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APPLICATIONS OF REMOTE-SENSING DATA IN ALASKA

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>SUMMARY of ACTIVITIES</td>
<td>5</td>
</tr>
<tr>
<td>Coordination and Information Exchange</td>
<td>9</td>
</tr>
<tr>
<td>Data Library</td>
<td>10</td>
</tr>
<tr>
<td>Data Processing Services</td>
<td>13</td>
</tr>
<tr>
<td>TRAINING and WORKSHOPS</td>
<td>18</td>
</tr>
<tr>
<td>ALASKAN NEEDS FOR RESOURCE INFORMATION</td>
<td>23</td>
</tr>
<tr>
<td>COOPERATIVE PROJECTS</td>
<td>25</td>
</tr>
<tr>
<td>Bureau of Land Management Fire Suppression</td>
<td>26</td>
</tr>
<tr>
<td>Site Selection of Power Line Right-of-Way</td>
<td>39</td>
</tr>
<tr>
<td>Mapping Leads in Sea Ice from Winter Landsat</td>
<td>40</td>
</tr>
<tr>
<td>Sale of Public Lands for Small-Scale Farming</td>
<td>44</td>
</tr>
<tr>
<td>Large-Scale Grain Farming</td>
<td>46</td>
</tr>
<tr>
<td>Other Projects</td>
<td>48</td>
</tr>
<tr>
<td>CONFERENCES AND MEETINGS ATTENDED</td>
<td>56</td>
</tr>
<tr>
<td>CONCLUSIONS AND RECOMMENDATIONS</td>
<td>59</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
</tr>
<tr>
<td>A - Educational Activities</td>
<td></td>
</tr>
<tr>
<td>B - Publications</td>
<td></td>
</tr>
<tr>
<td>C - Bristol Bay Native Association Workshop</td>
<td></td>
</tr>
<tr>
<td>D - Catalog of Remote Sensing Data</td>
<td></td>
</tr>
<tr>
<td>E - Project Descriptions/Chronologically</td>
<td></td>
</tr>
<tr>
<td>F - Project Descriptions/Type of Agency</td>
<td></td>
</tr>
<tr>
<td>G - Project Descriptions/Source of Data</td>
<td></td>
</tr>
<tr>
<td>H - Agency Contacts</td>
<td></td>
</tr>
<tr>
<td>I - Visitor Traffic and Product Orders</td>
<td></td>
</tr>
<tr>
<td>J - Technical Spin-off</td>
<td></td>
</tr>
<tr>
<td>K - Funding</td>
<td></td>
</tr>
<tr>
<td>L - Environmental Study of Prudhoe Bay Dock</td>
<td></td>
</tr>
</tbody>
</table>
ABSTRACT

These grant activities have emphasized the development of applications of remote-sensing data to a wide range of issues in Alaska which relate to the shortage of raw materials, energy exploration and development, and social problems such as the settlement of the land claims of Alaskan Natives. We have introduced a growing cross-section of public and private agencies in Alaska to the use of remote-sensing data, both satellite and aircraft. We have engaged in cooperative projects which involved the performance of operational activities, and we have provided assistance for data processing, enhancement and interpretation using facilities at the Geophysical Institute. Our goal is not merely to provide a pure service to the users, but to help state, regional and local agencies develop their own capabilities to use remote-sensing technology. Specifically, we expect in the future to focus more efforts in generating awareness by state agencies of remote sensing by seeking participation from legislative and executive branches, by providing training courses tailored to the needs of state personnel, and improving communication and coordination between users with related needs for resource information.
INTRODUCTION

There is a continuing need especially in Alaska for detailed information in areas related to natural resources for policy formation and program development by agencies of federal, state, and regional governments. Decisions relating to the management of "public interest" lands outlined in the Alaska Native Claims Settlement Act, the so-called "D-2 lands" will influence the course of economic and social development and the life style in Alaska for centuries to come. Such decisions require information which is based upon data greater in quantity, greater in quality of detail, and more frequently collected than ever before. This array, detail and frequency of data collection required to manage natural resources and to implement and maintain the resulting programs is conducive to the use of remote-sensing techniques. By means of remote sensing, methods of gathering, processing, interpreting, and evaluating data frequently are more cost effective than more conventional techniques, or are the only feasible way to address the problems associated with making intelligent decisions. Problems of huge physical scale or intricate technical complexity do not readily yield answers from simplistic or shallow procedures. The inventory and management of natural resources over vast areas are attractive applications for remote-sensing data, especially where very divergent interests are involved, such as occurs
in Alaska. This grant seeks to exploit these opportunities for beneficial uses of satellite and aircraft sensor technology.

Petroleum exploration and development offshore and onshore have a profound effect upon the adjacent land and its people. This is especially true for the confrontation in Alaska between the extractive industries and the tiny socio-economic structure of native villages in areas facing imminent development. Remote sensing of the environment is a tool to help manage and control this development in a timely fashion so that divergent interests can fit reasonably well with those values which best serve the indigenous people, the nation, the land and sea and the total resources of the region being impacted.

The Coastal Zone Management Act, the Alaska Statehood Act, the Alaska Native Claims Settlement Act, the National Environmental Policy Act, and the Federal Water Pollution Control Act Amendments are examples of legislation on the federal level which are generating increasing demands for information relating to natural resources. Some vital state interests involve future oil and gas lease sales being planned for the Outer Continental Shelf (OCS) by the federal government (BLM) or by the state in state-owned offshore waters, or a joint effort by both the federal and state governments. These lease areas include the Lower Cook Inlet I (Oct. 1977), Beaufort Sea (Dec. 1979), Northwest

The environmental issues involved with these proposed sale areas are complicated by conflicting interests. On one side the federal interests generally favor early dates for lease sales in the order of most promising potential for petroleum discoveries. On the other side the State of Alaska prefers a reordering of sale areas which takes into account the ability of onshore communities to adequately plan supporting facilities for exploration and development activities. The State also prefers a lease schedule which is considerably lengthened into the 1980's to allow communities additional time to obtain information and plan for the onshore impacts.

The need for a rational basis for both the ordering and the timing of the OCS lease sales should generate opportunities in the coming years to apply remote-sensing techniques to support State interests in some of the onshore areas to minimize the impacts and to draw upon the possible benefits of OCS leasing activities. The revised schedule for lease sales which will be strongly backed by the State of Alaska will be only one aspect of the overall state position. Consideration will also be given to stipulations in the announcement of lease sales that long-range analyses shall document the reasons that the sale will minimize social impacts on the public.
Oil and gas resources are vital to the nation and valuable to the State, and they will be developed. Fisheries resources are equally vital and are needed to feed people in Alaska and throughout the countries of the Pacific rim. Most of Alaska's prime timber resources are concentrated in coastal forests and are required for expanding urban developments. Prudent management of coastal resources involves the siting and timing of production activities to utilize these resources without undue impact upon resources which compete for stability in the same ecosystem space. Decisions will have to be made by appropriate agencies to locate oil and gas facilities away from critical habitat and to consolidate transportation routes into common corridors. These decisions will not be restricted only to state and federal entities, but will require that the state, federal, regional and local agencies work together to find common solutions rather than fragmented and conflicting approaches. As Alaska, both in the state and federal domain, gears up to meet the energy-related issues facing the nation there will be a growing role for efforts which adapt state-of-the-art tools to solving existing problems.
SUMMARY OF ACTIVITIES

There is a need for increased awareness by the user-agencies of the current technical capabilities of satellite remote-sensing, the various ways of applying this technology, and how the agency can train their own people to use the new technology. Well-established communication links between the University and the users is the key to effective utilization of remote sensing by a wide sector of public and private organizations. Each user should be aware of other uses of satellite technology to be able to benefit from the successes and failures of similar efforts elsewhere.

After years of minimal responsibility for management of the natural resources in Alaska, there is a growing opportunity for State involvement in programs designed to protect, manage, and develop natural resources. Decisions that must be made as the State exercises its new prerogatives of more self-determination require access to large amounts of data which describe existing patterns of the distribution of natural resources. Such data are also needed to define models which can serve a predictive role to assist in the formulation of alternative policies designed to protect, manage and develop these resources.

The recent need for resource information on the State level of government is also supported by a growing number of
federal programs that require State planning and regulation of various environmental aspects. Concurrent with this rapid acceleration in the demand for more resource data, there also has been rapid developments in the field of technology, such as remote sensing, which can aid the acquisition and processing of data pertaining to natural resources.

The use of natural resource data, including remote-sensing techniques, is not exactly new in the State arena. The Alaska Department of Highways has used these techniques as aids in siting and constructing roads based upon data relating to topography, load-bearing capability and stability of soils, engineering geology, and existing land uses. Managers in other agencies concerned with environmental conservation, land resources, fish and wildlife have also used data extensively for their decision-making processes and operational activities. A manager of natural resources is faced with the problem of allocating a whole range of ecosystems values of land, water, and air; both surface and subsurface, existing and potential. He must do so in an efficient manner within the ecological limits of the region and commensurate with the perceived needs of society. His basic problem is to convert masses of data into information that can be used to make good decisions. However, it is the gaps that exist between the data that these managers need
and the data that they have available to them that provide a driving mechanism for the activities related to this grant.

The importance of an adequate base of data on natural resources probably cannot be overstated. However, it would be a vast oversimplification to imply that a good data base will produce a good management decision, or that an inadequate data base will preclude good decisions. There are far too many other factors involved in the policy level and program implementation level to assign credit or blame to the adequacy of the supporting data base. At the same time, the availability of accurate, timely and relevant data describing natural resources contributes materially to better decisions in relating to the technical aspects of the resource problem being addressed.

Interestingly, the greatest need within an operational or mission-oriented agency for detailed data occurs primarily at the lower levels of implementation. The manager who determines the allowable uses and minimum sizes for parcels of land requires more specific and larger amounts of data than does the planner who establishes the broad goals of a land-use plan. Since remote sensing is especially applicable to activities that require large amounts of detailed data, our work has emphasized an effective liaison with many mission-oriented agencies at the operational level. A consistent, interactive channel of communication is essential to recognize the opportunities to apply satellite technology
to agency problems. Such communication implies that we remain cognizant of the changing needs of agency activities as well as agency officials remaining aware of the changing technology. The needs for information differ at the policy and program implementation levels, and we must take particular care to meet these differing needs in appropriate ways.

The University's role as a functional base for the applications of remote-sensing technology to all users of Alaskan data has become well known and highly respected. We continued efforts to expand the utilization of satellite technology that is appropriate to problems in the management of Alaskan resources. We seek involvement in cooperative projects which promise beneficial applications of remote-sensing technology, particularly satellite sensing, to agencies with operational problems to solve. Emphasis was given to those projects which had a good likelihood for significant decisions being made which were based upon the results of the activities supported by this grant.

There remains a need for a catalyst to speed up the interaction that presently is occurring. Various users of remote-sensing data have different goals and use different techniques and terminologies. Seldom do two agencies have identical problems and therefore seldom are there identical, perhaps not even similar, solutions. In working in the varied extremes that prevail in Alaska, we find there is one
continuum of environment problems which differ vastly. There never will be found an ideal, universal technique for applying remote sensing, or any other technology, to the ongoing problems of mission-oriented agencies. We avoid the tendency to pour everyone into the same mold and try to deal with individual problems and goals with tailored techniques without becoming fragmented in the process.

While most of our efforts were oriented toward specific projects, performing an operational project successfully requires supporting facilities and capabilities. Included in our activities was a general outreach effort which served to alert us when opportunities for new applications occurred, a data library and laboratory to generate the basic products that are required, and processing facilities to manipulate the data into suitable forms for analysis, interpretation and application.

Coordination and Information Exchange

We have maintained a statewide liaison with operational agencies of government and industry to maximize a sharing of appropriate levels of information. We enjoy a substantial base of goodwill and rapport with various user groups involved with environmental and resource management problems. We are generally recognized as the best source in Alaska for information on and assistance with remote-sensing technology and for suitable data products. Appendix H lists some of
the more significant agency contacts which have developed from the activities of this grant.

Many agencies are using our capabilities to a growing extent. The utility of these applications is borne out by the many user-agencies which have borne a major share of the cost of their data applications. Refer to Appendix K for a breakdown of other fund sources than this grant. When appropriate circumstances prevail, this grant is used to support the demonstration component of cooperative projects with user-agencies. Such pump-priming opposes the resistance to perform what can appear to be research or feasibility functions during the course of operational activities.

Data Library

An important service to the community of users within Alaska is the publishing of information catalogs and listings of available Landsat and aircraft imagery. While most data are available from national data banks, we archive the Alaskan data with low cloud-cover which are most relevant to Alaskan needs. Because of the huge geographical extent of the State of Alaska and delayed response times inherent in the national system of data distribution, it is impractical to rely on data searches conducted by others. Users have an immediate need to know what data are available when gathering information for problem-solving. Part of our coordination effort includes the distribution of catalogs which meets the
user's need for browsing among available data or searching for some specific regional coverage. Our current data catalog appears in Appendix D. As the body of locally stored data grows, maintaining an up-to-date bibliography of the total Alaska library will remain an important part of our activities.

The flow of non-Institute visitors to our library facility for satellite and aircraft images and digital tapes has gradually increased over the past several years to an average of 80 per month. These visitors came to examine and select data products and to order reproductions which cost an average of $3,500 per month from national data centers. Other orders for data that are urgently needed or specially enhanced for specific applications are handled by our own photo lab on a job-order, cost-reimbursable basis. Additionally, these visitors engage the photographic display and enhancement facilities which are co-located with the data archives in Room 501 of the Elvey Building.

A number of visitors from outside Alaska have used our data archives before going into the bush to perform summer field work. Their usual comment is one of surprise and appreciation for such a complete and useful library of remote-sensing imagery of Alaska. A day or two spent with our browse files usually saves them countless hours of searching for appropriate data using other means, plus a saving of many man-hours and logistics costs while in the field.
The activities of this grant over the past several years have shifted somewhat from training and consultation to participation in demonstration projects which require extensive analysis and interpretation of many forms of data. The activities of outside visitors and our own project requirements continue to justify the move made last year to a new and larger location on the fifth floor of the Elvey Building. The flow of data products from Landsat and NOAA satellites and from aircraft occupies eighteen file cabinets and twenty feet of shelves.

