Forest Service

Intermountain Forest and Range Experiment Station Ogden, UT 84401

General Technical Report INT-124

August 1982

How to Interpret Tree Mortality on Large-Scale Color Aerial Photographs

Frank C. Croft
Robert C. Heller
David A. Hamilton, Jr.

AUTHORS

FRANK C. CROFT is an image analyst with Technicolor Graphic Services at NASA Ames Research Center, Moffett Field, Calif. He has been analyzing digital Landstat imagery of Arizona and Nevada using a variety of hardware and software systems since 1980. Before that, he was a graduate research assistant working on a doctoral program at Colorado State University in forestry and remote sensing. He received a B.S. and an M.S. in forest resources from the University of Idaho in 1976 and 1978, respectively. Prior to that he was a pilot in the Air Force for 6 years after graduating from the United States Air Force Academy with a B.S. in 1969.

ROBERT C. HELLER, research professor of remote sensing at the College of Forestry, Wildlife and Range Sciences, has been teaching and conducting research since 1974 at the University of Idaho, Moscow. Prior to that time he was work unit leader of the nationwide Remote Sensing Project located at the Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif. He received a B.S. in botany and an M.F. in forest management from Duke University in 1940 and 1941, respectively.

DAVID A. HAMILTON, JR., is a research forester working in timber measurements and management planning research at the Forestry Sciences Laboratory, Moscow, Idaho. Since receiving his Ph.D. in forestry from Iowa State University in 1970, he has worked on the sampling and modeling of forest mortality and on the problem of specifying optimal precision levels for resource inventories.

RESEARCH SUMMARY

Related work has shown large-scale 70 mm color aerial photography to be an efficient means of measuring annual mortality. Equipment needed to interpret the photographs include a light table, a 2- or 4-power stereoscope (or combination 2- and 4-power), a micrometer wedge, and a template to define a subplot on which green trees are to be measured.

Three types of information are interpreted from the photographs. All trees that have died in the past year are identified by species. A subset of the green trees are counted by species. Crown diameters are measured on all trees that have died in the past year and on the subset of green trees.

Time needed to interpret a one-third-mile (0.54 km) strip of photography (eight frames at a scale of 1:2400) depends on the density and relative size of trees to be measured. Thus, although the average time required to measure a strip is approximately 1 hour, there is considerable variability in time needed to interpret photo strips located systematically over the forest.

Approved for publication by Intermountain Station
June 1981

United States
Department of
Agriculture

Forest Service

**Intermountain
Forest and Range
Experiment Station
Ogden, UT 84401**

General Technical
Report INT-124

How to Interpret Tree Mortality on Large-Scale Color Aerial Photographs

Frank C. Croft
Robert C. Heller
David A. Hamilton, Jr.

INTRODUCTION

This paper describes photo interpretation techniques used in sampling for mortality rates with large-scale aerial photographs in the Inland Empire. It is assumed that the interpreter has the ability to see in stereo and has a basic working knowledge of aerial photo interpretation. The more familiar the interpreter is with the area being measured, the easier and more accurate the interpretation will be.

In the USDA Forest Service's Northern Region, current management planning inventory methods rely on ground point sampling methods. These methods provide efficient estimates of stand development using variables such as volume, diameter, diameter growth rate, and height of trees in the plot. However, they do not provide an efficient method for collecting information on tree mortality rates. This is true because (1) expected mortality rates are low, about 0.5 percent per year (that is, one tree out of every 200 will die in a year's time); (2) mortality is not distributed uniformly over the entire forest, but is usually clustered; and (3) mortality is not distributed uniformly through time. To obtain acceptable precision in estimates of mortality rate with the current Northern Region sampling design, sample size would have to be greatly increased.

Another problem with existing techniques is that mortality trees are defined as trees the field crews estimate have died in the past 5 years. This is a task even trained entomologists and pathologists find extremely difficult to accurately and efficiently perform.

Because of the deficiencies of ground estimation of tree mortality, a new, relatively inexpensive method employing the use of large-scale color transparencies (70 mm format) was developed by Hamilton (1980[1]). With this method the interpreter has only to estimate mortality for the previous year. Flight strips one-third mile (0.54 km) long (eight frames at a scale of 1:2400) are systematically selected at the center of each township. The photography is flown between mid-July and mid-September. Interpretation of the imagery can then be delayed until the completion of the field season. In addition to its use for sampling mortality, the imagery also gives the manager a high resolution visual record of those parts of the forest included in the sample.

ACQUISITION OF 70MM COLOR PHOTOGRAPHY

Good interpretation results are dependent on two things: the skill of the interpreter and the quality of the photographs. Methods of improving the skill of the interpreter will be discussed later. Quality control of aerial photography is accomplished by contract specifications that should be clearly outlined before the flight to protect

[1] Hamilton, David A., Jr. 1980. Sampling and estimation of mortality using large scale aerial photography. Review draft. Manuscript on file at Intermountain Station's Forestry Sciences Laboratory, Moscow, Idaho, 26 p.

both parties. After the photography is flown, the color transparencies should be inspected for compliance. Among the specifications listed below, the first five may be considered standard for the majority of aerial photographic contracts. The last six are applicable to aerial photography acquired primarily for this type of mortality sampling.

Specifications:

1. Drift - less than 15 percent of photo width
2. Crab - less than 4 degrees
3. Image motion - less than 0.002 inches (0.05 mm)
4. Endlap - 60 percent ± 5 percent
5. Tilt - less than 3 degrees from vertical
6. Camera - 70 mm format with long focal length lens (135 mm - 304 mm)
7. Film - Kodak Ektachrome MS2448 (normal color transparencies)
8. Filter - haze filter (some combination of HF2, 3, 4, 5)
9. Scale - 1:1600-1:2400 preferred for identification of tree species (Heller and others 1977; Hamilton 1981)
10. Exposure - tree crown neither washed out from overexposure, nor shadows and colors too dark from underexposure. Photos should be taken from 1000 to 1430 local sun time to assure maximum sun angle and minimum shadow effect. Photos taken under a high overcast are also acceptable because they produce shadowless images that improve interpretation of tree species.
11. Photo number - nine photos per strip numbered consecutively would be ideal; this study included only eight photos per strip. Film takeup direction should be the same as flight direction. This will provide a sequence of photos that the interpreter may view in stereo and that will match small-scale resource photos or maps.

