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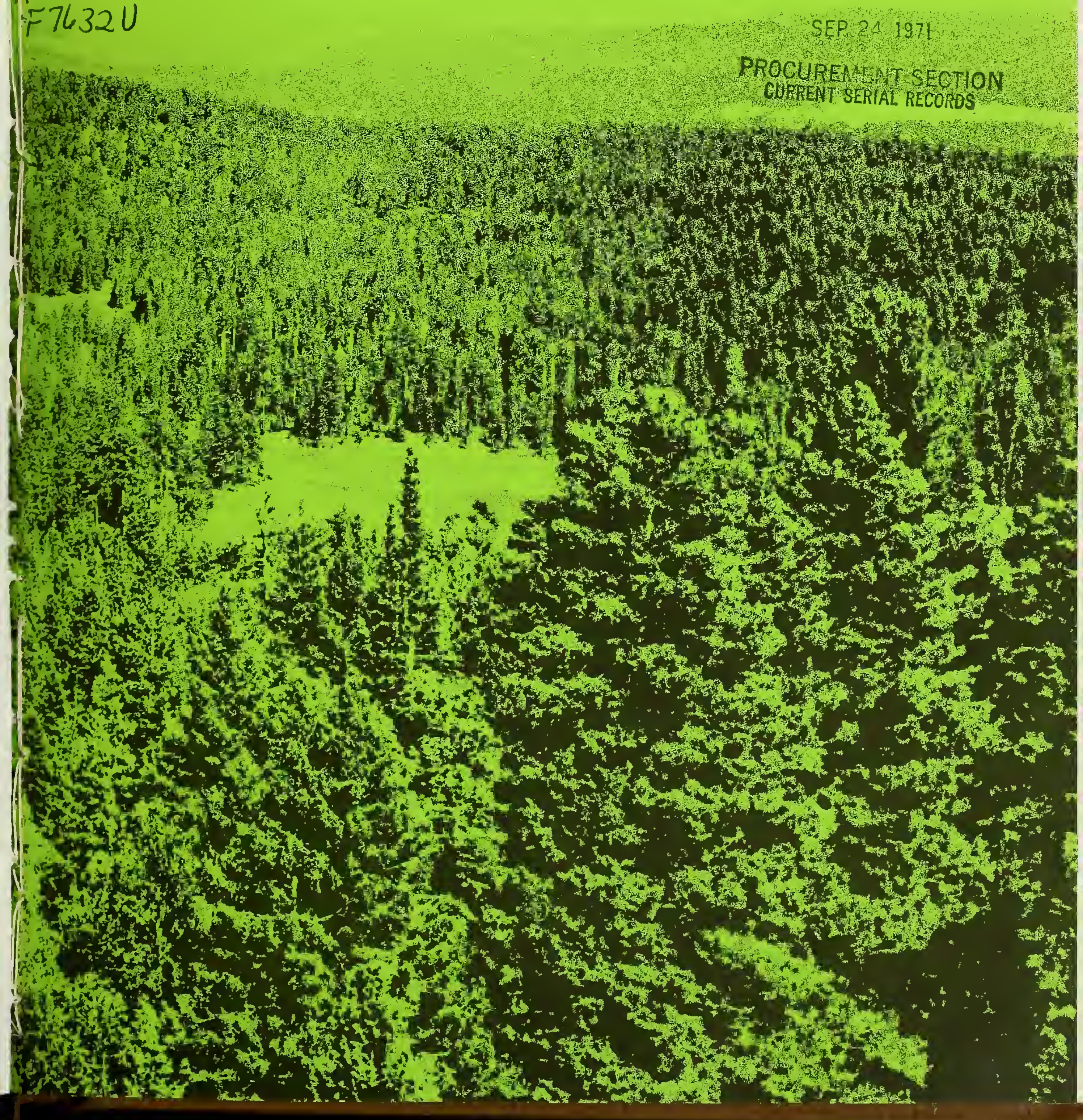
Frequency of STEM FEATURES AFFECTING QUALITY in ARIZONA MIXED CONIFERS

by Robert S. Embry
and Gerald J. Gottfried



ABSTRACT

Frequency of occurrence of visual stem features that affect end-product quality and yield is presented by species and size-class. Data were obtained in an overstory inventory of 1,800 acres of mixed conifer forests in the Arizona White Mountains.