The operation of the Landsat library frequently involves consulting services of at least four types:

1. Assisting the user in selecting the data which have the greatest potential of satisfying his needs.

2. Assisting the user in preparing orders for standard data products from the EROS Data Center or other national data centers. This is particularly appropriate when the need for data is not immediate and standard data products are satisfactory for this purpose.

3. Assisting the user in preparing a local work order for custom data products (images enhanced for the purpose of the investigation, density-sliced images, etc.).

4. Advising the user on data analyses and data interpretation facilities available either locally or at laboratories outside Alaska.

The Landsat data library, browse file, and associated consulting services and facilities remain an essential activity to provide applications assistance to all data
users in Alaska. Part of these activities were supported by a contract with the U. S. Department of the Interior, EROS Program Office, for a librarian. The amount of data products ordered through our library continues to increase by 25% to 50% per year and is indicative of the interest and practical value being placed on remote-sensing data by Alaskan users. Further evidence of a healthy, self-generating flow of applications is that we recorded around 80 "walk-in" visitors per month. A breakdown of these visitors appears in Appendix I. That there is a growing community of somewhat self-sufficient data-users which has resulted from our efforts over the years to find new applications for remotely sensed data.

Data Processing Services

An essential aid to new users of remote sensing has been the services of the centralized facilities for processing remote-sensing data at the University. It would be wasteful were each user agency to establish laboratory facilities and technical personnel to perform its own analysis and interpretation. A continuing activity of the University was the processing of remote-sensing data either photographically or digitally to the specifications of the user agencies. These activities were performed on our facilities on a job-order basis parallel to the applied research already under way. In most instances, the user agency is expected to bear the costs of such direct services,
but, for cases with above average expectation for beneficial decisions, funds from this grant were occasionally used to support data-processing services. We seek to minimize this kind of use of grant funds to encourage users to pay their fair share of costs and to learn to budget for similar work in the future.

A variety of processing services for the data is equally important as the timely access to specific data. The user needs to receive the data in a format best suited to his particular application, rather than "make do" with those standard data products that are available in due course of time. Data processing has been supported by the grant to support the goals of those cooperative projects which otherwise qualify for grant support.

Our experience and the published work of others has shown that the more substantial applications involve not only conventional photo interpretation but increasingly use computer-aided digital techniques of analysis and interpretation. Some of our users are tending to move from visual photo interpretation into the application of digital interpretation techniques.

Applying digital techniques with our present facilities is uneconomic except for small target areas because of two factors. One is that the original design concept of our digital color-display unit was intended to serve only limited test-areas associated with the early ERTS-1 feasibility
investigations. The other factor is the limited amount of numerical processing that can be performed economically with the University Computer Network, which is based upon the Honeywell 66/40. The data storage and central processing unit (CPU) is adequate for digital image processing, but computer charges are economic in the time-share or batch modes only. To adequately serve the needs of our community of data users we should have a greater capability to process digital Landsat data. Frequently, projects require moderately extensive, computer-aided analysis techniques which are beyond the capability of our in-house services.

Procurement of computer services from outside Alaska is an interim solution until we can develop a local capability to perform clustering and maximum-likelihood algorithms on a scale suited to users of regional analyses. The awkwardness of interaction and communications with very distant service firms regarding complex data-handling and processing decisions greatly extends the time and cost of a given project. In some instances it can mean the untimely end to an opportunity that otherwise deserved our involvement, which is counterproductive to the objective of this grant.

It is very unfortunate that we have not been able to add the hardware and software required to do the kinds of work required by Alaska's users of remote-sensing data. Not having the facilities at hand to perform digital analyses is
a severe handicap which we must continue to accept while we seek support to upgrade our basic capabilities. This handicap seriously impedes our participation in demonstration projects which should be designed to represent (when appropriate) the state-of-the-art techniques of satellite remote-sensing. Cooperative projects of a demonstration nature become tougher and more awkward under the constraints of few capabilities for locally processing digital data and under the guidelines of this grant which is devoted to applications rather than development of facilities.

One of the greatest hindrances in generating truly effective demonstration-projects with an operational impact within the user organization is the lack of timeliness in completing the necessary data analysis. Most mission-oriented agencies require prompt answers at the implementation level. It may not be the preferred mode but many times an urgent need is perceived so far downstream in a fixed sequence of events that thorough, systematic planning by the agency is impossible. In such instances, the agency typically will approach us in hopes that some last-minute miracle from space-age technology may save the day. If digital analysis of satellite data happens to be the obvious method to achieve a given goal within limited time constraints, we find that obtaining data-processing services "outside" entails a delay that is intolerable to the user. Such
inability to respond with an experimental technology (Landsat) to meet the time constraints of operational applications is a fault of the mechanism for the delivery of technological benefits, not the technology itself. To an extent we contribute to the ineffectiveness of this transfer process by our lack of capability to process digital data. We will seek to partially remedy this defect next year and to supplement this effort with perseverance and ingenuity to achieve a measure of in-house analysis of digital Landsat data.
TRAINING AND WORKSHOPS

The workshops that we participated in this year have emphasized specific applications tailored to the interests of the host agency rather than basic principles of remote sensing. There probably is a need for training in basic principles for workers who have had little or no exposure to remote sensing, but recently we have not tried to address this more basic type of training because we have limited resources, and more goal-oriented results are produced from specialized workshops than from generalized training. We have welcomed agencies that sought our help with training and provided indoctrination of individuals from agencies and formally structured workshops designed to meet specific operational needs of the agency.

NASA Active Microwave Users Workshop, Houston, Texas

We were invited to participate as part of the panel on applications during this three-day workshop. The workshop was designed for the community of non-radar experts and sought to define potential applications for data from synthetic aperture radar and to recommend to NASA the specifications which a space-borne SAR mission should have to be of maximum benefit. In addition to identifying key applications in resource management which have high probability of payoff applications, the panel emphasized that to be widely
acceptable for analysis and interpretation, the SAR data would have to be available in timely fashion in digital CCT form, geometrically corrected and distortion-free so that it could be overlaid onto digital Landsat MSS data and processed with computer techniques.

U.S. Forest Service, Forestry Applications Program Workshop, Houston, Texas

By invitation we attended a two-day forestry applications workshop along with two representatives from Region 10's Forestry Science Laboratory in Juneau and a representative from Regions 1, 2, and 4. The purpose of the workshop was to examine high-altitude, color-infrared aerial photography and demonstrate its advantages and disadvantages as part of a nationwide, Ten Ecosystems Study planned by the Forest Service. In large part, the workshop was intended to supplement the experience of the Alaska Region personnel in working with new types of aerial photography. One of the sites of the Ten Ecosystem Study will be in Alaska and will utilize Landsat and high-altitude aerial photography as prime data sources. The study will include one site in the proposed Porcupine National Forest in Alaska. Assistance from the Region 10 personnel would be required for the interpretation of the Alaskan RB-57 photography, although the major part of the work would be performed by personnel associated with the Forestry Applications Program at Houston. The RB-57 photos
were reviewed and recommendations made for type identification and separation, and minimum mapping units in certain critical areas which have been subject to repeated wildfires and which exhibit varying stages of vegetative rehabilitation.

Alaska Surveying and Mapping Convention, Remote Sensing Workshop, Anchorage

A three-day workshop on basic principles of photographic interpretation of remotely sensed data was presented by the staff of the EROS Data Center. Our participation extended throughout the course of the workshop, but mainly centered on aspects of data interpretation that were peculiar to the Alaskan environment. On the third day, four Institute staff members presented reviews of nine specific Alaskan projects which used modern remote-sensing techniques in operational applications. Approximately 80 persons attended the workshop, with most of them from the Bureau of Land Management. BLM is planning a major remote-sensing project next year in Alaska to prepare resource inventories of a wildland area.

U. S. Forest Service Open House Display of RB-57 Photography, Fairbanks

At the request of the Forest Service, we prepared a demonstration and display of the RB-57 aerial photography obtained last summer in the proposed Porcupine National
Forest. The purpose of the open house was to introduce many agency personnel in the Fairbanks area with the availability and potential usefulness of high-altitude color-infrared photography. Display equipment available to the visitors included standard and projection stereoscopes and a zoom stereoscope viewing station. About twenty persons attended the open house.

**U. S. Forest Service-Bristol Bay Native Association Workshop, Dillingham**

This workshop was designed at the request of the Bristol Bay Native Association to survey the potential timber industry in their region of Southwest Alaska. Topics covered included timber survey techniques, harvesting and sawmill operation, and economic and marketing factors associated with lumber production. Participants included three Forest Service personnel, two from the State of Alaska, and one each from the Federal-State Land Use Planning Commission and the Geophysical Institute. Nine persons from the Native villages and regional corporations in the Bristol Bay area attended the workshop. The details of the workshop appear in Appendix C.

**National Petroleum Reserve Workshop, Fairbanks**

A three-day workshop was held at the Geophysical Institute for field personnel from the U.S. Geological Survey, Bureau
of Land Management and the Fish and Wildlife Service. The goal of the training exercise was to prepare workers from various disciplines for a ground data collection effort in the National Petroleum Reserve in Alaska (NPRA). The project was based on a classification of digital Landsat data for cover type analysis of the reserve - 23 million acres in size.

The workshop involved an introduction to Landsat data, and proceeded through the detailed aspects and problems of digital computer analysis. Preliminary products from ten Landsat scenes were used as examples to illustrate digital techniques for analyzing Landsat data. Special attention was given to problems of signature extension through different geographic regions, the effect of aspect on signature variations, combinations of spectral classes to describe a cover type and errors of omission and commission. Approximately 15 people attended the workshop. After the workshop, the crew departed from Fairbanks for a 6-week ground data collection effort on the North Slope.
ALASKAN NEEDS FOR RESOURCE INFORMATION

The activities supported by this grant are purposely intended to emphasize cooperative projects which will include specific decisions and actions taken that are attributable to the information generated by the project. Such a policy reflects the constraints of the existing national climate which favors relevance in research at the expense of basic knowledge. We are discovering these criteria are not well-tailored to Alaskan needs. Stated simply, land-use planning and resource surveys in general are critically important to Alaska; yet, they seldom generate the desired operational activity which is the hallmark of relevance. It may appear that resource surveys come and go without end and seem to disappear into map cases and file cabinets for obscure purposes, if any use is made of them at all. Events in Alaska testify to the opposite condition--decisions that eventually will be based in part upon resource surveys will inevitably fix the mold of Alaska's future. Further, this mold-making process is underway at this time without adequate knowledge of the variety, scope, and detail of the resources being managed. The decision process is highly controversial and will remain an active topic for years to come in all segments of public and private life in Alaska.

Owing to the many social and political ramifications, as well as built-in provisions of existing statutes such as
the Native Claims Act and the Statehood Act, the timetable for such decisions regarding who will do what, where, and when in Alaska covers a period of many years. Such constraints mitigate against results that have immediate payoff and that can demonstrate practical relevance. In these instances the trade-off is very large in seeking short-term benefits from remote sensing at the expense of long-term benefits to the State. The course of many issues now being shaped in Alaska will be measured in terms of events over the next 100 or 200 years. It is unfortunate that satellite technology will play a smaller role in shaping major Alaskan events than the technology deserves.
COOPERATIVE PROJECTS

Whether a potential project can qualify for activities supported in part by this grant is contingent upon our ability to perceive the basic goals of the agency and to recommend an approach which would effectively utilize the tools of remote sensing. These concerns can be focused on several issues:

+ User needs in terms of awareness and ability to use new forms of data
+ Data availability in terms of timeliness and cost effectiveness
+ Availability of facilities for processing and interpreting the data
+ User readiness to take appropriate action based upon the information obtained from the data

Where possible, we have tried to prepare alternative strategies when interacting with agencies in the definition stage of a potential cooperative project. Flexibility which results from this kind of an open-end approach is more conducive to projects which are user-driven in contrast to an approach which tries to match technological solutions with operational problems. Summaries of projects with significant progress this year follow.
Bureau of Land Management Fire Suppression

The Bureau of Land Management (BLM) is responsible for suppressing wildfires on all federal lands and on state, private and military lands by agreement with land owners.

Wildfires had a severe impact on the rural areas of Alaska in the summer of 1977. More than 600 major fires in July and August burned more than 2 million acres of land, and 42 fires together accounted for 99.6 percent of the acreage that was burned. BLM spent more than $22 million this summer in fire control activities in Alaska. In at least one instance the application of Landsat data played a key role in BLM's fire-suppression efforts.

Not all wildfires are opposed by fire fighters, and this is especially true when, such as occurred this summer, many more fires are active than could possibly be manned simultaneously. BLM normally will fight a fire if it threatens life, property, or a resource of recognized value. BLM is developing procedures to determine when a wildfire can be allowed to burn with a beneficial result. Firefighters now work closely with resource managers to evaluate the effort that should be made to combat a fire. Three methods of fire suppression are commonly used, and which method is selected for a given fire depends upon many variable factors. Tanker trucks, retardant bombers, helicopter attack crews (helitack) and smoke jumpers may be used singly or in combination depending upon the location and size of a fire and
the natural factors such as fire-fuel ratios, moisture content, slopes and elevation of surrounding terrain, direction and speed of the wind, and availability of water bodies serving as fire breaks and sources of water for suppression activities.

Fire-suppression efforts are increasingly resource-oriented so as to provide maximum benefit to the environment. A decision whether to let a fire burn or put it out can wisely be made only if wildfires are considered part of a comprehensive study of existing ecosystems as well as land-use plans for an affected area. A key factor how a wildfire will affect a particular area may be further complicated by land which may fall into a multiple-use category.

As a result, any plan for fighting wildfires must be flexible. It is important to evaluate how important fire is or is not to achieve the goals of a land-use plan. In some instances long-term stability of the environment can be detrimental to wildlife, and fires are one aspect of natural disturbances to land. But the size of the fire, its type and intensity help to determine whether a fire may be beneficial to wildlife. Further, wildfires can have variable results depending upon the season of the year, for the impact on existing vegetation and the types of revegetation that are likely to occur are influenced by seasonal variables.

Some of the key environmental factors which influence decisions relating to wildfire management can be addressed
effectively by use of satellite remote-sensing, and the fire season in the summer of 1977 provided a good opportunity to apply Landsat data to fire-related problems.