EQUIPMENT NEEDED FOR INTERPRETATION

Proper equipment (fig. 1) can aid the interpreter in the job. The viewing table should use cool-white fluorescent tubes or some other balanced light source. The 70 mm format permits each frame to be viewed stereoscopically in roll form with a pocket stereoscope. The distance between frames is roughly equivalent to most interpreters' interpupillary distance. For this study, an Abrams 2/4-power, model CB-1 stereoscope was used. The selective lenses with 2-power or 4-power magnification were a considerable asset in identifying tree species.

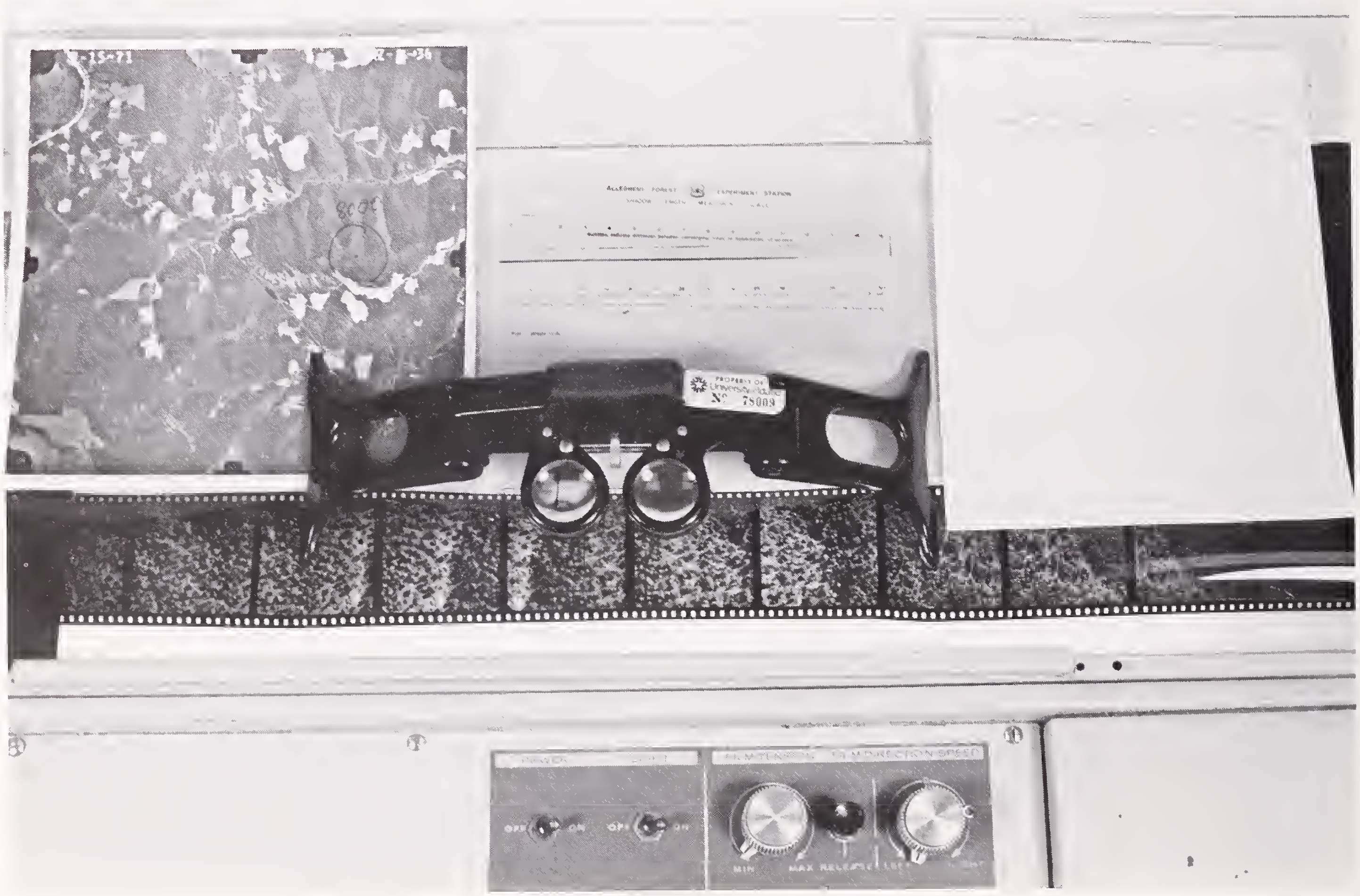


Figure 1.--A light table, Abrams 2/4-power stereoscope (in the 4-power position), square grid overlay (not clearly visible on frame under stereoscope), and micrometer wedge were used to interpret the 70 mm photo strips. The tally sheet was readily available for annotating data. The medium-scale resource photography is used to gain an understanding of the surrounding area.

A square grid overlay — each grid line 0.2 inch (5 mm) apart—is placed over each frame to be interpreted to insure the complete frame is examined (fig. 2). The entire overlay should be just larger than a single 70 mm frame. A square subplot, 0.6 inch (15 mm) on a side, is established in the center of the grid overlay.

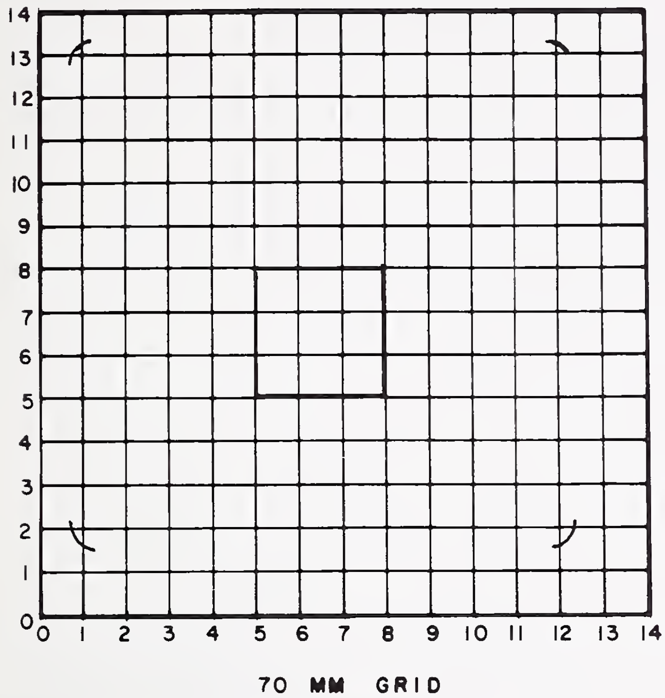


Figure 2.--A square grid overlay was used to outline the subplot of nine squares. Reference marks near the outside of the grid insure exact alinement on each frame.

