and three fully trained employees, as well as a back-up staff of three employees, to alleviate work peaks. This represents an increase of six fully trained staff members committed to the Remote Sensing program. The NAPL has a remote computer terminal for the rapid entering of computerized orders for ERTS imagery, or the retrieval of information concerning available coverage, cloud content, quality of imagery, etc. As well as having four phone lines, the NAPL has installed a telex, eliminating any delays which might occur when using normal postal service. Usage of the NAPL telex can reduce the transfer of information from 4 to 8 days, to hours.

4.5.1 Airborne Remote Sensing Program April 1, 1972 to January 31, 1973

The NAPL/RS section received 212 projects involving 805 rolls of 70mm and 9½" film. These figures do not reflect the number of tasks allotted by the CCRS, but indicate the number of individual jobs received at NAPL, including re-flights of various tasks, NASA overflights, etc. The NAPL experienced a 95% increase in the demand for airborne remote sensing over the 1970-71 program.

An average task (1 roll 9½" colour, 1 roll 70mm colour, 3 rolls 70mm B&W) requires six individual steps to complete:

1. Annotation ..... 3 man-hours
2. Indexing ..... 3½ man-hours
3. Documentation ..... 2 man-hours
4. Ordering ..... 2 man-hours
5. Coverage Map ..... 1½ man-hours
6. Catalogue ..... 4 man-hours

Total time to complete average task 16 man-hours.

The investigator's requirements are forwarded to NAPL/RC for reproduction after the first 10½ man-hours.

4.5.2 Earth Resources Technology Satellite Program - July 26, 1972 to January 31, 1973

The NAPL has entered 221 standing orders for ERTS imagery and has answered over 400 inquiries about ERTS imagery. Approximately 50 "secondary" orders for ERTS imagery have been processed. The NAPL have four staff members trained in the use of a remote computer terminal, capable of entering standing orders for ERTS or the retrieval of information about available coverage. A microfilm system will soon be available, showing an index map and the actual ERTS image.

4.5.3 General Information

The Remote Sensing program (Airborne and Satellite) represents 22% of the total imagery requested and reproduced. The NAPL expects to receive in excess of 11,900 requests for all types of aerial imagery. This represents a 19% increase over the 1971-72 fiscal year.

4.6 REPORT OF THE NATIONAL AIR PHOTO LIBRARY REPRODUCTION CENTRE

The Reproduction Centre is responsible for the reproduction of imagery from the Earth Resources Technology Satellite and the Airborne Remote Sensing programs of the CCRS, in addition to our original role of the reproduction of federal aerial survey photography. The unit has been severely taxed during the past year to meet the added demands placed on our facilities. Since July 1972, approximately 4000 man-hours have been devoted to the development of ERTS production making use of new equipment, and establishing new production procedures. The airborne remote sensing program is primarily responsible for the approximately 25% increase in colour reproduction we experienced in 1972 over the previous year.

NAPL Reproduction Centre moved to larger and more modern accommodation at 2464 Sheffield Road in April 1973. With, and since this move, we have acquired several pieces of major equipment to improve our reproduction capabilities and plant throughput. A brief description of such equipment is shown in Appendix 1. This move created a production backlog that contributed to late delivery of customer requirements throughout the peak season of Summer and Fall. The majority of problems encountered were caused by conflict of priorities involving the three programs we support. It is now established that production of ERTS imagery is to receive top priority, with requirements from airborne remote sensing and air survey to follow in that order.

Shift work spread available personnel too thin to effectively utilize production equipment so more use was made of overtime in an attempt to satisfy all customer demands. A Winter Works proposal submitted by Surveys and Mapping Branch to train people in photo reproduction work was approved in mid-January 1973. With the 90 man-months authorized, twenty-three persons were hired to be trained at NAPL and NAPL/RC. This program will terminate May 31, 1973. Effective April 1, 1973, the NAPL/RC has authorized an additional eleven man-years to cope with the increased commitment to satellite and airborne remote sensing programs and to replace production staff depleted by resignations and retirements. Official strength at this time will be 60 photographic technicians with 15 administrative and support staff.

Now that we are established in more suitable quarters with additional staff and more modern and sophisticated equipment, it will be possible to remain current with production requirements during the coming operations year. The training program originated for Winter Works employees will also be available to junior tradesmen, creating more knowledgeable technicians capable of production from a variety of unit equipment. Our staff will then be more flexible, permitting shift work and movement of personnel to different work areas as reproduction demands fluctuate.

APPENDIX 1

Krematic Colour Print Processor - A wide track colour print processor capable of processing roll or sheet paper up to 42" wide. Will produce a dry colour print in less than 10 minutes as compared to the 1 hour 20 minutes of previous machines in use.

Received: Oct. 1972

I^2S Colour Composite Printer/Enlarger - An electronic and mechanical device that provides automated enlarging of the EBIR 70mm B&W positive image to a 9" x 9" B&W and/or colour master production negative in roll or sheet form.

Received: Sept. 1972

Kodak Colorado Printer - A continuous roll printer to reproduce B&W or colour film on paper or film stock at contact sizes from 70mm to 9½ inches. Equipped with a colour analyzer to determine average filtration for exposure of rolls up to speeds of 100 ft/min.

Received: May 1972

Kodak MOD 11C Versamat Processor - A continuous processor for B&W film generated by ERTS. A third machine of this type was necessary to overcome scheduling difficulties in the handling of ERTS processing priorities in conflict with airborne remote sensing and aerial survey programs.

Received: February 1973

Kodak Supermatic 242 Processors (2) - Automatic processing of all sizes of Black and White enlargements - by cutting manual developing time of 1½ hours down to 3 minutes.

Received: April 1972

Log E R5B - Step and Repeat (2) - Capable of producing one or more dodged colour prints on roll paper or individual colour negatives or transparencies on roll film.

Received: April 1972

Borrowdale Copy Camera - Replacement for lost access to DND copy camera when we shared facilities at CFB Ottawa (North).

Received: March 1971

Video Colour Analyzer - A kodak model 1635 video colour analyzer modified to analyze colour imagery up to 9½" wide.

To be received: April 1973

Kodak 11S Printer/Enlarger - An automatic colour printer/enlarger which produces 9½" colour prints or transparencies from 70mm colour negative or positive originals.

Received: April 1972

Kodak Model 20 Processor - A continuous ekta-colour roll paper processor for prints made from colour negatives. Capable of processing two strands of 9½" wide paper at a rate of 13 feet per minute using kodak ektaprint three solution chemistry.

Received: May 1972

Lipsenor/Smith Ultrasonic Film Cleaner - A motion picture film cleaner modified to handle rolls of B&W and colour film up to 9½" wide. Capable of cleaning a 100' roll of film in approximately two minutes. This machine cleans by transporting film through a bath of trichlorethaine solution and quick dried by air pressure knives.

Received: March 1972

Devere Horizontal Enlarger - Replacement for DND horizontal enlarger we were able to make use of when we shared accommodation at CFB Ottawa (North).

Received: March 1972

Devere Vertical 10 x 10 Enlarger - To produce colour enlargements over 20" x 20" size such as ERTS imagery at a scale of 1:250,000.

Received: March 1972

Kodak 1811 Colour Film Processor - Acquired to lessen workload on kodak 1411 colour film processor and to improve colour film processing capabilities of the unit. The 1411 is now used solely for the processing of negative colour films, with the 1811 developing all positive colour films.

Received: April 1972

I^2S Colour Composite Printer/Enlarger - An electronic and mechanical device that will provide automated enlarging of the 70mm EBIR positive image to a 9" x 9" B&W or colour composite master production negative in roll or sheet form.

This machine is now used in limited manual production as it is not yet completely equipped for fully automated use. On receipt, several design and operating faults were noted, some of which were corrected in-house. It is expected that the manufacturer will complete the remaining modifications and repairs by March 31, 1973.

In the manual operating mode several tests were conducted prior to actual production of master negatives. Mechanical testing was necessary to determine exact enlarging factor, image sharpness, evenness of illumination, exposure times, and image registration. Corrections were devised to eliminate the fogging of stock film which was being caused by an unsafe stock film compartment and overly bright instrument panel lights.

Further testing was then undertaken to establish quality control procedures and to assess the optimum combination of film and chemistry to obtain maximum resolution on ERTS master negatives. B & W negatives of the four spectral bands will be produced on Kodak aerographic, type 2420, duplicating film processed in Kodak versaflow developer. The colour composite master negatives are exposed on Kodak aerocolour, type 2445, negative film processed in EA5/C22 chemistry.

By January 15, 1973 we had reached the point where we were capable of limited manual production of ERTS imagery. Two shifts per day are now able to produce approximately 800 master negatives, which is sufficient to remain current with the daily output of CCRS and gradually overcome the backlog that has been created.

Received: September 1972

5. REPORTS OF WORKING GROUPS

5.1 Agriculture
- Appendix: Members of the Working Group.

5.2 Atmospheric Sciences
- Appendix: Members of the Working Group.

5.3 Cartography and Photogrammetry
- Appendix 1: Skylab - Earth Resources Experimental Systems.
- Appendix 2: Members of the Working Group.

5.4 Data Handling and Satellite Technology
- Appendix: Members of the Working Group.

5.5 Data Retransmission
- Appendix 1: Canadian ERTS-1 DCP Experiments.
- Appendix 2: DCS Data Handling Procedure at CCRS.
- Appendix 3: Members of the Working Group.

5.6 Forestry, Wildlife and Wildlands
- Appendix 1: CFS ERTS Experiments to Dec. 31/72.
- Appendix 2: A Short Review of Major Remote Sensing Projects related to Forestry, Wildlife and Wildlands.
- Appendix 3: Members of the Working Group.

5.7 Geography
- Appendix 1: Remote Sensing Studies carried out by geographers in Canada.
- Appendix 2: Members of the Working Group.

5.8 Geoscience
- Appendix 1: Bibliography of Relevant Recent Publications.
- Appendix 2: Members of the Working Group.

5.9 Hydrology
- Appendix 1: IHD Projects with Remote Sensing Content.
- Appendix 2: CFS ERTS Experiments of Hydrologic Interest.
- Appendix 3: ERTS Evaluation Contracts Approved by CCIW.
- Appendix 4: ERTS Evaluation Contracts Let by DOE, Ottawa.
- Appendix 5: Airborne Tasks of CCRS of Interest to Working Group on Hydrology.
- Appendix 6: Additional Remote Sensing Projects of Hydrologic Interest.

5.9 Hydrology (continued)
- Appendix 7: Members of the Working Group.

5.10 Ice Reconnaissance and Glaciology
- Appendix 1: Remote Sensing Projects planned and/or undertaken by members of the Working Group and their resepctive agencies.
- Appendix 2: CCRS Airborne Tasks of Interest to the Working Group.
- Appendix 3: NASA ERTS Experiments related to Ice Research.
- Appendix 4: Recent Publications.
- Appendix 5: Members of the Working Group.

5.11 Limnology
- Appendix 1: Summary of Remote Sensing Activities.
- Appendix 2: Remote Sensing Program, 1972.
- Appendix 3: Members of the Working Group.

5.12 Oceanography
- Appendix 1: Airborne Projects of CCRS with oceanographic interest.
- Appendix 2: Members of the Working Group.

5.13 Photo Reproduction and Marketing
- Appendix 1: Report of Catalogue and Retrieval Committee
- Appendix 2: Members of the Working Group.

5.14 Sensors
- Appendix 1: List of Active Sensor Projects (March 1973)
- Appendix 2: Other Activities of the Working Group on Sensors
- Appendix 3: Members of the Working Group.

5.1 REPORT OF THE WORKING GROUP ON AGRICULTURE

5.1.1 Annual Report

In 1972, approximately 34 separate projects were accepted by the CCRS totalling approximately 9097 nautical miles of multi-spectral imagery. These projects were requested by research groups for assessment of multi-band imagery in relation to their current research programs on soil resources studies and evaluation of agricultural crop conditions. The exact number of projects and line miles is only approximate as a number of the projects were regionally multi disciplinary in nature and consequently may be reported by other groups. The number of line miles flown was reduced in 1972 considerably from the previous year primarily due to a large number of small areas being requested over specific test sites and less emphasis generally on block coverage. Such an approach may be more valuable to individual primary users but may not be of value to secondary users in the country. There was also greater interest in repetitive coverage of small areas to evaluate change in reflective characteristics with plant development throughout the growing season. Interest has continued in evaluating natural vegatative features to improve the location of boundaries of selected soil characteristics. Work continued on detailed studies for assessing crop loss from diseases in beans, potatoes and certain virus diseases of cereals. New studies to evaluate nematode infestation in tobacco was begun. However, even though this nematode study was not successful itself, other aspects of the imagery showed interesting features and hopefully these may be pursued another year. Studies were also begun to estimate crop acreage and these studies may be expanded next year. Particular emphasis is being put on specific crops which may be readily identified, such as fall-seeded cover crops and winter wheat. Adequate scanning instrumentation which

a) clearly delineates field boundries
b) accurately includes unwanted features and
c) includes all of the desired features is a serious limitation in these studies.

Obviously a great deal of work needs to be done in this respect.

Two important aspects are of very serious concern to all workers using remote sensing from aircraft and satellite for imaging agricultural crops. Since the crops are in dynamic state of change any features of the plant selected for identification purposes exist for only a few days. Consequently, it is most apparent that in order to image the associated reflective characteristics, the time element for imaging and verification is very limited. The first serious problem is scheduling of the sensor and the second is return time of the processed data for field verification. Experience in the last two years indicates that cloud interference is a most difficult aspect to handle. With very close liasion between the user and aircraft scheduling some excellent timing has been achieved (e.g. tobacco, bean, potato studies) and high quality imagery was obtained. In other cases cloud interference delayed flying most seriously and little information was obtained and valuable ground time was lost in making field observations (e.g. Research studies in Manitoba and Saskatchewan). In one province no imagery was obtained over a 6-week period - at the height of crop growth!

Consequently, alternative back-up systems are essential and serious consideration must be given to alternate systems if studies using crops are to be continued. Such aspects may involve stationary balloons, or microwave systems.

The second serious concern is return time of imagery on data. Success at imagery acquisition is completely negated if the image cannot be gotten back to the field for verification. Thus, the acquisition and processing and field observations must be a closely integrated unit. Return of imagery after crop harvest is practically worthless. Any advantage it may have is lost by then. Thus, again alternate back-up processing facilities must be available. The same considerations are pertinent to satellite imagery.

Of the ERTS test sites which were proposed in 1972, ERTS imagery was requested specifically for 10 of them and of these 10, two have been suggested for CCRS cornerstone projects. Up until January 1973, good quality imagery had been received for 2 of the 10 areas. (Lethbridge, Southern Manitoba); fair to poor quality for one area in Saskatchewan (Melfort) and no image at all for 7 of the areas (Brandon) Saskatoon, Swift Current, Edmonton, Chip Lake, Ottawa, Kent Co.). It is proposed to maintain these ten sites as a combination study of aircraft and satellite based imagery in 1973.

Close cooperation has been maintained with the Sensor Working Group to encourage investigation of the electromagnetic spectrum for the teledetection of soil water. Recently the Sensor Working Group called for tenders and gave a contract to one Canadian research agency to evaluate this possibility. It is hoped that the CCRS will be able to continue strong support in this activity. Since soil water is of interest to other disciplines, possibly other working groups may wish to participate more closely.

On September 19, 1972 the first Annual Meeting of the Agriculture Working Group was held in Ottawa. A copy of the Minutes was distributed to Chairmen of all Working Groups, from which the following paragraphs were excerpted.

5.1.2 Agricultural Researchers' Requirements (from Minutes of Meeting, Sept. 19/72)

All Members and Observers

Research is necessary to evolve remote sensing methods within the Canadian agricultural requirement. Certain primary requirements are imperative if efficient levels of remote sensing research are to be adopted and maintained.

1. Coordination of airborne sensing with ground observation - It is essential that close coordination be maintained prior to the actual flying between the scheduling of the aircraft and of the ground observational personnel.

   This applies not only to the establishment of priorities, but also to just prior, during, and completion of the mission.

   Because of the uncertainty of weather for flying and the state of growth development of crops, it is necessary that very close liaison be maintained to facilitate coordination.

2. Turn-around-time between exposure and receipt of imagery by investigation - For studies involving dynamic change of natural and cultural features, it is critical that the imagery be available to the investigator before the features can change appreciably. In the event that the imagery is delayed it is likely that the required information would be irretrievably lost.

   If the turn-around-time is not reliable this potential use of remote sensing will be abandoned.

   Alternative arrangements should be available for transporting and processing the imagery in the event that there is a break-down or disruption with normal procedures.

3. Condition and Operations of Airborne Sensors - It was proposed that the sensor equipment be operated in flight by experienced personnel in order that the best possible imagery be obtained.

4. Observational Sites - It was suggested that current experimental field areas such as agricultural research stations and university farms be considered as observational sites.

5. Balloon and other stationary platforms - Because of uncertain cloud conditions frequently affecting the opportunity to acquire imagery by aircraft, it was proposed that the concept of stationary platforms be investigated. Such platforms could be used for sequential sensing in the identification of features which may be shorlived. The platform also may feasibly replace other use of aircraft to eliminate costly stand-by time.

6. Quality Control - It was suggested that quality control of materials and methods be established to reduce the inherent variability occurring with all aspects of current aerial photography, especially, those dealing with tone and other densitometric aspects. With the current and imminent use of densitometry for crop and soil identification it is essential that exposure and reproduction variabilities be controlled.

7. Pilot Studies - It was proposed that initial studies of crop identification and acreage measurement be involved with special crops which appear to have known temporal and spectral characteristics, readily identifiable by present remote sensing methods such as fall-seeded crops.

8. Training Programs - Recommendation was made that the CCRS support training programs such as the two-week course recently conducted under Dr. A. McQuillan.

It was suggested that there be an exchange of imagery and results with other groups across canada.

5.1.3 Recommendations

The Agriculture Working Group recommends that:

1. The lines of communication be established clearly during the planning of a project so that close liaison is maintained during the scheduling of the aircraft, the operation of the sensors, the reproduction of imagery, and the recording of the field information.

2. A frequent review of priorities be maintained to administer unexpected changes to flying-sensor capabilities and vegetative-soil conditions.

3. The turn-around time between imagery and the viewing of the photography by the user be recognized as an essential aspect in the use of remote sensing. This aspect is particularly relevant where the vegetative-soil conditions are in a dynamic state and it is critical that the user have the imagery in hand when identifying and verifying the phenomena before change has occurred.

4. Research be undertaken by the CCRS to eliminate variability in exposing and processing of film that is inherent in current photography and to provide a basis for establishing standards and quality control.

5. A pilot study of crop identification and area measurement be carried out involving initially a few crops having known characteristics readily identifiable by remote sensing technology.

6. A review and consideration of stationary sensor platforms be undertaken to assure repetitive imaging of prime observational sites.

7. Prime observational sites be recognized for detailed multidisciplinal information and that research and demonstration farms currently conducting field studies be utilized to provide general information for both satellite and airborne remote sensing.

8. Short courses be arranged nationally and regionally and that support be given to CCRS whenever possible.

9. Support be given for development of a soil-moisture teledetection and quantification system to measure, specifically, soil-water within a few meters below the surface.

Appendix

Members of Working Group on Agriculture (1973) (CACRS)

Dr. A.R. Mack (Chairman), Soil Research Institute, Canada Dept. of Agriculture, Room 3010 K.W. Neatby Bldg., Ottawa, Ont. K1A OC6 (613) 994-9657

Dr. R.W. Anderson, Economics Branch, Research Div., Canada Dept. of Agriculture, Sir John Carling Bldg., CEF, Ottawa, Ont. (613) 994-9507

Mr. E. Brach, Engineering Research Service, Research Branch, Canada Dept.of Agriculture, Ottawa, Ont. (613) 994-5155

Mr. Jack Chevalier, General Manager, The Canadian Agricultural Chemical Association, 116 Albert St., Suite 716, Ottawa, Ont. K1P 5G3 (613) 232-6802

Mr. O. Code, Agriculture Statistics, Statistics Canda, #5 Temporary Bldg., Ottawa, Ont. K1A OL7 (613) 994-9814

Dr. P. Crown, Alberta Institute of Pedology, University of Alberta, Edmonton, Alta. 403-432-3241

Dr. E. Halstead, Sask. Institute of Pedology, University of Saskatchewan, Saskatoon, Sask. 306-343-2527

Mr. W.A. Hodgson, Plant Pathology Section, Research Station, CDA, Fredericton, N.B. 506-475-9931

Dr. Jim I. Liebfried, Marketing Coordinator, 7th Floor N., Canadian Wheat Board, 423 Main St., Winnipeg, Manitoba. R3B 1B3 204-985-3435

Mr. L. Philpotts, Secretary, Economic Branch, Canada Dept. of Agriculture, Sir John Carling Bldg., CEF, Ottawa, Ont. (613) 994-5504

Dr. R. Protz, Dept. of Soil Resources Science, University of Guelph, Guelph, Ont. 519-824-4120 Ex. 2481

Dr. Gerard - J. Quellette, Vice-Doyen, Faculte des Sciences de l'Agriculture et de l'Alimentation Universite Laval, Cite Universitaire Quebec 10, Que. 418-656-2378

M. Rene Raymond, Division des Sols Ministere de l'Agriculture et de la Colonisation Ste-Anne de la Pocatiere, Cte Kamouraska, P. Que. 418-856-1110

Mr. Murray Riach, Economics Branch, Ministry of Agriculture and Food, Parliament Bldgs., Toronto, Ont. 416-965-1064

Mr. Geo. Robertson, Agrometeorologist, Research Station, CDA, Swift Current, Sask. 306-773-4621

Mr. S.L. Sibbald, 640 Seventh Ave. S.W., Calgary, Alta. T2P OY5 (403) 261-9673

Mr. J.W. Strath, Kenting Ltd., 700 6th Avenue S.W., Calgary, Alta. 403-263-2980

Mr. C. Tarnocai, Dept. of Soil Science, University of Manitoba, Winnipeg, Manitoba 204-474-9354

5.2 REPORT OF THE WORKING GROUP ON ATMOSPHERIC SCIENCES

Appointments to the Working Group were made in September 1972 and the first and only meeting of the group was held at CCRS on December 5, 1972.

The main decision of the Working Group was to promote an awareness of the existence of CCRS and its facilities among the atmospheric sciences community in Canada by trying to arrange one or two sessions on remote sensing at the Seventh Annual Congress of the Canadian Meteorological Society. This Congress will be held at Dalhousie University, May 30-June 1, 1973. Dr. Morley has been invited to present a paper describing CCRS and its facilities. A second invited paper will be presented by Drs. Bill Smith and Harold Woolf of the U.S. National Environmental Satellite Service on the remote sensing of atmospheric temperature profiles from satellites. A "call for papers" has been distributed by CCRS.

Copies of a NASA report "Air pollution measurements from satellites" were to be obtained by Professor Young and distributed to the working group members. It was agreed that members should study this report and that a later meeting of the group would consider what contribution Canada and Canadian scientists might make in this area.

Working group members recognized an important difference between the atmospheric sciences interest in remote sensing and the interest of the other working groups of CACRS. In the case of atmospheric sciences, the primary interest is in sensing atmospheric properties and the surface is a nuisance, while for the other working groups the remote sensing of surface properties is the main interest and the atmosphere is a nuisance. This suggests that a mutual exchange of expertise may be useful in certain interpretation problems.

APPENDIX

Members of Working Group on Atmospheric Sciences

Dr. C.L. Mateer (retiring Chairman), A/Dir., Environmental Research Branch, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont. (416) 667-4782

Mr. E.G. Morrissey (incoming Chairman) Meteorological Services, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont. (416) 667-4812

Prof. A.I. Carswell, Dept. of Physics, York University, 4700 Keele St., Downsview, Ont. (416) 667-3316

Mr. W.L. Clink, Atmospheric Instrument Branch, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont. (416) 667-4668

Mr. John H. Davies, Manager, Barringer Research Ltd., 304 Carlingview Drive, Rexdale, Ont. (416) 643-4538

M. Michel Ferland, Service de la Meteorologie, Direction generale des Eaux, Ministere des Richesse Naturelles, 1640 Boulevard de l'Entente, Quebec 6, P.Q. (418) 643-4538

Prof. K.D. Hage, Dept. of Geography, University of Alberta, Edmonton, Alta. (403) 432-4348

Mr. L. Shenfeld, Air Management Branch, Ont. Dept. of Energy & Resources Management, 880 Bay St., Toronto 181, Ont. (416) 965-5068

Dr. H.E. Turner, Air Quality Research Branch, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont. (416) 965-5068

Dr. S. Woronko, Atmospheric Processes Research Branch, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont. (416) 667-4825

Prof. Charles Young, Dept. of Physics, University of New Brunswick, Fredericton, N.B. (506) 475-9471

5.3 REPORT OF THE WORKING GROUP ON CARTOGRAPHY AND PHOTOGRAMMETRY

5.3.1 The original Working Group on Cartography and Photogrammetry which completed its task with production of a report and recommendations in 1971, was reactivated in the Fall of 1972 and has so far held two meetings. (September 12, 1972 and January 5, 1973).

5.3.2 In its two meetings the Working Group has identified some key aspects of Remote Sensing which have particular interest or possible useful applications in Cartography and Photogrammetry. Subgroups composed of certain members and invited specialists have been formed to deal with each subject and to report back to the main Working Group. Findings and contributions in these specially identified fields, together with other information deemed useful to the cartographic and photogrammetric community, will be included in reports. These reports will be issued as and when sufficiently important information becomes available.

5.3.3 Specialist Subgroups

Accurate Height Determination

The Working Group considers the development of improved and cheaper means of terrain height determination as one of the most pressing needs in cartography and photogrammetry. A recommendation that the applications of remote sensing methods of height determination be investigated was made by the original Working Group. In keeping with this recommendation, the Surveys and Mapping Branch of the Department of Energy, Mines and Resources, together with the National Research Council of Canada and SPAR Aerospace Products Ltd. will undertake a pilot study of the state of the art in the field of remote sensing height determination. It is proposed to involve representatives of the Canadian air survey industry in this activity. The funding of the future investigation will be supplied by the above-mentioned agencies and administered through the Canada Centre for Remote Sensing. In order to monitor this and any other related activities, a subgroup will be formed with representatives from universities, the Department of Energy, Mines and Resources and other interested agencies. Dr. J. M. Zarzycki of Terra Surveys Limited, will coordinate the activities of this subgroup.

Spectral Signature Recognition and Sensors

This subgroup will have the task of defining spectral signature recognition and sensor needs with particular reference to cartographic procedures. It has been proposed that personnel of Surveys and Mapping Branch (EMR) undertake work in this field in cooperation with the Canada Centre for Remote Sensing. The membership of the subgroup consists of Mr. E.D. Baldock, Carleton University, Dr. A.J. Brandenberger, Laval University, Dr. V. Kratky, National Research Council of Canada, Dr. Masry, Univerisyty of New Brunswick, Mr. M.H. MacLeod, Ontario Government and a member of Surveys and Mapping Branch to be nominated.

Satellite Imagery Task Force

The Working Group is informed of and will monitor the activities of a Task Force on the Utilization of Satellite Imagery for Mapping, now set up in Surveys and Mapping Branch (EMR). Members of the in house task force represent the interests of all sectors of the S & M mapping effort that might benefit from the utilization of satellite imagery. The range of interest extends from possible 1:50,000 scale map revision, to very small scales for the National Atlas.

Until additional types of satellite imagery become available, the task force is concentrating on what can be accomplished with ERTS-A imagery. Investigations are currently underway to determine the usefulness of the imagery for photomapping, line map revision, and accuracies obtainable for medium and small scale mapping (1:250,000 and smaller).

Only limited results have been obtained to date, inlarge, partly due to the small amount of useable imagery available. However, guidelines are being established for such things as which bands appear to be best for specific uses, e.g. for the detection and location of new roads, new railways, reservoirs, etc. As interpretation, revision, and accuracy findings and guidelines are formulated and catalogued, they will be made available to potential users through publication.

To this date, preliminary and very limited accuracy checks have been performed on a few "precision-processed" ERTS images. The term "precision-processed" means that the images have been compared and corrected (as well as possible) to conform with1:250,000 maps of the national topographic series.

Comparisons have shown that there are still problems in "precision-processing" to be overcome. The problems are such things as scale variations across the format, skew (curvature) across the format, and the need to more exactly position the geographic grid marks. In one

case, a comparison of details shown on the ERTS image and the 1:250,000 map showed disagreements averaging about 375 metres. However, a useful 1:250,000 photomap with somewhat less than Class "B" accuracy could be produced from this imagery. In another area, a photomap at a scale of 1:500,000 (class "B" standards) could be produced.

These accuracies are expected to improve as more developmental work in image-processing is completed.

Skylab

Because imagery (from metric cameras) with characteristics meeting survey accuracy requirements will be returned to earth, the NASA Skylab workshop project was from the outset recognized as of particular interest to the Working Group on Cartography and Photogrammetry. A subgroup is, therefore, being formed to monitor forthcoming Skylab activity and information.

Mr. R.A. Stewart of the Surveys and Mapping Branch, EMR, is the principal investigator in a joint EMR/University of New Brunswick experiment to be based on imagery to be acquired from NASA. Coordination of this work is carried out by Canada Centre for Remote Sensing. It is intended that simultaneous airborne sensing and mapping quality air photography will be undertaken together with ground investigations at the time of the acquisition of the Skylab imagery. The area involved is a linear zone extending from Windsor to Quebec City, and from Chaleur Bay to the east coast of Newfoundland. (See appendix 1 for resume of the experiment).

The Working Group recommends that a symposium in which findings and information relating to the Skylab project can be presented and discussed, should be held as soon as reasonably possible after imagery is analysed and evaluated. Thus, if imagery is obtained in May of 1973, the symposium might be held in the late Fall of this year. If imagery is available in September 1973, May and September being the two likely periods for imagery acquisition, then the symposium could be scheduled for the Spring of 1974. Acquisition of the imagery needed for the Canadian experiment may take place at any time within an eight-month period following April 1973. Interest in evaluating the cartographic and photogrammetric uses of imagery, other than the chief investigator's proposals, has been indicated by Carleton University and Laval University. In addition, the Ontario Department of Highways plans to test the use of the imagery in mapping the provincial transportation network. The National Research Council of Canada has expressed interest in evaluating the imagery characteristics and the resolution of negative materials. The Canada Centre for Remote Sensing will investigate interpretation techniques for classifying earth cover features. It must be noted that the use of Skylab imagery supplied by NASA to the official experiment investigator and CCRS is governed by stipulations laid down by NASA.

5.3.4 Working Group Reports

The Group has decided on the preparation of an information report covering remote sensing in cartography and photogrammetry, which will be available after June 1973. Subjects to be dealth with will include:

a) An evaluation of ERTS-A imagery and data applied to mapping procedures. (Surveys and Mapping Branch, EMR, Ottawa).

b) A contribution dealing with the Skylab experiment. (Surveys and Mapping Branch, EMR-University of New Brunswick).

c) A study of the geometrical and photogrammetric characteristics of ERTS imagery. (National Research Council of Canada).

d) Correlation and comparison of high altitude conventional photography and ERTS imagery. (Laval University).

Appendix 1

SKYLAB - Earth Resources Experimental Systems

The SKYLAB manned satellite is now scheduled for launch in mid-May, 1973. Overall objectives of the mission include the study of man over an extended period in zero-gravity environment, and the execution of several engineering-technological experiments.

Of particular interest to the remote sensing fraternity are those sections of the mission dealing with earth sensing. The useful duration of the satellite orbit will be 8 months. The satellite will be manned for 5 of those months. Because of the myriad of experiments and observations to be performed, the amount of time scheduled for earth sensing is limited.

SKYLAB will orbit normally with its solar telescope and solar panels directed toward the sun. Each time an earth-sensing "pass" is scheduled the satellite has to be rotated to local-vertical earth orientation. Upon completion of the "pass" the satellite is rotated back to its normal orientation. The time available for earth sensing orientation is constrained by thermal shield limitations, thruster fuel requirements, solar energy requirements, and others.

The planned orbit is near-circular, at a nominal altitude of 235 nautical miles, and the inclination to the equator will be 50^{o}. Thus, only a narrow belt of southern Canada will be over-flown.

The Surveys and Mapping Branch, Department of Energy, Mines and Resources, has submitted a proposal to NASA for acquisition of selected SKYLAB imagery and attendant data. NASA has approved the proposal in general, and negotiations on some of the details are now being conducted. Imagery and data will be supplied to approved principal investigators free of charge by NASA in exchange for the results of the proposed investigations.

In addition to the author, two other Canadian principal investigators have been announced by NASA. They are Dr. K. Thompson, Inland Waters, Burlington, Ontario and Prof. D. Hall, University of Manitoba. Details of their proposals will no doubt be forthcoming shortly.

The Surveys and Mapping Branch has requested earth sensing along a track from Windsor to Quebec City and from Chaleur Bay to

the east coast of Newfoundland. Data from four different sensors have been requested. Different combinations of these sensors are to be employed over different sections of the track.

In general, it is expected that the following imagery and auxiliary data will be obtained:

1) Imagery from a 6-channel (6 lens) metric film camera system loaded with 2 colour, 2 black and white, and 2 infrared emulsions. Contract scale of this imagery will be 1:2,800,000. The ground resolution expected from the high-resolution colour film is in the order of 25 metres, for high contrast ratio ground detail (6.3 to 1). The black and white film should deliver about 35 metres, and the infrared about 75 metres.

2) Imagery from a special 18 inch focal length film camera. This single lens-emulsion combination should deliver a ground resolution of 15 metres. Contact scale of the photography will be 1:940,000.

3) Products from the Infrared Spectrometer will be 16mm film and the attendant tape. The field of view is relatively small, permitting the sensor to acquire small targets on the ground. The astronaut will find and track selected ground targets through a special Viewfinder-Tracking system, and will keep the spectrometer field of view fixed on the targets for several spectral scans. The ground coverage may be changed from a diameter of 7 to 70 miles by a zoom lens system.

4) Data from the Multi-spectral Scanner will consist of requested computer compatible tapes, for the 13 spectral bands sensed. The band widths contain spectral slices ranging from 0.41u to 12.5u.

The Surveys and Mapping Branch, Department of Energy, Mines and Resources, will conduct experiments to assess the usefulness of the precision photography for the purposes of photomapping, line mapping, and map revision for various topographic series, and for applications to thematic mapping, the National Atlas, and aeronautical charting. The Surveying Engineering Department, University of New Brunswick, will co-investigate the accuracies obtainable for photogrammetric mensuration work.

Officers at the Canada Centre for Remote Sensing will conduct experiments with the Multi-spectral Scanner and Infrared Spectrometer data for purposes of terrain cover classification and the development of interpretation techniques.

The precision photographic imagery will also be studied by the Photogrammetric Section of the Ontario Department of Transportation and Communications to determine the feasibility of such imagery for plotting highway nets and water courses.

It is expected that other universities, government agencies and possibly some private companies will become involved in additional experimentation on SKYLAB sensor data.

Earth sensing data acquired by SKYLAB should be received by the approved investigators a few weeks after the completion of the requested pass(es).

NASA directs that a close rein be kept on the distribution of the sensor data, that is, that it be released only to approved investigators. However, this approval is fairly easy to obtain for relevant and potentially useful experimentation.

All forms of imagery may be purchased from the Sioux Falls, U.S. Geological Survey, distribution centre shortly after the investigators have received their products.

A symposium on the preliminary findings of the various investigations is tentatively scheduled for a date about six months after receipt of the data.

Appendix 2

Members of the Working Group on Cartography and Photogrammetry (February 1973)

Mr. R.E. Moore, (Chairman)
Acting Director, Surveys & Mapping Branch, Dept. Energy, Mines & Resources, 615 Booth St., Ottawa. K1A 0E9

Mr. E.D. Baldock, Dept. of Geography, Carleton University, Ottawa, Ont.

Dr. A.J. Brandenberger, Directeur, Department de photogrammetrie, Faculte de Foresterie et de Geodesie, Universite Laval, Cite universitaire, Quebec, 10e., Quebec.

Mr. R. Brocklebank, President, McElhanney Surveying & Engineering Ltd., 200 Graphic Arts Bldg., 1200 West Pender St., Vancouver, B.C.

Mr. D.W. Crandall, Chief, Field Surveys, Surveys & Mapping Branch, Manitoba Dept. of Mines, Resources & Environmental Management, Room 816, Norqual Bldg., Winnipeg, Man.

Mr. G. Falconer (Secretary)
Geography Div., Directorate of Map Production, Surveys & Mapping Br., Dept. of Energy, Mines & Resources, 615 Booth St., Ottawa, Ont.

Prof. A.C. Hamilton, Chairman, Dept. of Surveying Engineering, University of New Brunswick, Fredericton, N.B.

Mr. T.H. Kihl, Director, Map Production Directorate, Surveys & Mapping Branch, Dept. Energy, Mines & Resources, 615 Booth St., Ottawa, Ont.

Dr. V. Kratky, Photogrammetric Research, Division of Physics, National Research Council, Montreal Rd., Ottawa. K1A 0S1.

Mr. M.H. MacLeod, Photogrammetric Engineer, Design Services Branch, Ministry of Transportation and Communications, 1201 Wilson Ave., Downsview 464, Ont.

Col. L.J. O'Brien, Director of Mapping & Charting, Dept. of National Defence, 615 Booth St., Ottawa, Ont.

Mr. J-N. Poulin, Directeur general du domaine territorial, Direction general du domaine territorial, Ministere des Terres et Forets, Hotel du gouvernement du Quebec, Quebec, P.Q.

Dr. J.M. Zarzycki, Executive Vice-President, Terra Surveys Ltd., 2060 Walkley Rd., Ottawa, Ont.

5.4 Report of the Working Group on Data Handling and Satellite Technology

5.4.1 Organization

This working group was formed in November 1972 and held its first meeting on November 22nd in Ottawa. Appendix 1 is a list of the members of the working group.

At the first meeting, the terms of reference were agreed upon and a number of sub-working groups were formed (Appendix 2).

A meeting of the leaders of the sub-working group was held on February 14th and the minutes of that meeting are included.

5.4.2 Recommendations for immediate action

The following recommendations are strictly preliminary, but it has become very obvious to the committee, even at this early stage, that immediate action should be taken on these items.

Extension of U.S./Canada Remote Sensing Agreement

It is imperative that negotiations to extend the U.S./Canada agreement be started immediately as the current agreement expires in 1975. The agreement should extend throughout the life of ERTS-B and should be expanded to include liaison and cooperation withe the U.S. Department of the Interior for ERTS-C and follow-on operational satellites. The agreement with NASA should be expanded and extended to allow full cooperation and deeper involvement of Canada in future NASA experimental earth observation satellites.

This action is vital regardless of the direction the Canadian earth resources program may take in the future, because no alternative plan can be implemented in such a tight time frame.

Sensor and Spacecraft Systems Development Program

It is vital that the Canadian government expand its program for the development of sensors suitable for satellite applications, as well as for the development of selected spacecraft systems (e.g. attitude control). This is necessary in order to protect Canada's stake in future satellite remote sensing technology, regardless of the path Canada chooses to follow.

Even if Canada simply cooperates with other countries in their space programs, her bargaining position is very weak if she has no technological input to these programs. If Canada elects for a more active role, this sensor and spacecraft system work is a mandatory prerequisite. The developments must be fully funded, since the application of the developments is too long term to expect industry to share the cost.

In addition to those sensors currently under development through CCRS, work should commence immediately on the development of a multi-spectral scanner system applicable to both aircraft and satellite.

Preliminary Study Contracts

In order to prepare for a full post-ERTS system study, and to assist the working group in preparation of its report, two study contracts should be let. The first will study available sensors, resolution and coverage requirements. The second, which will start after the first, but overlap it, will consider orbits, attitude control requirements and mission planning. The two contracts will be specified and coordinated by the working group. Close liaison between the two contractors will be required. The first contract could be let in late Summer or Fall of 1973, and the second about one month later. Each would be expected to take about three months and cost $20,000.

5.4.3 Comments on Canada's Technological Capabilities

During discussion within the various sub-working groups, we have examined the feasibility of high technology developments being performed within Canada. It is readily apparent that Canada does possess more than adequate technical capability to solve all major technological problems in connection with sensor development, spacecraft sub-systems including r.f. links, power supplies, attitude control systems, etc., and spacecraft structure. The rate of acceleration of knowledge in these areas is such that unless these capabilities are used, we may not be able to maintain the very advantageous technological position we hold at this time.

5.4.4 Reports

The sub-working group on Canadian participation in remote sensing satellite programs will make a preliminary report in September 1973 and a definitive report in February 1974. This latter report will provide specific recommendations for future

Canadian involvement in satellite programs, and will attempt to provide direction for the full study to be started in 1974. Cost estimates will not be included, however a qualitative assessment of the economics involved in the various alternatives considered will be included.

Appendix 1

Working Group on Data Handling and Satellite Technology

Dr. W.M. Strome, (Chairman)
Chief, Data Processing Division, CCRS,
2464 Sheffield Rd., Ottawa, Ont. 993-3350

Dr. R.E. Barrington, Communications Research Centre, Dept. of Communications, Shirley Bay, P.O. Box 490, Terminal "A", Ottawa, Ont. 996-7051 - Ext. 395

Dr. J.N. de Villiers, Data Acquisition Div., Canada Centre for Remote Sensing, Spartan Hangar, Ottawa, Ont. 995-3101

Mr. John Graham, Program Manager, Spar Aerospace Products, Ltd., 825 Caledonia Rd., Toronto 395, Ont. 186-9-781-1571

Mr. J.A. Hodgson, Dept. of Mines & Resources, Province of Manitoba, 1301 Ellice Ave., Winnipeg, Man. 161-774-2511

Dr. Alex Kavadas, Space Engineering Division, University of Saskatchewan, Saskatoon, Sask. 306-244-0976

Dr. John MacDonald, MacDonald, Dettweiler & Associates, Suite 201, 2182 West 12th Ave., Vancouver, B.C. (604) 732-8823

Mr. Joseph MacDowall, Chief, Applications Div., CCRS, 2464 Sheffield Rd., Ottawa, Ont. 993-3350

Dr. F.J.F. Osborne, (RCA Montreal), 1001 Lenoir St., Montreal 207, P.Q.

Dr. Ed. Shaw, Computing Devices of Canada, Ltd. P.O. Box 8508, Ottawa, Ont. 829-1800

Mr. C.I. Taggart, Operations Supervisor of the Meteorological Satellite Data Lab, Atmospheric Environment Service, Dept. of Environment, 4905 Dufferin St., Downsview, Ont. 186-9-667-4813

Mr. Jim Taylor, Telesat Canada, 333 River Rd., Ottawa, Ont. 746-5920

Mr. S. Washkurak, Geophysics & Geochemistry Div., Geological Survey of Canada, 601 Booth St., Ottawa, Ont. 994-5867

Dr. J.G. Bernier, ingenier Service de la Radiocommunication Direction des Etudes Techniques, Ministere des Communications, Complexe "G" - 5ieme etage, Cite parlementaire, Quebec 4, P.Q. 187-9-643-5395

Mr. Roger Defoe, P.Eng., Surveys and Mapping Branch, Dept. of Energy, Mines & Resources, 2464 Sheffield Rd., Ottawa, Ont. 993-3450

Appendix 2

Formation of Sub-Working Groups

a) Foreign Remote Sensing Technology Programs

i) for U.S. - receiving secretary is W.M. Strome

ii) for non-U.S. - receiving secretary is R. Defoe

b) Canadian Participation in Remote Sensing Satellite Programs

This sub-group also encompasses Ground Station Requirements and Data Retransmission.

Leader - J. Taylor

Members - R.E. Barrington
J. Graham
F. Osborne
W.M. Strome

c) Methods of Data Handling and Recording

This sub-group also encompasses Data Retransmission and the LRPA.

Leader - J. MacDonald

Members - J.N. de Villiers
E. Shaw

d) Impact of New Sensors on Data Handling

Leader - J.N. de Villiers

Members - J.G. Bernier
A. Kavadas
J. MacDowall

e) Image Enhancement Technology

Leader - J. MacDowall

Members - R. Defoe
J. MacDonald
E. Shaw
C. Taggart
M. Strome

5.5 REPORT OF THE WORKING GROUP ON DATA RETRANSMISSION

5.5.1 Introduction

In response to interest shown in the Data Collection System (DCS) of the Earth Technology Satellite launched in 1972 (ERTS-1) by potential users in many diciplines, Canada Centre for Remote Sensing (CCRS) sponsored a Working Group on Data Retransmission (WGDR) during the period April 1 to December 1, 1971. The working group was charged with estimating the total Canadian demand for sensor data transmission, collecting information on available and planned satellite systems and recommending action to correct identified deficiencies. The working group's report was published in 1972 as No. 21 of the CCRS report series.

5.5.2 Conclusions and Recommendations of WGDR

The report of the working group contained the following conclusions and recommendations:

1. Continued development of automatic data acquisition systems is necessary. The problems of sensor and power source reliability are present whether the data is recorded on site or transmitted. In view of recent advances in communications technology, sensor reliability and power consumption are expected to be limiting factors in the use of unattended data acquisition systems.

2. The greatest identified need for real-time data acquisition is in the field of meteorology, where plans for providing re-transmission services are proceeding on an international scale.

3. Ability to monitor sensor operation, more timely data acquisition, and a possible reduction in the sampling interval are identified as the major benefits to users of data collection systems. A program of familiarization and evaluation by the various operating agencies is recommended.

4. A coordination of effort in Canada's participation in international data retransmission experiments is recommended in order that maximum benefits in terms of experience can be realized for least cost.

5. There is no agency in Canada responsible for coordinating the efforts of those experimenting with data retransmission. Canadian interests in the area of meteorological data acquisition are represented internationally by its membership in organizations such as the World Meteorological Organization.

6. There has been a reluctance on the part of operating agencies to become familiar with current technology. Those responsible for technological developments must allocate sufficient resources to demonstrations of user benefits.

7. A continued exchange between potential users of data collection systems is recommended. Since the technology is that of communications, the agency responsible for organizing the continued user group should be the Department of Communications.

5.5.3 Activity During 1972 and Future Programs

The various programs which were carried out during 1972 will be discussed under the heading of the relevant satellite system.

1. Earth Resource Technology Satellite - 1 (ERTS-1)

Six proposals for experimentation with the Data Collection System (DCS) provided by ERTS-1 were made by Canadian investigators and approved by National Aeronautics and Space Agency (NASA) of U.S.A. A total of 14 data collection platforms were purchased for the Canadian program. Appendix 1 lists the investigators.

Data is returned to the experimenters in two ways:

a) computer print-out and punched cards are sent via diplomatic bag and mail. The data acquisition delay for this method varies from 8 to 18 days;

b) users are able to interrogate the CCRS computer and receive the latest transmitted data. Conversion to engineering units is done by CCRS as requested by the users. Delays of one to two days are encountered in this mode of operation. The delay may be reduced to a few hours by more frequent updating of the CCRS files. Appendix 2 describes the data handling procedure and shows a typical print-out available to Canadian DCS users.

Almost all of the present users have resubmitted proposals to NASA to continue or to expand their ERTS DCS experiments after 1973. These proposals were originally intended

for ERTS-B, but will be considered now for the extended ERTS-1 program, which is expected to last into 1975.

The experience of the Canadian DCS experimenters has shown that the platforms and the transmission link are, in general, very reliable.

2. Geostationary Operational Environmental Satellite (GOES)

U.S.A. expects to launch a GOES satellite in late 1973 or early 1974. Formal invitations for international participation are expected soon. The Canada Centre for Inland Waters (CCIW) and the Atmospheric Environment Service (AES) have submitted letters of intent to participate in the NESS program. AES has ordered a data collection platform radio set (DCPRS) at a cost of $4,600.

These ground sets will be available as both self-times and interrogated versions, and the processing and communication system is expected to provide nearly "real time" telemetry compatible with the continental meteorological teletype communication networks, ANSCII at 110 BAUD. Individual data transmissions should have a maximum duration of approximately 30 seconds. This duration is equivalent to 300 teletype characters at a 110 BAUD rate. Other bit rates and codes may be available by specification since decoding facilities will be available at the ground command station.

The DCPRS will have a 5 watt transmitter with a directional antenna which has a 10 db. gain. Computed reliability for a 3 db. margin is 89% at 80°N. latitude. (81°N. is the satellite horizon barring propagation anomalies).

An interrogated DCPRS will require approximately 200 milliwatts of DC power in the standby mode and 16 watts of DC power during the transmit code. The receiver frequency will be 468.826 MHz and the transmitter frequency will be approximately 401 MHz. The DCPRS will be limited to a -20°C to +50°C temperature range.

Initially the number of DCPR's planned for GOES will be modest, about 25 platforms. Once operational the system could contain 3500 platforms contacted once every 6 hour period. Ultimately, it is expected that more than 10,000 platforms could be interrogated each 6 hours.

Future applications for GOES may include synoptic and climatological data acquisition from areas where land line communications are not economically feasible.

3. Communications Technology Satellite (CTS)

This satellite is presently under construction by the Communications Research Centre (CRC) of the Canadian Department of Communications. The program is joint with NASA "to explore the application to satellite communications of advanced technology".

A Working Group on Data Experiments for CTS has been formed in order to define programs to be carried out in the area of data re-transmission. These experiments are planned to test the applicability of the systems to communication of data from data banks as well as from remote sensors. Dr. Peter P. Nuspl of CRC is the coordinator for this working group.

4. Multi-purpose UHF Satellite

The Department of Communications has under serious consideration a satellite communications system for Canadian domestic use operating in the UHF range. The system's purpose would be to provide low capacity communications facilities between small, low cost terminals in remote areas, employing a satellite in geostationary orbit.

The main service provided by the system would be voice telephony. Other services that can be accommodated on voice grade circuits, such as facsimile, telegraphy and radio program distribution would also be provided. The ground segment of the system would include mobile, transportable, and fixed stations, all characterized by low gain, wide beamwidth antennas and compact, low power radio equipment. Typically, the antennas would range from phased arrays with modest gain to virtually omnidirectional single element blades.

The characteristics of the system to meet this main requirement are such that several other services could also be readily provided. One of these is relay of emergency position indicating radio beacon signals, such as aircraft crash position indicators. Another is data retransmission from remote sensing platforms in a mode similar to that proposed by GOES.

The Department of Communications is funding a study by RCA Limited to determine the communication requirements of the major environmental monitoring networks in Canada,

to carry out a systems engineering study for meeting the data relay requirements with a specific geostationary communications satellite, to specify and design a standardized data transmission platform which would meet the majority of the needs, and to perform a detailed cost analysis for manufacturing the platform in quantity.

The study was begun in early 1973. Some of the review meetings for this study to which the user representatives have been invited will be combined with Data Transmission User Workshops.

5. The NIMBUS Satellites

In a cooperative program between NASA-Lewis Research Centre and Canada Centre for Inland Waters, the positioning accuracy of the IRLS System of NIMBUS IV was checked out on Lake Ontario. Errors ranged from 0.2 miles to 10 miles.

Two proposals have been submitted by Canadian investigators to NASA for participation in experiments using the NIMBUS F - TWERLE systems, planned for launch in mid-1974.

Dr. Joh Garrett of Marine Sciences Pacific proposes to use the system:

i) to accumulate data to enable the determination of the horizontal variability of temperature and velocity at scales of 100 to 500 km, and the effect of various averaging times on this variability; and

ii) to study the effect of individual storms on the motion and heat content of the upper layer of the ocean.

Dr. Garrett envisages deployment of 16 drifting buoys in the North Pacific.

Mr. R.E. Vockeroth of AES has proposed a program to evaluate the TWERLE systems for its ability to provide meteorological and location data from ships or floating sensor packages. He shall deploy one or two data collection packages on board ship in which the data is also recorded for future comparison with the received data.

5.5.4 Conclusions

4.1 Canadian agencies with a responsibility for environmental data acquisition are proceeding to gain experience in the use of satellites for data retransmission by using available foreign systems.

5.5.4

4.2 The Canadian Department of Communications (DOC) is funding a serious study to determine the needs and technical specifications for Canadian data collection networks.

4.3 A forum for exchange of experience exists in the form of workshops associated with the DOC contract review meetings.

4.4 CCRS has provided excellent service to the Canadian experimenters with the ERTS-1 DCS.

APPENDIX 1

CANADIAN ERTS-1 DCP EXPERIMENTS

Principal Investigator	Operating Agency	Number of Platforms	Location
R. Perrier	Meteorological Service, Quebec Department of Natural Resources	1	Duchesnay, Quebec
R.A. Halliday	Water Resources Branch Environment Canada	9	Western and Northern Canada
W. Zubrycky	Tides and Water Levels, Environment Canada	1	Ottawa, Ontario
H.W. MacPhail	Canada Centre for Inland Waters, Environmental Canada	1	Burlington, Ontario
C.E. Robinson	Atmospheric Environment Service, Environment Canada	1	Downsview, Ontario
J. Kruus	Water Resources, Branch, Environment Canada	1	Ottawa, Ontario
	TOTAL	14	

APPENDIX 2

DCS DATA HANDLING PROCEDURE AT CCRS

For the DCS experiments, Canada relies entirely upon decoding of the transmissions by the NASA system. Reception takes place at the Goldstone, California and Greenbelt, Maryland receiver sites. The data is decoded at Greenbelt and messages from platforms assigned to Canadian experiments transmitted via a dedicated line to CCRS in Ottawa.