Key words: Timber quality, mixed conifer forests.

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Frequency of Stem Features Affecting Quality in Arizona Mixed Conifers

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Robert S. Embry,
Associate Silviculturist

and

Gerald J. Gottfried,
Associate Hydrologist

Rocky Mountain Forest and Range Experiment Station[1]

[1]Central headquarters maintained at Fort Collins in cooperation with Colorado State University; Embry is located at Flagstaff in cooperation with Northern Arizona University, Gottfried is located at Tempe in cooperation with Arizona State University.

Contents

Frequency of Stem Features Affecting Quality in Arizona Mixed Conifers

Robert S. Embry and Gerald J. Gottfried

Mixed conifer stands occupy approximately 300,000 acres in Arizona. These are mostly uncut, all-aged stands on some of the most productive forest sites in the State. Seven coniferous and a deciduous species, in a wide variety of mixtures, characterize the mixed conifer forests (fig. 1):

- Engelmann spruce (Picea engelmannii Parry)
- Blue spruce (Picea pungens Engelm.)
- Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco)
- White fir (Abies concolor (Gord. and Glend.) Lindl.)
- Corkbark fir (Abies lasiocarpa var. arizonica (Merriam) Lemm.)[2]
- Ponderosa pine (Pinus ponderosa Laws.)
- Southwestern white pine (Pinus strobiformis Engelm.)
- Quaking aspen (Populus tremuloides Michx.)

Significant timber harvesting from these mixed stands began in 1966 on the Apache National Forest. Since then, cutting has increased annually. Stumpage values have also increased since 1966. Presently, saw logs are the primary product harvested, with a minor volume being taken for pulpwood and mine timbers.

Need for Basic Timber Quality Information

With the continuing trend toward new products, new conversion methods, and more diversified opera-

[2] *On the Kaibab Plateau, corkbark fir is replaced by subalpine fir (Abies lasiocarpa var. lasiocarpa (Hook.) Nutt.)*

Figure 1.--Stands such as this are characteristic of the mixed conifer forests in Arizona.

tions, the old saw-log concept of timber quality is no longer adequate. Standing timber must be described in terms of suitability for a range of potential products. Forest inventory information must categorize the tree resource in terms of physical stem characteristics that determine its suitability for specific products.

Stem quality for most primary products is largely determined by the same few features—diameter, height, sweep, crook, fork, and aggregate knot or limb characteristics. Suitability of the timber for a wide variety of products can be estimated if the size of timber and sufficient information about the frequency of occurrence of these characteristics is known. This paper reports the results of an inventory designed to produce this stem-quality data.

Mixed Conifer Area Studied

The area studied (fig. 2) consists of four watersheds totaling approximately 1,800 acres within the Black River Barometer Watershed in east-central Arizona. The area is typical of the uncut mixed conifer stands in Arizona found at elevations of 8,400 to 9,300 feet. Current gross sawtimber volumes average about 16,000 board feet per acre.

