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PREDICTING THE ABUNDANCE OF ADVANCE GROWTH IN BLACK SPRUCE FORESTS IN NORTHEASTERN ONTARIO: AN AERIAL PHOTOGRAPH INTERPRETIVE KEY

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INTRODUCTION

Foresters are constantly looking to develop lower cost management strategies. Natural regeneration of black spruce (*Picea mariana* [Mill.] B.S.P.) through the protection of advance growth offers the potential to integrate restocking with harvesting. This should result in lower costs than would artificial regeneration methods. Although most well drained, productive sites in northeastern Ontario require artificial regeneration methods to maintain a black spruce cover type, many poorly drained transitional and peatland sites can be regenerated by using prescribed natural treatments.

Collecting detailed information on site and stand conditions and on advance growth abundance within every stand allocated for harvesting is impractical due to cost and problems with access. Foresters need simple, practical tools to identify stands with the potential for abundant advance growth that can be related to forest inventory or preharvest inspection information, or identified on aerial photographs. Stand factors that can be related to the forest inventory will assist managers in carrying out forest-level planning for the management of advance growth. Stand and site factors that can be recognized on aerial photographs will assist in identifying the potential for advance growth in individual stands. When warranted, harvesting and silvicultural prescriptions to preserve advance growth are determined. This note explores the potential to identify stands having abundant advance growth by using aerial photograph interpretation.

METHODS

Black and white aerial photographs at a scale of 1:20 000 (standard Ontario Forest Resource Inventory [FRI] photographs) were obtained for each of the stands sampled in the advance growth survey. Each stand was described according to its gray tone, stand pattern, amount of canopy closure, size of canopy openings, size and number of linear drainageways, position on slope, slope complexity, grade (slope percent), tree species composition, percent black spruce, and, where visible, the appearance of the understorey. Since aerial photographic interpretation is subjective in nature, three interpreters described each stand independently to determine if attributes were replicable among them.

The stands were grouped into three classes of advance growth stocking:

1. High: stands with 70 percent or more stocking to advance growth, typically with advance growth density levels of 15 000–20 000 stems/ha;
2. Medium: stands with 40 to 69 percent stocking to advance growth, typically with advance growth density levels of 5 000–15 000 stems/ha; and
3. Low: stands with less than 40 percent stocking, typically with advance growth density levels of less than 5 000 stems/ha.

A multiple discriminant analysis was used to determine if any attributes of the aerial photographs were useful in discriminating advance growth stocking classes. Species

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composition, percent black spruce, slope grade, position on slope, number of linear drainageways, and stand pattern were significantly related to the discriminant axes, and were consistently described by all interpreters. The general relationships among these photograph attributes and the stocking levels of advance growth in the stand are summarized in Table 1.

Based on these results, the descriptions of photograph attributes were refined, and an aerial photograph interpretation key was developed. A fourth interpreter then described a subset of 49 stands to test the key. Using the key, the interpreter correctly identified the stocking class for 78 percent of the stands, and correctly discriminated the high stocking class from the medium and low classes for 84 percent of the stands.

AERIAL PHOTOGRAPH KEY

The aerial photograph interpretation key (Fig. 1) can be used to assign a stand to one of the three advance growth stocking and density classes described earlier. The key is intended to be used with black-and-white stereoscopic aerial photographs at scales ranging from 1:10 000 to 1:20 000. Mainly, it should be applied to mature or overmature stands in the black spruce working group. Depending on topographic variety, drainage pattern, and other factors some black spruce stands are quite variable in appearance. In these cases the photo interpreter can either subdivide the stand into smaller, more homogeneous units, or use the dominant condition within the stand to work through the key.