The last piece of interpretation equipment is a micrometer wedge, which is used to measure crown widths. Because of the size of the trees in the Inland Empire and the scale of the photography, two wedges are needed, 0.001 to 0.150 inch and 0.150 to 0.300 inch (0.025 to 3.81 mm and 3.81 to 7.62 mm) (fig 3.). The wedge was chosen over other types of crown width measuring instruments because of its simplicity and its ease of use on 70 mm format transparencies.

PHOTO INTERPRETATION PROCEDURES

Stand height cover classes[2] are initially delineated on medium-scale resource photography. Then this classification is transferred from medium-scale resource photography to the 70 mm mortality photography.

Every third frame of each photo strip is interpreted. On this set of photography we interpreted the second, fifth, and eighth frames. Since the pictures have 60 percent overlap, this results in little duplication of coverage on interpreted frames. As a part of this study, the beginning and ending times of interpretation for each frame were recorded.

The color transparencies were oriented on the light table so that the shadows face toward the interpreter, who advances the first frame to be interpreted to the middle of the light table and sets the stereoscope over the transparencies. At this time, any ground data available and any previous photos of the area should be examined. The site should be viewed stereoscopically to determine gross characteristics (that is, slope, aspect, elevation, habitat type, and so forth). The grid should be placed over each frame to be interpreted so that the subplot is established in a consistent location close to the center of the frame.

[2] In the Northern Region, forest stands are separated into 26 aerial photo classes. These are collapsed into nine classes for mortality sampling and estimation. A description of the nine classes is contained in appendix A.

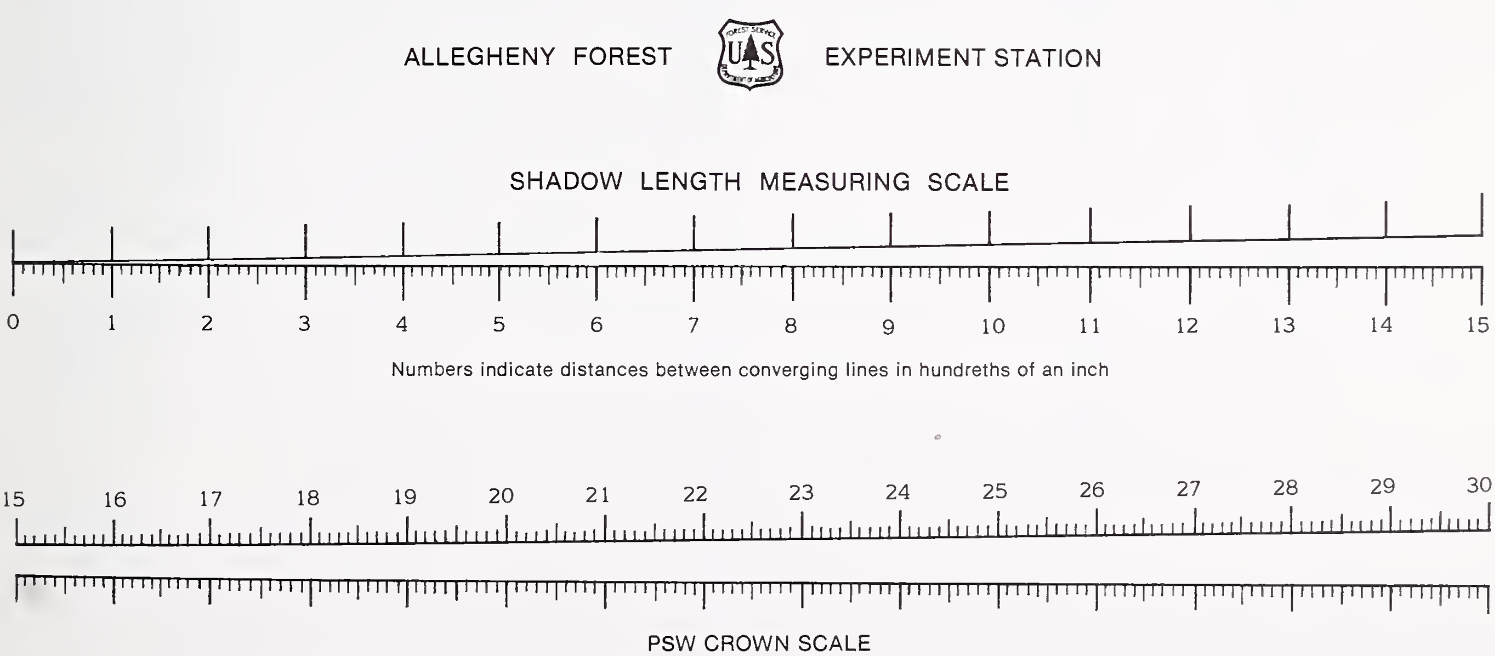


Figure 3.--A micrometer wedge was used to measure crown diameters. The first piece (top) measures distances from 0.001 to 0.150 inch (0.025 to 3.81 mm) while the second (bottom) measures from 0.150 to 0.300 inch (3.81 to 7.62 mm).

The interpreter may now begin to interpret the photos by locating all trees that have died in the past year. Such a tree is one on which the majority of the needles are retained and the foliage is brightly discolored. Trees dead for more than a year will usually have a dull discoloration of the foliage, and a significant portion of the needles will be gone. Interpretation of photographs flown over the same plots on two successive years has demonstrated that these criteria correctly categorize 90 percent of the 1-year mortality trees. Dying trees, identified by their slightly offgreen crown, are not counted as 1-year mortality trees. These trees will meet the definition of 1-year mortality trees in the following year. To include them in the count of mortality trees would result in double counting and inflated estimates of mortality rates.

The interpreter, who begins in one square and systematically covers all squares, should identify dead trees by species, measure their crown width with the micrometer wedge while viewing in stereo, and record whether each dead tree is located in or out of the central subplot. These data should be recorded on a tally sheet similar to the one in figure 4. If a dead tree is located outside the central subplot, its location is coded as 1. Location of all other measured trees (green and dead) is coded as 0.

Photo plot number	PI code	Species	Status (dead or alive)	Crown width	Size of subplot	Tree location
51-2	1	DF	D	.090	0	1
		PP	D	.084	0	1
		DF	D	.076	0	1
		PP	D	.063	0	1
		DF	D	.085	0	1
		DF	A	.139	0	0
		DF	A	.066	0	0
		DF	A	.149	0	0
51-5	1	WP	D	.098	0	0
		WP	D	.072	0	0
		WP	D	.096	0	0
		DF	D	.062	0	1
		WP	D	.078	0	1
		GF	D	.069	0	1
		WP	A	.105	0	0
		WP	A	.078	0	0
		DF	A	.125	0	0
51-8	1	WP	D	.079	1	1
		DF	D	.075	1	1
		GF	D	.091	1	1
		GF	D	.096	1	1
		DF	D	.086	1	1
		GF	A	.090	1	0
		DF	A	.136	1	0
		DF	A	.106	1	0
		WP	A	.069	1	0
		•	•	•	•	•
		•	•	•	•	•
		•	•	•	•	•

Figure 4.—Example of data recorded on tally sheet.

