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Aerial Photo Guide to New England Forest Cover Types

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Abstract

Presents color infrared photos in stereo pairs for identification of the New England forest cover types. Depicts range maps, ecological relations, and range of composition for each forest cover type described. The guide is designed to assist the needs of interpreters of color infrared photography.

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Introduction

This illustrated guide will aid interpreters of color infrared (CIR) aerial photography in identifying New England forest cover types. Forest cover types in this guide are those defined for the New England area by the Society of American Foresters (SAF) (Eyre 1980). Table 1 lists the SAF cover types, the SAF type groups to which they belong, and the USDA Forest Service Renewable Resources Evaluation (RRE) type groups (Waddell et al. 1989) to which they correspond.

Guide Organization

The guide is designed as a selection key. It presents detailed illustrations and descriptions for each forest cover type. The interpreter applies this information to decide which types best match the stands under study. The large number of forest cover types in New England and the variability within each in species composition and spatial arrangement, make them unsuited to the dichotomous distinctions required by an elimination key.

Each cover type is presented in a uniform format on two sides of a loose-leaf page. This arrangement allows interpreters to regroup the types to suit the needs of any project, and it simplifies revision and updating. On the front of each page are two aerial stereograms depicting the cover type, together with a summary of the identifying features. On the reverse side there is a map of the type's geographic range, a diagram illustrating its range of species composition, silhouette sketches of its main tree components, and a graphic representation of the ecological requirements of the principal tree species. In addition, several short paragraphs further describe the type and comparisons between it and other easily confused types. The user is assumed to have a 2-power lens stereoscope and an understanding of aerial photography principles. Those who require an introduction to aerial photo fundamentals are referred to Crisco (1988) or Rasher and Weaver (1990).

To avoid constantly repeating the word "type", as in "the Black Spruce type", a naming convention is used for distinguishing the species from the type. Lower case letters (black spruce) are used when referring to the species, and upper case letters (Black Spruce or BS) are used when referring to the type. Multiple-species types additionally feature a hyphen or slash in the name (Beech--Sugar Maple or B/SM).

Aerial Photographs

No aerial photo guide can offer more than a limited selection from the available range of photo scales and film emulsions. We chose two film/scale combinations to make this guide as broadly useful as possible for interpreters working with large- to medium-scale color infrared (CIR) imagery. The first exhibit on each page is a large-scale CIR stereogram, in the scale range 1:6000 to 1:8000. The second is a medium-scale panchromatic stereogram, in the scale range 1:20000 to 1:24000. The same site appears on both sets of photos. Type boundaries are shown on the large-scale stereograms, and the types are identified by the abbreviations given in the Contents and Table 1. The location of each large-scale stereogram is indicated on the corresponding medium-scale stereogram, which can be used to gain a broader perspective of the terrain in which the example stand was found. The CIR photos were taken from about 6500 feet above ground level with a hand-held Nikon F2A 35mm camera, 150mm

Table 1.--The SAF type groups and forest cover types presented in this guide, and the corresponding Renewable Resources Evaluation type groups

SAF type group	SAF type (abbr.)	RRE type group (Eastern)
Boreal Forest Region		
Boreal conifers	Balsam Fir (BF)	Spruce--fir
	Black Spruce (BS)	"
	Black Spruce--Tamarack (BS/T)	"
Boreal hardwoods	Aspen (Asp)	Aspen--birch
	White Birch (WB)	"
Northern Forest Region		
Spruce-fir types	Red Spruce (RS)	Spruce--fir
	Red Spruce--Balsam Fir (RS/BF)	"
	Red Spruce--Sugar Maple--Beech (RS/SM/B)	"
	White Birch--Red Spruce--Balsam Fir (WB/RS/BF)	"
Pine and hemlock types	Red Pine (RP)	White--red--jack pine
	Eastern White Pine (WP)	"
	White Pine--Hemlock (WP/H)	"
	Eastern Hemlock (H)	"
	White Pine--Red Oak--Red Maple (WP/RO/RM)	"
Northern hardwoods	Sugar Maple (SM)	Maple--beech--birch
	Sugar Maple--Beech--Yellow Birch (SM/B/YB)	"
	Beech--Sugar Maple (B/SM)	"
	Red Maple (RM)	"
Central Forest Region		
Upland oaks	White Oak--Black Oak--Red Oak (WO/BO/RO)	Oak--hickory
	Northern Red Oak (RO)	"
Other	Pitch Pine (PP)	Loblolly--shortleaf pine
Southern Forest Region		
Other	Atlantic White-Cedar (AWC)	Oak--gum--cypress

Nikkor f/3.5 lens, Wratten 12 (deep yellow) filter, and Kodak Ektachrome Infrared Film 2236.[1] They are enlarged approximately twice from original scale. Most of the CIR photography was taken during the summer of 1986. The medium-scale panchromatic stereograms were taken from standard USDA Agricultural Stabilization and Conservation Service (ASCS) 9-inch photo coverage, most of it acquired in the early 1970's with Fairchild aerial cameras, 8.25-inch lenses, Wratten 12 filters, and Kodak Plus-X Aerographic Film 2402. These are at contact scale.

