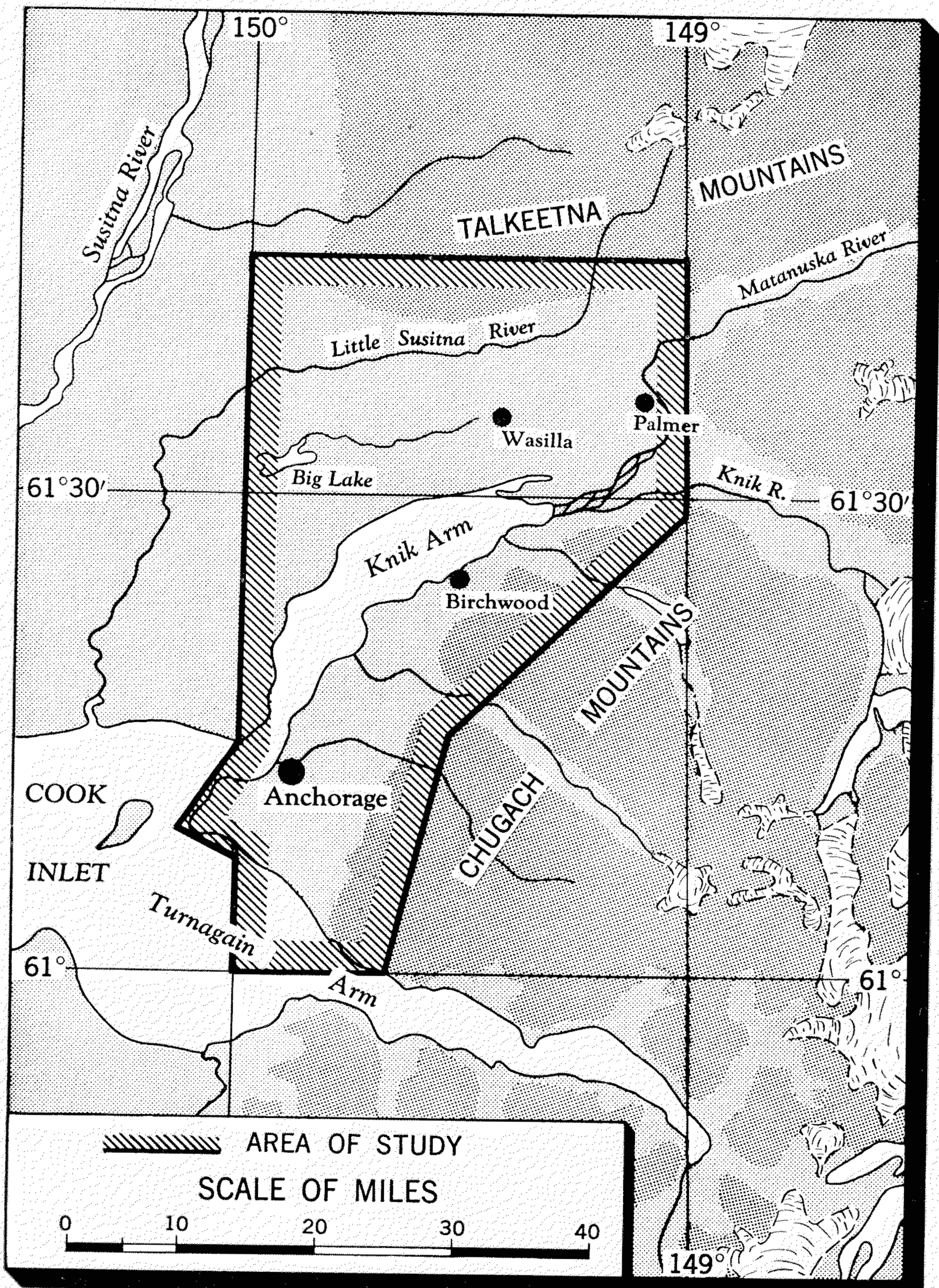

Fig. 1. Location map.