At CCRS, in Ottawa, the received message is recorded on a tele-typewriter and a 7-channel magnetic tape recorder, from which data is transferred and a permanent magnetic tape file system organized with one file for each day.

The DCS data is retrieved from the daily file and checked for transmission errors on the Greenbelt to Ottawa link, making use of a check sum digit transmitted from Greenbelt. Data lines with a detected check-sum error are identified with an asterisk replacing the check-sum. Conversion to engineering units is also done at this stage, using factors or algorithims supplied by the user.

The checked and converted messages are stored in files in the CCRS computer system. Each user may access his data by dialing the computer and logging in with his account number on a teletype. All data from platforms assigned to that account number will be typed out at the user's terminal and he will automatically be logged off. Two sets of account numbers have been issued. Use of one number will delete the data after it is typed out. Use of another will not delete data after interrogation. In this way, the same data may be accessed by more than one user.

Weekly, CCRS clears all data files and mails out the information. This is necessary to release the disk space for CCRS use.

APPENDIX 3

Members of the Working Group on Data Retransmission which was appointed by the Remote Sensing Centre for the period April 1971 to December 1, 1971

Dr. Jaan Kruus (Chairman)
Hydrologic Sciences Div., Water Management Service, Dept. of the Environment, Ottawa, Ont.

Mr. F.M. Anglin, Seismology Div., Earth Physics Branch, Dept. Energy, Mines & Resources, Ottawa, Ont.

Dr. John N. Barry, Research and Development Branch, Dept. of Communications, Ottawa, Ont.

Dr. I. Henderson, Defence Research Establishment, Ottawa, Ont.

Mr. R.M. King, The Shawinigan Engineering Co. Ltd., Montreal, Quebec.

Mr. Joseph MacDowall, IHD-IFYGL Centre, Canada Centre for Inland Waters, Dept. of the Environment, Burlington, Ont.

Dr. L.W. Morley, Remote Sensing Centre, Dept. Energy, Mines & Resources, Ottawa, Ont.

Mr. R.L. Shaffner, Canadian Council of Resource Ministers, Montreal, Quebec.

Dr. K.P.B. Thomson, Lakes Division, Canada Centre for Inland Waters, Dept. of the Environment, Burlington, Ontario.

Mr. R.E. Vockeroth, Atmospheric Environment Service, Dept. of the Environment, Downsview, Ontario.

Mr. L.R. Wagener, Hermes Electronics Ltd., Dartmouth, Nova Scotia.

Mr. D.E. Weese, Telesat Canada, Ottawa, Ont.

Mr. W. Zubrycky, Marine Sciences Branch, Water Management Service, Dept. of the Environment, Ottawa, Ont.

5.6 REPORT OF THE WORKING GROUP ON FORESTRY, WILDLIFE AND WILDLANDS

5.6.1 Introduction

The Working Group was formally constituted in September 1972 and held its first meeting on November 15 in Edmonton. The details given in the minutes of that meeting could be considered as part of the Annual Report. The highlights are given below.

5.6.2 Terms of Reference

The Working Group unanimously agreed that it is impractical that it become involved in screening and ranking individual requests for airborne missions by CCRS. The group sees its functions as:

1. To provide general guidelines to be used in deciding among competing requests.

2. To evaluate past programs and to comment on the merits and on trends observed. Reviews of costs and benefits should be prepared and used in setting guidelines for new requests.

In proposing that it withdraw from the screening of individual flight proposals the Group noted that the suggested six-month delay between the submission of a request and the final advice on "intention to fly" was unacceptable. Decisions must be made much more quickly and should be made by CCRS. If difficulties have to be resolved CCRS should consult the discipline and provincial chairmen concerned.

5.6.3 Secondment of Mr. A.A. Buys to CCRS

The Group noted with satisfaction that Mr. Buys of the Forest Management Institute, Canadian Forestry Service, had been seconded to CCRS. Mr. Buys will be Permanent Secretary of the FWW Working Group. His other main duties will be liaison between CCRS and the outside world, particularly users of remote sensing data in forestry, wildlife and wildlands. He will also undertake reviews and cost-benefit analyses of remote sensing activities.

5.6.4 Progress of ERTS and Other Experiments in Remote Sensing

Adequate preparations to complete many separate experiments which would have added up to a comprehensive evaluation of ERTS for Resource Managers were made, but progress was most disappointing because very few investigators received ERTS imagery. The situation is illustrated by that attached summary (Appendix 1) covering ERTS experiments by the Canadian Forestry Service.

A short review of other remote sensing projects is also attached (Appendix 2).

APPENDIX 1

CFS ERTS EXPERIMENTS TO DECEMBER 31, 1972

ERTS EXPERIMENT NO.	TITLE	LOCATION	INVESTIGATOR(S)	ACCOMPLISHMENTS	PROBLEMS
FMI-1	SO_2 Pollution Damage Study	Wawa, Ontario	P.A. Murtha	Interpretation of small-scale photography of test area completed. Report published.	No ERTS imagery received by investigator.
FMI-2	Wind Damage Detection	Sudbury, Ontario	W.C. Moore	Test area described and documented on small-scale photography. Low altitude aerial obliques (FMI charter) and ground photographs taken within a few days of ERTS passage. Additional background material gathered.	No ERTS imagery received by investigator. Non-delivery of ERTS imagery seriously affects progress because of seasonal and other changes in the test area.
FMI-3	Landslide Damage Detection	St. Jean Vianney, Quebec. South Nation River, Ontario. Frank, Alberta.	W.C. Moore	Descriptions and current SLAR imagery of test sites assembled. Also obtained current photography of South Nation slide and air obliques coinciding with ERTS pass (FMI charter).	No ERTS imagery. This precludes possibility of adequate check of vegetation and other anomalies that may be observed.
FMI-4	Drainage Basin Forestry Study	Rideau River Basin	W.C. Moore	Maps, background reports and aerial photography assembled and arrangements made to obtain additional information that may be required. The area has been visited and low altitude aerial obliques were taken coinciding closely with ERTS passage (FMI charter).	No ERTS imagery (although it must exist). Ground data assembled in 1972 will be less valuable next year.
FMI-5	Delineation of Forest Flooding		W.C. Moore	Reports and background material on forested basins concerned assembled. Arrangements made to obtain necessary data from Hydrological Services.	This is a Spring 1973 project (postponed because of delay in launch of ERTS).

APPENDIX 1 (Continued)

ERTS EXPERIMENT NO.	TITLE	LOCATION	INVESTIGATOR(S)	ACCOMPLISHMENTS	PROBLEMS
FMI-6	Seismic Line Detection	MacKenzie Valley	J.P. Peaker W.L. Wallace	A map of all seismic lines in test area has been completed.	No ERTS imagery. Ground documentation is based on 1971 photography, so the delay was unfortunate.
FMI-7	Leaf Development Variations Determination	Richmond-Moosenee, Ontario Transect	J.M. Wightman	Investigator has co-authored two publications on interpretation of small-scale aerial photos of test area. Background data on phenology of area assembled.	No ERTS imagery, although we know it must exist. CCRS did not obtain requested summer coverage of test area and FMI has not yet received fall aircraft coverage (Oct.) of half the transect. Project bogged down because of non-delivery of ERTS imagery and photographs.
FMI-8	Mapping of Forest Regions	Richmond-Moosenee, Ontario Transect	U. Nielsen	Investigator has co-authored reports on the detailed description of test area using small-scale photography. Background material (descriptions, maps and photographys) for the test area are assembled.	No ERTS imagery received by investigator.
FMI-9	Maritime Forest Phenology	New Brunswick	L. Sayn-Wittgenstein	Postponed to 1973 due to late launch of ERTS.	
FMI-10	Arctic Vegetation Examinations	MacKenzie Valley and Delta	L. Sayn-Wittgenstein	Maps and ground data assembled. Preliminary attemps made at interpretation and enhancement of ERTS imagery.	Not all available ERTS imagery delivered and not enough for proper sequential assessment.
FMI-11	Biophysical Features Interpretation Study	Peace River and Lake Claire	P. Gimbarzevsky	A preliminary interpretation of ERTS imagery has been made. Reported at Goddard, September 1972.	Interpretation was based on proof-quality ERTS imagery.

APPENDIX 1 (Continued)

ERTS EXPERIMENT NO.	TITLE	LOCATION	INVESTIGATOR(S)	ACCOMPLISHMENTS	PROBLEMS
FMI-12	Automatic Pattern Recognition Study	Canada	L. Sayn-Wittgenstein D. Kalensky	Interesting preliminary results from analysis of digitized data obtained from densitometer and aerial photographs and ERTS images.	Cannot get computer tapes from CCRS.
BC-1	Forest Insect Attacks Identification	Southern British Columbia	J.W.E. Harris R.F. Shepherd	High altitude photography interpreted and ground observations made.	Substandard ERTS imagery received by investigator. Still awaiting adequate imagery.
BC-2	Snow and Fog Distribution Study	Vancouver Island	E.T. Oswald	Test area and procedures determined.	No ERTS imagery.
BC-3	Tundra, Sub-alpine, Montane and Grassland Classifications	Interior British Columbia	E.T. Oswald	All ground data assembled.	No ERTS imagery received.
BC-4	Logging, Regeneration and Human Forest Activity	Vancouver Island and B.C. Interior	Y. Lee	Ground description of test sites made, aerial photography assembled, and successful low altitude air photo mission completed (CFS charter coinciding with ERTS passage.	No ERTS imagery. Results will certainly be impaired by delay in delivery.
AL-1	Chinook Snowpack Sublimation Assessment	South Western Alberta	D.L. Golding	Postponed to 1973 because of	
AL-2	Boreal Vegetation Study	North Western Alberta	P. Vaneck C.L. Kirby	Test area fully documented on maps and aerial photographs. Preliminary very promising results from interpretation of ERTS imagery from adjacent, similar Boreal Forest area. ERTS/Airborne spectral comparisons being made based on only test-corrected colour composite ERTS image available for this region. It just touches experiment area.	No ERTS imagery of whole test site.

APPENDIX 1 (Continued)

ERTS EXPERIMENT NO.	TITLE	LOCATION	INVESTIGATOR(S)	ACCOMPLISHMENTS	PROBLEMS
AL-3	Forest Fire Incidence Pattern Identification	Central Alberta	J. Niederleitner	Exact ground documentation of several conditions following forest fires (maps, mosaics and aerial photographs).	No ERTS imagery. Interpretation will again be difficult because of changes in the test area since it was documented.
AL-4	Snow-Melt Pattern Determination	Alberta	J.M. Powell	To be carried out in Spring 1973. Background material assembled.	
AL-5	Water Supply Through Forest Management	Rockies East Slope, South Western Alberta	C.L. Kirby K. Froning	Mosaics and both large and small scale 1972 aerial photography (CCRS and CFS charter) produced for an intensely studied experiment area.	No ERTS imagery. 1972 ground work may be outdated because opportunity for further checks has been lost.
AL-6	Lodgepole Pine Redbelt Survey	Rocky Mountains East Slope	J.K. Robins	Recently established study. Good aerial photography obtained and apparently being used by Alberta Government.	No ERTS imagery.
ON-1	Forest Fire Detection by Size and Intensity	Eastern Ontario	C.E. VanWagner	No progress because thermal capability on ERTS cancelled. Study may be continued with Nimbus E.	
ON-2	Spruce Budworm Infestation Detection	Northern Ontario	W.L. Sippell	Test area described and excellent 1972 large-scale coverage obtained (CCRS).	No ERTS imagery.
NF-1	Lichen Forest Recognition	Labrador	W.C. Wilton R. Wells	Test area documented and described in detail.	No ERTS imagery. Test area was missed during 1972 CCRS photography in Labrador.
NF-2	Examination of Strip Cutting Black Spruce	Newfoundland	R.C. VanNostrand	Mosaic and other descriptions of test area completed.	Still waiting for ERTS imagery. Area was cloud covered during 1972 CCRS aircraft mission.

APPENDIX 2

A SHORT REVIEW OF MAJOR REMOTE SENSING PROJECTS RELATED TO FORESTRY, WILDLIFE, AND WILDLANDS

Bio-physically oriented remote sensing projects in the above fields of interest, continue or were initiated, without abatement, from coast to coast in Canada, during 1972. Some of these efforts, encompassing both research and developmental work, have produced a variety of useful results and others are still in progress. The 11 items listed below constitute an incomplete, condensed selection of activities. However, together they reflect the complexity which characterizes the subject.

1. The economics of high altitude infrared scanning in forest fire detection is subject of study by a research group specialized in this field. The group also is actively interested in the use of semiconductors in infrared thermal photography.

2. Experiments with infrared and radar scanning methods are being carried out in the province of New Brunswick to check the behaviour and mobility of forest damaging insects.

3. The prototype of a gyro-stabilized aerial camera mount was successfully tested. A tilt indicator, which represents an alternative to the above noted aircraft attitude gyro, was developed on contract for a research unit by a private company, and underwent successful trials.

4. A number of projects by various agencies on wildland conditions and specific wildlife habitats, in which airborne photographic remote sensors are used, are in progress in several provinces.

5. Several semi-operational integrated land-vegetation mapping projects, e.g. involving the Mackenzie Transportation Corridor, are being undertaken on a cooperative, interdisciplinary basis.

6. A national, geographic land resource information system is now operational. Two, recently added, "retrieval enhancement" features are: Point capability and a real shape transformation (e.g. polygon to rectangular). These developments may be of prime importance to remote sensing projects which include the mapping of various types of data.

7. An extremely well illustrated "Guide to Air Photo Interpretation of Forest Damage in Canada", containing a dichotomous key to detect and define forest damage, is now available. A most useful application of black/white, colour, and false colour air photography is conclusively demonstrated with the advent of this publication.

8. An extremely interesting and wide ranging "land-management supporting" remote sensing program is under way in the Province of Ontario, and was reported on during the 1973 I.S.P. Congress in Ottawa.

9. The development of improved large-scale photographic systems is subject of active research by different agencies, and involve both, a helicopter platform with camera boom arrangement, and the use of fixed wing aircraft equipped with a synchronized radar altimeter-camera unit.

10. Research in photographic (Agfacontour film) and electronic enhancement techniques is in full progress.

11. Research in automated interpretation techniques for special purposes (e.g. wildlife) and in pattern recognition, are actively pursued.

Details on the organizations, investigators or participants involved in the above tabulated projects, are available, on request, from:

A.A. Buys,
Applications Division,
Canada Centre for Remote Sensing,
2464 Sheffield Road,
Ottawa, Ontario. K1A 0E4

APPENDIX 3

Members of the Working Group on Forestry, Wildlife and Wildlands

Dr. L. Sayn-Wittgenstein (Chairman)
Canadian Forestry Service, Dept. of the Environment, Ottawa. K1A 0E4

Dr. A.H. Aldred, Forest Management Institute, Canadian Forestry Service, Ottawa. K1A 0E4

Mr. J.B. Bruce, Inventory Division, B.C. Forest Service, Victoria, B.C.

Mr. A.A. Buys (Permanent Secretary)
Canada Centre for Remote Sensing, Dept. of Energy, Mines & Resources, 2464 Sheffield Rd., Ottawa. K1A 0E4

Mr. R.C. Goulden, Chief of Wildlife Operations
Dept. of Mines, Resources & Environmental Management, Winnipeg, Man.

Mr. J.D. Heyland, Quebec Wildlife Service, P.O. Box 7276, Quebec 7, P.Q.

Prof. G. Ladouceur, Faculte de Foresterie, Universite Laval, Quebec 10, P.Q.

Mr. R. Lafrance, Canadian International Paper Co., Sun Life Bldg., Montreal, P.Q.

Mr. K.J. Romaine, Lands Directorate, Dept. of the Environment, Ottawa. K1A 0E4

Dr. J.S. Rowe, Dept. of Plant Ecology, University of Saskatchewan, Saskatoon, Sask.

Mr. B.M. Smith, Dept. of Natural Resources, Room 549, Centennial Bldg., Fredericton, N.B.

Dr. J. Vlcek, Dept. of Civil Engineering, University of Toronto, Toronto, Ont.

Mr. Parker Williams, Integrated Resources Photography Ltd., P.O. Box 2278, Vancouver, B.C.

Mr. V. Zsilinszky, Ministry of Natural Resources, Parliament Bldgs., Toronto, Ont.

5.7 REPORT OF WORKING GROUP ON GEOGRAPHY

5.7.1 Introduction

The Working Group on Geography was established in August 1972. Present membership is given in Appendix 1. Three meetings were held in 1972.

The main function of the Working Group can be seen as one of reviewing remote sensing activities in the field of geography in Canada and of advising CCRS with respect to areas in which major thrusts in research and applications are desirable. The following report first describes briefly the role and scope of geography as a science and its interest in remote sensing, then presents a general framework within which the Working Group activities can be organized, and finally, based on this framework, some concrete proposals and recommendations for action as far as they have emerged from the Working Group discussions to date. It should be recognized that the Working Group is still in a somewhat formational stage, and an agreement on more formalized procedures for handling proposals for research and application studies is pending. Views and ideas expressed at the Working Group meetings are summarized here as well as is possible at this time.

5.7.2 A General Framework for the Working Group's Activities

Part of the discussion during the first meetings of the Working Group centred on the question what exactly it is that geography can contribute within a national remote sensing program. This is a legitimate question, not because geography is an ill-defined subject, but because of the inherent diversity of the subject. Geography is concerned with ineractions between geographical elements in situ (i.e. at one place), with interactions between places (particularly in human geography), and with interactions between man and his environment. Geographers may deal with landforms, climate, vegetation, land use, population, urban settlements and other things. However, a particular geographer is normally engaged in activities related to one or a few of these subjects only; he is a specialist in a subfield of geography. There is a common concern with what may be called the geographical viewpoint. In this sense, the Working Group on Geography may be the most interdisciplinary one in its outlook. This situation is also expressed by the fact that several non-geographers are members of the Working Group. As a result, there may be overlap with other Working Groups in some instances. Where such overlap is desirable, the logical consequence would be a co-operation between the groups concerned. Another result of this situation is that the Working Group on Geography may be the one which is most obviously interested in the establishment of multidisciplinary testsites.

It seems that the activities of this Working Group can be organized appropriately within a three-level framework as follows:

1. National inventory

   Here we think of small scale wide area studies essentially of the description and classification type which probably would be based mainly on ERTS imagery and result in maps of some kind. Such basic inventory and mapping activities would not have any single application in mind, but would be, hopefully, of a multi-purpose value. We think that useful information could be gathered and displayed which is not available now, particularly for the vast northern areas of Canada.

2. Regional analysis

   Here we are dealing with studies at a more detailed level within selected regions. It is particularly in this context that, in our view, the testsite idea would have value. Since a thorough analysis of a region is multi-faceted and often requires the collection of data of a more detailed and more special nature than a geographer legitimately can be asked to provide, be it in connection with land resources, water quality, forest management, etc., we hope that some of the other Working Groups would be interested in a co-operative venture.

   Regional analysis starts with description and classification as a necessary basic step. We can see a data gathering sequence from general to detailed, using satellite imagery, high-altitude photography, low altitude photography (and possibly some other types of remote sensing imagery) and ground studies. It should be pointed out that we do not propose to look at remote sensing data only and to determine what it can be used for. This is too one-sided an approach, a mistake which has been made too often in the past. To operate on more realistic grounds on has to look definitely at what information is available now (maps, census data, etc.).

5.7.2 Con't

Questions arising then are, for example the following: Is the information already available adequate for the purpose of analyzing and understanding a region? Do remote sensing data provide new information or can they be correlated with the existing data? If they are correlated with existing data, does this mean that remote sensing is redundant, or does it rather indicate that remote sensing is, in fact, useful because it can be used for monitoring changes and updating (for example, a data base of the census type)? If no correlation exists, what exactly is it that remote sensing data tell?

From here, regional analysis would go beyond the purely descriptive stage into explanation. The presently visible spatial patterns and structures are the manifestations of physical, biological as well as human agents, and all these have to be seen as operating over time (i.e., there is a historical perspective). Understanding how a region functions at present, and how it has developed in the past, will make the prediction of future developments possible, taking, of course, such constraints as governmental regulations into consideration. It may seem that this goes beyond what a Working Group on Remote Sensing should do. The point, however, is this: The geographer tries to explain observed facts by theories and models, as indicated earlier. To test theories and to implement models, data are needed. By looking at present activities in this field we can arrive at conclusions regarding data requirements. We may find that certain theories exist which remain untested because of lack of data. It is then precisely here that we come back to remote sensing to see to what extent it can, with its high spatial resolution, continuous coverage and temporal monitoring capabilities, fill some of the gaps.

Another area that should be investigated in the context of regional analysis is the rapidly emerging field of spatial information systems, i.e., computerized data banks with associated data processing and display facilities. Such systems have been largely based on map information so far (partly on maps derived by air photo interpretation). Are there means and ways of integrating remote sensing data into such systems in a more direct way, and what are the problems? Finally, we should investigate methods of displaying and, possibly, disseminating information derived from remote sensing (alone or in conjunction with other sources) in a more real time fashion. In other words, we would like to avoid the time consuming process of manual map preparation and subsequent printing and sacrifice some of the quality attainable with conventional map-making procedures for speed.

It may well turn out that some of the goals just outlined are too ambitious to be considered, even on theoretical grounds, by this Working Group alone. It is, therefore, important that links be maintained with existing national organizations, in the first place with the Canadian Association of Geographers (CAG). Hopefully, a fruitful co-operation will develop from such contacts. As a minimum, however, we can still consider the following: To develop a package of methods to rapidly collect, combine and display information on regions for applied purposes. Such a package would be of value, for example, for impact studies in connection with proposed new airports (examples: Montreal, Toronto), pipelines (example: Mackenzie Valley), hydro power projects (example: James Bay area) and the like. This should be of interest to planners and, consequently, links should be established to professional planning organizations as well.

3. Urban studies

Much of what we have said about regional analysis is also valid for urban studies. To distinguish them from regional analysis is justified because, firstly, we are dealing with a special topic and special problems and, secondly, the high density of people and activities requires work at a still more detailed level. The field of urban studies needs special attention in our view. No other Working Group is dealing with this topic. Research to find useful applications of remote sensing has been somewhat neglected, particularly in Canada although the number of studies reported is growing. Possibly this state-of-affairs simply reflects the difficulties involved of extracting data that are useful and sufficiently accurate for urban studies, but it remains to be seen how far this is in fact true. It would seem that remote sensing has at least a presently unused potential for applications at a relatively low level of sophistication.

5.7.2 Con't

The above tripartition of the proposed framework for activities is one of level of data collection, processing and display and, therefore, is associated with different degrees of detail, scale of mapping, etc. There are other aspects which have to be considered for all of these levels, namely

(a) Thematical concern: Within each level we may think of special themes as well as combinations of themes which can be looked at. Normally, we would be interested rather in a combination, because this would allow an analysis of interactions. However, for a particular application a more specialized study may be needed.

(b) Technical-methodological concern: Here we deal with the capability of different types of sensors to provide certain desirable information and with methods of data extraction, processing and display (for example, conventional image interpretation versus computerized methods.)

(c) Educational concern: The present state-of-the-art of remote sensing and new findings, as and when they become available, should be made more widely known. Not only should universities provide adequate and up-to-date education in this area, but special programs, directed at administrators and planners, should be implemented.

5.7.3 Recommended Activities

The framework just discussed can be regarded as an overall policy statement. Ideally we should be able to tackle the tasks at all fronts simultaneously. Current studies are outlined in Appendix 2. Given the present uncertainity with regard to the funding of remote sensing projects and, consequently, of just what and how much can be done, a more practical and promising approach is to be selective, to concentrate on a few things at a time and then, hopefully, build up to a coherent whole with time. The following is a list of some recommended activities as they have emerged so far from the Working Group discussions and from ideas expressed by individuals. "Proposed" indicates that an actual respective proposal has been made during Working Group sessions and that the item concerned appears in the minutes of the meetings. "To be considered" means that the the respective idea has been expressed but not discussed in detail and not officially proposed as yet.

1. National inventory

(a) Photomaps: The idea of producing photomaps of some kind on the basis of ERTS pictures is endorsed by the Working Group. Particularly, it is felt that the regular production of lithographic enlargements (so far done experimentally) would provide a useful and low cost document. This is not, strictly speaking, a photomap, unless the pictures would be precision-processed, but present experience with bulk-processed pictures demonstrates that they can be readily compared with topographic maps. The possibility of producing standard map information in the form of transparent overlays to facilitate comparison and locational referencing should be considered also.

(b) Land systems mapping (proposed); It is proposed to use ERTS pictures for the mapping of land systems. The land systems approach is a survey technique used heavily by CSIRO in Australia and other organizations to obtain information about relatively unexplored regions. It is a complex classification technique in that units are delineated on aerial (or space) photos which represent certain typical combinations of physiographic features, particularly landforms, soils, hydrography and vegetation. It is hierarchial in that smaller units which form recurring patterns are grouped into larger units. This technique would certainly provide valuable information on the vast northern areas of Canada, but it may also be useful as a first level of generalized background information for the heavily man-made landscapes of southern Canada. The inventory aspect is not the only useful feature of land systems mapping. It has a predictive value in that an understanding of the interrelationships between geographical elements in particular types of units helps to evaluate impacts resulting from a change in one or more of the components. Moreover, it provides a suitable spatial framework for sampling schemes if there is a need for obtaining more detailed data. It is proposed to carry out a study on a sample basis, using selected ERTS imagery from

5.7.3 Con't

different physiographic regions of Canada, and develop a suitable analysis and mapping technique which could be applied to a nation-wide survey of this type.

(c) Land cover mapping (to be considered): Using again ERTS pictures, the idea here would be to produce small scale maps which show general land cover categories, such as bare rock and soil, water, permanent snow and ice, different types of vegetation and large scale man-made features (particularly cities). Whether or not this could or should be combined directly with the land systems approach mentioned above for the more natural regions remains an open question. We would, however, see a need for a separate product of this type for the southern part of Canada, where natural conditions are heavily masked by man's activities. Again it should be considered to undertake a pilot study on a sample basis.

(d) Phenology mapping (proposed): It is proposed to employ ERTS images for an assessment of temporal (seasonal) changes, resulting in a small scale phenology map. Of particular concern would be changes in snow cover, natural vegetation and agricultural activities. It is anticipated that this would require image coverage over several years (making use not only of ERTS 1, but also of ERTS B and, hopefully, of additional follow-up satellites of a similar type) in order to develop seasonal patterns on a statistically valid basis. Again it is suggested that work be started on a sample basis for areas where suitable coverage over time now exists.

The three products above can be seen as a compendium, summarizing the geographical reality of Canada in compact form. It is believed that, when used in context, they would form a powerful tool and framework for investigations of ecological sensitivity, geomorphological processes, natural hazards, existing and potential land use and regional planning.

2. Regional analysis

(a) Assessment of data needs (to be considered): It is suggested that data needs for regional analysis be assessed through an analysis of the presently existing body of theories and models of regional processes as developed by geographers and other regional scientists. In order to not remain on a purely academic level this should be done in conjunction with an analysis of the information used to arrive at regional planning decisions. The basic asseumption is, however, that planning is a rational process which employs a certain minimum amount of theoretical concepts. A knowledge of overall data needs permits to determine what information could profitably be acquired by remote sensing techniques. Such a program would not only apply to regional analysis but to urban studies as well. It is not mentioned again below, but should be kept in mind.

(b) Establishment of testsites (proposed): It is proposed to establish a number of testsites in areas where good ground truth is already available or is being collected on a continuing basis and where existing facilities and manpower could be easily co-ordinated into a joint project. Hopefully, such testsites would be inter-disciplinary in nature and would be endorsed by other Working Groups as well. Examples of potential testsite areas are the following: The St. John River Basin, New Brunswick, where data are being collected for a water management study (although largely concerned with water, there are many ramifications, and a more comprehensive regional analysis would certainly profit from the work done at present): southern Ontario, where ground truth programs are in existence and various types of imagery have been flown, particularly in connection with the International Field Year on the Great Lakes (IFYGL); parts of Manitoba, where an inter-disciplinary program is already well underway. Suitable organizational schemes would have to be worked out. The expectation is that testsite work would be carried out under the co-ordinating supervision of respective provincial committees, but it is suggested that CCRS takes the first steps to ascertain if and how such a program can be implemented. The existence of testsites, which would allow to examine different types of data sensing, data extraction and data

5.7.3 Con't

2. (b) Con't

display techniques, would provide an opportunity to tackle the data base problem for regional analysis from the other end. Remote sensors can be evaluated as to their data producing potential and, in cases where they compete with more conventional data sources, cost-effectiveness studies could be undertaken under operational conditions.

(c) Correlation of image parameters with ground data (to be considered): As a study in the area of semi-automatic or automatic data extraction techniques, it is suggested that the usefulness of selected image parameters be evaluated by correlating them with ground truth data. Much of the work in automatic data extraction from remote sensing imagery done so far has concentrated on the classification of multispectral (in some cases multitemporal) signatures, using pattern recognition (discriminant and cluster analysis) techniques. While these approaches have their merits and have met with partial success and while research along these lines should be encouraged in Canada as well, we note that the use of spatial (textural) image information has been largely neglected. From conventional photo interpretation we known that textures are consistently an important indicator. It is, therefore, suggested that spatial signature concepts be developed and that their value for automatic recognition and mapping be evaluated by either employing pattern recognition procedures as above (ground data on a nominal scale) or correlation techniques, such as simple and multiple correlation and regression and canonical correlation (ground data on an interval or ratio scale). Spatial image parameters can be directly derived from an image (for example, variability of tones) or indirectly via preceding image processing operations (for example, density, length and orientation of edges). An experiment of a more special nature could be concerned with colour enhancement of texture. The idea would be to frequency analyze a picture (or segments of a picture), preferably by optical means, to reconstitute partial images from selected frequency and/or directional intervals, and to produce colour composites of reconstituted images. The question would be whether or not such a technique could enhance the spatial content of a picture in such a way that it would be more readily useful for a visual interpretation or for automatic data extraction.

3. Urban analysis

(a) Acquisition of urban imagery (proposed): It is proposed that CCRS acquires high altitude photography (preferably false colour) over major urban areas on a contingency basis. Such a program, if adopted, should be made public, and sample imagery should be made available to cities, i.e., primarily the planning agencies, concerned. To make sure, however, that such material is not simply shelved, the acquisition program should go hand in hand with a contact program in which planners would be made aware of the possible uses of imagery. The possibility of using CCRS personnel or people employed on such schemes as the present Winter Works program should be considered. This assumes that we know what the possible uses of remote sensing imagery are. We believe that there are some straightforward applications which are obvious. A more detailed and more sophisticated applications program could then be developed through the schemes mentioned below. The advantage would be that, hopefully, a fruitful rapport with planning agencies could be established meanwhile by this preliminary program.

(b) Background information, sample studies and Workshops (proposed): It is proposed to develop a Canadian capability of using remote sensing data for urban studies at a more advanced level systematically through the following steps: (1) A thorough search and analysis of relevant literature (complete and update CCRS' RESORS system if necessary); (2) Implement- of a number of studies of selected cities, primarily of those where the local planning agencies have expressed an interest in a remote sensing data collection capability during the preliminary program proposed above. Suitable study programs could then be developed in co-operation with these agencies; (3) Organization of workshops

5.7.3 Con't

3. (b) Con't

in which the results obtained in such studies are made known to a wider circle of planners and administrators.

(c) Extraction of three-dimensional city data (to be considered): As an example of a more specialized, experimental, and new type of study, it is suggested that methods and techniques of extracting data on building densities, areas, heights and volumes be explored. Of interest would be procedures of a semi-automatic or automatic nature other than the time consuming manual-visual measurements in a stereoplotter. A number of presently existing techniques used for terrain profiling should be evaluated as to their applicability to city profiling. In addition, it should be examined how far relationships of a more statistical nature can be established by using image parameters such as shadows, radial edges and the like. We believe that techniques of mapping a city rapidly in three dimensions would be of value to a number of study areas, for example, population estimation, activity analysis, traffic generation prediction, housing quality assessment and urban climatology. The remainder of this section of the report deals with recommended action which is of a general nature or applies to all of three levels distinguished above.

4. Data presentation and dissemination

(a) ERTS data depositories (proposed): It is proposed that regional depositories for ERTS imagery and possibly other remote sensing products be established in a manner similar to the depositories of national topographic maps maintained by the Surveys and Mapping Branch. ERTS images could be in the form of 16 mm film cassettes, the production of which is planned by CCRS.

(b) Thematical data packages: Appropriate ways and means of presenting and disseminating map data derived from any of the activities suggested above should be carefully examined. What should be avoided is a time consuming and costly program of producing conventional maps in printed form. It is conceivable that certain maps would be produced by computer and reproduced

(b) Con't

in this form. Others could be readily reproducible manuscripts. It can be considered to produce data packages consisting of: (1) the imagery on which the study was based; (2) the thematical map data in transparent overlay form, and (3) corresponding topographic map information. Such packages could be produced in a limited number to be available in open files at regional depositories (see above) to start with. Additional copies could then be produced on request.

5. Education

(a) Travelling exhibit (proposed): For the benefit of the remote sensing community potential remote sensing users as well as the public at large, it is proposed that CCRS considers the preparation of an exhibit which would inform about the Canadian remote sensing program, show selected products and describe sample applications. Such an exhibit would presumably not travel around the country on a stand-alone basis, but be shown in conjunction with national or regional meetings.

(b) Meetings, seminars, courses: The organization of regional meetings and seminars should be generally encouraged and supported by CCRS in whatever way possible (for example, by making available an exhibit of the type mentioned above, by sending representatives for presentations). The establishment of appropriate programs at universities should also be encouraged.

6. Remote sensing program organization

(a) Liaison between Working Groups (proposed): It is proposed that whenever appropriate, i.e., when particular Working Groups find that they have overlapping concerns, that the respective Working Groups exchange representatives attending the meetings.

(b) Contacts with potential funding agencies (to be considered): Since, at present, there seems to be no regular budget set aside for a remote sensing applications program, the question is whether CCRS should not consider to provide a service in the form of assistance in contacting and negotiating with potential funding agencies whenever a project proposed by a Working Group is deemed worthy of further consideration.

APPENDIX 1:

REMOTE SENSING STUDIES CARRIED OUT BY GEOGRAPHERS IN CANADA

The following is a list of remote sensing studies undertaken by geographers. It should be regarded more as a cross-section than a complete inventory. The time available did not permit the latter. It is restricted to Geography Departments at universities. Also, a bibliography could not be compiled. Apologies are extended to all those who, involuntarily, are omitted from this list. It is the intention to produce a more complete document for the next annual report.

1. McGill University, Montreal

   (a) Evaluation of a strip of 1:250,000 sidelooking radar (Motorola) imagery for terrain evaluation and summer-winter comparison in the Laurentian area; J. Parry; funded by Defence Research Board (DRB).

   (b) Evaluation of infrared line scan (Daedalus) imagery taken at different times of the day in the 8-14 micrometer spectral region over the Laurentian area for general terrain analysis; J. Parry; funded by DRB.

   (c) Evaluation of large scale (1:3000-1:5000) colour infrared photography for road deterioration studies; J. Parry; funded by DRB.

   (d) Evaluation of standard 1:70,000 panchromatic photography over a part of Labrador for military terrain analysis (offroad terrain mobility); J. Parry; funded by DRB.

   (e) Evaluation of ERTS imagery (infrared bands) over Labrador-Ungava with respect to the detection of changes in hydrological conditions and assocated geomorphological processes; J. Parry; funded by Canada Centre for Inland Waters (CCIW).

   (f) Evaluation of multi-level (low level to ERTS) imagery for investigating snowmelt hydrology in the Schefferville area; J. Parry; funded by Department of Indian Affairs and Northern Development.

   (g) Mapping of physiographic patterns on sample ERTS imagery (e.g., Montreal area); J. Parry; funded by Canada Centre for Remote Sensing (CCRS).

   (h) Study of land use changes along the Quebec-Vermont border on multispectral 70 mm photography provided by CCRS. Comparison with older standard photography; N. Drummond.

2. Laval University, Quebec City

   Land use mapping in the area of the new Montreal Airport; P. Clibbon.

3. University of Alberta, Edmonton

   (a) Use of infrared line scan (Daedalus) imagery, 8-14 micrometers, for the detection of springs in Karst areas of Western Alberta; M.C. Brown; funded by National Research Council (NRC) and Department of the Environment.

   (b) Water balance studies in lake basins of central Alberta, using 1:30,000 aerial photography and ERTS imagery; A.H. Laycock.

4. University of Guelph

   (a) Measurement of ground parameters for an ERTS simulation study as part of the International Field Year on the Great Lakes (IFYGL). Co-operative scheme, involving also Ontario Ministry for the Environment, CCIW, Canada Department of Agriculture and McMaster University, A. Falconer.

   (b) Joint project with the University of Michigan concerning the evaluation of ERTS (and Skylab) imagery, also part of IFYGL, Guelph responsible for ground truth; A. Falconer.

5. McMaster University, Hamilton

   (a) Hydrological and geomorphological studies in the Niagara Peninsula on high altitude ERTS simulation photography; P.J. Howarth; funded by US Geological Survey.

   (b) Urban and agricultural land use change detection in the Niagara Peninsula on high altitude photography provided by CCRS, integration with ground truth data provided by 1971; P.J. Howarth et al; funded by McMaster University Science and Engineering Divisional Research Board.

   (c) Evaluation of aerial photography and imagery for mapping different aspects

APPENDIX 1: CON'T

5. (c) Con't

of the landscape in the High Arctic; P.J. Howarth; funded by NRC and DRB.

(d) Investigation of beach processes and shoreline changes on high altitude photography flown by CCRS over New Brunswick and Prince Edward Island; S.B. McCann; funded by NRC.

(e) Karst studies in the South Nahanni River area, N.W.T. on high altitude photography provided by CCRS; D.C. Ford, funded by Parks Branch, Department of Indian Affairs and Northern Development and NRC.

(f) Ecological studies of Pen Island, Northern Ontario, on medium altitude photography and thermal imagery flown by CCRS; K.A. Kérshaw; funded by NRC and McMaster University.

(g) Evaluation of ERTS 1 imagery for snow cover interpretation; P.J. Howarth; funded by Hydrologic Sciences Div., Department of the Environment.

(h) Evaluation of ERTS 1 imagery for hydrologic studies; P.J. Howarth; funded by Hydrologic Sciences Div., Department of the Environment.

6. University of Waterloo

(a) Geomorphological mapping 1:25,000, compiled at 1:50,000 map sheet Galt, using standard aerial photography and supplementary multispectral 70 mm photography; A. Kesik, funded by NRC.

(b) Hydrographical map 1:50,000, sheet Galt, based on standard and supplementary photography of above; A. Kesik; funded by NRC.

(c) Automatic terrain cover recognition using multispectral and multitemporal 70 mm photography and pattern recognition procedures; D. Steiner, funded by NRC.

(d) Review of data collection by remote sensing and information systems for the Commission on Geographical Data Sensing and Processing, International Geographical Union; D. Steiner; funded by US Geological Survey and National Advisory Committee for

(d) Con't

Geographical Research, Department of Energy, Mines and Resources.

7. University of Sherbrooke

(a) Experimental determination of environmental parameters influencing remotely sensed terrestrial longwave radiation, in the 9.5-11.5 micron range, over different types of terrains (experimental plots); F. Bonn, P. Clément; funded by DRB.

(b) The use of remote sensors in the 9.5-11.5 micron spectral range as a tool for investigating the energy balance of slopes; F. Bonn, funded by NRC.

(c) Experimental determination of emissivities on natural and artificial water surface; P. Clément.

(d) Spatial extension of the relations established in (a) in order to find interpretation keys over known areas (flights done in the Eaton River Basin) F. Bonn, P. Clément in collaboration with B.J. Garnier, McGill University, funded by DRB.

8. University of Winnipeg

Evaluation of conventional and multispectral airborne imagery of channel morphology, Red River, Manitoba; D.M. Welch; funded by University of Winnipeg.

APPENDIX 2:

MEMBERSHIP OF WORKING GROUP ON GEOGRAPHY, 1972-3

Dieter Steiner, Chairman, Department of Geography, University of Waterloo, Waterloo, Ontario.

Allan Falconer, Secretary, Department of Geography, University of Guelph, Guelph, Ontario.

Marcel Belzile, Directeur de l'Inventaire Canadien des Terres, Office de Planification et de Developpment du Quebec, Hotel du Gouvernment, Quebec, P.Q.

George Falconer, Geography Division, Surveys and Mapping Branch, Department of Energy, Mines and Resources, 615 Booth Street, Ottawa, Ontario.

Kenneth Hare, Director-General, Research Co-ordination Directorate, Environment Canada, Ottawa, Ontario.

John Henderson, Planning Director, The Saint John River Basin Board, Fredericton, New Brunswick.

Philip Howarth, Department of Geography, McMaster University, Hamilton, Ontario.

Axel Kinnear, Secretary-Co-ordinator, Environment and Land Use Committee, Parliament Buildings, Victoria, British Columbia.

Janusz Klawe, Department of Geography, University of Alberta, Edmonton, Alberta.

Gerald McGrath, Department of Geography, Queen's University, Kingston, Ontario.

John Parry, Department of Geography, McGill University, Montreal, Quebec.

Thomas Peucker, Department of Geography, Simon Fraser University, Vancouver, British Columbia.

Awni Raad, Director, Soil & Water Division, Department of Agriculture and Forestry, Charlottetown, P.E.I.

Antoine Terjanian, Census Division (SC. Bldg.) Statistics Canada, Ontario.

David Welch, Department of Geography, University of Winnipeg, Winnipeg, Manitoba.

Barry Wellar, Ministry of State, Urban Affairs, Ottawa, Ontario.

5.8 REPORT OF THE WORKING GROUP ON GEOSCIENCE

Canadian Advisory Committee
on
Remote sensing for the year 1972

5.8.1 The Working Group was organized during the spring and summer of 1972. Current membership (14) of the Working Group (see Appendix 2) represents a broad range of interests as well as universities, industries and several levels of government across Canada.

5.8.2 Meetings of the Working Group on Geoscience, 1972

1. The Working Group held one meeting (Sept. 25) which served to inform the members about current developments in the Canadian program of remote sensing and about the status of the ERTS and SKYLAB experiments.

2. The Working Group proposed to assess the involvement of Canadian geoscientists in remote sensing by circulating a questionnaire. An initial draft of the questionnaire was prepared by Dr. Parry and Dr. Tanguay, and was circulated to members of the Working Group for comments. A revision was prepared by Dr. Gregory on the basis of comments received and this draft was prepared for mailing in 1973.

3. The Working Group noted that rocks and soils are the background in which other observations and measurements are made. Thus a competency in geoscience, particularly for surficial materials, was considered important to the mission of the Applications Division of CCRS.

4. The needs for a specialized training course and for closer interdisciplinary liaison were discussed but further consideration appeared necessary.

5.8.3 Recent Developments

1. Ecole Polytechnique has the nucleus of a multidisciplinary centre involving 3 professors:

   Dr. Robert Dufresne, Elect. Eng., instrumentation;
   Dr. Guy Faucher, Eng. Phys., image enhancement; and
   Dr. Marc Tanguay, Geol. Eng., applications and interpretation, spectral reflectance of rocks.

   Two graduate students are completing theses on (1) optical Fourier transforms and filtering, and (2) spectral reflectance of (volcanic) rocks. Another graduate student is starting further studies on the spectral reflectance of rocks.

2. A major exploration and mining company is planning to study the environments of its mining and processing facilities when relevant ERTS images become available. It has experimented with several methods of remote sensing and is assessing the possible use of ERTS enlargements (1/30,000) as base maps for airborne surveys. Other companies in the mineral industry are known to have interests in remote sensing, but the extent of their involvement is not known to the Working Group. At least one oil company is reported to have used airborne remote sensing for environmental studies in Western Canada.

5.8.4 Results of Remote Sensing Projects Relevant to the Geosciences

1. Twelve papers on the use of remote sensing in studies of various aspects of the terrain may be found in the Proceedings of the First Canadian Symposium on Remote Sensing (Feb. 1972)

2. Dr. D.C. Ford of McMaster University is assessing the use of airborne CIR photography to locate fractures and hydrological anomalies in the South Nahanni River area, NWT. Despite forest fire haze, the small-scale prints are reported to be better than conventional black and white photography for identifying boggy ground.

3. Dr. J.T. Parry of McGill University completed a preliminary analysis of the ERTS false-colour composite for the Montreal area. His annotation and overlay were to be used in a display prepared by CCRS in 1973.

4. Dr. R. Steffensen, consultant in Ottawa, completed a study of linears on ERTS images of the Gaspé Peninsula. His work will be reported at the NASA symposium on ERTS-1 in March, 1973, and at the annual meeting of the CIM in April, 1973.

5. Dr. A.F. Gregory, consultant in Ottawa, completed a preliminary assessment of two ERTS images in the Mackenzie Mountains, Yukon and two for Bathurst Inlet, NWT.

5.8.4 Con't

The preliminary assessment will be expanded for presentation to the NASA symposium on ERTS-1 in March, 1973. Among other things these studies show that seasonal images provide useful and sometimes different geological information. Snow cover, for example, suppresses terrain noise and the uniform surface combined with low sun angle serves to enhance texture, structure and relief.

5.8.5 Participation in Training

1. An unknown but significantly large number of persons with geoscience interests attended symposia on remote sensing in Ottawa and Ann Arbor, Michigan. A few attended training courses in Houston, Berkeley, Purdue and Ottawa.

2. Dr. J.T. Parry conducted a field trip and Dr. A.F. Gregory lectured on geological applications, both for the training course in Ottawa in September, 1972. Dr. R.L. Christie of the Institute of Sedimentary and Petroleum Geology in Calgary reviewed the Ottawa course for his institute and also for the GSC in Vancouver.

5.8.6 Publications and Talks

Members of the Working Group have noted the need for wider dissemination of the results of studies, particularly those related to applications. Six papers and the proceedings of a symposium (Appendix 1) have been brought to our attention as products of 1972. At least six more papers relevant to the geosciences are in preparation.

5.8.7 "Customer" Relations with CCRS

1. Airborne Surveys

One user reported difficulties in receiving data of good quality for his area of interest. In part, this was the result of haze from forest fires. He suggested that the airborne schedule might be organized to permit reflights, particularly for remote areas where the acquisition of concurrent ground truth is difficult to mobilize.

2. ERTS-1

2.1 Several reports have indicated that the ERTS-1 images produced by CCRS, and especially those of recent months,

2. Con't

2.1 are of exceptionally high quality although the geometry of precision-corrected images is not of cartographic quality.

2.2 While the processing difficulties at CCRS (and for that matter, NASA also) are known to some users, members of this Working Group noted many complaints about non-delivery of orders with delays of 4 - 6 months being cited.

2.3 One user has suggested that the indexing and ordering of images might be improved by using orbit and image number rather than geographic co-ordinates. Several users have indicated a need for some sort of index map indicating seasonal coverage of those parts of Canada for which good images of the terrain are available. At this early stage a composite map of available coverage might also be useful.

5.8.8 Specialized Training Course

There is a general consenus among members of the Working Group that a specialized training course is needed to emphasize applications in the geosciences. However, about half the members who provided information for this report suggested that such a course should await further studies and results. A general course with several specialized sessions might be a useful approach at the present time. A broader survey of needs for specialized training comprises part of the questionnaire previously mentioned (see 5.8.2, No. 2).

5.8.9 Forecast of Needs for Remotely-Sensed Data

1. The Working Group did not receive any proposals for remote sensing in 1973 and hence was not required to review, recommend or allot priorities to such proposals. The Quebec Department of Natural Resources noted a developing interest in the use of remote sensing to map geological structures and assist in geotechnical studies. Needs for colour, IR, CIR and radar were indicated and presumably specific requests will be made. Similarly, several other geoscience agencies appear to have projects in the early stages of formulation.

5.8.10 Progress in the Use of Remote Sensing in the Geosciences

During 1972, many potential users of remotely-sensed data continued to view the activity as very experimental. A small number of knowledgeable users assessed potential applications for a variety of data. Undoubtedly, the wide availability of ERTS-1 data will greatly alter this situation in 1973, as has already been demonstrated by the recent surge of interest in the use of ERTS images by previously uninvolved members of the geoscience community. The current main use appears to be interpretation of regional structure and similar information to assist the planning of exploration and mapping projects. Precise geometric correction is not required for these uses.

5.8.11 Recommendations

1. CACRS should consider the means of providing a strong interdisciplinary team for the Applications Division of CCRS including, in the view of this Working Group, a geoscientist with a broad knowledge of surficial materials.

2. CACRS should consider the means of improving interdisciplinary liaison. As a start, the minutes of all Working Groups might be circulated to all other Working Groups.

3. CACRS should consider the means of attaining closer liaison with users of remotely-sensed data, especially for airborne surveys in remote areas.

4. CACRS should consider the need to expedite production of ERTS images.

5. CACRS should consider the need for CCRS to provide more adequate feedback to users, especially those with long outstanding and unfilled orders.

6. CACRS should consider alternative means of providing training for the interpretation of remotely-sensed data, including the need for specialized training.

APPENDIX 1:

BIBLIOGRAPHY OF RELEVANT RECENT PUBLICATIONS

1. Proceedings of the First Canadian Symposium on Remote Sensing, February 1972, CCRS.

2. J.T. Parry and C.M. Gold. "A shadow height nomogram," Photogrammetric Engineering, Vol. XXXV III, No. 10, 1972, pp. 891-899.

3. J.T. Parry, Remote sensing techniques in the detection and surveillance of oil pollution in Canadian waters, Report under Contract OGR2-0293, Marine Sciences Directorate, Dept. of the Environment, November, 1972.

4. J.T. Parry and J. Beswick. The application of two morphometric terrain classification systems using air photo interpretation methods. Rept. 01GR-7090061 Defence Research Board of Canada, November, 1972.

5. Gregory, A.F. "A Possible Canadian Role in Future Global Remote Sensing", preprint 72-742 of paper presented at the CASI/AIAA Meeting "Space - 1972 Assessment", Ottawa, July 1972; in press, Canadian Aeronautics and Space Journal.

6. Gregory, A.F., "Potential Applications of Remote Sensing in the Oil Industry", paper presented to the 11th Annual Conference, Ontario Petroleum Institute, October 1972 (in press).

7. Gregory, A.F., "ERTS-1 Brings Mining New Perspective ", Northern Miner, November 30, 1972, p. 45.

APPENDIX 2:

MEMBERS OF WORKING GROUP ON GEOSCIENCE

CACRS

Dr. A.F. Gregory, Chairman. Geoscience Consultant, 909 Richmond Road, Ottawa, Ontario. K2A 0G8. 729-5563 3-3350

Dr. A.E. Christiansen, Geology Division, Saskatchewan Research Council, Saskatoon, Saskatchewan. (306)343-9506

Dr. R.L. Christie, Institute of Sedimentary and Petroleum Geology, 3303 - 33rd St. N.W., Calgary, Alberta. T2L 2A7

Dr. G.L. Colgrove, Chief Geologist, International Nickel Company of Canada, Toronto-Dominion Centre, Toronto, Ontario. 186-9-362-6311

Dr. A. Darnley, Chief, Regional Geophysics and Geochemistry Division, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario. 4-5789

Dr. D.C. Ford, Department of Geography, McMaster University, Hamilton, Ontario. 164-9-522-4971

Mr. H.A. Hittel, Shell Canada Limited, P.O. Box 880, Calgary, Alberta. (also representing Can. Petroleum Assoc.) (403)261-3600

Mr. R. Hornal, Resident Geologist, Department of Indian and Northern Affairs, Yellowknife, N.W.T. (709)873-4421

Dr. André Laurin, Directeur, Services géologiques, Ministère des Richesses naturelles, 1640, Boulevard de 1'Entente, Québec 6, Qué. 187-9-643-4606

Dr. J.T. Parry, Department of Geography, McGill University, Montreal, P.Q. 183-9-392-5496

Dr. B.R. Pelletier, Chief, Marine Geology, Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, N.S. (902)426-3703

Dr. M.G. Tanguay, Ecole Polytechnique, 2500 Ave. Marie-Guyard, Montreal 250, P.Q. 183-9-344-4731

Mr. N.H. Ursel, N.H. Ursel Associates Ltd., Suite 210, 2399 Cawthra Road, Mississauge, Ontario. 186-9-270-1624

Dr. J.O. Wheeler, Chief, Regional and Economic Geology, GSC, 601 Booth Street, Ottawa, Ont. 4-9224

5.9 REPORT OF THE WORKING GROUP ON HYDROLOGY

5.9.1 Summary of Meeting, Sept. 22, 1972

After an introduction to the organization of CCRS and the structure of various advisory and working groups, the members were given a tour of the facilities at 2464 Sheffield Road.

The members reported on remote sensing activities in their various disciplines and geographical areas. These are included in the projects.

Dr. I. Brown and Mr. J. MacDowall presented an outline of a course for Water Resource Managers which would introduce them to the technology of remote sensing. This course is planned to be one in the series of seminars on the Principles of Hydrology which has been organized by the Canadian National Committee for the International Hydrologic Decade. A decision has since been made to defer the course indefinitely.

Various announcements of meetings and courses were made and also mailed to the members.