[1]This film is identical to Kodak Aerochrome Infrared Film 2443. The number only designates the packaged 35mm format. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

Range Maps

Knowing the geographic range of cover types can help an interpreter eliminate unlikely types from consideration. Little systematic information is available on the geographic distribution of particular tree species combinations. Maps used in this guide show the shared ranges of the individual species comprised in the types. Range information was drawn from published sources, in particular Little (1971) and Fowells (1975). Figure 1 exemplifies the range maps in this guide.

Environmental Indices

Ecological information about the vegetation types under study is frequently useful to photo interpreters. The system of synecological coordinates developed by Bakuzis (1959) in Minnesota was adopted for this guide because it provides significant information about site requirements of species in an easily understood form suitable for graphic presentation. Bakuzis derived index values expressing the site preferences of species in terms of demands for moisture, nutrients, heat, and light (see also Bakuzis and Kurmis 1978; Bakuzis and Hansen 1959). These preferences are ranked on a scale from 1 to 5, in which 1 represents a low requirement and 5 a high requirement. A species with a moisture value of 5 favors wet sites; a species with a light value of 1 is shade-tolerant. Data from 301 field plots were used to adjust Lake States values to New England conditions following the methodology of Brand (1985). Figure 2 is an example of the environmental indices as presented in the guide. Each species component of a cover type is treated individually. See Appendix I for a full description of the method used for determining these values, and a discussion of the difficulties encountered when a single species frequently occupies a wide range of sites.

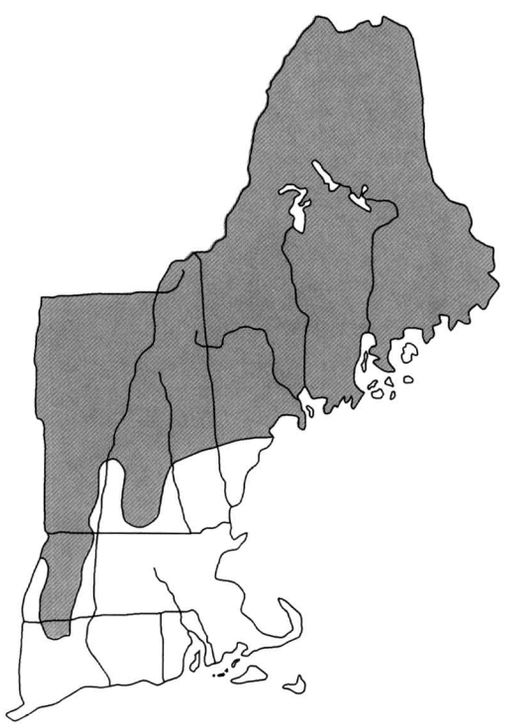


Figure 1.--Example of a range map showing the geographic distribution of the Red Spruce--Balsam Fir type in New England.

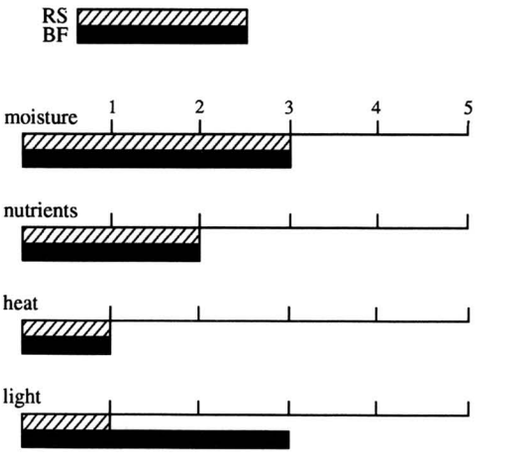


Figure 2.--Example of an environmental index showing the ecological relations of the Red Spruce--Balsam Fir type in New England. Diagram shows that RS and BF are alike in their requirements for moisture, nutrients and heat, and that RS is somewhat more shade-tolerant than BF.