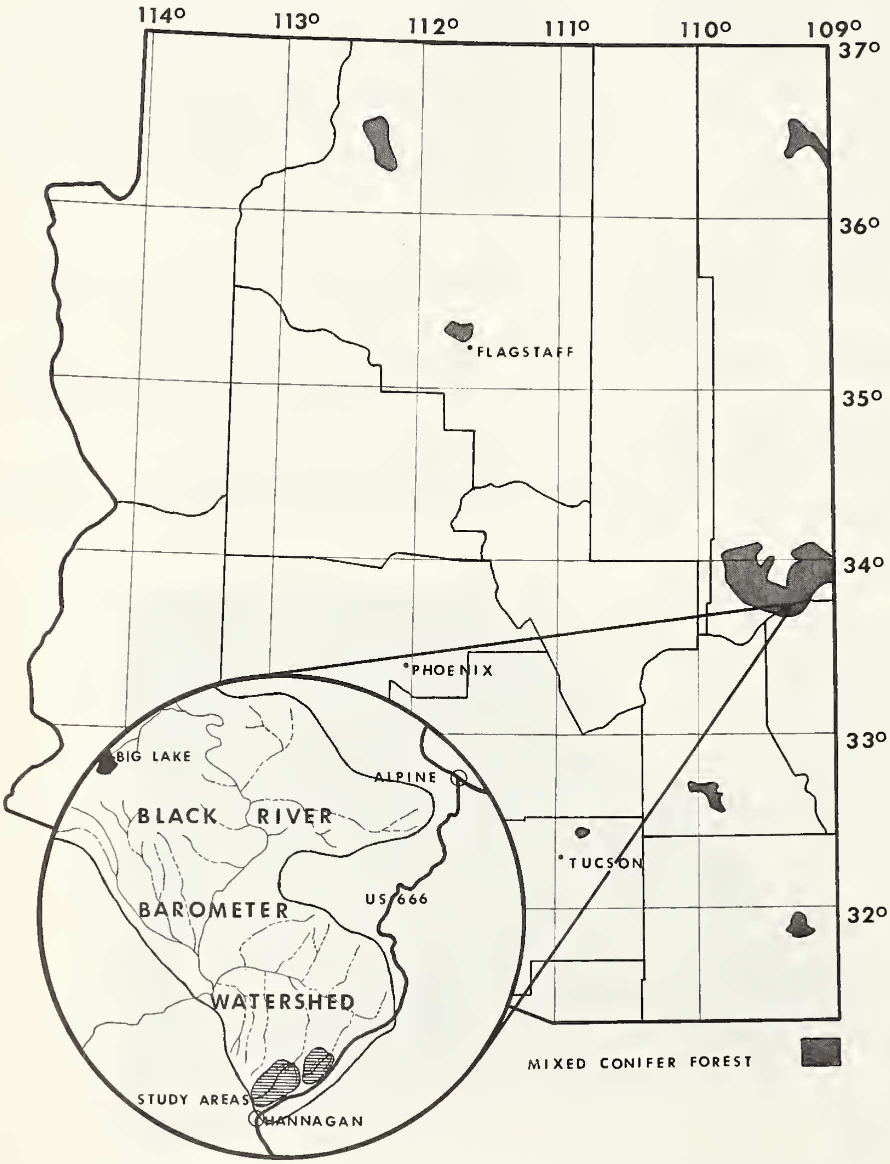

Figure 2.--
The study area, part of the Black River Barometer Watershed, is located on the Apache National Forest in east-central Arizona.

Measuring Stem Quality Characteristics

An overstory inventory of each watershed was made according to methods developed by Ffolliott and Worley.[3] Stem quality features were obtained from standing timber as described by Barger and Ffolliott.[4] The inventory method was designed to provide for systematic observation and measurement of all major visual stem characteristics related to primary product quality. The frequency of occurrence of observed features may be computed from data collected by this method.

Point-sampling techniques were used to select sample trees. A total of 556 permanent sample points were located on the pilot watersheds. Trees 7.0 inches d.b.h. and larger were selected at each sample point with an angle gage corresponding to a basal area factor of 25. A total of 3,336 trees were selected for observation and measurement (table 1).

[3]*Ffolliott, Peter F., and David P. Worley. An inventory system for multiple use evaluations. U. S. Forest Serv. Res. Pap. RM-17, 15 p., 1965. Rocky Mt. Forest and Range Exp. Sta., Ft. Collins, Colo.*

[4]*Barger, Roland L., and Peter F. Ffolliott. Evaluating product potential in standing timber. USDA Forest Serv. Res. Pap. RM-57, 20 p., 1970. Rocky Mt. Forest and Range Exp. Sta., Ft. Collins, Colo.*

Visual stem features that affect product quality and yield were recorded for each sample tree. Features observed and measured included (1) tree size—diameter and height; (2) stem form features of sweep, crook, fork, and lean; (3) injury features; and (4) log knot configurations in sawtimber stems.

Frequency of Stem Quality Features

All trees selected with the 25 BAF gage were aggregated by size class and species. Trees exhibiting the observed stem-quality features were summarized in a similar manner. Frequency of occurrence was indicated by the proportion of trees with a specific feature compared to the total number of selected trees. A species frequency-of-occurrence table was constructed for each observed quality feature. To facilitate presentation, the frequency-of-occurrence tables for individual stem features have been converted to bar graphs. The importance of each stem form and injury feature, how it affects quality, and data on its frequency of occurrence is presented by size class and species.