5.9.2 Highlights of Discussion

i) Review of Proposals

There was much discussion regarding the procedure for reviewing projects submitted to CCRS. It was felt that if provincial working groups were asked to review projects without reference to the discipline-oriented groups, not many hydrological projects would reach this working group. This might result in well co-ordinated provincial programs, but a lack of consolidation of programs in a discipline on a national basis.

ii) Key Problems: Snowcover and Soil Moisture

Two aspects of the problem of estimating water storage were identified as being of special interest to the majority of the members of the working group. These are the water equivalent of snow and soil moisture.

After the meeting, Mr. J. Sporns submitted proposals for projects to map snow-cover from satellites and to use radioactive methods for estimation of the water equivalent of snow. These will be discussed and possibly followed up during 1973.

5.9.3 Evaluation

The first meeting served to acquaint the membership with the field of remote sensing and with each other.

In order to show those topics within the general field of hydrology in which there is the most remote sensing activity, the projects listed in the appendices were classified as follows:

Topic	Number of projects
Snow and ice cover	20
Preceipitation	2
Soil Moisture and permafrost	4
Groundwater and hydrogeology	2
Evapotranspiration	0
Limnology (including pollution, biological, and energy transfer studies)	16
Rivers and estuaries	7
Instruments and methodology	3
Miscellaneous (including multi-disciplinary studies)	10
TOTAL	63

It is apparent from this listing that not many investigators are tackling the difficult problem of soil moisture sensing. On the other hand, there are many projects concerned with the remote sensing of snow and ice properties. A large area of common interest between the hydrology and limnology working groups is evident.

5.9.4 Future Activity

The working group hopes to be able to formulate and pursue a co-operative program for attacking the two problems identified. A Task Force was formed at the January, 1973 meeting to outline an approach for a national snow monitoring program. The working group maintains an interest in the development of soil moisture instrumentation being managed by the Sensor Working Group.

In addition, an increased awareness of programs carried out throughout Canada should lead to better co-ordination among provincial and regional experiments.

APPENDIX 1:
IHD PROJECTS WITH REMOTE SENSING CONTENT

SURFACE TEMPERATURE AND EVAPORATION REGIMES ON NORTHERN LAKES - AIRBORNE RADIATION THERMOMETER SURVEYS

File Ref.: BD-L-4 NORTH-1

UNESCO Res.: I-1 (I-44)

Objectives: Generally, participation in a survey of the water resources of Canada. Specifically, to estimate the annual cycle of surface-water temperature of a number of lakes in Northern Ontario and to qualitatively relate this to the causative factors; to estimate monthly evaporation losses from these lakes.

Instrumentation: Airborne infrared radiation thermometer; first order meteorological stations.

Progress During 1971 Field Season: Field work completed in 1969.

Plans for 1972: Major report in press; further analysis of data is planned.

Co-operating Agencies: Ontario Water Resources Commission, and Department of Energy, Mines and Resources.

Co-ordinator: Mr. T.L. Richards, Superintendent of Hydrometeorology, Atmospheric Environment Services, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario.

Publications: In Press: Richards, T.L., and Webb, M.S.: "Water Temperature and Evaporation Regimes and Freeze-up Characteristics of Selected Lakes in Northern Ontario", Climatological Studies No. 18, Canadian Meteorological Services, 1971.

BAKER CREEK BASIN

File Ref. IWB-RB-44 NORTH-9

UNESCO Res.: VI-6

Objectives: To provide a better measure of the variables in the water balance equation for this basin so that we might understand the relationships better for a Northern Subarctic environment with permafrost.

Instrumentation: Two hydrometric stations, 2 water level gauges, 4 snow gauges, 8 snow stakes, 1 recording precipitation gauge, 1 recording rain gauge, 4 standard rain gauges, 1 hygrothermograph, 8 soil temperature sites, 4 frost plugs, 1 vertical temperature profile, 4 max. and min. thermometers above ground, 4 max. and min. thermometers on the ground surface, a weather office at the airport.

Progress During 1971 Field Season: Continued with measurements of precipitation patterns. Installed additional temperature recording instruments for permafrost, soil and lower air temperature records (from Stevenson screen level to 50 ft. below surface in 8 sites). Completed mapping from air photos procured previously.

Plans for 1972: Continue with measurements of water balance patterns. Observe subbasin flow and relate to surface material patterns. Add net radiation and evapotranspiration measuring facilities and relate the results of each to each other. Add infra-red thermal photography with ground control.

Co-operating Agencies: Atmospheric Environment Service, Department of the Environment; Department of Indian Affairs and Northern Development; University of Alberta Institute of Earth and Planetary Physics (initial co-operative work in 1972 leading to stronger co-operation in 1973 and 1974); Northern Research Division, National Research Council (on permafrost - Dr. R.J.E. Brown); Laval University (on permafrost and streamflow - Dr. M. Frenette).

Co-ordinator: Dr. A.H. Laycock, Department of Geography, University of Alberta, Edmonton, Alberta.

Publications: Not Previously Reported: Ph.D Thesis: Kakela, P., 1969, "Snow and The Thornthwaite Balance in a Subarctic Environment", University of Alberta (unpublished). M.Sc. Thesis: Landals, A., 1970, "Variations in the Volume of Surface Runoff During the

APPENDIX 1 CON'T:

Publications Con't:

Snowmelt Period, Yellowknife, N.W.T.", University of Alberta (unpublished).

AREAL VARIABILITY OF PRECIPITATION

File Ref.: R-ALI-34 CAN-26

UNESCO Res.: I-29

Objectives: To study small scale time and space variations in precipitation. Related secondary studies include comparisons of precipitation gauges and observations of rainfall, snowfall, snow depth and accumulation.

Instrumentation: Integrated with the Bad Lake Project, IWB-RB-29, SASK-64, 12 Fischer-Porter Gauges; 34 Tipping Bucket Gauges; 5 Nipher Snow Gauges; 56 Standard Rain Gauges.

Progress During 1971 Field Season: In 1971, major effort has been directed to "Quality Control" of the precipitation measurements. Calibration tests were made on all of the Tipping Bucket Gauges. The depth measurements from these gauges have been compared with those obtained from "Standard" gauges. Work is now in progress in storing these data in computable, digestible form.

Work was also continued in effort to compare the relative water equivalent - obtained from ground survey measurements with those measured by the shield "Fischer-Porter" Gauges.

Plans for 1972: (a) Continuation of measurements of precipitation in context of the objectives of the program. (b) Continuation of the study of the areal distribution of snow - this program will be enlarged to include measurements of gully catch by gamma transmission techniques. (c) Analyses and processing of the collected data - this will be supported by topographic information which has been obtained giving a contour map of the area on a 2-foot contour interval.

Co-operating Agencies: Division of Hydrology, College of Engineering, University of Saskatchewan.

Co-ordinator: Mr. H.L. Ferguson, Atmospheric Environment Service, Department of the Environment, 4905 Dufferin St., Downsview, Ontario.

Publications: Not Previously Reported: Gray, D.M., Dycke, G.E., and O'Neill, A.D.J.: "Spatial and Temporal Variations of Densities and Albedos of Prairie Snowpacks". Res. Paper No. 6, Division of Hydrology, University of Saskatchewan, Saskatoon. Paper to be submitted for publication in Proceedings of the IHD/UNESCO/WMO sponsored Symposia on the Role of Snow and Ice in Hydrology, Banff, Alberta, September 1972.

REMOTE AIRBORNE TECHNIQUES

File Ref.: R-GW-9 CAN-6

UNESCO Res.: VI-4

Objectives: To evaluate some airborne techniques as applied to hydrology.

Instrumentation: Laser Fluorometer, Natural Gamma Radiation measurement system.

Progress During 1972 Field Season: A new version of the fluorometer has been built. Selection of components was based upon the experience gained with the first model. Laboratory experiments are encouraging, but no positive field results are available. During a test flight over an oil spill on the St. Lawrence, the need for better visual confirmation of the illuminate area became apparent.

In a joint project with the Geological Survey of Canada (GSC) and other agencies, a test survey of snow-cover in southern Ontario is being carried out using the GSC aircraft and instrumentation for monitoring natural gamma radiation patterns without snow were made in late 1972.

Plans for 1973: Further airborne tests for the fluorometer using controlled and accidental spills ate planned. A ground-based mobile version is

APPENDIX 1 CON'T:

Plans for 1973 Con't

being assembled.

Monthly flights of the gamma radiation survey are planned for January, February and March of 1973. Analysis of data and project evaluation will follow.

Co-operating Agencies: Laser Fluorometer: Water Quality Branch, Inland Waters Directorate;

and Canada Centre for Remote Sensing, Department of Energy, Mines and Resources

Natural Gamma Survey:

1. Geological Survey of Canada, Department of Energy, Mines and Resources;
2. Atmospheric Environment Service, Department of the Environment;
3. Great Lakes - St. Lawrence Study Office, Department of the Environment;
4. Ontario Hydro;
5. Ontario Ministry of Natural Resources;
6. Ontario Water Resources Commission;
7. Rideau Canal Services;
8. Trent University;
9. Others.

Co-ordinator: J. Kruus, Remote Sensing and Instrumentation, No. 8 Temporary Building, 870 Carling Avenue, Ottawa K1A 0E7, Ontario.

Publications: H. Gross, A. Davis, J. Kruus: Remote Sensing of oil on water using Laser induced fluorescence; AIAA Paper No. 71-1076; presented at Joint Conference on Sensing of Environmental Pollutants, Palo Alto, California, November 8-10, 1971.

P.A. Carr and H. Gross: Investigation of Infra-red anomalies in the Lac des Deux Montagnes area, Quebec; Inland Waters Directorate, Water Resources Branch; Ottawa, 1972; Scientific Series report No. 19.

EVALUATION OF WEATHER SATELLITE DATA FOR HYDROLOGIC PURPOSES

File Ref.: R-SIG-3 CAN-10

UNESCO Res.: IV-5 (IV-8)

Objectives: To study the application of satellite data to Canadian hydrologic problems such as snow cover in remote regions, ice cover on remote lakes, and snowpack in mountainous areas.

Instrumentation: Glossy prints obtained from the Meteorological Satellite Data Laboratory in Toronto are being used.

Progress During 1971 Field Season: A revised draft of a report on the freeze-up and break-up of lakes was begun.

Plans for 1972: The above report is to be presented to the First Canadian Remote Sensing Symposium at Ottawa, February 7-9, 1972. It is planned to continue studies using ERTS satellite data as they become available.

Co-operating Agencies: Atmospheric Environment Service, Department of the Environment.

Co-ordinator: Mr. H.L. Ferguson, Atmospheric Environment Service, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario.

RADIO-ECHO SOUNDING OF TEMPERATE GLACIERS

File Ref.: R-ID-5 CAN-37

UNESCO Res.: V-6

Objectives: 1971: To demonstrate the technique of radio echo sounding on temperate glaciers. To develop analysis techniques and interpretive computer software.

1972: To evaluate and identify various requirements for ice depth measurement. To understand the nature and causes of intra glacier echoes and their role in glacier hydrology and motion.

APPENDIX 1 CON'T:

Instrumentation: Radio echo sounding system operating at 620 MHz, complete with positioning and data handling units. Mounted on a Foremost Sure-Go tracked vehicle.

Progress During 1971 Field Season: Field trials conducted on Athabasca Glacier demonstrated the reproducibility of the system, both on a short term and long term basis. A rapid time varying glacier intrastructure was also noted, but due to mechanical problems, these features could not be further studied.

Plans for 1972: Spring - Ice-gravity work in Alaska, probably Malespina Glacier, Helicopter operation. Summer - Water table studies on Athabasca Glacier. Surface vechile. Fall - Overhaul. Winter - Permafrost studies if funding can be obtained.

Co-operating Agencies: 1971 - None. 1972 - Pemcan Ltd., Calgary.

Co-ordinator: Dr. R.H. Goodman, Inland Waters Branch, Department of the Environment, Ottawa K1A 0E7, Ontario.

Publications: Three in process of preparation.

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

File Ref.: R-L-7 CAN-27

UNESCO Res.: I-44

Objectives: Overall: The objectives of the IFYGL, established jointly with the U.S.A., are to understand the Lake Ontario drainage basin well enough to ensure that its water will always be sufficient and of good quality; and to improve the management of operations that can harm the environment, and assist operations that are affected by environmental conditions.

Progress During 1971 of Remote Sensing Program: On May 29, 1971, the third 60,000 ft. altitude NASA over-flight of the western Lake Ontario basis was undertaken. The previous flights were conducted on July 6, 1970 and October 19, 1970. The 10,000 sq. mile area extended south from latitude 44°20' to 42°45' N and west from 78°15' to 80°20' W. All flights were timed to simulate the lighting conditions planned for the U.S. Earth Resources Technology (ERTS) satellite, which is now due for launching on March 30, 1972. A major objective of this feasibility study is to fill gaps in our knowledge of the groundwater (soil moisture component) storage terms, but limnological information for CCIW scientists was also obtained. There were indications of internal waves, the turbulent characteristics of large plumes was noted, and observations were made of sediment transport in coastal regions. The land basin studies were undertaken at Guelph and McMaster universities with support from the United States Geological Survey. At Guelph, a technique was developed to derive consistent and representative tonal values and density readings from the photographs.

The Status of Canadian Projects with Remote Sensing Content

The following is a brief account of the status of each project as of July 31, 1972. The IFYGL designation, the principal agency and the principal investigator will be given in each case.

1. IFYGL Project IF

Principal Agency - Canada Centre for Inland Waters
Principal Investigator - K.P.B. Thomson

Object: To study the main thermal features and their effects on large-scale water circulations, using remote sensors. (CCRS/CCIW).

(a) Low Level IR Surveys:

The first phase of this experiment was carried out during the month of May. Severe fog conditions on Lake Ontario made data collection difficult and at times impossible. However, relatively good imagery was obtained on the following days: May 11, 18, 19 and 29.

APPENDIX 1 CON'T:

1. IFYGL Project IF (Con't)

(a) Con't

The sensor package flown in the Airborne Sensing Unit's Dakota contained a Daedalus line scanner, PRT-5 radiometer, and two Vinten cameras. Measurements of lake surface temperature and bathythermographs were obtained by a CCIW launch during each aircraft survey.

(b) High Level Scanner Survey:

The first phase of the high altitude survey of Lake Ontario was carried out by the CCRS Falcon aircraft on June 7, 1972. Unfortunately, only part of the project was completed due to poor weather conditions.

The Atmospheric Environment Service airborne radiometer survey was able to merge its operation to coincide with the overflight.

(c) Aerial Photography for Coastal Diffusion Studies:

A number of missions have been carried out near Oshawa in support of the Turbulent Diffusion Studies project (89 and 90 WM) using an aircraft on charter to CCIW. The aircraft, a Piper Comanchee, is equipped with two Hasselblad 70 mm cameras, a PRT-5 radiation thermometer, as well as humidity and air temperature sensors.

Some initial tests of the PRT-5 and complementary atmospheric sensors were carried out during the May alert period at the Air-Water interaction study site 2 km offshore near Niagara-on-the-Lake. It is hoped that some other flights of this nature can be made during other alert periods.

2. IFYGL Project 84BC

Principal Agency - Ontario Ministry of the Environment

Principal Investigator - G. Owen

Object: To survey the extent of Cladophora growth by means of overflights and ground parties. (CCRS/OWRC)

A number of photographic surveys have been carried out by CCRS aircraft over selected areas of the North shore of Lake Ontario as part of the Cladophora program. The flights were completed on June 5, 9 and July 5, 1972.

The writer has recently seen some examples of the photography and they appear to be of exceptional quality. They should provide a useful data source for this important project.

During the photographic missions it is planned to undertake tests of some new remote sensing devices. The first test, using the SPAR image intensifier tube, was carried out on the July 5th mission.

The University of Michigan also plan to fly their multispectral scanner at some time during cladophora survey.

3. IFYGL Project 70 WM

Principal Agency - Centre for Applied Research, McMaster University

Principal Investigator - A. Falconer

Object: To obtain surface observations of time-dependent data from the western end of the lake and the land part of the basin.

This project involves a number of agencies in the western Lake Ontario basin. For example, the Universities of Guelph and McMaster, as well as Provincial and Federal Government departments.

The photographic overflights of the western Lake Ontario basin, by a NASA RB57 aircraft, occurred on June 5th and 7th. The multispectral photography should be available for analysis in approximately 6 weeks from the time of the overflight.

4. IFYGL Project 94

Principal Agency - Canada Centre for Inland Waters

Principal Investigator - H.W. MacPhail

Object: To measure lake parameters in a remote or hostile environment and relay data in real time via satellite, using buoys with sensors, and a monitor receiver, and also collection data via the U.S. GOES satellite at a later stage. (CCIW)

APPENDIX 1 CON'T:

4. IFYGL Project 94 (Con't)

(a) IRLS Data Retransmission Experiment:

This project is a co-operative venture between CCIW and the NASA-LEWIS Research Centre in Cleveland, Ohio. The experiment will utilize the data retransmission facility of the NIMBUS IV satellite to track a buoy floating freely in Lake Ontario.

The IRLS interrogation package and the buoy have been provided by the NASA-LEWIS Research Centre, while CCIW has undertaken to provide a major ship to release and service the buoy. Mr. R.I. Jirberg is the principal co-operating scientist for the NASA-LEWIS Centre.

The buoy was released on July 17, in centre of Lake Ontario. the NIMBUS IV satellite interrogates the buoy every 12 hours and relays its positions as well as readings of air temperature and water temperature (at a depth of 2 meters).

It is hoped that this experiment will lead to information on near surface circulations in Lake Ontario.

(b) ERTS DCP Experiment:

Now that ERTS is "safely aloft", the second data retransmission experiment will commence at the beginning of August. Air temperature, humidity ad water temperature will be relayed from a moored buoy via the ERTS data retransmission facility. After initial tests at CCIW the buoy will be moved to the Niagara IFYGL test site. The buoy is expected to operate for 3 months without attention and the plan is to keep it in operation until December 1, 1972.

5. IFYGL Project 92

Principal Agency - Canada Centre for Inland Waters

Object: To evaluate high-resolution photography as an aid to bio-limnological investigations, and to provide remote sensing support for coastal projects.

6. IFYGL Project 23

Principal Agency - Atmospheric Environment Service

Object: To use precipitation observations from all sources, including radar, in obtaining the distribution of precipitation in time and space during the Field Year. (AES)

7. IFYGL Project 91

Principal Agency - Canada Centre for Inland Waters

Object: To investigate surface thermal features by aerial survey techniques. These features have a bearing on water movement studies and lake temperature effects.

8. IFYGL Project 16

Principal Agency - Atmospheric Environment Service

Object: To make weekly airborne radiation thermometer surveys over the lake, and issue maps showing the isotherms of surface-water temperature. (AES)

APPENDIX 2:

CANADIAN FORESTRY SERVICE

ERTS EXPERIMENTS OF HYDROLOGIC INTEREST

October, 1972

Experiment	Subject (location)	Investigator
FMI-4	Drainage basin study (Rideau River, S. Ontario)	W.C. Moore, FMI
FMI-5	Delineation of forest flooding (Rideau River, Ontario; Red River, Manitoba)	W.C. Moore, FMI
AL-1	Chinook snowpack sublimation (S.W. Alberta)	D.L. Golding, NFRC
AL-4	Snow-melt patterns (Alberta)	J.M. Powell, NFRC

FMI: Forest Management Institute, Ottawa

NFRC: Northern Forest Research Centre, Edmonton

APPENDIX 3:

ERTS EVALUATION CONTRACTS APPROVED BY LAKE RESOURCES SUBDIVISION CANADA CENTRE FOR INLAND WATERS

Contractor	Project Title
Acres Consulting Services	Studies on ice, Niagara River
Erindale College, Geography Department	Studies on western basin, Lake Ontario
McGill University, Geography Department	Freeze, break-up of lakes in Quebec, Labrador
Saskatchewan Research Council	Limnology, Hydrology of Big Quill Lake
University of Alberta, Geography Department	Surface and Groundwater inventory, N. Alberta and Yukon
CENTREAU	Hydrology, Limnology of St. Lawrence

More complete project descriptions and results are available from:

Dr. R.K. Lane,
Canada Centre for Inland Waters,
P.O. Box 5050,
Burlington, Ontario.

APPENDIX 4:

ERTS EVALUATION CONTRACTS LET BY WATER RESOURCES BRANCH, DEPARTMENT OF ENVIRONMENT, OTTAWA

CONTRACTOR	PROJECT TITLE	DESCRIPTION
1. I.D. Mollard and Associates Ltd.	Groundwater hydrology and hydro-geological studies.	A comparison between ERTS imagery and aerial photography as indicators of vegetation and hydro-geologic features indicative of aquifers.
2. Canadian British Engineering Consultants (1971) Ltd.	Evaluation of imagery from ERTS as a source of hydrologic data in the Canadian North.	A study of the feasibility of direct estimation of water storage and an estimate of value of information from ERTS images added to a comprehensive hydrologic model.
3. CARED, McMaster University	Evaluation of ERTS-A imagery for the interpretation of snow cover.	An area in Southern Ontario has been chosen for comparing ERTS imagery to other in formation
4. CARED, McMaster University	Evaluation of ERTS-A imagery for Hydrologic Mapping	To map drainage systems in Southern Ontario from ERTS imagery and to compare with other methods.

APPENDIX 5: AIRBORNE TASKS OF CCRS OF INTEREST TO WORKING GROUP ON HYDROLOGY

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Date Flown	% Complete
72-2 CF100	Mr. L.G. Timson	Photogrammetry Section, Dept. of Transportation and Communications, Postal Bag 4000, Kingston, Ontario.	To study and assess snow drift patterns as they affect Provincial highways and roads.	Alexandria, Ont.	February 5 March 9	66.6
72-3 C47	Mr. L.G. Timson	Photogrammetry Section, Dept. of Transportation and Communications, Postal Bag 4000, Kingston, Ontario.	To study and assess snow drift patterns as they affect Provincial highways and roads.	Alexandria, Ont.	January 8 February 23 April 20	100.0
72-6 A/C TBA	Dr. J. Kruus	Inland Waters Directorate, Dept. of the Environment, No. 8 Temporary Building, Room H-305.	To test laser fluoro sensor system	TBA	CANCELLED	
72-7 CF100	Mr. D.L. Golding	Northern Forest Research Centre, CFS, 5320 - 122 Street, Edmonton 70, Alberta.	To determine areas of snow pack disappearance during chinooks and its relation to elevation and land forms.	Banff National Park, Alberta	CANCELLED	
72-8	Mr. D.L. Golding	Northern Forest Research Centre, CFS, 5320 - 122 Street, Edmonton 70, Alberta.	To determine areas of snow pack disappearance during chinooks and its relation to elevation and land forms.	Banff National Park, Alberta	CANCELLED	
72-9	Mr. C. Pellegrin	Ministry of Transport, Marine Hydraulics Branch, Hydraulics Studies Division.	Record ice conditions. Determine ice thickness and type. Locate ice cracks and ridges.	St. Lawrence River, Montreal, Trois Rivieres.	February 5 April 7	66.6
72-10 CF100	Dr. S.B. McCann	McMaster University Coastral Research Program	To obtain information on late winter ice conditions at spring break-up.	New Brunswick, P.E.I.	March 7 May 9	100.0

APPENDIX 5: (Con't)

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Data Flown	% Complete
72-12 C47	Dr. J.N. De Villiers	Sensor Section, Data Acquisition Division, Canada Centre for Remote Sensing.	A study of Cladophera in association with Ontario Water Resources Commission using the spar image disector multispectral camera with 70mm camera back up.	Lake Ontario (Spar)	June 5, June 19 July 5 July 17	100.0
72-13 C47	Dr. J.R. Miller	York University, Faculty of Science, Downsview, Ontario.	To obtain reflection spectra from coniferous vegetation and from water and ice using the scanning interference filter photometer.	Ottawa - Toronto Lake Ontario	March 9 September 20	100.00
72-14 FALCON	Dr. K.P.B. Thomson	Canada Centre for Inland Waters, 867 Lakeshore Road. Box 5050, Burlington, Ontario.	Synoptic observation of Lake Ontario in support of IFYGL projects.	Lake Ontario	June 7 August 29	66.6
72-15 C47	Dr. K.P.B. Thomson	Canada Centre for Inland Waters, 867 Lakeshore Road, Box 5050, Burlington, Ontario.	Investigation of the time scale of dominant thermal features, and their relation to large scale circulations on Lake Ontario.	Oshawa	May 10, 18, 19, and 28 August 15, 21,25	100.0
72-18 CF100	Mr. J.M. Henderson	Canada-New Brunswick, Lorneville Environmental Impact Study, P.O. Box 277 - Post Office Building, Fredericton, N.B.	Evaluation of remote sensing techniques for data gathering for use in a variety of disciplines.	St. John, New Brunswick	April 13	100.0

APPENDIX 5: (Con't)

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Date Flown	% Complete
72-73 FALCON	Mr. E.J. Langham	Centre Quebecois des sciences de l'eau, (CEQUEAU), Instant national de la recherche scientifique, (INRS) Université du Québec.	a) To establish present boundaries of the reservoir. b) To investigate ecological damage due to flooding. c) To measure the distribution of superficial temperature of the reservoir.	Lake Manicouagan, Quebec.	October 25	100.0
72-92 FALCON	Jean Thie	Manitoba Remote Sensing Comm., 1301 Ellice Avenue, Winnipeg, Manitoba.	To evaluate high altitude remote sensing data for comprehensive watershed management.	North Manitoba Morris Watershed	August 19	100.0
72-93	Dept. of Mines, Resources and Environmental Management, Winnipeg, Manitoba.		To obtain high altitude remote sensing data for comprehensive watershed management by multi-disciplinary team.	Turtle watershed, Manitoba.	August 19	100.0
72-95 FALCON	Mr. C. Tarnocai		To evaluate environmental changes with remote sensing techniques.	Target of Opport. Manitoba.	August 14	100.0
72-96 FALCON	Mr. Jack Leggett	Fish & Wildlife Branch, Parliament Buildings, Victoria, B.C.	A multi-disciplinary study of remote sensing along Dean River and vital tributaries.	Dean River, British Columbia	August 9	100.0
72-104 C47	Mr. J.F.R. Gower		To obtain a surface temperature profile of Babine Lake for Lake circulation study.	Babine Lake, British Columbia		0.0

APPENDIX 5: (Con't)

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Date Flown	% Complete
72-108 C47	Mr. R. Kenneth McMillan	Department of Physics, University of Waterloo, Waterloo, Ontario.	The thermal plume dissipation from the Pickering Nuclear Power Station.	Pickering, Ontario.		0.0
72-110	Mrs. I. Wile	Ministry of the Environment, Water Quality Branch, Biology Section.	To determine aquatic plant cover in the Kawartha Lakes.	Kawartha Lakes	August 21, 31 September 15	100.0
72-111	Dr. M. Dickman	University of Ottawa, Biology Department.	To establish a base-line for interpret-ation of changes in aquatic vegetation.	Ottawa River, Gatineau.	August 19 September 5, 15	100.0
72-112	Mr. Jean Thie		To evaluate remote sensing data on north-ern inventories in boreal areas by multi-disciplinary group.	Thompson, South Bay, Manitoba.		0.0
72-120 FALCON	Mr. Paul E. Vandall Jr.	Dept. of Environment, (Federal) Bedford Institute of Oceanography.	Study the use of Remote Sensing techniques in Coastal Waters.	St. Lawrence, Gaspé	September 20 October 19	100.0
72-125	Prof. Wyman Harrison	University of Toronto, Department of Geography, Erindale College, 3359 Mississauga Road, Mississauga, Ontario.	To study oil spills in the St. Lawrence River.	Riviere-du-Loup	Proposed November	
72-126	Mr. R.O. Ramseier	Dept. of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa.	Interpretation of structure and texture of fresh water ice during formation, growth and decay.	Kingston (Area "A"), Lake St. Clair (Area "B") Lake Erie (Area "C")	Proposed February Proposed March Proposed March	

APPENDIX 5: (Con't)

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Date Flown	% Complete
72-73 FALCON	Mr. E.J. Langham	Centre Quebecois des sciences de l'eau, (CEQUEAU), Instant national de la recherche scientifique, (INRS) Université du Québec.	a) To establish present boundaries of the reservoir. b) To investigate ecological damage due to flooding. c) To measure the distribution of superficial temperature of the reservoir.	Lake Manicouagan, Quebec.	October 25	100.0
72-92 FALCON	Jean Thie	Manitoba Remote Sensing Comm., 1301 Ellice Avenue, Winnipeg, Manitoba.	To evaluate high altitude remote sensing data for comprehensive watershed management.	North Manitoba Morris Watershed	August 19	100.0
72-93	Dept. of Mines, Resources and Environmental Management, Winnipeg, Manitoba.		To obtain high altitude remote sensing data for comprehensive watershed management by multi-disciplinary team.	Turtle watershed, Manitoba.	August 19	100.0
72-95 FALCON	Mr. C. Tarnocai		To evaluate environmental changes with remote sensing techniques.	Target of Opport. Manitoba.	August 14	100.0
72-96 FALCON	Mr. Jack Leggett	Fish & Wildlife Branch, Parliament Buildings, Victoria, B.C.	A multi-disciplinary study of remote sensing along Dean River and vital tributaries.	Dean River, British Columbia	August 9	100.0
72-104 C47	Mr. J.F.R. Gower		To obtain a surface temperature profile of Babine Lake for Lake circulation study.	Babine Lake, British Columbia		0.0

APPENDIX 5: (Con't)

Task	Principal Investigator	Requesting Agency	Missions Objectives	Area	Date Flown	% Complete
72-108 C47	Mr. R. Kenneth McMillan	Department of Physics, University of Waterloo, Waterloo, Ontario.	The thermal plume dissipation from the Pickering Nuclear Power Station.	Pickering, Ontario.		0.0
72-110	Mrs. I. Wile	Ministry of the Environment, Water Quality Branch, Biology Section.	To determine aquatic plant cover in the Kawartha Lakes.	Kawartha Lakes	August 21, 31 September 15	100.0
72-111	Dr. M. Dickman	University of Ottawa, Biology Department.	To establish a base-line for interpret-ation of changes in aquatic vegetation.	Ottawa River, Gatineau.	August 19 September 5, 15	100.0
72-112	Mr. Jean Thie		To evaluate remote sensing data on north-ern inventories in boreal areas by multi-disciplinary group.	Thompson, South Bay, Manitoba.		0.0
72-120 FALCON	Mr. Paul E. Vandall Jr.	Dept. of Environment, (Federal) Bedford Institute of Oceanography.	Study the use of Remote Sensing techniques in Coastal Waters.	St. Lawrence, Gaspé	September 20 October 19	100.0
72-125	Prof. Wyman Harrison	University of Toronto, Department of Geography, Erindale College, 3359 Mississauga Road, Mississauga, Ontario.	To study oil spills in the St. Lawrence River.	Riviere-du-Loup	Proposed November	
72-126	Mr. R.O. Ramseier	Dept. of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa.	Interpretation of structure and texture of fresh water ice during formation, growth and decay.	Kingston (Area "A"), Lake St. Clair (Area "B") Lake Erie (Area "C")	Proposed February Proposed March Proposed March	

APPENDIX 6:

ADDITIONAL REMOTE SENSING PROJECTS OF HYDROLOGIC INTEREST

Mr. G.H. Morton, Water Survey of Canada, Calgary, Alberta.	Areal snow-cover observations of the Fisher-Highwood Mountain ranges.
Mr. D.F. Witherspoon, Great Lakes - St. Lawrence, Study Office, Cornwall, Ontario.	1. Surface water temperature forecasting based upon radiation thermometry. 2. Correlation between ESSA8 imagery and cloud cover to study incident energy.
Mr. U. Sporns, British Columbia Hydro, Vancouver, B.C.	Snowline monitoring from aircraft in British Columbia.
D. MacKay and K.C. Arnold, Glaciology Division, Ottawa, Ontario.	Breakup of the Mackenzie River and Delta.
H.S. Loijens, Glaciology Division, R. Grasty, Geological Survey of Canada and others.	Survey of snowcover using attenuation of natural gamma radiation.

APPENDIX 7:

MEMBERS OF HYDROLOGY WORKING GROUP

Dr. Jaan Kruus, Chairman, Inland Waters Directorate, Department of the Environment, H-303, No. 8 Temporary Building, Ottawa, Ontario. K1A 0E7 (613) 994-9802 994-9438, 994-9895

Dr. Ira Brown, Secretary, Canadian National Committee for IHD, Department of the Environment, No. 8 Temporary Building, Carling Avenue, Ottawa, Ontario. K1A 0E7 (613) 994-9678

Dr. K.S. Davar, Department of Civil Engineering, University of New Brunswick, Fredericton, New Brunswick. (506) 455-9471 Ext. 235

Dr. B. Dousee, Provincial Hydrologist, P.O. Box 2000, Charlottetown, P.E.I. (902) 892-3561

Dr. R.N. Farvolden, Chairman, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario. (519) 885-1211 Ext. 3791 (Gov't.: 169)

Mr. H. Ferguson, Atmospheric Environment Service, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario. (416) 667-4610 (Gov't.: 186-9)

Dr. D.M. Gray, Division of Hydrology, College of Engineering, University of Saskatchewan, Saskatoon, Saskatchewan. (306) 343-2100

Dr. W.K. Gummer, Water Planning & Management Branch, Inland Waters Directorate, Environmental Management Service, No. 8 Temporary Bldg., Ottawa, Ontario. K1A 0E7 (613) 994-9839

Mr. A.H. Jones, Water Management Section, Northern Development Program, Department of Indian & Northern Affairs, Ottawa, Ontario. (613) 996-4648

Mr. J.D. Mollard, J.D. Mollard Associates, 616 McCallum-Hill Building, Regina, Saskatchewan. (306) 523-8855

Dr. G.L. Nielsen, Department of the Environment, Government of Alberta, 10040 - 104 St., Edmonton, Alberta. (403) 425-1130 Ext. 352

Mr. R. Ostry, Ministry of the Environment, River Basin Research Section, Water Quantity Management Branch, 135 St. Clair W., Toronto 7, Ontario. (416) 965-6194 (Gov't.: 186-9)

Mr. Claude Pesant, Hydrometry Service, Waters Branch, Quebec Department of Natural Resources, 1640 de l'Attent Blvd., Quebec 6, Quebec. (418) 643-4554

Dr. F. Prantl, Atomic Energy of Canada Ltd., Chalk River Nuclear Laboratories, Chalk River, Ontario. (613) 687-5581 Ext. 208 (613) 584-3311 Ext. 208

Mr. U. Sporns, Hydrology Section, B.C. Hydro and Power Authority, 970 Burrard Street, Vancouver 1, British Columbia (604) 298-6722 Telex 04-53418

Mr. R.G. Tress, Airphoto Analysis Associates, 859 College Street, Toronto, Ontario (416) 531-4720 (Gov't.: 186-9)

Mr. D.F. Witherspoon, Engineer-in-Charge, Great Lakes-St. Lawrence Study Office, Department of the Environment, Environmental Management Service, Federal Building, Cornwall, Ontario. (613) 932-4325) (Gov't.: 180-9)

Mr. A. Warkentin, Water Resources Division, Manitoba Department of Mines & Resources, Resources and Environmental Management, Winnipeg, Manitoba. (204) 284-4470 (Gov't.: 161)

Mr. J. MacDowall, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario. K1A 0E4 (613) 993-3350

5.10 REPORT OF THE WORKING GROUP ON ICE RECONNAISSANCE AND GLACIOLOGY

5.10.1 Review of Activities

The initial meeting of the Ice Reconnaissance and Glaciology Working Group was held May 15, 1972, at the Canada Centre for Remote Sensing (CCRS) in Ottawa. After the introductions of members, the organization, structure and services of the CCRS were outlined with particular emphasis on the state of readiness for ERTS data reception, processing and dissemination. The members outlined the mission of their agencies and briefly described their fields of interest.

Discussion of the Terms of Reference indicated that possible areas of overlap with other working groups, particularly Hydrology, should be investigated and resolved so as not to be overlooked by both groups. Unlike NASA policy, CCRS would not fund university or government groups for interpretation. Funds would be made available for sensor development under the sensor development program.

Ongoing and planned remote sensing studies by the members and their respective agencies were discussed at length and it was agreed that project reports should be submitted for inclusion in the annual report. A tabulation of these projects is attached as Appendix 1. Priorities for the future were considered. These included better ground truth collection for sideways looking airborne radar (SLAR) and passive microwave projects, microwave radiometry at very high microwave frequencies and increased information on sea-ice thickness, drift and properties for navigation and off-shore drilling purposes.

Following adjournment, the members toured the ERTS Data Processing Section and the new facilities of the Air Photo Production Unit.

5.10.2 Recent Actions

The members of the Working Group are presently considering several projects for recommendation as "Cornerstone Projects". Ice forecasting has been identified as a primary field of concern, but the area has not yet been selected. Two possibilities being considered are the Gulf of St. Lawrence - Strait of Belle Isle region and the Beaufort Sea, both of which are important to navigation and petroleum interests.

A number of microwave instruments have recently been developed for the determination of ice thickness. These include the holographic radar developed by Dr. Iizuka of the University of Toronto under a sensor development contract. The Working Group has endorsed simultaneous trials of these instruments over salt and fresh ice to determine their relative merits and indicate where further research should be directed. Results of these tests should be presented as part of a symposium in 1974.

In response to a group in New Jersey studying the feasibility of an "ice reconnaissance satellite", the Working Group has recommended representatives to discuss and evaluate the proposal.

5.10.3 Assessment of Progress

The major emphasis of the Working Group has been toward the problems of ice reconnaissance. Information about sea ice presence, drift, thickness and strength on a synoptic basis is very limited and must be obtained to assist navigation and exploration for mineral resources. Recent developments in the Arctic, where ice is present most of the year have greatly emphasized the need for expanded ice reconnaissance activities. Oil and gas exploration has created a major need for ice information on an all year basis from areas not previously surveyed because they were considered out of range for shipping. Furthermore, the promulgation of the Arctic Waters Pollution Prevention Act has created a demand for all year surveillance over a huge area - a task unnumerically suited for remote sensing technology. Remote sensing techniques for all year and all weather surveillance remain inadequate despite recent advances in active and passive microwave systems.

Current projects have been listed and may be bound in the appendices to this report. Appendix 1 is a listing of 1972 remote sensing projects submitted by the Working Group. Appendix 2 tabulates CCRS airborne projects of interest. Because of the limited ranges of the CCRS aircraft, projects listed in this appendix tend to be in inland areas and do not reflect the general remote sensing effort in ice reconnaissance, most of which has been accomplished using DOE, DND and industrial aircraft. Appendix 3, NASA ERTS experiments, is included to give some indication of the trends in foreign ice research using ERTS data. Abstracts for the projects listed in this Appendix are in the *IEEE Transactions on Geoscience*

5.10.3 Con't
Electronics, January 1973.

Appendix 4 lists a number of papers read at conferences and/or published during the last two years. These represent some of the recent Canadian contributions to the remote sensing fields of interest to this Working Group.

APPENDIX 1: REMOTE SENSING PROJECTS PLANNED AND/OR UNDERTAKEN BY MEMBERS OF THE WORKING GROUP AND THEIR RESPECTIVE AGENCIES

Project Title	Principal Investigator	Co-operating Agency	Objectives	Data Source (Sensor)
Evaluation of ocean currents and ice movement using remote sensing techniques.	Dr. D. Bajzak, Faculty of Engineering and Applied Science, Memorial University, St. John's, Nfld.	Maritime Command, Department of National Defence	1) To develop remote sensing techniques for iceberg census; 2) To evaluate environment around icebergs.	AP, IRLS, SLAR
Iceberg drift study	R.T. Dempster, Faculty of Engineering and Applied Science, Memorial University, St. John's, Nfld.	None	The prediction of iceberg drift offshore Eastern Canada.	AP - Acoustics profiler
Study of Arctic sea ice at Pond Inlet, N.W.T.	J. Terasmae, Department of Geological Sciences, Brock University, St. Catharines, Ontario.	Canada Centre for Remote Sensing (EMR), Atmospheric Environment Service (DOE)	The application of remote sensing methods in determination of sea ice characteristics for the purpose of ice reconnaissance required for selection of Arctic transportation routes.	AP
Ice geology of the Southern Beaufort Sea	W. Jazrawi, Imperial Oil Limited, 500 Sixth Avenue S.W., Calgary, Alberta.	Arctic Petroleum Operators' Association	A study will be undertaken to investigate statistical and spatial aspects of typical ice features, such as landfast ice, transition zone, shear zone (open leads), winter pack, oressure ridges, and ice islands, along a number of traverses running offshore to the pack ice in an area from Cape Dalhousie to Shallow Bay.	AP

APPENDIX 1: (CON'T)

Project Title	Principal Investigator	Co-operating Agency	Objectives	Data Source (Sensor)
Count of ice islands - Beaufort Sea - 1972	K.R. Croasdale, Imperial Oil Limited, 339 - 50 Avenue S.E., Calgary, Alberta.	Arctic Petroleum Operators' Association	To count and determine the size and location of ice islands along the Beaufort Sea coast.	AP
Sea ice thickness measurement	Mr. A. Orange, Geophysical Survey Systems Inc., North Billerica, Mass.	Sunoco E&P Limited	To determine the thickness of first year sea ice to permit safe movement of a drilling rig across a 12 mi. expanse. Also used on multi-year and in snow cover.	Radar
UHF radiometry for determination of sea-ice thickness	Dr. A.W. Adey, Communications Research Centre, P.O. Box 490, Stn. A, Shirley Bay, Ontario.	Churchill Falls Power Corp., Memorial University	To investigate the feasibility of the UHF, multi-frequency technique and to bring the project to the stage where potential users of sea-ice data might be encouraged to assume financial and management responsibility for further studies and hardware development.	UHF Multi-frequency
Use of radio-echo sounding technqiue for the study of temperate glaciers	R.H. Goodmand, Inland Waters Directorate, Department of Environment, Ottawa, Ontario.	None	1) To study the propogation of meter length waves of electromagnetic radiation in a temperate glacier; 2) To determine the characteristic of intraglacial layers; 3) To map the bottom of a typical temperate glacier; 4) To develop techniques of interpretation and computer processing of radio echograms.	620 MHz radar

APPENDIX 1: (CON'T)

Project Title	Principal Investigator	Co-operating Agency	Objectives	Data Source (Sensor)
Canadian ice reconnaissance	Ice Division, Central Services Directorate, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario.	None	Develop pertinent statistics concerning frequency and height of pressure ridges, spatial variations and seasonal changes.	Laser, AP, IRLS
Arctic oceanography	E.L. Lewis, E.R. Walker, R.A. Lake, Frozen Sea Research Group, Marine Sciences Directorate, Pacific Region, c/o 825 Devonshire Rd., Victoria, B.C.	Glaciology Division, Inland Waters Directorate	1) Sea-ice cover - Arctic Archipelago, especially around Ellesmere Is.; 2) Snowmelt and runoff, d'Iberville Fiord, Ellesmere Is.	TIROS, NIMBUS, ERTS, AP, IRLS, SLAR
ERTS imagery evaluation	Dr. R.A. Lake, Frozen Sea Research Group, c/o 825 Devonshire Rd., Victoria, B.C.	Canada Centre for Remote Sensing	Runoff and sea ice tabulation	ERTS
A lake and sea ice experiment with Skylab Microwave Radiometry	R.O. Ramseier, Department of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa K1A 0E7, Ontario.	USGA, Aerojet General Electrosystems, CRREL	The long term objective is synoptic monitoring of ice location, extent, thickness, condition, and snow cover in fresh and salt water.	Passive microwave
Shore ice interaction in the Arctic Islands	R.O. Ramseier, Department of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa K1A 0E7, Ontario.	CCRS	To determine the shore ice interaction in the Canadian Arctic islands during the entire year in relation to proposed pipeline routings by the use of ERTS imagery.	ERTS (Colour densitometry) NIMBUS, passive microwave

APPENDIX 1: (CON'T)

Project Title	Principal Investigator	Co-operating Agency	Objectives	Data Source (Sensor)
Prediction of ship performance and break-up in the Upper St. Lawrence River based on remote sensing and related ground measurements.	R.O. Ramseier, Department of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa K1A 0E7, Ontario.	MOT, CRC, CCRS, ASU, NASA	To prepare a map for use by ship captains which shows the various ice conditions in terms of a ship classification similar to a facsimile weather map. To predict the break-up of the Upper St. Lawrence River.	IRAP, IRLS, SLAR, Passive microwave
Ground truth on Arctic sea ice - Bering Sea project (Joint US - USS study)	R.O. Ramseier, Department of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa K1A 0E7, Ontario.	NASA, USSR Academy of Sciences	To obtain ground truth on first year ice from the ice water edge to 63°N for correlation with US and USSR aircraft measurements of micorwave radiation emitted in the K to X band range.	Passive microwave (K-X band)
Ground truth on sea ice - Arctic Ice Dynamics Joint Experiment (AIDJEX)	R.O. Ramseier, Department of Environment, Inland Waters Directorate, 562 Booth Street, Ottawa K1A 0E7, Ontario.	NASA, USGS, Aerojet Electrosystems, CRC	Interpretation of the variations in brightness temperatures obtained from ground measurements, low and high level air-borne platforms.	Passive microwave
Research related to the properties and movement of ice	Miss Moira Dunbar, Defence Research Establishment Ottawa, National Defence Head-quarters, Ottawa K1A 0Z4, Ontario.	None	To construct predictive models for ice drift and movement from data obtained in three strategic Arctic channels.	Radar
Studies related to remote sensing in areas of defence interest	Dr. I.H.S. Henderson, Defence Research, Establishment Ottawa, National Defence Head-quarters, Ottawa K1A 0Z4, Ontario.	Department of National Defence	To improve the capabil-ility for detection, recognition and identi-fication of ground targets from aerospace	IRLS, SLAR AP, scat-terometer

APPENDIX 1: (CON'T)

Project Title	Principal Investigator	Co-operating Agency	Objectives	Data Source (Sensor)
Application of remote sensing techniques to Glaciology	A.D. Terroux, Inland Waters Directorate, Department of Environment, C-217, #8 Tempoary Bldg., Ottawa K1A 0E7, Ontario.	U.S. Geological Survey (Dr. M.F. Meier)	To determine the area of application of ERTS imagery to the study of snow and ice. The initial program will establish the resolution and accuracy required for snow distribution, spring snow depletion and snow lines.	AP, IRLS, ERTS, MSS

Abbreviations used:

AP	Air Photography
IRAP	Infra-red Air Photography
IRLA	Infra-red Line Scanning
SLAR	Sideways Looking Airborne Radar
MSS	Multi-spectral Scanning

APPENDIX 2: CCRS AIRBORNE TASKS OF INTEREST TO THE ICE RECONNAISSANCE AND GLACIOLOGY WORKING GROUP

Task	Principal Investigator	Requesting Agency	Missions Objective	Area	Date Flown	% Complete
72-9 CF100	Mr. C. Pellegrin,	Ministry of Transport, Marine Hydraulics Br., Hydraulics Studies Division.	Record ice conditions Determine ice thickness and type. Locate ice cracks and ridges.	St. Lawrence River, Montreal, Trois Rivieres.	February 5 April 17	66.6
72-10 CF100	Dr. S.B. McCann	McMaster University, Coastal Research Program.	To obtain information on late winter ice conditions at spring break-up.	New Brunswick, P.E.I.	March 7 May 9	100.0
72-13 C47	Dr. J.R. Miller	York University, Faculty of Science, Downsview, Ontario.	To obtain reflection spectra from coniferous vegetation and from water and ice using the scanning interference filter photometer.	Ottawa - Toronto Lake Ontario	Marcy 9 September 20	100.0
72-34 FALCON	Mr. A.C.D. Terroux	Glaciology Division, Environmental Management Service, Department of the Environment.	To study remotely sensed data of surface melting over a remote area of snow surface at $0^{o}C$.	Banff, Columbia Icefields	CANCELLED	
72-68 FALCON	Mr. T.K. Krishnan	Iron Ore Co. Canada, Sept-Iles, Quebec.	A multi-disciplinary assessment of ore deposits and zones of permafrost.	Schefferville, Quebec.	As Required	0.0
72-126	Mr. R.O. Ramseier	Department of the Environment, Inland Waters Dir., 562 Booth Street, Ottawa.	Interpretation of	Kingston (Area "A") Lake St. Clair (Area "B") Lake Erie(Area "C")	Proposed February Proposed March Proposed March	

APPENDIX 3: NASA ERTS EXPERIMENTS RELATED TO ICE RESEARCH

TITLE	PRINCIPAL INVESTIGATOR
GLACIOLOGY	
Snow survey and vegetation growth in high mountains (Swiss Alps)	Prof. Dr. Harold Haefner, Department of Geography, Blumlisalpstrasse 10, 8006 Zurich, Switzerland.
The cartographic application of ERTS/RBV imagery in polar regions (No. SR-149)	William R. MacDonald, U.S. Geological Survey, Chief, Branch of International Activities, 2100 "M" Street, N.W., Washington, D.C. 20242.
Glaciological and volcanological studies in the Wrangell Mountains, Alaska (110-13)	Dr. Carl S. Benson and Dr. Lewis Shapiro, Geophysical Institute, University of Alaska, Fairbanks, Alaska. 99701.
Satellite geological and geophysical remote sensing of Iceland (SR-9651)	Richard S. Williams, Jr., U.S. Geological Survey, EROS Program Office, Washington, D.C. 20242.
Detection of break-up characteristics of Alaskan watersheds	Dr. Robert F. Carlson, Institute of Water Resources, and, Dr. Gerd Wendler, Geophysical Institute, University of Alaska, Fairbanks, Alaska. 99701.
Evaluate ERTS imagery for mapping and detection of snow cover on land and on glaciers (#342-7)	Dr. Mark F. Meier, Water Resources Division, U.S. Geological Survey, 1305 Tacoma Avenue South, Tacoma, Washington. 98402.
Evaluate glacier mass balance by variations in transient snow-line positions	Dr. Gunnar Ostrem, Norwegian Water Res. and Elect. Bd., P.O. Box 5091, Oslo 3, Norway.

APPENDIX 3: (CON'T)

TITLE	PRINCIPAL INVESTIGATOR
GLACIOLOGY	
Evaluation of ERTS data for certain hydrological uses	Mr. Donald R. Wiesnet, U.S. Dept. of Commerce, NOAA/NESS, Suite 300, 3737 Branch Avenue, Hillcrest Heights, Maryland. 20031.
LAKE ICE	
The use of ERTS imagery in reservoir management and operation (MMC #89)	Mr. Saul Cooper, New England Division, Corps of Engineers and Dr. Paul Bock, The University of Connecticut
Applications of remote sensing to the surveillance of lake ice (MMC #072)	Dr. Leonard J. Porcello, Willow Run Laboratories, University of Michigan, Ann Arbor, Michigan. 48107.
Evaluation of ERTS data for certain oceanographic uses (MMC #106)	Dr. A.E. Strong, NOAA Satellite Service, 3737 Branch Avenue, Hillcrest Heights, Maryland. 20031.
SEA ICE	
Evaluate the application of ERTS-A data for detecting and mapping sea ice (SR #126)	James C. Barnes, Environmental Research & Technology, Inc., 429 Marrett Road, Lexington, Massachusetts. 02173.
Studies of sea ice in Spitzbergen area, formation of convection clouds	Ole H. Brammes, Norwegian Meteorological Institute, Oslo, Norway.

APPENDIX 3: (CON'T)

TITLE	PRINCIPAL INVESTIGATOR
SEA ICE	
Applicability of ERTS for surveying Antarctic iceberg resources (MMC #059)	Dr. John L. Hult, The Rand Corporation, 1700 Main Street, Santa Monica, California. 90406.
Demonstrating applicability of satellite data to hydrology and ice survey	Dr. Erkki Palosuo, Institute of Marine Research, 00141 Helsinki 14, Finland.
Sea ice in the Sea of Okhotsk and its influence on the Oyashio current (MMC #023)	Dr. Kantaro Watanabe, Kyoto Gakuen University, Nanjo, Sogabe-cho, Kameoka-shi Kyoto-fu, Japan.
Sea ice and surface water circulation, Alaskan Continental Shelf	F.F. Wright, Asst. Professor of Oceanography and Extension Oceanographer, Sea Grant Program, University of Alaska, 142 E. Third Avenue, Anchorage, Alaska. 99501.
PERMAFROST	
Arctic and subarctic environmental analyses utilizing ERTS-1 imagery	Dr. D.M. Anderson, Chief, Earth Sciences Branch, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. 03755.

APPENDIX 4: RECENT PUBLICATIONS

Adey, A.W., 1972 — Microwave radiometry for remote sensing from aircraft and spacecraft, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 613, 625.

Adey, A.W. et al, 1972 — Theory and field tests of a microwave radiometer for determining sea ice thickness, Communications Research Centre, Tech. Note No. 637, Ottawa, January 1972.

Adey, A.W., R.E. Barrington and T.R. Hartz, 1972 — Field tests of a UHF radiometer for determining sea ice thickness, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 287, 292.

Adey, A.W., et all, 1971 — Theory and field tests of a UHF radiometer for determining sea ice thickness, Cdn. Aeronautics and Space Journal, V.17, December 1971, p. 425.

Andrews, J.T. and R.G. Barry, 1972 — University of Colorado: 1971 summer field season in east Baffin Island, Arctic, V.25, No. 1.

Atmospheric Environment Service — Operation Ice Map 11 Side Looking Radar Trials, Spring, 1972.

