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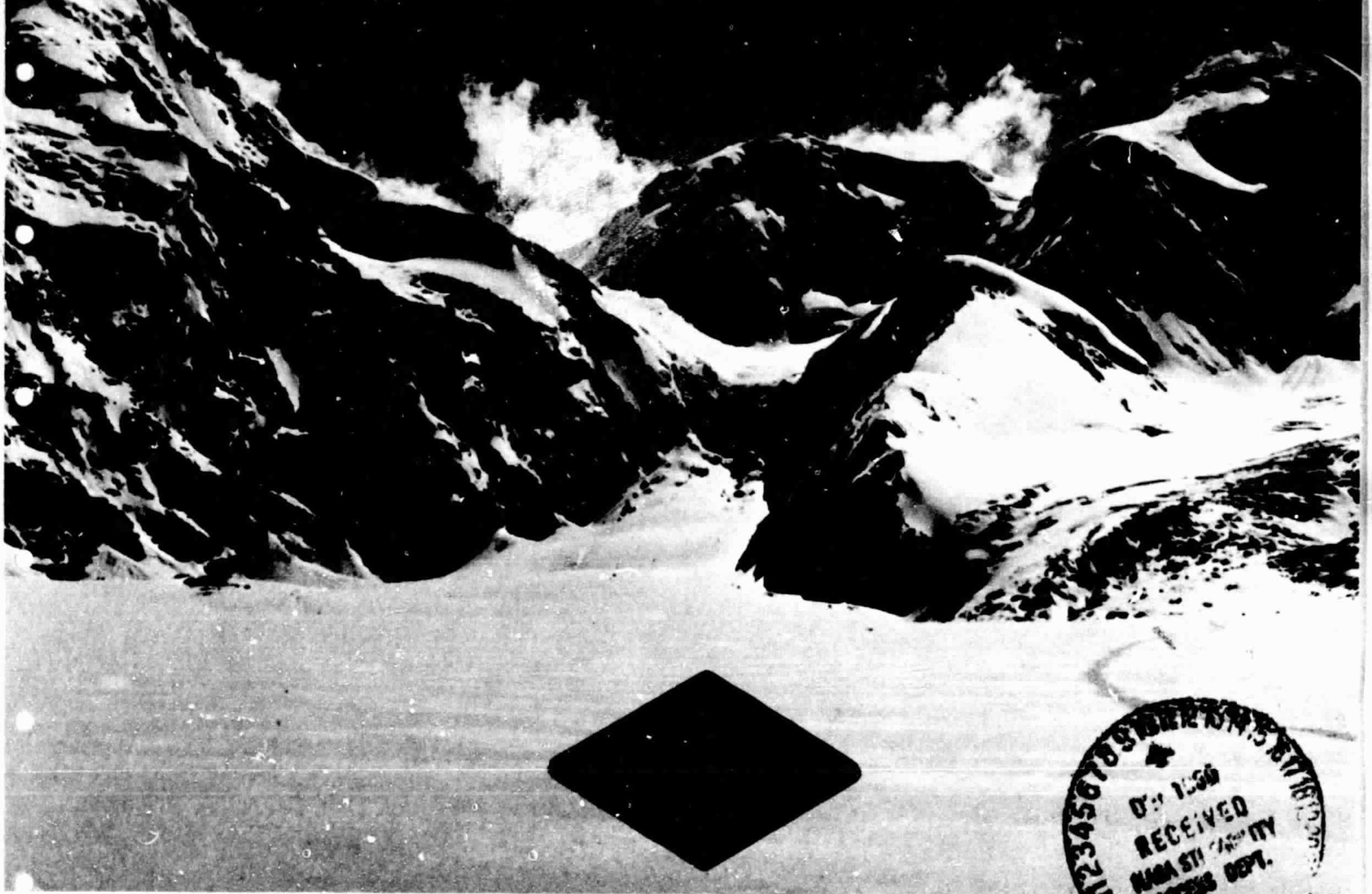

APPLICATIONS OF REMOTE-SENSING DATA IN ALASKA

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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 socioeconomic 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 indigeneous 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

Gulf of Alaska (June 1980), Kodiak (Oct. 1980), Lower Cook Inlet II (May 1981), and Bering Sea-Norton Sound (Dec. 1981).

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 interactic 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 on-going 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 remcte-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 perseverence 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:

<u>July 12, 1977</u> (Figure 2)

The base camp was located halfway between Chicago Creek and Independence mining camps on the Kugruk River. The

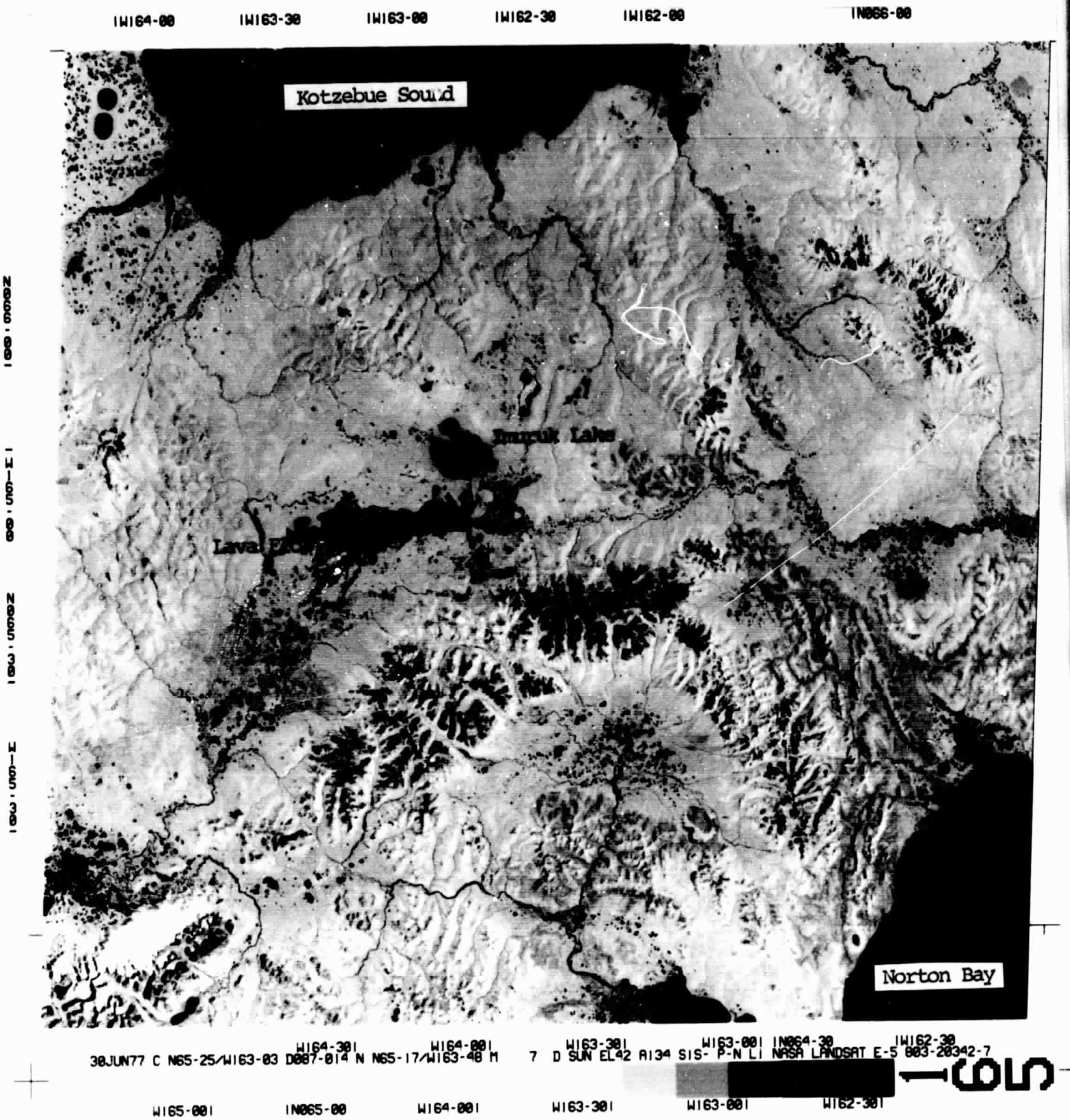

Figure 1. A Landsat image of a portion of the Seward Peninsula 9 days before the ignition of the Kugruk River fire.

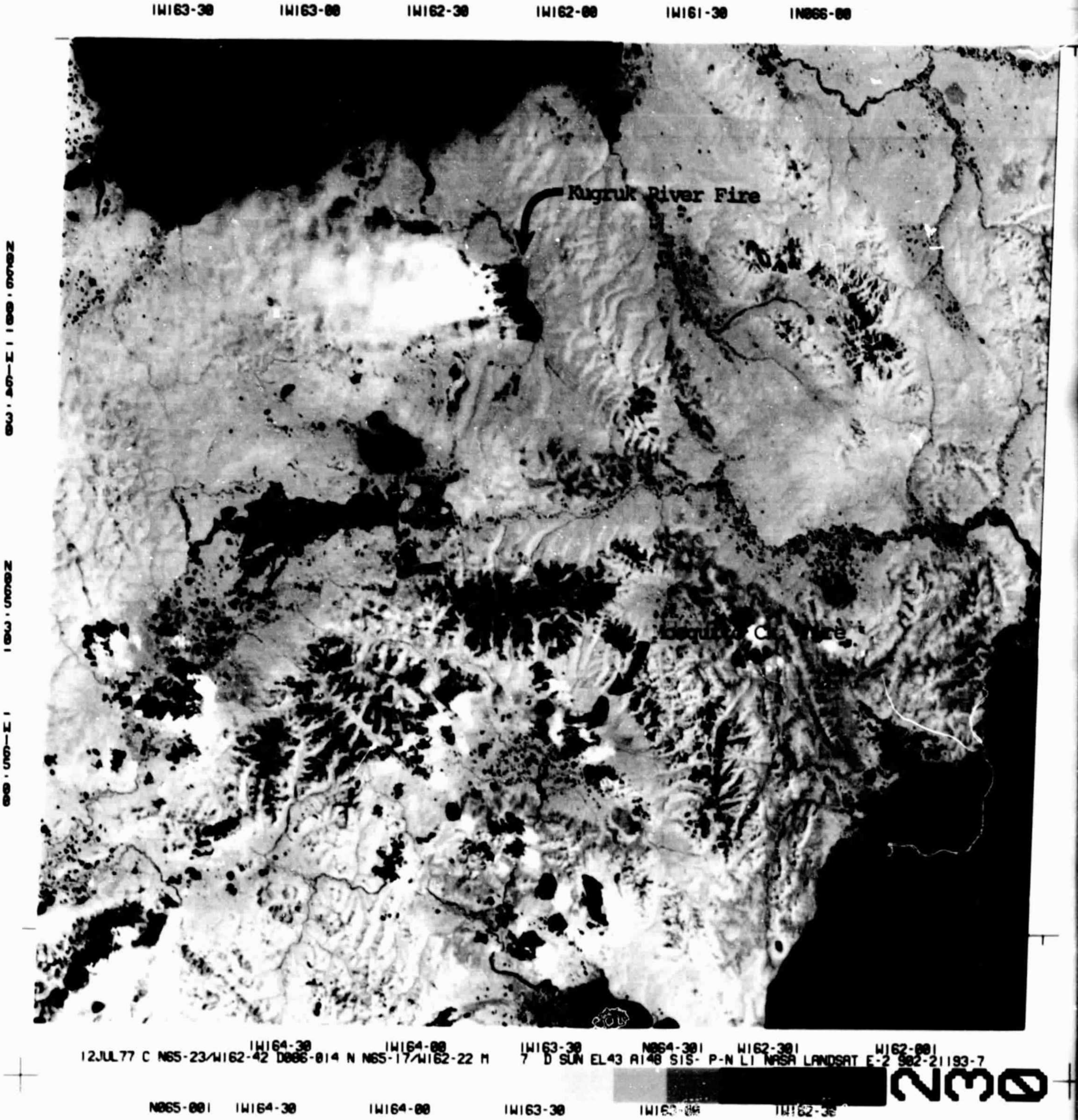

Figure 2. The Kugruk River fire 3 days after ignition. It has grown to approximately 20,000 acres.

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.

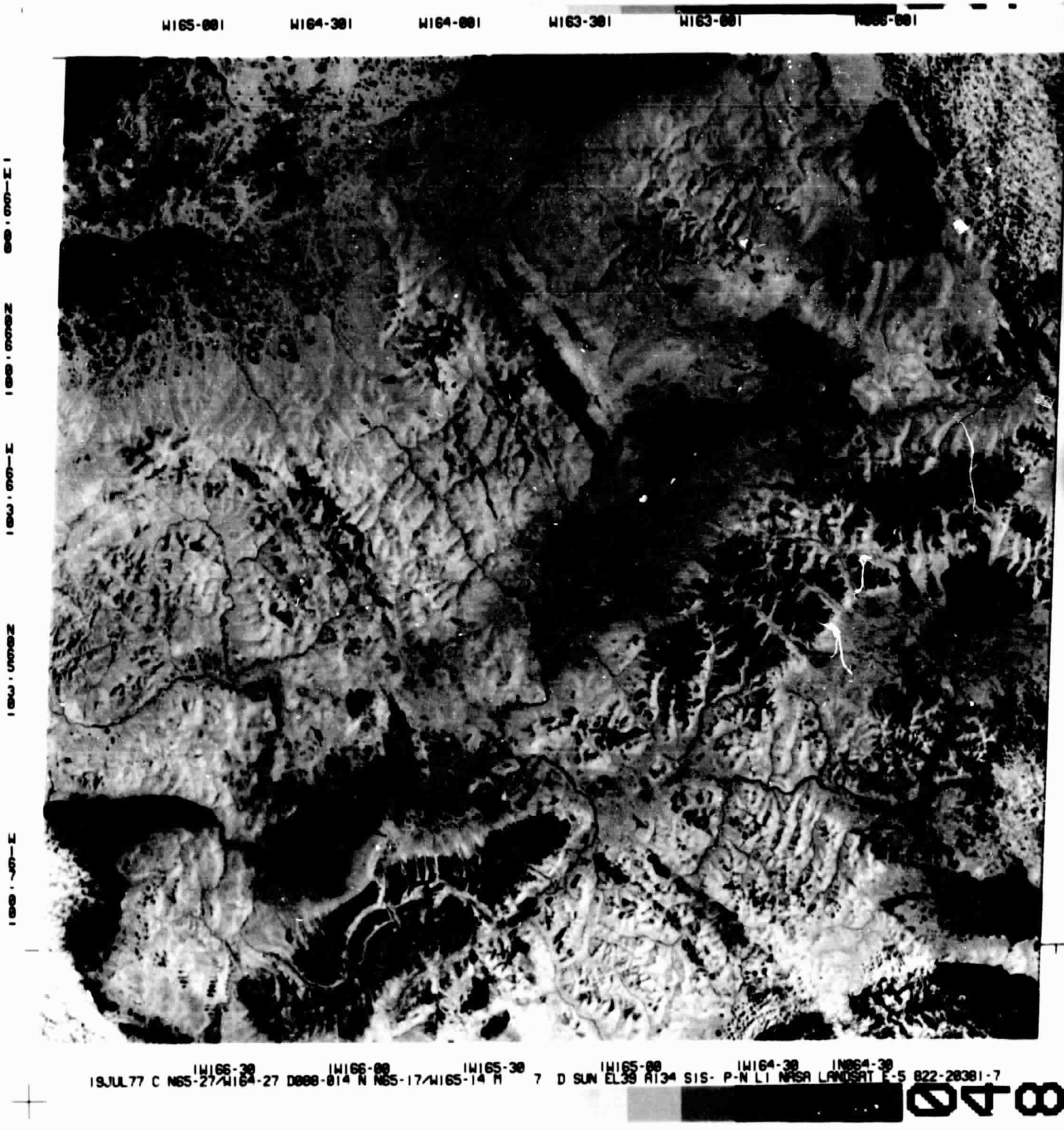

Figure 4. A few hours after this Landsat image on July 19, 1977, the fire erupted out of control again on the southwest as a result of a stiff wind.

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.