RATES OF TREE GROWTH AND FOREST SUCCESSION IN THE ANCHORAGE-MATANUSKA VALLEY AREA, ALASKA*

John C. Reed, Jr.[1] **and John C. Harms**[2]

Geographic setting

DURING the 1955 field season the vegetation in the Anchorage-Matanuska Valley area, Alaska, was studied as a part of an investigation carried out by the 535th Engineer Detachment (Terrain), U.S. Army Map Service. The area studied includes the lowlands bordering Knik Arm and the lower portions of the valleys of the Knik and Matanuska rivers. It extends from 61°07′ to 61°45′ north latitude. (Fig. 1). According to Sigafoos (1956) it lies in the Susitna-Copper River Spruce-Birch Forest Province. The vegetation types studied include those from sea level to tree line, which lies at an elevation of about 1,500 feet on the flanks of the Chugach Mountains and up to 2,000 feet on the flanks of the Talkeetnas. Dense alder stands extend several hundred feet above timberline.

Scope of investigation

The goal of the investigation was a forest cover type map primarily for military purposes. Choice of map units was governed by two primary considerations: logical continuity in forest succession, and ease of recognition on available aerial photographs (Stone, 1950). Eight principal forest cover types were distinguished. These are listed in the following table.

Table 1. Principal forest cover types in the Anchorage area.

I. Mature types undisturbed by recent fires
   1. Pure black spruce forest
   2. Pure white spruce forest
   3. Birch-white spruce forest
   4. Cottonwood-white spruce forest
   5. Alder thickets

II. Types representing stages in regrowth following fires or recent aggradation by streams
   1. Young birch-aspen-cottonwood stands (generally less than 40 years old)
   2. Submature birch-white spruce forest
   3. Submature cottonwood-white spruce forest

*Published by permission of Commanding Officer, U.S. Army Map Service.

[1]U.S. Geological Survey, Denver, Colo., formerly 535th Engineer Detachment (Terrain), U.S. Army Map Service.

[2]Dept. of Geology, Univ. of Colorado, Boulder, Colo., formerly 535th Engineer Detachment (Terrain), U.S. Army Map Service.

Non-forested areas are principally marsh, muskeg, or farmlands, although some slopes capable of supporting trees are only grass covered, probably because of the severity of past fires.

In the course of the field work 65 test plots with areas of one-fifth or one-tenth of an acre were laid out. Because of limitations of time the test plots were not distributed randomly, but were located in easily accessible areas typical of each forest cover type. All trees over three feet high in each plot were counted and their diameters recorded in two-inch size classes. The ages of selected trees were determined and their exact diameters and heights measured. Because of the large area covered by the birch-white spruce succession, most of the test plots were in the young birch-aspen-cottonwood forest type, the submature birch-white spruce forest type, and in the mature birch-white spruce forest type.

Distribution and rate of growth of tree types

Field mapping indicates that in general the most important factors controlling the distribution of tree species in the area studied are altitude, drainage, extent and severity of fires, regenerative ability of the species following a fire, and frequency of flooding. Except at higher elevations, exposure plays a minor role. The effects of geologic setting and soil types are negligible, except in so far as they affect the drainage. Once the trees are established, the rate of their growth depends mainly on the species, the amount of sunlight reaching an individual, the drainage, and to a minor extent, on altitude and exposure.

Figures 2 to 5 are scatter diagrams that summarize the growth rate data for birch (*Betula* spp.), white spruce (*Picea glauca*), black spruce (*Picea mariana*), and poplar (*Populus* spp.). The ages of the trees are plotted against the diameters. Site drainage characteristics are shown by symbols. Poorly drained sites include swamps and muskegs; moderately well drained sites include level or gently sloping areas underlain by impermeable glacial till or bedrock; well drained sites include areas underlain by outwash gravels, wind-blown silt, and recent alluvial deposits. Sites on shallow soil overlying till or bedrock on steep mountain sides are also classified as well drained.