Perhaps most of the fires in the remote areas of Alaska are caused by lightning and are not near settlements or important resources. This was the case with the Kugruk River fire on the Seward Peninsula, except that our previous analysis of Landsat digital data revealed that the area east of the Kugruk River comprised prime winter range for Native reindeer herders. This study (refer to FY 1976 Annual Report) had been a cooperative project between the Geophysical Institute, USDA Soil Conservation Service and the NANA Corporation, and utilized a computer-aided classification of digital Landsat data coupled with conventional soil survey techniques to map vegetative categories of concern for range management. On the basis of these existing results, BLM decided to confine the fire to the west of the Kugruk River. When, in fact, the fire did jump the river between Montana Creek and Mina Creek, it was halted by efforts aimed at preserving the highly valued range resources. Without access to the existing Landsat study, BLM would have been unable to justify fighting this fire at that point. Westward of Kugruk River the fire eventually burned nearly to the coast and covered 270,000 acres.

The Kugruk River fire was discovered 9 July 1977 when it covered only 15 acres. Coverage by Landsat of this fire
activity, of course, was not available until long after the fire was declared out (9 Sept. 1977). Even this retrospective imagery proved useful to BLM, and they ordered well over 100 scenes of this and other fire activity that occurred throughout the summer. Many of these prints were made into a series of regional mosaics by our staff to provide historical documentation of the worst season for wildfires in Alaska in 20 years.

It is evident that there would be immense value in the Landsat images if they could have been available to BLM in near real-time. Our experience with the emergency request for quick-access imagery for sea-ice applications in April (see pages 40-44 of this report) showed that even with NASA's very best efforts it would have been futile to attempt delivery of Landsat imagery soon enough to have been used "under fire" by regional managers and on-site fire fighters for operational decisions. The reports on the Kugruk River fire from the fire boss on scene forms an interesting correlation with the coverage provided by Landsat 1 and 2 during this period. Excerpts from the reports of fire-fighting conditions on the ground are presented below along with the appropriate Landsat image:

July 12, 1977 (Figure 2)

The base camp was located halfway between Chicago Creek and Independence mining camps on the Kugruk River. The
Figure 1. A Landsat image of a portion of the Seward Peninsula 9 days before the ignition of the Kugruk River fire.
Figure 2. The Kugruk River fire 3 days after ignition. It has grown to approximately 20,000 acres.
weather is hot, dry and windy to 25 mph from the east. The proposed anchor point for the fire is at the gravel bar on the Kugruk River. Fire size is between 20K and 25K acres. At 7 P.M. the fire makes a run toward the base camp and continues through the night. Equipment and men have to be moved onto the gravel bar to insure safety. There is zero visibility, hot, gusting winds to 35 mph from the west (during the night) and the fire size has grown to 35K acres.

July 18, 1977 (Figure 3)
Crews shuttled to work on ATV's to the southwest corner and the west side of the fire, which is now the active head of the fire. The anchor point is established on the southwest corner. Fire is still very active at this location and is burning in scrub alder. By 11:30 P.M. all visible flame is subdued on the entire fireline. Winds have been from the west and northwest. Fire size still at 94.4K acres.

July 19, 1977 (Figure 4)
First priority is to hold the southwest corner of the line. Crews are hot-spotting and find mop-up very difficult and slow due to the dryness and the heavy scrub alder which has fire burning in the root systems. At 3:30 P.M. the winds are stiff and out of the northeast. Blow-ups and spot fires are created, spotting to fifty yards ahead of the main
Figure 3. Nine days after ignition, the Kugruk River fire had spread to 94,000 acres. It remains active on the southwest perimeter.
Figure 4. A few hours after this Landsat image on July 19, 1977, the fire erupted out of control again on the southwest as a result of a stiff wind.
fire body. The southwest section of line is lost at 7 P.M. and the crews are sent to the Kugruk River and await the helicopter for the return shuttle, arriving at base camp at 2 A.M. Dust devils are everywhere the entire day. Fire consumed another 1,000 acres in the southwest corner and has escaped containment at this location.

July 20, 1977 (No Landsat coverage, but events of high interest)

Crews do not arrive at the fireline until 1:30 P.M. due to smoke. A last effort backfire is planned between two rocky knolls and the Kugruk River and another lake. The backfire is successful only briefly. Winds are from the northeast and are unfavorable, with some ground winds erratic. Dust devils are abundant throughout the area. Hose lays are run uphill from the river on one side and from the lake on the other side. ATV's and crews are working between these hose lays on the diagonal backfire line. The middle portion of the fireline is not complete when the backfire fuels are exhausted. There is no more suck created and the smoke and prevailing winds take over and blow the fire directly back at the fireline. Smoke conditions become very bad. All personnel and ATV's are moved to safe areas. Winds now steady from the northeast at 20 to 25 mph. The untied middle portion of the fire blows first and creates a fire
tornado that reaches to 1,000 feet above the ground. Ground winds experienced by this tornado are hurricane force and twist brush out by their root systems. Wind estimates are from 70 to 80 mph on the ground. The blow-up consumes 4,000 acres in this bottleneck and is running fast in a southwest direction. 3,000 feet of hose is lost.

July 30, 1977  (Figure 5)

Winds are from the northwest and favorable for the north section of the fire. The south side of the fire is now smoked-in due to this, and it is difficult to get much done around the Imuruk Lake region. Some of the backfire line is being hand-burned to clean it up. There are two trouble spots along the California Creek side of the backfire that are burning in alders and present mop-up problems. Inversion sets in rapidly and the crews get smoked-in on the line. North-side trouble spot blows up during the night and takes 30 acres across the backfire line. Pumps are brought in, but support is very difficult due to the smoke conditions. No fresh food for 8 days now.

August 23, 1977  (Figure 6)

Shuttled a crew to Asses Ears to cold-trail the fire perimeter northward along Magnet Creek. (August 24): A hot spot flared up along the Inmachuk River north of Utica camp, across from West Creek. Picked up more hot spots buried in
Figure 5. Heavy smoke shows the fire active on both north and south boundaries of the Kugruk River fire. Six other active fires are also present on this July 30, 1977 image.
Figure 6. While not yet declared out, the Kugruk River fire appears to be quiet by August 23, 1977. It had burned 270,000 acres. Some 300,000 additional acres were burned by six other fires that are visible on this image.
rocks and burning in peat from Virginia Butte to Imuruk Lake. No smokes, all hot spots were buried.

When the BLM Fire Control Officer viewed these images retrospectively, he stated that prompt access to such imagery could have saved many thousands of dollars and aided BLM in deploying their limited resources much more effectively. This application of Landsat imagery produced good benefits to the using agency, but it also indicates the truly dramatic value that quick-look images in Alaska could have. If NASA cannot provide direct image-generating equipment at their Alaska ground station (similar to that capability at GSFC, and in Canada, Brazil, Italy, Iran) it would seem logical that other funding sources should be sought from those federal and state agencies that would gain unique benefits from timely access rather than routine access to Landsat retrospectively.

Site Selection of Power Line Right-of-Way

Analysis and interpretation of U-2 high-altitude aerial photography near Fairbanks resulted in a change in the location of a river crossing of a Golden Valley Electric Association (GVEA) power line. A new power line was planned to connect a refinery and power-plant complex adjacent to the trans-Alaska pipeline with the Fairbanks area power grid. The
Alaska Division of Lands (ADL) recommended to GVEA that the location of an abandoned telephone-line crossing of the Chena River be used for the power line. With the aid of our staff and the remote-sensing data archived at the Geophysical Institute, the GVEA engineers determined that the recommended site entailed four crossings of the Little Chena River which has high recreational values and which also impacted private property to an undesirable extent. An enlargement of a U-2 photograph documented an abandoned trail not previously recognized by ADL and supported the amended application for a new location of the right-of-way. The U-2 analysis also was a key factor in negotiations with a private property owner to select a location that avoided heavily wooded areas. This application of high-altitude photography resolved a complex legal and environmental problem to the complete satisfaction of GVEA, ADL and the private property owners.

Mapping Leads in Sea Ice from Winter Landsat Imagery

Specially acquired imagery from April 6 and 7, 1977, proved very useful to the Atlantic Richfield Company during their offshore seismic exploration activities last spring. Refer to Figures 7 and 8. An ice lead opened in the area of the seismic camps, causing them to abandon their work and to deploy the field crew elsewhere. The seismic crews were operating slightly shoreward of the large lead in the ice
Figure 7. Sea-ice as shown by Landsat on April 1, 1977. ARCO was conducting seismic exploration near the long ice-lead in the center of this scene.
Figure 1. Ice conditions the following day showed that the ice shoreward from the initial lead is largely stable. The higher risk region is shoreward of the location of the seismic crews.
that is visible in the Landsat scene of April 6 (Figure 7). There was concern for the physical safety of the camp and personnel based upon uncertainty whether the lead might splay shoreward and either directly threaten the physical safety of the camp or possibly isolate the camp for an indefinite period on the offshore ice. The April 7 scene (Figure 8) clearly shows that the ice toward the shore is largely fast and stable and new leads are being formed seaward of the main lead so as to minimize the risks. The cost of maintaining the seismic crew on the sea ice is $2,500/hour around the clock, so it is important that the crew be deployed in the most effective manner. The seismic activities are organized such that the crew can travel across the ice almost as fast while taking sounding data as they can with the camp fully broken down for an emergency move. The Landsat images showed in retrospect that the extent and nature of the lead system was such that no undue haste was necessary in relocating the crew. It would have been possible to redirect the crew away from the area of risk in a manner which also gathered valuable data while relocating.

Operations were suspended and the camp was redeployed to minimize the degree of risk prior to the arrival of these images. In spite of special efforts by NASA to provide specially expedited images, ARCO did not realize the hoped-for
cost savings and expanded efficiency owing to delayed arrival of the images. However, the retrospective value of Landsat data was significantly impressive that ARCO planned to request special data acquisition and expedited distribution be repeated next winter. Low sun-angle imagery in mid-November is important because the pattern of rough ice that is established early in the winter is recognizable on Landsat imagery. The location of the rough ice helps them to avoid encounters with ice ridges which severely impede their mobile seismic camps. The possibility of impressive cost benefits was not fully realized this past winter owing to the time necessary to get the satellite image into the ARCO Anchorage center after acquisition. However, this experience with Landsat was sufficiently favorable to stimulate interest in the establishment of quick-turnaround data to support offshore exploration activities.

Sale of Public Lands for Small-Scale Farming

In 1974 the Alaska Department of Natural Resources (DNR) initiated the Delta Land Management Planning Study (DLMPS) with participation from several government agencies and private individuals. This interagency project was aimed at making land management recommendations for a 2.3 million acre area southeast of Fairbanks, which was subject to imminent and conflicting pressures for industrial, residential, agricultural and recreational uses.
Early in the study the planning team compiled an inventory of natural resources for the region, and thereby recognized the need for the assessment of flood hazards. This resulted in a cooperative project (refer to FY 1976 Annual Report) in 1976 between our staff and the USDA Soil conservation Service to use remote-sensing data to map the flood hazards caused periodically by wintertime stream icings and subsequent overflows.

This year, DNR is implementing some of the DLMPS management recommendations and is preparing to sell the agricultural rights on 5,500 acres of land that is deemed best suited to agricultural uses. This development is in a wilderness area and is called the Tanana Loop Agricultural Rights Sale.

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF LAND AND WATER MANAGEMENT
TANANA LOOP AGRICULTURAL RIGHTS SALE
AUCTION #230

PLACE OF AUCTION: Delta School Gymnasium
Delta Junction, Alaska

DATE OF AUCTION: Saturday, 29 April 1979

TIME OF AUCTION: 1:00 P.M., Bidder Registration
2:00 P.M., Information Briefing and Bidding

Subject to the provisions of AS 18.35, and pursuant to the regulations promulgated thereunder, the Director of the Division of Land and Water Management, or his authorized representative, will sell to the highest qualified bidder the agricultural use and development interests to the following described real property located within the Fairbanks Recording District:

UNITS FOR SALE
Fifty-seven (57) units classified Agriculture, ranging in size from 20 acres to 325 acres.
The parcels range in size from 20 to 300 acres and are intended for supplementary or avocational farming rather than large-scale grain farming. The layout of the parcels and the overall design of the development were substantially influenced by our interpretation of high-altitude aerial photos for the DLMPS. Furthermore the detailed placement of the parcels was impacted by our map of the flood hazards apparent on Landsat imagery from stream-icing overflows of Jarvis Creek. Such hazardous areas have been precluded from development by being designated natural greenbelts. The designated tracts for farming will be sold at public action exclusively for agricultural purposes in January, 1978.

**Large-Scale Grain Farming**

The Office of the Governor and the Alaska Department of Natural Resources are studying the feasibility of a state-subsidized, large-scale barley growing enterprise on the upper Tanana Valley near Delta Junction. Preliminary studies indicate that a major agribusiness should be economically and technically viable if existing wilderness land is opened for agriculture and the venture receives State support for land clearing, assistance in initial capitalization and marketing for the first ten years.
Delta land to be offered in summer

By DERDMOT COLE

JUNEAU—Land to be put into production for the Delta barley project is to be offered to farmers this summer, with full scale production scheduled to begin in 1989, the Hammond administration says.

Gov. Jay Hammond announced Friday he will seek appropriations from the legislature totaling about $15 million during the next two years to get the experimental farming project underway.

According to the administration's current timetable, details of the project, including eligibility standards, will be advertised in March and qualified applicants will be selected in July.

The farms are to be from 2,000 to 3,000 acres in size and buyers will purchase agricultural rights only under lease-sale agreements at a cost of about $150 an acre.

A total of 26 farms are scheduled to be available. A lottery system will be used if there are more applicants.

Bob Palmer, Hammond's special projects coordinator, has worked on the experimental program nearly two years. He said this week that a test clearing of some 2,000 acres is now being carried out.

Results from the test, which involves new clearing methods, are expected to be available late this summer. After the clearing, the state will begin full scale clearing of the 3,000 acres involved in the project.

Most of the $5 million the administration is asking for this year will go for clearing and surveying costs, Hammond said.

