

flying stage. Predation was also heavy on other nesting birds, particularly Snow Buntings (*Plectrophenax nivalis*), Oldsquaws (*Clangula hyemalis*), and Eiders (*Somateria* spp.). There was evidence that Long-tailed and Parasitic Jaegers (*Stercorarius longicaudus* and *S. parasiticus*), and Arctic Foxes (*Alopex lagopus*) were the principal predators. Long-tailed Jaegers were very abundant (groups of 20-30 were seen frequently) but were not breeding, possibly because of the scarcity of lemmings (*Dicrostonyx torquatus*). No lemmings were seen in 1966, but the abundance of burrows, nests, and droppings indicated that there had been a high population, perhaps as recently as 1965.

In addition to the detailed work on Lapland Longspurs, similar information was obtained on some aspects of the breeding of Snow Buntings. Also, a general survey of the birds of the Base Camp Lowland was made; the Cape Sparbo region and the area between Truelove Valley and the icecap were briefly investigated in early August. Twenty-three species of birds were recorded, of which thirteen were proved to be breeding. Nineteen specimens of twelve species of birds were collected for the Museum of Zoology, University of Michigan.

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## Icefield Ranges Research Project, St. Elias Mountains, Yukon, 1966.

### INTRODUCTION

The Icefield Ranges Research Project (IRRP) continued in 1966 to expand its areas of research (see Fig. 1). Though work began 1 June and continued until the first week in September, the major portion of the summer investigations was carried out between 20 June and 20 August.

Interdisciplinary by nature IRRP is a combination of investigations in many research fields. In the broad categories of

geography, geology, and biology, there were in 1966 twenty studies conducted by more than forty persons, including support personnel. Twelve graduate and two undergraduate college students represented eight colleges and universities in Canada and the United States. Three Canadian scouts, with a number of young students and technical personnel, also assisted in various programs.

The Arctic Institute was again awarded by the National Science Foundation a Research Participation for College Teachers (RPCT) grant to allow six teachers to take part in the IRRP research program. Three teachers who were awarded 1965-66 Academic Year Extension grants by the Division of Undergraduate Education in Science of the National Science Foundation returned as participants in the 1966 RPCT program. Participants were equally divided between the earth and biological sciences. IRRP also gave support in part to four independent short-term studies in geology and biology, as well as to a special reconnaissance of mountaineering objectives for the Yukon Territory's Canadian Centennial project in 1967.

### A STUDY OF THE KASKAWULSH GLACIER MEDIAL MORaine

A reconnaissance study of the medial moraine formed at the confluence of the north and middle arms of the Kaskawulsh Glacier was started for the purpose of collecting data for both a qualitative and quantitative investigation in an attempt to explain the distinctive morphology. Several profiles were run, one down the moraine from the base of the nunatak to a point 1,700 metres distant, and seven cross-profiles. Four triangulation stations provided control. Vertical aerial photographs were taken for mapping purposes. Thirty-one ablation stakes were set at 15-metre intervals across the moraine, and local change in moraine morphology was noted. Rock samples were collected at each stake site for later analysis. Transverse crevasses across the moraine, longitudinal lineation of different rock types, and longitudinal shear zones in the moraine were noted and vegetation samples were collected for identification and analysis.