Composition Diagrams

Composition diagrams, a graphical method of representing SAF type composition rules, illustrate the variation in species composition (or "range of composition") possible within each type. The diagrams also help interpreters visualize the illustrated stand's relation to other possible compositions included in the type. Figure 3 shows three kinds of composition diagrams used in the guide. It depicts idealized types defined by a single species, two species, and three species.

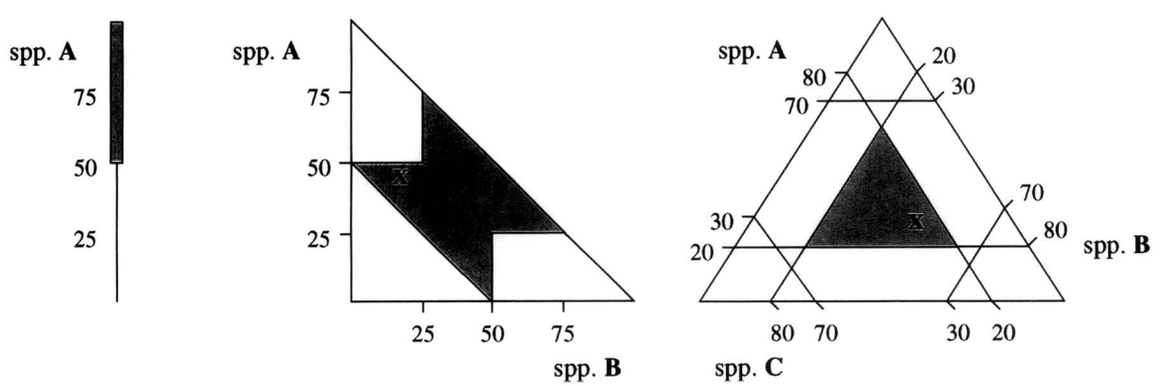
These diagrams, just as the verbal definitions they attempt to encapsulate, embody some ambiguities. First, they do not take into account species other than those mentioned in type definitions. Where "other" species make up more than 50 percent of a stand, the stand cannot be assigned to a type in the guide. Second, as the triangular composition diagram of three-species cover types does not permit consideration of other species, the percentages given in such diagrams do not refer to total stand composition, but to the portion of the stand formed by the defining species; that is, the percentages are the proportions that the defining species bear to each other (for example, sugar maple, beech, and yellow birch in the SM/B/YB type). The three-species diagram is probably the hardest to read. In this example, the **x** in the above three-species diagram can be read as 29 percent spp. A (the horizontal guide lines), 47 percent spp. B (the right-angled guide lines) and 24 percent spp. C (the left-angled guide lines). As mentioned above, these values represent the percentage of these three species relative to each other. The percent composition of the three-species types does not appear in the range of composition diagram, but is given in the caption under the CIR stereogram. See Appendix II for a full description of the design and creation of these diagrams.

Additional Information

The reverse side of each page in the guide also contains additional textual information about each type which can be used for reference. Data concerning the common situation, typical boundaries, and associate species is provided. This information was taken primarily from *Forest cover types of the United States and Canada* (Eyre 1980) and *Silvicultural systems for the major forest types of the United States* (Burns 1983). A final paragraph of comparisons identifies other similar types and describes how these can best be distinguished from one another. The tree silhouettes, provided in part simply for quick page reference, are taken primarily from Sayn-Wittgenstein (1960).

Ground Truth and Testing

Each of the sites depicted in this guide was visited on the ground. Point-sample data were collected at five plots within each stand to ensure correct type designation. After the guide was



Single-species type Two-species type Three-species type

Figure 3.--Example of composition diagrams. Shading shows the range of composition, in percent, for a type. General rules:

- The component species must comprise ≥ 50 percent of the stand.
- In two-species types, if the species combination comprises a majority while one species also comprises a majority, then 25 percent is the lower limit for the other species (or else the stand falls into the single-species types).
- In three-species types, in the similar situation where there is ≥ 50 percent of one of the component species, 20 percent is the lower limit for a single species and 30 percent is the lower limit for both other species combined (or else the stand falls into one of the single- or two-species types).

These rules are somewhat modified in practice, as the SAF classification does not recognize all possible two- and three-species combinations as types (see Appendix II). Superimposed on the diagrams is an X to demonstrate where within that range the example stand in the CIR stereogram occurs.

assembled, a test was conducted in which five interpreters classified 95 other New England forest sites as to cover type with and without use of the guide. Photographs used in this test were all CIR, ranging in scale from 1:6000 to 1:15840. Results showed an increase in type identification accuracy, significant at the 99 percent confidence level, when the guide was used. For further discussion of the accuracy test and results, see Hershey (1990) or Riemann (1987).