Because of the effect of shading, individual trees in a stand may show growth rates much lower than those of the dominant trees. Only data from the oldest trees at a particular site are included when it was apparent that shading had retarded the younger trees significantly.

Poplar has the highest growth rate of any of the trees measured, that is, a maximum increase in diameter of 0.4 inch per year on well drained sites. Birch and white spruce have growth rates of 0.10 to 0.15 inch per year on well drained sites, but white spruce is apparently more affected by poor drainage. Black spruce has the lowest rate of growth of any of the trees measured. The average rate of increase in diameter is 0.02 to 0.05 inch per year for trees growing in muskegs and slightly higher on better drained sites.

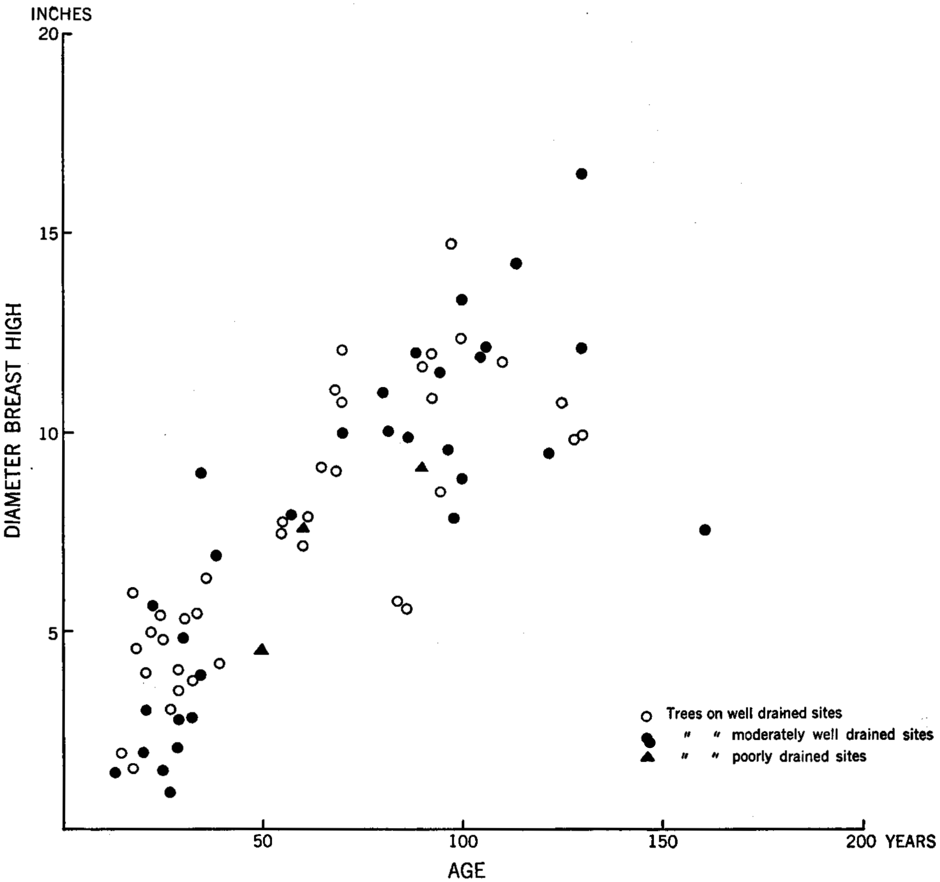

Fig. 2. Scatter diagram showing age and diameter of 71 birch trees.

Birch-aspen-cottonwood to birch-white spruce succession

Lutz (1953, 1956) has described the succession of vegetation following forest fires in the interior of Alaska. He states (1953, p. 3): "The complexity of the vegetation pattern is, in large measure, the result of fires." Fires were undoubtedly a common occurrence in the forests of the Anchorage-Matanuska valley area prior to the coming of the white man, but widespread settlement greatly increased their incidence. Extensive fires that occurred during the construction of the Alaska Railroad in 1916-17 have had a profound effect on the present distribution of vegetation types.