Brown, R.J., 1972 — Arctic environment effects on remote sensing DREO Report, R655.

Davies, J.H. and J.D. McNeill, 1972 — Airborne remote sensing of resistivity through the use of E-Phase techniques, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 647, 664.

Ferguson, H.L. and H.F. Cork, 1972 — The use of satellite photographs to determine the time of freeze-up and break-up of Canadian Lakes, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 269, 273.

Garnier, B.J., 1971 — The observation of topographic variations in surface radiative temperatures by remote sensing from a small aircraft, Proc. 7th. Intl. Symp. on Remote Sensing of Env., V.1, p. 495, 500.

Grasty, R.L. and P.B. Holman, 1972 — The measurement of snow water equivalent using natural gamma radiation, Proc. 1st. Cdn. Symp. on Remote Sensing pp. 633, 645.

APPENDIX 4: (CON'T)

Hamid, M.A.K., 1972 — New directions in microwave radiometry for remote sensing, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 627, 631.

Hartz, T.R., 1971 — A radiometer method for determining the thickness of sea ice, Communications Research Centre Report No. 1217, Ottawa, May 1971.

Iizuka, K. et al, 1973 — Review of electrical properties of ice and HISS down-looking radar for measuring ice thickness, Canadian Aeronautics and Space Institute, Aerospace Electronics Symposium, Saskatoon, February 5 to 7.

Irbe, J.G., 1972 — An operation program for measuring surface water temperature by airborne radiation thermometer (ART) survey, Proc. 1st. Cdn. Symp. on Remote Sensing, pp. 183, 200

Jacobs, J.D., 1972 — Use of satellite photography in the energy balance climatology of the Arctic. Ph.D. Thesis, University of Colorado (in preparation).

Johnson, J.D., 1971 — Use of side looking airborne radar for sea ice identification, JGR, V. 76, No. 9, p. 2138.

Meeks, D., R.O. Ramseier, G. Poe, W.J. Campbell and A. Edgerton, 1972 — Preliminary interpretation of surface based microwave measurements of Arctic sea ice, Trans. A.G.U., V. 53, No. 11, p. 1017.

Poe, G. et al, 1972 — Microwave emission characteristics of sea ice, Interim Progress Report 4027R-1, June 15, 1972, Aerojet-General Corp.

Ramseier, R.O., 1972 — Training program in interpretation of multispectral imagery, September 11-22, 1972, Canada Centre for Remote Sensing, ms.

Ramseier, R.O., D.F. Dickens and R.J. Weaver, 1972 — Ice information - Thousand Island area, Montreal, Lake Ontario Section, St. Lawrence River. Prep. for St. Lawrence River Seaway Authority, 11+ pp.

Venier, G.O. and F.R. Gross, — An experimental look at the used radar to measure snow and ice properties, Department of Communications, CRC Tech. Note No. 646, 29 p.

Wilheit, T. et al, 1971 — Aircraft measurements of microwave emission from Arctic sea ice, NASA/GSFC Preprint X-651-71-417.

Young, B.G., R.G. Apps and T.A. Harwood, 1971 — Infrared reconnaissance of sea ice in late summer, DREO Tech. Note 71-8.

APPENDIX 5:

MEMBERS OF THE WORKING GROUP
ON
ICE RECONNAISSANCE AND GLACIOLOGY

Dr. O.H. Løken (Chairman), Inland Waters Directorate, Department of the Environment, Rm. A-220, No. 8 Temporary Bldg., Ottawa, Ontario. K1A 0E7 (613) 994-9858

Dr. A.W. Adey, Communications Research Centre, Department of Communications, Shirley Bay, Ontario. (613) 996-8321

Mr. R.C. Baker, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario. (613) 995-3104

Dr. R.J.E. Brown, Division of Building Research, National Research Council, Montreal Road, Ottawa, Ontario. (613) 993-1466

Professor R. Dempster, Memorial University, St. Johns, Newfoundland. (709) 753-1200

Captain J.A. Gallant, Marine Operations Branch, Ministry of Transport, Place de Ville, Tower C, Ottawa, Ontario. K1N 0E6 (613) 992-1883

Dr. I.H.S. Henderson, Head, Remote Sensing Section, Defence Research Establishment, Ottawa, Ontario. K1A 0Z4 (613) 996-7051

Mr. H.G. Hengeveld, Ice Division, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario. (416) 667-4712

Mr. J. Hnatiuk, Gulf Oil of Canada Limited, 707 - 7th Avenue S.W., Calgary, Alberta. (403) 268-1477

Dr. M.P. Langleben, Department of Physics, McGill University, Montreal, Quebec. (514) 392-5127

Mr. W.E. Markham, Ice Central, Atmospheric Environment Service, Department of the Environment, Trebla Building, Ottawa, Ontario. K1A 0H3 (613) 996-5236

Dr. T.S. Murty, Marine Sciences Directorate, Department of the Environment, 615 Booth Street, Rm. 406, Ottawa, Ontario. (613) 994-9873

Dr. E.F. Roots, Department of Energy, Mines and Resources, 588 Booth Street, Rm. 209, Ottawa, Ontario. (613) 994-9048

Lt. Col. M. Sugumoto, DACS 3, National Defence Headquarters, Ottawa, Ontario. (613) 992-9584

Professor J. Terasmae, Chairman, Department of Geological Sciences, Brock University, St. Catharines, Ontario. (416) 684-7201, Ext. 311

Mr. A.C.D. Terroux (Secretary) Inland Waters Directorate, Department of the Environment, Rm. C-217, No. 8 Temporary Bldg., Ottawa, Ontario. K1A 0E7 (613) 994-5115, 994-9802

5.11 REPORT OF THE WORKING GROUP ON LIMNOLOGY

5.11.1 Summary of Meetings

The CACRS Working Group on Limnology has met three times, each time involving participation by staff from the Canada Centre for Remote Sensing which has provided information on CCRS and status reports on activities. Participation by Working Group members at these first meetings has generally been in the nature of discussions of personal and regional interests, information exchange, and explorations of possibilities for development of remote sensing programs. Although not many of the members are presently actively involved in specific ongoing remote sensing projects, each member has an active interest in exploring, promoting and developing remote sensing applications in his own sphere of geographical or disciplinary involvement.

The first meeting was held at the Canada Centre for Inland Waters, Burlington, May 23, 1972. The main results of this meeting included a general set of terms of reference, an exchange of information on the remote sensing interests of individual members, and a description of the objectives and organization of the Canada Centre for Remote Sensing.

The second meeting was held at the Saskatchewan Research Council, Saskatoon, October 20, 1972. The status of ERTS-1 and the initial problems in producing imagery were described by Dr. Morley, who also described his initial ideas on how the Working Group would best assist CCRS in reviewing project proposals.

At this meeting, some members viewed their first ERTS imagery and heard about some of the possibilities for different types of processing and presentation. This lead to a general agreement on the need for additional working meetings on the "science" aspects of remote sensing. This was realized at the third meeting, held in Ottawa, January 16-17, where time was devoted to scientific discussions based not only on members' programs but also on those of several guests, invited for that purpose. Members heard of productive results of air photo analyses of a lake restoration program conducted by the Ontario Ministry of the Environment, the development of laser-based techniques for pollutant identification, and of the interest in the marine community for colour measurements.

Also at the third meeting, members tackled the question of a "national program".

Members have participated in a number of conferences and other remote sensing meetings. One conference which developed at least in part due to the activities of members is the American Water Resources Symposium on Remote Sensing of Water Resources, scheduled for Canada Centre for Inland Waters, Burlington, June 11-14, 1973.

5.11.2 Recommendations for a National Program

This Working Group generally agreed that it would be difficult to specify particular projects, of a national nature, which could be undertaken by the group, because of the diversity of specializations of the members. However, the following recommendations have evolved:

1. A study should be performed to determine -

   a) What are the requirements for limnological measurements utilizing remote sensing?

   b) What are the capabilities of available and foreseeable sensor systems for obtaining those measurements?

2. CCRS was asked to proceed, as suggested by Dr. Morley, to develop an ERTS processing system capable of producing colour thematic maps containing summarized statistical information on numbers of lakes, surface areas of lake waters, lake perimeters and other pertinent information as may be proposed.

Working Group members agreed to commence immediate preparation of material for 1 (a).

In addition, a discussion of a possible recommendation for a field program took place. Three possibilities were presented, but were deferred for further consideration and discussion.

1. Studies in a 100 mile x 100 mile location in the Sudbury, Ontario area wherein are found a variety of lake types and sizes, and where extensive ground truth projects by the Federal and Ontario governments are currently in progress.

2. Studies in a portion of the Upper Great Lakes such as southern Lake Huron where large-scale open-lake features and detailed

coastal features will be ground-truthed over the next two years by Canadian and American investigators.

3. Studies in the Lake Manitoba drainage basin system which comprises large lakes, small lakes, and potholes, and which may receive extensive surfact attention during the next few years.

Such studies would be funded mainly through ongoing federal or provincial programs which could be modified to meet the possibly broader intersts of the Working Group.

APPENDIX 1

SUMMARY OF REMOTE SENSING ACTIVITIES
(With Initials of Contributors)

1. Studies relevant to limnology in British Columbia (T.G.N.)

-Fish Stream Habitat Survey

V.J. Swiatkiewiez, Regional Fisheries Biologist, B.C. Fish and Wildlife Branch, is attempting to assess suitability of steel-head trout habitat in two tributaries of the lower Fraser River, the Coquihalln River and Silver Hope Creek using airborne 70 mm RC 10 camera imagery. Low level imagery has been obtained for both watersheds. Potential adult spawning areas, juvenile rearing areas, status of small tributaries and pool-riffle areas will be classified from photographic coverage and checked with ground survey crews during Summer, 1973. Results to date seem promising.

-Lake Surface Temperature - Circulation Study

Dr. J.F.R. Gower has undertaken a circulation study of the large, multi-basin Babine Lake in northern British Columbia using surface temperature sensors. Perhaps the Chairman of the Oceanography Working Group should be contacted on this for further details and on the extent to which it will be covered in their report.

-Epibenthic Littoral Algal Study

Dr. T.G. Northcote is conducting a study on distribution and production of epibenthic algae along the shoreline of Kootenay Lake in southeastern British Columbia. Seasonal changes in distribution of turbid, nutrient-rich water entering the south end of the lake will be examined from ERTS imagery and related, if possible, to regional differences in growth and production of epibenthic algae in arms of the lake. A program to examine distribution and abundance of epibenthic algae along the shoreline using low-level colour photography from an aircraft platform is being planned for Summer, 1973. Ground truth will be established from detailed studies already underway on algae distribution and abundance at 22 stations around the lake.

2. University of Saskatchewan (U.T.H.)

Airborne imagery will be requested for a series of relatively small lakes which are considerably different in depths,

salinities, productivity, turbidity, etc. If suitable film and filters can be used, important information with respect to a number of parameters such as those mentioned could be obtained, as well as surface temperature and perhaps evaporation and inflows. It is absolutely essential that the flights be made at the same time as ground truthing is done. The latter can be coordinated with the flights if a couple of days notice is given. While of primary interest is the biota of the lakes, any physical and chemical factors which impinge on the biota are also of interest.

3. Universite du Quebec (E.J.L.)

A group of researchers at INRS-Eau have been studying the effects of the creation of the Manicouagan reservoir. In fact this is the fifth and greatest impoundment on the Manicouagan River and it has produced an annular lake some 50 miles across. Because of its considerable size and difficulty of access the collection of scientific data presents problems. Some of these data, however, may be obtained by remote sensing techniques and aerial and ERTS satellite imagery have been requested. Data is beginning to arrive from the first aerial photography and thermal scanning and these are still being examined. No ERTS data has yet arrived. This project will continue during 1973.

Funding has been sought for a second research project dealing with lake and basin hydrometeorology, so far without success. The project is being started nevertheless in the hope that the necessary support will be obtained early in 1973.

4. Province of Ontario (J.H.N.)

In conjunction with a detailed water management study of the Kawartha Lakes, between Balsam and the Bay of Quinte, an assessment of standing crops of macrophytes was undertaken to explore the feasibility of optimizing the use potential of these waters through mechanical weed harvesting.

As part of the study remote sensing techniques were employed to map weed beds. Coloured and infrared films were used at altitudes ranging from 600 to 3,000 metres. For the photographic coverage of the entire system, an altitude of 1,500 M was selected using an 85 mm focal length Zeiss camera and colour film. Supporting ground truth studies were undertaken to aid in the interpretation of photographic material. The results are currently being analysed and interpreted.

Remote sensing techniques were also utilized in conjunction with the IFYGL investigations for Cladophora growths in Lake Ontario.

Initial plans called for the delineation of growth beds through the use of remote sensing techniques including aerial photography using a Vinten (547) 70 mm camera with various film-filter combinations and the SPAR multispectral camera system over the range of 500 to 650 mm. Five flights were planned during the period of June 1 to August 31. Associated "ground truth" investigations to examine various water and algae related parameters including biomass were to be undertaken during each flight period at five sites and possibly at additional sites at the time of the maximum standing crop.

Because of development problems, the SPAR equipment has not been used in the program. The aerial photography that has been undertaken is summarized in Appendix 2.

Flights undertaken June 5 and 19 covering a total of 18 shoreline miles at three locations were developmental in nature permitting evaluations of film, filter, altitude, time of day and weather conditions. On July 5, a survey was made of 250 miles of shoreline at an altitude of 6,000 feet of which 21 miles were re-surveyed at an altitude of 1,000 feet to provide greater detail for interpretive purposes. Camera malfunction and under exposure of film resulted in useable colour negative imagery for 49 of the 250 miles. The survey was repeated successfully on July 17 and August 15. The latter survey included infrared photography over 70 miles of shoreline to determine the extent of shoreline accumulations.

During each flight period, surveys of three to four days duration were carried out at from three to five sites in the eastern portion of the lake. An additional three sites in the western portion were surveyed on one occasion in early July and an offshore site (Main Duck Island) was included in the August survey. For each survey water samples were taken at one to three locations for turbidity, total and suspended solids, total phosphorus, total nitrogen, chlorophyll a and phytoplankton analysis. Surface temperature and secchi disc transparency were also recorded. Bottom observations of per cent algae coverage, filament lengths, apparent colour, and substrate types were made using scuba at from one to three transects extending from shore to the outer limit of growth beds. Biomass samples were taken at depths of 1.5, 3 and 5

meters or to the outer extend of growth. From two to six replicate samples were collected randomly within growth beds using 0.25m^2 quadrats. Samples have been air-dried and weighed. Further analysis will provide ash-free dry weight data.

A cursory examination of aerial photographs has indicated best results were derived from the June 5 flight, growth beds being discernible to depths of approximately five meters (except in the North Channel). This was reduced to approximately three meters in later surveys because of increased turbidities. Growth beds in the western portion of the lake were not discernible from imagery obtained July 17 and August 15 because of high nearshore turbidities. It is concluded that sufficient data is available to estimate, with reasonable extrapolation, the area of growth beds along at least 133 miles of the north-eastern shoreline.

Considerable variability in air-dried weights of algae is apparent although variability in the organic dry weight data would be somewhat less. It is considered that insufficient sampling was undertaken for broad application of the data.

5. Ontario - Erindale College (W.H.)

- Remote Sensing of Oil Slicks

In conjunction with CCRS and I.N.R.S., Quebec, (Dr. George Drapeau), two releases of Venezuelan crude oil were made in the St. Lawrence River, off Riviere-du-Loup during November, 1972. These were imaged by CCRS aircraft (Reg. Nos. 12931 and 508) and an analysis of results indicate that -

- infrared line scanners provide little useful imagery,
- the RS14 imagery obtained with the UV detector is good; imagery under an overcast is doubtful,
- the CCTV videotape provides good imagery that improves under low-light conditions but, unfortunately, there is little hope of obtaining precise measurements from such records,
- photo imagery obtained on 2445 film and 2448 film is good,
- imagery recorded on 2405 film through a 47 filter is superior to that recorded on the same film through a 58 filter,
- sufficient useful imagery was obtained to permit measurement of the oil slicks on all passes,
- returns from the DOE Laser Fluorometer are inconclusive, and,
- operators were experiencing difficulties due to wide ranging temperature differences in various parts of the equipment, electrical interference from aircraft systems and, uncertainty over when the laser was striking the slick.

The following recommendations were made following a debriefing session at CCRS:

- adequate radio communication between air and ground crews is essential,
- for night operations, ships on location must be marked with a distinctive light pattern. Lights in the form of an arrow pointing to the oil slick location may be useful,
- the head and tail of a slick must be marked with floating flashers for night operations,
- a low light television system should be utilized on the next night operation, (it may be useful in recording the oil slick and it is almost mandatory for use in conjunction with the Laser Fluorometer), and
- a UV filter should be obtained for the RS14 prior to further oil-detection flights.

The foregoing experiment is to be repeated in February, in Bahamian waters. The DOE sensor will be used again and the RS14 with 4 UV filters will be employed to sense 7 Louisiana crude and naptha slicks, each of 260 gallons. A low-light-level TV will also be employed in this study.

The analysis of the imagery from the St. Lawrence and Bahamian experiments is expected to take about two years. Sensor utility will be related to the chemical "age" of a slick as well as the wind, wave, current, and temperature conditions in existence at the time the imagery is obtained.

- Remote Sensing of Rhodamine-WT dye

In conjunction with flushing studies of the lower Nottawasaga and lower Sangeen Rivers, Dr. J.C. Munday and I are examining the feasibility of using light aircraft and hand-held 35 mm cameras with various film-filter combinations to make time-series records of dye-cloud motions. Two experiments have been conducted. A third will be conducted this September. Surface-truth consists of fluorescene values determined by a ship making continuous transects of the dye cloud and monitoring concentrations with a fluorometer equipped with a flow-through door.

6. The Maritimes (J.R.W.)

- Dunk River Project in P.E.I.

The usefulness of remote sensing has been broached with the people at U.P.E.I. who are undertaking the study but I have heard nothing back from them.

- The Halifax County Lakes

This study has been underway for a couple of years by researchers at Dalhousie and Nova Scotia Tech. They are interested but we are just at the stage of seeing what remote sensing techniques could be usefully incorporated into the study. I have also suggested the involvement of the Nova Scotia Water Resources Commission but this has not proceeded beyond an expression of interest.

7. Federal - Canada Centre for Inland Waters (R.K.L.)

Remote sensing activities at the Canada Centre for Inland Waters now involve five full time staff, including two professional. Lake thermal work, involving infrared scanner and infrared thermometer surveys is in its seventh year at CCIW and is now being complemented by developing programs of multispectral photography, lake optics, satellite imagery, and satellite data retransmission.

- General Program

The 1972 remote sensing program was heavily involved with IFYGL (Appendix 2) on Lake Ontario. The main objectives were the continuation and improvement of the photographic program, and the conduct of surveys in support of limnological studies.

A number of high altitude infrared scanner surveys were carried out during the field season. The objective of these missions was to obtain I.R. scanner data on consecutive days in order to investigate the time variations of large scale surface thermal features over Lake Ontario.

A number of low altitude scanner surveys were also carried out in the Oshawa region over a much smaller area of the lake.

In addition to the infrared scanner work carried out in conjunction with CCRS, a number of local remote sensing missions were carried out using aircraft under charter to, and instrumented by, CCIW. This operation provided photographic support for the Oshawa Coastal diffusion study, dye plume studies in Lake of the Woods and Lake Ontario, and lake surface temperature data, as well as air temperature and humidity profiles, for the air-water interaction study at Niagara.

Further work on the biological aspects of remote sensing was conducted on Lake Memphremagog in cooperation with McGill University. Initial results indicate some interesting comparisons of water colour and chlorophyll gradients along the length of the lake.

- Satellite Studies

On July 25, 1972, Earth Resources Technology Satellite-1 was successfully launched into a geocentric polar orbit. The multi-spectral scanner aboard has functioned perfectly since launch, providing four-channel imagery of the earth's terrain on a synoptic basis. Imagery which has been observed thus far appears quite encouraging although imagery obtained over the Great Lakes since launch has suffered from extensive cloud cover, a situation which should alleviate as the winter season passes. Analysis of ERTS imagery at CCIW will continue to proceed along visual photointerpretative techniques. In addition automated photointerpretation is planned for the near future utilizing digital magnetic tapes supplied through the Canada Centre for Remote Sensing.

- Lake Optics Studies

A study of the characteristic optical parameters of Lake Ontario was carried out during the CCIW Lake Ontario Organic Particle Study (OOPS).

The parameters measured included: upwelling and downwelling irradiance, colour index, and attenuation coefficient as a function of depth and wavelength. The downwelling light intensity measurements were a vital input to the photosynthesis and carbon 14 assimilation studies.

A number of interesting correlations were obtained between the optical parameters and variations in the total particulate concentrations obtained from water quality measurements.

This was the first extensive optical study carried out by CCIW and the results obtained should have an important impact on future monitoring programs on the Great Lakes.

- Data Retransmission by Satellite

A program has been initiated to assess the collection of scientific data via a satellite telemetry link. An application (to NASA) was approved to commence this program using the ERTS-1 satellite.

A small buoy was instrumented with air temperature, water temperature (using a Rosemount platinum resistance sensor) and a Hygrodynamics relative humidity sensor. This was matched with a data collection platform designed for use with ERTS-1. The buoy was moored off the Niagara Bar and operated during the period July 31 to December 10, 1972.

The present system averages four transmissions per orbit and three orbits are received (on an average) every twelve hours. When comparing ground truth data with that received over the retransmission link the errors were in order of 0.5%.

An "IRLS" (Interrogation, Recording and Locating System) experiment was a cooperative program between CCIW and the NASA-Lewis Research Centre, located in Cleveland, Ohio, involving a data collection platform (DCP) and a special constructed buoy, supplied by NASA-Lewis. The logistic support and data evaluation was carried out by CCIW.

The object of the experiment was to evaluate the positioning capabilities of the system to measure large scale surface currents, while transmitting actual data.

During the period July to October, the buoy was released free-floating for three separate two-week periods. For the first two periods the buoy anchored itself in shallow water (a small anchor was connected to the buoy, on fifty feet of line). During a severe storm (weekend of October 14), the buoy finally came ashore and was damaged. The experiment was then terminated. The number of successful interrogations during the study was in the order of 60%.

- Contract Studies

The following contract work for interpretation of ERTS imagery has been arranged by CCIW for 1973 and 1974:

1. University of Toronto (Dr. J.C. Munday, Jr.)
   - Western Lake Ontario Water Mass Delineation.
2. Acres Consulting Service Ltd. (P.J. Denison) - ice regime on Lake Erie.
3. McGill University (Prof. J.T. Parry) - lakes in northern Quebec and Labrador (ice).
4. University of Alberta (Dr. A.H. Laycock) - surface and groundwater patterns in Cooking Lake and Gull Basins.
5. York University (Dr. A. Carswell) - optical ground truth with lidar.
6. Saskatchewan Research Council (J. Whiting) - lakes research and management of Big Quill Lake.
7. Universite Laval (Dr. A. Soucy) - St. Lawrence River lake systems.

APPENDIX 2

REMOTE SENSING PROGRAM 1972

Project	Location	Dates	Sensors	Ground Truth Measurements
1. Thermal gradient temporal evolution	Oshawa Lake Ontario	5/10/72 5/18/72 5/19/72 8/21/72 8/25/72 9/ /73 9/28/72 10/2/72 10/4/72	Infrared scanner $8\text{-}14_h$ Infrared radiometer $9\text{-}11_h$ Photographic	Survey launch surface temperature and bathythermograph recordings
2. Synoptic mapping of thermal and dynamic structures of Lake Ontario	Lake Ontario Hamilton to Kingston	6/7/72 8/28/72 8/29/72 10/27/72	Infrared scanner $8\text{-}14_h$ Photographic	Surface temperature infrared radiometer $9\text{-}11_h$ underflight, meteorological moored buoys
3. Dye Diffusion				
a) Patch b) Continuous flow	Oshawa Area Lake Ontario	6/5/72 6/27/72 6/28/72	Photographic	Fluorometer measurement of dye concentration profiles, surface drogues
c) Plume	Lake of the Woods, Ontario	7/28/72 7/29/72 7/31/72 8/1/72 8/3/72 8/4/72	Photographic	Lake current profiles, surface waves, winds, bathythemograph recordings
4. Experimental Survey	North Shoreline Lake Ontario	5/24/72 6/7/72	Photographic	Depth penetration Hydrographic charts
5. Algae and macrophyte concentrations and distributions	Lake of the Woods and Lake 227 Kenora Lake Memphremagog, P.Q.	8/3/72 9/20/72	Photographic Photographic	Algae concentration Lake 227, FRB Chlorophyll content McGill Biological Dept.
6. Atmospheric humidity profiles and lake surface radiometric temperature	Lake Ontario Niagara-on-the Lake	5/25/72 5/26/72 6/16/72 10/10/72 10/12/72 10/13/72	Infrared radiometers $8\text{-}14_h$ and $9\text{-}11_h$, air temperature, dew point temperature	Fixed tower surface water and air temp., dew point and winds

APPENDIX 3

MEMBERS OF THE WORKING GROUP ON LIMNOLOGY

Dr. Robert K. Lane (Chairman), Scientific Operations Div., Canada Centre for Inland Waters, Burlington, Ont.

Dr. Glenn Adams, Canadian Wildlife Service, Migratory Bird Sanctuary, Saskatoon, Sask.

Dr. G. Brunskill, Dept. of the Environment, Fisheries Services, Winnipeg, Man.

Mr. J. Deacon, Spartan Aero Limited, Ottawa, Ontario.

Dr. U.T. Hammer, University of Saskatchewan, Saskatoon, Sask.

Dr. Wyman Harrison, Dept. of Geography, Erindale College, Clarkson, Ont.

M. Michel P. Lamontagne, Qualite des Eaux, Ministere des Richesses Naturelles, Hotel du Gouvernement, Quebec.

Dr. E.J. Langham, Centre Quebecois des Sciences de l'eau, Universite du Quebec, Quebec, P.Q.

Mr. John Neil, Ontario Water Resources Commission, Toronto, Ont.

Dr. T. Northcote, Institute of Animal Resource Ecology, University of British Columbia, Vancouver, B.C.

Professor R. Winter, Economics Dept., Acadia University, Wolfeville, N.S.

5.12 RAPPORT ANNUEL du GROUPE DE TRAVAIL EN OCEANOGRAPHIE

5.12.1 Le Groupe de Travail en Océanographie a été formé au cours de l'été 1971, et a tenu deux réunions, l'une le 26 septembre 1972 au Centre Canadien de la Télédétection et l'autre le 11 janvier 1973 au Bedford Institute d'Océanographie. Une liste des membres est donnée dans l'Appendice A.

Le Groupe de Travail a décidé, avec l'accord du Directeur du CTD que le terme "océanographie" comprenait l'hydrographie.

La première réunion a été dévouée a familiariser les membres avec le programme et les installations du CTD et à établir les intérêts que chacun porte à la télédétection et la mesure dans laquelle elle peut contribuer à la résolution de problèmes océanographiques. La seconde réunion a repris ce dernier sunet, a parlé de la formation en télédétection, et a passé en revue les programmes canadiens en télédétection à but océanographique ou s'y rapportant.

5.12.2 Le Groupe de Travail en Océanographie a une position différents de celle des autres groupes. Jusqu'à présent il n'y a eu que peu d'exemples d'utilisation réussie de la télédétection en océanographie, et le plus grand intérêt actuel et de se préparer à ce qui pourrait être possible plus tard.

Parmi les techniques dont on dispose actuellement, voici celles qui semblent présenter le plus d'intérêt:

- photographie aérienne conventionnelle: zone des marées, tracé de la masse (ou des effluents) de l'eau, dépistage des courrants en suivant des bouées.

- balayage infrarouge et/ou radiométrie pour mesure et profil de la température. Les problèmes de transmission dus au brouillard et au plafond bas, ce qui arrive souvent au-dessus des régions côtières, imposent des limites assez strictes.

- la spectrométrie pour mesurer la couleur de l'eau et surtout la chlorophylle. Les nuages posent aussi un sérieux problème qui pourrait être partiellement résolu par l'utilisation simultanée de la radiométrie ou de la spectrométrie du ciel.

5.12.2

- la photographie stéréo en couleur pour mesurer la profondeur de l'eau. Elle exige des conditions difficiles à atteindre de transparence et de clarté de l'eau et de niveau des marées et exige également un calcul exact de l'attitude de l'avion. La groupe de travail a établi un comité de projet qui doit suivre un projet du CTD en hydrographie aérienne.

- profilomètrie à laser. A l'air prometteur pour mesurer la hauteur des vagues. Exige des informations sur l'attitude de l'avion.

- La radiométrie à micro-ondes. A l'air prometteur pour la détection de la salinité et pour mesurer la température de la surface par tous les temps. Il faut une installation pour levé des courbes de niveau. Une autre amélioration possible pourrait fournir des informations couverture de glace, dont l'épaisseur.

- Géodésie par satellite. Pourrait être utilisée pour mesurer la hauteur des vagues, le profil de la glace et des marées si on peut la rendre suffisamment précise.

- Fluorimétrie à laser. Pourrait être utilisée pour la détection de la pollution par le pétrole et la définition des masses d'eau.

- radar (doppler, basse fréquence ondes continues, etc...) assez prometteur en ce qui concerne l'étude des courrants et des vagues.

5.12.3 La situation de la formation en télédétection océanographique provient du stage embryonnaire des techniques concernées. Tant que nous n'aurons pas un grand nombre d'utilisateurs et d'utilisateurs potentiels, l'éducation sera limitée à des généralités sur la télédétection et aux possibilités futures de la télédétection en océanographie. Le groupe de travail considère que des cours spéciaux et des séminaires ne sont pas encore justifiés, mais que les possibilités de participation à des activités générales et spécialisées devraient être mieux réparties.

5.12.4 Le groupe de travail a discuté les utilisations qu'il connaît de la télédétection en océanographie au Canada et a exprimé au CTD l'intérêt qu'il porte a certains programmes d'exploration. Une liste des projets de 1972 qui intéressaient le groupe est donnée dans l'Appendice B.

5.12.5 Le groupe de travail recommande que le CTD augmente autant que possible l'attention portée à la télédétection des océans du point de vue (a) du champ d'application et (b) des instruments.

APPENDIX 1:

AIRBORNE PROJECTS OF CCRS WITH OCEANOGRAPHIC INTEREST

Task No.	Mission Objective	Area	Name of Investigator	Aircraft	Sensors Required
72-4-5	Imagery required to support experiment using NRL 4 band SLAR and scatterometry system over a variety of terrain and target types.	Eastern Ontario	Dr. I. Henderson DREA National Defence Headquarters, Ottawa K1A 0E4 996-7051 Ext. 484 & 555	CF100/ C47	Camera RC10 70 mm Daedalus Scanner PRT-5
72-6	To test laser fluoro-sensor system	TBA	Dr. J. Kruus No. 8 Temporary Building, Room H-305 Ottawa 994-9802	TBA	TBA
72-9	Record ice conditions. Determine ice thickness and type. Locate ice cracks and ridges.	St. Lawrence River Montreal Trois Rivières	Mr. C. Pellegrin 20th Floor Tower "C" Place de Ville Ottawa K1A 0N7 995-8061 or 996-6797	CF100	Camera RC10 70 mm
72-10	To obtain information on late winter ice conditions at spring break-up	New Brunswick P.E.I.	Dr. S.B. McCann Dept. of Geography McMaster University Hamilton, Ontario 164+9 522-4971 Ext. 536	CF100	Camera RC10 70 mm
72-11	Flight test of the SPAR image disector multispectral camera.	Ottawa area	Dr. J.N. de Villiers Canada Centre for Remote Sensing Ottawa 995-3104	C47	SPAR image disector Camera 70 mm
72-12	A study of Cladophera in association with Ontario Water Resources Commission using the SPAR image disector multispectral camera with 70 mm camera back up	Lake Ontario	Dr. J.N. de Villiers CCRS, Ottawa 995-3104 G. Owen, OWRC Regional Office Kingston (613) 546-3171	C47	Camera 70 mm SPAR image disector

APPENDIX 1: (CON'T)

72-13	To obtain reflection spectra from coniferous vegetation and from water and ice using the scanning interference filter photometer.	Ottawa Toronto Lake Ontario	Dr. J.R. Miller Faculty of Science York University 4700 Keele Street Downsview, Ontario 635-3836 or 635-3861	C47	Camera 70 mm Scanning Interference Filter Photometer
72-14	synoptic observation of Lake Ontario in support of IFYGL projects.	Lake Ontario	Dr. K.P.B. Thomson CCIW 867 Lakeshore Road Burlington, Ontario 164-9-637-4243	FALCON	Camera RC10 70 mm RS14 13 GHz Radiometer (see notes)
72-15	Investigation of the time scale of dominant thermal features, and their relation to large scale circulations on Lake Ontario. Ground truth will be obtained from launches, and from other workers in the Canadian Coastal chain region.	Oshawa	Dr. K.P.B. Thomson CCIW 867 Lakeshore Road Burlington, Ontario 164-9-637-4243 or 822-6946	C47	Camera 70 mm Daedalus PRT-5
72-17	Testing of closed circuit and low light level television systems for use as navigation aids.	Ottawa	R.D. Worsfold CFASU CFB Uplands 995-3013	C47	CCTV LLTV
72-26	To determine areas covered by water throughout the growing season and document patterns of water movement due to flooding. Obtain temperature profile of Lake Athabasca and smaller delta lakes.	Peace-Athabasca delta	G.L. Nielsen Albert Dept. of Environment Milner Bldg. 10040-104 Street Edmonton 14, Alta. (403) 525-1130 or 465-2510	FALCON	Camera RC10 RS14
72-51	The surveillance of suspended solids and active sediments deposition following peak flows during spring run-off, downstream of the Lemieux mudslide.	South Nation River	J.W. Murray Ministry of Natural Resources 880 Bay Street Toronto 181, Ontario 186-9-965-6294	C47	Camera 70 mm Daedalus

APPENDIX 1: (CON'T)

Task No.	Mission Objective	Area	Name of Investigator	Aircraft	Sensors Required
72-54	Feasibility study to investigate production of contour maps of chlorophyll abundance in the sea to locate and map areas of high plankton abundance and therefore search out fishing areas. Measurement of sea surface temperature.	Gaspe Penn.	Dr. Trevor Platt Marine Ecology Laboratory Bedford Institute Dartmouth, N.S. 169-9-426-3793	FALCON	Camera RC10 70mm RS14
72-104	To obtain a surface temperature profile of Babine Lake for lake circulation study.	Babine Lake B.C.	Dr. J.F.R. Gower, Dept. of the Environment 512-1230 Government St. Victoria, B.C. 388-3377	C47	Camera Zeiss Daedalus PRT-5
72-108	The thermal plume dissipation from the Pickering nuclear power station.	Pickering Ontario	R. Kenneth McMillan University of Waterloo Dept. of Physics Waterloo, Ontario 579-5424	C47	Camera 70mm Daedalus
72-101	To obtain remote sensing imagery for detailed steelhead investigations.	Coquihalla R. Silver Hope Cr. B.C.	V.J. Swiatkiewica British Columbia Wildlife 4529 Canada Way Burnaby 2, B.C. 435-4137	FALCON	Camera RC10 70mm IR Scanner
72-111	To establish a baseline for interpretation of changes in aquatic vegetation.	Ottawa River Gatineau	Dr. M. Dickman Dept. of Biology University of Victoria Victoria, B.C. 231-2439	C47	Camera 70mm
72-120	Study the use of Remote Sensing techniques in coastal waters.	St. Lawrence Gaspé	Paul E. Vandall, Jr. Bedford Institute Marine Ecology Laboratory Dartmouth, N.S. 231-2439	FALCON	Camera RC10 70mm
72-110	To determine aquatic plant cover in the Kawartha Lakes.	Kawartha Lakes	Mrs. I. Wile Water Quality Branch, OWRC, P.O. Box 213 Rexdale, Ontario 186-9-248-3058		Camera Zeiss 70mm

APPENDIX 2:

MEMBERS OF THE WORKING GROUP ON OCEANOGRAPHY

Dr. W.N. English (Chairman), Marine Sciences Directorate, Pacific Region, Department of the Environment, 1230 Government Street, 5th Floor, Victoria, B.C. (604) 388-3546

Dr. John Allen, Engineering Department, Memorial University, St. John's, Newfoundland. (709) 753-1200

Mr. N.M. Anderson, Hydrographic Service, Marine Sciences Directorate, Pacific Region, 1230 Government Street, 5th Floor, Victoria, B.C. (604) 388-3523

Monsieur F.R. Boudreault, Ministère de l'Industrie & du Commerce, Division de Biologie, 555, boulevard Henri IV (C-2-65) Québec 12, Qué. (418) 643-8084.

Monsieur André Cardinal Faculté des Sciences Université Laval, Québec 10, Qué. (418) 656-5759

Dr. Robert Edwards, Hermes Electronics Ltd., Esson Road, Dartmouth, Nova Scotia. (902) 466-7491

Mr. A.W. Fia, Vice-President, Rocket & Space Division, Bristol Aerospace Ltd., International Airport, Winnipeg, Manitoba. (204) 775-8331

Dr. Michel Khahil, Université du Québec, Rimouski, Qué. (418) 724-1614

Mr. J. MacDowall, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario. (613) 993-3350

Dr. Mikio Miyake, Institute of Oceanography, University of British Columbia, Vancouver 8, B.C. (604) 228-3632

Dr. Trevor Platt, Marine Ecology Laboratory, Bedford Institute of Oceanography, Department of the Environment, Dartmouth, Nova Scotia. (902) 426-3793

Mr. Ian Webster, Pollution Control Branch, Water Resources Service, Department of Lands, Forests & Water Resources, Parliament Bldgs., Victoria, B.C. (604) 387-5321

Secretary of the Working Group

Dr. J.F.R. Gower, Marine Sciences Directorate, Pacific Region, 1230 Government Street, 5th Floor, Victoria, B.C. (604) 388-3377

5.13 REPORT OF THE WORKING GROUP ON PHOTO REPRODUCTION AND MARKETING

5.13.1 Reproduction

During the past year the Reproduction and Marketing Committee have put special emphasis in two key areas:

1. System flow and scheduling.
2. Catalogues, Inventories, Data Retrieval.

The move of the NAPL/RC from Rockcliffe Air Base to Sheffield Road at a time of the year (April-May) when requests for photo reproduction are at a peak seriously affected production which was disturbing to many customers.

It is anticipated that in the coming year all reproduction requirements can be met within specific time frames hopefully to the satisfaction of all requestors.

It has agreed that:

1. ERTS reproduction will receive first priority.
2. Airborne remote sensing reproduction will receive second priority.
3. Conventional photography reproduction will receive third priority.

Proposed scheduling of Airborne Remote Sensing taska:

1. CCRS to set the priority for each task.
2. Turn around time to users to be stated in working days, not calendar days - due to union regulations.
3. NAPL and Airborne Ops (CCRS) to communicate each morning at 9:00 a.m. to provide status of each task current.
4. Airborne Ops to provide NAPL with status boards.
5. Turn around time products and documentation as follows:

   a) 3 days - original film to investigator - no annotation, indexing, or documentation - no requests for reproductions until after annotation and indexing, to be done on low priority.

   b) 5 days - Reproduction using continuous printing (e.g.) Colorado Printer - no annotation, indexing - no[1] quality control check - no secondary reproduction until after annotation and indexing. Annotation and indexing to be done on low[2] priority.

   c) 10 days - Film annotated, indexed and documented. Reproduction to be stereo pairs (9½") colour, strip prints beginning, middle, end (70mm) colour, complete continuous contact prints of B&W film. Plus continuous prints (undodged) from the Colorado Printer. (If requested).

   d) 21 days - Film annotated, indexed, documented. Photography reproduced as per the instructions of investigator.

6. NAPL will contact investigator and advise him of acquisition of film and status of task.

   NAPL to act as contact with investigator after requisition of film.

7. In-camera annotation acceptable as annotation when operation of system is available. Film to be annotated under Federal System when work load allows. The in-camera annotation will not be shown on index maps. NAPL will keep a cross reference file.
8. Quality control will not be required to annotate film showing lines, etc., as long as the system of two blank frames between lines and three frames between tasks is followed.
9. When required, film will be transported to and from NAPL - NAPL/RC immediately, instead of the once a day pickup.
10. "Secondary" or-ers will not be treated as priority orders, but will be placed into the normal flow of requests. (21 days).
11. Investigators receiving priority (a), (b) or (c) will receive his imagery via Air Express Collect or Banker's Express Collect.

1. Limited
2. Agreed on between CCRS and Users

Other factors that are expected to speed up delivery of imagery to requestors are:

(a) Coordination between (CCRS-ASU) and NAPL/RC-NAPL) has improved tremendously during the year and the majority of the frustrating system bugs have been eradicated.

(b) All additional equipment listed in the NAPL/RC report is now operational with the exception of the colour analyzer. The composite printer which is the key to ERTS production is only 60% effective but since January 15, 1973, has been operating on a two-shift basis and is maintaining the required production.

(c) Approved changes to "A" budget (Surveys and Mapping Branch) 1973-74 will provide an additional 11 man years to the NAPL/RC ($92,000 - salaries; $49,000 - materials).

(d) Approved "B" budget items will provide the porposed retrieval system for the NAPL with an additional 2 man years ($18,000) and $112,000 for operating and capital items.

(e) A total of 23 Winter Works personnel are on strength till May 31, 1973, undergoing training at the reproduction centre and preparing flight indices for microfilming at the NAPL.

(f) Training of personnel at both the NAPL and NAPL/RC has been carried out during the year and a thorough knowledge of the new equipment and a better understanding of user requirements has been attained.

5.13.2 Marketing

The committee agreed that (1) it was the responsibility of CCRS to fund a program to educate prospective users of ERTS imagery emphasizing its application to Canadian problems and the relationship of the airborne and satellite programs; (2) NAPL activity in the marketing field should be limited until April 1973 when:

(a) Staff increase to assure production is feasible.

(b) The composite printer is operational.

(c) Price increase is in effect in keeping with Treasury Board cost recovery directive.

In preparation for an active role in the marketing area the NAPL has confined itself to (1) preparing a catalogue, inventory and data retrieval system (Appendix 1); (2) obtaining telex and a remote computer terminal to provide better customer service.

The Surveys and Mapping Branch have indicated a willingness to assist in (1) the promotion of remote sensing products by preparing materials for displays at exhibitions and conferences and having knowledgeable persons attend such affairs to communicate directly with the public. (2) Involving the Research and Development Division of the Topographical Survey in an experimental program to determine the usefulness of a variety of photographic products.

The long range plan is to create a truly National Air Photo Service with the NAPL as the central marketing agency for all aerial photography in Canada originating from either satellite or airborne platforms held by all levels of government or commercial firms.

It is recommended that the CCRS appoint a Marketing officer as soon as possible to interface with the Chief of NAPL in order to formulate a cohesive marketing policy.

A committee of CACRS members with L.J. Chouinard as Chairman has been formed to study the vault preservation of the original remote sensing film. It is proposed that this committee serves as a channel of users' suggestions and recommendations to both NAPL and NAPL/RC. It will thus ensure a better contact between users and these agencies.

APPENDIX 1

REPORT OF CATALOGUE AND RETRIEVAL COMMITTEE FEBRUARY 1973

Introduction

In January 1972, a Working Group on Photo Reproduction and Marketing was created under the Chairmanship of Mr. W.G. Landles, Chief of the Aerial Photography Division of Topographical Survey.

One of the terms of reference of this Working Group stipulated:

"to recommend procedures for cataloguing, advertising and marketing ERTS and ARS imagery".

To attain part of this objective, a Catalogue and Retrieval Committee was formed at the first meeting of the group. Its member members were:

Mr. L.J. Chouinard, Chairman
Research and Development Section
Topographical Survey

Mr. P.K. Andrews
Chief, National Air Photo Library

Mr. W. Hyndman
Software Projects Engineer
Computing Devices of Canada

Dr. W.M. Strome
Chief, Data Processing Division
Canada Centre for Remote Sensing

Parallel to this planning activity within this CACRS Workshop, the Topographical Survey Directorate had received early in 1972, a report* from the Bureau of Management Consulting on the National Air Photo Library activities. It is important to note that this report studied the impact that created the new flux of ARS and ERTS imagery on this organization and that the conclusions of the report tied together under a single set of needs for production and marketing developments, mapping photography, ERTS and ARS imagery. It was thus a most fortunate convergence of studies and developments that guided the Catalogue and Retrieval Committee analysis and planning.

*Mr. R.A. Battram, "The National Air Photo Library, Catalyst for National Development".

The committee presented its report on April 1972. The proposals were accepted and the deadline for development was set to April 1, 1973. A 1973-74 budget of $130,000 was voted for the system implementation.

A development committee was formed under Mr. L.J. Chouinard's Chairmanship and Messrs. Andrews and Strome remained as members of this Committee. The new members were:

Mr. R. Defoe
Research and Development Section
Topographical Survey

Mr. B. Monkhouse
Computer Science Centre
Energy, Mines & Resources

Mr. C.H. Poole
Technical Services
Public Archives of Canada

A guiding objective for this development was to design a system that could be easily adapted to future information and marketing needs and to foreseeable new computer development. This implied that the system should be easily expanable and also convertible to most of the larger computer systems and to more complex data base organizations such as may be required for an on-line system.

System Description

At an early stage of its work, the committee decided that since ERTS, ARS and metric images had very different information sets and were produced under a different scheduling, each one of these types of imagery would be treated separately in three distinct sub-systems. Another reason for this decision was to enable the committee to more easily adapt each sub-system to users' information needs. It was agreed that at a much later stage of this project, the three sub-systems would likely be integrated into one system and the present design reflects this intention. In any case, this is a system design consideration and the user would not likely know the difference.

The ERTS Sub-System

The proposed name of this sub-system is:

Satellite Photography Information Catalogue and its abbreviated name is SPIC.

Description

The SPIC system is a single file maintenance system designed to provide information about the availability of imagery from ERTS. It supports a microfilm information system available on a subscription basis from the National Air Photo Library. The system is designed to produce an information package every 18 days but it will be capable of producing on any other time basis, for a sufficient number of scenes should be produced before an issue is prepared. A minimum of 1000 scenes is required.

A subscriber can obtain one of the following packages:

A Package:

1. A microfilm roll containing the images of index maps (See Figs. 1 and 2) showing the satellite position, the cloud coverage of the image and the microfilm frame number of each scene. ERTS scenes follow the index frames. The annotation on each scene will enable the user to place an order from the very scene. The MSS band 6 image is used for the microfilming of these. The index maps are produced for the latitudes up to latitude 75. Above this, a list only is produced; it also refers to the microfilm frame number of each scene.

2. A printed list of the imagery to complement the microfilm information.

B Package:

1. Xerox copy(ies) of the above index maps.

2. A printed list of the imagery.

System Procedures

The SPIC system matches input from two sources. The CCRS ERTS photo catalogue and the Reproduction Centre. To prepare an issue, the 9 x 9 contact prints of the band 6 images of each scene are microfilmed at the Reproduction Centre. The CCRS catalogue file is copied to magnetic tape and sent to the Computer Science Centre. This tape is treated as a transaction file to the previous Catalogue in order to provide validity checking with the following conditions:

1. No scenes should exist on the old Catalogue that have disappeared from the new one.

2. If identical frame numbers exist on both files, the locations cannot differ by more than a degree in lat. or long.

3. A quality rating of x or better for any band cannot be replaced by an 0.

In case 1, the old record is retained but in case 2 and 3 the transaction is accepted as an update of the catalogue. In all cases, a warning message is printed out.

The microfilmed images are viewed and each image identification number is read and copied beside the Microfilm frame number. The resulting list is compared against the catalogue file and the new imagery file is produced. This contains one record for every image on the microfilm roll and it is used to provide both the printed list and the plot. Let us repeat that information on images above 75° latitude will appear on the list only.

File Size and Growth

The ERTS satellite was supposed to be able to produce up to 1500 scenes of our country on an 18-day cycle and the SPIC system can support this. However, a far lower number of scenes has been produced so far and it is difficult to determine present growth.

In the period from July 23, 1972 (the ERTS launch date) to January 8, 1973, a span of 9½-18 day cycle with a theoretical total production figure of 14,000 scenes, 3900 of these had been identified, of which approximately 500 were in existence as 9 x 9 negatives (4 per scene). While this production rate is expected to improve very soon, it is not anticipated that a 1000 scene production cycle will occur more often than monthly.

The A.R.S. Sub-System

Description:

As for the ERTS system, the designers objective is to create a computer and microfilm system which would offer to users across Canada as much information on remote sensing imagery as may be requested.

Basically, this information will be provided in a package consisting of:

1. a book index where the entry will be the name of each one of the 1/250,000 NTS series sheets for which A.R.S. imagery exists. This book will refer to the appropriate cartridge and microfilm frame numbers;

2. a microfilm cartridge of the National Air Photo Library Remote Sensing Imagery Indexes. We are presently experimenting with the colour microfilming of these

2. indexes as it presenta a much greater readability over the standard black and white 16 mm microfilm. Let us note that colour microfilming is still at its infancy and that serious testing on film copy durability will be made before a decision to use colour film is taken;

3. a series of specialized lists will be produced upon request.

To ensure a better service across Canada, ten centres will be equipped with the above package along with a teletype (to speed orders to the National Air Photo Library) and a microfilm reader.

System Detailed Description

System Procedures, File size and growth and other system characteristics will be described in detail in a report that will be produced soon. We will not wait for a most complete definition of needs and preferences to complete a first design and implementation. Indeed, the base records will contain much more information than may be presently required and, as was noted before, the system is being designed with an expansion and reorganization intention in order to adapt it to users' needs as closely as feasible.

Tasks and Sub-Tasks

It is important to note that each record in the book index will be related to a 1:250,000 NTS sheet and that if a task extends to many such sheets, it will be divided in sub-tasks - one for each sheet - and each one of these sub-tasks will have a record and a microfilm index. For example, a task may extend over a summer period and consist of many sub-tasks flown in different areas. Each one of these sub-tasks under the same task will have a discrete record and index. This is consistent with the present NAPL procedures.