Technically, the only valid ways to measure crown diameter are at right angles to the radial displacement or in a real stereo image. However, because a relatively long focal length lens (12 inches or 304 mm) is usually used for this scale photography, and the majority of the trees measured are near the principal point of the frame of 70 mm photography, the errors in measurement due to radial distortion of the crown should be very small. The purpose of measuring crown diameter is to obtain a relative measure of size that may be used to rank the tree in the cumulative crown area distribution. Thus, there is little justification to expend the additional effort required to more accurately measure crown diameter.

Green trees are only measured within the central subplot. Generally, all trees within these central nine squares are to be identified by species and have their crown width measured. However, when the stand is very dense and homogeneous, a subsample of the central subplot may be selected for measuring green trees. The subsample is defined as the four squares in a randomly selected corner of the central subplot. The subsample is most easily selected by numbering the four corners of the central subplot and then selecting a number from a prepared list of uniform random numbers in the range of one to four.

If only four squares are measured as the green tree subplot, size of subplot is recorded as 1 for all trees (green and dead) measured on that frame. If nine squares are measured as the green tree subplot, size of subplot is coded as 0 for all measured trees. This further subsampling avoids excessive, time-consuming measurement of similar trees and does not introduce bias into the sample.

SPECIES IDENTIFICATION

Sayn-Wittgenstein (1978) developed a recognition manual for Canadian tree species that includes drawings and photographs for identifying trees on both large- and medium-scale aerial photography. Heller and others (1964), working in the northeast United States, developed general descriptions (appendixes B and C) of a few characteristics that might help identify trees in other parts of the United States. The characteristics listed in the appendixes (crown apices, crown margins, and foliage characteristics) and crown color have proven to be major distinguishing factors in species identification for species encountered in the Northern Region. Since all four characteristics change by site, season, and year, a standard description is difficult to develop. The impact on interpretation of this variation in the spectral signature of a single species is complicated by the variety of species in the Northern Region.

Six major trees in the Northern Region—ponderosa pine, western larch, Douglas-fir, grand fir, western white pine, and western redcedar—have been identified on large-scale aerial photography by Heller and others (1977). They found that pole and sapling size trees have similar crown shape and foliage characteristics regardless of species, and were therefore harder to identify than mature trees.

For this paper, three forestry students with backgrounds in aerial photo interpretation were used to identify mortality on 1:2400 color transparencies flown on the Clearwater and Kootenai National Forests in Idaho and on the National Forests straddling the continental divide in Montana. They determined that the following trees, when mature, could be identified by species: ponderosa pine, western white pine, lodgepole pine, Douglas-fir, grand fir, subalpine fir, Englemann spruce, and western redcedar. Those trees that could only be identified by genus were hemlock, larch, and juniper. Two pines, white bark pine and limber pine, could not be separated and were considered as one. Difficulty was also encountered in separating hemlock from cedar. Surveying larch mortality presented a problem in that it was difficult to distinguish between dead trees and trees defoliated by larch casebearer. Further, larch is deciduous, making it difficult to date mortality on the basis of foliage retention.

Characteristics that could be used to identify mature trees by species with reasonable reliability were noted. Appendix D lists by tree species and major characteristics those distinguishing factors the three interpreters used to identify tree species.

As an additional photo interpretation aid, the stereograms in appendix E are included. Each stereogram contains identified trees. A drawing of the foliage characteristics (from appendix C) accompanies each identified tree. The photos demonstrate the variability in descriptive characteristics that exists in trees of the same species. The descriptions included in this paper should only be used as a starting point.

Each new photograph set will have a unique set of characteristics to be used in species identification and mortality dating. The most efficient means of determining this set of characteristics is to have the interpreters visit a small subset of the photo strips on the ground and compare their photo interpretation with what actually exists. This also serves as an excellent method of training interpreters.

ANALYSIS OF TIME OF INTERPRETATION

Time spent on the photo interpretation was analyzed. The data were recorded by forest and by the number of squares sampled within the subplot (four or nine). Results are shown in table 1.

Variation in areas sampled led to a wide range of interpretation times. The frame that took 1 minute had only two live ponderosa pine in the subplot and no dead trees. The frame that took 100 minutes contained a very dense dog-hair lodgepole pine stand. Generally, the lodgepole pine stands were the most dense and required the most time to measure because of the small crown size. However, lodgepole stands were easy to identify by species. Other factors that caused the interpretation time to increase were poor image quality and a large mix of different species in immature stands. The results of this analysis of time data indicate that an average of just under 1 hour is required to interpret each one-third-mile (0.54-km) strip of photography.

This paper only describes the interpretation techniques and the specifications for obtaining the photography. The sampling design used by the Northern Region and the estimation procedures used to estimate mortality are discussed by Hamilton (see footnote 1).

Table 1.—Time required to accomplish photo interpretation of 70 mm stereograms

Forest	Number of squares interpreted in subplot	Number of frames interpreted	Time in minutes: Range	Mean	Standard deviation
Clearwater	9	152	4-37	16.7	9.13
	4	7	18-45	27.6	9.18
	Combined	159	4-45	17.2	9.37
Kootenai	9	104	2-60	19.0	10.82
	4	52	10-73	24.1	11.23
	Combined	156	2-73	20.7	11.19
Montana	9	285	1- 50	16.3	7.53
	4	193	8-100	21.4	10.94
	Combined	478	1-100	18.6	9.81
Entire project	Combined	793	1-100	18.7	9.81

PUBLICATIONS CITED

Hamilton, David A. Jr.
1981. Large scale color aerial photography as a tool in sampling for mortality rates. USDA For. Serv. Res. Pap. INT-269, 8 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Heller, Robert C., G. E. Doverspike, and R. C. Aldrich.
1964. Identification of tree species on large scale panchromatic and color aerial photographs. USDA For. Serv. Agric. Handb. 261, 24 p., Washington, D.C.

Heller, Robert C., S. A. Sader, and W. A. Miller.
1977. Identification of preferred Douglas-fir tussock moth sites by photo interpretation of stand, site, and defoliation conditions. DFTM Final Report, Univ. Idaho, Moscow, 23 p. Coll. For., Wildl. and Range Sci.