The forest succession that follows a severe fire on moderately well to well drained sites depends on the type of reseeding in the area. Generally the pioneer species are those with easily dispersed seeds, such as birch, aspen (*Populus tremuloides*), poplar, and willow (*Salix* spp.). The population graphs (Fig. 6) illustrate a typical succession following a severe fire in mature birch-white spruce forest. Four stages in the succession have been distinguished; these correspond to map units II-1, II-2, I-3, and I-2 of Table 1.

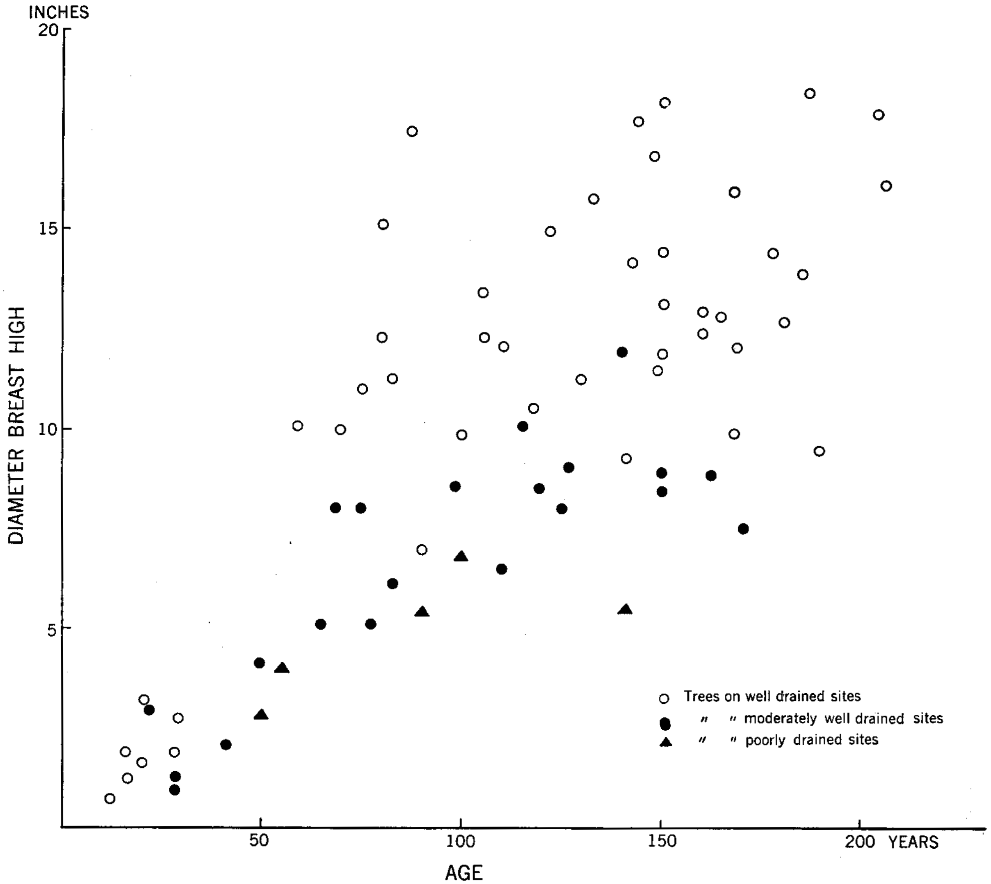

Fig. 3. Scatter diagram showing age and diameter of 71 white spruce trees.

