spreads more slowly but occasionally a tongue of water opens into Melville Bay. Once the southward spread is well established the proportion of truly open water tends to become higher and the southern boundary easier to identify.

The northern ice bridge usually breaks up in late July or August. The satellite pictures show the date fairly clearly as early August in 1966 and mid-August in 1967. Once the bridge has gone it becomes impossible to define the North Water at all from ice observations, as the area becomes merely part of the southward drift route, or melting ground, for ice from Kane Basin and farther north. Unfortunately observations are lacking for the freeze-up period, so the date of formation of the bridge and the extent of the North Water through the dark months can only be guessed at. It is reasonable to suppose that the bridge would form at the time Kane Basin freezes over, probably in October, and that the North Water is present from that time on. It should be possible to confirm this as soon as infrared imagery of sufficient definition is available from satellites.

Moira Dunbar
Defence Research Establishment Ottawa

A Forest Ecosystem on a Glacier in Alaska

INTRODUCTION

Russell[1] noted that alder, cottonwood, and spruce were growing on the Malaspina and nearby glaciers in the vicinity of Yakutat. Several papers in the 1890's and early 1900's note the occurrence of vegetation on glaciers, but the emphasis was on geological, especially glacial features. Significant published ecological observations of this important phenomenon have not been found.

Russell[2] describes the forest on the Malaspina Glacier as follows:

> The forest covering the greater portion of the lowlands extends up over the moraine-covered bluff of ice and thence inland on the surface of the glacier for 4 or 5 miles... On account of the melting of the ice, the debris and vegetation on the steeper slopes frequently slip down in small landslides, forming a chaotic accumulation of bowlders and uprooted trees.
>
> The debris on the surface of the escarpment, and covering the glacier to the north, is not of great thickness. Many of the bowlders are 8 or 10 feet in diameter, but when these are not present the layer of earth and stones which conceals the ice and forms the stratum on which vegetation has taken root, is, on an average, not more than 3 or 4 feet thick, and is frequently much less.
>
> The vegetation through which we cut a trail consisted principally of alders, growing to a height of 20 or 30 feet, but on the outer or older portion of the moraine there are dense groves of spruces, some of which are 3 feet in diameter. The spruce trees decrease in number and become of smaller size toward the interior.

In October 1968, I made a brief visit to the Kushtaka Glacier and a forest ecosystem that occurs on it; my observations follow.

THE KUSHTAKA GLACIER

The Kushtaka Glacier is a branch of the Martin River Glacier about 60 miles east-southeast of Cordova (Fig. 1). The Martin River Glacier is fed by the Bagley Ice Field

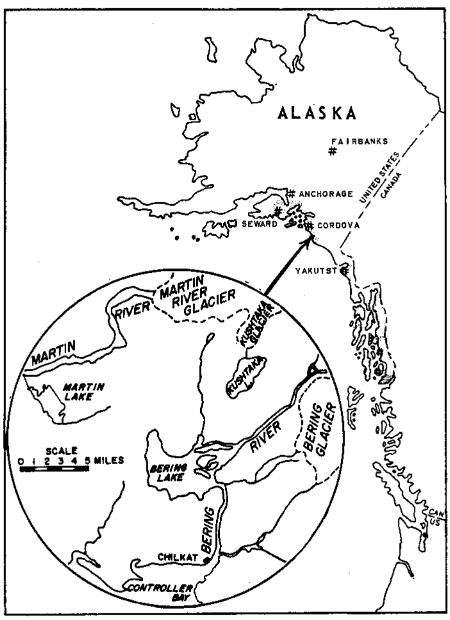

FIG. 1. Location of the study area.

in the Chugach Mountains. The snout of the glacier extends down to about 100 feet elevation. The vegetated portion of the Kushtaka Glacier is stagnant with many craters (Fig. 2).

