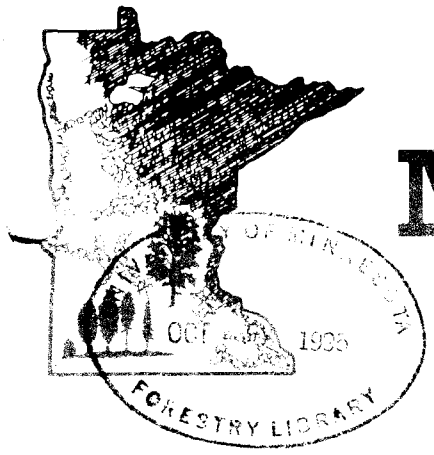

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TREE REPRODUCTION AND SHRUBS IN RELATION TO STAND AND SITE CONDITIONS IN ST. CROIX STATE PARK, MINNESOTA

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The investigative and analytical procedures utilized in documenting ecological relationships of St. Croix State Park forest were briefly discussed in an earlier paper.[2/] The previous report was primarily concerned with characteristics of the tree stratum. This report focuses on characteristics of tree reproduction and shrub populations, such as their distribution, composition, abundance, and height growth as related to forest cover types and site conditions.

In 1968, following preliminary study of 127 forest communities, 31 stands representing the apparent full range of variability of moisture and nutrient conditions in the park forest were selected for more intensive investigation. Data on tree reproduction, shrubs, and ground vegetation were obtained for individual species on 18 one-milacre plots in each stand. Figure 1 illustrates the distribution and stem density of tree reproduction and shrub populations within the classification framework previously described.[2/] Supplementary information on reproduction, shrubs, and soil characteristics is given in Table 1.

Conifer Reproduction

Conifer reproduction is limited to extreme site conditions. Pines, primarily jack pine (Pinus banksiana Lamb.) and white pine (Pinus strobus L.), occur on very dry, nutrient-poor sites; balsam fir (Abies balsamea (L.) Mill.) on wet, medium nutrient sites; and black spruce (Picea mariana (Mill.) B.S.P.) and tamarack (Larix laricina (Du Roi) K. Koch) on very wet, nutrient-poor sites (Figure 1).

Jack pine seedlings are few in number, and most of them do not exceed the height of ground vegetation. White pine reproduction is confined to red pine (Pinus resinosa Ait.) stands (Table 1) where mature white pines are a minor stand component. The present white pine reproduction, consisting mostly of one and two-year old seedlings, is of transient character. On these droughty sites ground cover species, primarily halfshrubs and grasses, provide pine reproduction with serious competition for soil moisture. On moist, medium to nutrient-rich sites pine reproduction is nonexistent. A few scattered white pine seedlings are present on moist, very rich sites.

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[2/] Kurmis, V., D. D. Ness and H. L. Hansen. 1970. Characteristics of forest stands in relation to edaphic conditions in St. Croix State Park, Minnesota. Minn. For. Res. Note No. 216, 4 pp.

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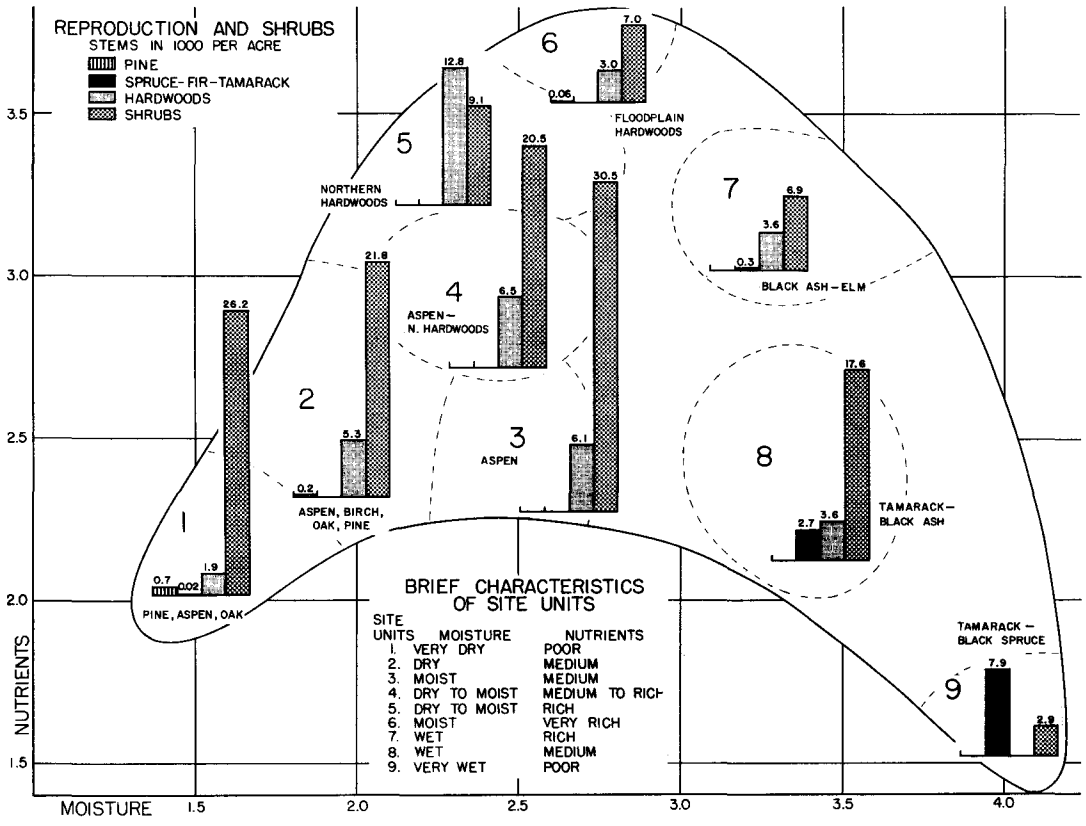