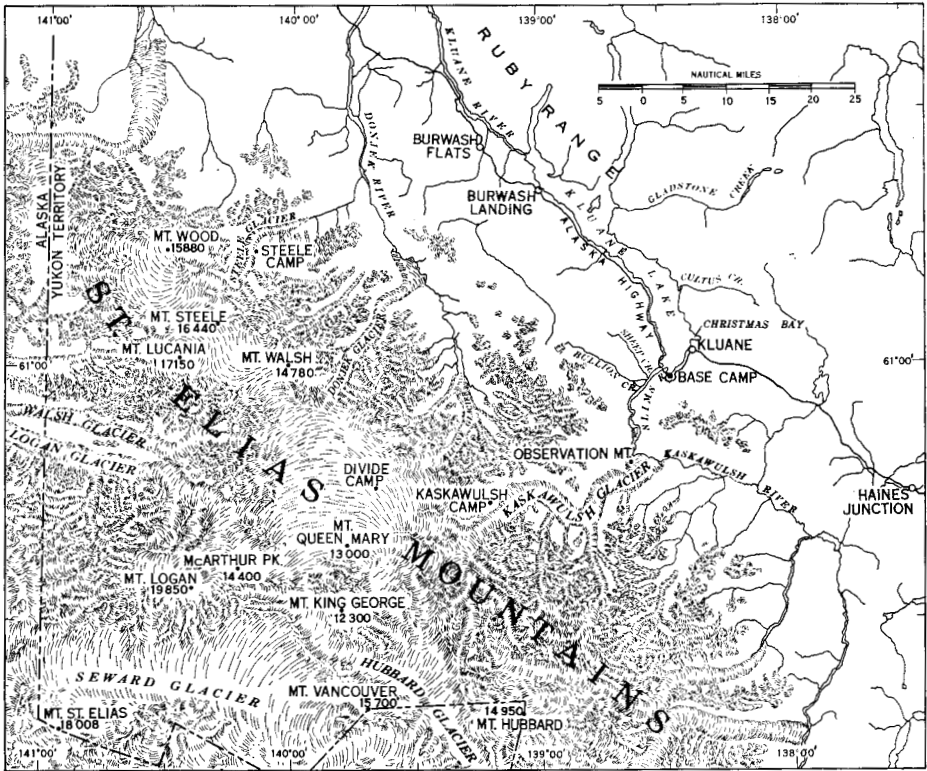


FIG. 1. Location of field studies, Icefield Ranges Research Project, St. Elias Mountains, Yukon, 1966.

#### MORPHOLOGICAL ANALYSIS OF STREAMS ON A GLACIER SURFACE

Although streams on glaciers are influenced by many factors similar to those which influence streams on land surfaces, they are also affected by a number of factors unlike those that occur on land. These include the movement of ice, glacier structure, and interrelationships existing because of the energy flux between moving water, glacier ice, and the atmosphere. The investigation was a continuation of work begun in 1965 which emphasized the defining and mapping of important parameters contingent upon the nature and pattern of glacier streams. Stream evolution and development were plotted from oblique aerial photographs taken about every two weeks during the 1965 field season. In 1966 research into the hydrology of the stream was more detailed the objective being to explain glacier stream

hydrology and morphology in terms of operative environmental processes. One stream in particular was studied in detail. Vertical aerial photographs were taken, ablation measurements were recorded daily, and standard synoptic weather observations were recorded at 3-hour intervals. In addition, qualitative observations were made on cryoconite holes and quantitative observations of the formation of a moulin and its subsequent development.

#### BEACH PROFILE STUDY

A reconnaissance study of the beach morphology along 1,000 metres of shoreline next to Kluane Base Camp was started to determine significant changes in its location, and in transport of beach materials from year to year and between summer storms. The presence of two and in some areas three bars has been established and preliminary ana-

lysis suggests that the innermost is subject to some modification. Also it was found that the shoreline had retreated more than sixty feet during the summer. Bottom sediment samples from crests and troughs of the bars were collected for later analysis.

#### ROCK GLACIER STUDIES

Base lines were measured, triangulation networks were established around four rock glaciers, and surface stations were tied to each local net. Block orientation or surface studies were made on two glaciers and about one hundred increment borings were taken from trees on and along the side of three of the four glaciers studied. A number of soil and bedrock samples were also collected. As a group these glaciers indicated at least three periods of advance.

#### CLOUD SEQUENCE INVESTIGATIONS ACROSS A MAJOR TOPOGRAPHICAL DIVIDE

From mid-June until mid-August cloud sequence photographs were taken at 3-hour intervals around and across the topographic (snow) divide of the Icefield Ranges in conjunction with standard synoptic weather observations. Cloud relationship (types and sequences) to reported regional weather patterns from the Pacific Maritime to the continental interior environment was studied. The purpose was to aid weather forecasting across a major glacier-covered mountain range and involved defining the climatic or 'weather' divide and its relation to the snow/hydrologic divide. Correlations and antitheses will be studied using standard synoptic observations, PIBAL, and radio-sonde observations from Yakutat, Alaska, and Whitehorse, Yukon, between 'strength' of weather systems and the extent and modification of the systems across a major mountain range.