Trees were grouped into four major size classes:

Size class	D.b.h. range (Inches)
Pole	7.0 - 10.9
Small sawtimber	11.0 - 16.9
Medium sawtimber	17.0 - 22.9
Large sawtimber	23.0 plus

Table 1.--Distribution of trees 7.0 inches d.b.h. and over on the mixed conifer study area, east-central Arizona

Species	Trees	Proportion of total trees	Sample points on which species occurred[1]	Frequency of occurrence[1]	Average of trees per acre
	Number	Percent	Number	Percent	Number
Engelmann spruce	467	14	194	35	24.6
Blue spruce	48	1	24	4	2.2
Douglas-fir	1060	32	389	70	35.4
White fir	490	15	213	38	14.8
Corkbark fir	111	3	64	12	7.0
Ponderosa pine	500	15	227	41	12.1
Southwestern white pine	186	6	133	24	7.4
Quaking aspen	474	14	178	32	37.1

[1]Based on a total of 556 permanent sample points.

Stem Form Features

Irregular form features in the merchantable stem can substantially influence product potential. Sweep, crook, lean, and fork are particularly important determinants of volume and quality of timber for specific end uses or products. Occurrence of these stem form features is presented in figures 3 through 15.

Observations of multiple crook—more than a single crook in the merchantable stem—were recorded on two of the four watersheds inventoried (fig. 8). A total of 247 permanent sample points were involved in this additional stem feature sampling.

SWEEP.--Recorded as:

1. Minor--less than 1/3 d.b.h. deviation in straightness.
2. Major--1/3 d.b.h. or more deviation in straightness.

Sweep reduces the usable volume of sawtimber stems, and limits the use of stems as commercial poles. Use for sawn structural members may be limited by grain that has too great a slope. Sweep may not lower recovery from pulpwood stems, but does reduce the amount of solid wood per cord.

Figure 3.--Sweep is defined as a gradual bend in the merchantable bole.

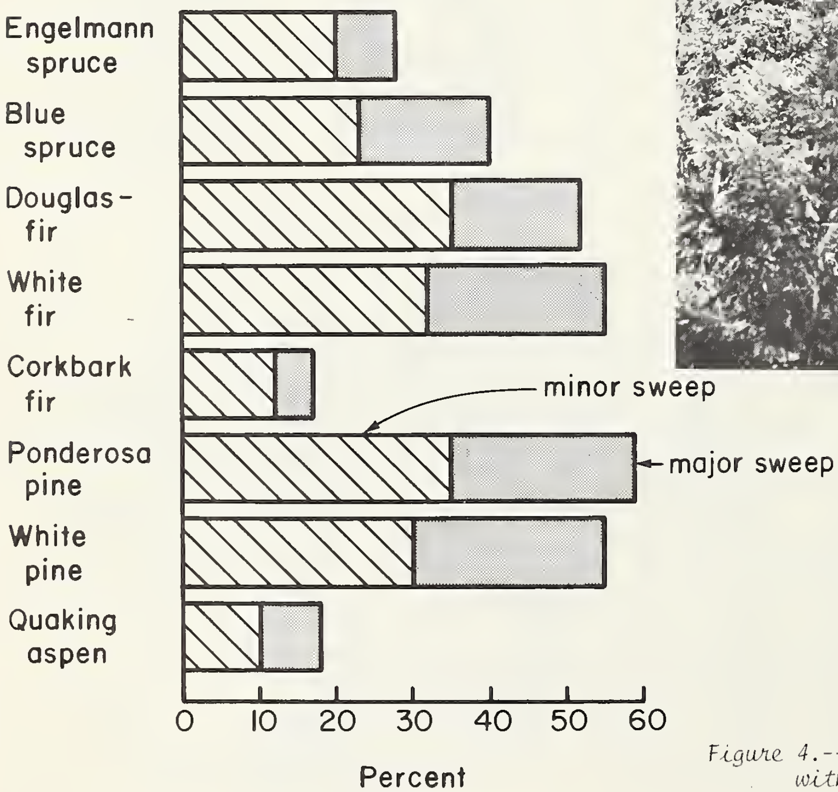

Figure 4.--Percentage of all sample trees with minor or major sweep.