VEGETATION

Succession on top of the glacier is very similar to, perhaps identical with, that on many tills left by the receding Mendenhall and Herbert Glaciers near Juneau[3]. After the raw soil surface is somewhat stabilized by

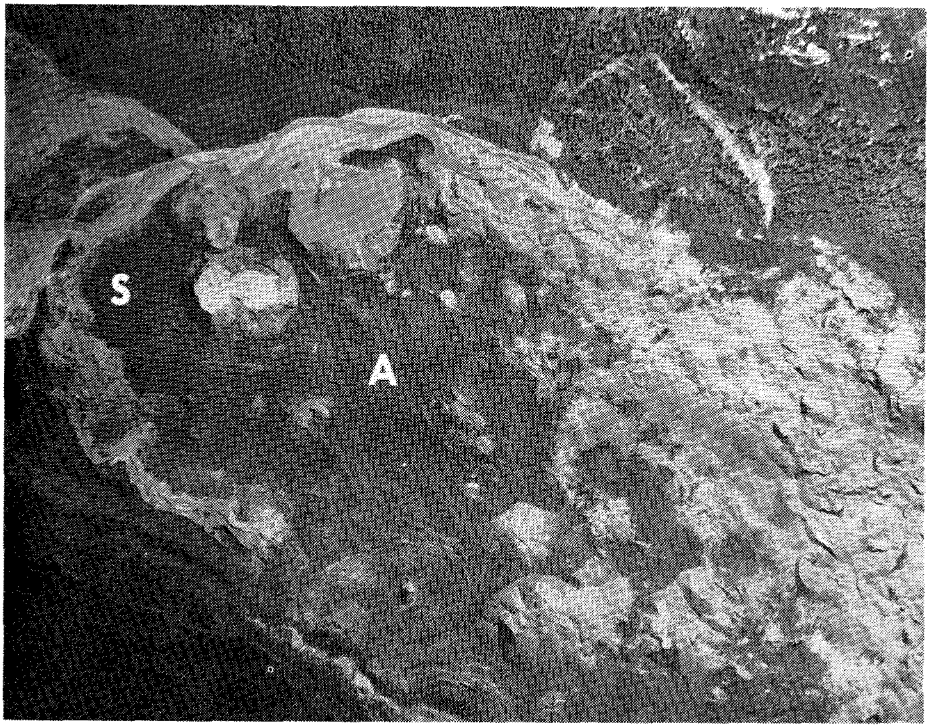

FIG. 2. Aerial view of the lower Kushtaka Glacier. S indicates Sitka spruce forest and A dense Sitka alder.

pioneer plants, dense Sitka alder with a few willows and cottonwoods dominate the site. Sitka spruce gradually overtops the shrubs, and within 100 years of vegetative establishment a dense Sitka spruce forest dominates.

The ecosystem on the snout of the Kushtaka Glacier is at the stage of development when the spruce forest has almost eliminated the alder from the site (Fig. 3). Just a few spindly alders are still alive, with many dead alder stems and stubs remaining under the canopy. The forest floor is thickly carpeted with mosses; *Rhytidiadelphus* and *Hylocomium* predominate. Only a few scattered higher plants grow in the understory. Ocular estimates of crown cover by species[4] are as follows:

Sitka Spruce (*Picea sitchensis*)	80%
Western Hemlock (*Tsuga heterophylla*)	5%
Mountain Hemlock (*Tsuga mertensiana*)	Trace
Cottonwood (*Populus spp.*)	Trace
Sitka Alder (*Alnus crispa* subsp. *sinuata*)	10%
Currants (*Ribes spp.*)	Trace
Devil's Club (*Echinopanax horridum*)	Trace
Wintergreen (*Pyrola secunda* subsp. *secunda*)	5%
Wood Fern (*Dryopteris dilatata* subsp. *americana*)	10%

Spruces range from about 6 to 12 inches in diameter 4.5 feet above the ground. One dominant spruce was about 65 years old and 55 feet tall, as determined by felling and ring count. This growth rate is similar to that of Sitka spruce growing on young till over bedrock below the Herbert and Mendenhall Glaciers.

SOIL

The soil is an infant Spodosol (Podzol). The profile description is as follows (Moist Munsell color notations[5]):

Horizon	*Depth inches*	*Description*
011	5-4	Litter of needles, twigs, etc.
012	4-0	Dark reddish-brown and black (5YR2/2 and 2/1) forest litter peat containing abundant roots; rapid percolation; abrupt wavy boundary.