APPENDIX 2

MEMBERS OF THE WORKING GROUP ON PHOTO REPRODUCTION AND MARKETING

W.G. Landles	Aerial Photography Division Chairman - S&M Branch
W.M. Strome	CCRS
E. McLaren	CCRS
Lt. R. Worsfold	CFASU
P. Andrews	NAPL
G. Nitschky	NAPL/RC
L. Chouinard	Research & Development - Topographical Survey
R. Defoe	Research & Development - Topographical Survey
N. de Villiers	CCRS
S. Zelitt	CCRS
W. Hyndman	Computing Devices

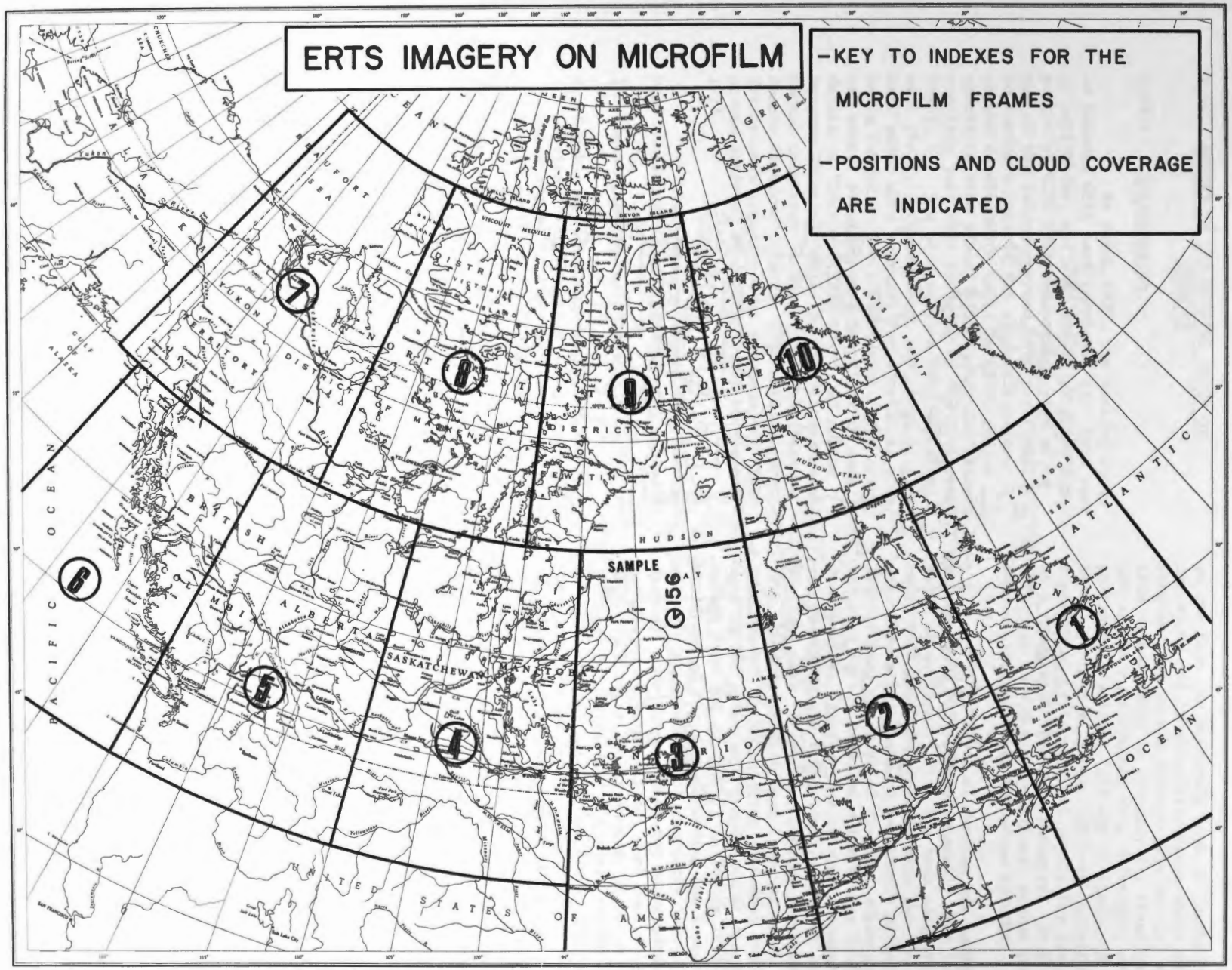
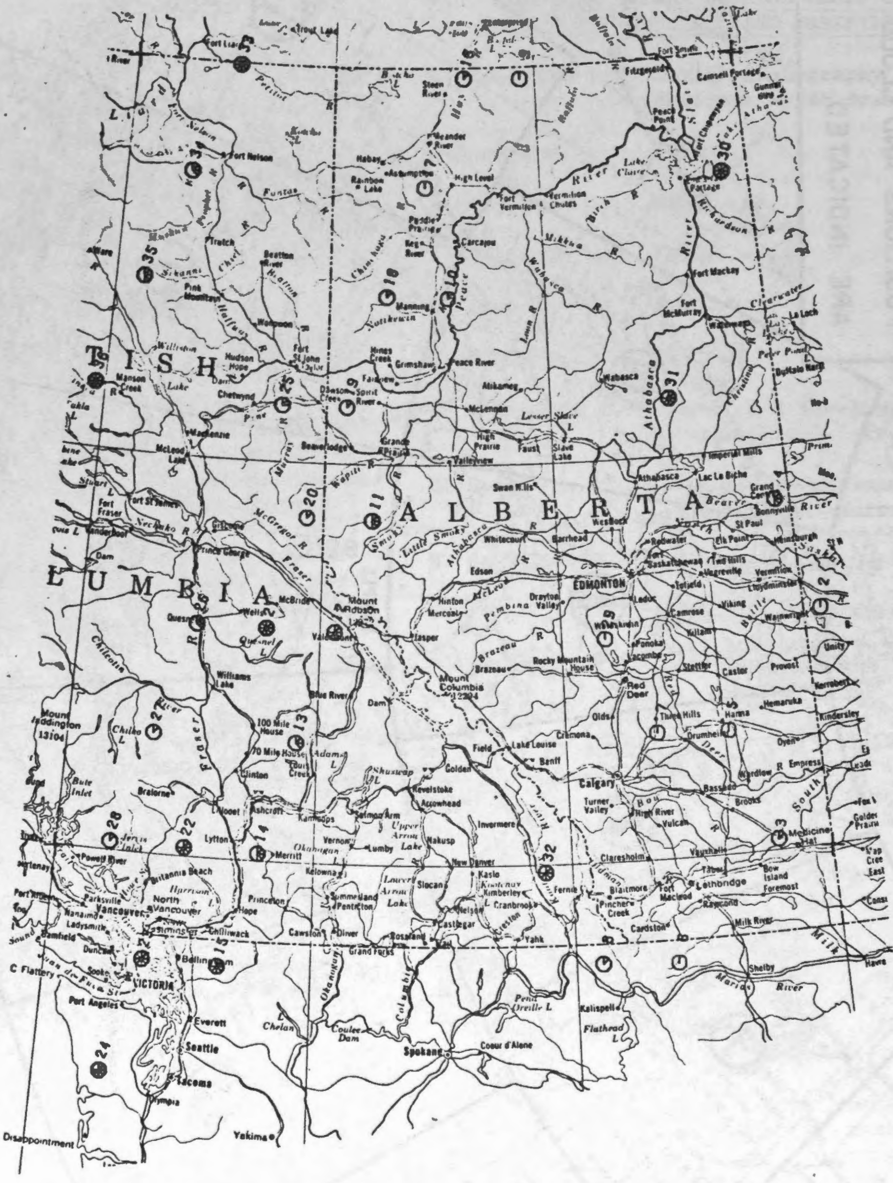


Fig. 1 Map of Canada showing the boundaries of each index map used in the SPIC system.



SAMPLE PLOT OF PAGE 5 (ALBERTA + B.C.)

Fig. 2 Sample of an index produced during a system simulation carried out on January 24, 1973. It shows the status of the imagery in Area 5 from launch date to simulation date.

5.14. REPORT OF THE WORKING GROUP ON SENSORS

5.14.1 Introduction

By March 1973, the Working Group on Sensors will have completed its third year of activities, and most sensor programs supported by CCRS over this period have moved out of the laboratory and into the field. Following a request for proposals on new sensor developments early in 1970, twelve contracts were placed with successful bidders totaling just over $200,000 in the first year (Table 1). Six of them have been supported over the full three years, and three programs were added more recently for a total of nine being funded at the present time. The original sensor programs were described in some detail in "Sensors", Report No. 10 to the Program Planning Office for the Interdepartmental Committee on Resource Satellites and Remote Airborne Sensing, published in 1971. The present report covers progress and milestones achieved subsequently, up to March 1973.

The sensor programs that survive must continue to meet the following criteria:

1. Innovative and technologically sound.
2. Capable of measuring parameters and physical variables that are relevant to Canadian resource management and environmental monitoring problems.
3. Undertaken by organizations capable of developing the sensor to the field prototype stage, and prepared to transfer it to industry.
4. Capable of achieving a market that would be attractive to industry either as a product or as a service.
5. Capable of being developed within the financial resources of CCRS.

While the original programs were selected on their own merit based on excellence, innovation and relevance, later programs have been motivated by direct stimulus from one or more of the user working groups. A recent example is the study on soil moisture measurement in response to specific requirements brought to our attention by the Working Group on Agriculture.

As the sensors being developed move into the hardware and field testing stages, the complexion of our problems change. we now face the difficult task of "marketing" our wares and creating situations where the programs can become commercially viable, and thus transferable to industry for those that now are being conducted by a university or government facility (six out of nine). A sensor program will have achieved operational status when it is at least paying for itself as a commercial entity in industry. It is our objective to achieve operational status for all sensor programs being supported by CCRS.

The level of funding has ranged between $200,000-$250,000 annually over the first three years. This has been adequate to carry 9-12 separate programs into the field prototype stage, each of relatively modest proportions. Because of the cost structure peculiar to the Canadian universities (whereby professorial salaries are covered seaparately, and overheads are exceptionally low) we can purchase more "sensor development per buck" from the universities than from industry. For this reason, there has been a gradual enrichment in the university proportion of the sensor budget from 48% in 1970-71 to 70% in 1972-73. While all of the sensor funding has been through the mechanism of contracts (not grants), some universities not experienced in contract work tend to treat such contracts much the same as grants-in-aid; although in the end all contractual obligations have been fulfilled before authorizing final payments. On the other hand, there is a critical level of funding in industry, below which the project has too low a visibility for adequate attention by management. The level would vary from company to company, but a figure of $15,000-$20,000 is the order of magnitude.

Field prototype manufacturing and testing is the expensive phase of most sensor development programs. Seven of the current programs being supported have reached this point. The investment in sensors so far by CCRS is over $630,000. A recent Treasury Board review concluded that there are other government programs available for the support of sensor development and so eliminated the CCRS sensor budget requested for 1973-74. CCRS has been able to allocate $100,000 internally from various sources to continue the sensor work at least for another year, but the future is still quite uncertain.

5.14.2 Funding of Sensor Programs

Aside from CCRS contracting, two categories of governmental support are available for the development of sensors. Firstly, there are the grant programs administered by various government departments including those

with direct interests in remote sensing, such as EMR, Environment and National Defence (DRB). NRC operates the largest grants program in support of university research. Normally, grants are awarded on the basis of initiatives exhibited by the individual researcher. Grant selection committees thus are reactive to grant proposals placed before them, and they are driven to select the successful ones on the basis of excellence and relative merits. Grants do not provide for the direction of effort toward specific problems and requirements of the granting department, except insofar as the proposal of the researcher coincides with such needs.

The second category covers the industrial incentive programs operated by NRC and Industry, Trade and Commerce (e.g. PRAI and PAIT). They are excellent mechanisms for effecting the transfer of technology from universities to industry once a development program shows encouraging signs of commercial viability. Normally, they would not be used to initiate new developments related to the specific needs of a government department.

There are no other government financial assistance programs known to the Working Group on Sensors that apply to the development of sensors to meet the needs of CCRS. For this reason, the working group passed the following resolution at its meeting on January 18, 1973:

5.14.3 Resolution

The Working Group on Sensors strongly urges the Treasury Board to reconsider its decision to eliminate the CCRS sensor development budget for the following reasons:

1. The present government investment of $630,000 will be lost if the programs are cancelled at this point in time - none have yet reached operational status.

2. Seven of the current nine programs being supported have reached the field prototype and testing phase where continuity and intensive support is paramount to success.

3. There are no alternative governmental funding sources that can assure support through to the stage of transfer to industry.

4. The sensor development programs are fulfilling specific requirements of the CCRS and its related user working groups - no other government support mechanism can play this role.

5. The importance of the sensor development program to CCRS has been demonstrated by its willingness to sacrifice other programs (in the amount of $100,000 for 1973-74) in order to provide at least some form of continuity.

6. Sensor development leads to commercially viable products or services for industry and thus contributes to the present policy of meaningful support to Canadian manufacturing and service industries.

TABLE 1

SENSOR DEVELOPMENT

PROGRAMS SUPPORTED BY CCRS - 1970-73

PROGRAM	CONTRACTOR	PRINCIPAL INVESTIGATOR	FUNDING ($)				STATUS (March 31, 1973)
			1970-71	1971-72	1972-73	TOTAL	
1. Ground Chopped Remote Sensor	Barringer Research	-	10,005.00	9,776.00	5,627.00	34,408.00	Complete resulting in Correlation Gas Analyzer (#16)
2. Multi-Spectral Camera System	Spar Aerospace	-	21,592.00	14,478.00	21,852.00	57,922.00	Field evaluation continuing
3. Image Tubes	University of Toronto	Dr.R.F.Garrison	3,500.00	-	-	3,500.00	Complete and terminated
4. Image Intensifier Correlation Spectrometer	York University	Dr.S.Jeffers	-	4,000.00	4,000.00	8,000.00	Ready for field testing
5. Inversion Layer Profiler	Barringer Research	-	3,630.00	3,000.00	-	6,630.00	Terminated - superceded in marketplace
6. Laser Air Pollution Mapping Study	University of Toronto	Dr.R.M.Measures	9,000.00	-	-	9,000.00	Completed
7. Laser Fluorosensor	University of Toronto	Dr.R.M.Measures	18,000.00	60,000.00	20,193.00	98,193.00	Continuing field and laboratory evaluation
8. Laser Radar System	RCA Limited	-	45,203.00	25,506.00	-	70,709.00	Terminated - costs exceed resources
9. Lidar	York University	Dr.A.Carswell	16,000.00	16,900.00	15,000.00	47,900.00	Continuing evaluation as marine Lidar
10. Microwave Holography (Holographic Ice Surveying System)	University of Toronto	Prof.K.Iizuka	18,000.00	43,568.00	58,768.87	120,336.87	Continuing field evaluation
11. Millimetre Wave Radiometer Study	RCA Limited	-	9,896.00	-	-	9,896.00	Complete and terminated

TABLE 1 (Continued)

SENSOR DEVELOPMENT

PROGRAMS SUPPORTED BY CCRS - 1973

PROGRAM	CONTRACTOR	PRINCIPAL INVESTIGATOR	FUNDING ($) 1970-71	1971-72	1972-73	TOTAL	STATUS (March 31, 1973)
12. Snow Depth and Density Measurement	University of Saskatchewan	Dr.A.Kavadas Dr.J.A.Koehler	7,000.00	-	-	7,000.00	Complete and terminated
13. Spectroscopic Devices	York University	Dr.G.Shepherd	26,750.00	36,500.00	20,000.00	83,250.00	Field evaluation complete
i) Multiplex Interference Filter Photometer							
ii) Michelson Interf-ferometer							Entering field evaluation phase
14. Semiconductor Infrared Photog-raphy (SCIRP)	CARED (McMaster University	Dr.W.Pinson	-	9,940.00	20,800.00	30,740.00	Early laboratory prototype
15. Sensor Survey	CARED (McMaster University	-	-	5,421.00	-	5,421.00	Complete
16. Correlation Gas Analyzer	Barringer Research	-	-	-	26,730.00	26,730.00	Ready for field trials
17. Soil Moisture Study	Barringer Research	-	--	-	10,000.00	10,000.00	Initial study in progress
SUB-TOTALS			197,576.00	229,089.00	202,970.87	629,635.87	
MISCELLANEOUS - Travel, Conferences, etc.			-	1,280.00	299.08	1,579.08	
TOTALS			197,576.00	230,369.00	203,269.95	631,214.95	

APPENDIX 1

LIST OF ACTIVE SENSOR PROJECTS (March 1973)

MULTISPECTRAL CAMERA SYSTEM

Contractor: Spar Aerospace Products Ltd.

Principle and Brief Description: The multispectral camera system uses an image dissector tube which is a type of photomultiplier where the optical image focussed on a sensitive area (photocathode) can be scanned or sampled elementally. The image causes photo-emission of electrons proportional to light intensity which are accelerated towards an aperture behind which is the photomultiplier. The size and shape of the aperture depends on the required resolution and the type of scan employed.

Used in the television mode, its aperture of 0.001-inch diameter provides a resolution of 1,000 TV lines per inch (20 lines/mm). The camera uses an ITT F 4052 tube with an S-20 response (300 to 700 nm). A wedge interference filter is placed in front of the system so that in one direction, y, the wavelength can be varied; and in the perpendicular direction, x, the camera can be line-scanned. When mounted in an aircraft, the line-scanning can be synchronized with the aircraft velocity so that a continuous strip of the terrain can be recorded similar to a conventional line-scanner. The wavelength then can be easily altered by varying "y" across the wedge interference filter. Thus, the multispectral camera can produce high resolution imagery at readily selected wavelengths within the range of the filter and the response of the tube.

Applications: It is a multi-purpose instrument that can be used for a wide variety of applications where the following are critical:

a) Rugged - no moving parts, highly reliable.

b) High spatial resolution - up to 40 lines/mn with .0005" aperture.

c) Large number of spectral channels which can be selected and programmed remotely.

d) Small spectral bandpass (10-35nm).

e) Wide dynamic range (10^4).

Status: During the first year, the system was designed, built and tested in the laboratory for spatial and absolute performance. In the second year, it was modified for aircraft installation and interfaced with the Daedalus tape recorder and playback system. Ground testing using a tripod-mounted scanning system was performed. Flight testing was conducted during the third year in and around Ottawa to produce imagery of correct quality.

Future Prospects: This instrument now is approaching operational status within the CCRS flight facility. It could be used for mapping cladophora on the Great Lakes during the Summer of 1973, for observing diseased pea crops in southwestern Ontario and for flights over forestry areas to look at disease and/or tree types.

The camera could be modified into a non-imaging spectrometer to measure spectral signatures or a scanning spectrometer. There are a number of other adaptations of the system that could be explored, depending on the interest and response of potential users.

IMAGE INTENSIFIER SPECTROMETER

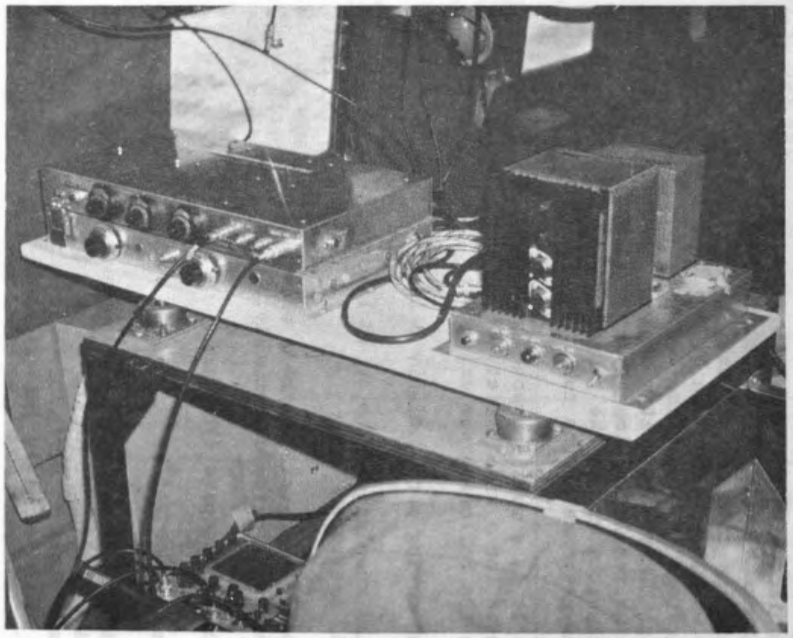
Contractor: Dr. Stanley Jeffers - York University

Principle and Brief Description: The project was motivated by the investigator's interest in using the Fraunhofer line depth technique for the detection of luminescence. The work followed an earlier contract with Dr. R. F. Garrison of the David Dunlop Observatory described in CCRS Report No. 10, Sensors. An ITT Type F-4708 image intensifier is mounted in the exit plane of a spectrograph. This device overcomes the inherently low dynamic range of photographic emulsions, and also provides an output in the form of an electrical signal which may be telemetered and interpreted. Furthermore, the electron image may be moved by means of an externally-applied magnetic field - a property that has been exploited in this project.

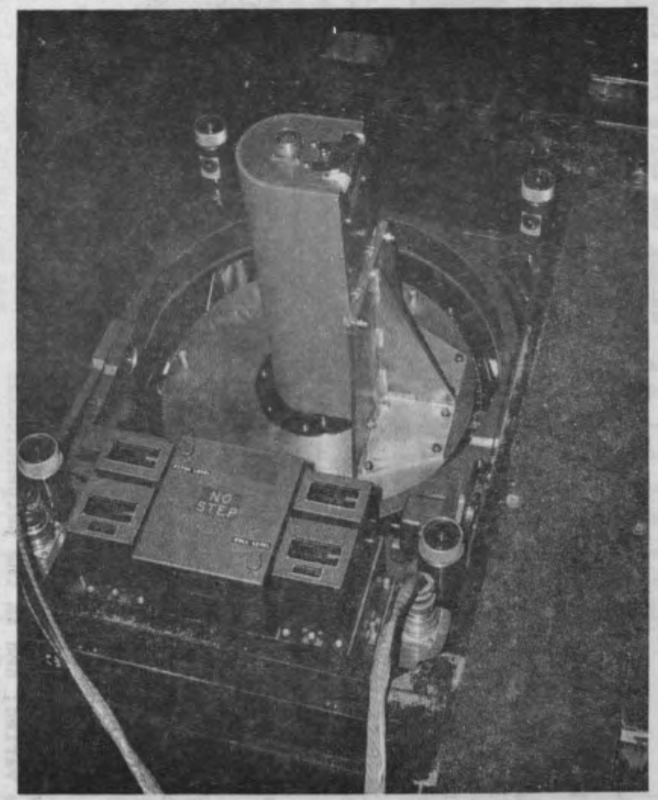
The image intensifier is a single stage device, electron-statically focussed with fibre optic input and output windows with a luminance gain of 100. It displays the spectrum of the source on its output fibre optic window over which there is a slit, the light transmitted through which is focussed onto an EMI 6094 photomultiplier tube. The electron image on the output window is deflected by a square-wave modulated transverse magnetic field, thus jumping the spectrum back and forth across the slit. The slit isolates the central region of a Fraunhofer absorption line and by jumping between it and the adjacent continuum, the instrument may be used to detect luminescence.

MULTISPECTRAL CAMERA SYSTEM

Spar Aerospace Products Limited



Electronics in DC-3



Optics in stabilized mount - DC-3

In order to detect luminescence, the part of the adjacent continuum that is selected must be well removed from the luminescence emission peak of the substance to be detected. The present instrument has magnetic coils that can achieve a separation of 50nm.

Applications:

- detection of luminescence from rhodamine dye.
- rapid recording of reflection spectra when operated as an image dissector tube.
- when operated as a correlation spectrometer (with correlation mask pressed against the output fibre optic window), it has a wide range of uses.

Status: During the first year, the basic instrument was built and tested using the sodium D lines at 589.0nm and 589.55nm. In the past year, it was improved with new deflection coils and better signal processing techniques. Field tests are being planned for mid-March, 1973 using the CCIW ship, Martin Karlson, from which rhodamine dye will be released. Mounted' in a CCRS aircraft, the instrument will attempt to detect dye luminescence, using a 6", f/15 reflecting telescope.

Future Prospects: If the instrument is successful in detecting dye luminescence, it could be valuable in environmental monitoring. It is yet too early to predict. The other applications have not yet been evaluated or pursued.

LASER FLUOROSENSOR

Contractor: Dr. Raymond M. Measures - University of Toronto

Principle and Brief Description: This project makes use of a high-powered laser to induce fluorescence in a wide variety of materials. The laser radiation is absorbed by the irradiated material, raising the molecules concerned to an excited state, from which they can decay with emission of longer wavelength radiation that can be detected by a suitable receiver mounted adjacent to the laser. The high intensity of the laser will increase the fluorescence signal, and the narrow beam will provide precise geometrical location of the fluorescing source.

The fluorosensing system consists of an 8" Newtonian telescope - photomultiplier receiver rigidly co-joined to an AVCO C-950 pulsed nitrogen laser emitting 10 nanosecond 100KW pulses of 337.1nm radiation at 100 pulses per second in such a way that the telescope field of view can be adjusted to overlap the laser-excited field for any given range. The control and monitoring electronics have been installed in a van, and the back-up power, water, gas and vacuum equipment in a 2-wheel trailer.

Applications:

- identification and mapping of oil slicks and dyes on water.
- water fluorescence - leading to data on the quality of the surface waters (effluent mapping).
- vegetation identification.
- fish tracking.
- bathymetric measurements.

Status: The mobile field unit trials were carried out at a field station in Scarborough overlooking Scarborough bluffs, 261 ft. above Lake Ontario. Controlled oil spills on the lake revealed the feasibility of remote oil spill detection at night from an airborne system at several thousand feet.

A laboratory program has been running in parallel with the field work using either a tunable dye laser in the 440nm to 480nm range, or a conventional second harmonic ruby laser at 347.1nm. Tests have been carried out to back up the field work on oil slicks, an and progress has been made towards oil type identification using different laser wavelengths. A miniature nitrogen laser also has been built to study fluorescence life-times and polarization effects.

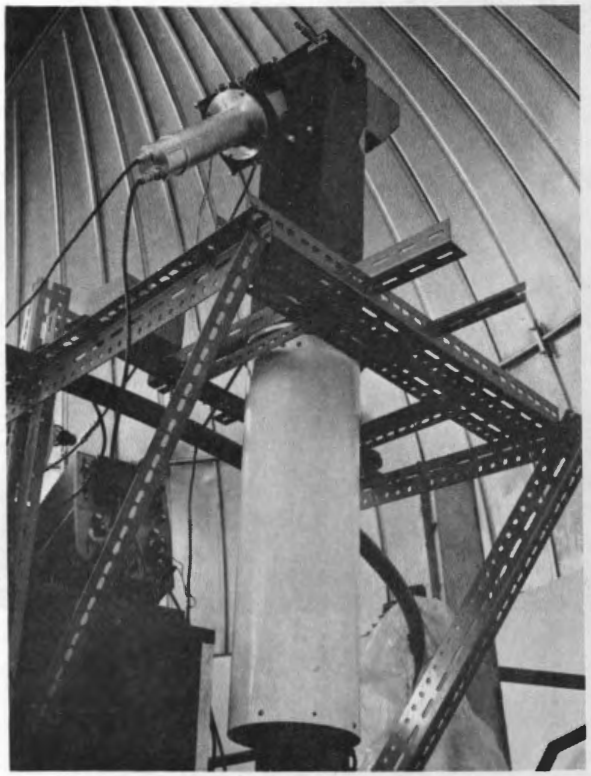
Future Prospects: Laser fluorosensing offers a promising method of oil slick monitoring, and future airborne measurements should reveal its full potential. As such it could form the basis of a service business. New applications in agriculture, fisheries and water quality monitoring have yet to be explored.

Parallel work with a CW laser is being conducted by the federal Department of the Environment, and close liaison between both projects is required. Also, similar work is being done in other countries, mainly in the U.S., and the field has become very competitive.

The future will depend on how well Canada can maintain its lead in this important new method of environmental monitoring.

IMAGE INTENSIFIER SPECTROMETER

York University - Centre for Research
in Experimental Space Science



LASER FLUOROSENSOR

University of Toronto
Institute for Aerospace Studies

LIDAR

Contractor: Dr. A. I. Carswell - York University

Principle and Brief Description: Optical probing of the atmosphere, or earth's surface with a high-power laser source and an optical receiver to measure back-scattered radiation is similar in principle to a radar, but at optical frequencies (LIDAR - Light Detection and Ranging). Lidars are sensitive to atmospheric constituents and characteristics not detectable by other means. The information is based on Rayleigh scattering of light by molecules and very small particles, Mie scattering by aerosols and Raman-scattered signal produced by the various Raman-active components of the atmosphere.

The Lidar built at York consists of a Q-switched ruby laser capable of providing up to 150 megawatts at the fundamental wavelength (694.3nm) in an 18 nanosecond pulse. The system is water-cooled and provides pulse repetition rates of 10 per minute. The system also contains a second harmonic generator to provide radiation at 347.2nm. The receiver includes four channels to permit simultaneous analysis of four backscatter signals capable of providing complete polarization measurements; the data is recorded as oscilloscope traces on Polaroid photographs, but also can be digitized and stored on magnetic tape. The unit is installed in its own mobile truck laboratory and now incorporates precise motor-driven horizontal and vertical steering-controls for aerosol and plume tracking.

Recent work has been directed towards the design of a marine lidar system employing a new cavity-dumped argon laser. It operates on a number of lines between 454 and 514nm. with a high average power (up to 2.5 watts on a single line) and high peak power (up to 100 watts). Pulses as short as 10 nanoseconds can be generated with repetition rates up to 20 MHz, and with mode-locking, pulses as short as 150 picoseconds can be achieved. Thus wavelength, pulse width and pulse repetition rate can be varied.

Applications:

- meteorology and air pollution monitoring.
- limnology and water pollution monitoring.

Status: The first two years were devoted to the construction and operation of the atmospheric lidar during which measurements were made of extinction coefficients, polarization properties, Raman backscattering and a wide variety of atmospheric conditions leading to a catalogue of atmospheric signatures.

Work in the third year has been directed to the assessment of lidar capabilities for quantitative remote sounding of inland waters leading to the design and laboratory assembly of a marine lidar system.

Future Prospects: The atmospheric lidar work is now self-supporting from other agencies such as the Atmospheric Environment Service and the Ontario Ministry of the Environment.

The marine lidar program will hopefully be supported partially by CCIW in future and will be devoted to laboratory and field tests in the coming year.

Both atmospheric and marine lidar systems offer potential as a service function for routine measurements and monitoring as well as scientific research. As such there is a promise of commercial spin-off to industry, and a market possibility for a small number of such lidars.

HOLOGRAPHIC ICE SURVEYING SYSTEM (HISS)

Contractor: Dr. Keigo Iizuka - University of Toronto

Principle and Brief Description: The HISS radar, designed to measure ice thickness using the holographic principle, consists of three major parts - transmitting and receiving antenna arrays, a receiver-transmitter unit and an airborne special-purpose computer, all designed for a helicopter installation. In contrast with conventional radars, the HISS radar measures the spatial distribution of the scattered wave, and from this determines the distance to the target (viz. the top and bottom surfaces of the ice). The radar is designed to measure sea-ice thickness up to four metres.

Applications:

- ice thickness measurement (salt and fresh water).
- ice condition reporting.
- possible thickness measurements of materials other than ice (e.g. asphalt).

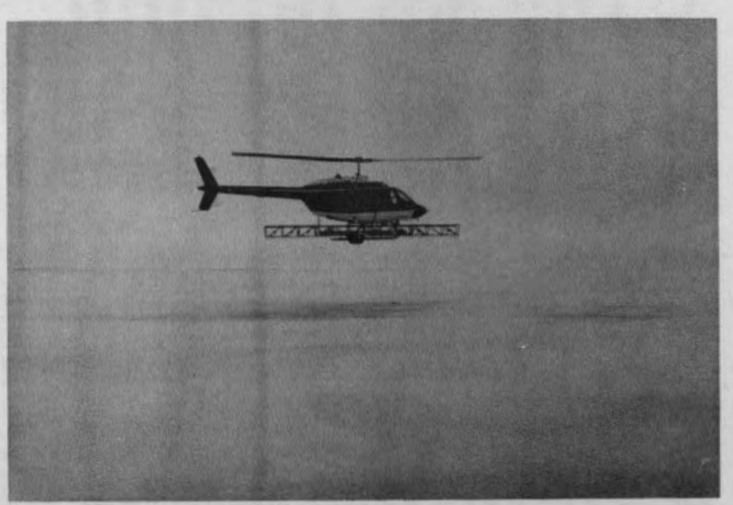
Status: During the first year the system was conceived and designed, actual construction began in July 1971. The antenna arrays and receiver-transmitter unit were completed and proven airworthy during the second year in preparation for arctic field tests using a 206A helicopter at four sites off the coast

LIDAR

York University - Centre for Research
in Experimental Space Science

HISS

University of Toronto



Off Tuktoyaktuk

near Tuktoyaktuk in May 1972. The airborne computer was not ready in time so the video data was taped for replay using a general purpose computer later. Over the past year, the Tuk data has been reduced and early results show encouraging signs. In parallel, the special-purpose computer has been readied, and shortly the Tuk tapes (from 9 hours of flying) will be processed for real-time readout.

Future Prospects: The future of this project depends on the results of running the Tuk tapes through the special-purpose computer. With positive indications, future field trials (with the computer operating) and refinements to the system will be carried out which should lead to a viable commercial product for which there is a very large market (arctic oil and gas industry, navigation of ice-covered waterways, etc.).

SPECTROSCOPIC DEVICES

Contractor: Dr. G. G. Shepherd - York University

Principle and Brief Description: Two spectroscopic devices are beind developed:

a) Multiplex Spectrometer,
b) Wide-Angle Michelson Interferometer.

The multiplex-spectrometer uses the passband peak wavelength change with angle of incidence on an interference filter. Scanning is provided by a 16-step multiplex mask, each scan requiring 2 seconds. The instrument will measure spectra in 15 narrowly-spaced bands (at 1.5nm intervals) in four selectable regions from 350nm to 1000nm determined by the interference filter in each of the four barrels.

The interferometer employs a field-widening technique using a cell in which gas under pressure simultaneously changes the refractive index and translates one reflector. It provides complete spectra limited only by the detector (350nm to 1000nm) with a resolving power of 200. A full scan for all spectral elements takes 1 second. The wide-angle feature allows for a multiple detector array to cover a large number of spatial elements.

Applications:

- Multiplex Spectrometer and Wide-Angle Michelson Interferometer.
- botany (most plant leaves are good reflectors in the near infrared due to the presence of chlorophyll).
- detection of plant life floating on water and algae mapping.
- ocean depth measurements and water temperature mapping.
- mapping atmospheric SO_2 concentrations.

Status: The multiplex spectrometer was flown three times over Lake Ontario, and once over the Kawartha Lakes during the Summer of 1972 in order to evaluate the possibility of algae concentration determinations. Ground truth data was acquired simultaneously. Results were encouraging for this application.

The interferometer has been assembled and tested in the laboratory, and the gas scanning technique was proven. Scan rates of 200 fringes/second were achieved and the wide angle effect has been demonstrated.

Future Prospects: Development of the multiplex spectrometer is complete and this project can now attract support from other sources. The interferometer should become a field-operational instrument within the next year.

SEMICONDUCTOR INFRARED PHOTOGRAPHY (SCIRP)

Contractor: Dr. W. Pinson - CARED (McMaster University)

Principle and Brief Description: SCIRP should prove to be a simple, yet inexpensive, method of infrared photography and holography. At infrared wavelengths, ordinary film will fog because of natural ambient thermal radiation. Fogging times (and thus storage life) depend on wavelength sensitivity and ambient temperature which become shorter at longer wavelengths and at higher temperatures. SCIRP overcomes this problem by introducing the image-forming substance only at the time of exposure. The Russians appear to be moving rapidly in this field.

A semiconductor replaces the silver halides of conventional photography, and wavelengths ranging from 600 to 3000nm are possible. Three methods are being investigated:

1. Contact Sensitized - two separate parts of the photographic process, each incapable of recording an image separately, are brought into contact during exposure.

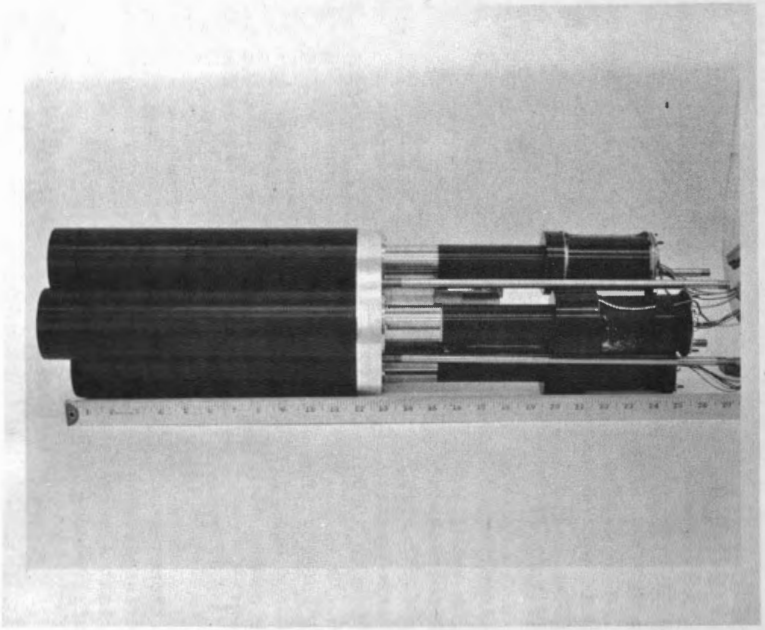
2. Electrically (current) Sensitized - an image is recorded only when an electric field is applied.

3. Differential Contrast Process - makes use of the uniform illumination of the thermal background radiation in order to remove it.

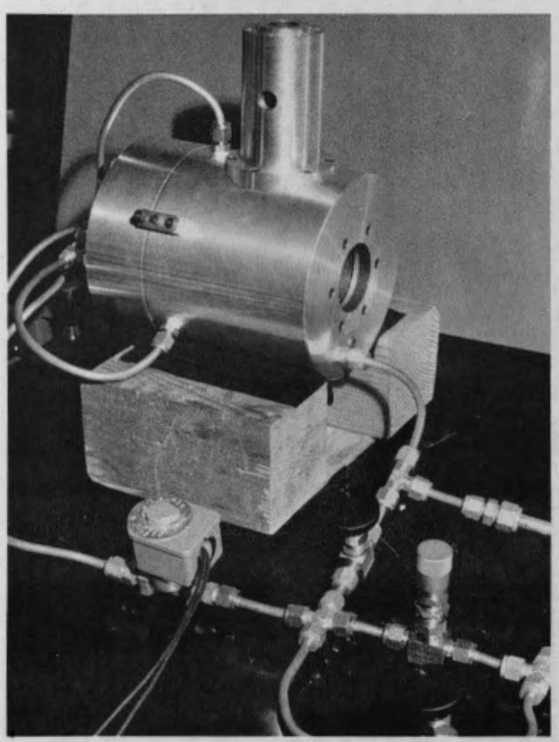
SPECTROSCOPIC DEVICES

York University
Centre for Research in Experimental Space Science

MULTIPLEX SPECTROMETER



WIDE-ANGLE MICHELSON INTERFEROMETER



The methods are based on electrode reactions which transform the distribution of intensity of infrared radiation on the surface of a semiconductor wafer or film into a current density or potential distribution, and as a final stage, into a distribution of a substance which is precipitated from an electrolytic solution to form a photographic image.

Applications:

- mapping forest fire perimeters through smoke and haze.
- medical and industrial diagnostics.
- agricultural and forestry mapping.
- infrared holography including time-lapse holography.

Status: During the first year, a thorough survey of the Russian literature was completed. Images were realized on p- and n-type silicon using the contact-sensitized process, and samples were prepared in order to tese all three SCRIP techniques. In the past year, contact-sensitized and physical development of latent images have been accomplished on silicon and lead sulphide. Efforts are being made to produce better semiconductor films with shorter exposure times with a view to airborne remote sensing applications.

Future Prospects: This program should lead to several patentable concepts involving infrared semiconductor films, substrates and a new type of camera. Its commercial potential thus is very large, but it should be emphasized that it is still in the early development phases. With adequate support, it could form the basis of a new proprietary industry for Canada.

CORRELATION GAS ANALYZER

Contractor: Barringer Research Limited

Principle and Brief Description: This instrument is designed to detect the presence of combustion gases associated with forest fires - the gas selected in carbon monozide. It is a non-dispersive gas analyzer designed to detect the decrease in energy in the incoming radiation due to the presence of an absorbing target gas. The instrument uses a reference cell containing N_2 or a non-absorbing gas in the region of interest, and a sample gas cell containing CO. Ground chopping is used based on the work of an earlier contract described in CCRS Report Number 10, Sensors. The incoming 4600nm. radiation is so chopped and passes, via a beam splitter, through both arms of the instrument to a double-element detector. When no target gas is present, the instrument is balanced and no signal is observed. When target gas drifts into the path of the instrument, a signal is observed proportional to the amount of gas present. A reference lamp is used to balance any variations in the respective gains of the two channels.

Applications:

- detecting presence of latent forest fires.
- detecting presence of a wide range of target gases.

Status: Since Barringer Research Limited is presently developing a similar instrument for another application, it has been possible to develop a 4600 nm. gas analyzer for CO in a relatively short time at considerable cost savings. A flyable breadboard should be ready for testing by March 31, 1973. Field trials using a CCRS aircraft over a suitable CO target, such as a fire, will be conducted early next fiscal year. If successful, such an instrument should find acceptance with most major forest-fire detection agencies throughout the world.

SOIL MOISTURE STUDY

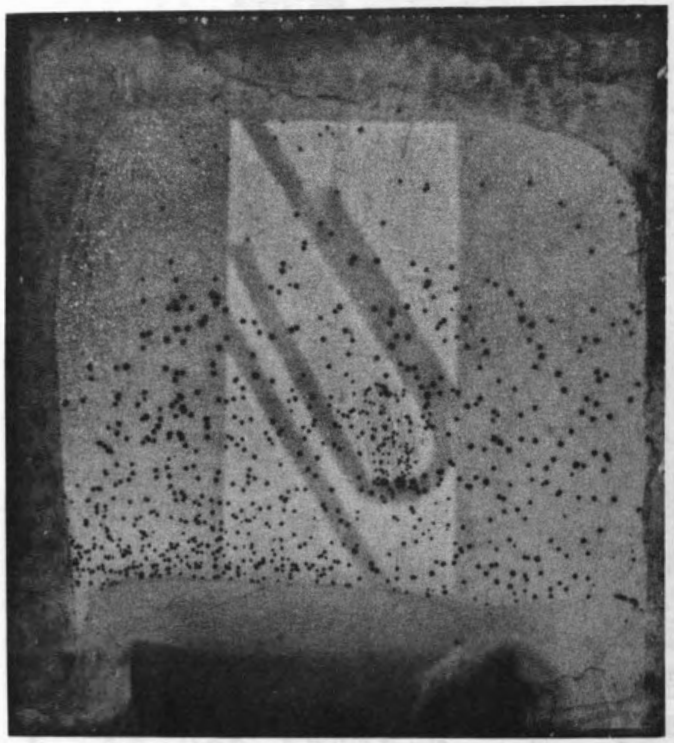
Contractor: Barringer Research Limited

Principle and Brief Description: A theoretical investigation is being conducted on the potential of electromagnetic techniques for remote sensing of soil moisture. The study specification called for an assessment of the capability of using such techniques between 10 kHz and 3GHz to monitor remotely the time variation in the amount of moisture contained within the uppermost few feet of the earth's crust. The quantity of interest is the amount of free water, that is, the amount that is not held under such tension as to be unavailable to vegetation. The problem is, to say the least, most difficult and there may be no solution.

Results are available on two important electrical parameters - resistivity and dielectric constant - either singly or in combination depending on the type of measurement, choice of frequency and the range of these two parameters. At low frequencies, conduction currents predominate, tending to emphasize resistivity. At high frequencies, the converse is true, and dielectric effects play the major role. Experience indicates that the minimum frequency employed will be in the order of 1 MHz since at lower frequencies the penetration depth becomes too large. At 1 MHz, typical values of resistivity and dielectric

SCIRP

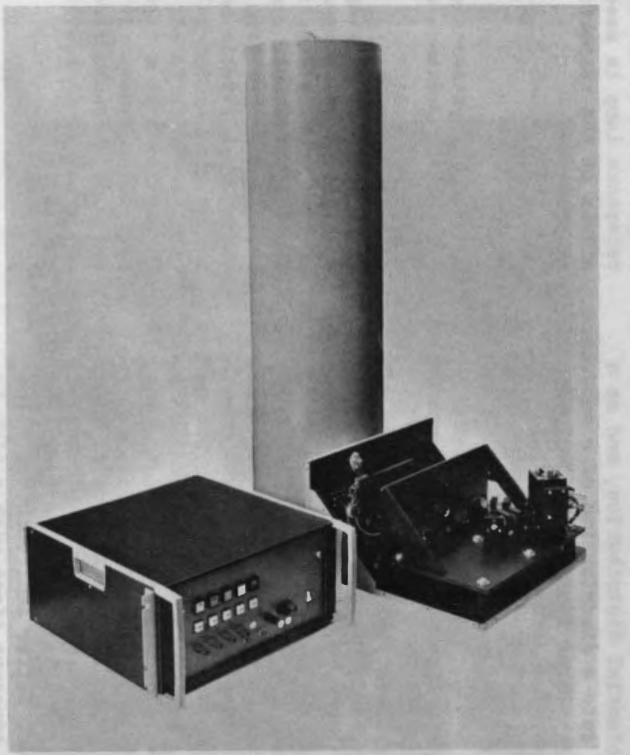
CARED - McMaster University



An image using SCIRP

CORRELATION GAS ANALYZER

Barringer Research Limited



All of the other programs are being reviewed again for possible patent implications. Even if patenting is not possible, the design rights can be valuable assets to the Crown where commercial exploitation occurs. For this reason, more attention will be devoted to these matters in future as the various programs approach maturity.

Finally, as mentioned earlier, the future activities of the Working Group on Sensors are uncertain. The broad strategies for sensor development will depend largely on the magnitude of the annual budget over the next few years.

APPENDIX 3

MEMBERS OF THE WORKING GROUP ON SENSORS

Member	Affiliation
Dr. Philip A. Lapp Chairman	14A Hazelton Avenue, Toronto, Ont. M5R 2E1
Mr. Joseph MacDowall Vice-Chairman and Secretary	Canada Centre for Remote Sensing, Dept. Energy, Mines & Resources, 2464 Sheffield Rd., Ottawa, Ont. K1A 0E4
Dr. Alex Kavadas	SED Systems Ltd., University of Sask. Saskatoon, Sask.
Dr. Harry Pullan	Director, Physics Dept., Ontario Research Foundation, Sheridan Park, Ont.
Mr. E.A. Godby	Associate Director, Canada Centre for Remote Sensing, Dept. Energy, Mines & Resources, 2464 Sheffield Rd., Ottawa, Ont. K1A 0E4
Dr. Allan Brewer	Dept. of Physics, University of Toronto, Toronto, Ont.
Dr. Henri Arsenault	Laval University, Quebec, P.Q.
Dr. George Pullan	National Defence Headquarters, Defence Research Board, 125 Elgin Street, Ottawa, Ont. K1A 0K2
Dr. Jaap de Leeuw	Institute for Aerospace Studies, University of Toronto, Toronto, Ont.
Dr. Ralph W. Nicholls	Dept. of Physics, York University, 4700 Keele St., Downsview, Ont.
Dr. D.F. Page	Head, Radar Section, Communications Research Centre, Dept. of Communications, P.O. Box 490, Station "A", Shirley Bay, Ottawa, Ont. K1N 8T5

constant are such that conduction currents are dominant, but displacement currents may not be negligible. At frequencies in the order of 100 MHz, displacement current and thus dielectric constant dominates.

The study divides into four parts:

1. Literature survey.

2. Identification of other physical factors that affect resistivity and dielectric constant such as salinity, soil density, organic matter, woil temperature and ion exchange effects.

3. Assessment of electromagnetic techniques that measure resistivity and dielectric constant to the desired depth.

4. Determination of other factors that could cause specious effects such as surface roughness, layering, propogation characteristics, etc.

Applications:

- agriculture and forestry.
- land use planning.
- geophysics.

Status: The study began in late 1972 and will be completed prior to March 31, 1973.

Future Prospects: If the theoretical investigation uncovers profitable directions for experimental work in this important field, resources will be found to support it.

APPENDIX 2

OTHER ACTIVITIES OF THE WORKING GROUP ON SENSORS

As of February 1973, the Working Group has held twelve meetings since its inception. Since the 1972 meeting of CACRS, it held its 8th meeting in Quebec City on March 15, 1972, 9th meeting at York University in Toronto on July 8, 1972, 10th meeting at the University of Toronto on October 31, 1972, 11th meeting at CCRS, Ottawa on January 18, 1973 and the 12th meeting at Saskatoon on February 6, 1973.

In accordance with its terms of reference, the Working Group has organized or participated in a number of workshops in order to encourage continuing contact between users and sensor development groups as follows:

Aerospace Electronics Symposium, CASI - Quebec City, March 14 and 15, 1972
- devoted entirely to sensor programs.

Annual General Meeting, CASI - Toronto, May 18 and 19, 1972.
- discussion sessions on:

a) Reflection Spectroscopy and Remote Sensing.

b) Soil Moisture and Remote Sensing.

3rd Annual Space Science Symposium - York University, June 6-9, 1972.
- sessions on reflection spectroscopy.

Aerospace Electronics Symposium, CASI - Saskatoon, February 5-7, 1973.
- devoted entirely to sensor programs.

Following initiatives by Prof. Nicholls on the need for a Canadian remote-sensing spectral atlas (CCRS Report No. 10, Sensors - Appendix C), the discussion session on reflection spectroscopy at the CASI Annual General Meeting and sessions on the same subject at York University's 3rd Annual Space Science Symposium, a sub-committee on Reflection Spectroscopy is being formed. While members of the sub-committee have been identified, its formation awaits official sanction.

DEMR and Canadian Patents and Developments, Ltd. now have reached an agreement on patenting procedures, and patent activity is now being started on two priority programs requiring such action HISS and SCIRP.

Member	Affiliation
Mr. A.M. Furlong	Electronics Branch, Dept. of Industry, Trade and Commerce, 112 Kent St., Ottawa, Ont. K1A OH5
Mr. W.L. Clink	Upper Air and Electronics Unit, Instrument Design and Development, Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ont.

6. REPORTS FROM PROVINCIAL REPRESENTATIVES

6.1 Alberta

6.2 British Columbia

6.3 Manitoba

6.4 New Brunswick

6.5 Newfoundland

6.6 Ontario

6.7 Prince Edward Island

6.8 Quebec

6.9 Saskatchewan

6.1 REPORT OF THE ALBERTA TASK FORCE ON REMOTE SENSING

6.1.1 Introduction

The Conservation and Utilization Committee of the Alberta government, chaired by Mr. H.W. Thiessen, Alberta's representative on the Canadian Advisory Committee on Remote Sensing, established an Alberta Task Force on Remote Sensing to enhance Alberta's ability to take advantage of the services of the Canada Centre for Remote Sensing.

Its membership (see Appendix) comprises personnel actively engaged in remote sensing in various disciplines and represents interested branches of the provincial government, federal government agencies in Alberta and the University of Alberta.

6.1.2 Task Force Activities

Brevity necessitates the inclusion of only some of the 1972 activities.

The establishment of a coordinator for remote sensing in Alberta was recommended and approved by the Conservation and Utilization Committee

A remote sensing information and questionnaire survey was distributed to 250 agencies and personnel throughout the province. Its object was to: (1) inform Albertans as to the Federal government's remote sensing program, (2) determine the potential Alberta demand for remote sensing imagery, and (3) ascertain the amount of interest in an Alberta remote sensing seminar.

The response was excellent indicating a keen but uncoordinated interest in utilizing remote sensing.

A detailed Alberta Remote Sensing Survey report was published and distributed.

The task force acting on a 90% affirmative response to the survey's question of a seminar organized the first Alberta Remote Sensing Training Course which is slated for the end of February 1973.

The purpose of the course is to develop a practical expertise in using remote sensing in earth resources surveys and management. It will emphasize the practical uses of remote sensing by utilizing imagery interpretation exercises based on actual research projects uder the guidance of the researchers involved.

Instruction will be provided by lecturers from the University of California headed by Professor R.N. Colwell, the CCRS, federal and provincial government agencies and private industry.

The course was over subscribed 10 days after the brochures were sent out.

A proposal for a remote sensing coordination center in Alberta was compiled and is presently under study.

In 1973 the task force is planning to structure a number of sub-committees to expand research and to include additional disciplines.

6.1.3 Coordinator

The establishment of a coordinator for remote sensing in Alberta was implemented with Cal D. Bricker, Alberta Department of Highways and Transport being designated.

The Coordinator to be responsible for (1) enhancing Alberta's ability to take advantage of the services of the Canada Centre for Remote Sensing (CCRS);(2) providing liaison with CCRS and a focal point for all Alberta users; (3) coordinating remote sensing applications from throughout Alberta, including provincial and federal activities as well as universities and industry, with the CCRS; (4) providing assistance and training; (5) providing assistance to Alberta's Canadian Advisory Committee on Remote Sensing member toward the development of an Alberta Remote Sensing Centre and; (6) liaison with the CCRS and other provinces on technical aspect of remote sensing.

During the year the coordinator has enhanced Alberta's ability to take advantage of the services of the Canada Centre for Remote Sensing through the establishment of a direct channel of communication to the Centre. Working procedures were set up to coordinate Alberta user requests for aircraft imagery. Research projects were flown during the year for various agencies. Typical projects included a study of tar sands pollution in the Athabasca River north of Fort McMurray, a regional planning study of the Fort McMurray area, and a study of highway route locations in the Rocky Mountains. The coordinator had representatives from the Canada Centre brief interested Albertans on the acquisition of ERTS imagery and to outline procedures for obtaining airborne remote sensing. To date, there appears to be approximately 200 professional people interested in remote sensing in the province. The coordinator has maintained contact with these individuals through a remote sensing newsletter, by forwarding technical remote sensing data, by lecturing to interested groups, and by developing a training program for Alberta users.

6.1.4 Projects 1972

In 1972 twelve research projects were submitted to the CCRS for airborne imagery and nine were completed. Weather, as usual, was the major factor in the requester's flying date not being met. Delays in receiving processed imagery of some projects caused the requester's problems in correlating the imagery with ground-truthing.

6.1.5 Projects 1973

It is estimated that there will be a greater requirement for CCRS airborne and ERTS imagery in 1973 than in previous years.

APPENDIX

MEMBERS OF ALBERTA TASK FORCE ON REMOTE SENSING

C.D. Bricker, Chairman,
Dept. of Highways and Transport.

G.L. Nielsen,
Alberta Dept. of the Environment.

D.B. Patterson,
Alberta Dept. of the Environment.

S.R. Hughes,
Dept. of Lands and Forests.

W. Wishart,
Dept. of Lands and Forests.

M.C. Brown,
University of Alberta.

P.H. Crown,
Alberta Institute of Pedology.

C.L. Kirby,
Canadian Dept. of Environment.

6.2 REPORT FROM THE COMMITTEE FOR REMOTE SENSING IN BRITISH COLUMBIA

6.2.1 Introduction

The Committee for Remote Sensing in British Columbia was established by the Environment and Land Use Committee and is made up of representatives of all resource departments in the Provincial Government. Representatives of the Universities and Industry were not included in the original formation of the Committee but representatives are to be invited in the very near future.

From this Committee the various departments work on their own particular projects using air photography obtained through CCRS and the provincial air survey organization. Mr. G. Howell-Jones of the Department of Agriculture has been the coordinator of the various groups throughout the province and has established the day-to-day contact with CCRS. It is hoped that one or two people will be permanently added to this staff in the coming year to augment the growing demand for information and imagery.

Up to recently it has been difficult to discover what areas have been requested and flown in B.C. For example, very little is known of the low level 1971 flying in the Rocky Mountains. We have now arranged that we should be informed directly of these requests and flying dates by the CCRS Airborne Section. Generally, the 70mm photography has had much more limited use than the 9 x 9 inch photography because it does not give complete coverage. Very little use has been made of the infrared scan to date.

Only a very few examples of ERTS imagery has been received in B.C. to date (Feb. 1973) and therefore there has not been the opportunity to make any meaningful assessment of this photography.

