PERMAFROST AND FORESTRY

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Little is actually known on this subject and it is difficult to separate the influence of the permafrost from that of the conditions leading to permafrost. Although some permafrost may be a postglacial relic and arise when the surface cover sufficiently insulates the soil against summer heat this condition is of little interest to foresters because most areas of this type have a mean temperature too low to permit tree growth. There are exceptions such as the lower Mackenzie River valley and the Mackenzie River delta. For the forester the most detrimental permafrost is that of the discontinuous zone where most of the frozen ground develops from the ground surface down after the growth of a dense coniferous forest.

A study of how permafrost develops in the southern fringe and how trees react to frozen ground in the permafrost region could provide information essential to management of Boreal region forests. It appears that under the climatic conditions of the northern Boreal forest an acid litter develops under the trees followed by a moss cover. This moss cover fills with snow and ice during the early snowstorms of the autumn and thus serves as a conductor of heat from the ground during the winter months. In the summer the surface of the moss dries and acts as an insulator hindering the transfer of heat to the underlying mineral soil. As a result only a portion of the winter's frost may be dissipated during the summer months and permafrost develops in areas south of the recognized permafrost zone.

The exact influence of this moss cover is not known although research is being conducted in this field by the Pulp and Paper Research Institute of Canada, the Federal Department of Forestry and other agencies. The first obvious effect is a lowering of soil temperatures which will discourage all trees or plants whose roots cannot grow in a cold soil. Next the acid litter which develops, especially under a spruce forest, is low in available nutrients, particularly nitrogen, so that regardless of the potential richness of the soil few of the nutrients can be assimilated. The acid litter tends to develop a glei surface on clayey or silty soils and this has the same effect as puddling clay for canal banks. The soil surface becomes impervious to moisture and an artificial water table develops which prevents soil aeration. This condition is also found in sandy soils where impervious "hard pans" can develop with the same ultimate results. Exact information on the growth inhibiting effect of this acid litter seems to be unavailable so it is not certain whether the reduction of soil temperature or the increase in acidity of the active soil layer is the growth deterrent. Probably both are contributing factors.

There are many examples proving that if the development of the acid litter and moss cover is prevented, spruce trees will grow quite satisfactorily in a very shallow active layer in permafrost regions. At Fort McPherson trees grow to heights exceeding 80 feet in an area where the average depth of thaw at the end of July is 12 inches. Steep slopes which have good drainage plus moisture trickling from the hillside develop moss layers very slowly and have good tree growth.

The engineer handles thin permafrost by digging through it, draining the area and backfilling with granular material. In areas of thick permafrost he tries to insulate the soil surface and take advantage of the strength of the frozen ground.

The forester cannot afford to do either. He must have a frost-free active layer or trees cannot grow but the cost of preparing the soil surface must be low. Early studies in Alaska indicate that the active layer had to be several feet thick but the Mackenzie Delta forests show that trees can grow on a very thin active layer as long as the soil surface is warm. Thus while the engineer wishes to keep the soil frozen the forester must keep it thawed. Although their aims seem diametrically opposed, engineering studies regarding the causes and effects of permafrost indicate what the forester must do. His major problem is to develop a method at a price which is not beyond the value of the final crop one hundred years later.

Trees grow very slowly on permafrost and the merchantable stands of the Mackenzie River delta are mostly about 200 years old although the writer believes that timber of small sawlog size might be grown on favourable sites in as little as 100 years. These stands of timber are found, however, where periodic floods from ice jams cover the forest litter with rich silts. The floods incorporate the leafy matter into the soil and effectively kill the moss layer. Above the range of periodic flooding the trees are almost entirely scrub. For example, Department of Forestry officers found a black spruce more than 300 years old only 6 feet tall.

Only a limited area is subject to the periodic flooding described at Fort McPherson, N.W.T. and more widely applicable procedures are required. At Inuvik, N.W.T. the Department of Agriculture bulldozed garden areas until the surface litter had been incorporated into the underlying mineral soil. This was a very expensive process, far too costly for the development of forest land, and there is no guarantee that the site would not degenerate quickly after trees begin to shade the soil. There are excellent gardens at Fort McPherson but again the development process is too slow and too costly for large scale use.

On the hillside above Norman Wells, N.W.T. a serious fire burned the forest and ground cover to the mineral soil. Downhill below the burn was deep Sphagnum and black spruce scrub with permafrost almost to the top of the mineral soil layer. Similar conditions were found uphill from the burn. On the burn area itself, however, no frost was found with a 42-inch soil augur. Fire is used in the Scandinavian countries to release chemicals at the surface of moss layers and thus promote tree growth. It might be effective in the Canadian North, especially if flat or gently sloping burn areas were ditched to provide adequate drainage. Considerable work is being done in Canada on the use of controlled burning and this may indicate possible procedures.

Uncontrolled burning is usually seriously destructive. Thin-soiled areas are normally the driest and with the litter removed by fire they degenerate to rock barrens. Swampy areas are usually too wet to burn and remain swamps. Since most of the bench land of the Northwest Territories is now so wet that fires would not affect it burning, controlled or uncontrolled would be difficult to utilize without extensive preliminary work.

In conclusion the conditions which lead to permafrost also lead to forest site degeneration, even in areas where soil and summer temperatures are suitable for tree growth. The forester's problem in such areas seems to be how to develop a "litter" layer which will permit warming of the upper soil horizons and how to prevent this layer developing into an insulating blanket which will foster permafrost.

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