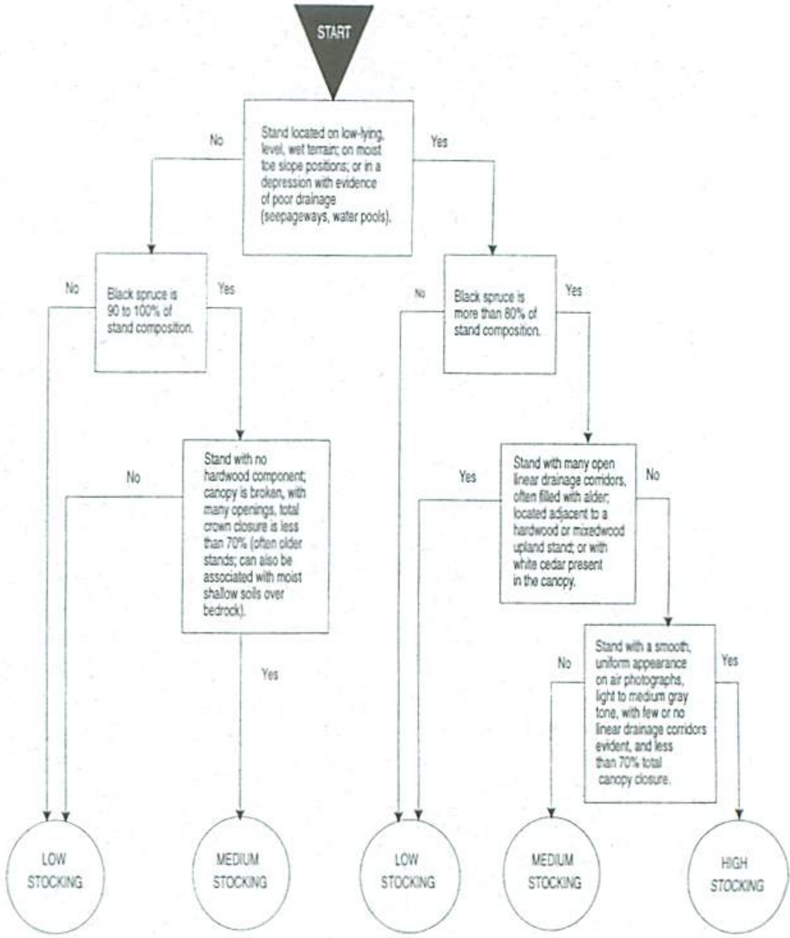

Figure 1. Key to determine the potential for black spruce advance growth for forest stands using 1:20 000 scale black and white aerial photographs.

Table 1. General relationships among aerial photograph attributes and stocking classes of black spruce advance growth.

Photograph attribute	Advance growth stocking class		
	High	Medium	Low
Pattern	Uniform Stippled	Mottled Patchy	Patchy Banded
Position on slope	Toe Depression Level (wetland)	Lower Middle	Upper Crest
Percent black spruce	90–100	80–90	<80
Stand type	Black spruce	Mixed conifer	Mixed hardwood and hardwood
Slope grade	Level	Gentle	Moderate to steep
Drainage pattern (Number of linear drainage corridors)	None Few	Medium	Many

NOTES ON USING THE KEY

Various decision points in the key require the photo interpreter to differentiate peatlands and peatland transitions from upland sites, determine canopy composition and degree of canopy closure, and differentiate shrub-rich peatland site types from poor site types. The following notes provide additional detail to help make these decisions.

Differentiating Peatlands and Peatland Transitions from Uplands

Peatlands develop in areas of restricted drainage, where the water table is high and organic matter accumulates. They tend to occur adjacent to the lowest points in the topography of an area, but also occur at higher elevations at any point where water accumulates. Typical locations for peatlands include:

- low-lying, flat areas corresponding to the lowest relief in the area;
- areas directly adjacent to waterways, such as lakes, rivers, streams, intermittent creeks, and drainageways;
- valley bottoms;
- level areas or depressions at the base of long slopes, especially in fine-textured soils (silts and clays);
- localized depressions in bedrock-controlled terrain; and
- localized depressions in till or outwash plains.

Peatland areas generally appear level, while adjacent uplands have a detectable slope (Jeglum and Boissoneau 1977). In areas of moderate to high relief, changes in the composition of the vegetation between uplands and peatlands are usually distinct. Black spruce, the principal tree species indicative of peatlands, sometimes occurs in combination with eastern white cedar (*Thuja occidentalis* L.) and larch (*Larix laricina* [Du Roi] K. Koch). The presence of upland species, including jack pine (*Pinus banksiana* Lamb.), trembling aspen (*Populus tremuloides* Michx.), white birch (*Betula papyrifera* Marsh.), balsam fir (*Abies balsamea* [L.] Mill.), or white spruce (*Picea glauca* [Moench] Voss.), help to differentiate upper slope conditions.

In areas with low relief, the vegetation boundary may be indistinct since moist areas on gentle slopes adjacent to peatlands often have vegetation with peatland characteristics. In this case, slope is a more reliable indicator of the upland–peatland boundary. Trees in the peatland are often taller in a narrow band immediately adjacent to the upland zone because of oxygen- and mineral-charged waters draining off the slope. This increase in tree height is a good indicator of the peatland boundary.

Peatlands that occur in circular or irregular depressions in bedrock or till terrain usually have a very distinct vegetation boundary. The tree canopy in these depressions often appears concave due to an increase in tree heights at the margin of the depression.