#### CATION CONTENT OF SNOW AND ICE IN THE AREA OF THE DIVIDE STATION

An interesting natural feature of the area is its marked climatic contrasts. Since its precipitation chemistry had not been previously investigated, measurements were made of absolute concentrations of Ca, Na, Mg, and K ions in the annual snow layer — particularly the winter layer — to record

any systematic changes in ion concentration with change in elevation, and to determine the amount and extent of local chemical migration or diffusion in snow and ice. (Atomic absorption spectroscopy will be employed for cation analysis.) Standard pit observations of snow temperatures, densities, stratigraphy and hardness values were carried out at Divide camp in conjunction with the snow sampling for cation analyses. Four shallow pits, two deep pits and a crevasse wall were sampled.

#### SNOW AND ICE SAMPLING FOR ANALYSIS OF Pb<sub>210</sub>

Snow and ice samples were collected for analysis of Pb<sub>210</sub> to try to determine the chronology of the accumulated snow as well as the world-wide distribution characteristics of Pb<sub>210</sub>. Total lead concentration and composition also will be determined because of an interest in the effect of petroleum lead on the natural lead composition and concentration with time. Samples will be analysed for vertical particulate mineral phases in the snow and ice.

#### TERRESTRIAL PHOTOGRAMMETRIC INVESTIGATION OF THE TERMINAL AREA OF THE KASKAWULSH GLACIER (see cover picture)

Seven photogrammetric bases and nine camera stations were set up around the Kaskawulsh Glacier terminus. This completed a network from which a detailed investigation of ice flow and wastage was started, making it possible to estimate the probability of radical changes in the drainage pattern. These observation stations will be reoccupied over a number of years for the main purpose of noting any significant changes in the form of the ice body which, in turn, might precipitate capture of the Slims River system by the lower-lying Kaskawulsh River. The work is being carried out in conjunction with the Canadian International Hydrologic Decade program.

#### GEOLOGY RECONNAISSANCE — ROCKS AND MINERALS

Profitable mining communities and single small subsistence mining operations were visited and observed in operation. Rocks

and minerals and rock suites were collected for later optical petrographic and mineralogic analysis.

#### RECONNAISSANCE ECOLOGY OF KLUANE LAKE AREA

A reconnaissance investigation, mainly ornithological, was started in 1966. Birds were netted, identified, and banded, and dragonflies collected for later identification and classification. The study covered parts of the Gladstone Valley and Cultus Creek on the eastern shores of Kluane Lake, Christmas Bay and the Base Camp area at the south end of the lake and an unnamed island near the mouth of the Slims River. Further studies will include netting, weighing, measuring and banding birds in an attempt to explain the presence of eastern species in certain niches along the continental side of the St. Elias Mountains and to establish the routes by which the birds enter the area.

#### PHYTOGEOGRAPHICAL STUDIES

The botany of the Icefield Ranges is practically unknown. Phyto-geographical studies, started in 1965, were continued in 1966 to be accompanied by cytological analysis and greenhouse studies. Investigations in 1965 which centred in the area of Base Camp and the Kaskawulsh nunatak were supplemented by collections from the Slims River flood plain between Sheep and Bullion Creeks, from Observation Mountain flanking the terminus of the Kaskawulsh Glacier, and from nunataks in the vicinity of Divide Camp. Over one hundred species of vascular plants from a wide range of habitats were collected. Flower buds and root tips were preserved for later cytological studies.

#### FLORA OF KLUANE AND QUALITATIVE RELATIONSHIPS OF PLANTS IN THEIR COMMUNITIES

A second study of plant communities bordering the east and south shores of Kluane Lake and in tundra regions of the Ruby Range was initiated in 1966. Primary areas of investigation were the Gladstone Creek drainage basin and associated upland, the area north of Christmas Bay and the Slims River. Representative collections of vascular plants were made, soil samples col-

lected for later analysis and a feasibility study of interaction between plant and animal established at fifteen sites about the south Kluane shore area.

#### A STUDY OF HUMAN MIGRATION IN THE YUKON

A one-month reconnaissance of the Yukon was made in order to determine the magnitude and direction of population movement, the nature and range of information available concerning migration, and the possibilities for the collection of comprehensive migration data by agencies operating in the Territory.

The reconnaissance will act as the foundation for a major study of migration to and from northern settlements during the summer of 1967 through the examination of the processes involved in movement.