Horizon	Depth inches	Description
A2	0-1	Dark gray (10YR4/1) very gravelly sandy loam; massive; very friable; 70% coarse fragments by volume; abundant roots; moderately rapid percolation; abrupt wavy boundary.
B	1-7	Dark grayish brown (10YR 4/2) with 10% blotches of brown to dark brown (10YR 4/3) very gravelly sandy loam; very weak fine and medium subangular blocky structure; very friable; 70% coarse fragments by volume; abundant roots; moderately rapid percolation; clear wavy boundary.
C	7-36	Dark gray (NA4/0) very gravelly sandy loam; massive; very friable; 70% coarse fragments by volume; thick coatings of fine sand, silt, and clay on tops of coarse fragments; common roots to 28 inches; saturated below 30 inches; moderately rapid percolation; abrupt wavy boundary.
—	36 +	Hard, clear ice.

Soil depth over ice ranges generally from 20 to 40 inches. Profile development is understandably very weak in such a young soil, but is similar to profiles in similar ecosystems below the Herbert and Mendenhall Glaciers.

DISCUSSION

This ecosystem is not unique. Similar brush and forest vegetation occurs on many glaciers in coastal Alaska[6]. It seems likely that there were large areas of stagnant ice during the

FIG. 3. Ground view of the Sitka spruce forest growing on top of the Kushtaka Glacier. Ice melting undermines the soil and vegetation, causing them to accumulate in a heterogeneous mixture at the base of the ice. The hardwood shrubs are Sitka alders, remnants of a once-continuous cover.

latter stages of the Wisconsin ice age. It also seems likely that, as the ice melted, superglacial till was extensive. This could have formed the substrate for extensive superglacial vegetation.

Ice melting is rapidly destroying this ecosystem (Fig. 3), as it was in those reported by Tarr and Martin[6]. Ecosystems on Wisconsin-age glaciers would also have been destroyed. However, organic matter, nitrogen, and other plant nutrients built up in the superglacial ecosystem could make significant contributions to young post-glacial ecosystems. For instance, ecosystems of this age below the Mendenhall Glacier have accumulated about 2,000 pounds per acre of nitrogen in and on the soil, not including that in the live vegetation[3].

Superglacial vegetation could have been important in hastening extension of plant ranges after deglaciation. Seed sources for much newly deglaciated land may have existed on nearby ice. Vegetated, stagnant ice bridges could have been important in the spread of vegetation and animals between islands and between the mainland and islands.

F. R. Stephens
USDA Forest Service,
Alaska Region,
Juneau, Alaska.

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A Northern North American Record of the Starling

The spread and establishment of the starling (*Sturnus vulgaris*) in many parts of North America since its introduction into New York City in 1890 is well known. It was not until recently, however, that evidence for its northward spread on this continent was obtained; the first record of this species from the Northwest Territories, near Fort Smith, was reported by Fuller[1]. Since that time starlings have repeatedly been seen in the Fort Smith and Yellowknife areas[2] and on 16 June 1964 Kuyt[2] found a nest at Lookout Point, about 225 miles northwest of Fort Reliance, Northwest Territories. Starlings were first reported in Alaska in 1960[3] and since that time several have been seen in interior Alaska.[4, 5]

On 27 June 1968 I observed a starling feeding at the edge of a sewer lagoon, about one-half mile north of Inuvik, Northwest Territories (68°21′N., 133°44′W.). This bird was not seen again despite several subsequent trips in the vicinity of where the original observation was made. This appears to be the most northerly record of the starling in North America, being about 120 miles north of the Arctic Circle.

This observation was made while I was employed on contract with the Canadian Wildlife Service.

Spencer G. Sealy
Museum of Zoology
University of Michigan

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Coordination of Arctic Research in the U.S.A.

To improve the coordination of basic, unclassified research conducted in the Arctic under the auspices of U.S. Government agencies, an Interagency Arctic Research Coordinating Committee was established in 1968. The committee members represent twelve Government agencies: the Department