Sayn-Wittgenstein, L.
1978. Recognition of tree species on aerial photographs. Inf. Rep. FMR-X-118, 97 p. For. Mange. Inst. Ottawa, Ont.

APPENDIX A

Aerial Photo Interpretation Classes for Mortality Sampling and Estimation

Photo interpre-tation class	Description
1	Stand height greater than 40 ft (12.2 m). Coarse texture, well or medium stocked. Cutover or uncut land.
2	Stand height greater than 40 ft (12.2 m). Fine texture, well or medium stocked. Cutover or uncut land.
3	Stand height greater than 40 ft (12.2 m). Coarse texture, poorly stocked. Cutover or uncut land.
4	Stand height greater than 40 ft (12.2 m). Fine texture, poorly stocked. Cutover or uncut land.
5	Stand height greater than 40 ft (12.2 m). Manageable or potentially manageable two-story stands. Understory well, medium, or poorly stocked. Cutover or uncut land.
6	Stand height less than 40 ft (12.2 m). Fine texture, well or medium stocked. Cutover, well and medium stocked residual after cutting.
7	Stand height less than 40 ft (12.2 m). Coarse texture, well, medium, or poorly stocked.
8	Stand height less than 40 ft (12.2 m). Fine texture, poorly stocked or apparently nonstocked. Cutover, poorly stocked residual or apparently nonstocked after cutting.
9	Other (noncommercial forest).

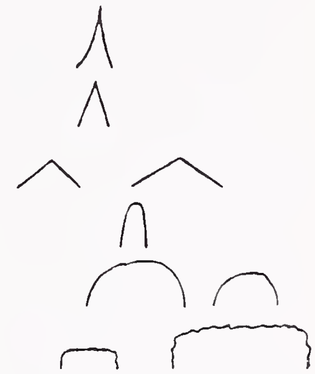
APPENDIX B

Interpretation Aid for Describing Tree Crowns[1]

Crown descriptions used by photo interpreters in species identification test

Crown apices

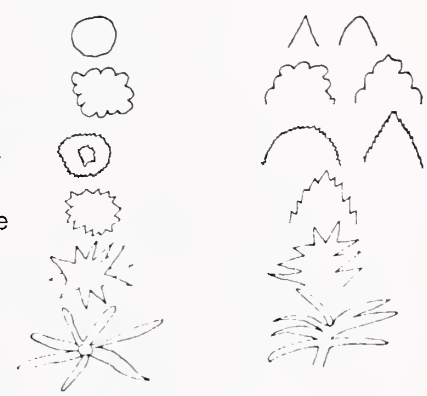
1. Acuminate
2. Acute
3. Obtuse
4. Narrowly rounded
5. Broadly rounded
6. Flat



Crown margins

Top view — Side view

1. Entire
2. Sinnuate
3. Finely serrate
4. Deeply serrate
5. Lobed
6. Parted



[1] Heller and others (1964).

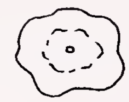
APPENDIX C

Interpretation Aid for Describing Foliage Characteristics[1]

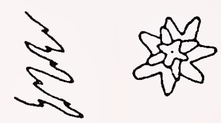
Conifers

Code No.

1. Light tip to center of bole with fine texture

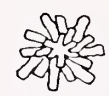


2. Layered branches

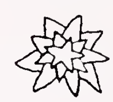


3. Wheel spokes

4. Columnar branches

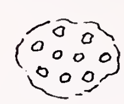


5. Layered triangular-shaped branches

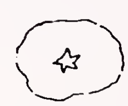


6. Small clumps

7. Small light spots in crown



8. Small starlike top



12. Dark spot in center of small clumps

16. Fine texture with scraggly long branches

---

[1] Heller and others (1964).

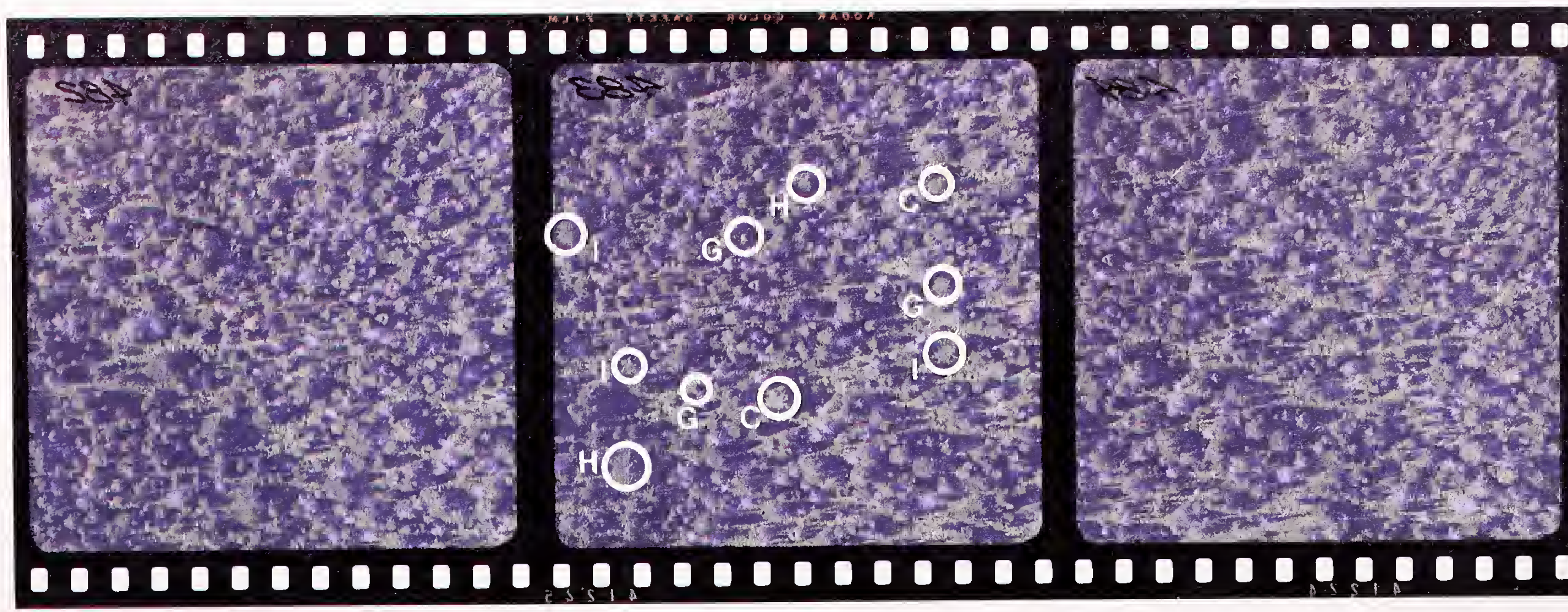
APPENDIX D

Descriptions of Major Characteristics of Trees in the Northern Rocky Mountains[1]