The drainage pattern is key to identifying areas where peatlands are likely to occur, since peatlands often form adjacent to linear drainage features. Evidence of surface water (small pools, intermittent creeks, and channels) may be present within peatlands. Internal drainageways, appearing as openings in the canopy, usually occur in linear, dendritic, fan-like, or net-like patterns.

Microtopography and drainage, in combination with vegetation indicators, can also be used to identify areas of moist soils. On moderate slopes, moist soils occur mainly on toe slope positions. On gentle slopes, moist conditions occur further up the slope on lower to toe slope positions. Moist soils become more common and extensive when areas associated with fine soils (e.g., lacustrine plains) begin to level out (become flatter), and on shallow to moderately deep soils on flat bedrock plains and plateaus.

Moist soils are strongly associated with the drainage pattern in fine-textured soils, and are located on gently sloping areas adjacent to peatlands, rivers, creeks, and small drainageways. Moist, fine soils are associated with draws and drainageways. These will be evident as linear or fan-shaped gulleys and channels, which appear to be indented or depressed within the slope. Moist conditions also occur in small depressions and flat areas within slopes.

Determining Stand Composition and Canopy Closure

Three decisions in the key are related to the proportion of black spruce or total hardwoods in the stand. These can be estimated from the proportion of the canopy cover for a species, or by referring to the species composition listed on an FRI map. Degree of canopy closure can be estimated using percent cover charts or similar aids. It is also useful to refer to the stocking level listed on an FRI map.

Differentiating Peatland Site Types

The last two decisions on the "peatland" side of the key differentiate rich peatland site types (ST) (McCarthy et al. 1984), with abundant tall shrubs in the understorey, from poorer site types having an understorey dominated by low, ericaceous shrubs and *Sphagnum* mosses. *Sphagnum* moss is an important medium for black spruce seed germination and layering. Tall shrubs tend to inhibit layering by causing black spruce trees to shed their lower branches (Groot 1984). They also inhibit seed germination by covering moss substrates with leaf litter, and compete with young trees. Consequently, poor peatland site types have higher levels of advance growth than do rich peatlands.

Part of the decision relates to the number of open linear drainage corridors within the stand. For the purpose of this key, stands with many of these features are considered to have at least five internal linear drainageways, of different sizes and oriented in many different directions, with at least one drainageway wider than 50 m, and open (less than 10 percent tree cover).

Rich peatlands (ST 13, Conifer–Speckled Alder [*Alnus incana* spp. *rugosa* (Duruoi) Clausen]) vary in tone, texture, and pattern from uniform, closed canopies to open stands having many internal linear drainage corridors. These consist of shrub-filled, linear canopy openings to stands having a patchy appearance because of tree clumps interspersed with canopy openings in a net-like pattern. Rich peatland forests are often irregular, elongated, or linear in shape; delta-like (fan-shaped); or occur as bands adjacent to uplands. They often border drainage areas, such as rivers and streams, or occur adjacent to slopes on lake margins. The presence of eastern white cedar in the canopy is diagnostic of this site type.

Nutrient-intermediate ST 12 (Black Spruce–Speckled Alder) is typically characterized by the presence of few to many internal linear drainage features, interspersed within a canopy having a smooth to fuzzy appearance and medium gray tone. These intermediate forests are often irregular, elongated to linear in shape, and follow drainage patterns or occur as bands of varying width adjacent to poor site types.

Poor, black spruce-dominated peatlands have a characteristic smooth, uniform appearance. Nutrient-poor site types (ST 11, Black Spruce–Labrador tea [*Ledum groenlandicum* oeder]; and ST 14, Black Spruce–Leatherleaf [*Chamaedaphne calyculata* (L.) Moench]) typically have diagnostic pale tones or light colors caused by open canopies, few tall shrubs, and abundant *Sphagnum* moss on the forest floor. Stands comprised of these site types are usually somewhat round or oval in shape, but vary according to the surrounding terrain.

McCarthy et al. (1994) provides further information about site types and the forest ecosystem classification for northeastern Ontario.

MANAGEMENT APPLICATIONS

This photographic key provides a method that foresters may use to determine the potential for black spruce advance growth prior to harvesting individual forest stands. However, predictions of advance growth potential determined by using the key should be treated with due caution. Field checking to confirm advance growth levels prior to making prescriptions is recommended whenever possible. Suggested uses for the key include:

1. Forest-level applications, e.g., determining potential areas suitable for prescribed natural treatments to help allocate resources;
2. As a screening mechanism to identify stands for field checking; or
3. To determine advance growth potential in inaccessible areas.

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