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PROGRESS REPORT OF THE RESEARCH PROJECT
ON

THE ECOLOGY OF THE SPRUCE-FIR
FOREST TYPE OF
ISLE ROYALE NATIONAL PARK

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By

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This report is a summary of progress on this research project since the last report of January 1, 1972. It is mainly concerned with the effects of fire on the boreal forest ecosystem type of Isle Royale National Park and the succession that follows fire.

During the summer, data were collected along transects which crossed burn boundaries where topography was similar on both sides of the burn. Four of these were across 1936 burn boundaries and two were across the boundary of an older burn on Smithwick Island. Other data were collected in plots layed out in more or less homogeneous forest stands of varying age.

A study of litter depths along the 1936 burn transects showed that on two of the transects the litter layer was distinctly thinner in the burned portion as compared to the unburned portion. Similar results were obtained in the two transects on Smithwick Island. On two other 1936 burn transects, however, no difference was noted.

In all transects, windfalls were more abundant in the unburned portions. Also, windfalls were generally found to be more numerous on older stands than on younger ones.

The soil pits dug in all transects revealed rather poorly developed podsol soil profiles with indistinct horizons on all study areas. Soil texture was relatively similar throughout. It generally fell within the range of a sandy loam. The greatest differences among the soils of the study plots revealed by analysis of soil samples was in the amount of mineral material greater than 2 millimeters. This quantity was significantly greater for the plots on the small offshore islands (Mott and Smithwick) than for those on the main island.

A large portion of this year's research was devoted to the study of the reproduction of tree species with emphasis on the role that fire plays in tree reproduction. The reproduction was treated in two classes, the seedling class (up to 1 meter high) and the sapling class (from 1 meter high to 5 centimeters in diameter). Density for both classes was sampled at each sampling point for all plots and transects. Each individual of the seedling class was further classified as one of the following:

- (1) seedling on litter,
- (2) seedling on moss,
- (3) seedling on rotted wood,
- (4) vegetative reproduction.

The height and age of each was also determined. Age was determined by counting segments between terminal bud scale scars.

For each species, the percentages of individuals in each of the four classes of origin referred to above are given in Table 1 below.

TABLE 1

	<u>balsom fir</u>	<u>white spruce</u>	<u>paper birch</u>	<u>quaking aspen</u>	<u>mountain ash</u>
% litter	78	39	32	99	78
% moss	5	9	3	0	1
% rotted wood	16	51	53	1	13
% vegetative reproduction	1	1	12	0	8

The reproduction of balsom fir (Abies balsamea) is by far the most abundant and ubiquitous of all tree species in the study area. A wide

spectrum of seedling ages is found in almost all plots. Both the seedling and sapling densities, however, are considerably greater in the older forest stands than in the 1936 burn stands. Reproduction, as shown by Table 1, is mostly by seed germination in litter. This is true even on the deeper litter of the older stands.

White spruce (Picea glauca) reproduction is relatively rare in most stands. It is most abundant, however, on the burned portions of two of the 1936 burn transects, located near Wallace Lake. It was absent from the unburned portion of these transects. It is interesting that these are the same two transects along which there is a considerable reduction in litter depth from the unburned to the burned portion. On the other two 1936 burn transects where no reduction in litter depth was found, white spruce was rare along the entire length of the transects. Spruce reproduction is also relatively rare on all of the older stands of approximately 100 years or more in age, except for one. The exception is an almost pure stand of spruce (a rarity on Isle Royale) near the head of Tobin's Harbor. This stand had an above average number of windfalls providing a large amount of rotted wood on the forest floor which, according to Table 1, is a preferred site for spruce germination. This, combined with the abundance of seed trees could account for the high reproduction of spruce in this stand.

Unlike fir, then, it appears that spruce has rather exacting requirements for seed germination and survival. The transect studies indicate that fire may be an important ecological factor in spruce reproduction. The results suggest that the important effect of fire may be the reduction in litter depth. This is supported by the fact that in the burned part of the Wallace

Lake transects, 83% of seedlings were on litter and 11% on rotted wood, whereas on all of the older burn plots combined, only 24% of seedlings were on litter and 67% were on the rotted wood. Spruce seems to germinate on litter, then, only if the litter is thin (or lacking); otherwise, it shows a preference for rotted wood. That fire sometimes promotes spruce reproduction is further supported by the fact that white spruce, either by itself or along with other species, was a pioneer species following fire in some of the older stands whose age structures were studied (see previous progress report, January 1, 1972).

White birch (Betula papyrifera) in the seedling class was found to be very abundant and ubiquitous, but somewhat less so than balsom fir. It was a surprise to find the highest seedling density on the climax stands of Smithwick Island, and the lowest on the 1936 burn stands. Also, in the transects, the unburned segments had higher birch seedling densities than the burned segments. This may be due to the greater abundance of rotted wood in the older stands. Rotted wood, as shown by Table 1 is a highly preferred site for seedling germination for paper birch.

Although the seedling density of birch in the older stands was very high, there were very few seedlings older than three years. Seedling mortality here is apparently very high. In fact, sapling densities were found to be greater in the 1936 burn stands than in the older stands. This is probably due to the shade-intolerant nature of paper birch. As Table 1 shows, about 12% of the reproduction of paper birch on the stands studied was in the form of stump sprouts.

Quaking aspen (Populus tremuloides) reproduction is completely lacking in several of the stands studied, usually where aspen is absent from the tree layer. Almost all reproduction was found to occur on litter. The fast rate of growth and the fact that practically none of the reproduction was on rotten logs suggests that most of these young shoots were not seedlings at all but rather were succor sprouts. Since aspens sprout from the underground plant parts, they are not readily distinguishable from seedlings in the field.

Mountain ash (Sorbus americana) reproduction is fairly abundant everywhere. As in the case of paper birch, seedlings are more abundant in older stands while saplings are more abundant in the younger stands. Mountain ash, however, is practically absent in the tree layer wherever moose browsing occurs.

The results obtained thus far indicate that fire affects tree reproduction in several ways on Isle Royale: (1) It provides the necessary increase in light on the ground to make possible reproduction of shade-intolerant species. (2) It may reduce thickness of the soil litter layer and thereby favor reproduction of species like spruce which germinate best on mineral soil. (3) It usually consumes windfalls and hunks of rotted wood, thereby reducing the amount of germination on these media. Thus a fire which burns windfalls and other hunks of wood but is not intense enough to burn the litter layer, might actually curtail white spruce germination. (4) It stimulates the production of stump sprouts or succor shoots in species such as paper birch, quaking aspen and mountain ash.

The Wallace Lake transects revealed the effects of heavy moose browsing following fire. On the unburned portion of the transect the forest was composed of fir, aspen, birch, and white spruce in order of abundance, while on the burned portion trees were sparse and consisted mostly of white spruce and black spruce (Picea mariana) with smaller amounts of northern white cedar (Thuja occidentalis) and aspen. Due to repeated browsing, the aspen and birch never emerged from the seedling or sapling class. These two species, which predominate throughout much of the 1936 burn forest, were suppressed from the tree strata here, permitting the spruces to prevail as dominants.