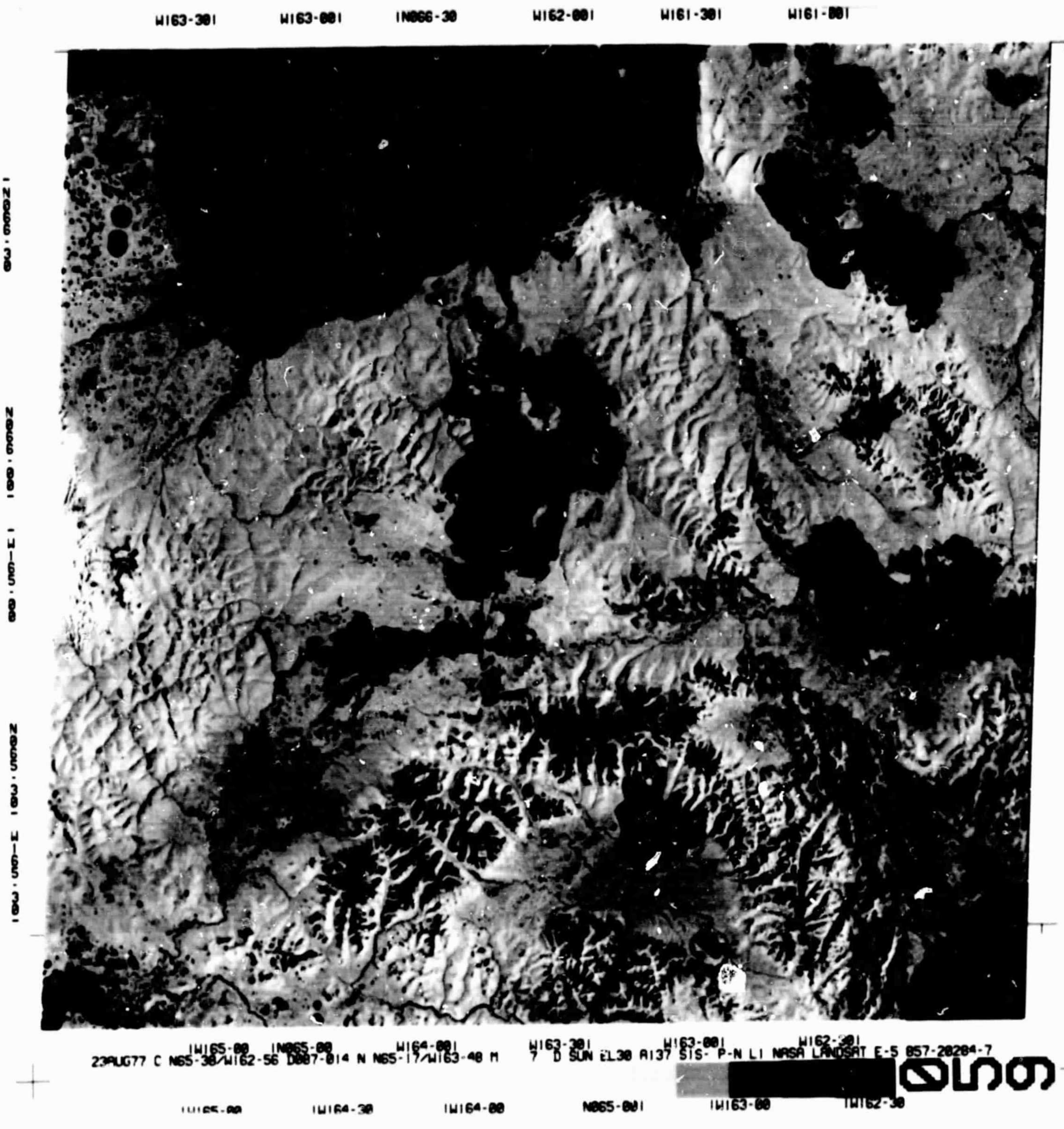

Figure 6. While not yet declared out, the Kugruk River fire appears to be quiet by August 23, 1977. It had burned 270,000 acres. Some 300,000 additional acres were burned by six other fires that are visible on this image.

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

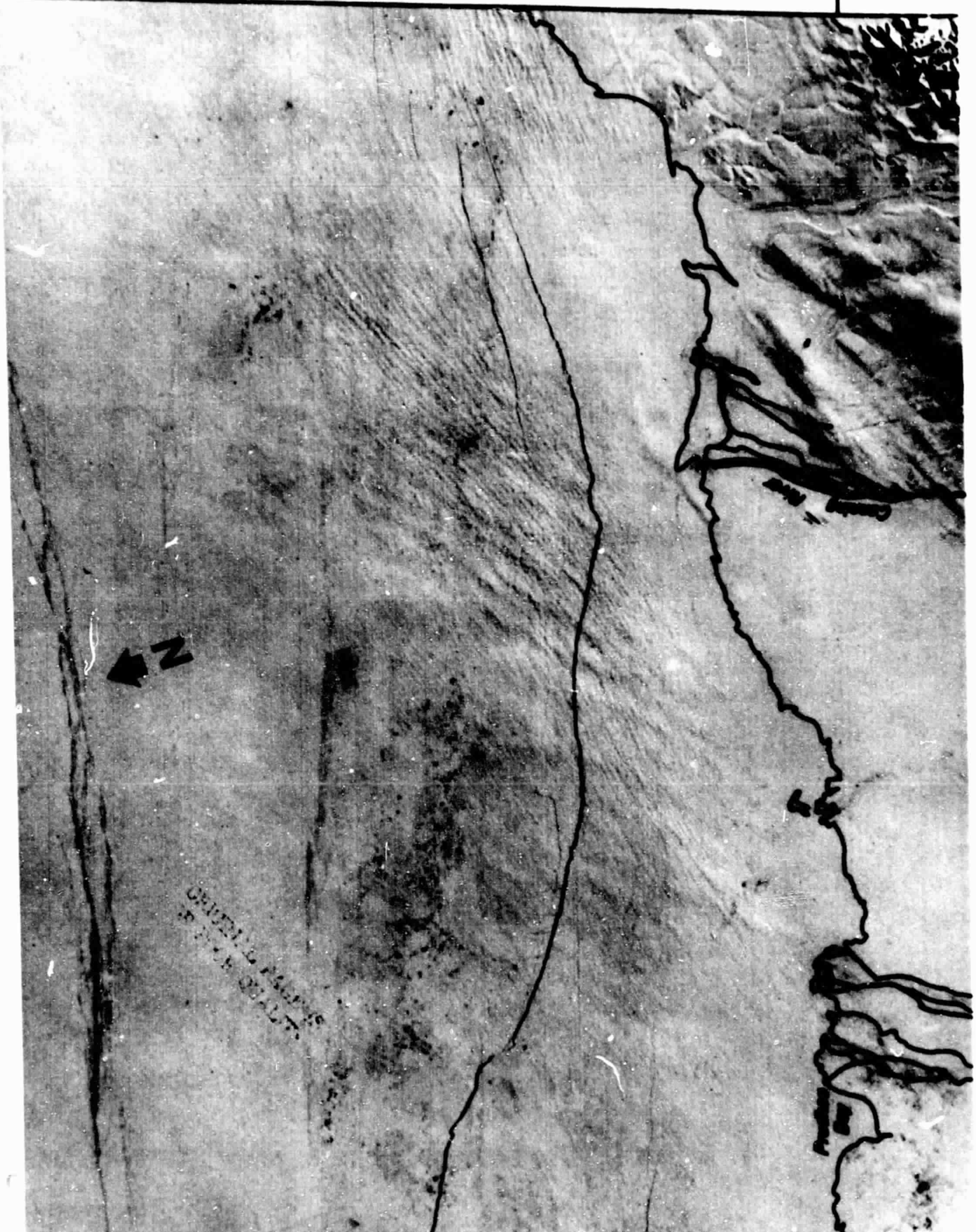

Figure 7. Sea-ice as shown by Landsat on April 8, 1977. ARCO was conducting seismic exploration near the long ice-lead in the center of this scene.

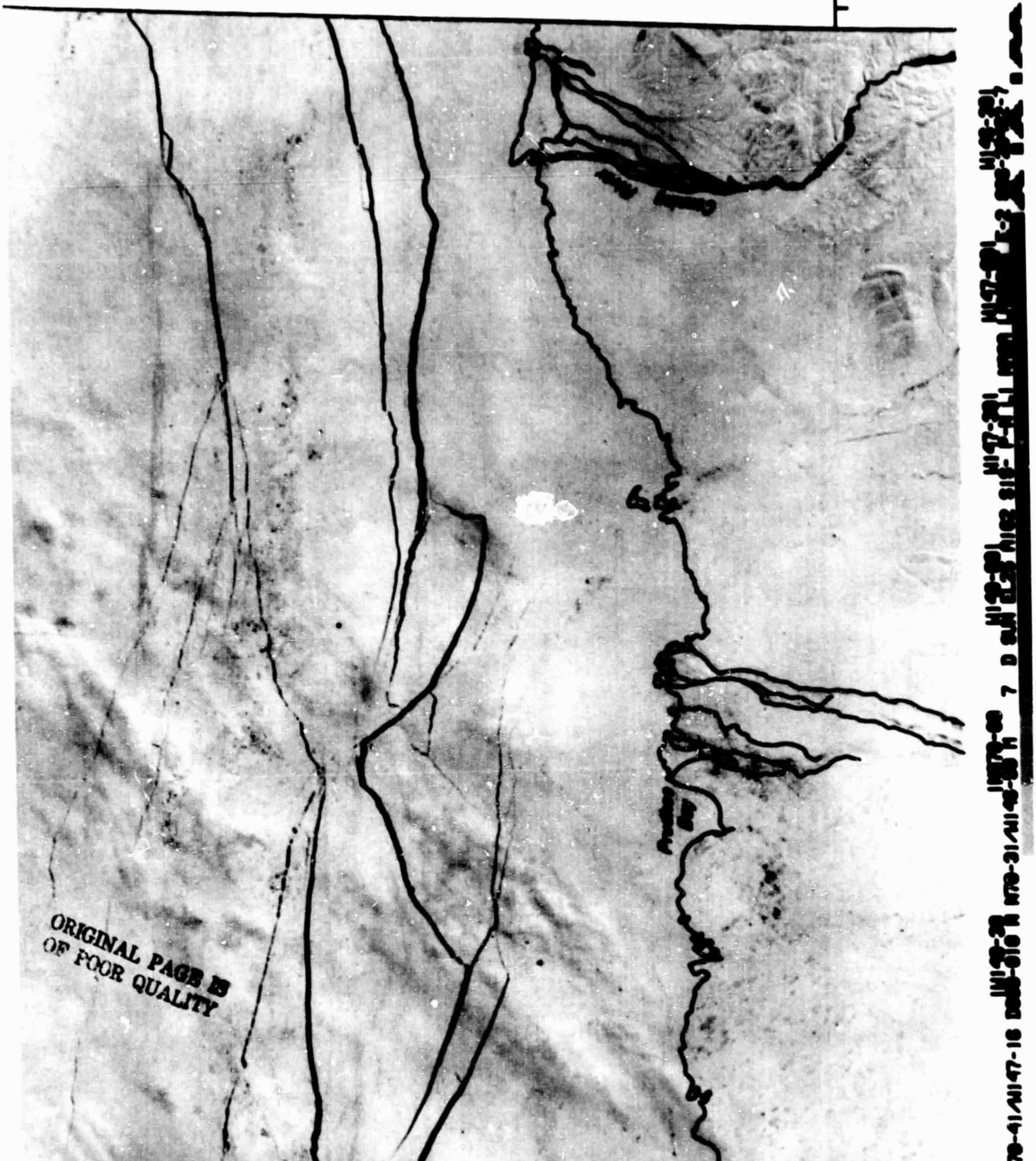

Figure 8. Ice conditions the following day showed that the ice shoreward from the initial lead is largely stable. The higher risk region is seaward of the location of the seismic crews.

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

<u>TANANA LOOP AGRICULTURAL RIGHTS SALE</u>

AUCTION #230

PLACE OF AUCTION:	Delta School Gymnasium Delta Junction, Alaska
DATE OF AUCTION:	Saturday, 29 April 1978
TIME OF AUCTION:	1:00 P.M., Bidder Registration 2:00 P.M., Information Briefing and Bidding

Subject to the provisions of AS 38.35, 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:

<u>UNITS FOR SALE</u>

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 enterprize 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 DERMOT COLE
News-Miner Bureau

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 1980, the Hammond administration says.

Gov. Jay Hammond announced Friday he will seek appropriations from the legislature totalling 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 they are analyzed the state will begin full scale clearing of the 55,000 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 reelection, said, "Our goal is to place 50,000 acres of state land in the Delta Junction area in agricultural production by 1980. To help this industry to get upon 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 5,000 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 rape seed 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 preceeding 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 preceeding 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 longshore 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.

[illegible]

MINES & GEOLOGY BULLETIN

[illegible]

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 about 30 inches square that can be conveniently affixed to a wall.

The mosaic was compiled for DGGS by the University of Alaska Geophysical Institute from Landsat imagery taken at an altitude of 915 kilometers (570 miles) during July 1972 through September 1976. The map, which will be sent in a mailing tube, may be obtained from any DGGS mining information office (p. 1) for $7.

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.

CONFERENCES AND MEETINGS ATTENDED

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:

American Society of Photogrammetry, Annual Convention, Seattle, Sept. 27 - Oct. 1, 1976.

OCSEAP Meeting on Bird Investigations, Anchorage, October 20-22, 1976.

OCSEAP Beaufort Sea Symposium, Barrow, Feb. 7-11, 1977.

11th International Symposium on Remote Sensing of Environment, University of Michigan, Ann Arbor, April 25-29, 1977.

Conference on Machine Processing of Remotely Sensed Data, Purdue University, West Lafayette, Indiana, June 21-23, 1977.

Landsat in Alaska, Remote Sensing for Resource Inventories, BLM, Anchorage, June 30, 1977.

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 petroleum 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 occuring changes occuring 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:

Introduction to Remote Sensing, Fairbanks, Dec. 11-15, 1972.

Introduction to Remote Sensing, Anchorage, Jan. 15-26, 1973.

Introduction to Remote Sensing, Juneau, April 9-14, 1973.

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

American Society of Photogrammetry, Annual Meeting, Washington, D.C. March 11-16, 1973.

Briefing on Satellite Data to Governor William A. Egan, Fairbanks, May, 1973.

FY 74

24th AAAS Alaska Science Conference, Fairbanks, Aug. 14-15, 1973.

American Society of Photogrammetry, Fall Convention, Oct. 2-5, 1973.

Conference on Machine Processing of Remotely Sensed Data, Purdue University, Oct. 16-18, 1973.

Alaska Rural Development Council, Anchorage, December 5-6, 1973.

Third ERTS Symposium, Washington, D.C., December 10-14, 1973.

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

Alaska Rural Development Council, Fairbanks, July 11-12, 1974.

City of Nenana Development Council, Nenana, September, 1974.

Alaska Rural Development Council, Anchorage, October 2-3, 1974.

Alaska Rural Development Council, Fairbanks, December 11-12, 1974.

25th AAAS Alaska Science Conference, Anchorage, February, 1975.

Alaska Surveying & Mapping Convention, Anchorage, February, 1975.

Alaska Rural Development Council, Juneau, March 12-13, 1975.

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

Alaska Rural Development Council, Fairbanks, July 14-15, 1975.

Tenth International Symposium on Remote Sensing of Environment, University of Michigan, October 6-10, 1975.

Alaska Rural Development Council, Palmer, October 8-9, 1975.

Alaska Rural Development Council, Kodiak, January 13-14, 1976.

Alaska Rural Development Council, Juneau, April 13-14, 1976.

Conference on Machine Processing of Remotely Sensed Data, Purdue University, June 29 - July 1, 1976.

FY 77

Alaska Rural Development Council, Fairbanks, July 14-15, 1976.

Active Microwave Users Workshop, Houston, August 10-12, 1976.

American Society of Photogrammetry, Annual Convention, Seattle, September 27 - October 1, 1976.

Alaska Rural Development Council, Kotzebue, October 13-14, 1976.

OCSEAP Meeting on Bird Investigations, Anchorage, October 20-22, 1976.

Forestry Applications Workshop, Houston, December 6-9, 1976.

Alaska Rural Development Council, Anchorage, January 19-20, 1977.

Alaska Surveying and Mapping Convention, Anchorage, Jan. 24-25, 1977.

OCSEAP Beaufort Sea Symposium, Barrow, Alaska, February 7-11, 1977.

Bristol Bay Forestry Workshop, Dillingham, Alaska, April 9-10, 1977.

Alaska Rural Development Council, Juneau, Alaska, April 13-14, 1977.

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 Imagery, Scientific Report on NASA Contract NAS 5-21833, Institute of Arctic Biology and Geophysical Institute, University of Alaska, 1973.

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 NAS5-21833, Geophysical Institute, University of Alaska, 1973.

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, 1973.

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, Geophysical Institute, 1973.

Miller, J. M., Environmental surveys in Alaska based upon ERTS data, Summary of Results, Third Earth Resources Technology Satellite-1 Symposium, Vol. II, p. 12, NASA/GSFC Report SP.357, 1973.

Miller, J. M. and A. E. Belon, Alaska and the super eye, Alaska Magazine, Vol. 39, No. 9, p. 34, September 1973.

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 Report X-650-73-127, 1973.

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, 1973-1976.

Belon, A. E. and J. M. Miller, Applications of ERTS data to resources surveys of Alaska, Proceedings of the Third ERTS-1 Symposium, NASA/GSFC, Vol. I(B), 1899-1907, 1974.

Belon, Albert E. and John M. Miller, The role of satellite remote sensing in Alaska's future, Proceedings of the Alaska Survey and Mapping Convention, Anchorage. 1974.

Miller, J. M. and A. E. Belon, A summary of ERTS data application in Alaska, Proceedings of Ninth International Symposium on Remote Sensing of the Environment, University of Michigan, 2113, 1974.

Miller, J. M. and A. E. Belon, The University of Alaska ERTS program, Proceedings of the 24th Alaska Science Conference "Climate of the Arctic", University of Alaska Press, in press, 1974.

Stringer, W. J., Feasibility study for locating archaeological village sites by satellite remote sensing techniques. Final report, ERTS-1 project GSFC no. 110-14, Oct. 17, 1974.

Stringer, W. J., The morphology of Beaufort Sea shore-fast ice, Proceedings of the Symposium on Beaufort Sea Coast and Shelf Research, Arctic Institute of North America, 165-172, 1974.

Belon, A. E., J. M. Miller and W. J. Stringer, Environmental assessment of resource development in the Alaskan coastal zone based on LANDSAT imagery, Proceedings of the NASA Earth Resources Symposium, Houston, Texas, Volume II, NASA Report TM X-58158, 1975.

Miller, J. M., A. E. Belon, L. D. Gedney and L. H. Shapiro, A look at Alaskan resources with LANDSAT data, Proceedings of the Tenth International Symposium on Remote Sensing of Environment, University of Michigan, Vol. II, p. 879, 1975.

Miller, J. M., A. E. Belon and W. J. Stringer, A look at Alaskan resources with LANDSAT data, Proceedings of the Tenth International Symposium on Remote Sensing of the Environment, University of Michigan, in press, 1975.