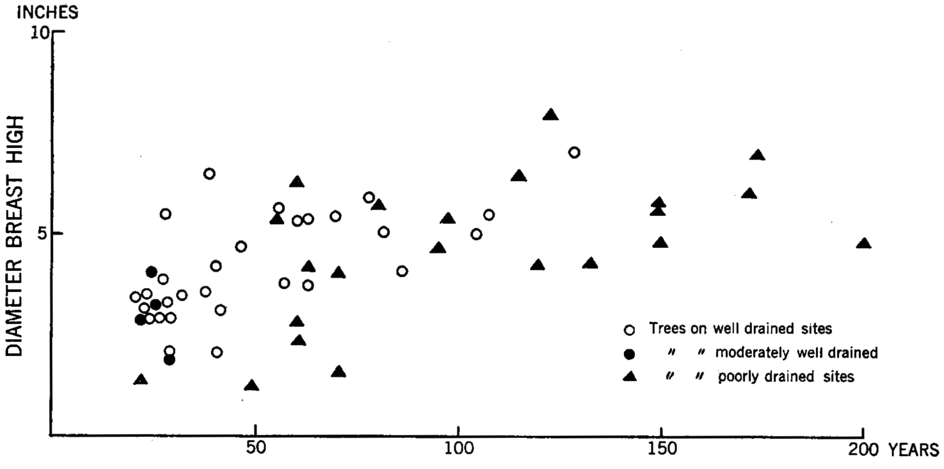

Fig. 4. Scatter diagram showing age and diameter of 55 black spruce trees.

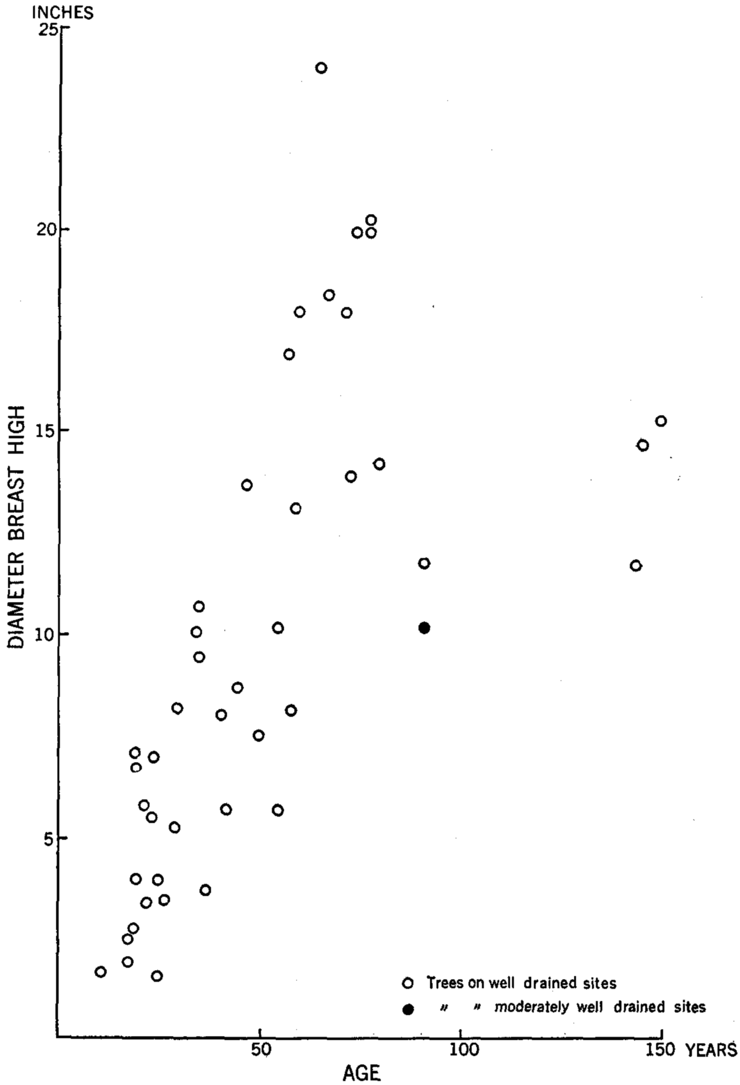

Fig. 5. Scatter diagram showing age and diameter of 44 poplar trees.