Those costs will be passed on to purchasers of the land. A grain elevator and support services such as roads and power will also be provided, officials say. These costs will also be passed on to purchasers to bring the total cost per acre to $150.

"The whole project has been designed toward family farm economic units," Palmer said. Using modern methods, he noted, farms the size being planned for Delta can be handled by a family.

At a press conference here Friday, Hammond, who is running for re-election, said, "Our goal is to place 50,000 acres of state land in the Delta Junction area in agricultural production by 1989. To help this industry get off on its feet so that it may become self-supporting requires a serious commitment by the state.

"While the state will need to help, initially, with the financing and marketing, our extensive studies show that the project should pay its own way within a few years," Hammond added.

The administration has had its eyes on the Orient as a possible market for some of the crops that will be grown. Officials plan to check that theory this year by selling up to 3,000 tons to companies doing business in the Far East. Palmer said the administration has met with some Delta farmers currently doing business to discuss the test-marketing plan and another meeting has been set to work out the details.

According to Palmer, various studies have shown that the Delta project can eventually exist without a subsidy because of the combination of large farms, high quality barley and rapeseed that can be grown, and the high yields per acre that the land can provide.
The Delta Barley Project is the preliminary plan which in part has sprung from recommendations of the Delta Land Management Planning Study (see preceding project description). It would entail the establishment of 800 large grain farms on a tract of 56,000 acres identified by the DLMPS study as best suited to agriculture. Clearing of the land would be done by the State at a cost in the neighborhood of $13 million. An efficient land-clearing technique is a major factor in the economic viability of the Delta Barley Project, and DNR has organized clearing experimentation on a 2,000 acre test plot. Our staff aided the selection process for determining the location of the test plot by the use of Landsat imagery in conjunction with soils maps. An important criteria was to define the test plot such that the variety of terrain conditions typically represent what would be found throughout the entire 56,000 acre region.

Legislative approval for the Delta Barley Project was received from the 1977 Legislature, and DNR expects to proceed with clearing experiments during the winter of 1977-78.

Other Projects

Besides the major projects involved with this grant during the reporting period, there were a multitude of less significant activities which of themselves exhibited good
success from the user's point of view. For various reasons they do not fall into the category of operational activities with resulting important decisions or actions taken. In some instances there was only an initial interaction by our staff—a pump-priming effort—after which the activity became chiefly an in-house effort by the user with minimal involvement on our part. Or, they may have had more emphasis on generalized planning and broadening of an information base with only tenuous likelihood for specific actions. Projects of the latter type usually receive no funds from this grant but remain valid indicators of the overall value of our outreach activities.

These applications are important in their own right and should not be completely discounted. They were very important to the user-agency, and as a body they describe the kinds of introductory or supplementary assistance that we are called upon to provide rather consistently. The following activities are not of themselves justifiable results of this grant, but they form an important ingredient into the overall success in achieving the grant objectives. Without these many smaller opportunities to interact and remain involved in a constructive and active fashion, we would not be able to participate in the larger, more significant projects that do produce the results that are desired.

The Anchorage District Office of BLM sought assistance in obtaining the best summer Landsat coverage of their
region of responsibility in Alaska, which extends from 58°N to 64°N latitude. Their goal was to build a reference file of 1:250,000 scale Landsat scenes in false color-infrared for use with resource management studies. We suggested a total of 44 scenes, 26 of which had already been reconstituted into color. BLM ordered a complete set of these prints to provide total coverage of that region.

The Outer Continental Shelf Environmental Impact Program (OCSEAP) funded by NOAA/BLM had a requirement for Landsat data providing coverage of all the coastal zones of Alaska. We maintained standing orders and routinely archived all Landsat scenes of coastal areas for use by OCSEAP investigators. These accessions also expanded the extent of our browse file of Landsat scenes for all users, without cost to this grant. A related activity was the accession of 1500 frames of medium and low-altitude aerial photography and SLAR imagery acquired by NOAA contractors in support of the OCSEAP program. A specific request by one OCSEAP investigator sought our help to confirm by Landsat data a possible persistent gyre east of Kodiak in the Northwest Gulf of Alaska. Landsat imagery had an important role last year in documenting a gyre near Prince William Sound, and it was thought that a parallel condition might exist in the eastern Gulf. In this case, however, either the gyre is non-persistent or there is too little sediment transport to use satellite remote-sensing as a primary tool to delineate long-term patterns of circulation.
In August, Woodward-Clyde Consultants asked our assistance in obtaining copies of existing aerial photography of the Prudhoe Bay area to support a study of coastal processes and sediment transport along the northwest shore of Prudhoe Bay. The purpose of the study was to evaluate the environmental effects of a 2-mile extension to an existing gravel dock which had been built on an emergency basis the preceding winter. Prudhoe Bay is bordered offshore to the west by a series of barrier islands, the easternmost of which is only 1.5 km from the dock extension. There had been concern that altered wave patterns would increase erosion west of the dock extension, and that sedimentation of the shallow lagoon west of the dock could occur and that the barrier islands might experience increased erosion resulting from interruption of its sediment source. The study was based upon field measurements as well as aerial photography, both historic and current. The project concluded that the long-shore transport of sediment has been interrupted by the dock, the accumulation of sediment trapped against the base of the dock is relatively low, the rate of erosion of the shoreline west of the dock has been retarded, and the barrier islands are not affected by the dock. These conclusions are important to the future of the dock and the knowledge of the environmental impact of certain aspects of onshore petroleum development activities.
The Division of Geological and Geophysical Surveys (DGGS), Alaska Department of Natural Resources, for the past several years has used Landsat imagery for various tasks related to geologic applications. Photogeologists within the agency have found the images directly useful for many operational activities with only a minimum of interaction from our staff. Without even a suggestion or recommendation from us, they asked us to build a Landsat mosaic of the entire state at a scale of 1:1,000,000. Owing to the size of the final product, approximately seven feet by eight feet (excluding the Aleutian Chain), the mosaic was prepared in five sections on a regional basis. The mosaic will also match a new USGS geologic map series of Alaska. The work was completed in March and went on sale to the general public through DGGS offices in Anchorage and Fairbanks. Below is a reproduction of agency announcements of the availability of the mosaic.

**STATE OF ALASKA**
**DEPARTMENT OF NATURAL RESOURCES**
**Division of Mines & Geophysical Surveys**

**MINES & GEOLOGY BULLETIN**

**Late October Set for Release of Satellite Photomap of Alaska**

A satellite map of Alaska is scheduled for release by DGGS in late October. The 1:1,000,000-scale map, a black-and-white photo mosaic, shows the detailed topography of all of the 49th State except the Aleutian Chain and St. Lawrence Island. The map consists of five sheets, each about 30 inches square that can be conveniently affixed to a wall.

The mosaic was compiled for DGGS by the University of Alaska Cooperative Institute from Landsat category images of an altitude of 914 kilometers (570 miles) during July 1972 through September 1974. The map, which will be sold at a nominal rate, may be obtained from any DGGS mining information office ($5) or FE.
In a similar but unrelated activity, the Federal-State Land Use Planning Commission acquired over 100 black-and-white Landsat scenes at 1:500,000 scale for complete coverage of Alaska. In addition, they paid the cost of reconstituting into color some 68 Landsat scenes for coverage in color of major interest areas. These Landsat products formed a general reference file for Anchorage-area users of satellite data.

The NASA U-2 aircraft from Ames Research Center was in Alaska briefly in October for an atmospheric sampling mission. On a non-interference basis, the aircraft also acquired high-altitude color-infrared photography of the coast of the Gulf of Alaska plus the pipeline transect from Valdez to Delta. Vegetation was totally senescent at this season, so the photography had less than normal value than if the flights could have been flown in July as requested. Coastal processes along the Gulf were of value to OCSEAP investigators and the pipeline coverage proved useful to document construction activities of the pipeline. These photos were cataloged and archived in our remote-sensing data library for future browse, reference and analysis work.

This year the Bureau of Land Management, both on the national and state levels, began to utilize to a significant degree remote-sensing technology to aid in their resource-management functions. A major, operational remote-sensing
program in Alaska was established in cooperation with NASA's Applications Systems Verification Test (ASVT) program at Johnson Space Center. The overall objective is to test and demonstrate a resource inventory system for wildlands based on remotely sensed data and oriented toward the needs of BLM State and District Offices. NASA/BLM selected a prime contractor from industry, ESL, Inc., to perform the work, and the Geophysical Institute was selected as a subcontractor to perform certain functions. These tasks include generation of keys and training aids for photo interpretation of large-scale and small-scale photography, vegetative and geologic maps from manual interpretation of Landsat images and aerial photography, collection of ground data, and assistance in the analysis of digital Landsat data and technology transfer to BLM personnel in Alaska.

The study site is a 1.2 million acre region in central Alaska located in the general vicinity of the Denali Highway roughly extending from Paxson to Cantwell. While no NASA grant funds are involved in this project, it is a significant forward step by one of the federal agencies most involved with management of resources on public lands in Alaska, and it follows years of liaison work by our staff with Alaska BLM officials.

The Fairbanks Town and Village Association, a non-profit corporation, used a custom-enlarged U-2 photograph of
Ft. Yukon in site-selection studies for a small-boat harbor. The synoptic view of the islands, meanders of the Yukon River, the existing trails and land-use patterns played a key role in the site-selection process. The project is incomplete pending allocation of funds for construction by the Corps of Engineers.

Assistance was provided to the Water Resources Division, U. S. Geological Survey, in determining water depth of various lakes on the arctic coastal plain. Estimates of depth were prepared by density-slicing techniques on water bodies of a digitally enhanced image. The thinner gray levels are associated with more shallow lakes. USGS will do field work to determine the extent of the correlation between gray levels and water depths.
We have continued our involvement in the Alaska Rural Development Council, an organization devoted to statewide developmental concerns especially as they affect rural regions. The interests of the Council include the long-range analysis and development of natural resources, especially agriculture, land-use planning and development, and the development of rural governmental and industrial entities.

Meetings this year were attended by various Institute staff and were held in Fairbanks, Kotzebue, Anchorage, and Fairbanks. Problems addressed at the meetings included development plans of Native regional corporations, industrial development in the interior of Alaska, improvement of nutrition and housing improvements in rural villages, development of the reindeer industry, improvement of the management of wildlife resources, water resources in the southcentral region, land classification and disposal policies of the State, agricultural development near Delta and Nenana, establishment of national interest (D-2) lands, impact of the 200-mile limit for fisheries, and coastal zone management issues. Several of these topics, namely the reindeer industry, water resources, land policies and disposal, and agricultural development have led us into projects utilizing remote sensing.
Additional workshops, referenced in the Workshops and Training section, attended included the Active Microwave Users Workshop, Houston, Texas, August 10-12, 1976; Forestry Applications Workshop, Houston, Texas, December 6-9, 1976; Alaska Surveying and Mapping Convention, Anchorage, Alaska, January 24-25, 1977; and Bristol Bay Forestry Workshop, Dillingham, Alaska, April 9-10, 1977.

Further technical meetings and conferences attended included the following:


Two poster sessions relating to remote-sensing applications in Alaska were presented at the 11th International Symposium on Remote Sensing of the Environment. They were titled, "Reindeer range inventory in Western Alaska from
computer-aided digital classification of Landsat data", by
T. H. George, W. J. Stringer, and J. N. Baldridge, and
"Impact of Environmental information from Landsat to petro-
leum exploration in the Gulf of Alaska", by J. M. Miller.
CONCLUSIONS AND RECOMMENDATIONS

The activities of this grant are designed to generate useful and reliable information from the flood of acquired remote-sensing data that are accumulating in data repositories and photographic archives. Productively utilizing such data will increase within a decade new knowledge of the geography and environmental processes of Alaska that rivals the sum of the knowledge that was acquired during the previous two centuries. The functions supported by this grant provide the interaction between the advancement of technology and the ability of potential users to benefit from new forms of data. Without some form of catalytic activity to transfer the technology of remote sensing into the market of informational needs of governments and industry, the former would likely outstrip the latter.

Experience with satellite remote-sensing in Alaska has demonstrated that this new technology makes unique contributions to the information base that is essential for prudent management of natural resources by state and local governments. It is the only feasible means to conduct inventories of resources in many instances in comparison with the cost, time and manpower involved with conventional techniques. The repetitive coverage afforded by Landsat permits monitoring of slowly occurring changes occurring in large areas. The
multispectral and synoptic aspects of Landsat provide for new means of studying the environment which generates new types of information that could not be obtained otherwise. Landsat also provides data in a uniform digital format which lends itself readily to computer processing and incorporation into computer-based information storage and retrieval systems.

Whether the benefits from practical uses, for example of Landsat, will approach its full potential depends upon the ability of the institutions which possess high technology as well as the users to organize themselves to mutually profit from the new capabilities. Successful interaction between the sources and users of technology requires that we solve a number of institutional and administrative problems.

The constraints are many and present challenges that must be resolved if the program is not destined to atrophy. For various political and administrative reasons there remains a lack of a federal commitment to the continuity of the satellite program for earth resources. Uncertainty whether the program will be viable five years hence and if so whether there will be data that is basically compatible with the techniques being developed today is a deterrent to low-budget users. They understandably are wary lest they be enticed to adopt with effort and expense a new information system only to be cut off in the long run at worst, or to extensively modify their data interpretation techniques at least.
Perhaps even a more severe constraint is the lack of a commitment to an operational earth resources system. The existing multi-agency structure to acquire and distribute satellite data was designed and functioned satisfactorily for experimental and research applications. However, the delays and uncertainties in obtaining Landsat data from existing distribution channels is frustrating and frequently precludes its use by operational agencies. It is ironic that the United States, which pioneered earth-resources satellites, still lacks the capability of generating on a routine basis images for immediate operational applications. This capability does not exist for the western United States and Alaska. Most other countries which have recognized the value of Landsat and established receiving stations have provided the operational capability to produce quick-look images. The lack of quick turn-around time for Landsat data is one of the prime factors which influence non-federal users to conclude there is a lack of a permanent federal commitment to the program. Consequently many users shy away from the data.