Stringer, W. J. and S. A. Barrett, Katie's Floeberg, The Northern Engineer, Vol. 7, No. 1, Spring 1975.

Stringer, W. J., J. M. Miller, A. E. Belon, L. H. Shapiro and J. H. Anderson, Application of satellite remote-sensing data to land selection and management, Proceedings of the NASA Earth Resources Symposium, Houston, Texas, Volume 1-C, p. 1785, NASA Report TMX-58168, 1975.

George, T. H., J. E. Preston, W. J. Stringer, Range Resource Inventory from Digital Satellite Imaging on the Baldwin Peninsula, N. W., Alaska. Report to the Soil Conservation Service, February, 1976.

Miller, J. M., T. H. George, Use of Satellite Data in Mapping Ecosystems in Alaskan Coastal Zones, Presented at the Alaskan Science Conference, Fairbanks, Alaska, Aug. 1976.

Stringer, W. J. and S. A. Barrett, Ice motion in the vicinity of a grounded floeberg, Proceedings of the Third Conference on Port and Ocean Engineering under Arctic Conditions, University of Alaska, 1976.

Stringer, W. J., T. H. George, R. M. Bell, Identification of flood hazard resulting from aufeis formation in an interior Alaska stream. Information and Evaluation Report, Soil Conservation Service, 1976.

George, T. H., W. J. Stringer, J. N. Baldridge, Reindeer Range Inventory in Western Alaska from Computer Aided Digital Classification of LANDSAT data, Presented at the 11th International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, April 1977.

Miller, J. M., Impact of environmental information from Landsat to petroleum exploration in the Gulf of Alaska, Proceedings of the Eleventh International Symposium on Remote Sensing of the Environment, Environmental Research Institute of Michigan, Vol. II, 1065, 1977.

APPENDIX C

Bristol Bay Native Association Workshop

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
P.O. Box 1628
Juneau, Alaska 99802

February 17, 1977

Mr. Andrew Golia
Economic Planner
Bristol Bay Native Association
P.O. Box :79
Dillingham, Alaska 99576

3220

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 did'nt 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	Sawmill Improvement Specialist, U.S. Forest Service, San Francisco, Calif.
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

6200-11 (1/69)

2/17/77

DILLINGHAM MEETING

TENTATIVE AGENDA

Tuesday, March 15

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

Wednesday, March 16

8:30 AM	Using Satellite Photography for Resource Inventory	John Miller
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

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 410
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

WORLD WOOD Special Feature—

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

Tiverton, Devon, UNITED KINGDOM

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

Résumé: Les utilisateurs actuels et futurs de scieries mobiles trouveront la description de huit variétés fondamentales avec des observations sur la performance et les exigences. On décrit les avantages des différents types de scierie et on offre des directives pour une sélection éventuelle. Dans les pages qui suivent se trouvent les spécifications de base des modèles 18 et vous pourrez utiliser notre Service Lecteurs pour obtenir des renseignements supplémentaires.

Zusammenfassung: Gegenwärtige und zukünftige Benutzer von mobilen Sägewerken finden nachstehend die Beschreibung von acht grundlegenden Arten von Sägewerken mit Bemerkungen über ihre Leistung und Anforderungen. Die Vorzüge der verschiedenen Typen werden erläutert und Ratschläge für eine eventuelle Auswahl erteilt. In den folgenden Seiten findet der Leser grundlegende Daten der 18 Modelle und kann dank des Leserdienstes weitere Auskünfte einholen.

Sumario: Los utilizadores actuales y futuros de aserraderos móviles encontrarán la descripción de ocho tipos fundamentales de aserradores con observaciones sobre capacidad y exigencias. Se discuten las ventajas de varios tipos y se ofrecen directivas para una selección eventual. En las páginas siguientes se encuentran especificaciones de modeles 18 y se pueden obtener informaciones ulteriores con nuestro Servicio de Lectores.

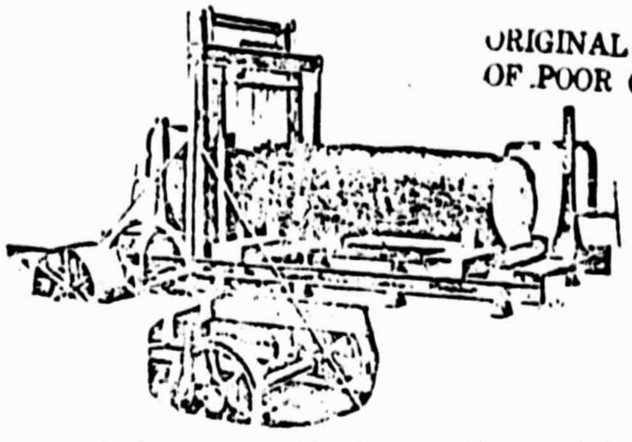

Figure 1: Not the *original* portable mill, but an old one, made by Thomas Robinson & Son Ltd., UK, now discontinued.

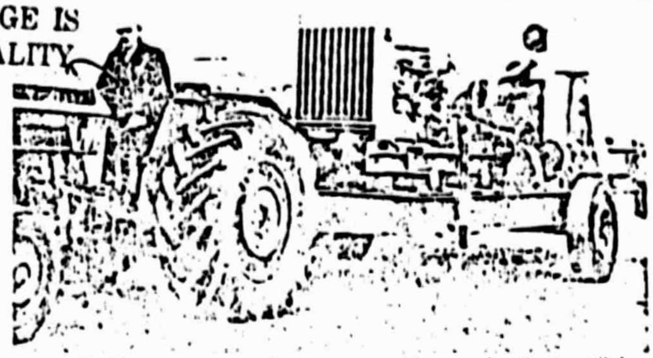

Figure 2: Center portion of a transportable circular Bush Mill by Stenner of Tiverton has two wing portions to carry track that are registered to the center. They also carry carriage and auxiliaries. Note alignment of jacks.

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) bandsaws; and (3) chainsaws, each with many variations. Many decades ago both portable and transportable frame saws were marketed but it is doubtful if they are currently available. Thomas Robinson & Son Ltd., Rochdale, England, made a portable breaking down frame saw in sizes up to 1.80 m (72 inches) dia logs with no part exceeding 502 kg (1,120 pounds) for ease of transport (see Figure 1).

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 1.80 m and 1.20 m (72 inches and 48 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 benches: 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

Figure 3: The Wick Industries International unit is a typical one with two circular saws set at 90° to one another and with saw moving over a stationary log.

are simple and effective, easily moved and very suitable for softwoods and hardwoods within limited weights.

Variations on this design include infeed log chains, 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 sawn 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 appreciable 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 fail of the saw unit are usually standard features; the sawyer normally rides with the machine on a platform. Main drive is by

Figure 4: This transportable mill with circle saws has a log carriage and auxiliaries. Made by Webb & Gifford Division, it is also available with top saw for greater depth of cut. This one is mounted on an industrial truck suspension system and has an independent diesel engine. It will handle logs up to 7 m long and weighing up to 9 tons.

C6

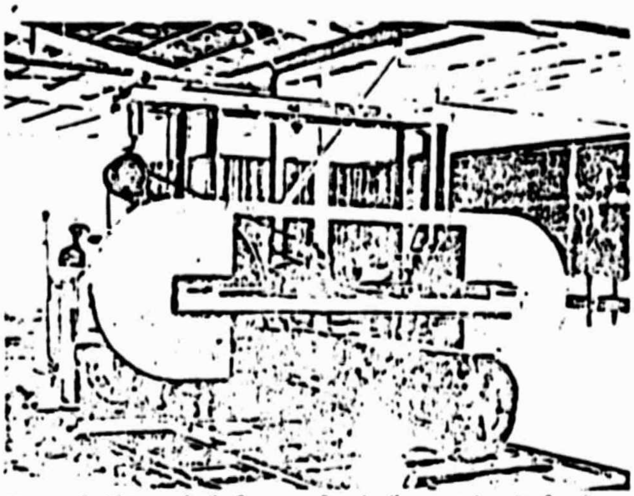

Figure 5: This UK-built Forestor Band. ll operating in Southeast Asia shows the type where the bandsaw unit moves over a stationary log. This unit will take logs up to 1.8 m dia and to any length. Drive is from a 71.5-kW diesel engine.

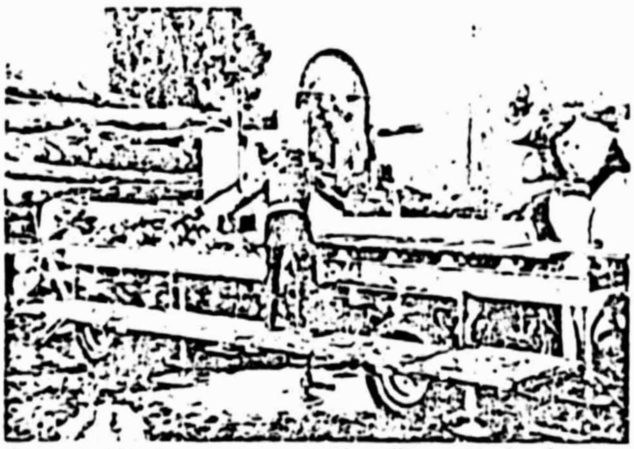

Figure 6: This Stenner transportable rolling table log bandsaw has 1.06-m pulleys, a 127-mm wide saw and a self-contained diesel engine.

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 4.87 m (16 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, either separate or built-on driving unit—electric or diesel—and the sawing headrig tiltable to provide greater ground clearance. A machine with 1.06 m (42 inches) dia saw pulleys for 127 mm (5 inches) wide saws, is shown in Figure 6.

Chainsaw types are simplest

Chainsaw units: The simplest is the 2-man unit with guide referred to earlier, a useful machine designed for a restricted use. Larger machines use a horizontally-disposed chainsaw cutting longitudinally through a stationary log, 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 1.80 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.

Selecting the correct machine type

Before deciding the type of machine to purchase, it is essential to define very clearly the *duty required* from is. 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 sawntimber 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 sawntimber: 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 imput 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.

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 back-up 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. Circulars will stand a modest amount of abuse; they waste good timber as saw kerf—25 mm (½ 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

2204-22022	August 14, 1975	20	69.34N	162.49W	34	165	Point Lay
2201-22031	August 14, 1975	20	66.57N	166.21W	36	159	Shishmaref
2207-22182	August 17, 1975	5	73.22N	160.03W	29	172	Chukchi Sea
2207-22184	August 17, 1975	20	72.07N	162.44W	31	169	Chukchi Sea
2208-20404	August 18, 1975	5	73.19N	135.40W	29	172	Beaufort Sea
2208-20411	August 18, 1975	10	72.05N	138.20W	30	169	Beaufort Sea
2209-22312	August 19, 1975	20	68.12N	171.55W	33	162	Chukchi Sea
2213-21103	August 23, 1975	25	69.38N	149.46W	31	165	Sagavanirktok
2214-21163	August 24, 1975	20	68.26N	152.56W	31	163	Chandler Lake
2221-21554	August 31, 1975	10	71.59N	157.13W	26	170	Barrow
2229-20590	September 8, 1975	20	69.22N	147.24W	25	166	Sagavanirktok
2230-21042	September 9, 1975	0	70.39N	146.48W	24	169	Flaxman Island
2230-21063	September 9, 1975	10	64.02N	155.06W	29	159	Ruby
2233-21211	September 12, 1975	15	71.54N	148.47W	22	171	Beaufort Sea
2233-21213	September 12, 1975	10	70.38N	151.06W	23	169	Harrison Bay
2244-20403	September 23, 1975	5	73.07N	136.13W	16	175	Beaufort Sea
2244-20405	September 23, 1975	5	71.53N	138.49W	17	173	Beaufort Sea
2244-20421	September 23, 1975	25	68.01N	144.58W	21	166	Arctic
2244-20435	September 23, 1975	15	62.39N	150.37W	25	160	Talkeetna
2244-20441	September 23, 1975	25	61.17N	151.44W	27	158	Tyonek
2245-20470	September 24, 1975	20	70.36N	142.36W	18	170	Barter Island
2245-22302	September 24, 1975	10	70.35N	168.25W	18	170	Chukchi Sea
2246-20533	September 25, 1975	2	68.02N	147.48W	20	166	Philip Smith Mts
2246-20540	September 25, 1975	0	66.43N	149.26W	21	165	Beaver
2246-20542	September 25, 1975	5	65.22N	150.54W	22	163	Tanana
2247-20594	September 26, 1975	0	66.41N	150.53W	21	165	Bettles
2248-21050	September 27, 1975	5	68.03N	150.42W	19	167	Chandler Lake
2248-21053	September 27, 1975	0	66.44N	152.20W	20	165	Bettles
2249-21093	September 28, 1975	0	71.54N	145.59W	15	173	Beaufort Sea
2249-21123	September 28, 1975	15	62.40N	157.45W	23	161	Iditarod
2250-21151	September 29, 1975	0	71.56N	147.22W	15	173	Beaufort Sea
2254-21425	October 3, 1975	10	57.02N	169.06W	26	156	Pribilofs
2254-21431	October 3, 1975	10	55.38N	169.56W	27	155	Bering Sea
2255-21451	October 4, 1975	20	67.57N	160.50W	17	167	Baird Mts.
2262-22240	October 11, 1975	0	71.48N	164.49W	11	174	Chukchi Sea
2262-22242	October 11, 1975	0	70.32N	167.06W	12	172	Chukchi Sea
2276-22005	October 25, 1975	0	71.52N	158.54W	05	175	Chukchi Sea
2276-22021	October 25, 1975	20	68.00N	165.03W	09	169	Point Hope
2278-22125	October 27, 1975	2	70.36N	164.05W	06	173	Chukchi Sea
2278-22131	October 27, 1975	5	69.19N	166.06W	07	171	Chukchi Sea
2279-22185	October 28, 1975	5	69.21N	167.30W	07	171	Chukchi Sea
2280-20435	October 29, 1975	0	61.18N	151.46W	14	163	Tyonek
2280-20442	October 29, 1975	25	59.56N	152.49W	15	162	Seldovia
2282-20554	October 31, 1975	5	59.57N	155.39W	14	162	Iliamna
2283-20583	November 1, 1975	0	69.21N	147.28W	05	171	Sagavanirktok
2283-20590	November 1, 1975	0	68.03N	149.17W	07	169	Philip Smith Mts
2283-20592	November 1, 1975	0	66.44N	150.55W	08	168	Bettles
2283-20595	November 1, 1975	0	65.24N	152.25W	09	167	Wiseman
2283-21001	November 1, 1975	0	64.02N	153.46W	10	165	Ruby
2283-21004	November 1, 1975	0	62.40N	154.59W	11	164	McGrath
2283-21010	November 1, 1975	0	61.19N	155.57W	13	163	Lime Hills
2283-21013	November 1, 1975	20	59.56N	157.06W	14	162	Dillingham
2283-21015	November 1, 1975	20	58.34N	158.03W	15	161	Nushagak Bay
2284-21033	November 2, 1975	2	71.53N	144.33W	03	175	Beaufort Sea
2284-21035	November 2, 1975	0	70.38N	146.51W	04	173	Beechey Point
2284-21042	November 2, 1975	0	69.21N	148.53W	05	171	Sagavanirktok
2284-21044	November 2, 1975	0	68.02N	150.42W	06	169	Chandler Lake
2284-21051	November 2, 1975	0	66.43N	152.20W	08	168	Bettles
2284-21053	November 2, 1975	0	65.22N	153.49W	09	167	Melozitna
2284-21060	November 2, 1975	0	64.02N	155.09W	10	165	Ruby
2284-21062	November 2, 1975	0	62.40N	156.22W	11	164	Iditarod
2284-21065	November 2, 1975	0	61.18N	157.29W	12	163	Sleetmute
2284-21071	November 2, 1975	0	59.55N	158.31W	13	162	Dillingham
2284-21074	November 2, 1975	0	58.32N	159.29W	15	161	Nushagak Bay
2285-21091	November 3, 1975	0	71.56N	145.55W	02	175	Beaufort Sea
2285-21094	November 3, 1975	0	70.40N	148.12W	04	173	Beechey Point
2285-21100	November 3, 1975	0	69.21N	150.15W	05	171	Umiat
2285-21103	November 3, 1975	10	68.03N	152.05W	06	170	Chandler Lake
2285-21105	November 3, 1975	0	66.45N	153.43W	07	168	Hughes
2285-21112	November 3, 1975	0	65.25N	155.11W	08	167	Melozitna
2285-21114	November 3, 1975	0	64.04N	156.32W	10	165	Nulato
2285-21121	November 3, 1975	0	62.42N	157.46W	11	164	Iditarod
2285-21123	November 3, 1975	0	61.21N	158.54W	12	163	Sleetmute
2285-21130	November 3, 1975	0	59.58N	159.57W	13	162	Goodnews
2285-21132	November 3, 1975	0	58.35N	160.56W	14	161	Hagemeister Island
2285-21135	November 3, 1975	5	57.12N	161.51W	15	160	Bristol Bay
2287-21222	November 5, 1975	0	66.47N	156.33W	07	168	Shungnak
2287-21224	November 5, 1975	0	65.27N	158.01W	08	167	Kateel River
2288-21274	November 6, 1975	0	68.04N	156.22W	05	170	Howard Pass
2288-21280	November 6, 1975	0	66.46N	158.00W	06	168	Shungnak
2288-21283	November 6, 1975	0	65.26N	159.29W	07	167	Candle
2288-21285	November 6, 1975	0	64.05N	160.51W	09	165	Norton Bay
2288-2129?	November 6, 1975	0	62.43N	162.05W	10	164	Kwiguk
2289-21320	November 7, 1975	10	71.56N	151.37W	01	175	Beaufort Sea
2289-21323	November 7, 1975	10	70.44N	153.50W	02	173	Teshekpuk
2290-21375	November 8, 1975	5	71.55N	153.04W	01	175	Beaufort Sea
2290-21381	November 8, 1975	10	70.43N	155.1?W	02	173	Teshekpuk
2291-20022	November 9, 1975	10	64.26N	137.56W	07	167	E. of Charley River
2291-20025	November 9, 1975	10	64.05N	139.18W	08	166	East of Eagle
2291-21451	November 9, 1975	10	66.48N	162.16W	05	168	Kotzebue
2291-21454	November 9, 1975	5	65.28N	163.45W	07	167	Bendeleben
2291-21460	November 9, 1975	5	64.07N	165.0?W	08	166	Nome
2292-21492	November 10, 1975	0	72.01N	155.5?W	00	175	Barrow