Reproduction that takes place after severe fires in mature birch-white spruce forest in the study area generally leads to a dense stand of birch saplings with an admixture of cottonwood and aspen (Fig. 7). Scattered white spruce seedlings are found in the understory. Because of the dense shade, ground vegetation is sparse and consists mainly of mosses, lichens, horsetail (*Equisetum* spp.), bunchberry (*Cornus canadensis*), low bush cranberry (*Vaccinium vitis-idaea*), and twinflower (*Linnaea borealis*). Thirty to forty years after the fire the majority of the birch are 2 to 4 inches in diameter. Stem density is very high, up to 6,000 stems per acre (Fig. 6A). The canopy density is 95 to 100 per cent and the canopy height is 30 to 40 feet.

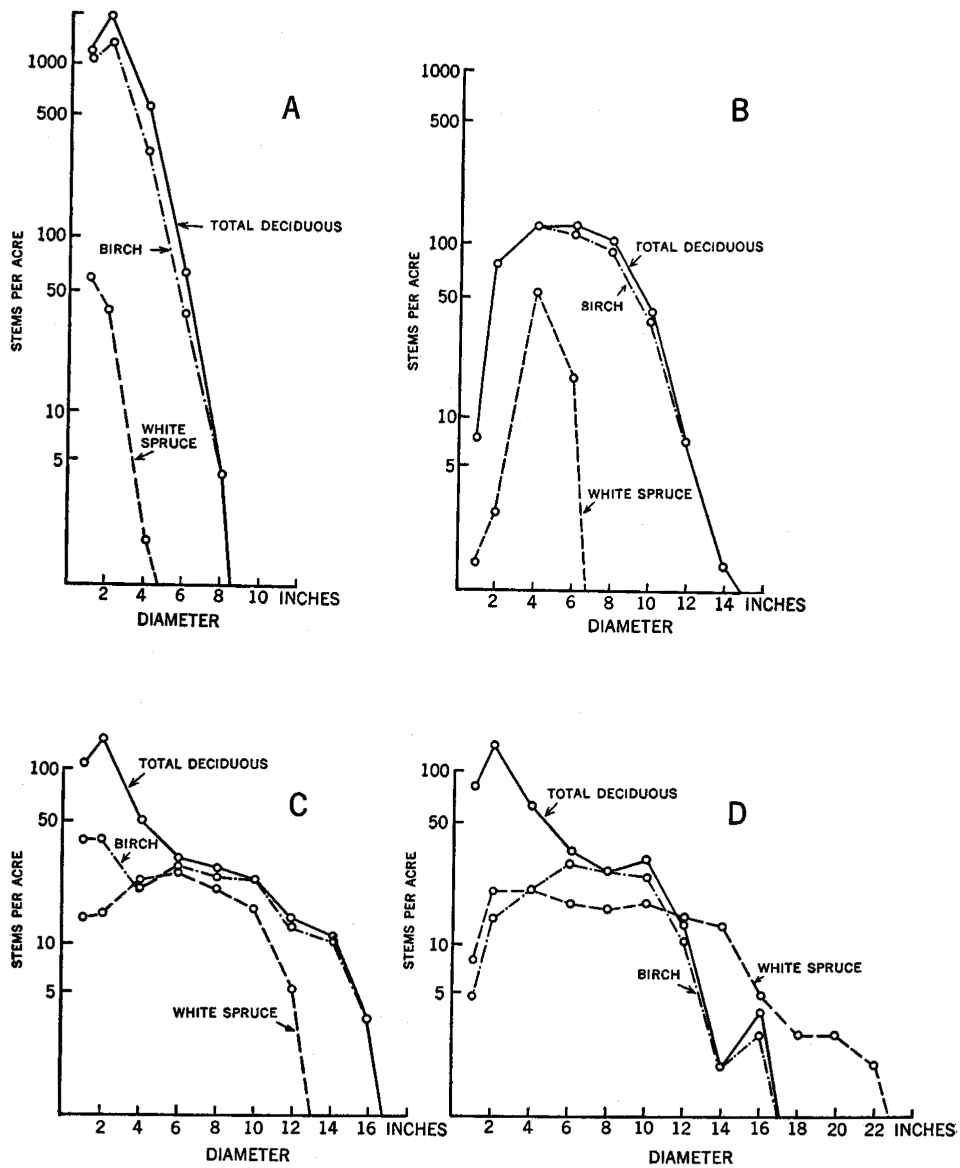

Fig. 6. Population diagrams showing number of stems per acre by two-inch size classes in four stages in the birch-white spruce succession.