Many times there may be deadlines mandated by forces outside a user’s influence which do not permit a leisurely approach to problem-solving. If current data are mandatory, typically five weeks elapse before one can even determine what data were acquired by the spacecraft, then another six
to eight weeks elapse until one can obtain an image, and two to five months to obtain a digital tape. With time constraints such as these, one can understand a lack of enthusiasm on the part of some users. If one in truth has a powerful and beneficial product, the customer has reason to expect a timely delivery.

Another institutional constraint to full utilization of satellite remote-sensing is that many state, regional and local agencies lack the specific expertise or technical capacity to upgrade their in-house capabilities to include the techniques of interpretation of remote-sensing data and digital analysis in particular. Such users should have assistance to develop their own capabilities initially, and continuing assistance to stay abreast of new developments. This need is one which can be and has been addressed directly by this grant—to provide a systematic and ongoing transfer of remote-sensing technology.

A key ingredient in providing beneficial assistance is the flexibility to interact in different ways with different users. State and local agencies tend to have their own specialized institutional environment with a majority of their goals of a purely operational nature. On the other hand, the typical problem relating to management of natural resources is fragmented, multidisciplinary, and amenable to feasibility studies as well as decision-making. Such a situation presents problems in coordination, from a lack of
a specially trained staff, and with budgeting restrictions which mitigate against new programs not totally operational and planned long before in advance. By being sensitive to the internal climate of the agencies, we seek to interact in ways which are most appropriate to each administrative unit. While our approach is systematic as far as results are concerned, we seek to adjust our methods to suit the needs of each user.

With these grant activities we have emphasized the development of applications of remote-sensing data to a wide range of issues in Alaska which relate to the shortage of raw materials, energy exploration and development, and social problems such as the settlement of the land claims of Alaskan Natives. We have introduced a growing cross-section of public and private agencies in Alaska to the use of remote-sensing data, both satellite and aircraft. We have engaged in cooperative projects which involved the performance of operational activities, and we have provided assistance upon request for data processing, enhancement and interpretation using facilities at the Geophysical Institute.

There is a continuing opportunity to work with new agencies and personnel to introduce the operational benefits of remote sensing and to upgrade existing users into more extensive and intensive use of these data and state-of-the-art techniques that are available through research activities.
of the University. We recognize the need to continue a strong commitment to an ongoing program in assistance with the technical applications of remote sensing. Our goal is not merely to provide a pure service to the user community, but to help state, regional and local agencies develop their own capability to use Landsat and other remote-sensing products. Results from our assistance to federal agencies have in the past outstripped our success with non-federal users, so one of our future goals is to focus more efforts in generating state awareness of remote sensing. Our objectives will include the following:

+ improve user awareness by increased interaction and liaison
+ seek greater awareness and participation in state-oriented remote sensing activities by the legislature and executive branches of the State
+ enhance technical capabilities by custom designed training courses
+ provision of technical assistance and consultation with operational problems
+ development of demonstration projects and feasibility studies
+ improved communication between users via a remote-sensing newsletter
+ develop improved software to accommodate local processing of digital Landsat data
+ seek means to coordinate efforts in remote sensing when several users have related needs for data or information on resource inventories
By an appropriate mix of the above activities, we plan to provide the means for acquiring, processing, archiving, and disseminating data and to contribute the technical assistance for the analysis and interpretation of the remote-sensing data. These cooperative activities are specifically designed to transfer satellite and high-altitude sensing technologies into results that agencies in the public and private sectors can use. These techniques are continually evolving into more powerful forms, and by keeping abreast of new products and services we seek to spread such benefits into the decision-making process affecting Alaskan resources. Such decisions influence the daily lives of most all Alaskans today and will direct the course of economic and social life in Alaska for years to come.
APPENDIX A

EDUCATIONAL ACTIVITIES

A. Conferences, Workshops and Briefings

FY 73

Short Course on Remote Sensing Technology and Applications,
Purdue University, July 31-August 11, 1972.

Department of the Interior Remote Sensing Training Course,
Sioux Falls, October 26-November 21, 1972.

Alaskan Workshops:


Symposium on Significant Results from ERTS, GSFC, March 5-9, 1973.

American Society of Photogrammetry, Annual Meeting, Washington, D.C.

Briefing on Satellite Data to Governor William A. Egan, Fairbanks,

FY 74


Conference on Machine Processing of Remotely Sensed Data, Purdue


Alaska Surveying and Mapping Convention, Anchorage, Feb. 6-8, 1974.

Ninth International Symposium on Remote Sensing of Environment,
University of Michigan, April 15-19, 1974.
FY 75
City of Nenana Development Council, Nenana, September, 1974.
Capital Site Selection Committee, Anchorage, March, 1975.
NASA Earth Resources Survey Symposium, Houston, June 9-12, 1975.
Symposium on Machine Processing of Remote Sensing Data, Purdue University, June 3-5, 1975.

FY 76
Tenth International Symposium on Remote Sensing of Environment, University of Michigan, October 6-10, 1975.
Alaska Rural Development Council, Palmer, October 8-9, 1975.
Conference on Machine Processing of Remotely Sensed Data, Purdue University, June 29 - July 1, 1976.

FY 77
Active Microwave Users Workshop, Houston, August 10-12, 1976.
American Society of Photogrammetry, Annual Convention, Seattle, September 27 - October 1, 1976.
A. Forestry Applications Workshop, Houston, December 6-9, 1976.
Eleventh International Symposium on Remote Sensing of Environment,
University of Michigan, April 25-29, 1977.
Conference on Machine Processing of Remotely Sensed Data, Purdue
University, June 21-23, 1977.
Landsat in Alaska, Remote Sensing for Resource Inventories,
Anchorage, June 30, 1977.

B. Courses and Faculty

Three to five courses that are heavily dependent upon remote sensing
are taught each year in the earth and biological sciences curricula.
These courses are taught by three faculty members and involve between
80 and 110 students. Usually three research assistants are involved in
the overall remote-sensing program at the University of Alaska.
APPENDIX B

SELECTED BIBLIOGRAPHY OF GEOPHYSICAL INSTITUTE
PUBLICATIONS RELATING TO REMOTE SENSING

Anderson, J. H. and A.E. Belon, A new vegetation map of the
Western Seward Peninsula, Alaska, Based on ERTS-1
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Institute of Arctic Biology and Geophysical Institute,

Belon, A. E. and J. M. Miller, An interdisciplinary feasibility
study of the applications of ERTS-1 data to a survey of
the Alaskan environment-Task 1, Report on NASA contract
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Belon, A. E. and J. M. Miller, Applications of ERTS data to
resource surveys of Alaska, Third Earth Resources Technology
Satellite-1 Symposium, Vol. 1B, NASA/GSFC SP-351, p. 1899,

Belon, A. E. and J. M. Miller, Remote sensing by satellite -
application to the Alaska environment and resources,
1972-73 Annual Report, p. 127, University of Alaska,

Miller, J. M., Environmental surveys in Alaska based upon ERTS
data, Summary of Results, Third Earth Resources Technology

Miller, J. M. and A. E. Belon, Alaska and the super eye, Alaska

Miller, John M. and Albert E. Belon, A Multidisciplinary survey
for the management of Alaskan resources utilizing ERTS
imagery, Symposium on Significant Results obtained from
ERTS-1, Vol. II - Summary of Results, p. 39, NASA/GSFC

Stringer, W. J., Shore-fast ice in vicinity of Harrison Bay,
The Northern Engineer, Vol. 5, No. 4, Winter 73/74.

Belon, A. E. and J. M. Miller, Applications of remote sensing
data to the Alaskan environment, Report on NASA Grant
NGL 02-001-092, Geophysical Institute, University of Alaska,

Belon, A. E. and J. M. Miller, Applications of ERTS data to
resources surveys of Alaska, Proceedings of the Third


APPENDIX C

Bristol Bay Native Association Workshop
Dear Andy:

Shortly after talking to you today about the agenda, I learned that our Regional Forester, John Sandor, will also be able to attend the meeting.

I tried to get back to you by phone, but didn't have any luck. Will you please see that the final agenda includes him, as I've shown on the enclosed run-down? Also, please make overnight accommodations for him Monday and Tuesday.

Here's a listing of titles, in case you need them:

John Sandor  
Regional Forester, Alaska Region, U.S. Forest Service, Juneau, Alaska

Bob Janes  
Director, State and Private Forestry, U.S. Forest Service, Juneau, Alaska

John White  

Keith McGonagill  
Logging Engineer, U.S. Forest Service, Juneau, Alaska

Ed Hajdys  
Inventory Forester, State Division of Lands, Department of Natural Resources

John Miller  
Geophysical Institute, University of Alaska

We're looking forward to the session with you.

Sincerely,

Robert C. Janes  
Director, State and Private Forestry
Tuesday, March 15

9:00 AM  Introduction  Andy Golia
9:15  Cooperative Forestry Programs and  John Sandor
      Technical Assistance
9:30  Film: "History of Sawmills in Alaska"
10:00 Small Sawmill Operations - types, methods,  John White
      costs, practices, etc.
12:00 Lunch
1:00 PM  Logging Systems and Techniques - methods,  Keith McGonagill
         consideration in the Bristol Bay region,
         costs, practices, etc.
2:30 PM  Silvicultural Practices - cutting methods,  Bob Janes
         regeneration, etc.
3:00  Timber Inventory Techniques - use of aerial  Ed Hajdys
      photos, timber cruising instruments, etc.
4:00 Field Demonstration - timber cruising  Ed Hajdys

Wednesday, March 16

8:30 AM  Using Satellite Photography for Resource  John Miller
         Inventory
11:15 AM  Laws and Regulations - Federal and State  Bob Janes
11:30 AM  "Where Do We Go From Here"?  Andy Golia
         Feasibility studies, marketing, etc.
         "How can the Forest Service assist"?  John Sandor
12:00 End session
May 12, 1976

PORTABLE SAW MILLS

ADCO West
800 E. Locust
Emmett, Idaho 83617

Belsaw Machinery Company
315 Westport Road
Kansas City, Missouri 64111

Brunette Machine Works, Ltd.
149 Nelson Street
New Westminster, B.C.
Canada

Corinth Machinery Company
Box 711
Corinth, Mississippi 38834

Corley Manufacturing Company
Box 471
Chattanooga, Tennessee 37401

Dolmar North American Corporation
Box 1027
Monrovia, California 91016

Forest All Corporation
Sheep Davis Road
Concord, New Hampshire 03301

Frick Company
Forest Machinery Division
West Main Street
Waynesboro, Pennsylvania 17268

Garrett Enumclaw Company
711 Highway 410
Enumclaw, Washington 98022

Granberg Industries Ltd.
201 Nevin Avenue
Richmond, California 94801

Hartzell Hydraulic Products Division
Hartzell Industries, Inc.
Box 919
Piqua, Ohio 45356

Hosmer Machine Company, Inc.
Contoocook, New Hampshire

Jackson Lumber Harvester Company, Inc.
Highway 37
North Mondovi, Wisconsin 54755

Lane Manufacturing Company
Montpelier, Vermont 05602

Mater Machine Works
Box 41C
520 S. 1st Street
Corvallis, Oregon 97330

Meadows-Mill Company
North Wilkesboro, North Carolina 28659

Mobile Manufacturing Company
6810 N.E. Cornfoot Drive
Portland, Oregon 97218

Star Machinery Company
241 S. Lander Street
Seattle, Washington 98134

Steel Structures, Inc.
Box 1398
Eugene, Oregon 97401
Survey of Portable Sawmills

WW SUMMARY: Users and potential users of portable sawmills will find descriptions of eight basic varieties of mill with remarks on type performance and requirements. Merits of different types are discussed and guidelines for selection are given. In the pages following, basic specifications of 18 models can be found with Reader Service facilities available for obtaining further information.

By JACK MILLS,
Sawmill Engineering and Woodworking Plant Consultant, and WORLD WOOD Correspondent

PORTABLE SAWMILLS are in use in many different parts of the world. No one known to us has ever tried to estimate the number in operation at present, but it must run into thousands. There is wide variety in the conditions in which they are used, in the types of wood cut, in log sizes, and in reasons for use of a portable mill. There are an almost equal number of machine types. This article surveys the main machine configurations and gives pointers on design features to look for and on operating practices. In pages following, brief specifications and illustrations for 18 different makes of portable mills are given.

Two distinct types of mill are covered by the generally used term "portable." The truly portable mill has no wheels but is designed for easy shipment. It breaks down into components light enough to be loaded readily—either manually, with standard equipment, or by logging tower—and to be carried on the road as standard loads. Finally, re-assembly of the portable mill should not be unduly complicated.

The transportable sawmill is one initially designed with wheels, which can be detachable, for towing from site to site. In some cases these mills have loose auxiliary components that can be loaded onto the main chassis for transport. Semi-mobile and mobile mills are corresponding intermediate phases.

One major variation in all types of machine is that of either moving the log through the fixed saw (or saws), or moving the saw through a stationary log. The latter type predominates in the lower price range although it has become quite sophisticated during the last two decades.

Within the broad concept of the portable or transportable sawmilling machine there is a very wide range of choice. It ranges from a two-man operated chainsaw unit...
with a simple structure to guide the cut through a fixed log, to the circular bush mill with conventional log carriage. Between these two extremes are machines to suit almost every need of normal log conversion.

Of special interest is that most of the machines, particularly those for the larger sizes of logs, can be effectively used as permanent equipment in a normal sawmill and are in fact often purchased as such. Even when the need for mobility no longer exists, some mobile machines can readily be introduced into a sawmill for permanent installation.

Mobile machines are broadly classified by the type of cutting tool used, i.e., (1) circular saws, one or more; (2) band saws; and (3) chainsaws, each with many variations. Many decades ago both portable and transportable machines could be introduced into a sawmill for permanent installation.

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Circular saw types

Machines using the circular saw include:

The circular bush mill, a heavy-duty machine generally with two saws set in line one above the other and up to 1.50 m (72 inches) dia and a conventional log carriage. The machine is often fixed but is available as:

- transportable with detachable wheels and a system of jacks for alignment;
- self-contained or independent diesel engine or electric motor, in sizes for logs up to 1.20 m (48-inch) diameter.

This type is inherently heavy equipment and receives a substantial prime mover for transport. Also advance preparation, an essential factor in any movable machine, has to be thorough. Figure 2 illustrates a typical machine. Saws are usually inserted tooth type with their wide saw kerf and high horsepower demand. This type is mainly a hardwood machine but it is equally effective on large diameter softwoods, and for all sawing programs.