2292-21494	November 10, 1975	0	70.43N	158.15W	02	173	Meade River
2292-21501	November 10, 1975	10	69.25N	160.19W	03	171	Utukok River
2292-21503	November 10, 1975	0	68.07N	162.09W	04	170	DeLong Mts.
2292-21510	November 10, 1975	0	66.48N	163.47W	05	168	Kotzebue
2292-21512	November 10, 1975	20	65.27N	165.15W	06	167	Teller
2293-21550	November 11, 1975	3	72.01N	157.21W	00	175	Chukchi Sea
2293-21552	November 11, 1975	20	70.44N	159.42W	01	173	Wainwright
2293-21561	November 11, 1975	0	68.08N	163.33W	04	170	DeLong Mts.
2293-21564	November 11, 1975	0	66.49N	165.11W	05	168	Shishmaref
2293-21570	November 11, 1975	10	65.29N	166.40W	06	167	Teller
2298-20432	November 16, 1975	0	62.47N	150.33W	07	164	Talkeetna
2298-20434	November 16, 1975	15	61.25N	151.41W	08	163	Tyonek
2298-20450	November 16, 1975	0	57.17N	154.38W	12	161	Kodiak Island
2299-20490	November 17, 1975	15	62.51N	151.55W	07	164	Talkeetna
2300-20544	November 18, 1975	20	62.48N	153.23W	07	164	McGrath
2300-20551	November 18, 1975	15	61.26N	154.31W	08	163	Lime Hills
2300-20553	November 18, 1975	20	60.03N	155.34W	09	162	Lake Clark
2302-21040	November 20, 1975	0	69.29N	148.37W	00	171	Sagavanirktok
2302-21043	November 20, 1975	0	68.10N	150.29W	01	169	Chandler Lake
2302-21045	November 20, 1975	0	66.50N	152.11W	02	168	Bettles
2302-21052	November 20, 1975	0	65.30N	153.40W	04	167	Melozitna
2302-21054	November 20, 1975	0	64.09N	155.02W	05	165	Ruby
2302-21061	November 20, 1975	0	62.48N	156.16W	06	164	Iditarod
2307-2135[illegible]	November 25, 1975	10	60.07N	165.34W	07	164	Nunivak Island
230[illegible]1350	November 25, 1975	0	58.44N	166.33W	08	16[illegible]	Bristol Bay
230[illegible]72	November 25, 1975	2	54.34N	169.08W	12	159	Bering Sea
230[illegible]4	November 25, 1975	0	53.10N	169.54W	13	158	Is. of the Seven Mtn.
2317-[illegible]03	December 5, 1975	10	57.21N	156.02W	08	160	Becharof Lake
2374-21070	January 31, 1976	5	57.04N	160.35W	12	153	Port Heiden
2375-21115	February 1, 1976	0	59.51N	160.11W	10	155	Ten Lakes Area
2375-21122	February 1, 1976	0	58.28N	161.09W	11	154	Hagemeister Island
2381-21434	February 7, 1976	2	67.46N	161.11W	05	161	Baird Mts.
2381-21443	February 7, 1976	15	65.06N	164.14W	07	159	Bendeleben
2381-21452	February 7, 1976	5	62.24N	166.47W	10	156	Black
2381-21455	February 7, 1976	0	61.02N	167.52W	11	155	Hooper Bay
2382-21504	February 8, 1976	5	63.44N	167.01W	09	157	Bering Straits
2382-21511	February 8, 1976	0	62.23N	168.13W	10	156	St. Lawrence Is., Bering Sea
2383-21551	February 9, 1976	0	67.45N	164.06W	06	161	Noatak Delta
2383-21554	February 9, 1976	5	66.25N	165.42W	07	160	Shishmaref
2383-21560	February 9, 1976	15	65.05N	167.10W	08	158	Teller - Nome
2383-21563	February 9, 1976	1	63.44N	168.29W	09	157	St. Lawrence Is.
2384-22005	February 10, 1976	1	67.43N	165.37W	06	161	Point Hope
2384-22012	February 10, 1976	0	66.23N	167.11W	07	160	Teller - Shishmaref
2384-22014	February 10, 1976	5	65.03N	168.36W	08	158	Bering Straits
2385-20243	February 11, 1976	0	63.54N	145.20W	10	157	Big Delta
2385-20250	February 11, 1976	15	62.33N	146.33W	11	156	Gulkana
2385-22061	February 11, 1976	0	69.13N	165.00W	05	163	Cape Lisburne
2385-22063	February 11, 1976	0	67.54N	166.47W	06	161	Point Hope
2385-22070	February 11, 1976	0	66.35N	168.23W	07	160	Bering Straits
2386-20295	February 12, 1976	0	65.00N	145.29W	09	158	Circle
2386-20301	February 12, 1976	10	63.54N	146.42W	10	157	Big Delta - Mt. Hayes
2386-22113	February 12, 1976	0	70.30N	164.23W	05	165	Point Lay
2386-22115	February 12, 1976	10	69.13N	166.25W	06	163	Cape Lisburne
2387-20344	February 13, 1976	0	69.53N	143.50W	07	161	Coleen
23[illegible]-20351	February 13, 1976	0	66.34N	145.27W	08	160	Fort Yukon
[illegible]387-20353	February 13, 1976	5	65.14N	146.55W	09	158	Circle
[illegible]388-20394	February 14, 1976	5	70.27N	141.32W	05	165	Barter Island
2388-20400	February 14, 1976	0	69.11N	143.31W	06	163	Demarcation Point
2388-20403	February 14, 1976	0	67.54N	145.18W	07	161	Christian
2388-20405	February 14, 1976	0	66.33N	146.56W	08	160	Beaver
2388-20412	February 14, 1976	0	65.13N	148.23W	10	158	Livengood
2388-20423	February 14, 1976	15	61.08N	152.02W	13	155	Tyonek
2388-20430	February 14, 1976	5	59.46N	153.03W	14	154	Mt. Augustine
2389-20452	February 15, 1976	0	70.27N	143.03W	06	165	Barter Island
2389-20454	February 15, 1976	0	69.11N	145.01W	07	163	Camden Bay
2389-20461	February 15, 1976	0	67.53N	146.47W	08	161	Christian
2389-20463	February 15, 1976	0	66.33N	148.24W	09	160	Beaver
2390-20513	February 16, 1976	5	69.40N	146.26W	07	163	Lake Peters
2391-20564	February 17, 1976	0	70.27N	145.52W	06	165	Camden Bay
2391-20571	February 17, 1976	0	69.09N	147.51W	07	163	Sagavanirktok
2392-21023	February 18, 1976	0	70.32N	147.09W	07	165	Flaxman Island
2392-21025	February 18, 1976	0	69.15N	149.10W	08	163	Sagavanirktok
2392-21055	February 18, 1976	10	59.50N	158.43W	15	153	Ten Lakes Area
2392-21061	February 18, 1976	10	58.27N	159.40W	16	152	Nushagak
2393-21083	February 19, 1976	0	69.15N	150.35W	08	163	Umiat
2393-21113	February 19, 1976	10	59.50N	160.10W	15	153	Goodnews
2394-21135	February 20, 1976	15	70.34N	149.59W	07	165	Prudhoe Bay
2394-21142	February 20, 1976	0	69.17N	152.00W	08	163	Umiat
2394-21171	February 20, 1976	0	59.51N	161.34W	16	153	Bethel
2394-21174	February 20, 1976	0	58.29N	162.32W	17	152	Hagemeister
2394-21180	February 20, 1976	0	57.06N	163.26W	18	151	Bering Sea
2395-21191	February 21 1976	20	71.48N	149.09W	07	167	Beaufort Sea
2395-21193	February 21, 1976	5	70.33N	151.25W	08	165	Harrison Bay
2395-21214	February 21, 1976	10	63.56N	159.41W	13	157	Kaltag
2396-21263	February 22, 1976	0	66.37N	158.21W	11	159	Shungnak
2396-21272	February 22, 1976	0	63.56N	161.07W	13	157	Unalakleet
2396-21275	February 22, 1976	5	62.34N	162.21W	14	155	Kwiguk
2396-21284	February 22, 1976	10	59.50N	164.30W	16	153	Kuskokwim Bay
2396-21290	February 22, 1976	15	58.27N	165.27W	17	152	Bering Sea

2397-21330	February 23, 1976	0	63.58N	162.31W	14	157	Solomon
2397-21333	February 23, 1976	5	62.37N	163.44W	15	155	Yukon Delta
2397-21335	February 23, 1976	5	61.15N	164.51W	16	154	Marshall
2397-21342	February 23, 1976	10	59.53N	165.54W	17	153	Nunivak Island
2397-21344	February 23, 1976	15	58.31N	166.51W	18	152	Bering Sea
2398-21362	February 24, 1976	5	71.49N	153.26W	08	167	Beaufort Sea
2398-21364	February 24, 1976	15	70.34N	155.42W	09	165	Barrow
2398-21380	February 24, 1976	0	66.38N	161.09W	12	159	Baldwin Penninsula
2398-21405	February 24, 1976	5	57.06N	169.13W	19	151	Pribilofs
2399-21420	February 25, 1976	0	71.50N	154.48W	08	167	Beaufort Sea
2399-21422	February 25, 1976	0	70.35N	157.03W	09	165	Barrow
2399-21425	February 25, 1976	0	69.17N	159.05W	10	163	Utukok River
2399-21431	February 25, 1976	5	67.59N	160.54W	11	161	Baird Mts.
2399-21434	February 25, 1976	0	66.40N	162.31W	12	159	Shishmaref - Kotzebue
2399-21440	February 25, 1976	0	65.19N	164.00W	13	158	Bendeleben
2399-21443	February 25, 1976	0	63.59N	165.21W	14	157	Nome
2399-21445	February 25, 1976	0	62.38N	166.34W	15	155	Black
2399-21452	February 25, 1976	0	61.16N	167.42W	16	154	Hooper Bay
2399-21463	February 25, 1976	15	57.08N	170.37W	20	151	Pribilofs
2400-21492	February 26, 1976	15	66.38N	164.01W	13	159	Shishmaref
2400-21495	February 26, 1976	0	65.18N	165.30W	14	158	Imuruk Basin
2400-21501	February 26, 1976	0	63.58N	166.50W	15	157	Nome
2400-21504	February 26, 1976	0	62.37N	168.03W	16	155	Tip of St. Lawrence Is.
2401-21550	February 27, 1976	0	66.37N	165.30W	13	159	Shishmaref
2401-21553	February 27, 1976	0	65.17N	166.58W	14	158	Teller
2401-21555	February 27, 1976	0	63.56N	168.17W	15	156	St. Lawrence Is.
2402-20191	February 28, 1976	0	61.15N	146.13W	18	154	Valdez
2402-20194	February 28, 1976	0	59.53N	147.15W	19	153	Montague Island
2402-20200	February 28, 1976	5	58.31N	148.12W	20	152	Gulf of Alaska
2402-22005	February 28, 1976	10	66.38N	166.55W	13	159	Shishmaref
2402-22011	February 28, 1976	0	65.18N	168.22W	15	158	Teller
2403-20222	February 29, 1976	0	69.15N	139.13W	12	163	Herschel Island
2403-20252	February 29, 1976	0	59.51N	148.42W	19	153	Seward
2403-20254	February 29, 1976	0	58.28N	149.40W	20	152	Gulf of Alaska
2403-22054	February 29, 1976	0	69.15N	1[illegible]4.59W	12	163	Cape Lisburne
2404-22115	March 1, 1976	25	67.58N	168.13W	13	161	Point Hope
2404-22121	March 1, 1976	10	66.39N	169.49W	14	159	Naukan, Siberia
2407-20492	March 4, 1976	0	55.43N	157.17W	24	149	Chignik
2407-20495	March 4, 1976	5	54.20N	158.04W	25	148	Simeonof Island
2408-20501	March 5, 1976	15	71.49N	141.50W	12	167	Beaufort Sea
2409-20555	March 6, 1976	0	71.51N	143.32W	12	167	Beaufort Sea
2409-20564	March 6, 1976	15	69.17N	147.48W	14	163	Sagavanirktok
2410-21013	March 7, 1976	20	71.49N	144.57W	12	167	Beaufort Sea
2410-21061	March 7, 1976	10	57.05N	160.36W	24	150	Bristol Bay - Ilnik
2411-21071	March 8, 1976	5	71.48N	146.31W	13	167	Beaufort Sea
2412-21130	March 9, 1976	0	71.50N	147.46W	13	167	Beaufort Sea
2412,21132	March 9, 1976	15	70.34N	150.01W	14	165	Harrison Bay
2413-21194	March 10, 1976	15	71.48N	149.13W	14	167	Beaufort Sea
2413-21220	March 10, 1976	0	71.[illegible]4N	162.01W	22	154	Russian Mission
2413-21222	March 10, 1976	0	59.52N	163.03W	23	152	Bethel
2413-21225	March 10, 1976	0	58.29N	164.00W	24	151	Bristol Bay
2413-21231	March 10, 1976	0	57.05N	164.53W	25	150	Bering Sea
2413-21234	March 10, 1976	0	55.42N	165.43W	26	149	Bering Sea
2413-21240	March 10, 1976	0	54.18N	166.30W	27	148	Unalaska Island
2413-21243	March 10, 1976	10	52.54N	167.15W	28	147	Umnak Island
2414-21242	March 11, 1976	5	71.53N	150.34W	14	167	Beaufort Sea
2414-21244	March 11, 1976	15	70.37N	152.50W	15	165	Harrison Bay
2415-21300	March 12, 1976	10	71.54N	151.51W	14	168	Beaufort Sea
2415-21302	March 12, 1976	10	70.38N	154.08W	15	165	Ikpikpuk
2415-21332	March 12, 1976	20	61.20N	164.48W	23	154	Nelson Island
2415-21342	March 12, 1976	10	58.35N	166.48W	25	151	Bering Sea
2416-21361	March 13, 1976	5	70.37N	155.40W	16	165	Barrow
2416-21381	March 13, 1976	15	64.02N	163.54W	21	156	Golovin
2416-21393	March 13, 1976	0	59.56N	167.16W	24	152	Nunivak Island
2417-21415	March 14, 1976	10	70.39N	156.58W	16	165	Meade River
2417-21424	March 14, 1976	5	68.03N	160.50W	18	161	Utukok River
2417-21431	March 14, 1976	20	66.44N	162.28W	19	159	Kotzebue
2417-21440	March 14, 1976	10	64.03N	165.18W	21	156	Nome
2417-21442	March 14, 1976	10	62.41N	166.31W	22	155	Black
2417-21445	March 14, 1976	10	61.19N	167.39W	23	154	Hooper Bay
2417-21471	March 14, 1976	15	71.56N	156.11W	15	168	Barrow
2418-21491	March 15, 1976	15	65.24N	165.25W	21	158	Teller
2418-21494	March 15, 1976	5	64.04N	166.45W	22	156	Nome
2418-21500	March 15, 1976	0	62.43N	167.59W	23	155	Black
2419-21525	March 16, 1976	10	71.58N	157.31W	16	168	Barrow
2419-21532	March 16, 1976	20	70.41N	159.49W	17	165	Wainwright
2419-21541	March 16, 1976	15	68.06N	163.41W	19	161	DeLong Mts.
2419-21543	March 16, 1976	15	66.46N	165.19W	20	160	Shishmaref
2419-21550	March 16, 1976	10	65.25N	166.48W	21	158	Teller
2419-21552	March 16, 1976	5	64.05N	168.09W	22	156	Bering Sea
2420-21583	March 17, 1976	15	71.55N	159.03W	16	168	Chukchi Sea
2420-21590	March 17, 1976	10	70.39N	161.20W	17	165	Wainwright
2420-21592	March 17, 1976	5	69.22N	163.21W	18	163	Point Lay
2420-21595	March 17, 1976	5	68.03N	165.11W	19	161	Point Hope
2420-22001	March 17, 1976	15	66.44N	165.49W	20	159	Shishmaref
2420-22004	March 17, 1976	5	65.24N	168.17W	22	158	Teller
2421-22042	March 18, 1976	10	71.56N	160.28W	17	168	Chukchi Sea