A. Young birch thickets (average of 11 one-tenth of an acre test plots). Average age of oldest trees 33 years.
B. Submature birch-white spruce forest (average of 6 one-fifth of an acre test plots). Average age of oldest trees 77 years.
C. Mature birch-white spruce forest (average of 19 one-fifth of an acre test plots). Average age of oldest trees 135 years.
D. Near climax white spruce-birch forest (average of 5 one-fifth of an acre test plots). Average age of oldest trees 170 years. The age of the oldest trees probably does not indicate the age of the stand.

Fig. 7. Typical young birch thicket. Forty-year old stand of birch growing on moraine south of Big Lake (Anchorage C-8 quadrangle). Most trees are 1 to 2 inches in diameter, largest are 6 inches.

Fig. 8. Submature birch stand with understory white spruce growing on level gravel terrace near Birchwood (Anchorage B-7 quadrangle). Stand is about 70 years old. Most of the birch are 4 to 6 inches in diameter.

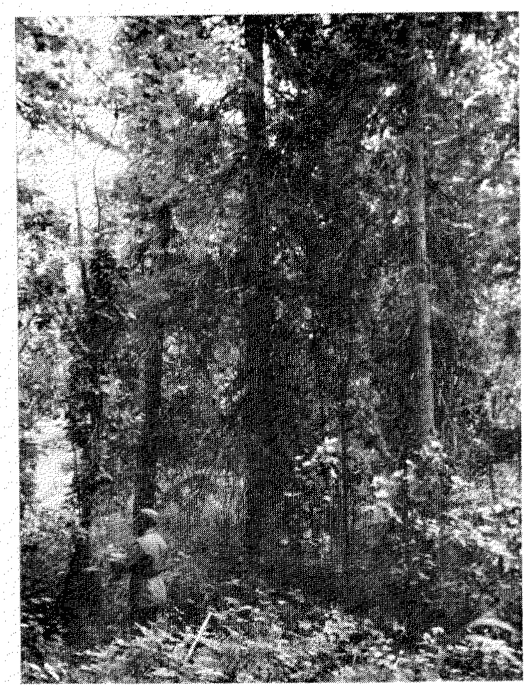

Fig. 9. Mature birch-white spruce stand on gravel terrace near Palmer (Anchorage C-6 quadrangle). Oldest tree is approximately 110 years, largest is about 14 inches in diameter.

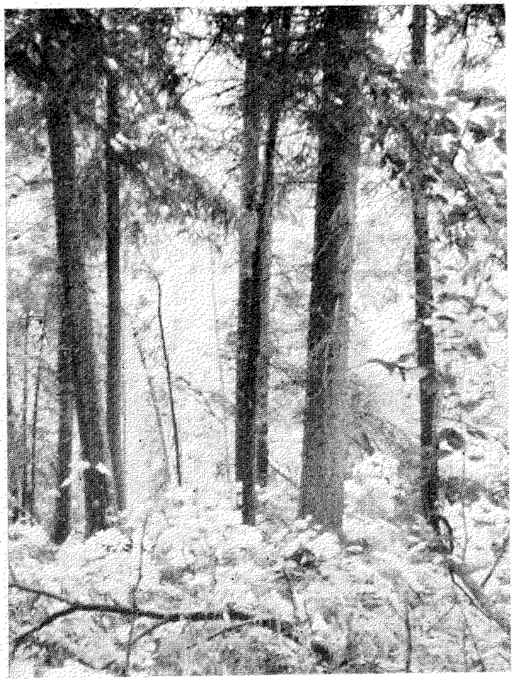

Fig. 10. White spruce-birch forest on north flank of Chugach Mountains near Birchwood. Oldest tree is 177 years, largest is about 20 inches in diameter.