Species	Crown apex	Crown margin	Foliage characteristics	Color
A — ponderosa pine	broadly rounded	sinuate	dark spot in center of small clumps	yellow-green
B—western white pine	narrowly rounded	*lobed or serrate	small clumps	blue-green
C—lodgepole pine	acute to narrowly rounded	sinuate	very small clumps	yellow-green
D—larch	*acute to narrowly rounded	lobed	fine texture with long scraggly branches	light green
E—Douglas-fir	*acute	*deeply serated to lobed	layered, triangular shaped branches	medium green
F—grand fir	acute	*serrate to lobed	layered branches	dark green
G—subalpine fir	acuminate	*finely serrate	layered branches	dark green
H—Engelmann spruce	acute	serrate	layered branches, top may be a brownish-green due to presence of cones	*medium green
I—hemlock	acute	parted	wheel spokes	*dark green
J—western redcedar	acute	parted	wheel spokes	brownish yellow-green
K—white bark and limber pine	broadly rounded	*sinuate or lobed	scraggly branches	*blue-green to brownish green
L—juniper	broadly rounded	entire to sinuate	rounded and smooth	grey to light blue-green

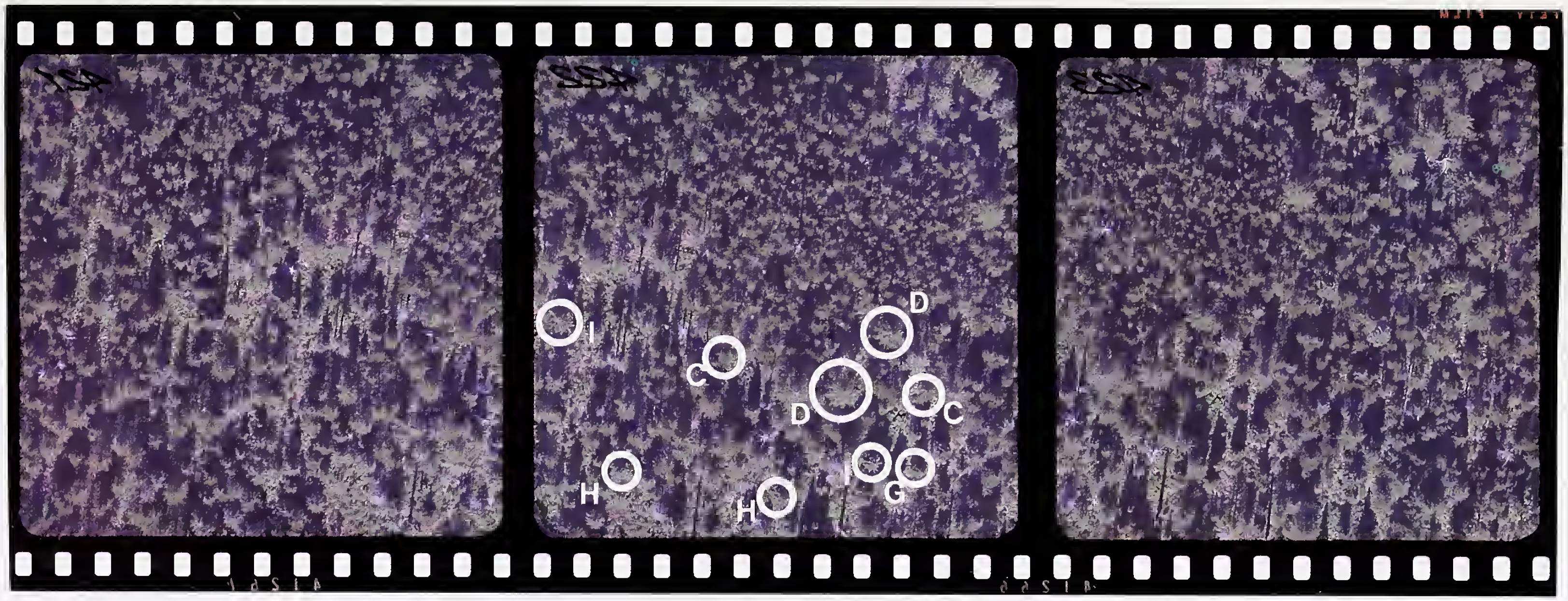
[1] As agreed upon by all three interpreters during the initial work based on large-scale color transparencies taken during the summer months. An asterisk in the left corner of the block indicates those descriptions where all three interpreters did not agree. In these cases, the most common description is listed.