2421-22044	March 18, 1976	5	70.40N	162.46W	18	165	Wainwright
2421-22051	March 18, 1976	10	69.22N	164.48W	19	163	Point Lay
2421-22053	March 18, 1976	0	68.04N	166.37W	20	161	Point Hope
2421-22060	March 18, 1976	15	66.44N	168.15W	21	160	Bering Straits
2421-22062	March 18, 1976	20	65.25N	169.43W	22	158	Bering Straits
2422-22100	March 19, 1976	10	71.57N	161.51W	17	168	Floeberg
2422-22102	March 19, 1976	10	70.40N	164.09W	18	166	Chukchi Sea
2423-22160	March 20, 1976	10	70.42N	165.35W	18	166	Chukchi Sea
2423-22163	March 20, 1976	10	69.25N	167.37W	20	163	Chukchi Sea
2423-22165	March 20, 1976	20	68.07N	169.25W	21	161	Chukchi Sea
2424-20383	March 21, 1976	10	70.41N	141.15W	19	166	Beaufort Sea
2424-20390	March 21, 1976	5	69.24N	143.17W	20	163	Barter Island
2424-20413	March 21, 1976	10	61.21N	151.55W	26	153	Tyonek
2424-22212	March 21, 1976	15	71.57N	164.49W	18	168	Chukchi Sea
2424-22215	March 21, 1976	5	70.41N	167.07N	19	166	Chukchi Sea
2424-22221	March 21, 1976	5	69.23N	169.09W	20	163	Chukchi Sea
2425-20444	March 22, 1976	0	69.24N	144.42W	20	163	Mt. Michelson
2425-22275	March 22, 1976	0	69.23N	170.33W	20	163	Chukchi Sea
2425-22282	March 22, 1976	0	68.05N	172.22W	21	161	Chukchi Sea
2426-20493	March 23, 1976	10	72.00N	141.47W	19	168	Beaufort Sea
2426-20541	March 23, 1976	20	57.15N	157.38W	30	149	Ugashik
2427-20592	March 24, 1976	5	58.37N	158.10W	29	151	Nushagak
2427-20595	March 24, 1976	5	57.14N	159.04W	30	149	Port Heiden
2427-21001	March 24, 1976	10	55.50N	159.56W	31	148	Port Moller
2428-21015	March 25, 1976	20	69.27N	148.57W	21	164	Sagavanirktok
2428-21044	March 25, 1976	0	60.01N	158.39W	29	152	Ten Lakes Area
2428-21062	March 25, 1976	15	54.29N	162.06W	33	147	Cold Bay
2430-21131	March 27, 1976	10	69.30N	151.45W	22	164	Harrison Bay
2430-21163	March 27, 1976	0	58.42N	162.27W	31	151	Goodnews
2430-21165	March 27, 1976	0	57.19N	163.21W	32	149	Bristol Bay
2430-21172	March 27, 1976	10	55.55N	164.12W	33	148	Bristol Bay
2431-21185	March 28, 1976	15	69.28N	153.12W	23	164	Umiat
2431-21203	March 28, 1976	0	64.10N	159.28W	27	156	Norton Bay
2431-21215	March 28, 1976	0	60.04N	162.53W	30	152	Baird Inlet
2431-21221	March 28, 1976	10	58.42N	163.50W	31	151	Bering Sea
2431-21224	March 28, 1976	0	57.18N	164.44W	32	149	Bering Sea
2431-21230	March 28, 1976	0	55.55N	165.35W	33	148	Bering Sea
2432-21234	March 29, 1976	10	72.03N	150.16W	21	169	Beaufort Sea
2432-21241	March 29, 1976	20	70.47N	152.34W	22	166	Harrison Bay
2432-21243	March 29, 1976	15	69.30N	154.37W	23	164	Ikpikpuk River
2432-21252	March 29, 1976	0	66.52N	158.06W	25	160	Shungnak
2432-21261	March 29, 1976	0	64.11N	160.56W	27	156	Norton Bay
2432-21282	March 29, 1976	15	57.19N	166.13W	32	149	Bering Sea
2433-21295	March 30, 1976	20	70.48N	154.01W	22	166	Teshekpuk
2433-21302	March 30, 1976	0	69.31N	156.03W	23	164	Lookout Ridge

2433-21311	March 30, 1976	5	66.53N	159.31W	26	150	Shungnak
2433-21320	March 30, 1976	5	64.13N	162.20W	28	156	Norton Bay
2433-21322	March 30, 1976	15	62.51N	163.35W	29	155	Kwiguk
2434-21353	March 31, 1976	0	70.47N	155.21W	23	166	Teshekpuk
2434-21365	March 31, 1976	10	66.52N	160.55W	26	160	Selawik
2434-21371	March 31, 1976	10	65.32N	162.25W	27	158	Bendeleben
2434-21374	March 31, 1976	10	64.11N	163.46W	28	156	Solomon
2434-21380	March 31, 1976	10	62.50N	164.59W	29	155	Black
2435-21405	April 1, 1976	5	72.04N	154.33W	22	169	Beaufort Sea
2435-21423	April 1, 1976	20	66.53N	162.22W	26	160	Kotzebue
2435-21430	April 1, 1976	20	65.32N	163.51W	27	158	Bendeleben
2436-21463	April 2, 1976	10	72.05N	155.54W	22	169	Beaufort Sea
2436-21470	April 2, 1976	10	70.49N	158.14W	23	166	Meade River
2436-21472	April 2, 1976	10	69.32N	160.18W	25	164	Point Lay
2436-21475	April 2, 1976	5	68.14N	162.08W	26	162	DeLong Mts
2437-21524	April 3, 1976	10	70.51N	159.37W	24	166	Wainwright
2437-21531	April 3, 1976	15	69.33N	161.41W	25	164	Utukok River
2437-21533	April 3, 1976	20	68.15N	163.31W	26	162	DeLong Mts
2438-21580	April 4, 1976	10	72.07N	158.41W	23	169	Chukchi Sea
2439-20234	April 5, 1976	20	61.29N	147.26W	32	153	Anchorage
2440-20293	April 6, 1976	10	61.30N	148.53W	32	153	Anchorage
2440-20295	April 6, 1976	10	60.08N	149.56W	33	152	Seward
2440-20302	April 6, 1976	10	58.45N	150.54W	34	150	Afognak
2440-20304	April 6, 1976	20	57.22N	151.48W	35	149	Kodiak
2440-22095	April 6, 1976	0	70.50N	163.56W	25	166	Chukchi Sea
2440-22101	April 6, 1976	0	69.32N	166.00W	26	164	Chukchi Sea
2440-22104	April 6, 1976	10	68.14N	167.49W	27	162	Point Lay
2440-22110	April 6, 1976	20	66.55N	169.38W	28	160	Chukchi Sea
2441-20321	April 7, 1976	20	70.49N	139.37W	25	166	Beaufort Sea
2441-22153	April 7, 1976	10	70.51N	165.21W	25	167	Chukchi Sea
2441-22155	April 7, 1976	10	69.34N	167.25W	26	164	Chukchi Sea
2441-22162	April 7, 1976	10	68.16N	169.15W	28	162	Chukchi Sea
2442-20380	April 8, 1976	5	70.50N	141.02W	26	167	Beaufort Sea
2442-22214	April 8, 1976	0	69.32N	168.55W	27	164	Chukchi Sea
2442-22220	April 8, 1976	0	68.14N	170.45W	28	162	Chukchi Sea
2443-20434	April 9, 1976	0	70.52N	142.26W	26	167	Beaufort Sea
2443-20440	April 9, 1976	15	69.35N	144.29W	27	164	Mt. Michelson
2444-20492	April 10, 1976	0	70.53N	143.46W	26	167	Barter Island
2444-20495	April 10, 1976	5	69.36N	145.50W	28	164	Mt. Michelson
2445-20550	April 11, 1976	10	70.51N	145.16W	27	167	Flaxman Island
2445-20553	April 11, 1976	20	69.35N	147.19W	28	164	Sagavanirktok
2447-21101	April 13, 1976	0	58.48N	160.53W	37	150	Hagemeister Island
2447-21104	April 13, 1976	0	57.25N	161.48W	38	149	Bristol Bay
2447-21110	April 13, 1976	0	56.02N	162.39W	39	147	Bristol Bay
2447-21113	April 13, 1976	20	54.38N	163.27W	40	146	False Pass

2448-21121	April 14, 1976	0	70.54N	149.30W	28	167	Prudhoe Bay
2448-21124	April 14, 1976	10	69.36N	151.34W	29	164	Umiat
2448-21153	April 14, 1976	0	60.10N	161.20W	36	152	Bethel
2448-21160	April 14, 1976	0	58.47N	162.19W	37	150	Hagemeister Island
2450-21245	April 16, 1976	0	66.59N	157.57W	32	160	Shungnak
2450-21254	April 16, 1976	10	64.17N	160.49W	34	157	Norton Bay
2450-21261	April 16, 1976	10	62.56N	162.03W	35	155	Kwiguk
2450-21272	April 16, 1976	20	58.48N	165.13W	38	150	Bering SEa
2451-21285	April 17, 1976	0	72.12N	151.23W	28	170	Beaufort SEa
2451-21292	April 17, 1976	0	70.56N	153.44W	29	167	Teshekpuk
2451-21303	April 17, 1976	10	67.01N	159.20W	32	160	Shungnak
2451-21310	April 17, 1976	20	65.40N	160.50W	33	158	Candle
2451-21312	April 17, 1976	10	64.19N	162.11W	34	157	Solomon
2451-21315	April 17, 1976	15	62.58N	163.26W	35	155	Yukon Delta
2452-21344	April 18, 1976	0	72.10N	152.46W	28	170	Beaufort Sea
2452-21350	April 18, 1976	0	70.54N	155.07W	29	167	Barrow
2452-21364	April 18, 1976	20	65.39N	162.16W	34	158	Bendeleben
2452-21373	April 18, 1976	0	62.56N	164.53W	36	155	Yukon Delta
2452-21380	April 18, 1976	5	61.34N	166.01W	37	153	Nelson Island
2452-21382	April 18, 1976	10	60.11N	167.05W	38	151	Nunivak Island
2453-21395	April 19, 1976	0	73.26N	151.32W	27	173	Beaufort Sea
2453-21402	April 19, 1976	0	72.12N	154.13W	29	170	Beaufort Sea
2453-21404	April 19, 1976	0	70.56N	156.35W	30	167	Barrow
2453-21420	April 19, 1976	0	67.01N	162.14W	33	160	Baldwin Pen.
2453-21422	April 19, 1976	0	65.40N	163.45W	34	158	Bendeleben
2453-21425	April 19, 1976	0	64.19N	165.05W	35	157	Nome
2453-21434	April 19, 1976	0	61.35N	167.29W	37	153	Hooper Bay
2453-21440	April 19, 1976	0	60.12N	168.32W	38	151	Bering Sea
2453-21443	April 19, 1976	0	58.49N	169.30W	39	150	Bering Sea
2453-21445	April 19, 1976	5	57.25N	170.24W	40	148	Bering Sea
2454-21460	April 20, 1976	10	72.13N	155.37W	29	170	Barrow
2454-21471	April 20, 1976	10	68.21N	161.55W	32	162	DeLong Mts.
2454-21474	April 20, 1976	10	67.02N	163.35W	33	160	Noatak
2454-21480	April 20, 1976	10	65.41N	165.06W	34	158	Teller
2454-21483	April 20, 1976	0	64.20N	166.28W	35	157	Nome
2455-21541	April 21, 1976	0	64.15N	167.58W	36	156	Nome
2456-21575	April 22, 1976	15	70.54N	160.55W	31	167	Wainwright
2456-21582	April 22, 1976	10	69.36N	162.59W	32	165	Point Lay
2456-21584	April 22, 1976	0	68.18N	164.58W	33	162	Point Hope
2456-21591	April 22, 1976	0	66.58N	166.30W	34	160	Chukchi Sea
2456-21593	April 22, 1976	0	65.37N	168.00W	35	158	Teller
2456-22000	April 22, 1976	10	64.16N	169.22W	36	156	Bering Sea
2457-20231	April 23, 1976	0	61.31N	147.24W	38	153	Valdez
2457-20234	April 23, 1976	0	60.09N	148.26W	39	151	Montague Island
2457-20248	April 23, 1976	0	58.45N	149.25W	40	149	Tip of Kenai Pen.
2457-22040	April 23, 1976	0	69.38N	164.20W	32	165	Point Lay
2457-22042	April 23, 1976	0	68.19N	166.12W	33	162	Point Hope
2457-22045	April 23, 1976	0	66.59N	167.51W	34	160	Chukchi Sea
2457-22051	April 23, 1976	0	65.39N	169.22W	35	158	Bering Straits
2458-22101	April 24, 1976	0	68.17N	167.43W	34	162	Point Hope
2458-22110	April 24, 1976	0	65.37N	170.51W	36	158	Chukotsch Pen.
2459-20321	April 25, 1976	0	69.37N	141.28W	33	165	Demarcation Point
2461-20431	April 27, 1976	5	70.56N	142.14W	32	167	Beaufort Sea
2461-20433	April 27, 1976	20	69.38N	144.19W	33	165	Barter Island
2464-21004	April 30, 1976	5	69.34N	148.41W	34	165	Prudhoe Bay
2465-21065	May 1, 1976	0	68.18N	151.59W	36	162	Chandler Lake
2465-21071	May 1, 1976	0	66.58N	153.39W	37	160	Bettles
2465-21074	May 1, 1976	0	65.38N	155.08W	38	158	Melozitna
2465-21080	May 1, 1976	0	64.17N	156.30W	39	156	Galena
2465-21083	May 1, 1976	0	62.55N	157.45W	40	154	Iditarod
2465-21085	May 1, 1976	20	61.32N	158.54W	41	152	Holy Cross
2466-21114	May 2, 1976	1	70.53N	149.33W	34	167	Prudhoe Bay
2466-21123	May 2, 1976	5	68.17N	153.27W	36	162	Chandler Lake
2466-21130	May 2, 1976	1	66.57N	155.07W	37	160	Walker Lake
2467-21170	May 3, 1976	0	72.10N	148.33W	33	170	Beaufort Sea
2467-21172	May 3, 1976	0	70.54N	150.54W	34	167	Beaufort Sea
2467-21204	May 3, 1976	15	60.11N	162.47W	43	150	Bethel
2468-21224	May 4, 1976	5	72.09N	149.59W	33	170	Beaufort Sea
2468-21231	May 4, 1976	10	70.53N	152.19W	34	167	Harrison Bay
2468-21245	May 4, 1976	15	65.37N	159.25W	39	158	Candle
2468-21251	May 4, 1976	15	64.16N	160.46W	40	156	Norton Bay
2468-21254	May 4, 1976	20	62.54N	162.01W	41	154	St. Michael
2472-21460	May 8, 1976	5	70.51N	158.10W	36	167	Barrow
2474-21570	May 10, 1976	0	72.07N	158.40W	35	170	Chukchi Sea
2474-21572	May 10, 1976	5	70.51N	161.02W	36	167	Wainwright
2474-21575	May 10, 1976	20	69.33N	163.06W	37	164	Point Lay
2474-21581	May 10, 1976	10	68.14N	164.57W	38	162	Point Hope
2474-21584	May 10, 1976	0	66.55N	161.35W	39	160	Shishmaref
2474-21590	May 10, 1976	10	65.34N	168.04W	40	158	Teller
2479-20451	May 15, 1976	20	62.48N	152.05W	44	153	Talkeetna
2479-20453	May 15, 1976	10	61.26N	153.14W	45	151	Lime Hills
2479-20460	May 15, 1976	5	60.02N	154.17W	46	149	Lake Clark
2479-20462	May 15, 1976	5	58.39N	155.15W	47	147	Katmai
2480-20503	May 16, 1976	15	64.08N	152.20W	43	155	Lake Minchumina
2480-20512	May 16, 1976	15	61.24N	154.41W	45	151	Lime Village
2484-21120	May 20, 1976	20	68.09N	153.34W	41	161	Survey Pass
2484-21125	May 20, 1976	0	65.28N	156.42W	43	157	Huslia
2484-21132	May 20, 1976	10	64.07N	158.03W	44	155	Kaltag
2484-21143	May 20, 1976	20	60.01N	161.28W	47	149	Bethel
2484-21150	May 20, 1976	20	58.39N	162.25W	48	147	Hagemeister Island