Machines with two circular saws set at 90° with overlapping tips, one for the vertical cut, the other for the horizontal cut. Saw spindles and driving unit—generally an industrial petrol or diesel engine—on an assembly move along a beam parallel to the stationary log. The beam has vertical and horizontal adjustments to locate the cut in the log. Diameters of saws limit the cut piece to about 300 x 150 mm (12 x 6 inches). Wide boards—using full log diameter—cannot be cut. Saws are usually inserted tooth type.

The framework supporting the beam is often large enough to receive a number of logs at a time, while simpler machines deal only with one or two logs. Inherent deflection on the long beam presents problems with the straightness of the horizontal cut, possibly acceptable in some operations, and binding of the horizontal saw can produce a rougher sawn face.

Log placing can be a tedious, labor-intensive job unless adequate facilities are available. Logs are often only manually secured by wedging and their own weight and rigidity problems are evident as the log weight is reduced.

Feed along the log and vertical and horizontal adjustments are generally powered, with some manual options. Some sophisticated versions of this type are very effective on straightforward conversion to sections up to the maximum. This type is easily transported and of modest comparative cost, making it useful for frequently encountered situations. Figure 3 shows a typical machine.

The Scotch bench: This type has a horizontal saw spindle with a circular saw at each end and a roller bed or flat tables on rollers, a simple, powered feedgear, driven by any suitable prime mover self-contained or independent, and built-in wheels for rapid movement. It is also widely used as a fixed installation. It is fed from one side with logs for breakdown, with the sawn pieces moved across to the infeed of the other side for boarding and salvage operations. It is mainly a softwood machine, with a three- or four-man crew, but is also used for hardwoods within the manual handling limit. It uses inserted tooth or spring set saws according to location. It is often supplied with a wooden frame which can be made at the site to receive the metal parts.

Circular rack bench: A simple machine with saws up to 1.5 m (60 inches) dia, flat tables running on rollers and a hand or powered feedgear to racks under the tables. Normally a fixed machine but readily broken down into modest weight units for easy transport and needing only a simple foundation.

Circular saw headrigs with log carriages: These are found with one or two saws, a conventional log carriage, and feedgear driven from the saw spindle, all mounted on a steel chassis with wheels and a jacking system. They
are simple and effective, easily moved and very suitable for softwoods and hardwoods within limited weights.

Variations on this design include infed chain conveyors, off-
feed roller conveyors and, in some cases, a double-saw edger and a crosscut saw permitting finished boards to be produced in one through pass. Occasionally a log loading device is also included. Some of these features are built onto the main chassis; others are loose and transported with the machine and easily reassembled. Usually, inserted tooth saws and independent power units are used, with a flat belt drive. Figure 4 illustrates a basic type of machine.

Bandsaws

Bandsawing machines mainly have a horizontal saw moving through a stationary log. Very probably, they were introduced initially as low-cost static machines for permanent sites, since their simple foundation and easy dismantling into modest weight units lend appreciably towards mobility.

The conventional horizontal bandsaw unit has the two vertical columns mounted on bogies with flanged wheels running on steel rails. The log rests between the rails and is secured by dogs on independent log supports. Rails can be any reasonable length to give higher utilization by having cutting at one station and loading at another, or logs end to end.

This type is made for logs up to 1.80 m (72 inches) dia, which also permits smaller logs to be sawn side by side. Accuracy of rail alignment in the horizontal plane is critical with this type of machine; if the rails undulate, the saw faces will similarly undulate (wavy cutting) with consequent de-grading. This requires log supports to be independent of the rails. Older existing machines may not have these independent supports fitted but they are a worthwhile addition.

The type is generally used for through-and-through sawing and wavy-edged cants up to 300/400 mm (12 to 16 inches) thick; the logs can be squared by manipulation and 90° supports used with cants for boarding-off. A simple overhead gantry crane spanning the machine and covering the whole log cutting length and log yard is a great asset. It reduces non-cutting time and assists in avoiding distortion of the rails by mishandling the logs, as indeed should any log handling equipment.

The thin wide bandsaw with its low kerf wastage provides appreciably economies compared with the circular saw, but it is far less tolerant of abuse than the latter, particularly the inserted tooth type. Therefore, good all-around sawing practice, including bandsaw servicing, is an essential concomitant with these machines, and it pays good dividends in more accurate sawing and good finish.

Powered feedgear and powered rise and fall of the saw unit are usually standard features; the sawyer normally rides with the machine on a platform. Main drive is by
selecting the correct machine type

Before deciding the type of machine to purchase, it is essential to define very clearly the duty required from it. Many factors have to be considered. Among them:

- The general location for operation, the interval between movements to new sites; the availability of a power source—electric, diesel oil or petrol; the transport facilities for moving the machine in and the sawn timber out; the log extraction equipment to feed the machine; the availability of servicing facilities and spare parts.

- The sizes and species of the logs; if the largest log sizes are found only in small numbers, it may be better policy to select a machine that will deal more efficiently with the average sizes.

- The market for the sawn timber: the sizes of the end-product, the accuracy of sawing, the quality of the sawn faces; the location of the markets; and transport to the markets.

- The required throughput required to meet the assumed markets: whether one or more machines are necessary to handle adequately the log output from the minimum set of log extraction equipment, what would be the expected conversion factor—round log input to sawn product. This seldom works out to calculated figures, particularly with below average grade logs. The utilization factor of the machine(s)—how many minutes per hour is the saw actually cutting wood. This is often surprisingly low in practice, although good organization appreciably improves it. The level of skill of the sawing crew in general and their application to the job and the supervision of the operation and personnel all influence the overall efficiency.

- Other factors peculiar to the particular area of operation: terrain, climate, rainfall, road conditions, and manpower availability.

With these factors fully in mind a choice can be made.

Electric motor on the cross beam or diesel engine on an electric motor on the cross beam or diesel engine on an extension of one of the bogies. Power requirements are related to the width of saw and required duty. Currently available from makers are two edging saws on the cross beam, permitting square edged boards to be produced at one pass which is very efficient. Figure 5 shows a typical machine carrying a 14/15.5 cm (5.5/6 inches) wide saw on 1.20 m (47.5 inches) dia saw pulleys.

A variation of this design is with the sawing unit mounted on a beam and travelling over a stationary log. This type is used for logs up to about 810 mm (32 inches) dia by 4.57 m (15 feet) long.

Rolling table log saw: This is another bandsaw type which is effectively the standard machine mounted on a wheeled chassis with jacks, tow bar, etc. The machine is mounted on a portable rolling table log carriage with the saw adjustable vertically on four corner columns. They are most commonly used in a sawmill to break down oversize logs into smaller pieces for further conversion on standard machines, but they are easily dismantled into manageable units for transport and readily re-erected on four prepared concrete blocks. As a full conversion machine they have the disadvantage of a high saw kerf wastage which would be excessive in production of boards. They require loading either from above by crane or with the logs being rolled sideways between the columns. This type can be used on logs up to 1.50 m (72 inches) or more and to around 5 m (16 feet) long.

What to demand from a portable sawmill

Portable or transportable sawmilling machines should, in general, have all the design characteristics of their equivalent fixed machines: robustness and weight in the right places—though weight alone does not necessarily make for a good design. Other requirements are: Adequate saw guides and saw guards, a cutting tool—be it circular, band or chain—adequate for the required sawing program; a main drive suitable for the saw and sawing duty, and certainly not underpowered; for portable machines, ease of dismantling and re-assembly in an accurate manner and ease of transport; and, for transportable machines, there should be adequate means for towing and alignment of modules. Good designs and equipment always cost more initially, but the higher cost is always a worthwhile investment.
However, the greatest influence will be the sizes and species of the logs and the output and quality required of the goods. Whether or not to select a circular or a bandsaw machine is affected by the economy of the latter and the better sawn face it produces compared with the circular saw. Offset against this is the higher level of skill in both using and servicing a wide bandsaw.

Whatever type of machine is chosen adequate backup equipment is essential: obviously, extraction and transport are musts, but are beyond the scope of this article.

Too much emphasis cannot be placed on the importance of adequate maintenance and saw servicing facilities and spare parts held at the working site. Skimping these requirements is just bad business and the lack of a critical spare part is certain to lead to costly immobility of a machine. If bandsaws are used, then ample money should be allocated to a set of good saw servicing equipment. This is really essential, and applies almost equally to circular and chainsaws. No cutting machine is better than its cutting tool.

There are factors for and against any cutting tool selected. Basic requirements for circular saws are that: the plate should be kept in good tension, the teeth sharpened regularly, and the whole kept in good balance. If teeth are spring set, the set should be consistent and the teeth equally spaced. Inserted tooth saws are common on conversion work; the teeth are easily replaced at modest cost, and a small electric grinder operated from singlephase supply provides reasonably accurate grinding, sometimes while on the spindle. Circulat will stand a modest amount of abuse; they waste good timber as saw kerf—25 mm (¼ inch) on the larger saws is not unusual—and they consume a lot of horsepower.

The thin, wide bandsaw is, comparatively, very economical on saw kerf wastage, needs less horsepower for a given duty, but is far less tolerant of abuse than the circular saw. When well used and maintained it is a very good tool and produces a more accurate dimension and a better sawn face than the circular, and can cut longer cuts. The tooth shape should be considered carefully against the species of log, the length of cut and feed speed; if widely different requirements prevail then saws are needed for each purpose. All this is just good practice, but applies more particularly to remote areas where the portable machine is most appropriate. Still on saws, a good saw doctor is a blessing.

The costs of these machines vary as widely as the extensive choice available. Added to the basic cost must be the charges for getting the machinery to the working site, and this can be quite expensive. Packing for shipment, from works to port, port to site, freight and insurance, are further costs; they mount up, and world prices are not getting less.

The axiom that "you get what you pay for" applies to all products from reliable makers. Probably most equipment is purchased through a local agent who adds his cover charge; but a good agent is well worth his commission in providing advice and after-sales service.

Selection of a portable sawmilling machine is the application of good sawmilling sense to a conversion operation with an overall awareness of the special requirements of the type of machine, its working environment and the market requirements for its end-product.
APPENDIX D

CATALOG OF REMOTE-SENSING DATA

JUNE 1975 - JULY 1977

Prepared by:

Remote-Sensing Library
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
<table>
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APPENDIX E

PROJECT DESCRIPTIONS
Listed Chronologically

CHIRIKOF ISLAND SURVEY
1) Bureau of Land Management FY 73

Landsat images were used to verify that there were no gross errors in the charted location of Chirikof Island - a small, uninhabited island in the North Pacific Ocean, 175 miles south of Kodiak. BLM, therefore, decided to accept the existing survey data which generated a significant reduction of 24 man-weeks of field work.

REGIONAL ENVIRONMENTAL ATLASSES
2) Federal-State Land-Use Planning Commission for Alaska FY 73

After a period of training and orientation on the use of Landsat images, the Commission's Resource Planning Team generated a map of the major ecosystems of the entire state. These data subsequently were used in the preparation of a documented and illustrated series of "Regional Profiles" which formed a comprehensive atlas of natural resources, climatic, geographic and demographic information covering the entire state.

GLACIER SURGE
3) USGS Water Resources Division FY 74

Repetitive coverage by Landsat images documented the sudden surge of Tweedsmuir Glacier in 1973. The massive extent of the surge caused U.S. and Canadian investigators to maintain regular aerial surveillance of the glacier during the summer of 1974 to watch for the formation of a glacier-dammed lake should the surging moraine block the Alsek River and thereby threaten the Alsek Valley and Dry Bay with massive outburst flooding. The surge of Tweedsmuir Glacier failed to completely block the river and no hazardous condition developed.
NATIVE LAND SELECTIONS - DOYON LTD.  
4) Bureau of Indian Affairs FY 74-75

From Landsat images we mapped the location of forests with potential for harvesting commercial timber on approximately 5 million acres of land subject to selection by Doyon, Ltd., an Alaskan Native corporation. Selections of land made in December 1975 were based substantially upon our work.

SALVAGE HARVEST OF DISEASED SPRUCE 
5) Alaska Dept. of Natural Resources FY 74

Assistance was provided the agency in mapping the stands of diseased white spruce from a heavy attack by spruce beetles. Satellite data lacked the resolution required for accurate results in complex mosaics of mixed forests and wildlands in Alaska, but low-altitude color-infrared photography was useful. The action taken was a timber-salvage sale on infested state lands comprising 425-million board feet.

CONSTRUCTION OF TIMBER HAUL-ROAD 
6) Northland Wood Products FY 74

Up-to-date U-2 photographs were used to plan the timber-harvesting operation in a remote area. Relocation of planned road construction to avoid permafrost bogs and exploit existing fire trails was the action taken.

REGULATION OF SURFACE TRANSPORT ON ESPENBERG PENINSULA 
7) National Park Service FY 74

A vegetation map of a portion of the Espenberg Peninsula was prepared by photo interpretation of a Landsat image. This work later supported the denial of an application to transport an oil-drilling rig on the surface of the ground. To protect the environment the equipment was dismantled and flown to the site by helicopter.
Various types of enhanced Landsat images were analyzed to delineate regions susceptible to flooding in the vicinity of Delta Junction. The documented flood-prone areas were avoided in the State's plan for both large- and small-scale agricultural development in the area.

**ENVIRONMENTAL SURVEY ON YAKUTAT FORELAND**

9) [Alaska Department of Environmental Conservation FY 76](#)

An environmental survey of the Yakutat Forelands was prepared from an analysis of digital Landsat data. Much of the Forelands was shown to be unsuited for industrial development which was expected to accompany the petroleum exploration in the Gulf of Alaska. The onshore facilities were, therefore, concentrated in Yakutat Harbor and at Dry Bay rather than the environmentally sensitive region of the Forelands.

**REINDEER-RANGE SURVEY**

10) [U. S. Soil Conservation Service FY 76](#)

A pilot project to produce plant and soil inventory information of the rangelands of the Seward Peninsula was so profitable to the Soil Conservation Service that the agency extended the technique to produce a range inventory of 4-million acres from digitally processed Landsat data. The results are being used to regulate grazing leases for reindeer herding by the Northwest Alaska Native Association.