One of the most interesting and combined projects using all forms of CCRS photography is being undertaken by the B.C. Forest Service Productivity Committee in the Nimpkish Valley on Vancouver Island. This study involves industry and both Provincial Government and Federal Government personnel in an integrated investigation of management practices and timber growth. All four bands of the 70mm photography and 9 x 9 inch prints, both colour and infrared, are being used and the Climatology Division of B.C. Land Inventory is planning to use the 70mm Scan in the same area on this project.

A large number of individual projects are being undertaken in the Province and the following five projects have been selected as representation of the type of uses being made by CCRS imagery.

6.2.2 Fish and Wildlife Branch

The Fish and Wildlife Branch requested two remote sensing flights in 1972: low level coverage of the Coquihalla and Silverhope River Systems near Hope, and coverage of the Dean River System north of Bella Coola.

The Coquihalla-Silverhope project was requested to give accurate photographic coverage of two important steelhead fish streams. The biologists hope to use the photos to study the physical habitat of the systems (spawning channels, barriers to fish migration, etc.) and to use the information in improving steelhead populations.

The Dean River is also an important steelhead system. There has been no low-level aerial photography of this area since about 1956, and since this time there have been drastic changes due to logging. The new photos are excellent and give a good indication of logging activity in this area. The biologist is using the photos as well to study steelhead habitat, and hopes to use the thermal scan to locate concentrations of fish, especially in the upper regions of the river.

Stikine special inter-disciplinary project:

This project covers part of a remote, largely inaccessible area of considerable interest to our northern Fish & Wildlife biologists and other disciplines. The photos include parts of the Stewart-Cassiar Highway construction and Dease Lake Development, with which we are involved. Due to lack of access, most of our knowledge of the area comes from winter-flying, when game animals are most visible. The photos offer a chance to correlate information gathered during winter flying with summer photography.

Extent of plant cover in poorly-vegetated areas can be difficult to determine on black and white photos, but colour and colour infrared allow biologists to distinguish rock from alpine and semi-alpine vegetation, and from muskeg. The infrared colour also promises to be useful in determining water content of soils.

Also in the Stikine area the B.C. Land Inventory (CLI) have delineated land forms

and vegetation types. On this pilot project personnel are developing a biophysical base map and expertise in methodology that can be used by all resource sectors in land inventory studies. It is not expected that the full extent of the use of these photos in this project will be known for at least a year.

Conventional high altitude B&W photography 1:60,000, is being used along with colour infrared which is particularly good to determine the rock from alpine and semi-alpine vegetation and muskeg.

The Department of Mines, the mining industry and the Parks Branch are also showing considerable interest in the photography of this area.

6.2.3 Parks Branch

Some of the activities of sections of the Parks Branch are listed as follows:

The Interpretation Division is involved in the presentation to the public of the parks indigenous value as well as general park information. Blowups and CCRS imagery for Manning and Golden Ears Provincial Parks have been used for trail and campground location, nature house and other interpretive sites and features such as lakes, streams, snowfields, waterfalls and cinder cones.

System Planning Section of the Planning Division is concerned with planning an overall system of parks for British Columbia. Colour 9 x 9 inch prints have been used in Edziza, Garbaldi and Cathedral Provincial Parks as well as in the Daisy Lake and Duffy Lake park proposals. The prints are used for recognizing the land resource for park values. Features as mentioned above as well as vegetative types, surficial geology, historical geology, land history (settlement, development, fire or insect damage), hydrology, beaches including composition of the material are easily discernible on these colour prints.

The Master Planning Section is concerned with planning a particular park. Blow-ups of the 9 x 9 inch colour photos to 1:30,000 approximately have been used in Golden Ear, Manning and Sasquatch Provincial Parks. They are used as a base "map" for overlays of recreation land type classification, the B.C.L.I. data, and development plans.

The Management Section is concerned witht he management of parks. The photos have been used for checking on any resource activities in the parks. In Golden Ears Provincial Park they were used for checking the extent of logging. They were also used for policing debris clean-up in Alouette Lake.

General. The photos have also been used as a visual picture ofr discussion with other people (with the Branch, outside the Branch in other Departments as well as with the public). It is envisaged that other uses are just waiting to be discovered.

6.2.4 Pacific Forest Research Centre

Limited high level photography of British Columbia was obtained in 1971 by the Pacific Forest Research Centre, Canadian Forest Service, Victoria and more extensive photography was obtained in 1972. True colour film (2445) in 9 x 9 inch and 20 x 20 (enlarged) formats, and 70mm infrared colour and black and white films were used.

Detection and Appraisal of Forest Pest Damage: The photographs were examined for forest tree defoliation and/or mortality caused by winter cold and drought, fume damage and the following insect pests: spruce budworm, black-headed budworm, western false hemlock looper, western hemlock looper, Douglas-fir tussock moth, larch casebearer, spruce beetle and mountain pine beetle.

Areas where discoloured foliage was recognizable during low level aircraft observational surveys were visible on the colour film, but not on the black and white films. These latter will be examined later with additive viewing equipment; it is understood this will be available in Ottawa later this year. The infrared colour films resulted in imagery on which conifers were shown too dark and too blue to be of value. This may be due to the altitutde from which the photography was taken; the film is known to be useful at lower levels. Different filters and better exposure might result in useful pictures in the future.

To date the photographs have been used to construct maps of several significant insect infestations; these were sketch-mapped in the usual manner by aerial observers and improved using the photographs. The photos also are being used to train Forest Insect and Disease Survey field staff in pest damage interpretation. Further, chemical control programs against two of the pests are being considered for this coming summer; in these situations the photographs would be used for precise locating of areas to be sprayed, avoiding unnecessary application of insecticides.

Land Form and Vegetation Type Studies: Currently, the principal use made of the high altitude photography has been in connection with recognizing and delineating landforms, and, to a lesser extent, in separating some vegetation types, vigor classes and regeneration age classes on the colour infrared. Thermal infrared has been used to some advantage in recognizing landforms and drainage systems. One of the principal advantages of the small scale is the prominence with which landform features stand out in stereo; however, a higher degree of eye strain is realized with these photos as opposed to conventional photos or with the 70mm high altitude photography.

Logging and other General Forestry Information: High altitude aerial photography is being studied to obtain an overview of forestry practices, including logging, road construction and regeneration. The study areas are a powerline (to observe the progess of land clearing (i.e. logging)) and the Greater Victoria Water District lands, which are under intensive management. The high altitude photography was principally obtained for comparison with ERTS imagery, which is of greatest interest, but no imagery is yet available.

6.2.5 ERTS

Only one colour and several black and white images of British Columbia have been available to date. Spruce budwork damage can be seen on it. Combined ERTS band images will be examined for pest damage when suitable equipment is available. Land form and vegetation type studies will also involve ERTS imagery, as will other studies of forestry practices, such as logging and regeneration.

6.2.6 Training

A five-day course in Remote Sensing was conducted by Forest Management Institute, Ottawa, for CLI and Canadian Forest Service personnel in Victoria during the year. Approximately thirty people attended this course and due to the demand for more instruction an additional course is scheduled for April of this year.

6.2.7 Marine Sciences

Department of the Environment is using much of the photography of the Fraser River for studies of the location of the Fraser plume and environmental studies of the Squamish Estuary.

6.2.8 General Remarks

One of this summer's projects by B.C.L.I. and the Soils Division, Kelowna, will be on Vancouver Island where 9 x 9 inch colour prints and 18 x 18 inch enlargements will be used for land form, soil and vegetation mapping.

There is no question of the demand for CCRS facilities diminishing in British Columbia in the future. This province has always been favoured by its own air survey organization and users have been well supplied with medium scale photography. Now, however, the more sophisticated photography and ERTS imagery will only serve to whet the appetite of all users.

Requests from British Columbia for CCRS imagery for the coming year are expected to be double what they were for last year; it is hoped that CCRS facilities are equipped to handle this increased volume.

Mr. Howell-Jones has developed a new form of Index Map for CCRS photography. Copies are available upon request. This is a very comprehensive index and contains all the information a user would require.

6.3 REPORT OF THE MANITOBA REMOTE SENSING COMMITTEE

6.3.1 Summary

The coordinating committee in Manitoba is the MRSC, representing provincial, federal, university and private interests. Seven working groups are in operation (Land, Vegataion, Water, Geology, Permafrost, Sensors, Urban) with about 110 members.

A proposal for a Regional Centre was submitted to Ottawa and was not approved. We are going ahead with a small scale provincial centre associated with the Provincial air photo library.

The 1972 flying program was partly successful, but especially northern areas (our priority, received poor coverage). Imagery delivery time was a disaster and did much harm to our program and reduced interest of investigators.

The MRSC did not have sufficient time to coordinate activities properly and to handle all the user requests.

The 1973 program will be similar in size to the 1972 program: emphasis will be towards the north.

6.3.2 Recommendations

1. Delivery time of Airborne and Satellite imagery should be improved considerably.

2. CACRS should make every possible effort to get cost-shared Regional Interpretation Centres established.

3. The CCRS should play a more active roll in interpretation projects in the regions.

4. Working group chairmen should keep provincial coordinators informed about their activities (working group meetings).

5. Priorization of Provincial test sites should be done by the provincial coordinator and head airborne operations. Crew should check with provincial coordinator about changes and discuss program almost on a daily basis when in the area.

6. Regional contact persons inside CCRS may be desirable for good communication and cooperation. Such persons could be seconded to assist in Regional Centre activities on a part-time basis (e.g. 19%).

7. Colour additive viewing of negative and positive transparencies of the ERTS-MSS appears to have high potential. It is therefore suggested that negatives of all MSS bands become available via the regular standard order form.

6.3.3 Manitoba Remote Sensing Committee

The MRSC represents the remote sensing interest for provincial and federal agencies, universities and private industry in Manitoba. It was initiated early in 1971 to coordinate the remote sensing activities in Manitoba and to provide a vehicle for communication with the CCRS in Ottawa. During 1972 its activities related mainly to:

1. preparation of proposals for regional and provincial interpretation centres;

2. coordination of the 1972 remote sensing flying program;

3. coordination and stimulation of working group activities; and

4. organization of seminars, workshops, symposia.

Presently the Committee is composed of the following persons:

Mr. J. Thie, Chairman, Dept. Mines, Resources and Environmental Management.

Mr. D.H. Hall, University of Manitoba, Dept. of Earth Sciences and Chairman of the U. of M. Remote Sensing Committee.

Mr. C. Tarnocai, Canada Dept.of Agriculture.

Mr. R.C. Goulden, Dept. of Mines, Resources and Environmental Management.

Dr. G. Trick, Dept. of Industry and Commerce, Manitoba Research Council.

The activities during 1972 were mainly directed to the preparation of proposals for a Regional and Provincial Interpretation Centre and the stimulation of working group activities. Also members of the committee presented papers, gave lectures and talks to a wide variety of organizations and assisted in training programs.

As well, efforts were made to achieve a multi-disciplinary and multi-agency approach to evaluation of remote sensing test sites. This culminated in the in the presentation of a package of flying proposals to

Ottawa: "1972 Remote Sensing Data Acquisition in Manitoba".

During 1973 the Committee will continue to function but some task will be taken over by the Provincial Remote Sensing Centre. The MRSC will advise the Provincial Centre and will continue to advise the senior executive of provincial and federal agencies, universities on remote sensing matters and may suggest actions. The MRSC will continue to work towards the establishment of a federal-provincial cost shared Remote Sensing Interpretation Centre.

6.3.4 Remote Sensing Working Groups

Working groups (figure 1) continued to operate in 1972 and some groups were added. Presently the following are active:

LANDS Working Group - Chairman, Dr. G. Beke, Pedologist, Manitoba Soil Survey, University of Manitoba, Winnipeg.

VEGETATION - Chairman, Mr. R. H. Lamont, Chief, Forest Inventory Surveys and Mapping Branch, Norquay Bldg., Winnipeg.

WATER - A/Chairman, J. Thie.

GEOLOGY - Chairman, Dr. W.D. McRitchie, Geologist, Mines Branch, Fort Osborne Barracks, Winnipeg.

URBAN ENVIRONMENT - Chairman, Mr. J. Thie.

PERMAFROST - Chairman, Mr. C. Tarnocai, Pedologist, Manitoba Soil Survey, University of Manitoba, Winnipeg.

SENSORS - Chairman, Dr. F. Konopasek, Dept. of Physics, University of Manitoba.

The objectives of these working groups is to provide a medium for actively interested persons and organizations to learn about remote sensing, evaluate and apply techniques, discuss results and generate new ideas for methodologies and applications. Requests for test sites are usually generated and discussed by these groups before final consideration by the MRSC and submission to the CCRS.

During 1972 one spring workshop to discuss the flying program and one fall workshop to discuss resulting imagery were held by each of the working groups.

These working groups have a total of more than 110 working group members. Membership is open to any interested individual or organization.

The following organizations have representation on the working groups and/or have requested imagery in 1971, 1972 or 1973:

Provincial - Water Resources Branch; Resource Projects; Environmental Protection; Planning Branch; Forestry Operations - Wildlife Operations; Mines Branch; Forest Inventory; Metro - Waterworks and Waste Disposal; Industry and Commerce; Manitoba Hydro; Soils and Crops; Crop Insurance, M.D.A.; Dept. of Highways; Dept. of Municipal Affairs.

Federal - Soil Survey; Freshwater Institute; C.D.A. Research Stations, Brandon-Glenlea; Canadian Forestry Service; Canadian Wildlife Service; Geological Survey of Canada.

University - Dept. of Earth Sciences (U of M).
Dept. of Physics (U of M).
Dept. of Geography (U of M, U of W).
Centre for Transportation Studies.
Dept. of Zoology (U of M).
Environmental Studies (U of M).
Landscape Architecture (U of M).
City Planning (U of M).
Dept. of Soil Science (U of M).
Dept. of Botany (U of M).
Dept. of Entomology (U of M).

Private - Hudson Bay Exploration and Development Company Ltd.; INCO; Templeton Engineering; Applied Photogrammetric Science; Crossier, Greenberg & Partners; Ripley, Klohn & Leonoff; UNIES Ltd.; Reid, Crowther & Partners; Ducks Unlimited; Underwood McLellan & Assoc.

6.3.5 Representation on National Remote Sensing Working Groups (CACRS)

The following Manitobans were members of the federal working groups in 1972:

Mr. C. Tarnocai - Agriculture
Dr. J.L. Liebfried - Agriculture
Mr. A. Warkentine - Hydrology
Dr. G. Adams - Limnology
Mr. R.C. Goulden - Forestry, Wildlands and Wildlife
Mr. A. Hodgson - Data Handling
Dr. D.M. Welch - Geography
Dr. G. Brunskill - Limnology
Mr. D.W. Crandall - Cartography and Photogrammetry

The activities of these groups have been limited up to now and most of the initial meetings had an informative character.

It appears essential that a good communication exists between the Provincial Remote Sensing Committee and the representatives. This was certainly not always the case during 1972. To overcome this problem meetings will be held between the above mentioned group and the MRSC on a regular basis. It is also suggested that the chairman of the National Working Groups keep the provincial committee chairman informed about their activities.

6.3.6 Manitoba Remote Sensing Centre

The Manitoba Remote Sensing Committee prepared a proposal for a Regional Interpretation Centre, located on the University of Manitoba Campus and to be financed by the federal and provincial governments. The final version of this proposal was submitted to the Honourable Donald MacDonald, Dept. of Energy, Mines and Resources, by the Honourable Sidney Green, Minister of Mines, Resources and Environmental Management on August 11, 1972.

The negative response on this proposal was quite dishartening, especially since initially suggestions of cost-sharing had been made by federal officials.

The Treasury Board's decision does not alter the fact that such centres are needed in Canada, especially in Manitoba. The user interest and practical application of the Manitoba Remote Sensing Program is such that some kind of Interpretation Centre set up in Winnipeg is necessary. Without an expanded effort by the province the large amount of data provided by resource satellites and remote sensing aircraft cannot be used adequately. Therefore the Manitoba Remote Sensing Committee evaluated a number of alternatives drawn up on the basis of full financing by the Province of Manitoba.

The one considered the most reasonable short term alternative was proposed and included in the budget estimates for 1973-74. The objectives and functions are:

Objectives: To plan and perform integrated programs of airborne data acquisition and groundtruth investigation.

To store and disseminate interpreted and uninterpreted information (imagery) to resource managers, users, and researchers.

To assist in the coordination and stimulation of the use of remotely sensed data,

a) by fostering and coordinating regional working groups;
b) by communicating the newest developments in interpretation and data handling techniques to user agencies as well as by serving as a repository for such remotely sensed data;
c) by stimulating mission oriented and basic remote sensing research;
d) by advising user agencies who wish to use remote sensing in operational programs;
e) by providing limited assistance in training programs for universities, technical colleges and user agencies.

To assist users with the interpretation of raw data (satellite and airborne) according to user demands and priorities set by the Manitoba Remote Sensing Committee.

Facilities: To fulfill the objectives the Centre will have the following facilities and capabilities:

- Interpretation Instrumentation accessible to all users like Bausch and Lomb Stereoscopes, double scanning stereoscopes, colour enhancement equipment; colour additive viewers for satellite imagery, density slicing equipment.

- Expert staff will be available to the user to assist in interpretation and guide in the use of equipment and enhancement methods.

- Office and work space will be available for user to work on an hourly, daily, weekly or monthly basis.

- All remote sensing imagery in Manitoba (Airborne and Satellite) will be stored in the Centre; the user can view it at the facilities of the Centre or borrow it for specific periods of time.

- A Remote Sensing Literature Library will provide information related to the latest developments in remote sensing.

- Staff of the Centre will be available to the user in specifying and tailoring sensor packages on remote sensing aircraft to their specific needs. It will be able to assist in drawing up proposals to Ottawa.

- Because of association with the Provincial air photo library the following services are available in addition: darkroom facilities; coverage of all existing conventional aerial photography of the province; good storage, distribution and ordering capabilities; photogrammetric equipment.

Staffing: Two professionals, technical and stenographic support provided by the Surveys Branch.

Term: Two years, until a full-scale federal-provincial Regional Centre is operational.

Benefit-Cost Analysis: In the course of writing the proposal the MRSC did some preliminary benefit-cost calculations. In Fig. 2 histogram shows the relation of the operational functions and budget size for four interpretation centre alternatives.

In Fig. 3 the benefit-cost is demonstrated for four alternatives. Note the ratio is the best with the largest budget size considered. The Benefit-Cost ratio may drop somewhat with higher budgets.

The alternative operating in Manitoba during 1973-74-75 is C. Benefits of alternative C are based on operational techniques which could be applied immediately. Estimates tend to be conservative.

6.3.7 1972 Flying Program

Areas Covered: Test site requested in the 1972 program are indicated in Fig. 4,5,6 for respectively spring, summer and fall flying. They are described in more detail in the report "1972 Remote Sensing Data Acquisition in Manitoba". Also objectives, sensor packages and agencies involved are identified.

Success of Coverage: Drawn in superimposed on the maps are the areas actually covered. On these maps the results look somewhat better than the true status. Realizing the weather conditions and the workload of the airborne operations program, we cannot be dissatisfied. However there are a large number of shortcomings at the federal and provincial level.

Quality of imagery is quite satisfactory, especially when the climatic conditions are taken into consideration.

Problems: The most common problems are discussed briefly below:

a) no sufficient overlap between consecutive prints and flight lines;
b) cloud cover;
c) usually most test areas were covered considerably later than requested, often resulting in less useful imagery and declining interest by investigation;
d) because of the unpredictability of the date of flying, it proved to be very difficult to coordinate groundtruthing and airborne operations. It is suggested that during 1973 one person will be continuously in charge of this aspect.
e) Priorities identified by the MRSC were apparently not given sufficient emphasis in Ottawa. As a result areas of low priority were often covered first. Especially the North, which was the most important area for our test sites, received a rather inadequate coverage. Certainly this was not only due to weather conditions.

Imagery Delivery: The slow delivery of imagery is shown in Fig. 7. This caused a considerable problem in many ways and has been very harmful to the program. In Manitoba we have experienced a loss of interest by investigators, even after they had gathered their groundtruth data. Also many were not able to carry out their groundtruthing because imagery was received at too late a date in the growing season, or even after the end of the growing season.

Indirectly as a result of this slow delivery the annual workshop/symposium had to be delayed as well as our test site proposal for 1973.

Multi-Disciplinary Approach: The Manitoba Remote Sensing Committee emphasizes a multi-disciplinary and multi-agency approach to remote sensing evaluation programs. Only be interacting at the study level can we get the best understanding of the interaction of elements within ecosystems of interest.

It is our initial impression that such an approach is even more essential with small scale satellite imagery. However we also found that considerable more coordination is needed for multi-disciplinary projects. No single individual or agency is directly responsible for a test site. This may cause less commitment to finalize a project properly or to evaluate imagery adequately. This is especially true when there are problems with the flying and imagery delivery.

6.3.8 1972 Satellite Coverage

During 1972 a considerable portion of Manitoba was covered by reasonable and good quality satellite imagery. Preliminary analysis found more information then was expected in populated and natural areas. Very interesting results were obtained using different colour enhancement techniques.

The main problems with the satellite imagery is the slow delivery and the variation in quality.

6.3.9 Preliminary Results of Test Areas

Evaluation of results made a very slow start in 1972 mainly due to the slow delivery of imagery. However about 25 investigators reported their preliminary findings on the recent workshop-symposium in Manitoba (Feb. 5-6, 1973). This workshop was attended by about 200 persons. A summary report of this workshop and the progress of other investigators in Manitoba will be distributed in the near future.

GEOLOGY: As a result of evaluation of the Thompson-Pukatawagen and Bissett test sites, geologists of the Mines Branch completely changed their initially somewhat skeptical attitude towards remote sensing. They showed a substantial improvement in some parts of their mapping activities and are keenly interested in developing the methodology as an operational tool. Main use was made of airborne data from high altitudes.

LANDS: In the Lands Working Group interest of the investigators varies from soil mapping to planning and construction. As the group is rather large (about 40) only the most important applications are discussed.

Soil Survey: In the North, forested area, South, Agricultural areas. Very promising results from airborne data re soil mapping, salinity etc. Especially satellite provides a good operational base for a rapid survey of northern areas.

Geomorphology: Satellite provides excellent information related to physiography, ice flows, fracture patterns and surface deposits in almost all areas in Manitoba. Mapping done in the Winnipeg and York Factory areas.

Landscape Planning: Attempts are made to use airborne data (Brandon area) for regional planning.

Dam Sites: Manitoba Hydro used some of the Gillam test site for site analysis of the Limestone Rapids area; results are very promising related to soil mapping, permafrost, drainage conditions, gravel locations, etc.

Permafrost: Mapping at airborne and satellite quite successful (Churchill - South Indian, Norway House).

VEGETATION: Most of the work done is in the fields of crops, wildlife (habitat) and mapping of ecosystems.

- Wild rice studies: Areas with a high potential of producing wild rice are being mapped from R.S. imagery (Whitemouth, Bissett, Elma).

- Peatland ecosystems: High promise shown in the interpretation and description of peatlands and associated permafrost (Wekusko, Elma).

- Habitat studies: especially for waterfowl, attempts are being made to use data from R.S. for management decisions. (Oak Hammock). Also wetlands mapping (Shoal Lake, Delta Marsh, Saskatchewan Delta, Netley Marsh) have indicated good potential. Especially high altitude colour I.R.

- Forestry Inventory: No serious attempts have yet been made to use R.S. data for the regular forest inventory; but more attention to this will be given during 1973.

- Tree disease surveys: Canker worm disease survey was shown to be feasible. Could provide data for a very selective spraying program in 1973 when used on an operational basis (Winnipeg area).

- Land-Use mapping: Work was done in the Morden area, Winnipeg area, Glenlea, etc. with airborne imagery with a limited success. Satellite information (Winnipeg and Portage areas) shows much information but in a general way. High potential for land use patterns and relation to soils, drainage and land form.

- Crop disease surveys: Limited amount of work done, no exciting results yet.

- Caribou habitat: Wallace Lake area and Northern Manitoba, no significant result yet.

- Geese nesting: Little Seal River, no results yet.

- Arctic and Sub-Arctic ecosystems productivity: Churchill area - no results yet.

WATER: Flying for the more water oriented test areas was not too successful. No significant spring inundation did occur and flights were too late for snow melt survey.

- Flooding studies: Impact assessment of flooding on vegetation in Kettle Rapids area. Results very good.

- Survey of Prairie Potholes: Initial evaluation shows much promise re turbidity, salinity, etc.

- Groundwater discharge: few attempts made but not too successful. However satellite shows some promise in some areas. Also I.R. scan in Morden area. Groundwater flows in peatlands can be successfully identified even on satellite.

- Turbidity: Minor attempts to use satellite, shows promise in Lake Winnipeg area.

URBAN:

Urban Ecosystems: Shows promise, some work in Brandon area for landscape planning. In Winnipeg area no sufficient results available other than the use for canker worm infestations. Difference in watering of golf courses, parks, etc. quite apparent. Interesting temperature fluctuations (day and night).

Pollution: Not much work done yet, but I.R. scan gave little information yet. Perhaps enhancement techniques may help.

6.3.10 1973 Remote Sensing Program

The program is not finalized yet. Fig. 8 shows the requests received so far. Likely the total requested line miles will not exceed 1972. Emphasis this year will be very much on the NORTH.

A proposal is drawn up for long-term ecological monitoring of the Churchill-Nelson diversion in Northern Manitoba. As remote sensing provides the only feasible tool to monitor this large area much attention will be given in 1973 to the evaluation of a Northern test site. Likely a rather large one will be proposed for this area in which a number of multi-million dollar projects are carried out.

The Manitoba Remote Sensing Centre is also preparing a proposal for a quick resource inventory of the "inaccessible" areas of Northern Manitoba based on R.S. techniques. It is felt that the satellite will enable this with a low cost and small number of man years.

BENEFIT-COST ANALYSIS

AREA OF APPLICATION	1973-1974 IMMEDIATE BENEFITS	1974-1978 NEAR FUTURE BENEFITS
Permafrost Mapping	> $ 60,000/year	Multiple thereof per year
Road Location	> 20,000/year	Multiple thereof per year
Gravel Pit Location	> 20,000/year	Multiple thereof per year
Development and Expansion of Northern Communities	> 20,000/year	Multiple thereof per year
Surveys related to Lake Winnipeg, Churchill, Nelson Scheme	> 40,000/year	
Updating Existing Resource Information	> 20,000/year	> $ 40,000/year
Environmental Monitoring (South Indian, Churchill, Nelson, Hudson Bay)		> $100,000/year
Environmental Protection Monitoring		> $ 60,000/year -$100,000/year
Resource Surveys (Wildlife, Forestry, Water, Fisheries)	> 35,000/year	> $100,000/year
Photo Mapping	> 10,000/year	> $ 20,000/year
Surficial Geology and Soil Surveys	> 10,000/year	> $ 30,000/year
Pipeline Location Studies		> $ 50,000/year
Cropping Patterns, Land Use Surveys		> $ 30,000/year
Imagery Obtained	30,000/year	
Imagery Library	20,000/year	> $ 60,000/year
TOTAL Benefits More Than	$315,000/year	$700,000/year

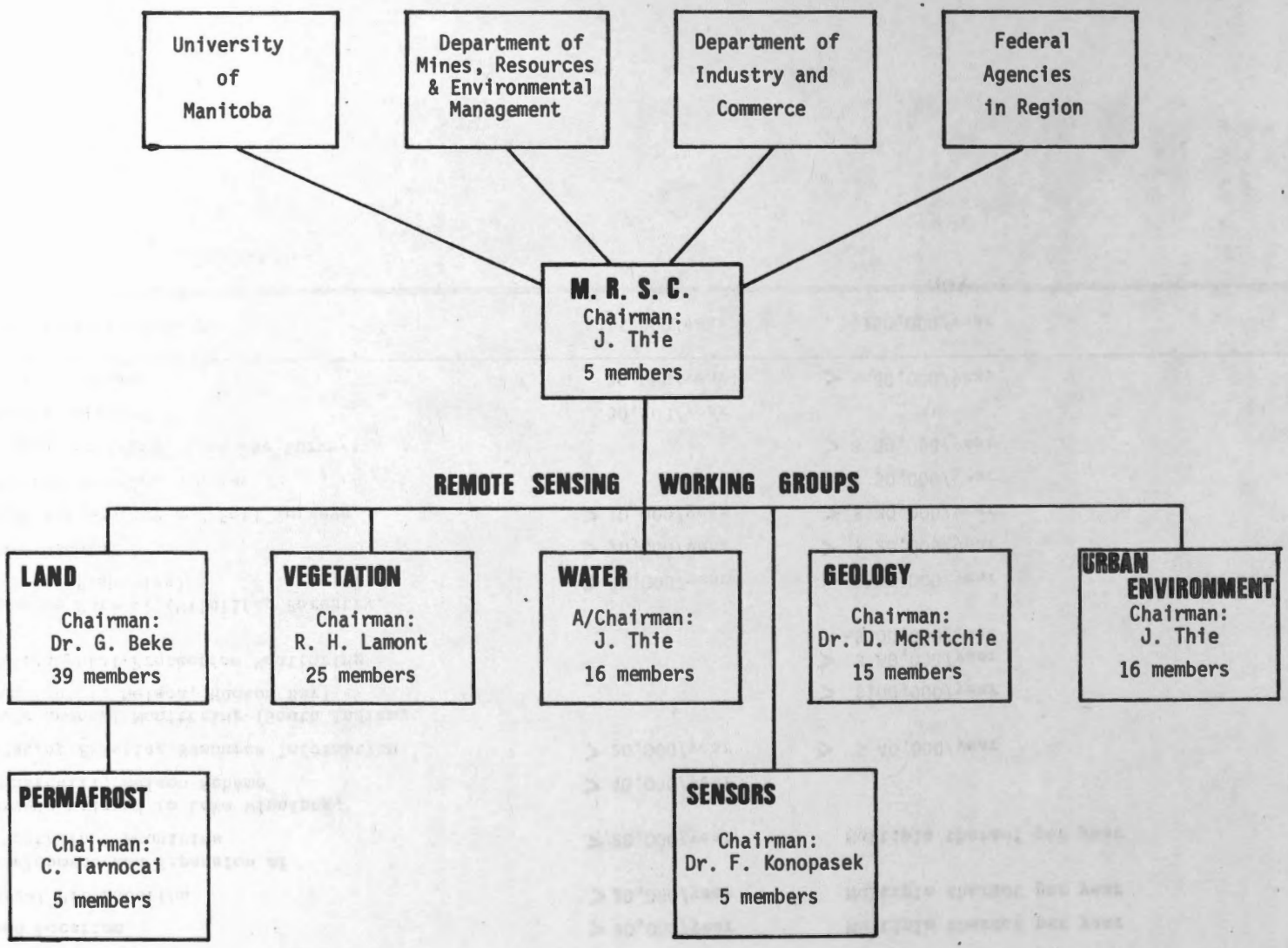


Fig. 1 - Remote Sensing Working Groups

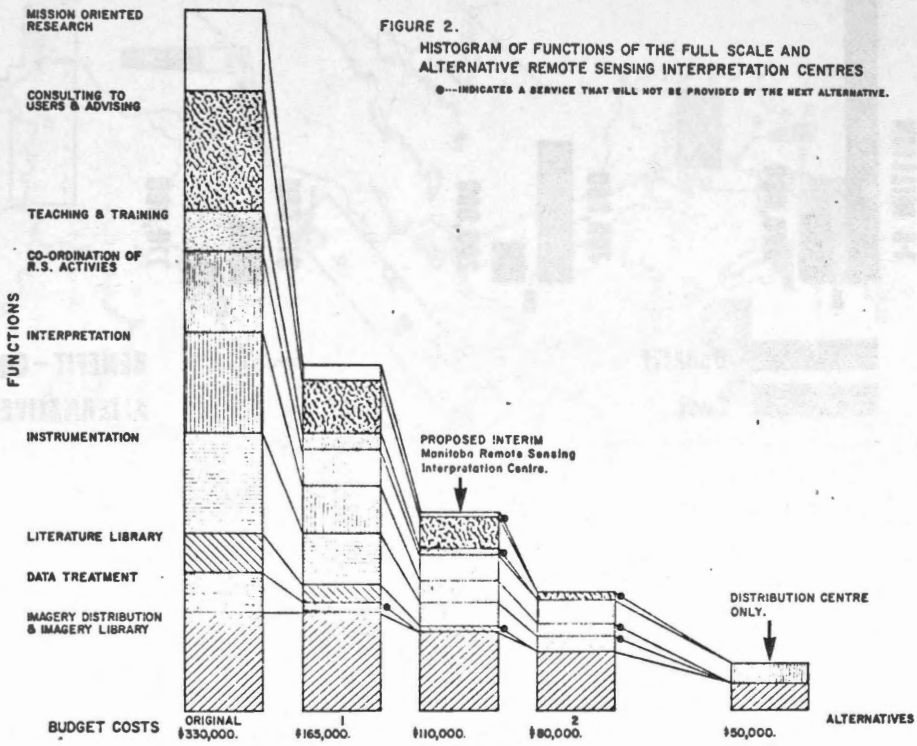


FIGURE 2.
HISTOGRAM OF FUNCTIONS OF THE FULL SCALE AND ALTERNATIVE REMOTE SENSING INTERPRETATION CENTRES
●---INDICATES A SERVICE THAT WILL NOT BE PROVIDED BY THE NEXT ALTERNATIVE.

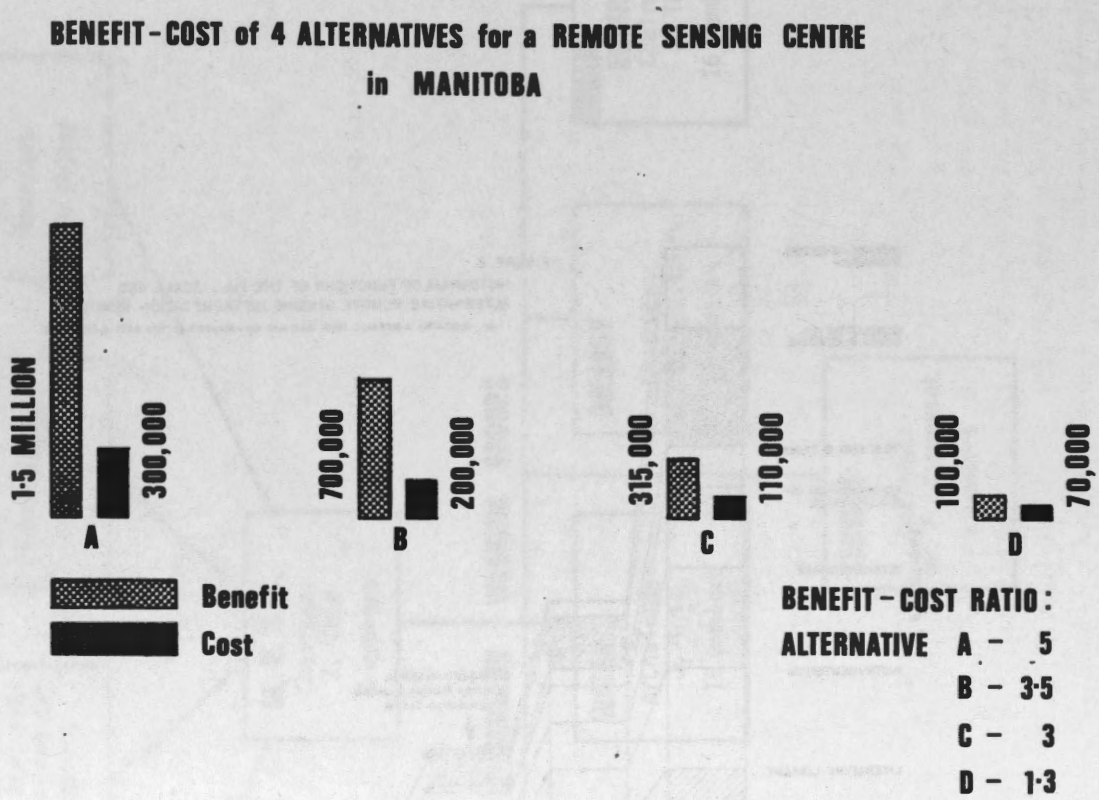
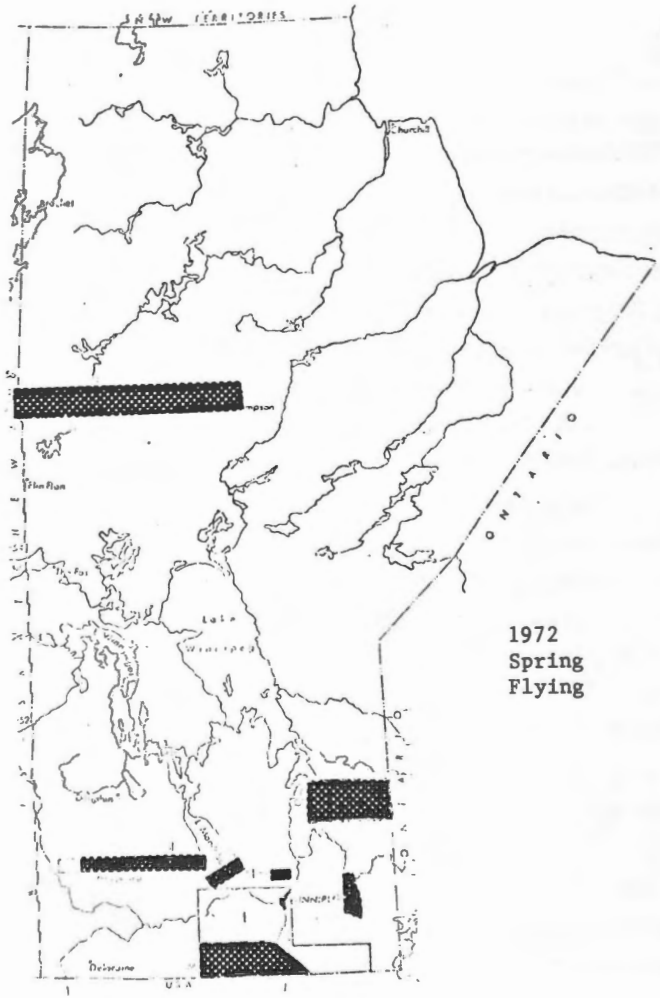
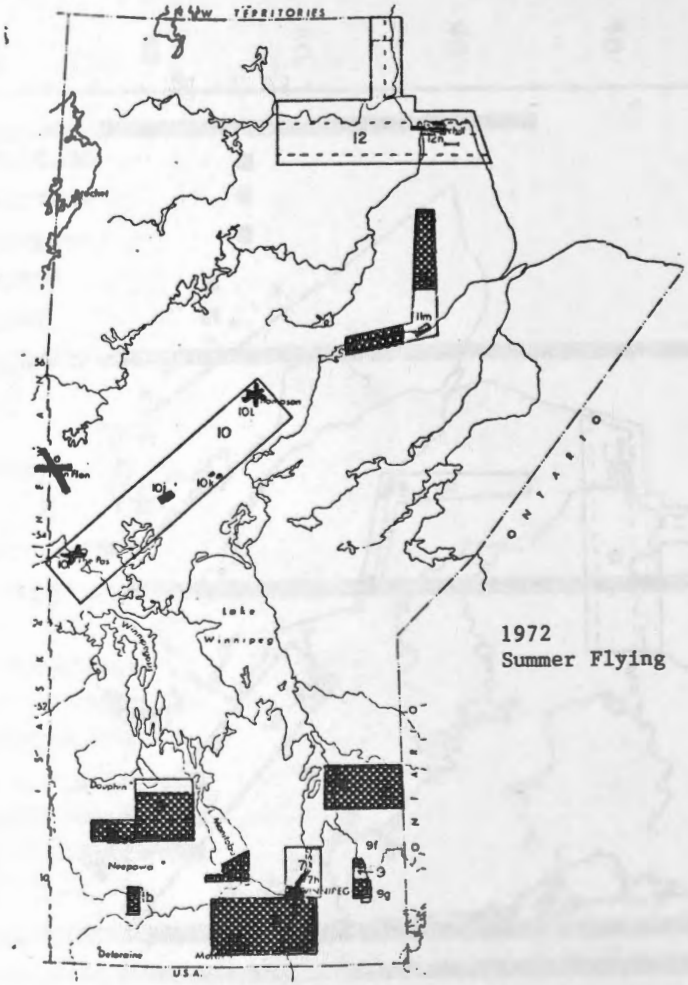


Fig. 3 - Benefit-Cost of 4 Alternatives for a Remote Sensing Centre in Manitoba



1972
Spring
Flying

Fig. 4 - 1972 Spring Flying



1972
Summer Flying

Fig. 5 - 1972 Summer Flying

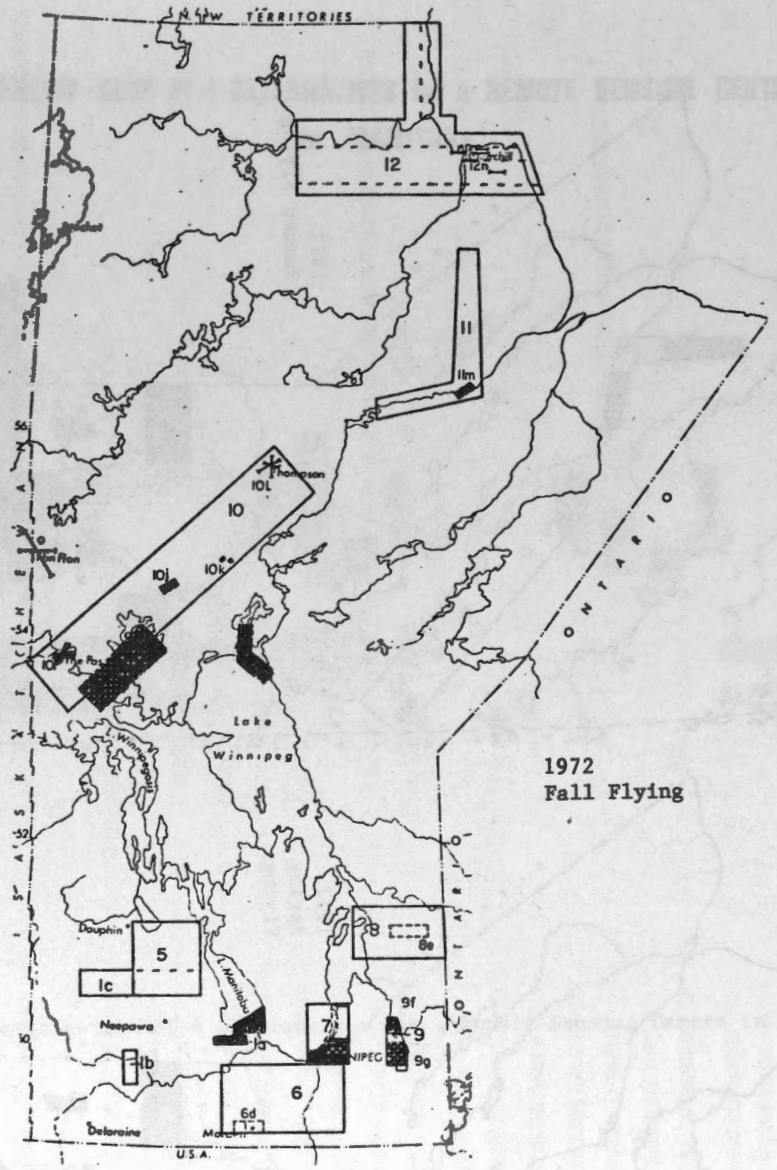


Fig. 6 - 1972 Fall Flying

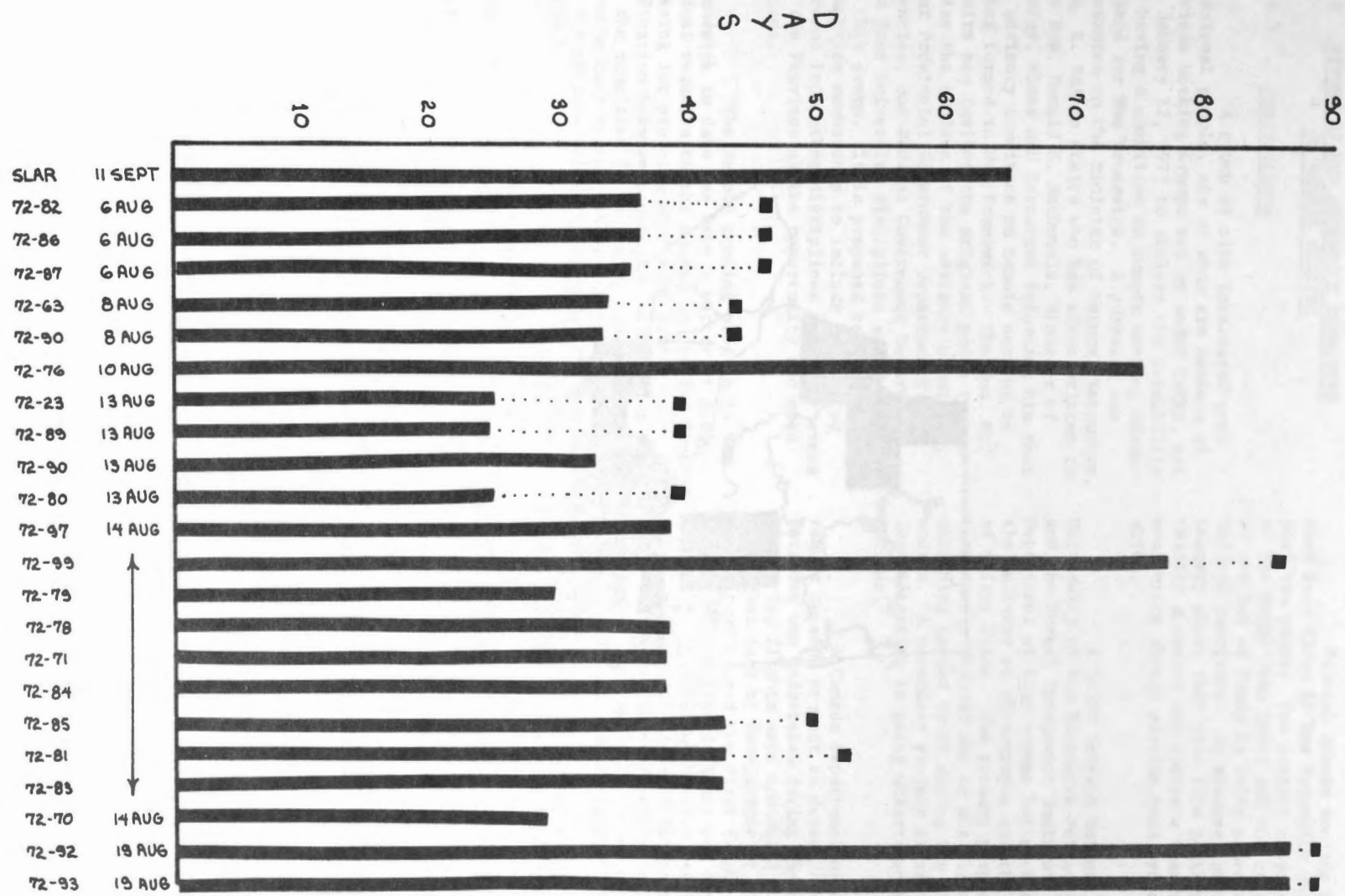


Fig. 7 - Imagery Delivery Times

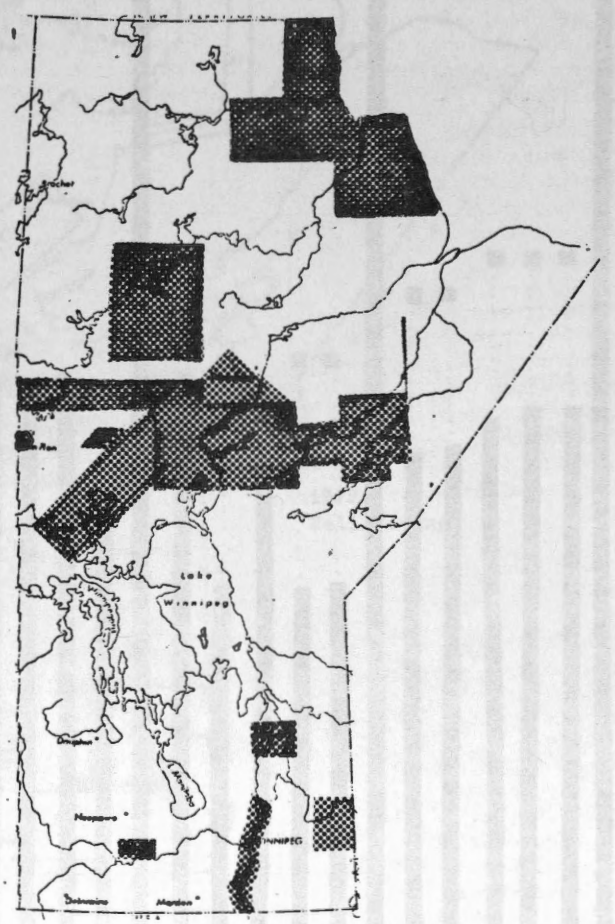


Fig. 8 - Test Sites Requested for 1973

6.4 REPORT OF NEW BRUNSWICK COMMITTEE ON REMOTE SENSING

6.4.1 Introduction

A group of nine interested professional people, six of whom are members of various Working Groups set up under CACRS, met on January 12, 1973 to explore the possibility of having a committee on remote sensing established for New Brunswick. A proposal was presented to the Minister of Natural Resources, Hon. A. Edison Stairs who has since written to the Hon. Donald S. MacDonald, Minister of Energy, Mines and Resources informing him that an advisory committee on remote sensing is being formed in New Brunswick. The Hon. Mr. Stairs has invited the original group to comprise the nucleus of the advisory committee; four Provincial Government Departments and Agencies, one Federal Government Department and four University disciplines are represented in this group. It is proposed to expand the committee membership to include interested persons from other disciplines and other areas of the Province as the opportunity and need arises.

The remote sensing program in New Brunswick to date has been a matter of individual requests to the Canada Centre for Remote Sensing for projects with very little coordination between provincial users. The aim of the committee is to foster cooperation between user groups and to increase the number of disciplines using the results from any one project.

The present membership of the committee is as follows:

Prof. Charles Young, U.N.B. Physics
Mr. John Henderson, Saint John River Basin Board
Prof. Kersi Davar, U.N.B. Civil Engineering
Prof. Angus Hamilton, U.N.B. Survey Engineering
Mr. Wm. Hodgson, Agriculture Canada
Prof. Ken Burke, U.N.B. Geology
Mr. Louis P. Albert, N.B. Dev. Policy Secretariat
Mr. Franklin Cardy, N.B. Dept. of Fisheries & Environment
Prof. Wm. Hilborn, U.N.B. Forestry
Mr. Burtt M. Smith, N.B. Dept. of Natural Resources, Chairman

At present there are no subcommittees or working groups associated with the advisory committee but it is understood that a committee from several disciplines at the University of New Brunswick is in existence and is willing to work with the N.B. committee on remote sensing.

Several remote sensing projects have been flown in New Brunswick during the past two years. The project covering the mouth of the Saint John River and the adjacent area of the Bay of Fundy is being processed by the Bedford Institute. An examination of the imagery shows that tide flow patterns are readily apparent and indicate that further monitoring should provide much useful information.

A joint project between the University of New Brunswick Forestry Faculty and the Forest Management Institute of the Department of Environment had problems with the delivery of photographs and the indexing of flight lines. The primary purpose has been temporarily shelved due to the difficulty of obtaining ground truth during the winter months. A secondary project of tree species identification is being undertaken with some success.

A Canada Department of Agriculture remote sensing project to detect disease in potatoes was undertaken during the Summer of 1972. Two flights were scheduled at specific dates, but lack of development of the disease under study caused the first flight to be cancelled; the second flight was flown successfully. A seven week delay before the prime investigator received the prints negated any current use, however subsequent work with the imagery indicated that areas of diseased potatoes could be readily identified.

There are undoubtedly other remote sensing projects that have been flown in New Brunswick that the committee is not aware of at present.

Interest in remote sensing activities for 1973 is increasing and the committee is hopeful of being able to present a package of projects to CCRS in time for consideration this year. The main project that will be presented concerns the St. John River Basin. A comprehensive study is under way at the present time that will provide a large amount of ground truth that could be coordinated with remote sensing.

Remote sensing is required in three broad fields:

1. Snow cover - depth, water equivalent, liability of flooding in the lower velley.

2. Land use - the interaction of agriculture, forestry, and urban development, including the detection of insect and disease problems.

3. Water quality and ecology - to monitor the movement and diffusion of the effluent from pulp mills, food processing plants and several small communities through three hydro electric headponds. Also to provide an inventory of aquatic growth in the estuary area of the river.

A second request will be for a coverstone remote sensing project to establish base values of air and water quality for the Lorneville area of the Bay of Fundy where major industrial developments are being considered.

Several other projects are being considered, at least as targets of opportunity.

The main problems in the pase seem to have been with delays in delivery and the quality of prints. We understand the delivery problem has been largely resolved for 1973. Since quality of the finished product is so much a function of weather and atmospheric conditions, particularly in eastern Canada, investigators will have to continue to make the choice between some imagery of poor quality or no imagery at all in many cases. A suggestion that might help is for investigators to select a greater range and number of targets of opportunity so that some return can be assured for the time and energy expended by all concerned.