2485-21184	May 21, 1976	20	65.27N	158.11W	43	157	Koyukuk	
2485-21190	May 21, 1976	0	64.06N	159.31W	44	155	Unalakleet	
2485-21202	May 21, 1976	0	60.00N	162.56W	47	148	Bethel	
2487-21285	May 23, 1976	0	69.25N	156.11W	40	163	Meade River	
2487-21291	May 23, 1976	0	68.06N	158.01W	41	161	Howard Pass	
2487-21294	May 23, 1976	5	66.46N	159.39W	42	159	Selawik	
2487-21303	May 23, 1976	0	64.05N	162.26W	44	154	Solomon	
2487-21305	May 23, 1976	0	62.43N	163.40W	45	152	Kwiguk	
2488-21364	May 24, 1976	0	62.26N	165.16W	46	152	Black	
2488-21371	May 24, 1976	0	61.03	166.24W	47	150	Hooper Bay	
2488-21373	May 24, 1976	0	59.40N	167.27W	48	148	Nunivak Island	
2494-20280	May 30, 1976	20	61.20N	148.59W	47	149	Anchorage	
2494-20283	May 30, 1976	20	59.57N	150.01W	48	147	Kenai Pen.	
2494-20285	May 30, 1976	20	58.34N	150.59W	49	145	Chugach Islands	
2494-20292	May 30, 1976	10	57.11N	151.53W	50	143	Kodiak	
2495-20305	May 31, 1976	5	70.40N	139.49W	40	166	Beaufort Sea	
2495-20311	May 31, 1976	5	69.23N	141.52W	41	163	Demarcation Point	
2495-20325	May 31, 1976	15	64.02N	148.09W	46	153	Fairbanks	
2495-20332	May 31, 1976	20	62.41N	149.22W	47	151	Talkeetna Mts	
2495-20334	May 31, 1976	1	61.19N	150.30W	48	149	Anchorage	
2495-20341	May 31, 1976	0	59.56N	151.31W	48	147	Kenai	
2495-20350	May 31, 1976	10	57.10N	153.22W	50	143	Kodiak	
2495-20352	May 31, 1976	10	55.47N	154.12W	51	141	Trinity Island	
2496-20363	June 1, 1976	20	70.39N	141.15W	42	163	Barter Island	
2496-20393	June 1, 1976	20	61.18N	151.53W	48	149	Tyonek	
2496-20395	June 1, 1976	20	59.55N	152.56W	49	147	Iliamna	
2496-20402	June 1, 1976	10	58.32N	153.53W	50	145	Katmai	
2497-20421	June 2, 1976	0	70.41N	142.38W	41	165	Demarcation Point	
2499-20531	June 4, 1976	0	71.56N	143.19W	40	168	Beaufort Sea	
2499-20540	June 4, 1976	5	69.22N	147.39W	42	162	Sagavanirktok	
2500-20590	June 5, 1976	5	71.54N	144.48W	40	168	Beaufort Sea	
2500-20592	June 5, 1976	10	70.38N	147.05W	41	165	Prudhoe Bay	
2500-20595	June 5, 1976	5	69.20N	149.07W	41	162	Sagavanirktok	
2501-21044	June 6, 1976	0	71.53N	146.16W	40	168	Beaufort Sea	
2501-21051	June 6, 1976	1	70.37N	148.33W	41	165	Prudhoe Bay	
2505-21305	June 10, 1976	5	61.16N	164.54W	48	148	Nelson Island	
2505-21312	June 10, 1976	0	59.53N	165.55W	49	146	Nunivak Island	
2505-21314	June 10, 1976	0	58.31N	166.52W	50	144	Bering Sea	
2505-21321	June 10, 1976	0	57.07N	167.46W	51	142	St. George Island	
2506-21340	June 11, 1976	5	69.19N	157.44W	43	162	Lookout Ridge	
2506-21343	June 11, 1976	5	68.00N	159.32W	44	159	Noatak	
2506-21363	June 11, 1976	0	61.15N	166.16W	49	148	Hooper Bay	
2506-21370	June 11, 1976	5	59.53N	167.18W	49	146	Nunivak Island	
2506-21384	June 11, 1976	5	54.18N	170.48W	53	137	Bering Sea	
2507-21404	June 12, 1976	5	66.39N	162.39W	45	157	Kotzebue	
2507-21422	June 12, 1976	0	61.14N	167.47W	49	148	Hooper Bay	
2507-21424	June 12, 1976	0	59.52N	168.48W	49	146	Nunivak Island	
2507-21431	June 12, 1976	0	58.29N	169.45W	50	143	Bering Sea	
2507-21433	June 12, 1976	2	57.06N	170.39W	51	141	Pribilofs	
2508-21444	June 13, 1976	25	71.52N	156.15W	41	167	Barrow	
2508-21462	June 13, 1976	5	66.41N	164.00W	45	157	Shishmaref	
2508-21480	June 13, 1976	20	61.16N	169.08W	49	148	Bering Sea	
2508-21482	June 13, 1976	20	59.53N	170.10W	50	146	Bering Sea	
2509-20103	June 14, 1976	5	61.15N	144.46W	49	148	Valdez - Chitina	
2509-20105	June 14, 1976	20	59.52N	145.48W	50	145	Cordova	
2509-21520	June 14, 1976	5	66.39N	165.30W	45	157	Shishmaref	
2510-21562	June 15, 1976	0	71.49N	159.15W	41	167	Peard Bay	
2510-21570	June 15, 1976	20	69.16N	163.31W	43	161	Point Lay	
2510-21572	June 15, 1976	5	67.57N	165.19W	44	159	Point Hope	
2511-22021	June 16, 1976	15	70.35N	162.58W	42	164	Chukchi Sea	
2515-20412	June 20, 1976	15	71.49N	140.41W	41	167	Beaufort Sea	
2524-21331	June 29, 1976	10	70.33N	155.49W	42	163	Point Barrow	
2524-21334	June 29, 1976	5	69.15N	157.50W	43	160	Lookout Ridge	
2525-21410	June 30, 1976	15	64.01N	165.25W	46	151	Norton Sound	
2525-21412	June 30, 1976	1	62.39N	166.36W	47	149	Kwiguk - Black	
2525-21415	June 30, 1976	0	61.17N	167.43W	48	146	Hooper Bay	
2525-21421	June 30, 1976	25	59.55N	168.45W	49	144	Nunivak Island	
2526-21480	July 1, 1976	10	59.53N	170.11W	49	144	Bering Sea	
2526-21491	July 1, 1976	20	55.44N	172.52W	51	138	Bering Sea	
2527-21534	July 2, 1976	10	59.55N	171.34W	49	144	St. Matthews Island	
2527-21552	July 2, 1976	5	54.22N	175.04W	52	136	Bering Sea	
2528-21590	July 3, 1976	10	61.16N	172.03W	48	146	Bering Sea	
2528-22001	July 3, 1976	0	57.08N	174.56W	50	140	Bering Sea	
2528-22004	July 3, 1976	0	55.44N	175.46W	51	138	Bering Sea	
2531-20313	July 6, 1976	15	65.23N	146.48W	45	153	Livengood	C +D
2531-20320	July 6, 1976	2	64.02N	148.07W	46	151	Fairbanks	C +D
2531-20322	July 6, 1976	1	62.41N	149.21W	47	148	Talkeetna Mts.	C
2531-20325	July 6, 1976	10	61.19N	150.28W	48	146	Anchorage	
2532-20383	July 7, 1976	20	61.15N	151.57W	48	146	Tyonek	
2532-22194	July 7, 1976	10	68.02N	171.03W	43	158	Chukchi Sea	
2533-20450	July 8, 1976	5	58.31N	155.22W	49	142	Katmai	
2533-20455	July 8, 1976	5	55.45N	157.05W	51	138	Gulf of Alaska	
2533-22250	July 8, 1976	0	69.18N	170.38W	42	160	Chukchi Sea	
2534-20504	July 9, 1976	20	58.30N	156.48W	49	142	Naknek	
2534-20511	July 9, 1976	5	57.06N	157.41W	50	140	Ugashik	C
2536-20585	July 11, 1976	15	69.18N	149.12W	41	160	Sagavanirktok	
2537-21034	July 12, 1976	10	71.54N	146.16W	39	166	Beaufort Sea	
2537-21043	July 12, 1976	5	69.21N	150.3[illegible]W	41	160	Umiat	
2538-21092	July 13, 1976	10	71.53N	147.43W	39	166	Beaufort Sea	

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2539-21151	July 14, 1976	20	71.52N	149.13W	39	165	Beaufort Sea	
2539-21153	July 14, 1976	0	70.36N	151.29W	40	163	Harrison Bay	
2539-21160	July 14, 1976	2	69.19N	153.29W	41	160	Ikpikpuk	
2540-21205	July 15, 1976	0	71.54N	150.36W	39	166	Beaufort Sea	
2540-21211	July 15, 1976	5	70.38N	152.53W	40	163	Harrison Bay	
2540-21214	July 15, 1976	5	69.21N	154.54W	41	160	Ikpikpuk	
2541-21263	July 16, 1976	0	71.53N	152.04W	38	165	Beaufort Sea	
2541-21270	July 16, 1976	0	70.37N	154.19W	39	163	Teshekpuk	
2541-21272	July 16, 1976	0	69.20N	156.21W	40	160	Lookout Ridge	
2541-21281	July 16, 1976	10	66.41N	159.45W	42	155	Selawik	
2541-21284	July 16, 1976	15	65.21N	161.13W	43	153	Candle	
2542-21324	July 17, 1976	15	70.39N	155.45W	39	163	Barrow	
2542-21330	July 17, 1976	20	69.21N	157.46W	40	160	Lookout Ridge	
2543-21380	July 18, 1976	0	71.53N	154.90 W	38	165	Barrow	
2543-21382	July 18, 1976	20	70.37N	157.07W	39	163	Barrow - Meade River	C
2544-20034	July 19, 1976	15	61.20N	143.19W	46	147	McCarthy	
2545-20093	July 20, 1976	0	61.17N	144.47W	45	147	Valdez	
2546-20133	July 21, 1976	20	66.43N	141.06W	42	155	Black River	
2547-20185	July 22, 1976	15	68.05N	140.50W	40	158	Table Mts	
2548-20234	July 23, 1976	15	70.38N	138.28W	38	163	Beaufort Sea	
2548-20243	July 23, 1976	20	68.03N	142.18W	40	158	Table Mts.	
2548-22063	July 23, 1976	5	71.54N	162.04W	37	165	Floeberg	
2548-22065	July 23, 1976	0	70.38N	164.21W	38	163	Chukchi Sea	
2549-20292	July 24, 1976	0	70.49N	139.54W	38	163	Beaufort Sea	
2549-22124	July 24, 1976	1	70.39N	165.35W	38	163	Chukchi Sea	
2551-22243	July 26, 1976	15	69.23N	170.37W	38	160	Chukchi Sea	
2554-20575	July 29, 1976	20	70.43N	147.00W	37	163	Beechey Point	
2555-21031	July 30, 1976	10	71.57N	146.08W	35	166	Beaufort SEa	
2556-21094	July 31, 1976	0	69.26N	151.49W	37	160	Umiat	
2557-21143	August 1, 1976	10	72.01N	148.51W	35	166	Beaufort SEa	
2557-21150	August 1, 1976	0	70.46N	151.10W	36	163	Harrison Bay	C
2557-21152	August 1, 1976	0	69.29N	153.11W	37	161	Ikpikpuk	C
2557-21170	August 1, 1976	10	64.09N	159.28W	41	152	Norton Bay	
2558-21202	August 2, 1976	5	72.00N	150.19W	35	166	Beaufort Sea	
2558-21204	August 2, 1976	0	70.44N	152.37W	36	163	Teshekpuk	
2558-21211	August 2, 1976	0	69.27N	154.40W	37	161	Ikpikpuk	
2561-21395	August 5, 1976	10	64.10N	165.15W	40	153	Solomon	
2561-21404	August 5, 1976	5	61.26N	167.38N	42	148	Hooper Bay	
2561-21411	August 5, 1976	1	60.04N	168.41W	43	146	Nunivak Island	
2562-21445	August 6, 1976	0	66.49N	163.54W	38	156	Kotzebue	
2564-21555	August 8, 1976	10	68.12N	165.06W	36	159	Point Hope	
2564-21561	August 8, 1976	2	66.51N	166.45W	37	156	Shishmaref	
2566-20233	August 10, 1976	15	69.31N	140.15W	34	161	Demarcation Pt.	
2566-20231	August 10, 1976	20	70.47N	138.12W	33	164	Beaufort Sea	
2568-20391	August 12, 1976	10	55.54N	155.33W	43	142	Chirikof Island	
2557-21155	August 1, 1976	0	68.11N	155.01W	38	158	Killik River	C
2562-21433	August 6, 1976	50	70.45N	158.24W	35	163	Barrow	C
2569-20395	August 13, 1976	0	72.05N	140.13W	31	167	Beaufort Sea	
2569-20401	August 13, 1976	2	70.49N	142.32W	33	164	Barter Island	
2570-20462	August 14, 1976	5	69.33N	145.56W	33	162	Flaxman Island - Mt. MIchelson	
2573-21030	August 17, 1976	20	70.50N	148.08W	31	164	Beechey Point	
2575-21163	August 19, 1976	2	64.15N	159.27W	36	154	Norton Bay	
2575-21170	August 19, 1976	5	62.53N	160.41W	37	152	Unalakleet	
2576-21204	August 20, 1976	15	69.33N	154.33W	31	162	Ikpikpuk	
2576-21215	August 20, 1976	20	65.34N	159.31W	34	156	Kateel River	
2576-21222	August 20, 1976	20	64.13N	160.52W	35	154	Norton Bay	
2577-21285	August 21, 1976	5	61.32N	164.38W	37	151	Marshall	
2578-21340	August 22, 1976	15	62.56N	164.55W	36	153	St.Michael	
2578-21343	August 22, 1976	5	61.34N	166.03W	37	151	Hooper Bay	
2581-21484	August 25, 1976	0	70.53N	159.38W	29	165	Peard Bay	C
2581-21491	August 25, 1976	25	69.36N	161.42W	30	163	Pt. Lay	C.
2581-21500	August 25, 1976	20	66.58N	165.12W	32	158	Shishmaref	
2582-20122	August 26, 1976	0	66.57N	140.48W	31	159	Black River	
2582-20125	August 26, 1976	0	65.36N	142.18W	32	157	Charley River	C+D
2582-20131	August 26, 1976	0	64.15N	143.40W	33	155	Big Delta	C+D
2582-20134	August 26, 1976	20	62.53N	144.54W	34	153	Gulkana	
2582-21545	August 26, 1976	10	69.34N	163.10W	29	163	Pt. Lay	
2582-21552	August 26, 1976	10	68.16N	165.01W	30	161	Pt. Hope	
2583-20165	August 27, 1976	0	70.51N	136.47W	28	165	Chukchi Sea	
2583-20172	August 27, 1976	0	69.33N	138.51W	20	163	Herschel Island	C
2583-20174	August 27, 1976	0	68.15N	140.41W	30	161	Table Mtn	C
2583-20181	August 27, 1976	1	66.55N	142.19W	31	159	Black River	C
2583-20183	August 27, 1976	1	65.34N	143.49W	32	157	Charley River	
2583-20190	Augast 27, 1976	0	64.13N	145.10W	33	155	Big Delta	C+D
2584-22071	August 28, 1976	0	66.56N	169.29W	31	159	Chukotsch Penn.	
2584-22073	August 28, 1976	0	65.36N	170.58W	32	157	Chukotsch Penn.	
2585-22113	August 29, 1976	10	70.53N	165.21W	27	166	Chukchi Sea	
2585-22120	August 29, 1976	0	69.36N	167.25W	28	163	Cape Lisburne	
2585-22122	August 29, 1976	20	68.17N	169.16W	29	161	Chukchi Sea	
2586-20365	August 30, 1976	20	61.30N	151.46W	34	152	Tyonek	
2591-21062	September 4, 1976	5	58.47N	161.00W	34	150	Hagemeister Island	
2592-21075	September 5, 1976	5	72.09N	147.18W	24	169	Beaufort Sea	
2592-21082	September 5, 1976	20	70.53N	149.38W	25	166	Harrison Bay	
2593-21174	September 6, 1976	20	58.44N	163.51W	34	150	Bering Sea	
2594-21192	September 7, 1976	2	72.10N	150.01W	23	169	Beaufort Sea	
2598-21425	September 11, 1976	5	70.50N	158.14W	23	167	Pt. Barrow	C
2601-22003	September 14, 1976	20	68.10N	166.30W	24	163	Pt. Hope	
2605-20400	September 18, 1976	0	68.11N	146.23W	22	163	Arctic	
2608-20560	Septmmber 21, 1976	15	72.01N	144.32W	18	170	Beaufort Sea	
2618-20130	October 1, 1976	0	61.24N	146.11W	23	158	Valdez	
2618-20133	October 1, 1976	0	60.01N	147.14W	24	156	Montague Island	
2618-20135	October 1, 1976	15	58.36N	148.12W	25	155	Gulf of Alaska	

2619-20162	October 2, 1976	20	69.25N	138.57W	16	157	Herschel Island
2619-20185	October 2, 1976	1	61.20N	147.36W	22	158	Valdez
2620-20220	October 3, 1976	5	69.25N	140.27W	15	167	Herschel Island
2623-20432	October 6, 1976	5	55.44N	157.10W	25	154	Chirikof Island
2624-20440	October 7, 1976	10	71.54N	141.53W	12	172	Beaufort Sea
2625-20535	October 8, 1976	20	58.31N	158.13W	23	156	Naknek
2647-21142	October 30, 1976	5	63.59N	159.41W	10	163	Norton Bay
2650-21321	November 2, 1976	15	61.15N	166.21W	12	161	Hooper Bay
2650-21324	November 2, 1976	20	59.53N	167.23W	13	160	Nunivak Island
2651-21371	November 3, 1976	5	63.58N	165.26W	09	163	Nome'
2652-21425	November 4, 1976	2	63.58N	166.49W	09	163	Nome
2656-20240	November 8, 1976	20	58.27N	151.09W	12	159	Afognak
2656-20243	November 8, 1976	10	57.05N	152.03W	13	158	Kodiak
2658-20350	November 10, 1976	20	59.53N	153.00W	11	160	Iliamna
2662-20584	November 14, 1976	2	57.05N	160.36W	12	158	Bristol Bay
2665-21154	November 17, 1976	15	57.07N	164.55W	11	158	Bering Sea
2750-20431	February 10, 1977	15	58.37N	156.52W	13	150	Naknek
2750-20434	February 10, 1977	15	57.14N	157.46W	14	149	Ugashik
2752-20505	February 12, 1977	1	70.43N	147.01W	04	162	Beechey Point
2752-20512	February 12, 1977	5	69.25N	149.04W	05	160	Sagavanirktok
2758-21262	February 18, 1977	0	66.45N	161.09W	10	157	Selawik
2758-21264	February 18, 1977	0	65.24N	162.37W	11	155	Bendeleben
2758-21271	February 18, 1977	0	64.02N	163.57W	12	154	Solomon
2758-21273	February 18, 1977	10	62.42N	165.12W	13	153	Black
2758-21280	February 18, 1977	0	61.19N	166.18W	14	151	Hooper Bay
2758-21282	February 18, 1977	10	59.57N	167.21W	15	150	Cape Mendenhall
2758-21303	February 18, 1977	20	52.58N	171.36W	19	146	Amukta
2760-21392	February 20, 1977	20	61.16N	169.12W	14	151	Bering Sea
2760-21395	February 20, 1977	0	59.54N	170.15W	15	150	Bering Sea
2760-21401	February 20, 1977	20	58.31N	171.12W	16	149	Bering Sea
2765-20250	February 25, 1977	0	59.54N	151.37W	17	150	Seldovia
2765-20252	February 25, 1977	5	58.31N	152.34W	18	149	Afognak Island
2765-20255	February 25, 1977	10	57.07N	153.28W	19	148	Kodiak
2766-22104	February 26, 1977	10	70.39N	167.13W	09	162	Chukchi Sea
2767-20333	February 27, 1977	10	69.19N	144.54W	11	160	Mt. Michelson
2767-20362	February 27, 1977	10	59.54N	154.30W	18	150	Iliamna
2767-20365	February 27, 1977	10	58.31N	155.27W	19	149	Katmai
2767-20371	February 27, 1977	5	57.07N	156.21W	20	148	Ugashik
2767-20374	Feburary 27, 1977	20	55.45N	157.10W	21	146	Gulf of Alaska
2767-20380	February 27, 1977	20	54.21N	157.57W	22	145	Gulf of Alaska
2768-20384	February 28, 1977	20	70.37N	144.21W	10	162	Flaxman Island
2768-20391	February 28, 1977	5	69.19N	146.22W	11	160	Mt. Michelson
2769-20443	March 1, 1977	20	70.37N	145.48W	11	162	Flaxman Island
2769-20445	March 1, 1977	10	69.20N	147.48W	12	160	Sagavanirktok
2769-20481	March 1, 1977	10	58.31N	158.19W	20	148	Naknek