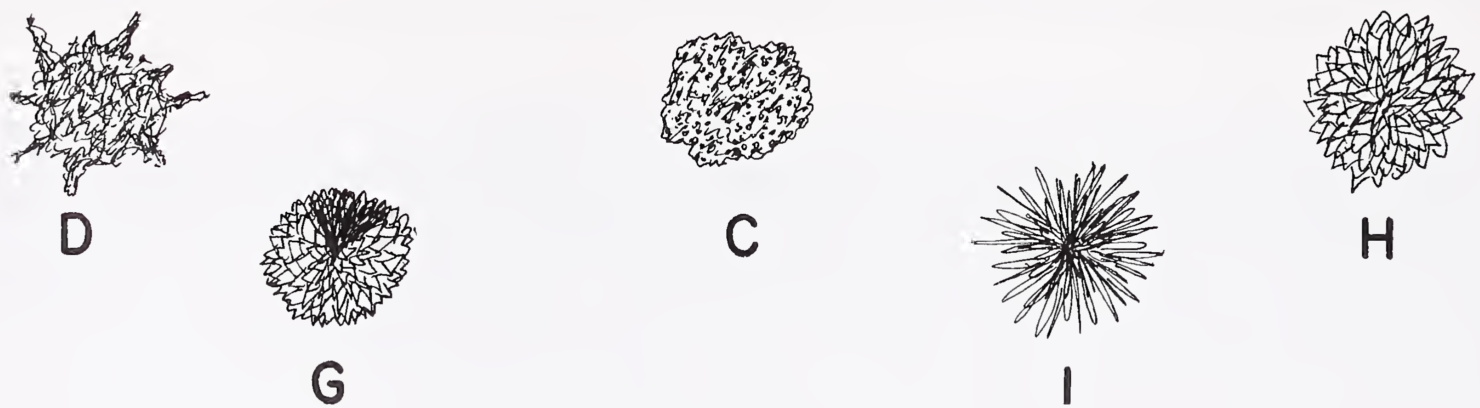
APPENDIX E



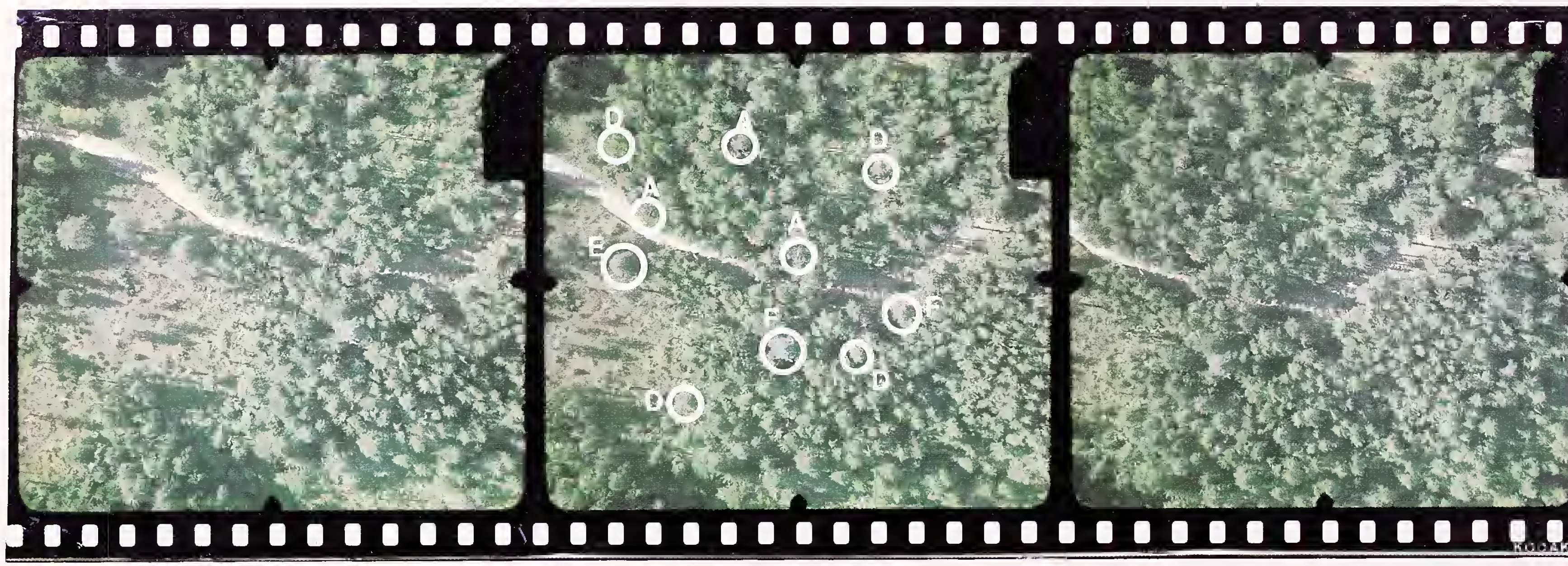
E-1. Kodak Ektachrome, MS 2448, scale 1:2400 exposed over the Clearwater National Forest. The four tree species identified by letters in this triplet[1]: *C* represents lodgepole pine, which is scattered throughout the stand and has typically yellowish-green feathery appearance of the foliage. *G* is subalpine fir, which has a distinctly conical shape; all ages are represented. *H* represents Englemann spruce, which can look brown or grey at the apex when the tree has a good cone crop. *I* represents hemlock, which typically has long conical branches radiating from the bole; it often looks like western redcedar. The drawings below the triplet combine the crown margin and foliage characteristics that were determined by the interpreters to best describe that tree species. There was no ground check to verify the identification of these species. The identification of the subalpine fir and lodgepole pine is much more positive than that of the Engelmann spruce and hemlock.

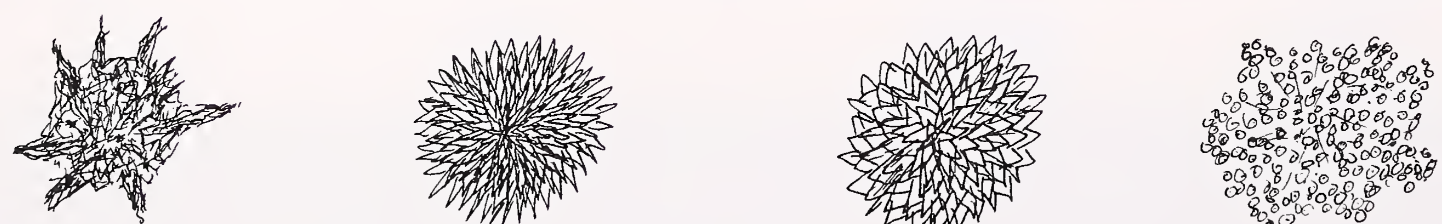
[1] These letters refer to the letters preceding the common name in appendix D.