#### STEELE GLACIER OBSERVATIONS

In July and in late August reconnaissance parties were flown by helicopter to the Steele Glacier to observe the surge which was seen to have started in 1965. Gross surface features were plotted, the rate of surface movement measured, and qualitative observations recorded. Immediate cooperation and support was forthcoming from the Surveys and Mapping Branch, Canada Department of Energy, Mines and Resources, with the result that two vertical air photo runs were flown for mapping and research purposes in August and in September. In addition, oblique photo reconnaissances flights have been made at intervals during the winter by the Water Resources Branch, Whitehorse, Yukon, to observe and estimate activity of the Steele Glacier. From July 1966 until the end of the year the rate continued at 1,300 feet per month.

#### BASE CAMP

The summer of 1966 saw the beginning of a modest building program at Base Camp. During the six years that IRRP has been at Kluane Lake, personnel have increased from eight in 1961 to a high at one time in 1966 of nearly sixty. Facilities, though necessarily temporary, have been unable to keep pace with the increase. Thus the building program was initiated in late April and continued through the summer. Two temporary

panel buildings, two family cabins, and a laundry and wash house now augment the living and research space formerly consisting of two Jamesway huts and the many tents which still serve as the primary sleeping quarters.

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## Polar Bear Studies During 1966

Polar bear migratory habits and population dynamics are relatively unknown and to learn more about these aspects, the Arctic Institute of North America (AINA) is supporting a long-range, research project. With funds from the Office of Naval Research the Institute sent Dr. Martin W. Schein to the Arctic Research Laboratory at Point Barrow during April 1965 and he returned to ARL with Dr. Vagn Flyger in March 1966.

With the help of the able pilots at the Arctic Research Laboratory and their small ski equipped airplanes, they developed the following technique for capturing bears. When weather permitted they flew out over the ice in the general area north of Point Barrow with Cessna 180 airplanes. While one airplane flew at an elevation of about 100 feet and searched for polar bear tracks, the other airplane, containing Flyger and Schein, flew slightly behind and at an altitude of about 500 feet. Upon finding polar bear tracks, the planes followed them until they came upon the bear. The plane containing the biologists went on ahead about two or three miles in the direction the bear was travelling and deposited Flyger and Schein on the ice where they hid behind a pressure ridge. The plane then took off and the two planes drove the bear to the waiting biologists. When the bear got to within approximately 50 yards, it was shot with an automatic projectile syringe from a rifle. Syringes contained the drug succinylcholine chloride which paralyzed the bear within a few minutes. While the bears were immobile, they were examined, measured, and marked with ear tags and dye so that they could be recognized later if seen.

Five bears were captured but of these four died because of a combination of overdoses of the drug and circumstances connected with chasing the bear with aircraft. Much, however, was learned from these animals which made it possible to be more successful in capturing and marking bears in Svalbard during August 1966.

The Norsk Polarinstittutt invited Dr. Flyger, supported by AINA, and Dr. Albert W. Erickson, supported by the New York Zoological Society, to accompany them on a polar bear capturing expedition to Svalbard during the summer of 1966. This expedition under the direction of Mr. Thor Larsen from the University of Oslo, operating in the pack ice near Kong Karls Land in a seal hunting vessel was able to capture four bears, mark them, and release them alive. This time a different drug was used: M-99, a synthetic opiate. Working from a ship was much easier than with aircraft because it was possible to observe the bear closely before shooting it with a projectile syringe, thus lessening the chance of an overdose.

Plans are now under way for a large scale program to mark polar bears over the entire Arctic. In any event it is hoped that the Arctic Institute of North America and the Norsk Polarinstittutt will again work together to capture bears in the Svalbard region during 1967 and 1968.

The feasibility of studying bear movements with radio transmitter-receivers is being explored with the National Aeronautics and Space Agency (NASA), Telemetric methods which have been used on other animals including brown and black bears are not applicable to arctic conditions. Recently developments in satellite technology have raised the possibility that perhaps polar bears can be studied by employing a Nimbus B satellite. Such a satellite would pick up messages (giving location, heart-beat, respiration rate, internal temperature, and external temperature) from a transmitter-receiver on a collar around the neck of the bear and relay them to a tracking station on earth. The practicability of this is being studied at present with NASA.

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