2770-20494	March 3, 1977	10	71.51N	144.57W	10	164	Beaufort Sea
2772-21045	March 4, 1977	0	59.54N	161.40W	20	149	Goodnews
2773-21094	March 5, 1977	0	62.37N	161.03W	18	152	Holy Cross
2773-21101	March 5, 1977	0	61.15N	162.09W	19	150	Marshall
2773-21103	March 5, 1977	0	59.52N	163.10W	20	149	Kuskokwim Bay
2774-21143	March 6, 1977	0	65.21N	159.54W	17	155	Candle
2774-21150	March 6, 1977	0	64.00N	161.14W	18	153	Norton Bay
2776-21244	March 8, 1977	0	69.19N	157.52W	14	160	Lookout Ridge
2776-21251	March 8, 1977	0	68.00N	159.39W	15	158	Misheguk Mts
2777-21305	March 9, 1977	0	67.59N	161.07W	16	158	Baird Mts
2777-21311	March 9, 1977	0	66.40N	162.41W	17	136	Kotzebue
2778-21360	March 10, 1977	0	69.18N	160.45W	15	160	Utukok River
2778-21363	March 10, 1977	0	68.00N	162.33W	16	158	DeLong Mts
2778-21365	March 10, 1977	0	66.40N	164.10W	17	156	Kotzebue
2778-21372	March 10, 1977	0	65.20N	165.38W	18	154	Teller
2778-21374	March 10, 1977	0	63.59N	166.57W	19	153	Bering Sea
2778-21381	March 10, 1977	0	62.58N	168.09W	20	152	St. Lawrence Island
2778-21383	March 10, 1977	0	61.15N	169.15W	21	150	Bering Sea
2779-21410	March 11, 1977	10	71.53N	157.55W	14	164	Barrow
2779-21415	March 11, 1977	5	69.19N	162.12W	16	160	Pt. Lay
2779-21421	March 11, 1977	0	58.01N	163.59W	17	158	DeLong Mts
2779-21424	March 11, 1977	0	66.41N	165.36W	18	156	Shishmaref
2779-21430	March 11, 1977	0	65.21N	167.03W	19	154	Teller
2780-20064	March 12, 1977	5	61.15N	146.23W	22	150	Valdez
2780-21464	March 12, 1977	0	71.50N	159.29W	14	164	Floeberg
2780-21470	March 12, 1977	0	70.34N	161.43W	15	162	Wainwright
2780-21473	March 12, 1977	5	69.17N	163.44W	16	160	Point Lay
2782-21594	March 14, 1977	5	66.40N	169.56W	19	156	Bering Straits, Chukotsch Penn.
2782-22000	March 14, 1977	0	65.20N	171.24W	20	154	Chukotsch Penn.
2783-20212	March 15, 1977	5	69.17N	142.12W	15	160	Demarcation Pt.
2783-22041	March 15, 1977	5	70.34N	166.02W	16	162	Chukchi Sea
2785-20321	March 17, 19.7	13	70.34N	143.04W	17	162	Barter Island
2785-20353	March 17, 1977	2	59.51N	154.33W	27	149	Lake Iliamna
2785-20360	March 17, 1977	10	58.29N	155.30W	26	147	Katmai
2786-20373	March 18, 1977	0	71.51N	142.11W	16	164	Beaufort Sea
2786-20375	March 18, 1977	20	70.35N	144.27W	17	162	Flaxman Island
2786-20382	March 18, 1977	15	69.18N	146.27W	18	160	Mt. Michelson
2787-20434	March 19, 1977	5	70.35N	145.50W	18	162	Flaxman Island
2788-20485	March 20, 1977	10	71.51N	145.09W	17	164	Beaufort Sea
2788-20492	March 20, 1977	5	70.35N	147.24W	18	162.	Prudhoe Bay
2788-20494	March 20, 1977	0	69.17N	149.24W	19	160	Sagavanirktok
2789-20543	March 21, 1977	0	71.53N	146.33W	18	164	Beaufort Sea
2789-20550	March 21, 1977	0	70.37N	148.48W	19	162	Beechey Point
2789-20552	March 21, 1977	0	69.19N	150.48W	20	160	Umiat

2790-21004	March 22, 1977	5	70.38N	150.10W	19	162	Harrison Bay
2790-21010	March 22, 1977	0	69.20N	152.10W	20	150	Umiat
2791-21060	March 23, 1977	0	71.50N	149.24W	18	164	Beaufort Sea
2791-21062	March 23, 1977	10	70.34N	151.39W	19	162	Harrison Bay
2791-21065	March 23, 1977	10	69.17N	153.39W	20	150	Ikpikpuk
2791-21083	March 23, 1977	0	63.57N	159.48W	24	153	Norton Bay
2791-21085	March 23, 1977	0	62.36N	161.01W	25	151	HolyCross
2791-21092	March 23, 1977	0	61.15N	162.09W	25	150	Marshall
2791-21094	March 23, 1977	0	59.52N	163.09W	27	148	Baird Inlet
2791-21101	March 23, 1977	20	58.30N	164.07W	28	147	Bering Sea
2792-21114	March 24, 1977	0	71.54N	150.49W	19	164	Beaufort Sea
2792-21120	March 24, 1977	15	70.37N	153.06W	20	162	Tesnekpuk
2792-21123	March 24, 1977	0	69.20N	155.01W	21	160	Ikpikpuk
2792-21134	March 24, 1977	0	66.21N	159.56W	24	154	Candle
2792-21141	March 24, 1977	0	64.00N	161.15W	25	153	Norton Bay
2793-21172	March 25, 1977	5	71.51N	152.14W	19	164	Beaufort Sea
2793-21174	March 25, 1977	5	70.35N	154.30W	20	162	Tesnekpuk
2793-21181	March 25, 1977	0	69.18N	156.30W	21	160	Lookout Ridge
2793-21190	March 25, 1977	0	66.40N	159.35W	23	156	Selawik
2793-21192	March 25, 1977	0	65.13N	161.22W	24	154	Candle
2793-21195	March 25, 1977	0	63.38N	162.42W	25	153	Norton Bay
2793-21201	March 25, 1977	0	62.37N	163.54W	26	151.	Kwiguk
2793-21204	March 25, 1977	5	61.15N	164.59W	27	150	Marshall
2793-21210	March 25, 1977	10	59.53N	166.00W	28	148	Nunivak Island
2794-21230	March 25, 1977	0	71.32N	153.39W	20	164.	Beaufort Sea
2794-21233	March 26, 1977	0	70.36N	155.[illegible]W	21	162	Barrow
2794-21235	March 26, 1977	0	69.19N	157.56W	22	160	Lookout Ridge
2794-21242	March 26, 1977	0	68.00N	159.44W	23	158	Misheguk Mtn
2794-21244	March 26, 1977	0	66.41N	161.20W	24	156	Kotzebue
2794-21251	March 26, 1977	0	65.21N	162.47W	25	154	Bendeleben
2794-21253	March 26, 1977	0	64.00N	164.07W	26	153	Solomon
2794-21260	March 26, 1977	0	62.39N	165.19W	26	151	Kwiguk
2794-21262	March 26, 1977	20	61.17N	166.25W	27	150	Hooper Bay
2794-21265	March 26, 1977	0	59.54N	167.27W	28	148	Nunivak Island
2794-21271	March 26, 1977	5	58.32N	168.24W	29	147	Bering Sea
2795-21284	March 27, 1977	10	71.52N	155.06W	20	165	Beaufort Sea
2795-21291	March 27, 1977	10	70.36N	157.21W	21	162	Meade River
2795-21293	March 27, 1977	10	69.18N	159.21W	22	160	Utukok River
2795-21300	March 27, 1977	0	68.00N	161.09W	23	158	Misheguk Mtn
2795-21302	March 27, 1977	0	66.40N	162.45W	24	156	Kotzebue
2795-21305	March 27, 1977	10	65.20N	164.13W	25	154	Bendeleben
2795-21323	March 27, 1977	20	59.54N	168.51W	29	148	Bering Sea
2796-21342	March 28, 1977	0	71.54N	156.30W	20	165	Barrow
2796-21345	March 28, 1977	0	70.38N	158.47W	21	162	Wainwright
2.96-21351	March 28, 1977	0	69.20N	160.47W	22	160	Pt. Lay

2797-21412	March 29, 1977	20	68.01N	164.00W	24	158	Delong Mts
2797-21430	March 29, 1977	10	62.39N	169.36W	28	151	Bering Sea
2797-21432	March 29, 1977	10	61.18N	170.43W	29	150	Bering Sea
2797-21435	March 29, 1977	10	59.55N	171.45W	30	148	Bering Sea
2797-21441	March 29, 1977	20	58.33N	172.42W	30	147	Bering Sea
2797-21453	March 29, 1977	10	54.22N	175.13W	33	143	Bering Sea
2798-21470	March 30, 1977	20	68.00N	165.30W	24	158	Pt. Hope
2798-21473	March 30, 1977	10	66.41N	167.06W	25	156	Shishmaref
2798-21475	March 30, 1977	0	65.21N	168.33W	25	154	Bering Straits
2798-21482	March 30, 1977	0	64.00N	169.52W	27	153	St. Lawrence Island
2798-21484	March 30, 1977	0	62.38N	171.05W	28	151	St. Lawrence Island
2798-21491	March 30, 1977	1	61.16N	172.12W	29	150	Bering Sea
2798-21493	March 30, 1977	10	59.54N	173.13W	30	148	St. Matthews
2798-21500	March 30, 1977	5	58.31N	174.10W	31	147	Bering Sea
2799-20090	March 31, 1977	20	69.18N	139.15W	23	160	Herschel Island
2799-20113	March 31, 1977	10	61.18N	147.45W	29	149	Valdez - Anchorage
2799-21515	March 31, 1977	10	70.35N	163.07W	22	162	Chukchi Sea
2799-21522	March 31, 1977	10	69.18N	165.07W	24	160	Chukchi Sea
2799-21524	March 31, 1977	10	68.00N	166.54W	25	150	Pt. Hope
2799-21531	March 31, 1977	10	66.40N	168.30W	26	156	Chukchi Sea
2799-21533	March 31, 1977	10	65.20N	169.57W	27	154	Bering Straits
2799-21540	March 31, 1977	10	64.00N	171.15W	27	153	St. Lawrence Island
2800-20142	April 1, 1977	10	70.37N	138.48W	23	162	Herschel Island
2800-20144	April 1, 1977	0	69.19N	140.56W	24	160	Demarcation Pt.
2800-21571	April 1, 1977	10	71.52N	162.18W	22	145	Floeberg
2800-21573	April 1, 1977	10	70.36N	164.33W	23	162	Chukchi Sea
2800-21580	April 1, 1977	10	69.19N	166.33W	24	160	Chukchi Sea
2800-21582	April 1, 1977	10	68.00N	168.19W	25	158	Pt. Hope
2800-21585	April 1, 1977	10	66.42N	169.57W	26	156	Chukotsch Penn.
2800-21591	April 1, 1977	10	65.20N	171.24W	27	154	Chukotsch Penn.
2801-20200	April 2, 1977	20	70.37N	140.00W	23	162	Beaufort Sea
2801-22040	April 2, 1977	0	68.01N	169.45W	25	158	Chukchi Sea
2801-22043	April 2, 1977	0	66.42N	171.21W	25	156	Chukotsch Penn
2802-20260	April 3, 1977	20	69.21N	143.33W	25	160	Demarcation Pt.
2802-22085	April 3, 1977	10	70.39N	167.21W	24	162	Chukchi Sea
2802-22092	April 3, 1977	0	69.20N	169.21W	25	160	Chukchi Sea
2802-22094	April 3, 1977	0	68.02N	171.09W	26	158	Chukchi Sea
2803-20314	April 4, 1977	20	69.22N	144.58W	25	160	Mt. Michelson
2803-22150	April 4, 1977	10	69.21N	170.42W	25	160	Chukchi Sea
2804-20373	April 5, 1977	0	69.24N	146.22W	25	160	Mt. Michelson
2804-20411	April 5, 1977	10	57.12N	157.45W	34	145	Ugashik
2804-20414	April 5, 1977	20	55.49N	158.26W	33	144	Stepovak Bay
2805-20422	April 6, 1977	10	71.55N	143.19W	24	165	Beaufort Sea

2805-20424	April 6, 1977	10	70.39N	145.54W	25	162	Flaxman Island
2805-20431	April 6, 1977	10	69.21N	147.54W	25	160	Sagavanirktok
2805-20463	April 6, 1977	10	58.33N	158.24W	34	164	Naknek
2805-20465	April 6, 1977	20	57.09N	159.16W	34	145	Bristol Bay
2806-20482	April 7, 1977	10	70.39N	147.15W	25	162	Beechey Pt
2806-20485	April 7, 1977	0	69.22N	149.15W	25	160	Sagavanirktok
2806-20514	April 7, 1977	0	59.57N	158.49W	33	148	Dillingham
2806-20521	April 7, 1977	10	58.33N	159.48W	34	146	Nushagak
2807-20534	April 8, 1977	20	71.57N	146.21W	24	165	Beaufort Sea
2808-20592	April 9, 1977	10	71.57N	147.43W	25	165	Beaufort Sea
2809-21050	April 10, 1977	10	71.58N	149.15W	25	165	Beaufort Sea
2809-21080	April 10, 1977	10	62.43N	160.57W	32	151	Holy Cross
2809-21085	April 10, 1977	10	59.58N	163.06W	34	148	Kuskokwim Bay
2810-21104	April 11, 1977	10	72.00N	150.37W	26	165	Beaufort Sea
2810-21125	April 11, 1977	10	66.27N	159.49W	31	154	Candle
2810-21131	April 11, 1977	10	64.06N	161.09W	32	152	Norton Bay
2810-21134	April 11, 1977	10	62.45N	162.27W	33	151	Kwiguk
2810-21140	April 11, 1977	10	61.24N	163.30W	33	149	Marshall
2811-21162	April 12, 1977	10	71.58N	152.06W	26	165	Beaufort Sea
2811-21165	April 12, 1977	0	70.42N	154.23W	27	163	Tesnekpuk
2811-21171	April 12, 1977	0	69.24N	156.24W	28	160	Lookout Ridge
2811-21194	April 12, 1977	10	61.21N	164.57W	34	149	Marshall
2812-21223	April 13, 1977	10	70.42N	155.49W	27	163	Teshekpuk
2812-21230	April 13, 1977	0	69.24N	157.51W	28	160	Lookout Ridge
2812-21232	April 13, 1977	10	68.05N	159.39W	29	158	Misheguk Mtn
2812-21235	April 13, 1977	10	66.45N	161.16W	30	156	Selawik
2812-21241	April 13, 1977	10	65.25N	162.43W	31	154	Bendeleben
2812-21244	April 13, 1977	10	64.04N	164.03W	32	152	Solomon
2812-21250	April 13, 1977	10	62.42N	165.16W	33	151	Black
2812-21253	April 13, 1977	10	61.21N	166.24W	34	149	Hooper Bay
2812-21255	April 13, 1977	10	59.58N	167.25W	35	147	Nunivak Island
2812-21262	April 13, 1977	10	58.36N	168.22W	36	146	Bering Sea
2812-21264	April 13, 1977	20	57.12N	169.15W	37	144	Bering Sea
2813-21281	April 14, 1977	0	70.42N	157.09W	28	163	Barrow - Meade River
2813-21284	April 14, 1977	0	69.24N	159.12W	29	160	Utukok River
2813-21290	April 14, 1977	5	68.06N	161.01W	30	158	Misheguk Mt
2813-20302	April 14, 1977	0	64.06N	165.28W	33	152	Nome
2813-21304	April 14, 1977	10	62.43N	166.41W	34	151	Black
2814-21333	April 15, 1977	15	71.58N	156.25W	27	165	Pt. Barrow
2814-21344	April 15, 1977	5	68.06N	162.32W	30	158	DeLong Mt
2814-21360	April 15, 1977	0	64.05N	166.54W	33	157	Nome
2814-21362	April 15, 1977	25	62.44N	168.06W	34	151	Bering Sea
2815-21391	April 16, 1977	0	71.58N	157.54W	27	165	Chukchi Sea
2815-21393	April 16, 1977	0	70.42N	160.09W	28	163	Wainwright
2815-21400	April 16, 1977	0	69.25N	162.09W	29	160	Pt. Lay
2815-21402	April 16, 1977	0	68.06N	163.57W	30	158	DeLong Mts
2815-21405	April 16, 1977	0	66.46N	165.34W	31	156	Shishmaref
2815-21411	April 16, 1977	0	65.26N	167.01W	32	154	Teller
2815-21414	April 16, 1977	5	64.06N	168.20W	33	152	Bering Straits
2816-21445	April 17, 1977	0	72.01N	159.08W	28	165	Floeberg
2816-21451	April 17, 1977	0	70.45N	161.25W	29	163	Wainwright
2816-21454	April 17, 1977	0	69.28N	163.29W	30	160	Pt. Lay
2816-21460	April 17, 1977	0	68.09N	165.17W	31	158	Pt. Hope
2816-21463	April 17, 1977	0	66.49N	166.55W	32	156	Shishmaref
2816-21465	April 17, 1977	2	65.29N	168.23W	33	154	Teller
2816-21483	April 17, 1977	15	60.02N	173.07W	37	147	St. Matthews
2816-21490	April 17, 1977	20	58.39N	174.09W	37	146	Bering Sea
2817-21512	April 18, 1977	10	69.28N	164.52W	30	160	Pt. Lay
2817-21514	April 18, 1977	0	68.10N	166.40W	31	158	Pt. Hope
2817-21521	April 18, 1977	10	66.50N	168.17W	32	156	Shishmaref
2817-21523	April 18, 1977	20	65.29N	169.45W	33	154	Bering Strait
2818-21564	April 19, 1977	0	70.46N	164.16W	29	163	Chukchi Sea
2828-21570	April 19, 1977	5	69.28N	166.19W	30	160	Cape Lisburne
2818-21573	April 19, 1977	20	68.10N	168.09W	31	158	Pt. Hope
2818-21575	April 19, 1977	0	66.51N	169.47W	32	156	Chukchi Sea
2818-21582	April 19, 1977	10	65.30N	171.16W	33	154	Chukotsch Penn.
2819-22022	April 20, 1977	20	70.46N	166.47W	30	163	Chukchi Sea
2819-22033	April 20, 1977	10	66.50N	171.12W	33	156	Chukotsch Penn.
2821-20334	April 22, 1977	10	60.04N	154.24W	38	147	Iliamna
2821-20341	April 22, 1977	10	58.41N	155.22W	39	145	Katmai
2821-20343	April 22, 1977	10	57.18N	156.16W	40	144	Ugasnik
2821-20350	April 22, 1977	10	55.54N	157.06W	41	142	Sutwik Island
2823-20412	April 24, 1977	10	72.04N	143.20W	30	166	Beaufort SEA
2824-20505	April 25, 1977	15	60.04N	158.45W	39	147	Taylor Mt.
2824-20511	April 25, 1977	20	58.41N	159.43W	40	145	Naknek
2824-20523	April 25, 1977	15	54.[illegible]N	162.14W	43	140	Sanak Island
2825-20531	April 26, 1977	5	70.49N	148.27W	32	163	Beaufort Sea
2825-20565	April 26, 1977	10	58.43N	161.06W	40	145	Hagemeister Island
2825-20572	April 26, 1977	10	57.19N	162.00W	41	143	Bering Sea
2825-20574	April 26, 1977	0	55.55N	162.50W	42	142	Cold Bay
2825-20581	April 26, 1977	5	54.32N	163.38W	43	140	Unimak Island
2826-20582	April 27, 1977	0	72.05N	147.32W	31	166	Beaufort Sea
2826-20585	April 27, 1977	25	70.49N	149.50W	32	163	Beechey Point
2826-21021	April 27, 1977	0	60.05N	161.35W	40	147	Bethel
2826-21023	April 27, 1977	10	58.43N	162.32W	41	145	Hagemeister Island
2827-21040	April 28, 1977	0	72.05N	148.59W	31	166	Beaufort Sea
2827-21043	April 28, 1977	0	70.49N	151.18W	32	163	Harrison Bay
2827-21063	April 28, 1977	0	64.12N	159.37W	37	152	Norton Bay
2827-21070	April 28, 1977	0	62.51N	160.51W	38	150	Unalakleet
2828-21094	April 29, 1977	0	72.06N	150.21W	32	166	Beaufort Sea