Figure 1. Abundance of tree reproduction and shrubs by site units and cover types in moisture-nutrient coordinates in St. Croix State Park, Minnesota

Distribution of mature balsam fir is restricted mainly to a few narrow and often abrupt transitional areas between upland forests and swamps. Young balsam fir seedlings appear in adjacent lowland and upland communities indicating the invading character of this species. However, periodic flooding of the lowland communities and moisture shortage on upland habitats result in high seedling mortality of this species.

On very wet, nutrient-poor sites, black spruce and tamarack reproduction is present in considerable numbers, especially in stands with sufficient exposure to light. The rate of height growth exhibited by seedlings and layers is slow on the nutrient deficient, poorly decomposed organic soils.

Hardwood Reproduction

Maximum hardwood reproduction occurs on dry to moist, nutrient-rich sites, primarily in well developed northern hardwood communities (Figure 1). In this type, elm (Ulmus spp.), ironwood (Ostrya virginiana (Mill.) K. Koch), and blue beech (Carpinus caroliniana Walt.) are the most abundant species followed by black ash (Fraxinus nigra Marsh.), red maple (Acer rubrum L.), northern red oak (Quercus rubra L.), bur oak (Quercus macrocarpa Michx.), and American basswood (Tilia americana L.). Sugar maple (Acer saccharum Marsh.) reproduction is only locally present on sites where mother trees escaped past fires. Well drained flood plains show similar reproduction composition. New growth of silver maple (Acer saccharinu L.) is found scattered along the river banks.

Table 1. Stand characteristics of the St. Croix State Park forest summarized by site criteria derived from analysis of 1967 survey data

Site units and forest cover types	Basal area (ft^2/acre) normal	range	Tree diameters (dbh-inches) normal	range	Tree ages (years) normal	range	Tree heights (feet) normal	range
1. Very dry, nutrient-poor, sandy to loamy sand soils supporting the following types:								
Jack pine	90	40-120	4, 7	2-15	25, 55	20-95	20, 50	20-70
Red pine	110	50-200	8, 14	7-21	65	65-85	65	50-70
Aspen	100	80-150	6	5-10	45	40-50	55	50-60
Red oak	90	40-120	9	6-19	50	50-80	50	40-55
2. Dry, medium nutrient, loamy sand to loam soils supporting the following types:								
Aspen	100	60-150	7	6-14	45	25-60	60	40-75
Paper birch	90	80-110	6	5- 9	45	40-50	55	50-60
Red and bur oak	100	80-120	7	3-17	55, 150	40-150	45	35-50
Red and white pine	150	80-170	9, 14	5-26	70	60-95	65	50-70
3. Moist, medium nutrient, loamy sand to sandy loam soils supporting the following type:								
Aspen	90	45-110	11	5-16	55	45-65	70	60-75
4. Dry to moist, medium to nutrient-rich, sandy loam to sandy clay loam soils supporting the following type:								
Aspen	110	50-125	11	5-21	60	45-75	65	45-75
5. Dry to moist, nutrient-rich, loam to silt loam soils supporting the following type:								
Northern hardwoods	120	90-150	*	2-29	*	30-220	*	30-80
6. Moist, nutrient-very rich, loam to silty loam soils supporting the following type:								
Floodplain hardwoods	125	120-130	*	2-32	*	40-140	*	40-80
7. Wet, nutrient-rich, fine textured mineral, and well decomposed organic soils supporting the following type:								
Black ash-elm	130	50-150	*	2-24	*	40-250	*	30-85
8. Wet, medium nutrient, fine textured mineral and moderately decomposed organic soils supporting the following type:								
Tamarack-black ash	120	90-150	*	2-17	*	40-225	*	30-75
9. Very wet, nutrient deficient, poorly decomposed organic (sphagnum peat) soils supporting the following type:								
Tamarack-black spruce	80	50-100	4	1- 8	60	50-70	35	25-45

* Characterized by wide variation in tree sizes, ages, and heights.