6.5 PROGRESS REPORT ON REMOTE SENSING PROJECTS IN NEWFOUNDLAND-1972

6.5.1 Introduction

This brief progress report is prepared for presentation at the meeting of the Canadian Advisory Committee on Remote Sensing to be held February 19-22, 1973.

The individuals with responsibility for the conduct of the various projects are identified, and it is hoped that anyone interested in communicating with them will not hesitate to do so.

Extensive work was carried out in Newfoundland using remote sensing imagery in 1972. During the last ten years, the whole Province has been photographed at two separate scales (1:15,840 and 1:50,000). These photographs were used in carrying out the Canada Land Inventory and Newfoundland Forest Inventory. In 1972, special remote sensing imagery was obtained through the Canada Centre for Remote Sensing and through the Maritime Air Command, Department of National Defence, to facilitate various research projects.

Approximately 800 line miles were flown over the Island of Newfoundland and 2,000 line miles over Labrador by C.C.R.S. Each line was photographed at a scale of approximately 1:110,000 using the following film filter combinations: -

(a) black and white infrared with a Wratten 89B filter

(b) plus X aero film with a Wratten 25A filter

(c) double X aero film with Wratten 12 and 58 filters

(d) colour negative with HF5 filters

(e) colour infrared with a Pan 250 filter

The format for a, b, c and d was 70 mm. and 9" x 9" for e. In addition to the aerial photography, a thermal map of a strip centered along the flight path was obtained for each line. All the above photography was requested by various agencies and departments of the Provincial and Federal Governments and by the Memorial University of Newfoundland.

The Maritime Air Command supported an oceanographic research project which is being carried out by the Faculty of Engineering of Memorial University. Five 100-mile strips of the ocean surface were mapped, using a thermal mapper (infrared line scan) and a side looking radar instrument. This mapping was supported with panoramic aerial photography. Some low altitude thermal mapping was also carried out around selected icebergs within the experimental area.

For several research projects 5" x 4" and 70 mm. aerial photography was obtained, using a K25 and two Hasselblad 500 EL cameras mounted in the cargo hold of a Beaver aircraft.

Some investigations were to be centered around "ERTS" imagery, but no imagery has as yet been received. The usefulness of "ESSA" weather satellite imagery for ice detection is currently under investigation.

6.5.2 Projects

The various projects involving the use of remote sensing are grouped according to their subject matter, and are presented under the relevant main heading. This description of projects is not complete, as up-to-date first hand information is not available from the principal investigators for some of the projects.

(1) Environmental Studies

a) The effect of flooding on vegetation

Investigator: Dr. D. Bajzak, Faculty of Engineering & Applied Science, Memorial University, St. Johns.

With the development of the Churchill Falls power project a large lake was created in Labrador, which has and will have a tremendous influence on the environment of that part of the Province. To monitor the changes due to the flooding, extensive ground and aerial observations have been carried out by the Churchill Falls Labrador Corporation, using helicopters and vessels, and these investigations will be continued in future years. The data obtained are used as ground controls for a project initiated by Memorial University and supported by Churchill Falls Labrador Corporation. Within the framework of this project high altitude aerial photography, thermal and radar mapping are being used to determine their sensitivity in detecting environmental changes due to the flooding.

Three detailed test lines were established within the reservoir, and along these

6.5.2 Con't

lines detailed observations of vegetation and of shoreline conditions have been made, and will be made, twice each year. In addition to ground observations, the surroundings of these lines are photographer from a helicopter at various scales.

The colour-infrared photography carried out by the C.C.R.S. covers approximately 90 per cent of the total reservoir area, while the thermal and radar maps cover only narrow strips immediately under the flight lines followed in the survey work. It is anticipated that the analysis of field data and the interpretation of imagery will be completed in May, 1973.

b) Pollution studies

Investigator: Mr. H. Doane, Clean Air, Water and Soil Authority, St. Johns.

An attempt was made to detect dead trees which had been killed by stack emissions from the phosphorous plant at Long Harbour, Placentia Bay, using the high altitude colour infrared photography obtained for the relevant areas. This photography was found inadequate for this purpose, principally because the scale of the photographs was too small. It is obvious now that much larger scale photography would be required to obtain results and provide an effective means of monitoring the influence of stack emissions from various industrial operations on adjacent vegetation.

c) Forest insect damage survey

Investigator: Mr. J. Bouzane, Canadian Forestry Services, St. Johns.

The local Research Centre of the Canadian Forestry Services initiated a project to map forest stands which have been severely damaged by the hemlock looper, using the 1:110,000 scale colour-infrared photography. This study is progressing well and yielding results.

(2) Wildlife Studies

a) Habitat and survey of ungulates

Investigator: Mr. E. Mercer, Newfoundland Wildlife Service, St. Johns.

The high altitude photography provided by C.C.R.S. is being used for mapping caribou habitats and areas which have been over-browsed by moose. Various caribou habitats on the islands in Placentia Bay and on the southwest coast of Newfoundland have been mapped. The mapping of areas which have been over-browsed by moose has just started, and in this work large areas of dead vegetation can be readily distinguished on the small scale colour-infrared photographs. It is probably going to be necessary to obtain larger scale imagery, however, to delineate the smaller areas as required in this study.

In order to carry out a census of the caribou herd on the Buchans plateau, C.C.R.S. carried out infrared photography at a 1:20,000 scale. Unfortunately, results have not been positive since the scale is too small to detect the animals. However, it is hoped that with further field testing it will be possible to determine the most appropriate scale for this purpose. It is the intention of the Wildlife Service to then carry out on a regular basis caribou herd census of all the various management areas in the Province. It is well established that aerial photography is the best method to obtain accurate census figures.

In order to obtain essential information for moose management, it is necessary to fairly accurately determine forest conditions, identifying cut-over, burned, and diseased-killed areas, as well as other important features. There is a good indication that this can be done using the high altitude colour-infrared aerial photographs, and it is hoped that the management unit of the Provincial Forest Service will carry out this task.

b) Waterfowl census

Investigator: Dr. D. Bajzak, Faculty of Engineering & Applied Science, Memorial University, St. Johns.

The National Research Council and the Canadian Wildlife Service are supporting research being carried out by the Faculty of Engineering at Memorial University on appropriate means of conducting census of various species of waterfowl. The objective of this project is to develop methods of automatic separation and counting of birds by species and by sex and age classes, using aerial photography, micro-densitometry, and pattern recognition techniques. First, the most appropriate scale and the film and filter combination must be established for each species, or group of species. Following this,

(2) Con't

b)

the images of birds must be digitized and appropriate patterns established. In the last phase of the process each uniform pattern detected in the digitized image field must be compared to the pre-established pattern, sorted accordingly and counted. This process is conducted on an IBM 370 Model 155 Computer.

Using a camera system with two 70 mm. Hasselblads appropriate aerial photographic procedures were developed for the census of the greater snow goose along the St. Lawrence River, and on Bylot Island, North West Territories, and of the eider ducks in Newfoundland. Images of blue goose, diver ducks, and of caribou are also under investigation. The pattern recognition work and the programming of the computer is in progress.

(3) Forest Inventory and Canada Land Inventory

Investigator: Mr. K. Beanlands, Newfoundland Forest Service, St. Johns.

A province-wide forest inventory, which was designed by personnel of the Forest Management Institute, Ottawa, is being conducted by the Newfoundland Forest Service. Double-sampling techniques are used based on ground observations and on the interpretation of 1:15,840 scale aerial photographs. This project was completed for the Island of Newfoundland and is near to its completion for the forested portion of Labrador.

Land capability classification and mapping for forestry, wild life and recreation, was carried out covering the Island of Newfoundland. Maps and descriptions of units were prepared and they will be published in the near future. Agricultural capability classification was carried out by the Canada Department of Agriculture for selected areas on the Island of Newfoundland, and a portion of this study was recently published.

(4) Bio-physical Land Classification

Investigator: Dr. R. Wells, Canadian Forestry Service, St. Johns.

In connection with the Canada Land Inventory the Newfoundland Research Centre of the Canadian Forestry Service carried out three pilot projects to test the applicability of a newly developed land classification system. These projects were completed and the results are prepared for publication.

(5) Agriculture

Investigator: Mr. J.W. Williams and D. Neilson, Newfoundland Department of Agriculture, St. Johns.

Plans have been developed for a remote sensing program in the field of agriculture in which various forms of imagery will be used for soil survey and classification, land use classification, and crop disease detection. The high level imagery will be tested for its applicability to the extension of the Canada Land Inventory, to located suitable regional pastures and blueberry lands, and for possible detection of various crop diseases. Although this programme is ready to get under way, copies of the imagery have not yet been received.

(6) Geology

Investigator: Mr. B.A. Greene, Provincial Department of Mines and Energy, St. Johns.

The high level multi-spectral aerial photography obtained in 1972, both on the Island and in Labrador, is being tested for geological mapping of bed rock and for its usefulness in mineral exploration. The colour and infrared colour photography seems best suited to map lithologies of contrasting colour, such as diabase dykes cutting granites. The use of the imagery for mineral exploration is limited, however, because of the extensive forest cover, and the lack of information concerning the influence of bedrock lithology and the structure on the spectral signature of the overlying vegetation. Attempts are being made to establish these relationships in areas containing a wide variety of known mineral occurrences that have been photographed.

The "ERTS" imagery, when it is available, will be tested for the interpretation and mapping of various geological features.

(7) Ocean and Ice Research

a) Investigator: Dr. D. Bajzak, Faculty of Engineering and Applied Science, Memorial University, St. Johns.

In 1972, an iceberg research project was

(7) Con't

a)

conducted by the Faculty of Engineering at Memorial University, centered on a coastal area off Saglek Bay, Labrador. The movement of various icebergs was recorded from a shore based radar tracking station, and data of the physical characteristics of the ocean were obtained along three base lines from the C.S.S. DAWSON, a research vessel of the Bedford Institute of Oceanography. Currents were measured, using moored current meters, and by tracking drogues set a different depths. The dimension of icebergs was determined with the aid of terrestrial stereo photography and underwater sonar profiling.

The Maritime Air Command provided remote sensing imagery in support of the above research obtained along five 100-mile long miles, which were flown with a reconnaissance aircraft. Mapping by radar was carried out from an altitude of 8,000 feet simultaneously with aerial photography obtained using a KS 116 panoramic camera. Thermal maps were produced for the same lines, flying at 3,000 feet. Larger scale thermal mapping was carried out for the base line containing the current meters, and for short strips around selected icebergs. Expendable thermometers were dropped from the aircraft in the corners of the experimental area and their recordings monitored.

The remote sensing data complemented and extended the coverage obtained by the ship, while the ship's observations provided ground truth for the remote sensing imagery. The radar maps are being used to show the distribution of icebergs and to indicate larger current patterns. The thermal maps are being evaluated both visually and mechanically, using a densitometer, for the detection of currents and of water bodies having uniform surface temperatures. The aerial photography provided back-up imagery for the radar mapping.

All the imagery has only recently been received from the Maritime Air Command, but it is anticipated that the analysis of the data will be complete by the end of August, 1973.

b) Lake Melville Ice Experiments

Investigator: Dr. A.A. Bruneau, Faculty of Engineering and Applied Science, Memorial University, St. Johns.

A major investigation of the characteristics of the ice which forms annually in Lake Melville is being investigated with special emphasis placed on those aspects which afford the major barriers to extended shipping in that area. The ice regime is a complex one in which thermal cracking, ridging and rafting occur, together with the formation of a composite sheet, made up of frozen lake water, frozen slush, wet slush and snow, in various proportions at various times of the year.

Aerial photography has been conducted to determine something of the patterns of freeze-up, and the ground truth obtained on the ice is being used for the calibration of the UHF remote ice thickening sensing apparatus developed by the Federal Department of Communications. These investigations are now well under way, and preliminary results would appear to establish the usefulness of this equipment.

c) Aerial detection of ice conditions

Investigator: Dr. J.M. Jones

Associated with the ice research program described above in 7 (b) simple experiments have been initiated, utilizing a Hasselblad 500 EL camera and three Ricoh 35 mm. automatic cameras, to determine most appropriate film-filter combinations for monitoring the surface conditions of the ice cover. Knowledge of these will be useful in the overall experiment, and it will be important to be able to distinguish water, slush, bare ice, and snow-covered ice under a variety of conditions. No results of these investigations are as yet available.

8. Newfoundland "ERTS" Project

Supervisor: Mr. G. Cooper, Faculty of Engineering, Memorial University of Newfoundland

This project is sponsored under the Federal Winter Works Program, and will be carried on until May 31 of this year. Although it was not initiated until 1973, much of the work that is being carried out relates to imagery earlier obtained.

Team members working in Newfoundland are experienced in geology, forestry, engineering and wildlife, and although no "ERTS" imagery has as yet been received, they are developing techniques and becoming familiar with procedures using small scale aerial photography.

8. Con't

We anticipate that this project will yield a great deal of useful information, and will stimulate further interest in the use of remote sensing techniques.

6.5.3 Projected Remote Sensing Activities for 1973

Although a formal Provincial committee, which represents users in Newfoundland, is not established, the various users who have requested the imagery obtained in 1972 have maintained contact with each other, and are now at the point of bringing forward proposals for 1973. Many of the users have not carried out sufficient evaluation of last year's imagery to be able to determine an optimum program for this year, but we anticipate that this will soon be accomplished.

Two test projects based on "ERTS" imagery were designed last year by the personnel of the Canadian Forestry Service in Newfoundland and Ottawa. Furthermore, a number of "ERTS" proposals have been received relating to the use in fields of wildlife, geology, geography, oceanography and mining, but all of this activity is as yet being held in abeyance pending the availability of "ERTS" imagery.

A meeting of Provincial users is now organized in order to evaluate last year's results, and to work out final recommendations for future work. However, it is becoming obvious that extensive work will be required in ice and ocean related research, and in land vegetation classification and mapping, especially for Labrador. Furthermore, there is vastly increased interest in the use of these techniques for geological mapping in the Province, and requests for activity in this area will doubtless arise.

Compiled by:

D. Bajzak
A.A. Bruneau

6.6 REPORT OF THE CHAIRMAN, ONTARIO COMMITTEE ON REMOTE SENSING

6.6.1 Introduction

On May 18, 1972 the Ontario Cabinet Committee on Resources Development instructed the Ministry of Natural Resources to form an internal committee in co-operation with the Ministry of Transportation and Communications. The purpose of this committee was to investigate Ontario's need and mode of involvement in the national remote sensing program and was to submit a policy proposal on the matter.

6.6.2 Committee

Accordingly, the Ministry of Natural Resources set up an ad hoc committee which included members from other ministries (see Appendix 1) presently using any type of remote sensing data in their day-to-day activities.

6.6.3 Proposal

The Ontario Remote Sensing Committee had four successive meetings on August 10, September 7, 28 and November 28, 1972. The committee, at the last meeting, finalized the policy proposal prepared and unanimously accepted it for submission.

It was recognized in the proposal that there would be a need within the Ontario government to:

1. Co-ordinate remote sensing activities;
2. Centralize equipment and expertise;
3. Provide access to the constant stream of data being generated;
4. Provide, as required, specialized interpretation services for inter ministry use;
5. Develop new applied techniques to manage the environment and resources more effectively and efficiently and at lower cost;
6. Avoid duplication of expensive equipment, complement, and effort.

An objective which would resolve the issues listed above was formulated.

Objective:

To provide a highly specialized service for the collection, processing, interpretation, and development of applications of remote sensing data - whether provided by technical equipment within the Ontario government or from other sources - applicable to resources and environmental management, and land use planning in the Province of Ontario.

The objective is attained through the following sub-objectives:

1. To set priorities on all requests within the province for federally supplied remote sensing data;
2. To provide an overview of the provincial program to ensure that duplication does not occur;
3. To provide advice to government agencies on the effectiveness and suitability of remote sensing applications presently in use while developing and publicizing new applications;
4. To provide, as required, specialized equipment as well as specialized interpretation services beyond the existing capabilities of ministries;
5. To evaluate and modify remote sensing hardware to be used in the development of new data gathering and interpretation techniques;
6. To conduct research and training programs in remote sensing data processing and interpretation systems and to maintain liaison with other agencies in Ontario with similar interests;
7. To maintain a central remote sensing image library.

6.6.4 Current Status

The Policy Proposal for a Continuing Remote Sensing Centre was presented to the Cabinet Committee on Resources Development on December 7, 1972. As a result, the Cabinet Committee has instructed the Ministry of Natural Resources to investigate the willingness of other interested ministries to use the services of such a centre and to contribute funds to the provincial remote sensing program. This investigation is in progress and we expect to receive the Cabinet Committee's final decision soon. With the presentation of the policy proposal, the Ontario Remote Sensing Committee had to be disbanded, and for the time being all remote sensing matters in Ontario are to be looked after by the Ministry of Natural Resources.

Although the Ontario Remote Sensing Committee has been disbanded, informal inter-ministerial communication between the ex-

6.6.4 Con't

members still exists. Each ex-member has his communication channels established within his ministry, and important matters receive prompt attention. Most activities so far have focused on the promotion of the concept about the Ontario Remote Sensing Centre. Formal working groups have not yet been established at the provincial level.

The relationship of the Ontario Government to universities and to industry is proposed to be established by an unfolding organization, the Ontario Association for Remote Sensing, under the chairmanship of Prof. Stanley H. Collins, University of Guelph. This organization will hopefully provide a formal body for university and industry representation to the proposed Ontario Remote Sensing Centre.

6.6.5 Projects

Remote sensing projects within the Ontario Government have been conducted for many years. Most projects have been based on the use of standard aerial photography and on traditional interpretation techniques (See Appendix 2). Some projects are of relatively broad topics, including the use of various remote sensing imagery and interpretation techniques. Many, however, are of specific remote sensing studies, which to date have used both medium-scale panchromatic photography and specialized 35 mm supplementary aerial photography (SAP). Most projects will progressively incorporate the use of ERTS and high-altitude imagery from the Canada Centre for Remote Sensing. The list of projects in Appendix 2 indicates current and future applications. The current applications refer to ongoing projects in 1973, which may extend into 1974. Many projects in resource surveys and environmental monitoring are of a continuing, seasonal or periodical program. Where traditional ground technique is replaced, cost benefit ratio will be determined as early as possible.

Intensive interpretation research and post-graduate studies are conducted at the Universities of Guelph, McMaster, Toronto, and Waterloo (See Appendix 3).

A proposal for NASA sponsorship has been prepared and submitted for approval by a U.S./Canadian company - OVAAC 8 International- regarding the use of ERTS 2 imagery for urban planning for part of Southern Ontario.

6.6.6 Problems

As I see it three major problems affect the Canadian remote sensing program: 1. the public impression, 2. the handicapped Canadian industry, and 3. the quality of results achieved.

1. Remote sensing is often over-sold by promoters and the layman tends to generalize that it is too academic, too research-oriented, and too expensive. Consequently, government policy-makers are reluctant to allot funds for continuing programs.

2. The Canadian industry interested in remote sensing is handicapped for two reasons: (a) It is uncertain of the success of the new technology (sensors and interpretation) and investment in expensive hardware is considered risky. (b) Canadian firms are not eligible for NASA sponsorship for remote sensing investigations. Thus Canadian experience is not being gained to the extent that it should be.

3. Present policies allow U.S. companies to be hired by NASA to conduct experiments in Canada if these experiments are endorsed by a local government. The interpretation, if done by people not familiar with local conditions, could lead to misconceptions resulting in the discrediting of remote sensing.

6.6.7 Recommendations

I suggest that Problem 1 be handled through skilled public relations work and well designed training programs at all academic levels.

People who have the background and opportunity to promote remote sensing should be well equipped to make lucid presentations, have attractive handouts (imagery), and be prepared to hold miltidisciplinary discussions aided by convincing references. These people should be helped by their own resources as well as by a continuous supply of information received from the CCRS. That supply should be in the form of well illustrated abstracts of concrete remote sensing achievements, interesting to and comprehensible by a hetero-calibre audience. Also, articles on remote sensing should often be published in periodicals with a broad circulation. Easy reading and progress reports might be the right approach.

Formal training programs do progress in a few universities. However, educators

6.6.7 Con't

should take steps to reinforce their related courses with interpretation exercises of satellite, hi-flite, and low-level imagery as intensively as possible. Specialists can prepare interpretation kits of Canadian conditions for multidisciplinary purposes to suit specific requirements. Eventually, regional interpretation centres will be established that will make hardware available for such courses on a practical basis.

In-service training courses are expected to be developed by the proposed regional interpretation centres.

The solution to Problems 2 and 3 is certainly difficult, mainly because of the political implications. However, two possibilities may be considered to overcome the difficulties that could help increase the participation of the private sector:

Canadian participation of professionals should be required when a remote sensing investigation is to be conducted in Canada by foreign sponsorship. And, similar studies should be encouraged and sponsored by the federal and provincial governments.

Of course, these are not the only problems and the only solutions in our beloved field of interest. My point of view is, however, presented by bringing up the above problems which, hopefully will contribute to the observations of other reporters.

Finally, I must say that progress within the Canadian remote sensing program is highly regarded in Ontario, and aggressive provincial participation is forecasted for the immediate future.

Acknowledgement

Ursel, Norman H., Norman H. Ursel Associates Limited, Mississauga, Ontario. Communications regarding the relations of the private sector to remote sensing.

Victor G. Zsilinszky,
Provincial Co-ordinator,
Ministry of Natural
Resources, Toronto.

APPENDIX 1:
MEMBERS OF ONTARIO COMMITTEE
ON REMOTE SENSING

Chairman: V. Zsilinszky, P.Eng., R.P.F.
Surveys and Mapping Branch
Ministry of Natural Resources

Co-Chairman: B.S. Mathur, P.Eng.
Design Services Branch
Ministry of Transportation and
Communications

J.E. Brubaker, P.Eng., Extension Branch, Ministry of Agriculture and Food

W.G. Cleaveley, R.P,F., Field Services Division, Ministry of Natural Resources

R.M. Dixon, R.P.F., Forest Management Branch, Ministry of Natural Resources

W.E. Jenns, R.P.F., Ontario Land Inventory, Ministry of Natural Resources

M.H. MacLeod, P.Eng., Design Services Branch, Ministry of Transportation and Communications

G.K. Ormerod, Economic Planning Branch, Ministry of Treasury, Economics and Intergovernmental Affairs

L. Shenfeld, P.Eng., Air Management Branch, Ministry of the Environment

R.O. Standfield, Policy Research Branch, Ministry of Natural Resources

Dr. M.D. Palmer, P.Eng., Water Quality Branch, Ministry of the Environment

Dr. E.G. Pye, P.Eng., Geological Branch, Ministry of Natural Resources

APPENDIX 2:

LIST OF REMOTE SENSING PROJECTS WITHIN THE ONTARIO GOVERNMENT

MINISTRY OF NATURAL RESOURCES
(Compiled by V.G. Zsilinszky)

1. DIVISION OF FORESTS

Current Studies:

a. Plantation success survey - colour IR photography

b. Nursery seedbed inventory - colour IR photography

c. Fomes annosus survey in Southern Ontario- colour IR photography

d. Artificial fertilization success survey- colour IR photography

e. Mapping of cutover, wind, sleet and herbicide spray damage - black and white panchromatic and IR photography

f. Fume damage monitoring (Wawa and Sudbury) colour IR and panchromatic photography and ERTS imagery

Future Applications:

a. Frost pocket monitoring - IR thermal scanning

b. Screening of nursery stock - IR monitoring

c. Regional monitoring of insect, fungus, fume, fire and other damages - colour IR photography, ERTS imagery

d. Slash survey - colour photography

e. Flood patterns - colour IR photography, ERTS imagery

f. Airborne timber operational crusing - colour photography

2. DIVISION OF MINES

Current Studies:

a. Access and density of traverse coverage - panchromatic photography

2. Con't

b. Rock distribution and accurate location - panchromatic photography

c. Structural analysis of bedrock and surficial glacial deposits - panchromatic photography

d. Geological interpretation for small scale map compilation - panchromatic photography overflight, airborne gamma-ray, spectrometric and VLF radio phase surveys & ERTS imagery

e. Geomorphic and quaternary studies for location of natural aggregates and identification of construction hazards - panchromatic photography, airborne VLF E-phase resistivity surveys.

Future Applications:

a. Regional structure and interrelationships - overflight and ERTS imagery

b. Monitoring erosional features and other surface phenomena - overflights, ERTS and SLAR imagery

c. Multiple radiometric surveys - overflights

3. DIVISION OF FISH & WILDLIFE

Current Studies:

a. Big game and water fowl census - thermal IR imagery

b. Habitat assessment - big game, furbearers and waterfowl - panchromatic and colour IR photography

c. Movement and distribution of mammals - radio telemetry

d. Waterfowl and polar bear distribution - assessment of snow and ice condition in the Hudson Bay Region - multi-spectral photography and ERTS imagery

e. Creel census by counting sports-fishing boats - panchromatic photography

Future Applications:

a. Movement and distribution of moose, deer, foxes and black bear - telemetry

b. Beaver inventory - panchromatic photography

3. Con't

Future Applications Con't:

c. Deer year site studies - colour IR photography

d. Snow and ice conditions, time of freeze-up, break-up, chronology of pack-ice distribution, depth and melting of snow - ERTS imagery

4. DIVISION OF PARKS

Current Studies:

a. Archeological reconnaissance - Old Fort William site and ancient Indian settlement at Long Point - colour IR photography

b. Provincial park site selection - panchromatic photography

c. Nature trail location - panchromatic photography

d. Park development - panchromatic photography

Future Applications:

Traffic surveys on lakes and in parks - panchromatic and colour photography

5. DIVISION OF LANDS

Current Studies:

a. Forest inventory aerial sampling - large scale colour photography

b. Shoreline classification, cottage inventory and aquatic vegetation studies - panchromatic, colour and colour IR photography

c. Erosion and deposit studies on shorelines - comparative panchromatic photography

d. Survey point discoveries - panchromatic photography

Future Applications:

a. Map revision - panchromatic photography, overflights and ERTS imagery

b. Land ownership disputes - panchromatic and colour photography

5. Con't

Future Applications Con't:

c. Real time description of pond appearance and disappearance and change of lake perimeters, ERTS imagery

6. FIELD SERVICES DIVISION

Current Studies:

a. Mapping of going forest fires obscured by smoke - thermal IR imagery

b. Detection and mapping of hot spots during mop-up - thermal IR, real time imagery

c. Localized detection of incipient lightning fires - thermal IR imagery

d. Detection of illicit stills at night (for RCMP) - thermal IR imagery

Future Applications:

a. High altitude thermal detection for precise geographic definition of lightning occurrence - high resolution thermal IR imagery

b. Monitoring littorial drift on the shorelines of the Great Lakes - overflight imagery

MINISTRY OF THE ENVIRONMENT
(Compiled by M.D. Palmer and L. Shenfeld)

1. WATER QUANTITY BRANCH

Current Studies:

Ground water discharge, soil moisture and recharge/discharge relationships, land use - multispectral photography and thermal IR imagery

Future Applications:

The results of the two current studies which are pilot projects will provide direction for further investigations.

2. WATER QUALITY BRANCH

Current Studies:

Aerial surveillance for oil slicks, algae

2. Con't

Current Studies Con't:

blooms, dredging operations and marine construction - true and false colour photography

Future Applications:

Floating and submerged acquatic plants on the Kawartha and lower Great Lakes - multispectral photography

3. SANITARY ENGINEERING BRANCH

Current Studies:

a. Pollution surveys - multispectral true and false colour photography

b. Locating sludge disposal or sanitary landfill sites - true and false colour photography

4. INDUSTRIAL WASTES BRANCH

Future Applications:

a. Mapping of existing mining tailings and their affect on water courses - multispectral photography

b. Locating new disposal areas - true and false colour photography

c. Detection of spills of hazardous materials - multispectral, true and false colour photography

5. PROJECT DEVELOPMENT BRANCH

Current Studies:

Location of pipelines, water and waste treatment plants - multispectral photography

6. STRATEGIC PLANNING BRANCH

Current Studies:

a. Onakawana development study (lignite deposits) - panchromatic photography

b. Rights-of-way for Ontario Hydro - panchromatic photography

c. Hazard land mapping - panchromatic photography

6. Con't

Future Applications:

Extension of hazard land mapping - multispectral photography

7. AIR MANAGEMENT BRANCH

Current Studies:

a. Studies of behaviour of large plumes from major point sources as well as from cities as a whole - overflight, ERTS and weather satellite imagery

b. Delineate areas of haze which are widespread and extend into Ontario from U.S. - overflight, ERTS and weather satellite

c. Delineate areas of air pollution by damaged vegetation - colour IR photography

Future Applications:

Monitoring of air quality with respect to concentrations of a number of pollutions which can be measured by specialized sensor

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
(Compiled by B.S. Mathur)

1. DESIGN SERVICES BRANCH

Current Studies (Conventional Photography):

a. Engineering soils surveys

b. Search for natural aggregates

c. Evaluation of hydrological problems

d. Geotechnical studies related to foundations and instability problems

e. Terrain evaluation for transportation modes

Future Projects:

a. Engineering soils survey - colour infrared photography and thermal imagery

b. Granular search - colour infrared photography and thermal imagery

c. Ground water conditions - S.A.P. system

d. Watershed and hydrological studies - ERTS imagery

1. Con't

Future Projects (Potential):

a. Study of areas susceptible to frost heaving along major highways - multi-spectral photography and theral imagery

b. Pavement condition survey - S.A.P. system

2. ENVIRONMENTAL & OPERATION PLANNING BRANCH

Current Studies (Conventional Photography):

a. Environmental and feasibility studies

b. Operation planning studies

Future Projects:

a. Environmental and feasibility studies using various R.S. techniques.

b. Operation planning studies using various R.S. techniques

c. To provide detailed and typical base data - overflights

d. To monitor the affects of a transportation facility on the environment - overflights

MINISTRY OF AGRICULTURE AND FOOD
(Compiled by J.E. Brubaker)

Current Studies:

a. Changes in fruit planting acreages in the Niagara area

b. Maps of farms, particularly in the fruit areas for the design of tile and surface drainage systems

c. Harwich Township was flown in 1971 and again in 1972 to determine changing corn acreages

d. The tobacco areas were flown to determine acreages and to determine the spread of various diseases

e. The light bean areas have been flown to check for disease

Future Applications:

a. Electronic scanning for crop acreages, wooded areas and changes over the years

b. Identification of broad uses of land and checking this against data received from regular mail-ins

c. Determine crop growing conditions such as soil moisture, state of maturity, crop damage and extent of injury from such things as flood, hail, drought and pests as well as determining plant diseases, nutritional deficiencies, etc.

d. Length of time, location and size of areas periodically flooded

e. Macro and micro drainage patterns and watersheds

MINISTRY OF TREASURY, ECONOMICS AND INTERGOVERNMENTAL AFFAIRS
(Compiled by G.K. Ormerod)

Future Applications:

Investigation of new town sites:

- water supply
- soil base and construction materials
- drainage slope
- vegetation

Monitoring and planning of urban fringe and rural areas:

- land use succession on a short term basis and mapping of special broad scale land use patterns

- particular uses of holdings which may be classified as "agricultural"

- developments taking place in relation to transportation corridors and services

Regional planning for resource-based recreational supply areas:

- escarpments
- river valleys
- physical indicators of environmental quality
- lakes classification re recreational carrying capacities and quality constraints

APPENDIX 3:

LIST OF REMOTE SENSING PROJECTS AT UNIVERSITIES

McMASTER UNIVERSITY
(Reported by P.J. Howarth)
Department of Geography

Current Studies:

a. Hydrologic and geomorphic studies in the Niagara Peninsula - Dr. P.J. Howarth and W.D. Bruce - ERTS I simulation photography

b. Urban and agricultural land use change detection in the Niagara Peninsula - Dr. P.J. Howarth, L.G. Neilly with Drs. F. Betak, L.J. King and L.G. Reeds - CCRS photography

c. Photo-interpretation and mapping in the High Arctic - Dr. P.J. Howarth - Aerial photography

d. Coastal studies in the Maritimes - Dr. S.B. McCann, E.A. Bryant and F. Armon - CCRS photography

e. Karst studies in the South Nahanni River area - Dr. D.C. Ford and G.A. Brook - CCRS photography

f. Microclimate and Ecological Studies in the Sub- rctic - Drs. W.R. Rouse and K.A. Kershaw, and graduate students - CCRS photography

g. An evaluation of ERTS I imagery for the interpretation of snow cover - Drs. P.J. Howarth and M.-kWoo - ERTS I imagery

h. An evaluation of ERTS I imagery for hydrologic mapping - Dr. P.J. Howarth and W.D. Bruce - ERTS I imagery

UNIVERSITY OF GUELPH

Current Studies:

DEPARTMENT OF LAND RESOURCE SCIENCE
(Reported by R. Protz)

Assessment of multispectral imagery for soil surveys - R. Protz and A. Symeonakis - 12-channel scanner and panchromatic photography

SCHOOL OF ENGINEERING
(Reported by D. Sudom)

Interpretation of ERTS imagery to investigate potential applications - S.H. Collins and Federal Winter Works Program Team (6) - ERTS I imagery

DEPARTMENT OF GEOGRAPHY
(Reported by A. Falconer)

Simulation studies of the ERTS I and 2 data. USGS contract through Centre for Applied Research and Engineering Design, McMaster University - Investigation: P.J. Howarth, G. Harris, A. Falconer, R. Protz, S.H. Collins and T. Dickinson - NASA imagery

Ground truth correlated with imagery for soil surveys - Co-operative project with IFYGL, Michigan

UNIVERSITY OF TORONTO

Current Studies:

DEPARTMENT OF GEOGRAPHY - ERINDALE COLLEGE
(Reported by J.C. Munday)

a. Water mass delineation in western Lake Ontario - J.C. Munday - ERTS I imagery

b. Oil slick motion and behaviour in cold and tropical waters - W. Harrison - CCRS imagery

c. Oil slick behaviour - W. Bien: MSc. thesis-CCRS imagery

UNIVERSITY OF WATERLOO
(Reported by D. Steiner)

Current Studies:

DEPARTMENT OF GEOGRAPHY

a. Geomorphological and hydrographical mapping in the area of Map Sheet Galt, Ontario 1:50,000 - A. Kesik - standard survey photography and 70 mm b/w and colour photography

b. Automatic terrain recognition on multispectral and multitemporal air photos - D. Steiner - 70 mm b/w photography

DEPARTMENT OF EARTH SCIENCE

Detection of polygonal soil patterns (periglacial ice wedge patterns) in an area near Kitchener, Ontario - A. Morgan - standard survey photography and CCRS imagery.

6.7 REPORT OF THE CHAIRMAN OF THE P.E.I. COMMITTEE ON REMOTE SENSING

6.7.1 Summary of Activities:

The province of Prince Edward Island joined the National Remote Sensing program in May, 1972. The provincial commitment to this program has been made with the hope that the technique will eventually be used as a tool for the management of provincial programs designed to service Island residents, industry and resources.

The economy of the province is heavily dependent on resource-generated industries including agriculture, fisheries, and tourism. Therefore, the well being and indeed the survival of the province is closely related to the wise management of the Island basic resources of soil and water.

Since Remote Sensing encompasses the interests of a wide range of resource-related departments and agencies, the structure of P.E.I. committee includes representatives of different provincial departments and other interested agencies. The committee membership is as follows:

Dr. Awni Raad, Department of Agriculture and Forestry - Chairman

Mr. Don Champion, Department of Environment and Tourism - Member

Dr. Winston Johnston, Agricultural Research C.D.A. - Member

Dr. J.C. Cheverie, Biology Department UPEI - Member

Mr. Floyd Wilson, Department of Environment and Tourism - Secretary

Mr. Norbert Stewart, Department of Agriculture and Forestry - Member

The membership will be expanded soon to include representatives from Department of Fisheries, Department of Community Services and Municipalities.

At the present time, there are no current programs in Remote Sensing in P.E.I. due to the fact that the provincial involvement did not start until May of last year. However, the provincial committee has been able to co-ordinate an ambitious provincial program for 1973 - 1974 fiscal year. (See Appendix).

Project proposals were solicited and a variety of projects submitted by agencies responsible for the management of programs in environmental pollution abatement, agriculture, and forestry. These projects have been discussed with the participants with special reference to management benefits, needed logistics, and feasibility.

Consultation with available literature relevant to projects was done by investigators and individual members of the committee. The financial responsibility of projects will be undertaken by concerned agencies. However, facilities and expertise for imagery interpretation are sometimes hard to come by. This is mainly due to lack of practical involvement of most provincial staff in remote sensing projects.

Membership in the C.C.R.S. working groups includes only that of the chairman of the committee in the geography working group. Increased involvement of other members of the committee in different working groups is recommended. Nominations for such membership will be presented to the National Advisory Committee in the immediate future after consultation with the committee.

Prince Edward Island has submitted a list of projects to the center. The commencement of all or some of these projects is scheduled for early spring of 1973. Summary descriptions of the projects are attached to this report.

The committee, in asking different investigators for project write-ups, emphasized the importance of management objectives since they constitute the provincial criteria for financing and endorsement.

The C.C.R.S. has been consulted on technical matters relating to imagery specifications which can best serve the objectives of the different projects.

Major remote sensing projects which can be useful to the existing provincial programs are described later in this report.

6.7.2 Major Problems and Recommendation

A major problem in remote sensing is the lack of appreciation of its potential to serve the direct users in solving resource-related problems at reasonable costs. Although tremendous progress has been achieved in developing techniques for imagery acquisition, nevertheless, interpretive knowledge of imagery

6.7.2 Con't

in terms of resource development and management seems to br quite limited at the present time.

Reasons for this may include the absence of standard methods and techniques to serve as a basis upon which similar experiences can be meaningfully related. Another reason could be the fact that research and development efforts in the interpretive aspects of remote sensing have not been adequate. Most of the interpretation work has been done so far by agencies outside the center.

It is realized that certain provinces which have the financial and technological resources are capable of developing the technique and consequently make efficient use of the national program. However, other provinces such as Prince Edward Island which only recently had joined the national program, still lack the resources needed to fully enjoy the benefits of the program.

Identification of national priorities with respect to certain resource-related programs which are in effect in all provinces seems to offer some hope for positive use of the remote sensing technique by all Canadians. Once these programs are identified, then the C.C.R.S. can adopt these programs in all aspects including financing, research and development to the stage of delivery to users.

I can suggest few of these programs, but I am sure there may be others which can be added to the list by other participants in this meeting.

Of highest priority is the Federal-Provincial programs in crop insurance. Each province has a program which is usually cost shared between Federal and Provincial governments and producers.

Up-to-date inventory of land use is another national priority. The problem is national in scope due to accelerated changes in use patterns of the land which may be detrimental to provincial and national goals.

Sediment pollution of Canadian rivers, lakes, and estuaries due to exposure of agricultural land, highway and urban construction can be considered as a national program. Each of these programs can be assigned to the proper working group to initiate research and development programs which will allow different user agencies, namely provincial government departments to employ the technique in the management of local programs.

I propose that these programs, as well as other similar programs, be discussed in our meeting to find out means by which a National Remote Sensing Program can be used to the best advantage.

The cost-sharing of remote sensing projects which has been in effect during phase I of the program, should be maintained and possibly modified during phase II of the program. Since the benefits of the program to users will be the main thrust of phase II, it is only logical that federal contribution be maintained if not increased in proportion to the increased utility of the program.

The assistance of the center to provinces can be made more effective if the cost-sharing will extend to include technical staff as well. Assignment of federal professional staff to provincial committees seems to be a step in the right direction. Presently, the grouping of provinces into a regional center or a functional committee can be considered economically and technologically a feasible endeavour.

Another current concern is the management of the proposed program to recruit local talents, namely recent university graduates to work in the local remote sensing projects. Should this program be finally approved, it is proposed that provincial committees be consulted in matters relating to number of persons to be employed and the selection prcess of candidates. The P.E.I. provincial committee recommends that recruits for this type of work be selected from the local institutions, namely UPEI and Holland College.

Final recommendations of the P.E.I. committee on remote sensing are as follows:

1. Extension of cost-sharing arrangements to include phase II.
2. Higher degree of involvement by the center in areas of research and development of certain projects which have wides national relevance.
3. Establishment of regional interpretation centers to service provinces#and local user agencies.
4. Federal participation in staff training programs to meet the technical requirements of the local remote sensing program.

Awni Raad, Chairman, P.E.I. Provincial Committee on Remote Sensing, Charlottetown, P.E.I.

APPENDIX

PROVINCE OF P.E.I.
PROJECTS FOR ACQUISITION OF REMOTE SENSING IMAGERY
1973-1974

DESCRIPTION OF PROJECT	LOCATION	MANAGEMENT OBJECTIVES	AGENCY INVOLVED	TIME OF ACQUISITION	IMAGERY REQUIRED
1. A survey of variation in population levels of Spruce Budworm Emphasis will be placed on the location of epicenters and the spread of budworm from these centres. This information will be extremely useful in the management of control measures by the P.E.I. Department of Agriculture and Forestry.	West Prince and East Kings Counties	To establish guidelines needed for effective control of the insect through location of epicentres and the degree of worm infestation around these centres.	Ian Miller, PEI Dept. of Agric. & Forestry	Late June to Mid-July	1:12,000 false colour infrared and true colour B&W panchromatic
2. A survey of the effects of Larch Sawfly on the vigor of larch trees.	Brudenell to Mermaid	Larch sawfly has been defoliating Island larch trees severely for the last three years, and there is presently mortality occurring in some areas. Remote Sensing would provide an indication of the amount of mortality and the vigor or the trees in the infected areas. This would lead to management recommendations for increased harvesting of additional expenditures on control measures, if warranted, upon examination of remote sensing imagery.	Ian Miller, PEI Dept. of Agric. & Forestry	Mid-August	1:12,000 false colour infrared and true colour B&W panchromatic
3. To survey the effects of released predators in the control of Larch sawfly.	Wood Islands to Richmond	To establish the degree of effectiveness of released predators.	Ian Miller, PEI Dept. of Agric. & Forestry	Mid-August	1:12,000 false colour infrared and true colour B&W panchromatic

DESCRIPTION OF PROJECT	LOCATION	MANAGEMENT OBJECTIVES	AGENCY INVOLVED	TIME OF ACQUISITION	IMAGERY REQUIRED
4. To survey the age of cut woodland in the province.	Eastern Kings County	To establish long term policy on woodland development to meet local requirements.	Ian Miller, PEI Dept. of Agric. & For-	Mid-August	1:12,000 false colour infra-red and true colour B&W panchromatic
5. A survey of the effects of the Forestry Management Program.	South eastern Kings County	To provide basis for planning and evaluation of current and future programs in Forestry.	Ian Miller, PEI Dept. of Agric. & For-	Early October	1:12,000 true colour and infrared B&W panchromatic
6. An evaluation of tonal variations of Remotely Sensed imagery as an indicator of CLI capability classes.		More precise delineation of capability allows for better returns from investments in higher capability areas.	Ian Miller, PEI Dept. of Agric. & For-	Early July	False colour Infrared, true colour B&W panchrom-atic
7. A survey of Barley-Yellow Dwarf Virus infestations in Barley and other cereal varieties. The survey may provide information with respect to source of over-wintering of the virus and to the dispersal pattern.	To be selected	1) To provide basis needed for development of research projects to provide the technical information to control the disease. 2) To provide a measuring tool for the adjustment of claims under the Crop Insurance Program.	Dr. L.S. Thompson- CDA Research Stn. Charlottetown Dr. H.W. Johnston- CDA Research Stn. Charlottetown R. McInnis- PEI Dept. of Agric. & For-estry Dr. A. Raad- PEI Dept. of Agric. & For-estry	Late July	To be estab-lished
8. To establish a method of surveying the effects of Winter-Kill on the development of for-age-legume stands on PEI. This survey assumes importance due to the fact that instantaneous on site evaluation of winter-kill is not always feasible.	To be decided	To provide guidelines needed to establish variety toler-ance and performance under winter climatic conditions prevailing on PEI.	Dr. Michio Suzuki - CDA Research Stn. Charlottetown	Mid-May to end of first week of June	To be estab-lished

DESCRIPTION OF PROJECT	LOCATION	MANAGEMENT OBJECTIVES	AGENCY INVOLVED	TIME OF ACQUISITION	IMAGERY REQUIRED
9. A survey of the moisture capacity of different soils of the Island as influenced by soil type, slope, and climate Under existing conditions, certain soil properties such as presence of impervious soil layers, depth of soil, degree or slope, and local climate will influence moisture regime.		Information obtained from the survey will be used to establish guidelines for fertility management of different crops on different soils of the Island.	A. Bootsma PEI Dept. of Agric. & Forestry N. Stewart - PEI Dept. of Agric. & Forestry J. McDougall - CDA Research Stn. Charlottetown F. Wilson - PEI Dept. of Environment & Tourism	July-August	B&W Infrared colour, false colour IR
10. Survey the level of organic matter of PEI soils under different management conditions.		To provide guidelines for fertility and moisture management required for different crops.	N. Stewart - PEI Dept. of Agric. & Forestry R. Veinot - PEI Dept. of Agric. & Forestry J. McDougall - CDA Research Stn. Charlottetown F. Wilson - PEI Dept. of Environment & Tourism	Summer	Colour, Colour infrared B&W red band

DESCRIPTION OF PROJECT	LOCATION	MANAGEMENT OBJECTIVES	AGENCY INVOLVED	TIME OF ACQUISITION	IMAGERY REQUIRED
11. A survey of potash magnesium, and calcium contents in different soils of the Island. Total Ca + Mg will provide information on the adequcy of liming programs, also the K:mg ratio has proven to be of great significance in influencing the rate of uptake of Mg by forage crops thus effecting the nutritional balance of livestock.	Selected	To established guidelines of fertility management needed for the production of nutritionally adequate forage crops, and to provide information on the adequacy of liming and the need for adjustment in government programs relating thereto.	R. Veinot PEI Dept. of Agric. & Forestry Dr. A. Raad - PEI Dept. of Agric. & Forestry N. Stewart - PEI Dept. of Agric. & Forestry		Colour, false colour infrared
12. A survey of forage areas of PEI - to detect areas of grasslegume mixtures - to determine the amount of legume in the mix - to determine, if possible, the kind of legume in the mix.		Canada Census data indicate that forage crop seeding patterns are static even with increased research and extension efforts directed toward certain changes. Census data may not be sufficiently sensitive to detect changes of concern. A more adequate assessment of actual use patterns is desirable; or a shift in research and extension efforts may be indicated.	Dr. C.B.Wills- CDA Research Stn. Charlottetown	Last half	To be established
13. A survey of selected tobacco plots and fields.	To be selected	To ascertain the usefulness of Remote Sensing as a tool to indicate ripeness in tobacco and thence time of harvest to obtain maximum quality.	K. Lalacheur- CDA Research Stn. Charlottetown	Late August	Infrared
14. A survey of selected corn and potato plots of known fertilization management.	Selected	To use Remote Sensing as a technique for fertilizer recommendations if nutrient deficiencies or other deficiencies can be detected.	Dr. R. White- CDA Research Stn. Charlottetown D. Munro - CDA Research Stn. Charlottetown		

DESCRIPTION OF PROJECT	LOCATION	MANAGEMENT OBJECTIVES	AGENCY INVOLVED	TIME OF ACQUISITION	IMAGERY REQUIRED
15. A survey of selected potato plots infested with late blight.	Selected	To establish a basis for determining crop loss. To provide a measuring tool for adjustment of crop insurance claims.	L. Callbeck- CDA Research Stn. Charlottetown W. Lewis - PEI Dept. of Agric. and Forestry	August-Sept.	Infrared
16. A survey of sedimentation load, current movements, temperature and outfall locations in estuarine waters as influenced by land use, climate, and industrial	Malpeque, S'Side, Charlottetown Cardigan	To allow for management decision with respect to the degree of discharge purification and land use control required to maintain and upgrade the quality of water and marine life in the major estuaries of PEI.	D. Champion - Environmental Control Commission N. Stewart - PEI Dept. of Agric. & Forestry	Spring, Fall	To be discussed
17. To detect locations of discharge zones and flow patterns of ground water, zones of high water tables, and salt-water intrusion.	Province wide	To provide basis for assessment of groundwater potential and its capacity to meet projected needs of Agriculture, Industry, and Urban centres of P.E.I.	Dr. B. Dousse- Environmental Control Commission D. Champion - Environmental Control Commission	Spring, Early, Fall	To be discussed
18. A survey of the bottom material in the near shore area of selected sites to detect location and extent of aggregate material	Nail Pond, Dog Island, Launching	To provide guidelines regarding the extent of aggregate removal from shorelines in accordance with established government policy of resource conservation and environmental quality	F. Wilson - Dept. of Environment & Tourism	Summer	Colour, blue green portion of visible

6.8 RAPPORT ANNUEL 1972: PROJET SATELLITES-RESSOURCES ET TELEDETECTION AU QUÉBEC

6.8.1 Généralités:

L'Année 1972 a marqué la formation du Comité Québécois de la Perception à Distance (C.Q.P.D.), un comité inter-ministériel qui groupe une dizaine de ministères. Notre participation aux Groupes de Travail du CACRS a été assurée par de nombreuses demandes et finalement, des personnes furent choisies sur presque tous les groupes. Elle a aussi marqué nos débuts avec quelques projets en télédétection et permis une coordination dans plusieurs secteurs d'activité tels que l'agriculture et les domaines relatifs à l'environnement. Ce fut donc une année où l'effort principal fut de s'initier et ensuite de sensibiliser des personnes de différents ministères, d'universités et de compagnies aux possibilités de la télédétection sous toutes ses formes. En 1973, il faudrait que cet effort se poursuive et même s'intensifie.

6.8.2 Structure du C.Q.P.D. et ses Relations avec d'autres Organismes

Le C.Q.P.D. ne s'est pas donné de structure et fonctionne comme comité d'étude et de direction sous l'animation du coordonnateur québécois en télédétection. Il est cependant supporté par les ministères suivants:

- Terres et Forêts (T & F)
- Richesses Naturelles (RN)
- Agriculture et Colonisation (MAC)
- Affaires Municipales (Af. M)
- Tourisme, Chasse et Pêche (TCP)
- Office de Planification et de Développement du Québec (O.P.D.Q.)
- Affaires Intergouvernementales (Af. I)
- Communications (MC)*
- Industrie et Commerce (IC) (Ces derniers se sont retirés dernièrement)

En appendice, on trouvera les documents suivants:

- Appendice 1: liste des membres du Comité Québécois de la Perception à distance (C.Q.P.D.), au 4 janvier 1973.

*Le ministère des Communications a soutenu ce comité depuis sa formation en y affectant un ingénieur à temps partiel.

- Appendice 2: un graphique montrant les Groupes supportant le C.Q.P.D. (présents et futurs)

- Appendice 3: les relations entre les organismes en télédétection.

6.8.3 Etat Actuel du Programme Provincial:

Le C.Q.P.D.: Le C.Q.P.D. est composé de 12 membres et il a connu une certaine activité au cours de l'année. Déjà deus (2) réunions ont été tenues et à l'une d'elle, participaient le Dr Morley et les principaux dirigeants du CCRS.

Les groupes de travail du CACRS: La représentation du Québec sur les différents groupes de travail du CACRS fut organisée et présentement 22 personnes oeuvrent sur ces comités. Les efforts déployés par ces représentants démontrent bien le vif intérêt que les différents ministères et organismes portent à la télédétection.

Autres Activités: Un film intitulé "The World of Invisible Colour" de la compagnie Bendix et présenté grâce à la collaboration de la compagnie Aviation Electric Ltd et le concours de la compagnie Aéro Photo Inc. qui à aussi installé un exhibit, a attiré 40 personnes venant de différentes régions de la Province.

En septembre, le cours sur la télédétection organisé par le CCRS et donné à Vanier, Ont. avec visites au Mont-Tremblant et à Ste-Scholastique, a attiré six (6) participants du Québec. Ces participants étaient les suivants:

- M. Jean Beaubien, Centre de Recherches Forestières Laurentides 643-3683
- M.J.-L. Bélair, Centre de Recherches Forestières Laurentides 643-3683
- M. Jean-Guy Bernier, ministère des Communications 643-5395
- M. Claude Desloges, Gauthier, Poulin, Thériault & Associés 681-0001
- M. Douglas Heyland, ministère du Tourisme, de la Chasse et de la Pêche 643-4040
- M. Reynald Letarte, ministère des Terres et Forêts 643-4400

Une conférence sur "La Pollution de l'Environnement et la Télédétection" fut donnée à l'Université Laval par le Dr A. Kokline au mois de novembre.

Un centre de télédétection: Des efforts considérables ont été déployés pour former un centre de télédétection. Cet organisme doit s'occuper de faire la promotion et la coordination des projets, de créer une banque de données, ainsi que de rechercher et fournir des méthodes avancées, de faire l'interprétation d'images de télédétection aérienne et spatiale, adaptée à nos régions. Le résultat de ces efforts ne s'est pas encore matérialisé.

D'une façon provisoire et grâce à l'initiative du CCRS, le programme fédéral des "travaux d'hiver" a accordé des subsides pour l'installation d'un centre de télédétection. Le Département de Photogrammétrie de la Faculté de Foresterie et de Géodésie de l'Université Laval, vient d'être choisi comme centre régional de la télédétection pour la province de Québec. La durée du contrat est de quatre (4) mois et se termine le 31 mai 1973.