Significance and Variability of Color and Texture

Color

Differences in reflectance create differences in color and tone on the photographic image that allow discrimination of plant species and vegetation types. The characteristic surface, thickness, internal structure and pigment content of leaves, and the characteristic structure and geometry of the canopy, as determined by the orientation of the plants and their leaves, all affect the amount of radiation reflected. Infrared reflectance in particular offers broad potential for type discrimination. Vegetation reflects much more near-infrared (and mid-infrared) than visible light, and subtle differences between species in crown characteristics can show up as large differences in infrared reflectance (color/tone). For example, the needle foliage of conifers creates internal shadows. This, in combination with the fact that the leaves themselves reflect less infrared radiation, gives them a darker appearance than hardwoods in the infrared. Typical CIR imagery combines this reflectance information from the near-infrared with information from the green and red visible bands in a "false-color" display. Once the interpreter becomes accustomed to this display, it is a highly useful tool for identifying tree species and forest cover types, especially in areas where topography and other physical features are not strong indicators, as in New England.

Color must be dealt with in relative terms. Color infrared photography is not consistent enough to allow a species or type to be described in precise hue, chroma, and value terms. Factors such as shadow, season, printing process, film batch, and exposure can all affect the appearance of color photography, and CIR, in particular, is extremely sensitive to some of these. Intensity of tones and shades can vary considerably between missions, film batches, and formats (and somewhat even within a frame as well as between frames) as a result of changes in sun angle, light intensity, exposure, and/or variations in the film and processing (Enslin and Sulivan 1974; Nielson and Wightman 1971). Much information about a type can be gathered from its color, but the interpreter of CIR must assess image color carefully.

However, although absolute color may change, relative colors remain consistent and can be relied upon. Tables 2 and 3 were developed from the study of the New England species on many different photographs. Species were observed to differ independently in both color and color intensity. In the tables, the species are ranked as to where they fall relative to each other within an observed range. With respect to color, conifers (with the exception of hemlock) range from a grey-brown to a green in CIR, and hardwoods (including hemlock) range from a pink to an orange. Color intensity is an attempt to capture the strength/concentration/saturation of the color and is expressed simply as ranging from soft to intense color.

Texture

Texture is the second significant clue in species and forest type identification. The texture of a single tree on an image is determined primarily by its crown shape, branch structure, crown size, and at very large scales, its foliage type and orientation. Typical descriptions of texture refer to the impressions this creates, such as: needle-like, feathery, well-defined, indistinct, billowy, upright tufts, fine, lacy, clumped (for example, Ciesla and Hoppus 1989; Sayn-Wittgenstein 1960). The texture of a stand is determined by the size class of the trees in the stand, crown diameter, crown closure, and to a certain extent, texture of the individual crowns. For example, an even canopy will produce a much softer texture than a more open or broken and uneven canopy with many emergent trees. Similarly, a type of primarily small-crowned species will exhibit a much finer texture than large crowns. Some example descriptors of stand texture are: finely-textured, carpet-like texture, fuzzy, honeycomb, pincushion, smooth, even, uniform, popcornball, pockmarked, lumpy, and rough.

Texture is a much more consistent feature than color, but the impression of texture changes with photo scale. Table 4 presents a comparison of the relative textures of New England tree species on

photography at scales of approximately 1:6000. It was developed to accompany the two previous tables on relative color. Both softwood and hardwood crowns are ranked in texture from soft to well-defined.

Table 2.--The relative color of species on CIR photography. Softwoods (excluding hemlock) are ranked from grey-brown to green; hardwoods (including hemlock) are ranked from pink to orange

Color range	Species	Color range	Species
grey-brown		pink	
	White pine		Hemlock
	Red pine		Beech
	Pitch pine		White oak
	Balsam fir		Sugar maple
	Red spruce		Red maple
	Black spruce		Aspen
	Tamarack		White birch
	dead stem		Red oak
green		orange	

Table 3.--The relative color intensity of species on CIR photography

Softwoods	Color intensity	Hardwoods
	soft color	
Hemlock		White birch
White pine		Yellow birch
Balsam fir		Beech
Pitch pine		Aspen
Tamarack		Sugar maple
Black spruce		Red maple
Red pine		White oak
Red spruce		Red oak
Atlantic white cedar		
	intense color	

Table 4.--The relative texture of species' crowns on photography near the scale of 1:6000

Softwoods	Texture	Hardwoods
	soft	
Hemlock		White birch
White pine		Beech
Pitch pine		Aspen
Red pine		Yellow birch
Tamarack		Red maple
Balsam fir		White oak
Black spruce		Sugar maple
Red spruce		Red oak
Atlantic white cedar		
	well-defined	