Summary of Forest Conditions. The topography is relatively flat, and the vegetation consists principally of upland forest types. Most of these upland communities are associated with well-drained sandy soils which provide a relatively xeric habitat. This tendency for droughtiness is indicated in Figure 2 by a concentration of communities ordinated over lower portions of the moisture gradient. To some extent, the xeric aspect of upland forest communities may be attributed to site disturbances such as fire and logging. By contrast, the lowland forests (site units 7, 8, and 9 in Table 1) have been less disturbed and, with few exceptions, are limited to small acreages along drainageways. It should be noted that the concentrations of communities in Figure 2 do not indicate directly the park area occupied by these communities since areal control was only a general consideration of the sampling procedure.

Aspen and jack pine are the two major cover types in the park. The aspen type, primarily quaking aspen (Populus tremuloides Michx.), occurs over a much greater range of site conditions than does the jack pine type. Communities of either type are typically even-aged indicating stand origin following major disturbance. Jack pine (Pinus banksiana Lamb.) is almost exclusively limited to the more xeric and nutrient-deficient edaphic conditions (Figure 2). By comparison, aspen is present on a wide variety of upland forest sites. On nutrient-poor sites, aspen may be a minor component of a predominantly pine overstory, but it characteristically occurs in pure stands, over-topping a weakly developed shrub layer. Mature aspen tends to associate with various hardwood species on soils of intermediate nutrient status. Such stands commonly include a well developed understory of the more tolerant northern hardwood species. Aspen is an incidental stand component on nutrient-rich upland sites.

Northern red oak (Quercus rubra L.) and paper birch (Betula papyrifera Marsh.) are the next most common tree species of the upland forest. Both are distributed over a wide range of site conditions and are associated with a variety of species. They occasionally form pure stands. The open woodlands of pure red oak appear to be relatively stable communities. The origin of pure birch communities is disturbance-related, and invasion by other tree species is in progress. Red maple (Acer rubrum L.) is present with various other species on moist, medium nutrient sites, and commonly occurs as an understory and codominant species.

Red pine (Pinus resinosa Ait.) is associated with relatively xeric and poor to medium nutrient site conditions (Figure 2). Stands of pure or near pure red pine are few in number and occupy a very limited area. Such stands are distinctly even aged indicating a post-disturbance origin. White pine (Pinus strobus L.) is the usual and minor associate. Red and white pine are most commonly present as scattered, relict, and open grown trees in association with other species.

Northern hardwoods occur on moist, nutrient-rich sites. American basswood (Tilia americana L.), bur oak (Quercus macrocarpa Michx.), northern red oak, and American elm (Ulmus americana L.) are the common species of the type. Species of lesser frequency include sugar maple (Acer saccharum Marsh.), ironwood (Ostrya virginiana Mill), and black ash (Fraxinus nigra Marsh.). Other species occur sporadically as associates. Analysis of age data and various other stand characteristics indicates that the contemporary northern hardwood communities originated primarily from sprout growth following destruction of the mother stand. Well drained flood plains adjacent to the St. Croix and Kettle Rivers support relatively unique associations of tree species. Several northern hardwood species are represented, but the character species of the type is silver maple (Acer saccharinum L.). Butternut (Juglans cinerea L.) and bitternut hickory (Carya cordiformis (Wangenh.) K. Koch), near the northernmost natural range for these species in Minnesota, are occasionally present.

Black ash-elm, and tamarack-black ash communities occur on flat lowlands adjacent to natural drainageways. A slight drainage gradient and local micro-relief serve to impede surface run-off from such areas. Thus, site moisture relationships are related to stream flow regimen and internal drainage characteristics of the soil. The drier phase of such site conditions appears to favor the black ash-elm type. Communities of both types are characterized by considerable variation in age, size, and density of stand components.

Tamarack (Larix laricina (Du Roi) K. Koch) associates with black spruce (Picea mariana (Mill.) B.S.P.) on very wet, imperfectly drained, and nutrient-poor sites (Figure 2). Stands are small in areal extent and of irregular physiognomy due to frequent windthrow.

Age data, stand composition, and historical records attest to relatively severe and widespread disturbance by fire and logging activities. More intenstive investigation is in progress to further clarify the ecological interrelationships of the park forest.

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