By the time the stand reaches 70 to 80 years, most of the dominant birch are 6 to 8 inches in diameter (Fig. 6B, Fig. 8). The spruce are 2 to 6 inches in diameter, but have not yet reached the canopy. The crown density is still high and canopy height is 60 to 70 feet. The stem density has decreased to 400 to 600 stems per acre, mainly on account of mortality among the birch. Birch is not shade tolerant so that the smaller trees do not survive; white spruce has a low mortality since it tolerates shade.

At an age of 120 to 140 years the stem density has decreased to about 200 trees of over 2 inches in diameter per acre (Fig. 6C, Fig. 9). Some of the larger birch and spruce reach 20 inches in diameter. Many of the birch are overmature and are suffering from decay and frost cracking. The density of the canopy has decreased to between 60 and 85 per cent. The canopy is made up mainly of birch. The larger spruce trees, 70 to 90 feet high, reach 10 to 20 feet above the birch canopy. Birch are able to reproduce locally in the openings left by fallen trees, this is reflected by the second maximum in the two-inch diameter class of the birch population curve. Alder (*Alnus* spp.) frequently occurs in the understory, causing the marked increase in the total number of deciduous stems in the smaller size classes. Because of the open canopy ground vegetation is quite dense, consisting mainly of grasses, high bush cranberry (*Viburnum edule*), currant (*Ribes* spp.), rose (*Rosa* sp.), devils club (*Oplopanax horridus*), and tall fireweed (*Epilobium angustifolium*).

Since spruce are longer lived and the seedlings are shade tolerant, it might be expected that normal forest succession would eventually lead to pure stands of white spruce. However, this condition is seldom reached in the study area, probably because new generations of birch arise to maintain a considerable population as soon as the canopy is opened by the death of overmature trees. The white spruce may also be killed by insects and disease and the same agents may interfere with their production of seed.

The stands showing the highest ratio of spruce to birch are found close to timberline on the north flank of the Chugach Mountains (Fig. 10). The average population of these stands is shown in Fig. 6D. The ground vegetation is similar to that of the mature birch-white spruce forest. The average age of the larger spruce is 170 years.

Other successions

Two other forest successions were noted: poplar to poplar-white spruce to white spruce; and birch-black spruce to black spruce. The former is common on well drained alluvial terraces bordering streams; the latter is found on both poorly drained and well drained soils. Not enough data were collected to prepare population curves for these successions.

Conclusions

1. Soil type and surficial geology are relatively unimportant as direct controls of distribution of vegetation in the area. Occurrence of fires and availability of seed immediately following a fire are of far greater importance.
2. Growth rate is controlled by amount of sunlight and drainage characteristics of the site.
3. Cottonwood and aspen have the highest growth rates observed. Birch and white spruce have a lower growth rate. Drainage conditions apparently have more effect on white spruce than on birch. Black spruce has the lowest growth rate.
4. In the area studied a mixed birch-white spruce forest is generally self perpetuating. Only in small areas have pure white spruce stands developed from the birch-white spruce association.

References

Lutz, H. J. 1953. 'The effects of forest fires on the vegetation of interior Alaska'. *U.S. Forest Service, Alaska Forest Research Center Station Paper No. 1,* 36 pp.

——— 1956. 'Ecological effects of forest fires in the interior of Alaska'. *U.S. Dept. of Agric. Tech. Bull. 1133.* 121 pp.

Sigafoos, R. S. 1956. 'Vegetation map of northwestern North America'. Unpublished MS in files of Military Geological Branch, U.S. Geological Survey.

Stone, K. H. 1950. "Aerial photographic interpretation of natural vegetation in the Anchorage area, Alaska". *Surveying and Mapping,* Vol. 10, pp. 199–207.