**NATIVE LAND SELECTIONS-CHUGACH NATIVE ASSOCIATION**

11) [Chugach Native Corporation FY 76](#)

A survey of resources in a 1,000 square-mile region was prepared for the Chugach Native Corporation. A new block of land had become available for their land selections under a revision of the Native
Claims Settlement Act, and the Corporation was faced with early-selection decisions based upon inadequate information. This project evaluated the commercial timber-resources from which the land selections were subsequently made.

**RELOCATION OF OFFSHORE DRILLING PLATFORM**

12) **BP Alaska Inc.** FY 76

A digital classification map from Landsat data was used to determine the current location of low-relief gravel islands in the Sagavanirktok River delta near Prudhoe Bay. The original intent of the oil firm was to locate a drilling platform during the winter on an island shown on USGS maps. The gravel island was not found by probing beneath the sea-ice. By consulting the Landsat data, the company recognized that no stable island was acceptably located and decided instead to construct an artificial island. Landsat data helped provide the justification for the environmental impact of the amended drilling-permit application.

**SEDIMENT PLUMES IN GULF OF ALASKA**

13) **National Oceanic and Atmospheric Administration** FY 76-78

Landsat images of sediment plumes in the western Gulf of Alaska provided compelling evidence of a persistent system of gyres. The implications of this information ultimately caused the Department of the Interior to delete one-million acres from a scheduled lease-sale for petroleum exploration rights only five days prior to the sale.

**WILDFIRE SUPPRESSION IN WESTERN ALASKA**

14) **Bureau of Land Management** FY 77

An existing rangeland map prepared by digital analysis of Landsat data proved the key element in wildfire suppression activities in July 1977. A major wildfire (approximately 270,000 acres) in western Alaska...
burned over part of rangeland used by reindeer herders. On the basis of the resources mapped by an earlier cooperative project, BLM decided to confine the fire to the west of the Kugruk River to preserve prime reindeer habitat. When the fire did jump the river, BLM concentrated their suppression efforts at this point and thus preserved the range resources of highest value.

RELOCATION OF POWER LINE

15) Golden Valley Electric Association FY 77

Analysis and interpretation of U-2 photography was the basis for a change in the right-of-way location of a new high-voltage power line near Fairbanks. The regulatory agency, Alaska Division of Lands, recommended that the utility (GVEA) use an abandoned telephone-line crossing of the Chena River. Interpretation of the U-2 photo determined that the recommended site was susceptible to frost heaving of power poles and also heavily impacted private property. An amended application for a river crossing permit was filed and ultimately approved by the Division of Lands.

RISE EVALUATION OF SEA-ICE CONDITIONS

16) Atlantic Richfield Company FY 77

Special, quick-turn-around provision of Landsat imagery by GSFC was used to evaluate the risk associated with a newly opened ice lead in the Beaufort Sea. The images showed that the risk to the seismic crews working on the ice was minimal. Further interpretation of the image revealed the extent of the rough ice which enabled the mobile seismic camps to avoid large ridges, which severely impede their travel.
LAND-SALE PLANNING
17) **Alaska Division of Lands** FY 77

The mapping of flood-prone regions from Landsat images was used to design the layout of agricultural parcels of land ranging in size from 20 to 300 acres in the Tanana Loop Sale which sold the agricultural rights on 5,500 acres of land to the public. The hazardous areas were precluded from development and were mostly designated as natural green-belts.

PLANNING OF LARGE-SCALE LAND-CLEARING EXPERIMENT
18) **Alaska Division of Lands** FY 77

The location of an experimental 2,000 acre plot for studying the most effective means of land clearing was chosen in part from the results of an earlier Landsat analysis of terrain features. An important criterion was to include a variety of terrain conditions which would be representative of the entire 56,000 acre project that is being subsidized by the state to establish a large-scale grain agribusiness.
APPENDIX F
PROJECT DESCRIPTIONS
LISTED BY TYPE OF AGENCY

A. FEDERAL AGENCIES:

CHIRIKOF ISLAND SURVEY
1) Bureau of Land Management FY 73

Landsat images were used to verify that there were no gross errors in the charted location of Chirikof Island - a small, uninhabited island in the North Pacific Ocean, 175 miles south of Kodiak. BLM, therefore, decided to accept the existing survey data which generated a significant reduction of 24 man-weeks of field work.

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NATIVE LAND SELECTIONS - DOYON LTD.

4) Bureau of Indian Affairs FY 74-75

From Landsat images we mapped the location of forests with potential for harvesting commercial timber on approximately 5 million acres of land subject to selection by Doyon, Ltd., an Alaskan Native corporation. Selections of land made in December 1975 were based substantially upon our work.

REGULATION OF SURFACE TRANSPORT ON ESPENBERG PENINSULA

7) National Park Service FY 74

A vegetation map of a portion of the Espenberg Peninsula was prepared by photo interpretation of a Landsat image. This work later supported the denial of an application to transport an oil-drilling rig on the surface of the ground. To protect the environment the equipment was dismantled and flown to the site by helicopter.
FLOOD HAZARDS
8) U. S. Soil Conservation Service and Alaska Division of Lands  FY 75-76

Various types of enhanced Landsat images were analyzed to delineate regions susceptible to flooding in the vicinity of Delta Junction. The documented flood-prone areas were avoided in the State's plan for both large and small-scale agricultural development in the area.

REINDEER-RANGE SURVEY
10) U. S. Soil Conservation Service  FY 76

A pilot project to produce plant and soil inventory information of the rangelands of the Seward Peninsula was so profitable to the Soil Conservation Service that the agency extended the technique to produce a range inventory of 4-million acres from digitally processed Landsat data. The results are being used to regulate grazing leases for reindeer herding by the Northwest Alaska Native Association.

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B. REGIONAL AGENCIES:

REGIONAL ENVIRONMENTAL ATLASES

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APPENDIX G

PROJECT DESCRIPTIONS
LISTED BY SOURCE OF DATA

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1) Bureau of Land Management FY 73

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WILDFIRE SUPPRESSION IN WESTERN ALASKA

14) Bureau of Land Management FY 77

An existing rangeland map prepared by digital analysis of Landsat data proved the key element in wildfire suppression activities in July 1977. A major wildfire (approximately 270,000 acres) in western Alaska burned over part of rangeland used by reindeer herders. On the basis of the resources mapped by an earlier cooperative project, BLM decided to confine the fire to the west of the Kugruk River to preserve prime reindeer habitat. When the fire did jump the river, BLM concentrated their suppression efforts at this point and thus preserved the range resources of highest value.

RISE EVALUATION OF SEA-ICE CONDITIONS

16) Atlantic Richfield Company FY 77

Special, quick-turn-around provision of Landsat imagery by GSFC was used to evaluate the risk associated with a newly opened ice lead in the Beaufort Sea. The images showed that the risk to the seismic crews working on the ice was minimal. Further interpretation of the image revealed the extent of the rough ice which enabled the mobile seismic camps to avoid large ridges, which severely impede their travel.

LAND-SALE PLANNING

17) Alaska Division of Lands FY 77

The mapping of flood-prone regions from Landsat images was used to design the layout of agricultural parcels of land ranging in size from 20 to 300 acres in the Tanana Loop Sale which sold the agricultural rights on 5,500 acres of land to the public. The hazardous areas were precluded from development and were mostly designated as natural greenbelts.
PLANNING OF LARGE-SCALE LAND-CLEARING EXPERIMENT

18) Alaska Division of Lands FY 77

The location of an experimental 2,000 acre plot for studying the most effective means of land clearing was chosen in part from the results of an earlier Landsat analysis of terrain features. An important criterion was to include a variety of terrain conditions which would be representative of the entire 56,000 acre project that is being subsidized by the state to establish a large-scale grain agribusiness.

B. HIGH ALTITUDE AIRCRAFT PHOTOGRAPHY

CONSTRUCTION OF TIMBER HAUL-ROAD
6) Northland Wood Products FY 74

Up-to-date U-2 photographs were used to plan the timber-harvesting operation in a remote area. Relocation of planned road construction to avoid permafrost bogs and exploit existing fire trails was the action taken.

FLOOD HAZARDS
8) U. S. Soil Conservation Service and Alaska Division of Lands FY 75-76

Various types of enhanced Landsat images were analyzed to delineate regions susceptible to flooding in the vicinity of Delta Junction. The documented flood-prone areas were avoided in the State's plan for both large and small-scale agricultural development in the area.
RELOCATION OF POWER LINE
15) Golden Valley Electric Association FY 77

Analysis and interpretation of U-2 photography was the basis for a change in the right-of-way location of a new high-voltage power line near Fairbanks. The regulatory agency, Alaska Division of Lands, recommended that the utility (GVEA) use an abandoned telephone-line crossing of the Chena River. Interpretation of the U-2 photo determined that the recommended site was susceptible to frost heaving of power poles and also heavily impacted private property. An amended application for a river crossing permit was filed and ultimately approved by the Division of Lands.

PLANNING OF LARGE-SCALE LAND-CLEARING EXPERIMENT
18) Alaska Division of Lands FY 77

The location of an experimental 2,000 acre plot for studying the most effective means of land clearing was chosen in part from the results of an earlier Landsat analysis of terrain features. An important criterion was to include a variety of terrain conditions which would be representative of the entire 56,000 acre project that is being subsidized by the state to establish a large-scale grain agribusiness.

C. LOW ALTITUDE AIRCRAFT PHOTOGRAPHY

NATIVE LAND SELECTIONS - DOYON LTD.
4) Bureau of Indian Affairs FY 74-75

From Landsat images we mapped the location of forests with potential for harvesting commercial timber on approximately 5 million acres of land subject to selection by Doyon, Ltd., an Alaskan Native corporation. Selections of land made in December 1975 were based substantially upon our work.
SALVAGE HARVEST OF DISEASED SPRUCE
5) Alaska Dept. of Natural Resources FY 74

Assistance was provided the agency in mapping the stands of diseased white spruce from a heavy attack by spruce beetles. Satellite data lacked the resolution required for accurate results in complex mosaics of mixed forests and wildlands in Alaska, but low-altitude color-infrared photography was useful. The action taken was a timber-salvage sale on infested state lands comprising 425 million board feet.

REINDEER-RANGE SURVEY
10) U. S. Soil Conservation Service FY 76

A pilot project to produce plant and soil inventory information of the rangelands of the Seward Peninsula was so profitable to the Soil Conservation Service that the agency extended the technique to produce a range inventory of 4 million acres from digitally processed Landsat data. The results are being used to regulate grazing leases for reindeer herding by the Northwest Alaska Native Association.
## APPENDIX H

### AGENCY CONTACTS

**LISTED BY PROJECT NUMBER**

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Contact 1</th>
<th>Phone 1</th>
<th>Contact 2</th>
<th>Phone 2</th>
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<tbody>
<tr>
<td></td>
<td>Mr. Tom Hazard, Head of Technical Services (Retired)</td>
<td>907-277-1561</td>
<td>Bureau of Land Management, 555 Cordova St., Anchorage, AK. 99501</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. John Hall, Director of Technical Services</td>
<td>907-279-9565</td>
<td>Federal-State Land Use Planning Commission, 733 W 4th Ave, Anchorage, AK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Larry Mayo, Hydrologist</td>
<td>908-452-1951</td>
<td>USGS Water Resources Division, Federal Bldg. Box 11, 101 12th Ave, Fairbanks, AK 99701</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Art Woll, EROS Coordinator</td>
<td>202-343-2336</td>
<td>Bureau of Indian Affairs, 1951 Constitution Ave, Washington, DC 20245</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. James B. Haynes, Resources Analyst</td>
<td>907-452-4755</td>
<td>Doyon, Ltd. 1st and Hall Sts, Fairbanks, AK 99701</td>
<td></td>
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<tr>
<td></td>
<td>Mr. Enzo Becia, Forester (Transferred)</td>
<td>907-279-9565</td>
<td>Federal-State Land Use Planning Commission, 733 W 4th Ave, Anchorage, AK</td>
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</tr>
<tr>
<td></td>
<td>Mr. Larry Flodin, Partner</td>
<td>907-452-4000</td>
<td>Northland Wood Products, 1500 College Rd, Fairbanks, Alaska 99701</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr. Ralph Root</td>
<td>907-279-7402</td>
<td>National Park Service, 524 W 6th Ave, Anchorage, AK 99501</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Ted Freeman, State Resource Conservationist</td>
<td>907-276-4246</td>
<td>Soil Conservation Service, 2221 E. Northern Lights Blvd, Anchorage, AK 99504</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Douglas C. Toland, Research Analyst (Resigned)</td>
<td>907-465-2666</td>
<td>Ms. Charlette Chastain, Chief, Environmental Analysis, Alaska Dept. of Environmental Conservation, Pouch O, Juneau, AK 99811</td>
<td></td>
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<tr>
<td></td>
<td>Mr. James E. Preston, District Conservationist (Transferred)</td>
<td>907-274-4558</td>
<td>Mr. Ralph Bell, Water Resource Specialist (Retired) and Mr. Ted Freeman, State Resource Conservationist Soil Conservation Service, 2221 E. Northern Lights Blvd, Anchorage, AK 99504</td>
<td></td>
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<tr>
<td></td>
<td>Mr. Carl Probes</td>
<td>907-278-2611</td>
<td>Chugach Native Association, 912 E 15th St, Anchorage, AK 99501</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Roger Herrera</td>
<td>907-278-2611</td>
<td>BP Alaska Inc, P.O. Box 4-1739, Anchorage, AK 99509</td>
<td></td>
</tr>
</tbody>
</table>
13. Dr. Jerry Galt, Oceanographer  
   Pacific Marine Environmental Laboratory, 3711 15th Ave NE, Seattle, WA 98105  
   and  
   Dr. Gunter Weller, Manager, Arctic Project Office  
   BLM-NOAA OCS Environmental Assessment Program, 611 Elvey Bldg,  
   University of Alaska, Fairbanks, AK 99701