2828-21101	April 29, 1977	0	70.49N	152.40W	33	163	Harrison Bay
2828-21103	April 29, 1977	0	69.32N	154.43W	34	160	Ikpikpuk River
2828-21115	April 29, 1977	0	65.35N	159.41W	37	154	Candle
2828-21121	April 29, 1977	5	64.13N	161.02W	38	152	Norton Bay
2829-21153	April 30, 1977	0	72.06N	151.46W	32	166	Beaufort Sea
2829-21155	April 30, 1977	0	70.50N	154.05W	33	163	Teshekpuk
2829-21162	April 30, 1977	0	69.32N	156.08W	34	160	Ikpikpuk
2830-21211	May 1, 1977	0	72.05N	153.13W	32	166	Beaufort Sea
2830-21213	May 1, 1977	10	70.49N	155.33W	33	163	Barrow
2830-21220	May 1, 1977	20	69.31N	157.36W	34	160	Lookout Ridge
2830-21222	May 1, 1977	0	68.13N	159.24W	35	158	Misheguk Mt
2830-21225	May 1, 1977	10	66.54N	161.03W	36	156	Selawik
2830-21231	May 1, 1977	20	65.33N	162.31W	37	154	Bendeleben
2830-21234	May 1, 1977	20	64.12N	163.52W	38	152	Solomon
2830-21240	May 1, 1977	20	62.51N	165.06W	39	150	Black
2830-21245	May 1, 1977	10	60.08N	167.18W	41	146	Nunivak Island
2831-21280	May 2, 1977	10	68.13N	160.48W	36	158	Misheguk Mt
2831-21283	May 2, 1977	10	66.54N	162.27W	37	156	Baird Mt
2831-21285	May 2, 1977	20	65.33N	163.55W	38	154	Bendeleben
2831-21292	May 2, 1977	10	64.12N	165.16W	39	152	Nome
2831-21294	May 2, 1977	10	62.51N	166.30W	39	150	Black
2832-21334	May 3, 1977	10	68.13N	162.12W	36	158	DeLong Mt
2832-21341	May 3, 1977	20	66.54N	163.51W	37	156	Kotzebue
2833-19590	May 4, 1977	20	58.43N	146.42W	43	144	Gulf of Alaska
2833-19593	May 4, 1977	20	57.21N	147.34W	44	142	Gulf of Alaska
2834-21441	May 5, 1977	0	70.53N	161.12W	34	163	Wainwright
2842-20460	May 13, 1977	0	72.13N	144.27W	35	166	Beaufort Sea
2843-20514	May 14, 1977	0	72.11N	145.40W	36	166	Beaufort Sea
2846-19292	May 17, 1977	0	60.10N	138.32W	45	145	Yakutat
2846-19294	May 17, 1977	0	58.47N	139.31W	46	143	Yakutat Forelands
2846-21094	May 17, 1977	20	69.34N	154.37W	38	160	Ikpikpuk
2848-19410	May 19, 1977	20	58.47N	142.22W	46	142	Gulf of Alaska
2848-21201	May 19, 1977	5	72.10N	153.07W	37	165	Beaufort Sea
2849-19462	May 20, 1977	10	60.10N	142.50W	46	144	Yakataga
2849-21255	May 20, 1977	10	72.10N	154.28W	37	165	Beaufort Sea
2849-21282	May 20, 1977	5	64.17N	165.13W	43	150	Nome
2849-21284	May 20, 1977	0	62.55N	166.28W	44	148	Black
2849-21291	May 20, 1977	0	61.33N	167.36W	45	146	Bering Sea
2850-21325	May 21, 1977	10	68.19N	162.12W	40	157	DeLong Mt
2850-21340	May 21, 1977	10	64.17N	166.42W	43	150	Nome
2850-21343	May 21, 1977	5	62.55N	167.56W	44	148	St. Lawrence Is.
2851-21380	May 22, 1977	10	69.37N	161.43W	39	160	Pt. Lay
2851-21383	May 22, 1977	0	68.18N	163.34W	40	157	DeLong Mt
2851-21385	May 22, 1977	0	66.58N	165.13W	41	155	Shishmaref
2852-21434	May 23, 1977	10	69.37N	163.15W	40	159	Pt. Lay

2852-21441	May 23, 1977	0	68.18N	165.05W	41	157	Pt. Hope
2853-21510	May 24, 1977	5	63.56N	170.53W	44	150	St. Lawrence
2856-20254	May 27, 1977	10	61.30N	151.52W	46	145	Tyonek
2856-20261	May 27, 1977	0	60.08N	152.55W	47	143	Lake Clark
2856-22060	May 27, 1977	0	70.55N	166.54W	39	162	Chukchi Sea
2857-20285	May 28, 1977	0	69.35N	144.33W	40	159	Camden Bay
2857-20315	May 28, 1977	0	60.08N	154.18W	47	143	Lake Clark
2859-20393	May 30, 1977	5	72.07N	143.08W	39	165	Beaufort Sea
2860-20460	May 31, 1977	10	69.34N	148.52W	41	159	Prudhoe Bay
2860-20492	May 31, 1977	20	58.45N	159.38W	48	141	Nushagak Bay
2861-20543	June 1, 1977	20	60.09N	160.04W	47	143	Goodnews
2861-20550	June 1, 1977	0	58.46N	161.02W	48	140	Hagemeister Island
2862-20563	June 1, 1977	10	72.08N	147.20W	39	164	Beaufort Sea
2863-21024	June 3, 1977	20	70.53N	151.07W	40	161	Harrison Bay
2863-21030	June 3, 1977	10	69.38N	153.10W	41	158	Ikpikpuk
2863-21044	June 3, 1977	20	64.15N	159.32W	45	149	Norton Bay
2863-21051	June 3, 1977	0	62.53N	160.46W	46	147	Unalakleet
2864-19282	June 4, 1977	0	60.07N	138.22W	48	142	Yakutat
2864-19285	June 4, 1977	0	58.44N	139.20W	49	140	Yakutat Forelands
2866-21191	June 6, 1977	20	72.06N	152.59W	40	164	Beaufort Sea
2868-19511	June 8, 1977	0	60.03N	144.21W	48	142	Kayak Island
2868-21313	June 8, 1977	0	69.33N	160.20W	42	158	Utukok River
2869-19562	June 9, 1977	20	61.26N	144.44W	47	144	Chitina
2869-21380	June 9, 1977	5	66.35N	165.19W	44	153	Shishmaref
2870-20020	June 10, 1977	20	61.27N	146.11W	47	144	Chitina
2870-21422	June 10, 1977	10	70.46N	161.27W	41	161	Wainwright
2870-21431	June 10, 1977	20	58.12N	168.12W	43	155	Pt. Hope
2871-21483	June 11, 1977	5	69.30N	164.47W	42	158	Pt. Lay
2872-21544	June 12, 1977	20	68.11N	168.00W	43	155	Pt. Hope
2872-21550	June 12, 1977	5	66.52N	169.39W	44	152	Chukotsch Peninsula
2872-21553	June 12, 1977	10	65.31N	177.07W	45	150	Chukotsch Peninsula
2877-20390	June 17, 1977	5	70.48N	145.33W	41	160	Camden Bay
2880-05154	June 20, 1977	5	67.27N	143.21W	12	301	Yundik Lake, Coleen, ascending mode
2882-21095	June 22, 1977	15	62.46N	162.17W	47	144	St. Michael
2883-21142	June 23, 1977	20	66.51N	159.40W	44	151	Selawik
2883-21144	June 23, 1977	15	65.30N	161.09W	45	149	Candle
2883-21151	June 23, 1977	5	64.39N	162.30W	46	147	Solomon
2884-21200	June 24, 1977	5	66.48N	161.09W	44	151	Kotzebue
2884-21203	June 24, 1977	5	65.27N	162.36W	45	149	Bendeleben
2884-21205	June 24, 1977	5	64.36N	163.55W	46	146	Solomon
2885-21252	June 25, 1977	0	68.38N	160.45W	43	154	Misheguk Mt
2885-21254	June 25, 1977	0	66.46N	162.33W	44	151	Kotzebue
2885-21261	June 25, 1977	5	65.23N	164.01W	45	149	Bendeleben
2885-21263	June 25, 1977	5	64.07N	165.22W	46	146	Nome
2885-21270	June 25, 1977	5	62.48N	166.35W	47	144	Black

2886-19810	June 26, 1977	20	57.15N	146.15W	50	135	Gulf of Alaska
2886-21292	June 26, 1977	0	73.15N	153.41W	39	168	Beaufort Sea
2886-21310	June 26, 1977	15	68.08N	162.24W	43	154	Delong Mts
2886-21312	June 26, 1977	0	66.48N	164.02W	44	151	[illegible]
2886-21315	June 26, 1977	0	65.28N	165.30W	45	149	Teller
2886-21321	June 26, 1977	0	64.07N	166.50W	46	146	Nome
2886-21324	June 26, 1977	5	62.49N	168.03W	47	144	St. Lawrence Island
2887-21350	June 27, 1977	5	73.15N	154.59W	39	165	Beaufort Sea
2887-21355	June 27, 1977	15	70.44N	159.56W	41	159	Wainwright
2887-21361	June 27, 1977	2	69.27N	161.57W	42	156	Pt. Lay
2887-21364	June 27, 1977	10	68.09N	163.46W	43	153	Delong Mts
2887-21370	June 27, 1977	5	66.49N	165.25W	44	151	Shishmaref
2887-21373	June 27, 1977	0	65.29N	166.52W	45	149	Teller
2887-21375	June 27, 1977	0	64.08N	168.12W	46	146	Bering Sea
2887-21382	June 27, 1977	3	62.46N	169.27W	46	144	St. Lawrence Island
2887-21384	June 27, 1977	25	61.24N	170.35W	47	142	Bering Sea
2888-21413	June 28, 1977	10	70.41N	161.26W	41	159	Wainwright
2888-21420	June 28, 1977	5	69.24N	163.27W	42	156	Pt.Lay
2888-21422	June 28, 1977	5	68.05N	165.15W	43	153	Pt. Hope
2888-21425	June 28, 1977	0	66.46N	166.53W	44	151	Shishmaref
2888-21431	June 28, 1977	0	65.25N	168.21W	45	148	Teller
2888-21434	June 28, 1977	0	64.04N	169.42W	46	146	St. Lawrence Island
2888-21440	June 28, 1977	25	62.43N	170.58W	46	144	St. Lawrence Island
2889-21462	June 29, 1977	0	73.12N	157.58W	39	165	Chukchi Sea
2889-21465	June 29, 1977	0	71.57N	[illegible]	40	162	Floeberg
2889-21471	June 29, 1977	0	70.41N	162.53W	41	159	Icy Cape
2889-21474	June 29, 1977	0	69.24N	164.55W	42	156	Pt. Lay
2889-21480	June 29, 1977	0	68.05N	166.44W	43	153	Pt. Hope
2889-21483	June 29, 1977	0	66.45N	168.21W	44	151	Shishmaref
2889-21485	June 29, 1977	0	65.25N	169.49W	45	148	Bering Straits
2890-20132	June 30, 1977	5	58.35N	151.07W	49	137	Seldovia
2890-21523	June 30, 1977	0	71.53N	162.02W	40	162	Floeberg
2890-21525	June 30, 1977	0	70.42N	164.20W	41	159	Chukchi Sea
2890-21532	June 30, 1977	0	69.24N	166.21W	42	156	Cape Lisburne
2890-21534	June 30, 1977	5	68.05N	168.09W	43	153	Pt. Hope

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 ATLASES
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.

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.

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 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.

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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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.

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.

SEDIMENT PLUMES IN GULF OF ALASKA

13) National Oceanic and Atmospheric Administration FY 76-77

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.

B. REGIONAL AGENCIES:

REGIONAL ENVIRONMENTAL ATLASES

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.

C. STATE AGENCIES:

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.

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LAND-SALE PLANNING

17) <u>Alaska Division of Lands</u> 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) <u>Alaska Division of Lands</u> 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.

ENVIRONMENTAL SURVEY ON YAKUTAT FORELAND

9) <u>Alaska Department of Environmental Conservation</u> 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.

D. PRIVATE AGENCIES:

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

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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.

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

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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.

APPENDIX G

PROJECT DESCRIPTIONS
LISTED BY SOURCE OF DATA

A. SATELLITE

CHIRIKOF ISLAND SURVEY
1) Bureau of Land Management FY 73

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GLACIER SURGE

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FLOOD HAZARDS

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LAND-SALE PLANNING

17) Alaska Division of Lands FY 77

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PLANNING OF LARGE-SCALE LAND-CLEARING EXPERIMENT

18) Alaska Division of Lands FY 77

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B. HIGH ALTITUDE AIRCRAFT PHOTOGRAPHY

CONSTRUCTION OF TIMBER HAUL-ROAD

6) Northland Wood Products FY 74

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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) <u>Alaska Dept. of Natural Resources</u> 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>U. S. Soil Conservation Service</u> 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

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8. Mr. Ted Freeman, State Resource Conservationist, 907-276-4246
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APPENDIX I

VISITOR TRAFFIC AND PRODUCT ORDERS

(FY 73 and FY 74 data are not available)

	VISITORS				PRODUCTS ORDERED		
Year	Univ.	Federal	Non-Fed.	Private	Images	Tapes	Value
FY 75	278	107	85	144	182	14	$30,278
FY 76	224	106	62	155	259	3	31,397
FY 77	521	174	142	377	314	5	74,085
	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

FY 73	$10,050
FY 74	36,550
FY 75	96,815
FY 76	267,350
FY 77	245,335
	$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

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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 evalute 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

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*Alaska Department of Natural Resources, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, Alaska/NOAA-Outer Continental Shelf Environmental Assessment Program, U. S. Environmental Protection Agency, U. S. Fish and Wildlife Service, National Marine Fisheries Service, and U. S. Army Corps of Engineers.

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 important 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 important 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 $meters^3$ 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.