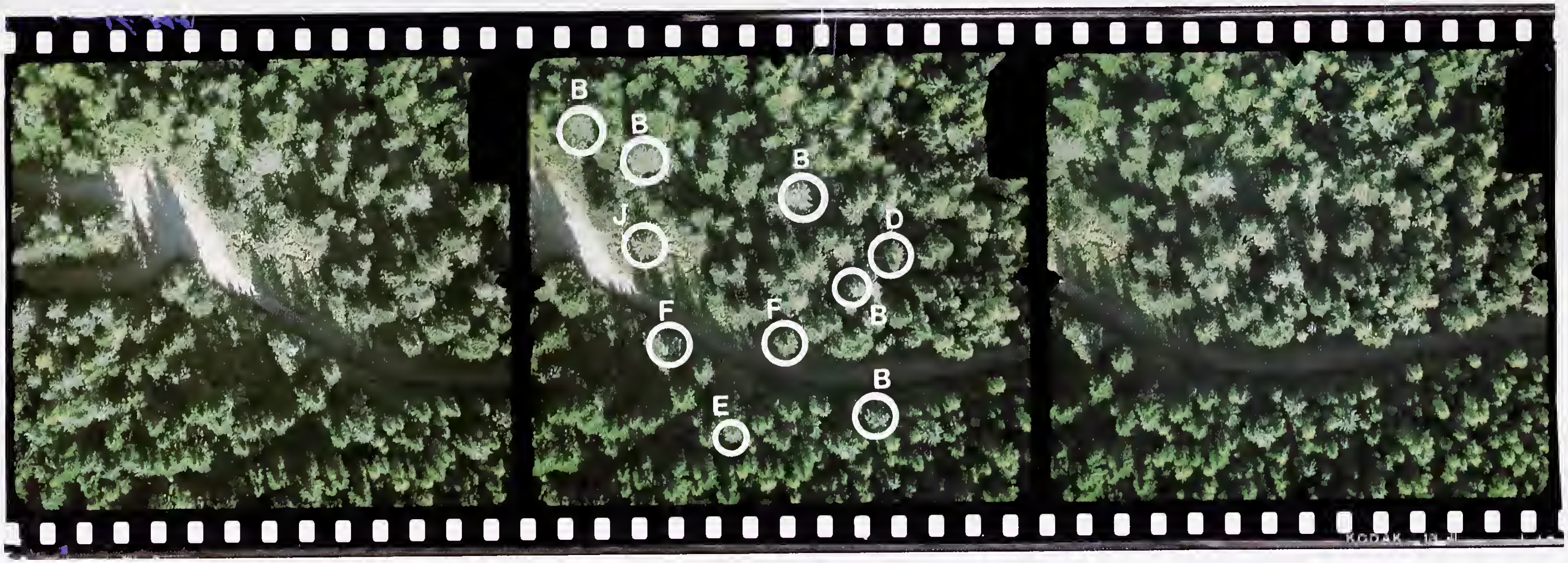
E-2. Kodak Ektachrome, MS 2448, scale 1:2400 exposed over the Clearwater National Forest. The five tree species identified by letters in this triplet: *C* represents lodgepole pine, which is scattered throughout the stand and has typically yellowish-green feathery appearance of the foliage. *D* represents larch, which always has a very fuzzy texture with a few scraggly branches. *G* is subalpine fir, which has a distinctly conical shape; all ages are represented. *H* represents Englemann spruce, which can look brown or grey at the apex when the tree has a good cone crop. *I* represents hemlock, which typically has long conical branches radiating from the bole; it often looks like western redcedar. The drawings below the triplet combine the crown margin and foliage characteristics that were determined by the interpreters to best describe that tree species. There was no ground check to verify the identification of these species. The identification of the subalpine fir and lodgepole pine is much more positive than that of the Engelmann spruce and hemlock.

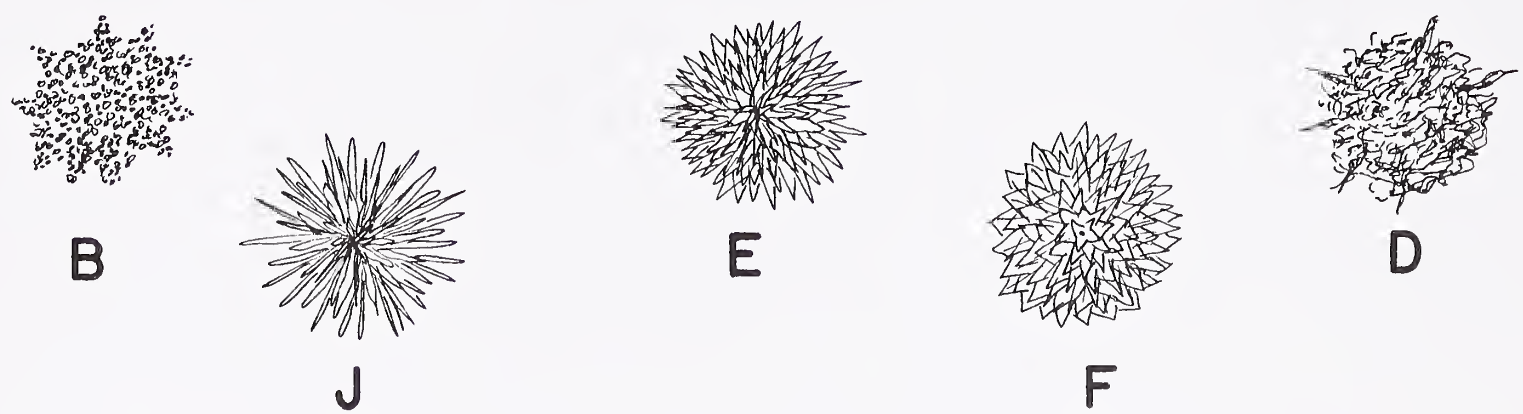




D E F A

E-3. Kodak Ektachrome, MS 2448, scale 1:1600 in the St. Joe National Forest. The four tree species identified by letters in this triplet: *A* represents ponderosa pine whose clumps can be readily seen at this scale; note the variation in color. *D* represents larch, which is always fuzzy in texture. *E* represents Douglas-fir, which had the most variable characteristics. *F* represents grand fir, which was consistently the easiest tree to identify. The drawings correspond to the distinguishing crown margin and foliage characteristics by which the tree was described. These trees were ground checked.





E-4. Kodak Ektachrome, MS 2448, scale 1:1600 in the St. Joe National Forest. The five tree species identified by letters in this triplet: *B* represents western white pine, which can be identified as a pine and is normally very blue in color. *D* represents larch, which is alway fuzzy in texture. *E* represents Douglas-fir, which had the most variable characteristics. *F* represents grand fir, which was consistently the easiest tree to identify. *J* represents cedar, which has a very strong star appearance with a slight brown tint. The drawings correspond to the distinguishing crown margin and foliage characteristics by which the tree was described. These trees were ground checked.

Croft, Frank C., Robert C. Heller, and David A. Hamilton, Jr.
1982. How to interpret tree mortality on large-scale color aerial photographs. USDA For. Serv. Gen. Tech. Rep. INT-124, 13 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

This paper describes photo interpretation techniques for use in sampling for mortality rates with large-scale aerial photography in the Inland Empire. Specifications are given for 70 mm color transparencies. Equipment needed for interpretation is described. Procedures to be used in interpreting the 70 mm photography are discussed with particular emphasis given to problems of species identification. Time required to interpret a single frame of photography is determined for a broad range of stand conditions.

KEYWORDS: mortality sampling, photo interpretation, 70 mm photography, species identification

The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

The Intermountain Station includes the States of Montana, Idaho, Utah, Nevada, and western Wyoming. About 231 million acres, or 85 percent, of the land area in the Station territory are classified as forest and rangeland. These lands include grasslands, deserts, shrublands, alpine areas, and well-stocked forests. They supply fiber for forest industries; minerals for energy and industrial development; and water for domestic and industrial consumption. They also provide recreation opportunities for millions of visitors each year.

Field programs and research work units of the Station are maintained in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1982-0-579-354