14. Mr. Bill Hill, Fire Control Officer  
   Bureau of Land Management, P. O. Box 3505, Ft. Wainwright, AK 99703

15. Mr. Charles Parr, Real Property Officer  
   Golden Valley Electric Association, P. O. Box 1249, Fairbanks, AK 99701

16. Mr. Joe Stevens, Geophysicist (Transfered)  
   Atlantic Richfield Company, P.O. Box 360, Anchorage, AK 99510

17. Ms. Meg Hayes, Plans Chief  
   Alaska Division of Lands, 4420 Airport Rd., Fairbanks, AK 99701

18. Mr. Allen Epps, Natural Resources & Land-Use Planning Spec.  
   USDA Cooperative Extension Service, University of Alaska, Fairbanks, AK 99701  
   and  
   Dr. Allan Linn, Director  
   Alaska Division of Agriculture, P. O. Box 1088, Palmer, AK 99645

OTHER AGENCY CONTACTS
Not Related to Specific Projects

Federal:
Mr. Karl M. Hegg, Research Forester  
U.S. Forest Service, Forestry Science Laboratory  
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Dr. Mike Morford  
NOAA/National Marine Fisheries Division

Dr. Arthur LaPerriere, Remote Sensing Coordinator  
U.S. Fish & Wildlife Service, 813 D St., Anchorage, AK 99501

Mr. Ralph M. Bell  
USDA Soil Conservation Service, 2221 E. Northern Lights Blvd,  
Anchorage, AK 99504

Mr. Glen H. Greeley  
USA Corps of Engineers, P.O. Box 7002, Anchorage, AK 99510

Dr. Erk Reimnitz  
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Mr. Steve Clautice, Mr. Fred Bethune, and 907-479-2243
Ms. Sheila Champion
Alaska Div. of Lands, 4420 Airport Rd, Fairbanks, AK 99701

Private organizations:
Mr. Richard Firth
Woodward-Clyde Consultants

Mr. Phil Holdsworth, owner
INEXCO Mining Co., 1009 Mendenhall Apts., Juneau, AK 99801

Mrs. Susan K. Cage, Geologist
Fulf Oil Co., Box 1392, Bakersfield, CA 93302

Leo P. Fay, Senior Geologist
Atlantic Richfield Co., Box 360, Anchorage, AK 99510

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Mr. L.E. Heiner, Partner 907-479-6231
Research Associates of Alaska, P.O. Box 80006, Fairbanks, AK 99708

Dr. George Divoky 415-868-1221
Pt. Reyes Bird Observatory
4990 Shoreline Highway, Stinson Beach, CA 94970

Mr. Richard Swainbank 907-452-1655
R & M Consultants Inc., 711 Gaffney Rd, Fairbanks, AK 99701
APPENDIX I

VISITOR TRAFFIC AND PRODUCT ORDERS

(FY 73 and FY 74 data are not available)

<table>
<thead>
<tr>
<th>Year</th>
<th>Univ.</th>
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<th>Non-Fed.</th>
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<td>259</td>
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<td>521</td>
<td>174</td>
<td>142</td>
<td>377</td>
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1,023 | 387   | 289     | 676      | 755     | 22     | $135,760 |
APPENDIX J
TECHNOLOGICAL SPIN-OFF

The following projects have at least an indirect relationship between our activities and a resulting extension of the technique. We played at least a catalyst-type of role and thereby these projects deserve mention as "spin-off" results from grant activities, even though one spin-off is non-commercial.

A. Use of Thermal Scanner to Monitor Pile Performance on Alyeska Pipeline

After initial discussions about the existing state-of-the-art, Exxon Production Research Corporation developed their own helicopter-mounted thermal imager for routine surveillance of the refrigerated piles which support the hot pipe above permafrost. System development cost was around $750,000 and annual surveillance operations cost about $200,000.

B. Statewide High-Altitude Aerial Photography Program

The value of the first U-2 mission to Alaska in 1973 convinced several agencies, especially BLM and the Land Use Planning Commission, to seek wider coverage in Alaska. A wide base of support of the concept was developed and culminated in a 13-agency Temporary Task Force for Remote Sensing which generated a cooperative agreement to cost-share the complete coverage by U-2 and RB-57 aircraft of high-altitude photography of the mainland portion of Alaska during the period 1977-1980. Costs of the NASA missions will be totally reimbursable from the state, federal, and regional agencies and should approach $1.5 million.
APPENDIX K

OTHER FUNDING BY FISCAL YEAR

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$656,100

OTHER FUNDING BY TYPE OF AGENCY

A. Federal Agencies $405,825
B. Regional Agencies 10,000
C. State Agencies 162,000
D. Private Agencies 78,275

$656,100

NOTE: Not all funds listed were necessarily contracted through grantee. Included are out-of-pocket costs contributed by cooperating agencies to achieve objectives of the cooperative projects. The large step increase in other funds appearing in FY 76 reflects the impact of two major projects heavily oriented in remote sensing funded on a multi-year basis by the NOAA/BLM Outer Continental Shelf Environmental Assessment Program (OCSEAP). Neither of the OCSEAP projects received NASA grant funds, but were included in the tabulation of other funding sources because they are a direct outgrowth of our earlier activities and they contribute significant momentum and viability to remote-sensing activities of the Geophysical Institute.
APPENDIX L

Final Report on Environmental Studies Associated with the Prudhoe Bay Dock

Coastal Processes and Marine Benthos

PREPARED FOR
NORTH AMERICAN PRODUCING DIVISION
NORTH ALASKA DISTRICT
ATLANTIC RICHFIELD COMPANY
ANCHORAGE, ALASKA

12 April 1977

by

G. W. Gridler, Jr. — Coastal Processes
Principal Investigator

G. A. Robilliard — Marine Biology
Principal Investigator

R. W. Firth, Jr. — Project Manager

Woodward-Clyde Consultants
4781 Business Park Blvd., Suite 1, Anchorage, Alaska 99503
ACKNOWLEDGMENTS

A number of scientists provided invaluable assistance, input, and ideas to Woodward-Clyde Consultants during these studies and the preparation of this report.

A number of state and federal agencies provided assistance in the design of these studies and participated in program design meetings: Alaska Department of Natural Resources, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, the Alaska/NOAA - Outer Continental Shelf Environmental Assessment Program, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Army Corps of Engineers. In addition, Tom Hablett of the National Marine Fisheries Service assisted us in the field.

Professor Douglas Inman, Director of the Shore Processes Group at Scripps Institution of Oceanography, reviewed our planning of the coastal processes study and provided review comments and input throughout the field, analytical, and report preparation periods. Messrs. Greg Geehan, Steve Pawka, and Bob Lowe, under Professor Inman's guidance, assisted in the measurement and prediction of incident wave energies and produced the wave refraction diagrams.

Drs. William Wiseman and Edward Owens of the Louisiana State University Coastal Studies Institute served as outside reviewers of the coastal processes study.

Dr. Al Belon and Mrs. Katie Martz of the University of Alaska Geophysical Institute provided historical aerial photographs of the Prudhoe Bay area. Drs. Peter Barnes and Erk Reimnitz of the U.S. Geological Survey at Menlo Park, California, provided ideas and relayed unpublished results of several of their studies in Alaska.
Dr. Paul Dayton and Mr. John Oliver, polar marine ecologists with Scripps Institution of Oceanography, provided outside review of the marine biology study and unpublished information from their ongoing studies in Antarctica.

Dr. Charles Green, an independent consultant, and Dr. Robert Smith, of the University of Southern California, conducted the hierarchical analysis and its preliminary interpretation.

Mr. John Chapman, of the Bodega Bay Institute of Pollution Ecology, identified the amphipod specimens collected during the field program; Drs. Barry Roth and William Light, independent consultants, assisted in the identification of molluscs and polychaetes, respectively.

In the field, Mr. Angus Gavin provided special assistance at critical times. Mr. Terry Bendock of the Alaska Department of Fish and Game provided the fish used for the baited traps as well as valuable information to Woodward-Clyde Consultants.

Dr. D. W. Chamberlain, Mr. C. H. Dunaway, Jr., Ms. Lydia Lake, Mr. Roland Wilson, Mr. Scott Osborne, and Mr. Les Sellers of Atlantic Richfield Company provided important logistical assistance throughout the project, and especially in the field. In addition, Dr. Chamberlain assisted technically in the field studies in August and September, and provided comments to the authors during data analysis and report preparation.
EXECUTIVE SUMMARY

GENERAL

This report presents the results of two concurrent studies, sponsored by Atlantic Richfield Company in cooperation with a number of state and federal agencies,* to evaluate the environmental effects of the dock extension constructed during the winter of 1975-1976 off the northwestern shore of Prudhoe Bay. The studies began in the ice-free season during the second week of August 1976, and field sampling was completed by September 21. The first study, coastal processes, included measurements of shoreline erosion and deposition, longshore sediment transport, and computation of selected wave refraction patterns. The second study, marine biology, emphasized bottom-living organisms (benthos) and water and sediment characteristics of importance to their existence. A third study, on fish and their migration patterns, was conducted by the State of Alaska Department of Fish and Game and will be the subject of a separate report by that Department.

Prudhoe Bay, on the Beaufort Sea coast immediately west of the mouth of the Sagavanirktok River, is bordered offshore to the west by a series of barrier islands. The easternmost is Stump Island, which is

located 1.5 kilometers west of the dock extension, and was included in
the study area (see Figures 2-1 and 2-2). The coast of the Beaufort Sea
is completely frozen about 10 months of the year; most of the impor-
tant coast-shaping processes and nearshore biological activities take
place during the open-water season, August and September. Predominant
open-water season winds are from the northeast, but severe storms
from the northwest, which occur every few summers, may be very im-
portant in modifying the coastline. Other physical factors, especially
ice presence and scouring in winter and spring and river water influx
during summer, are the major influences on nearshore biotic communities.

COASTAL PROCESSES

OBJECTIVE

The objective of this study was to determine how coastal processes
which occur during the open-water season are affected by the dock
extension. Emphasis was placed on evaluating whether altered wave
patterns would increase erosion down-wave (west) of the extension; if
sedimentation of the shallow lagoon west of the dock would occur; and
if increased erosion of Stump Island was resulting from interruption
of its source of sediment. The effects of the original dock, built
in 1974, also were evaluated because its effects on coastal processes
may not be separable from those of the extension.

APPROACH

The coastal processes studies involved field and analytical
phases. Field measurements were planned for the open-water season
because this is the period when most coastal-shaping activities occur.
Field data were collected in two two-week periods, near the beginning
and end of the ice-free season, to bracket the open-water period. Although predominant winds during summer are from the east, storms—especially severe storms from the northwest—are thought to be of major importance in moving sediment and shaping coastlines. Therefore, by separating measurements into two periods, it was hoped to obtain at least "before-storm" and "after-storm" measurements, if not actually be present during a storm.

To document coastal changes, measurement of beach and underwater bottom profiles was emphasized. Wind and wave measurements were obtained; sediment samples were collected for grain size analysis; and aerial photographs were taken to document the positions of beach/bottom profile transects and general coastal morphology. Analytical studies consisted of the calculation of wave-refraction patterns using a computerized wave-refraction program, calculation of longshore transport, and the review of other Beaufort Sea Coastal studies to compare with these results. The wave-refraction model was run for a variety of wave conditions (periods and directions), and the spreading and focusing of waves were plotted as they encountered shallow water, the dock extension and original dock, and the shorelines nearby. The longshore sediment transport utilized field observations of wave heights in the calculations, and the results were compared with field estimates of sediment deposition as a check of the calculations.

RESULTS

Surface winds at Prudhoe Bay were generally calmer in the summer of 1976 than in 1967-1972 and 1974. Ninety percent of the observations were 15 mph or less while only 50 to 75 percent were less than 15 mph in 1974; as expected, the predominant wind direction was easterly. Strongest winds occurred on 13 and 21 August and 18 September, when
storms with winds of 15 to 25 knots occurred. During these periods, waves breaking as high as 0.6 meter (2 feet) on the extension were observed.

The beaches in the study area are composed of sand and gravel sorted into bands. Stump Island and the dock are principally gravel and one or two sand bars are present offshore of Stump Island. Much of the sand in the area originates from the Sagavanirktok River; the source of gravel on Stump Island and the beaches is unknown, but the former may be a remnant of an eroding tundra shoreline or of the scouring effects of the mid-Wisconsin glacial epoch.

Measurements of the profiles of these beaches and Stump Island show that between the two observation periods little change occurred, except at the east foot of the original dock, where a measured 0.8 meter of sand and gravel was added between 14 August and 14 September. Sediment transport values of the present study can be compared with those of other studies, which have shown that some islands are being moved westward 6 to 25 meters/year and, specifically Stump Island and parts of the shoreline east of Pt. McIntyre, receded 2 meters or more between 1950 and 1970.

Wave refraction calculations show that the shoreline southeast of the dock during summer is not affected by the dock, except at its immediate base, but the shore to the west is protected from easterly waves, which were causing some erosion of a large portion of the shoreline before either dock was constructed. Stump Island does not see wave-shadowing effects of the dock because westerly-moving waves that hit the eastern tip of the island just miss the end of the dock. During the summer of 1976, longshore sediment transport was estimated at about 1,000 meters³ for a three-month period; it could be much greater than this in a summer with very intense wave conditions. The sand being transported to the west is interrupted and trapped.
against the original dock and is deposited at its eastern (windward) base. This, along with material derived from the dock itself (about half of that deposited), resulted in the 0.8 meter rise in beach elevation mentioned above (accumulation of sediment at the base since its construction in 1974 is shown in Figure 2-13). It is expected that accumulation of material here will be slow, and many tens of years would be needed to fill it in up to Dockhead #2, if at all.

CONCLUSIONS

1. The existence of the original dock has interrupted longshore transport, and about 1,000 cubic meters per year of sand are now being trapped against the base of the east side of the original dock; this is a relatively low sediment accumulation.

2. Before dock construction, between 1950 and 1970, the shoreline west of the dock underwent some erosion; now that area is shielded from the predominant wave direction. Other than at the base of the original dock, the shoreline east of the dock has not been affected.

3. Stump Island, located to the west of the dock extension, is not affected by the dock.

4. The dock itself appears to be the most seriously affected portion of the shoreline; a severe storm may remove large quantities of material.

5. Because study of coastal processes during a single summer may not be representative of processes in other summers, a number of years of monitoring may be needed to confirm, modify, or add to these conclusions.