Il importe donc maintenant de réexaminer la situation pour déterminer quelle sera la suite réservée à ce centre de télédétection.

6.8.4 Etas des projets actuels

Projets soumis au CCRS: Les projets de télédétection réalisés au Québec furent au-delà de treize (13). De ce nombre, cinq (5) ont été soumis au CCRS avec la collaboration du coordinnateur et un seul a été refusé (le territoire étant hors du rayon d'action des avions du CCRS). Parmi ceux-ci, l'on peut mentionner les projets suivants:

Un projet de collection des données hydro-météorologiques en se servant du satellite "ERTS-1": L'expérience se poursuit et les résultats sont très encourageants. Il est aussi proposé de poursuivre le projet avec "ERTS-B" lorsqu'il sera lancé.

Un projet d'inventaire forestier: Les photos aériennes ont été reçues très récemment, ainsi que seulement quelques images de ERTS. Cependant, des photos aériennes préliminaires ont révélédes phénomènes qui rendent l'interprétation difficile, telle une surintensité centrale "Hot Spot", des différences de teintes entre les différents rouleaux de film IR couleur, etc... Il est cependant possible d'identifier certaines caractéristiques recherchées et nécessaires poour le travail.

Un projet en Agriculture: Ce projet consistait à identifier des épidémies de nainisme Jaune de l'orge ou "BYDV" (Barley Yellow Dwarf Virus). Cependant, les épidémies ne se sont pas produites...ou très peu! L'on a pu relever des endroits légèrement affectés. L'on a aussi déterminé que la meilleur échelle à utiliser était de 1:4000 sur format de 9" x 9" en transparent. L'on a de plus observé des effets de drainages déficients dans des cultures de mais et autre céréales. L'on a aussi réalisé que les phénomènes mentionnés plus haut, surintensité centrale (Hot Spot), etc..., réduisaient les possibilités d'interprétation. L'on croit que la distance focale, l'ouverture des lentilles et les filtres devraient être revisés de façon à éviter au moins cet effet de surintensité centrale. L'on a aussi mis au point une boîte lumineuse portative (en auto) pour lire les rouleaux de films transparents et il semble que ce soit très utile, car les transparents contiennent plus d'informations que les photos sur papier!

Les projets de CENTREAU: Des projets ont été exécutés au Centre de Recherches sur l'eau (CENTREAU) à l'université Laval. En Appendice 4, au paragraph #2, l'on trouvera l'énoncé des projets en cours.

Autres projets: Une étude sur l'utilisation d,une caméra de télévision, installée a bord d'un avion léger et permettant d'identifier certains groupements forestiers, a débuté récemment. Cette étude permettra de déterminer le type de caméra, de lentille, de magnétoscope et de moniteur nécessaires pour réaliser certains travaux.

Au Département de Photogrammétrie de la Faculté de Foresterie et de Géodésie de l' Université Laval, une étude a été réalisée et a pour titre "L'avenir de l'Inventaire des Ressources et de la Conservation de l'Environnement par la Télédétection" (par Dr A. Kokline).

La conclusion est que le Centre de Recherches sur la Cartographie des Ressources (C.R.C.R.), un organisme projeté, devrait aussi comporter l'aspect télédétection. Les résolutions appropriées seront étudiées sous peu par les autorités de l'université.

Il est intéressant de noter qu'une compagnie privée à Québec (Aéro Photo Inc.) qui a fait ses propres relevés, a obtenu des résultats très satisfaisants d,études de plumes de pollution thermique dans les equx du St. Laurent. La résolution des courbes isothermiques fut de l'order de 0.5 degrés C. La bande 3.7 à 5.5 microns et l'altitude fut de 1,000 pieds et plus.

6.8.5 Pronostics des Activites et des Projets pour 1973

Un Centre de Télédétection: Le centre (temporaire) de télédétection à l'Université Laval, comprendra dix (10) personnes. Les disciplines envisagées au début porteront principalement sur la géologie, la géographie, l'hydologie et l'écologie bien que des conseillers sont aussi prévus pour répondre aux questions dans d'autres disciplines.

La formation de ce centre tombe à point, car actuellement, plusieurs personnes ont été contactées vis-à-vis leurs besoins en télédétection. Dans un grand nombre de cas, le besoin immédiat est d'enseigner à certaines personnes ce que c'est que la télédétection et qu'est-ce que celà peut faire pour solutionner leurs problèmes. Une façon de faire serait d'organiser des rencontres sur des bases locales et régionales. Il est proposé d'étudier l'organisation d'un contre régional de télédétection pour faire suite au projet temporaire actuel.

Seminaire: Il est proposé de tenir au moins une journée d'information et de mist à jour pour les personnes avancées en télédétection. Ceci pourrait se faire conjointement avec une université et le CCRS, de préférence à Québec.

Etudes de Programmes Futurs: Il est proposé d'étudier les possibilités des programmes futurs en télédétection tels que ERTS-B, C, Skylab, etc..., et de voir quels ministères ou organismes pourraient bénéficier le plus d'une participation à ces expériences.

Projets 1973: Parmi les projets conçus pour l'année 1973, l'on peut mentionner les suivants:

-Projets soumis par le ministère de Tourisme, de la Chasse et de la Pêche, Service de la Faune, M.J.-D. Heyland:

Expérience de différentes combinaisons films/filtres devant être utilisés pour la détection et une définition détaillée de plusieurs espèces de sauvagines ainsi que de certains mammifères et du Saumon de l'Atrantique.

Mise au point de techniques électroniques et photographiques pour l'interprétation des différents habitats de la faune sauvage (photo enhancement). De nouvelles techniques sont aussi requises pour une meilleure interprétation des photographies des populations animales prises pour un inventaire (photo enhancement). Exemple: séparer les classes d' âge chez les espèces où cette séparation se fait à l'aide du dimorphisme des couleurs.

Essai de plusieurs instruments et techniques pour le dénombrement des animaux sur une photographie verticale.

Interprétation des images ERTS et des photographies à petite échelle des habitats de plusieurs districts dans la Province. Ces interprétations devant être faites en regard de la distribution des populations animales, par exemple: quelle est la relation entre l'habitat et la distribution du caribou sur la Côte-Nord et le Labrador.

Projets soumis par le ministère des Richesses Naturelles, Hydrométéorologie, M.R. Perrier:

A court terme, les services de Météorologie et h'Hydrométrie poursuivent les travaux actuellement en cours à la station de Duchesnay où une plate-forme est utilisée pour transmettre des données hydrométriques, nivométriques et météorologiques via le satellite ERTS-A. Actuellement des formules d'application sont remplies afin que ce programme se poursuive à l'aide du satellite ERTS-B au moment du lancement de ce dernier.

A long terme, l'intérêt est de connaître l'épaisseur et l'équivalent d'eau sur les bassins versants des rivières situées en territoire inhabité. A cette fin, l'on croit qu'il sera possible, dans un avenir rapproché, d'interpréter certains types de photos à l'aide de satellites pour évaluer l'épaisseur et l'équivalent d'eau du manteau nival. Bien que ceci ne fasse pas l'objet d'un projet précis, l'on songe à entreprendre une étude dans ce sens avec le Centre de Recherches sur l'eau de l'Université Laval. Concurremment, la connaissance de certaines variables limnologiques pourrait être obtenue en utilisant les techniques de télédétection et c'est pourquoi un projet a été entrepris en collaboration avec Centreau.

Projets soumis par le ministère des Richesses Naturelles, Services Géologiques, Dr. A.-F. Laurin:

En général, les professionnels sont grandement intéressés à utiliser les photos aériennes prises à haute altitude, soit en noir et blanc ou en couleur, afin de délimiter de facon plus précise les grands accidents majeurs de la croûte terrestre, c'est-à-dire, failles, diaclases, limites entre provinces géologiques, etc.

De plus, le service de Géotechnique est intéressé à obtenir des photographies aériennes de divers types pour l'étude régionale de sglissements de terrain. Ce service utilise présentement les photos noir et blanc disponibles à la photothèque provinciale, toutefois, il pourrait utiliser avec profit les types suivants:

(a) infra-rouge noir et blanc - échelle 1320' au pouce pour la région des Basses-Terres du St-Laurent (incluant Saguenay - Lac St-Jean) et une fois les secteurs-cibles définis, il pourrait utiliser:

(b) infra-rouge couleur - échelle 1/40,000 - pour les Basses-Terres du St-Laurent;

(c) infra-rouge couleur - très haute altitude (satellite);

(d) photos couleurs normales et fausses couleurs dans certains secteurs des Basses-Terres; les échelles seraient déterminées en fonction du secteur étudié;

(e) photos Radar (SLAR) de certains secteurs spécifiques.

Projets soumis par le ministère des Terres et Forêts, Inventaire Forestier, M. P.-H. Tremblay:

Vu que les projets de 1972 ne sont pas encore complétés dû à l'arrivée tardive des photos aériennes et spatiales, il est nécessaire de poursuivre, de terminer et de tirer toutes les conclusions possibles de ces études avant d'élaborer un nouveau programme de recherches en télédétection.

Projets soumis par le ministère de l'Agriculture et de la Colonisation, M.R. Raymond:

Organiser des cours ou des conférences d'information pour débutants en télédétection.

Organiser des sessions d'étude ou séminaires pour faire le point de l'avancement des sciences de la télédétection (pour les personnes plus avancées dans le domaine).

Projets soumis par le ministère des Affaires Municipales, Hygiène du Milieu, M.R. Moisan:

Leurs projets sont semblables à ceux du MAC (paragraphe

M. Moisan me mentionne ce qui suit: "Nous ferons l'acquisition, en 1973, d'un système de télémétrie qui nous fournira rapidement des données précises sur les niveaux de pollution atmosphérique dans la région de Montréal. Les polluants étudiés seront: les poussières, le CO, le SO_2, les hydrocarbures, les oxydants et les oxydes d'azote. Les données que nous posséderons grâce à ce réseau de détection de la pollution pourraient certainement servir à l'interprétation des données qui peuvent être transmises par satellite ou par autres moyens de télédétection".

Projets soumis par CENTREAU de l'Université Laval, Dr. A. Soucy:

On trouvera en Appendice 4, aux paragraphes 3 et 4, une description de ces projets.

Projets soumis par l'Université de Montréal, Ecole Polytechnique, Dr. M. Tanguay

Les projets de 1973 seront la continuation de ceaux commencés en 1972.

- Rehaussement d'images (Photo enhancement) par filtrage optique.

- Etude de réflectance spectrale de roches, laves, etc.

- Développement d'un senseur dans la bande de l'ultraviolet.

Il existe aussi d,autres projets qui seront soumis plus tard par d'autres universités québécoises.

6.8.6 Problemes Majeurs et Recommendations pour Amelioration

Délai des photos ERTS: Les délais de livraison des photos de ERTS ont causé des problèmes et devraient être améliorés.

"Hot Spot": La correction de la surintensité centrale ("Hot Spot"), dans la prise de certaines photos, devrait être réglée. Ce problème a déjà été étudié dans le passé lors d'expériences au lac Ontario réalisées par le Dr Allan Falconer de l'Université de Guelph en Ontario pour le compte de la NASA. Des facteurs de correction ainsi que des équations ont été établies pour tenir compte de cet effet de coussin. Réf.: "Simulation Studies of ERTS-A & B Data for Hydrologic Studies in the Lake Ontario Basin" by J. MacDonald, A. Falconer and K.-P.-B. Thomson, conférence présentée lors du "4th Annual Earth Resources Program Review", M.S.C./NASA, Houston, Tex. - Jan. 1972. Un soin pour emeliorer l'uniformité des couleurs avec les films IR couleur est aussi recommandé.

Délai d'information: De l'information rapide sur les projets aériens et spatiaux demandés concernant une province, devrait être fournie au coordinnateur de cette province le plut tôt possible de façon à faciliter son travail.

Information sur d'autres projets: Une information, la plus complète possible, sur les projets ERTS-B, Skylab, NOAA, etc... devrait être fournie aux coordonnateurs pour en assurer l'étude et la diffusion efficace. On pourrait aussi en parler dans le bulletin de nouvelles "Télédétection au Canada"!

Centre régional: La formation à Québec d'un centre régional de coordination et de recherche en interprétation de données de télédétection, devrait être encouragée et par le gouvernement provincial et par le gouvernement fédéral. Ce centre ferait suite au centre temporaire organisé preésentement à l'Université Laval par le CCRS.

APPENDICE 1

COMITE QUEBECOIS DE LA PERCEPTION A DISTANCE (C.Q.P.D.) AU 4 JANVIER 1973

Arsenault, André Ingénieur - Service Technique de la Circulation, Ministère de la Voirie, Boulevard Pierre-Bertrand, Charlesbourg-Ouest, Qué. - 643-6702

Belzile, Marcel, Agronome - Coordonnateur provincial, Inventaire Canadien des Terres, Office de Planification et de Développement du Québec, Hôtel du Gouvernement, Québec. 643-8780 (En stage d'études à L'Université Laval, utiliser son adresse résidentielle - 656-1886) - Résidence: 774, Le Payeur, Ste-Foy, Qué.

Bernier, Jean-Guy, Ingénieur - Ministère des Communications, Direction des Etudes T Techniques, Service de la Radiocommunication, Complexe "G" - 5ième étage, Cité Parlementaire, Québec 4, Qué. - 643-5395

Hendler, Mortimer, Ingénieur - Directeur des Services Hydrométéorologiques, Ministère des Richesses Naturelles, 1640, Boulevard de l'Entente, Ch. 323, Québec 6, Qué. 643-4563

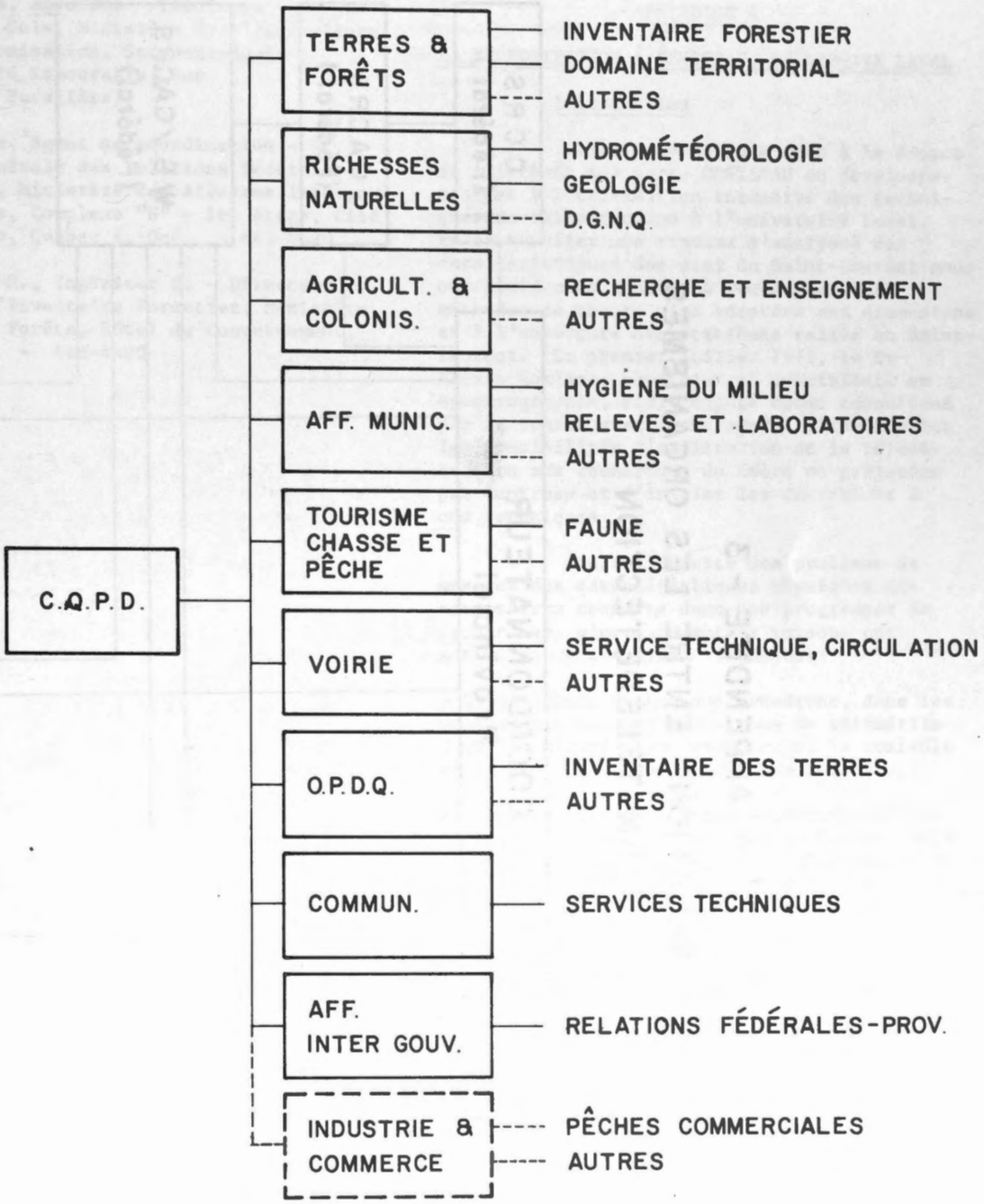
Heyland, Douglas, Biologiste - Service de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche, Edifice de la Faune, Casier postal 7276, Québec 7, Qué. - 643-4040

Laurin, Dr André - Directeur de Services Géologiques, Ministère des Richesses Naturelles, 1620, Boulevard de l'Entente, Québec 6, Qué. - 643-4606

Moisan, Raymond, Ingénieur - Adjoint du Directeur, Hygiène du Milieu, Services de Protection de l'Environnement, Ministère des Affaires Municipales, Edifice "D" - 3ième étage, Cité Parlementaire, Québec 4, Qué. 643-6440

Page, Yves-L., Ingénieur M. Sc. - Service des Relevés et des Laboratoires, Services de Protection de l'Environnement, Ministère des Affaires Municipales, Edifice "D" - Chambre 404, Cité Parlementaire, Québec 4, Qué. 643-2006

Poulin, Jean-Noel, Ingénieur f. - Arpenteur g. - Directeur général du Domaine Territorial, Ministère des Terres & Forêts, 200, Chemin Ste-Foy, Québec 6, Qué. 643-7410



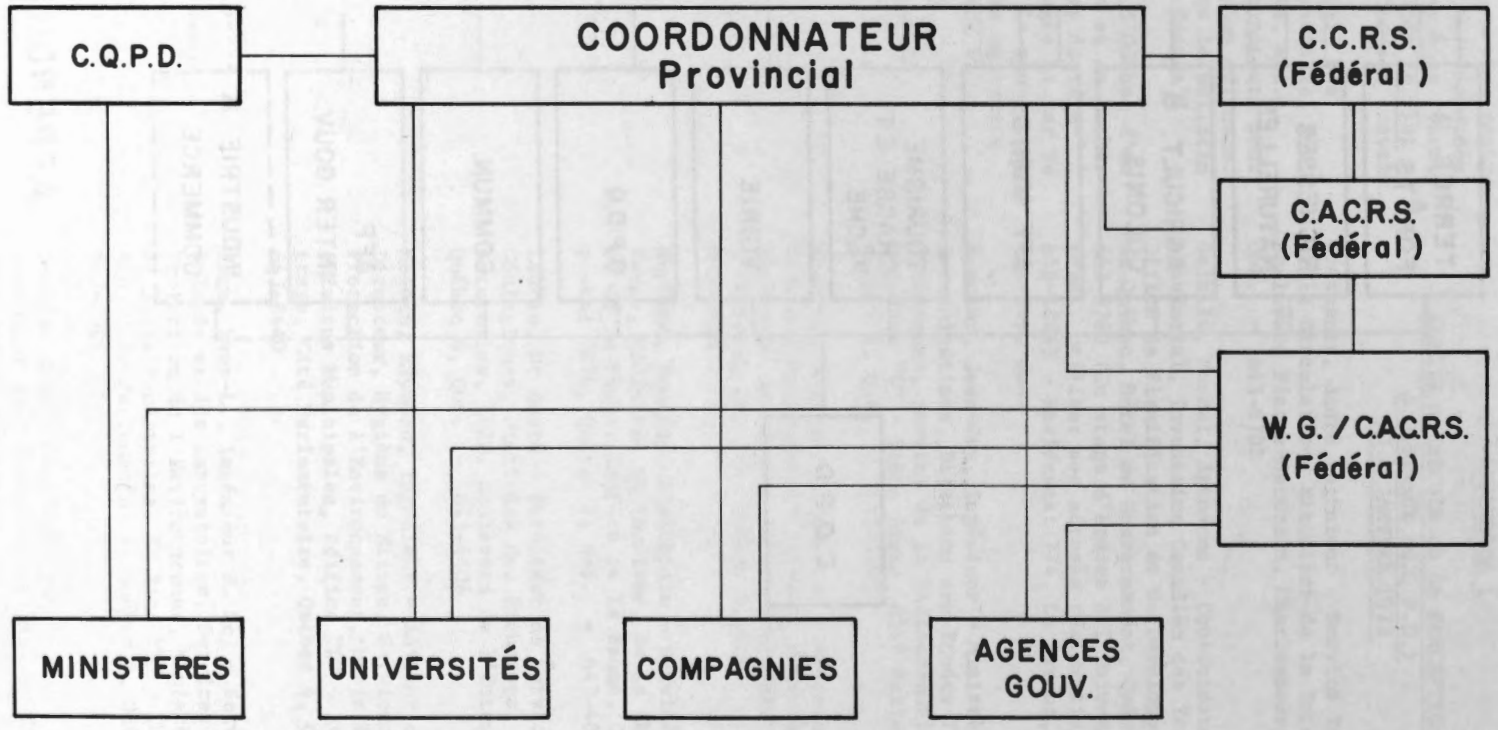
APPENDICE - 2

LES GROUPES SUPPORTANT LE C.Q.P.D.

——— PRÉSENT FUTUR --------

APPENDICE - 3

LES RELATIONS ENTRE LES ORGANISMES EN TÉLÉDETECTION



Raymond, René, Agronome - Pédologue - Division des Sols, Ministère de l'Agriculture et de la Colonisation, Ste-Anne-de-la-Pocatière, Cté Kamouraska, Qué. 856-1110 (La Pocatière)

Taillon, Jean, Agent de coordination - Direction générale des Relations Fédérales - Provinciales, Ministère des Affaires Intergouvernementales, Complexe "H" - 1er étage, Cité Parlementaire, Québec 4, Qué. - 643-8690

Tremblay, P.-H., Ingénieur f. - Directeur du Service de l'Inventaire Forestier, Ministère des Terres & Forêts, Hôtel du Gouvernement, Québec, Qué. - 643-4400

APPENDICE 4

LA TELEDETECTION A CENTREAU, UNIVERSITE LAVAL

Introduction

Plusieurs raisons sont à la source de l'intérêt que porte CENTREAU au développement et à l'utilisation intensive des techniques de télédétection à l'université Laval. En particulier nos travaux d'analyses des caractéristiques des eaux du Saint-Laurent nous ont rapidement conduit à rechercher des méthodes de mesure plus adaptées aux dimensions et à l'envergure des problèmes reliés au Saint-Laurent. Le premier juillet 1971, le Dr Alexis Kokline, physicien et spécialiste en spectrographie, était engagé comme consultant par le centre avec comme mandat d'inventorier les possibilités d'application de la télédétection aux recherches en cours ou projetées par Centreau et d'initier les chercheurs à ces techniques.

Outre l'acuité des prolémes de mesures des caractéristiques physiques des territoires couverts dans nos programmes de recherches, plusieurs autres raisons ont motivé notre décision. Signalons:

- l'importance énorme que prendront, dans les années futures, ces techniques de télémétrie dans l'évaluation des ressources, le contrôle et la protection de l'environnement, etc.;

- l'inexistence de centres universitaires ou d'organismes gouvernementaux, au Québec, déjà engagés à fond, soit dans le développement de nouvelles techniques, soit dans l'utilisation intensive des techniques existantes.

- les besoins, similaires à ceux de CENTREAU, pressentis par d'autres groupes de chercheurs de l'université tels le Centre du recherches en aménagement et développement du territoire (CRAD), le Centre d,études nordiques, etc.;

- l'existence de facilités techniques importantes pour la restitution et l'interprétation photographique, de même qu'un personnel hautement spécialisé, au département de photogrammétrie de la faculté de Foresterie et Géodisie;

- etc.

Depuis lors, différents projets ont été formulés, dont quelques-uns déjà en opération. Nous verrons dans les pages qui suivent les grandes lignes de ce programme de recherches axé sur la télédétection.

1. L'information des chercheurs

La mesure de paramètres physiques au moyen de vecteurs aéroportés étant relativement nouvelle, à l'exception des techniques classiques, peut-on dire, de cartographie topographique, le premier jalon à poser a été de faire une revue de la littérature dans ce domaine, d'établir des rapports avec les organismes y oeuvrant déjà, de participer aux congrès, colloques, séminaires, etc., et finalement d'en informer les chercheurs susceptibles de former le premier noyau d'une équipe multidisciplinaire.

Sans prétendre posséder une documentation complète sur le sujet, nous pouvons toutefois compter sur de nombreux documents de base, tant sur les techniques d'avant-garde utilisées en télédétection que sur les résultats, méthodes d'analyse, et interprétations de ces techniques.

2. Projets en cours

Mesure des concentrations de suspensides dans l'eau - Ce projet, sous la responsabilité de messieurs Marcel Frenette du département de Génie civil et Gilles Ladouceur du département de Photogrammétrie, consiste à déterminer les concentrations de suspensoides dans l'eau par télédétection. L'étude densitométrique de photographies panchromatiques s'est révélée très valable pour des concentrations inférieures à 40 mg/l, soit de l'ordre des plus fortes concentrations retrouvées dans le fleuve. On prévoit cette année étendre la précision de cette méthode de mesure par analyse multispectrale dans le proche infrarouge.

Analyse des données de ERTS sur le Saint-Laurent - Sous contrat avec le ministère de l'Environnement du Canada, nous devons cette étude établir:

- les corrélations qui peuvent exister entre les données transmises par satellite (ERTS) et les résultats accumulées jusqu'à maintenant sur la qualité de l'eau du Saint-Laurent, en particulier pour les lacs Saint-Pierre et Saint-Louis. Plus d'une cinquantaine de paramètres (couleur, turbidité, etc.) ont été compilés et il est probable qu'on puisse relier les variations spatio-temporelles de ces paramètres aux variations densitométriques de l'imagerie de ERTS sur le Saint-Laurent;

- les informations qui peuvent en être tirer quant à l'utilisation du territoire, la couverture nivale, la formation de la glace sur le fleuve, les courants thermiques, etc.

Responsable: A. Kokline
Assistant: J. P. Magnan, physicien
Collaborateurs: Peter Clibbon (géographie)
Marcel Frenette (génie civil)
Victorin Lavoie (agriculture)
et autres.

3. Projets soumis pour financement

Détermination des zones de végétation aquatique et riparienne par l'analyse multispectrale - Par analyse multispectrale (entre .38 et 4.5$_h$), par thermographie (1.35 à 4.5$_h$) et par photographie dans le proche infrarouge (.7 à 1.35$_h$) nous espérons pouvoir mettre au point une méthodologie susceptible de nous procurer à moindre effort des informations pertinentes sur la végétation du littoral du Saint-Laurent.

Outre M. Kokline, ce projet s'appuie principalement sur la collaboration de MM. Héroux (faculté de Foresterie et Géodésie), Lavoie (faculté des Sciences de l'agriculture et de l'alimentation) et Bernard (biologiste à CENTREAU).

Etude de la "signature spectrale" des polluants dans l'eau du Saint-Laurent - Ce projet se divise en deux parties:
(a) analyse multispecrale de chacun des éléments identifiés dans nos analyses de la qualité de l'eau du Saint-Laurent, àdes concentrations voisines de celles rencontrées en nature;
(b) addition dans la solution, de traceurs qui, par addition ou soustraction de certaines bandes de fréquences propres aux caractéristiques des traceurs, augmenteront la sensibilité de la mesure des polluants.

Cette étude groupera tous les chercheurs du centre qui ont été amenés jusqu'à maintenant à effectuer des analyses des caractéristiques des eaux du Saint-Laurent (MM. Gubeli, Barbeau, Frenette, Ouellet, Verrette, etc.), en plus de M. Kokline.

Etude de la diffusion par télédétection - Les caractéristiques physico-chimiques des eaux des tributaires du Saint-Laurent sont en général fort différentes de celles du Saint-Laurent, de sorte que les données qui pourraient nous être fournies par le Centre canadien de télédétection, devraient nous permettre de définir la zone de mélange de ces eaux. Nous envisageons également l'utilisation de traceurs facilement repérables par télédétection. Cette étude sur la diffusion se fera probablement à partir de la rivière Saint-Maurice et intéressera plus spécifiquement M. Jean-Louis Verrette du département de Génie civil en collaboration avec M. A. Kokline.

4. Projets en cours d'élaboration - Plusieurs projets sont actuellement ébauchés et verront jour à la fin de la présente année ou au cours de l'année 1974-75. Mentionnons principalement:

Mesure du drainage des sols par thermographie- Responsable: M. Gilbert Sylvestre de la faculté des sciences agricoles et de l'alimentation.

Etude de l'eutrophisation des lacs par télédétection - Mesure de paramètres hydrodynamiques, et des variations spatio-temporelles du plancton et de la végétation aquatique; identification des sources de pollution.
Responsables: MM. José Llamas (Département de Génie civil); André Cardinal (Département de Biologie).

Etude de la couverture nivale du Nouveau-Québec par la méthode SLAR en fonction de la distribution de la végétation - Responsable: M. Serge Paillette de la faculté de Foresterie et de Géodésie.

Mesure de la salinité de l'estuaire du Saint-Laurent par Lidar - Responsable: M. Yvon Ouellet (Département de Génie civil).

Etude de la structure et mesure de la résistivité de certaines formations géologiques par la thermographie - Responsable: M. Vladimir Hucka, (Département de Mines et métallurgie).

Cette liste non exhaustive pourrait également comprendre des projets sur le dépistage et le contrôle de la "tordeuse des bourgeons de l'épinette", sur la détection des nappes d'huile, etc.

5. Conclusion

Ce rapide tour d'horizon de l'intérêt manifesté par les chercheurs, pour le développement des utilisations de la télédétection et des techniques qui y sont reliées, ne comprend pas l'effort que déploient dans le même sens d'autres groupes tels le département de génie électrique, sous l'impulsion de M. Martin Fournier, ou le département de photogrammétrie sous la direction de M. Arthur J. Brandenberger. Il va sans dire que devant une telle situation, on peut prévoir queles recherches déjà initiées dans ce domaine ne sont qu'un début à une suite importante de programmes de recherche.

L'ampleur de ces programmes est largement conditionnéé cependant par des contraintes externes: développement d'organismes gouvernementaux intéressés directement à ces aspects, soutien financier des organismes de subvention, soutien technique du Centre canadien de télédétection, etc.

A ces contraintes doit également s'ajouter un morcellement des efforts des différentes équipes de chercheurs intéressés à ces questions à l'Université Laval, ce qui diminue d'autant la portée et l'efficacité des recherches entreprises.

Nous sommes toutfois confiants de l'expansion rapide de ce secteur de recherche. Centreau, pour sa part n'aspire qu'à apporter sa contribution et sa collaboration à tout démarche vouée au succés de cette entreprise.

6.9 SASKATCHEWAN PROVINCIAL CO-ORDINATOR'S REPORT

6.9.1 Reports and discussion on the Aircraft Programme of the Canada Centre for Remote Sensing. In general, most people felt that the program had merit, but was still suffering from 'birth pangs'.

(a) There were a number of instances where we were unable to get photography at all or it was taken at a time which was not useful (i.e. certain crop stages are critical, ground truthing of certain items has a short life span, etc.).

(b) There were a number of instances in which ground truth sites were missed by one or more flights, or where portions of a project were missed.

(c) The 'turn around' time was unacceptable at times and very inconvenient at others.

(d) Some of the photography was of inferior quality.

(e) There were instances where a part of the multispectral photograpy was taken one day and part the next; this intensified the correlation problem.

(f) In some cases the scale proved to be unsuitable.

(g) Liaison between the Canada Centre, the flight crew and the prime investigators ranged from marginal to non-existent.

The general opinion seemed to be that the above problems seemed to nullify much of the value of the program. We recognize that Canada Centre was given a very short gestation period and it is not at all surprising that problems have arisen. We hope that we can somehow solve most or all of these prior to the 1973 season.

6.9.2 A number of agencies indicated plans, some tentative, to request flights in the 1973 seasons:

(a) Quill Lake Area - Saskatchewan Research Council.

(b) Meadow Lake Area - University of Saskatchewan, Saskatoon, Geography Dept.

(c) Humboldt-Basin Area - University of Saskatchewan, Saskatoon, Biology Dept.

(d) North and South Saskatchewan Rivers - University of Saskatchewan, Saskatoon, College of Engineering.

(e) Waskesiu-Wollaston Area - University of Saskatchewan, Saskatoon, Geology Dept.

(f) Dempster Highway - University of Saskatchewan, Saskatoon, College of Engineering.

(g) Potash Belt and Rosetown Area - Saskatchewan Institute of Pedology.

6.9.3 A number of investigators have placed standing orders for ERTS imagery. In most cases, these are for preliminary evaluation of techniques. One investigator, Dr. R.G. Arnold of Saskatchewan Research Council, reports that non-delivery of ERTS imagery standing order for NTS map sheets 63M and 73P is hampering the planning of 1973 Summer field work.

7. REPORTS OF SPECIALTY CENTRES

7.1 Canada Centre for Inland Waters

7.2 Forest Management Institute

7.3 Remote Sensing & Instrumentation Section, Glaciology Division

7.1 CANADA CENTRE FOR INLAND WATERS

Canada Centre for Inland Waters is designated by the Inland Waters Directorate, as a remote sensing speciality centre for lake studies. CCIW's remote sensing program is now in its seventh year and involves a full time staff of 5 people. A full account of CCIW Remote Sensing Program is included in the Limnology Working Group's Annual Report. The Program includes both operational and research aspects of remote sensing.

Infrared line scanner and multiband photographic surveys of the Great Lakes have been a main part of the program. Most of these surveys have been carried out in conjunction with other CCIW Limnology programs. However, in some cases, studies have been undertaken for other agencies, ie. studies on Lake Memphremagog and Lake of the Woods, thermal effluent studies on Lake Ontario.

In the past year, there was considerable demand for remote sensing support for other CCIW IFYGL programs.

During 1972, two full time staff members were assigned to the ERTS program. Our ERTS program is now well established and automated. Photo-interpretation of ERTS data tapes is planned for the near future. As well as our interest in ERTS, CCIW is one of the few Canadian agencies to have a SKYLAB contact. Coincident with the Satellite program, a number of successful data retransmission experiments have been carried out during the past year.

As well as our regular remote sensing program, CCIW has been, or will be, involved with a number of sensor development trials and evaluations. They include: the measurement of surface chlorophyl by airborne spectroscopic techniques (CRESS York University, and NASA-Lewis), the development of underwater lidar techniques for limnological studies (Dr. Carswell, York University, under contract).

In addition, a total of six studies for the interpretation of ERTS-1 data for lake research were contracted during the latter part of 1972.

Finally, in keeping with our mandate as a specialty center, CCIW will be host for an international Symposium on the remote sensing of Water Resources sponsored by the American Water Resources Association on June 11 - 14, 1973, in Burlington.

7.2 STATUS OF REMOTE SENSING STUDIES IN THE FOREST MANAGEMENT INSTITUTE, CANADIAN FORESTRY SERVICE, OTTAWA

The Institute's remote sensing studies evaluate new developments in this field for their usefulness in forestry applications, and devise operational procedures for such applications. The new developments currently being evaluated include satellite photography (ERTS), thermal and radar scanners, high-altitude photography, image slicing and enhancement, and new uses of more conventional photography. Results of the studies are made available through publications and Institute-sponsored training seminars. This report outlines the current status of of the studies.

7.2.1 ERTS Experiments

The Institute has two functions related to ERTS: one is to co-ordinate all ERTS experiments of the Canadian Forestry Service, the other is to conduct such experiments. The goal of these experiments is to determine the usefulness of ERTS imagery, which is received in several wave-bands, in broad vegetation mapping, analysis of land conditions, assessment of human conditions in the forest, detection of forest damage and insect outbreaks, and in estimating areas logged or burned. In each experiment, the objectives are defined, the test area is selected and documented, and the value of ERTS imagery in meeting the objectives is assessed. A general lack of suitable imagery has delayed the completion of the experiments, but preliminary results show the ERTS imagery can be used to separate some vegetation types, to delineate broad physiographic land units, to distinguish clear from sediment-laden water, and to identify strip-logging, burned areas, roads, power-lines, bridges, ski-slopes and power dams.

7.2.2 High-altitude Photography

At a scale of about 1:150,000, the photography may be useful in broad forest classifications, in separation of species groups, in the evaluation of ERTS imagery and, with sequential photography, in monitoring area changes and logging operations. Findings to-date indicate that colour-infrared photos permit broad forest classifications, separation of coniferous, deciduous and mixed forests, and identification of common forest associations.

7.2.3 Infrared Line-scan Imagery

This imagery, in the 3-5 micron range, records the heat that objects release. Apart from the obvious use in forest fire detection, it could be useful to describe forest sites, to identify species, and to detect and appraise insect and disease damage in forests. Investigations so far have shown the imagery to be useful in recording sites of cooler microclimate and to detect moisture stresses in trees.

7.2.4 SLAR Imagery

Side Looking Airborne Radar (SLAR) differs from other systems in that radiation is emitted as well as received. The radiation can penetrate cloud and rain and, at the longer wavelenghts, snow and foliage. At present, only low-quality imagery is available, at scales ranging from 1:200,000 to 1:1,000,000. It has potential for delineation of geomorphic features and, by inference, of vegetation. Also, a fairly accurate separation of forest, swamp, agricultural land and water can be made where the terrain is level. The utility of SLAR imagery for forestry purposes depend largely on the availability of systems of higher resolution, which are presently available to the military only.

7.2.5 Forest Damage Assessment

The usefulness of different types of film has been investigated, including black and white, normal colour, colour-infrared, and black and white infrared. Colour-infrared has been found particularly useful in delineating damage levels due to biotic (spruce budworm, fomes annosus and balsam woolly aphid), and abiotic (SO_2) agents. The value of different scales of photography in damage assessment has also been investigated.

7.2.6 Image Enhancement

Two techniques are under investigation: in one, small variations in grey shades or dye layers are isolated and assigned colours to make the differences more apparent. This type of image enhancement can be achieved either electronically (Digicol system) or photographically (Agfa-contour film). In the other, imagery obtained at different wave-lengths are assigned colours and subsequently combined. A "Colour Additive Viewer" is on order for this purpose. This technique is particularly well suited to interpretation of ERTS imagery. Both techniques are designed to make photo-interpretation more efficient and to increase the amount of information extracted from the images. Depending on the scale of photography, the techniques can be used to distinguish individual species or vegetation types, separate forest from non-forest land, or to delineate boundaries.

7.2.7 Related Studies

The Institute is conducting several other studies which make use of remote sensing data. In one study, the use of large-scale aerial photography (LSP) in forest inventories is explored. At present, efforts are concentrated on the development of sampling designs for such inventories, and on a photographic system yielding consistently acceptable LSP.

Another study deals with the establishment of criteria for quantitative evaluation of images, and automatic interpretation of forest types.

In support of the ERTS experiments, a mathematical approach to pattern recognition is being studied. Tests are concentrated on those key parameters which can be used to identify objects on ERTS imagery by textures and spatial variations. Initial results indicate that serial correlation patterns differ for treed muskeg, open muskeg, coniferous forest, ice, and water.

Last, a bio-physical approach to land classification is being developed. Remote sensing data from different wave-bands is used extensively. Geological and vegetation features are used to produce a classification suitable for integrated resource evaluation.

7.3 REPORT OF THE REMOTE SENSING AND INSTRUMENTATION SECTION, GLACIOLOGY DIVISION, WATER RESOURCES BRANCH, DOE

The remote sensing part of this Section consists of 4 professional and technical personnel. During 1972, their efforts were directed towards remote sensing projects in support of glaciology, hydrology and water quality programs as follows:

7.3.1 Educational Leave

Mr. A.C.D. Terroux attended the graduate program in Remote Sensing at the University of Michigan, Ann Arbor. He was one of the first students registered for this interdisciplinary Master's program. The courses were in the fields of hydrology and

7.3.1 Con't

meteorology, as well as in the physics of remote sensing. Mr. Terroux chose for his thesis topic "An Investigation of Snow-pack around the Melting Point with Thermal Infra-Red Sensors". The thesis will be completed in 1973.

7.3.2 Instrumentation

Mr. H. Gross has been assisting Dr. A.R. Davis of Water Quality Branch with design, assembly and testing of a laser fluorometer for detecting heavy oil and other fluorescent targets from the air. The first flights to demonstrate successful operation of the instrument were carried out during the week of February 11, 1973. Developments and testing will be continued to make this an operational tool for pollution monitoring.

7.3.3 Analysis of Ice Jam Characteristics and Stream Flows on the Mackenzie

Velocity profiles from cour IR photography were prepared using a Wild A7 stereo plotter with ice flows, foam and sediment as tracers. These were compared with monocular plots of ice flow positions. Ice block sizes and orientations in the navigation channels are being prepared.

The purpose of these studies is to evaluate the possibility of monitoring the changes in the stream bed resulting from ice jamming, ice scour, flooding and engineering structures.

7.3.4 Co-ordination and Services to ERTS DCS Users

The section has been responsible for contact between CCRS and the ERTS DCS users. This has involved determination of the requirements of the users, duplication and mailing of teletype data while the CCRS data handling program was being implemented, and instruction and assistance to the DCS users in obtaining their data from CCRS.

7.3.5 Management of ERTS Image Evaluation Contracts

Four studies are being funded to evaluate the information content of ERTS images for hydrologic purposes. The largest problem in all studies has been to obtain the required images for the contractors. The following describes briefly the studies funded:

(a) Evaluation of ERTS-A imagery for the interpretation of snow cover.

This study, being carried out by Dr. P. Howarth of McMaster University and CARED, will focus on the problems of identifying snow cover from ERTS imagery and mapping of, as far as possible, in Southern Ontario. Dr. Howarth has requested also airborne coverage simultaneous with the dates of ERTS overflights. The results of the natural gamma attenuation studies and ground truth programs will also be available for this investigation.

The best imagery available for this study will probably be the quick-look results from PASS for February 17 and 18.

(b) Evaluation of ERTS-A imagery for hydrologic mapping.

This is another program carried out by Dr. Howarth. It will concentrate on mapping selected drainage systems. Suitable imagery was not available from CCRS because the Prince Albert receiver was down on the only pass of the autumn when there was no cloud over the area of interest. Since the image contains also portions of U.S.A., it was not listed in the Non-U.S. catalogue published by NASA. In January, the existence of a good image available in the U.S.A. became apparent. Copies of this have now been ordered.

(c) Evaluation of ERTS imagery as a source of hydrologic data in the Canadian North.

Professor S. Solomon of Waterloo University is the prime investigator for this project, being carried out by Canadian-British Engineering Consultants (1971) Ltd. Two approaches are being considered.

The area of lakes with gently sloping shore lines may change sufficiently to be resolved by ERTS. The total area of surface water within a scene can also be used as an indication. Some 82 possible lakes were identified. A search for imagery has so far yielded three frames, with no repetitive coverage for any.

In the other approach, the incremental value added by ERTS images to a comprehensive hydrologic model is being evaluated. It is felt that even qualitative information such as the existence or not of ice or snow could add considerably. Snow cover is, at present, an output of the

7.3.5 Con't

(c) model. Availability of suitable ERTS imagery may allow periodic checks and corrections of the modelling process throughout winter.

(d) Hydrogeologic information from ERTS

J.D. Mollard and Associates Ltd. is evaluating the ability of ERTS imagery to locate vegetation and geologic features indicative of the existence of aquifers. They are comparing available ERTS images in selected areas to aerial photography from various levels and to records of actual groundwater production. Dr. P. Carr of the Hydrology Research Division will collaborate with Dr. Mollard in the preparation of a paper for the OCSPAR Symposium to be held in May.

7.3.6 Assistance to Various Investigators

The section has provided facilities and assistance to various projects related to water resources. Water Quality Branch is carrying out a survey of the St. Lawrence. The section has assisted with the specification of the task, the ordering of the data and data analysis. The Environmental Protection Service came to the section for assistance in evaluating imagery from a task flown over the St. John River.

The major piece of capital equipment, a colour display densitometer, has been used for planimetry of ice types on the St. Lawrence, measurement of brine area in photographs of ice sections, colour enhancement of weather satellite images, photographs and IR scanner output. It has been used by Marine Sciences Directorate personnel from both East and West Coasts, for Environmental Protection Service projects, for a DPW study of the Mackenzie Valley, and by investigators from Manitoba.

APPENDIX 1:

RECENT PUBLICATIONS BY THE FOREST MANAGEMENT INSTITUTE RELATING TO REMOTE-SENSING APPLICATIONS

Aldred, A.H. 1972	Decisions on combining data from several sensors. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa, 3 p.
Aldred, A.H. 1972	World participation in remote sensing from space. Proc. Comm. VII, Int. Society for Photogrammetry, 20 p.
Aldred, A.H. 1972 and L. Sayn-Wittgenstein	Tree diameters and volumes from large-scale aerial photographs. Can. Dep. Environ., Forest Management Institute, Inform. Rep. FMR-X-40, 39 p.
Brun, R. 1972	A new stereotype-digitizer system for measuring and processing tree data from large-scale aerial photographs. Can. Dept. Environ., Forest Management Institute, Inform. Rep. FMR-X-41, 35 p.
Gimbarzevsky, P. 1972	Terrain analysis from small-scale aerial photographs. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa. 7 p.
Gimbarzevsky, P. 1972	The role of aerial photography in the Canada Land Inventory classification program. Proc. Comm. VII, Int. Society for Photogrammetry. 9 p.
Murtha, P.A. and J.W.E. Harris, 1970	Air photo-interpretation for balsam woolly aphid damage. J. Remote Sens., Vol. 1, No. 5 pp. 3-5.
Murtha, P.A. 1971	Frost pockets on thermal imagery. For. Chron., Vol. 47, No. 2. 3p.
Murtha, P.A. 1972	SO_2 forest damage delineation on high-altitude photographs. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa. 5 p.
Murtha, P.A. 1972	Classification of forest damage from air photos. Proc. Comm. VII, Int. Society for Photogrammetry, 8 p.

APPENDIX 1: (CON'T)

Murtha, P.A. 1972 — Thermal infrared line-scan imagery for forestry? Can. Dep. Environ., Forest Management Institute Inform. Rep. FMR-X-45, 46 p.

Murtha, P.A. — A guide to air photo interpretation of forest damage in Canada. Can. Dept. Environ., Publ. No. 1292, 63 p.

Nielsen, U. and J.M. Wightman, 1971 — A new approach to the description of the forest regions of Canada using 1:160,000 colour infrared aerial photography. Can. Dept. Environ., Forest Management Institute Inform. Rep. FMR-X-35, 25 p.

Nielsen, U. and J.M. Wightman, 1971 — Evaluation of ultra-small-scale aerial photography for forestry: background and specification of initial studies. Can. Dept. Environ., Forest Management Institute Inform. Rep. FMR-X-39. 16 p.

Nielsen, U. 1972 — Effects of spectral filtration and atmospheric conditions on aerial photography obtained in 1970 and 1971. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa. 4 p.

Nielsen, U. 1972 — Agfacontour film for interpretation. Photogramm. Eng., 38(11): 1099-1105.

Sayn-Wittgenstein, L. and A.H. Aldred, 1969 — A forest inventory by large-scale aerial photographs. Pulp Pap. Mag. Can. 70(17), 92-95.

Sayn-Wittgenstein, L. and W.C. Moore, 1972 — The ERTS experiments of the Canadian Forestry Service. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa. 8 p.

Wightman, J.M. 1972 — High altitude photography records and monitors logging operations. Proc. 1st Canadian Symposium on Remote Sensing, Ottawa. 3 p.

8. LIST OF MEMBERS, CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING, 1972

English, Dr. W. Chairman, Working Group on Oceanography, Deputy Director, Pacific Region, Marine Sciences Branch, Department of the Environment, 512 Federal Building, Vancouver, B.C.

Løken, Dr. O.H. Chairman, Working Group on Ice Reconnaissance and Glaciology, Head Glaciology Subdivision, Hydrologic Sciences Division, Inland Waters Branch, Department of the Environment, Room A-222, No. 8 Bldg., Ottawa, Ontario.

Mateer, Dr. C.L. Chairman, Working Group on Atmospheric Sciences, Atmospheric Environment Services, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario.

Mack, Dr. A.A. Chairman, Working Group on Agriculture, Soil Research Institute, Canada Department of Agriculture, K.W. Neatby Bldg., Ottawa, Ontario.

Barrington, Dr. R.E. Chairman, Working Group on Satellite and Ground Station Engineering, Communications Research Centre, Department of Communications, Shirley Bay, P.O. Box 490 - Terminal "A", Ottawa, Ontario.

Lapp, Dr. P.A. Chairman, Working Group on Sensors, Consultant, 14A Hazelton Avenue, Toronto, Ontario. M5R 2E1

Kruus, Dr. Jaan Chairman, Working Group on Hydrology, Inland Waters Branch, Department of the Environment, Room H-305, No. 8 Temporary Building, Ottawa, Ontario.

Steiner, Dr. Dieter Chairman, Working Group on Geography, Department of Geography, University of Waterloo, Waterloo, Ontario.

Sayn-Wittgenstein, Dr. Leo Chairman, Working Group on Forestry, Wildlife and Wildlands, Co-ordinator, Forest Appraisal Program Operations Branch, Canadian Forestry Service, 396 Cooper Street, Department of the Environment, Ottawa, Ontario.

Gregory, Dr. A.F. Chairman, Working Group on Geoscience, Geoscience Consultant, 909 Richmond Road, Ottawa, Ontario. K2A 0G8

Moore, Mr. R.E. Chairman, Working Group on Cartography and Photogrammetry, Director, Topographical Survey Directorate, Department of Energy, Mines and Resources, Room 716, Surveys and Mapping Branch, 615 Booth Street, Ottawa, Ontario.

Landles, Mr. W.G. Chairman, Working Group on Photo Reproduction and Marketing of Remotely-Sensed Data, Chief, Aerial Photography Division, Surveys and Mapping Branch, Department of Energy, Mines and Resources, 615 Booth Street, Ottawa, Ontario.

Lane, Dr. R.K. Chairman, Working Group on Limnology, Canada Centre for Inland Waters, Department of the Environment, P.O. Box 5050, Burlington, Ontario.

Strome, Dr. W.M. Chairman, Working Group on Data Handling, Chief, Data Processing Division, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario.

Morley, Dr. L.W., Director, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario.

Godby, Mr. E.A., Associate Director, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario.

Peter, Brig. Gen. P.F., Director General, Aerospace Systems, Canadian Forces Headquarters, Ottawa, Ontario. K1A 0K2.

Baker, Mr. R.C., Chief, Data Acquisition Division, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario.

Naysmith, Mr. J.K., Chief, Water, Forests and Lands Division, Northern Economic Development Branch, Department of Indian Affairs and Northern Development, Ottawa, Ontario.

McLarty, Mr. D., President, Canadian Association of Aerial Surveyors, Suite 17, 47 Elgin Street, Ottawa, Ontario.

Thurston, Mr. F.R., Director, NAE, National Research Council, Montreal Road, Ottawa, Ontario.

PROVINCIAL REPRESENTATIVES: 1972

Kinnear, Mr. A.C., Co-ordinator/Secretary,
Environment and Land Use Committee,
Parliament Buildings, Victoria, B.C.

Thiessen, Mr. H.W., Director, Interdepart-
mental Planning Division, Department of the
Environment, Government of Albert,
505 Agriculture Bldg., Edmonton, Alberta.

Bricker, Mr. Cal D. (Alternate), Co-ordinator
Remote Sensing in Alberta, Planning Branch,
Department of Highways and Transport,
106 Street & 97 Avenue, Edmonton, Alberta.

Thie, Mr. J., Chairman, Manitoba ad hoc
Committee on Resource Satellites and Remote
Airborne Sensing, Department of Mines and
Natural Resources, Division of Research and
Planning, 1301 Ellice Avenue, Winnipeg 21,
Manitoba.

Bernier, Dr. J.G., Department of Communicat-
ions, Director General of Engineering,
Government of the Province of Quebec,
Quebec, P.Q.

Bruneau, Dr. A.A., Dean, Faculty of Engineer-
ing and Applied Sciences, Memorial University
of Newfoundland, St. John's, Newfoundland.

Pepper, Dr. T., Saskatchewan Research Council,
Saskatoon, Sask.

Raad, Mr. Awni, Director, Soil and Water
Division, Department of Agriculture and
Forestry, Government of Prince Edward Island,
Charlottetown, P.E.I.

Zsilinszky, Surveys and Mapping Branch,
Ministry of Natural Resources, Whitney Block,
Parliament Buildings, Toronto, Ontario.

PUBLISHED BY
THE DEPARTMENT OF ENERGY,
MINES AND RESOURCES,
OTTAWA.