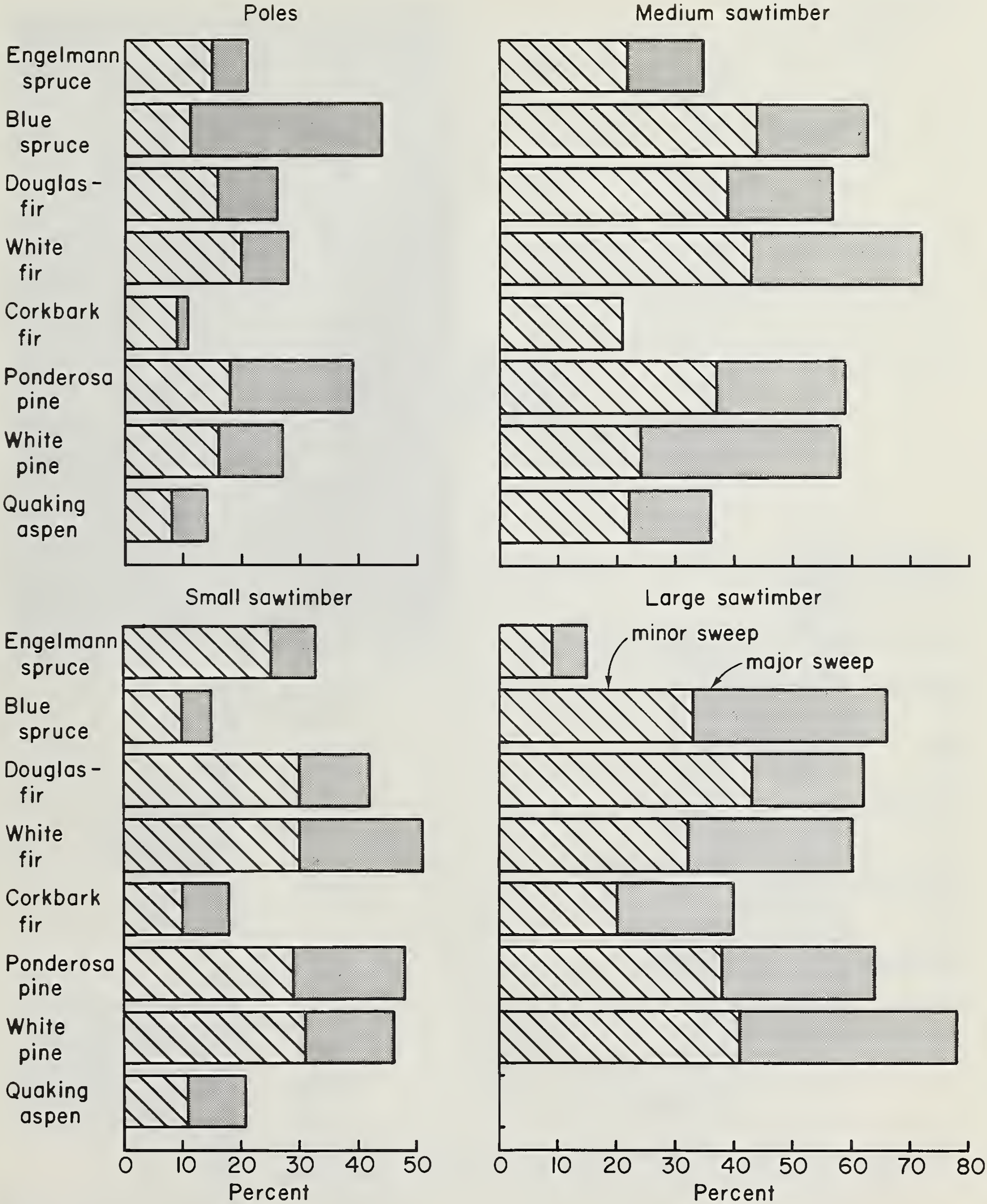

Figure 5.--Percentage of sample trees in four size-classes with minor or major sweep.

CROOK:--Recorded as:

1. Minor--less than ½ mean diameter deviation in straightness within a section 5 feet or less in length.
2. Major--½ mean diameter or more deviation in straightness within a section 5 feet or less in length.

Crook may reduce or limit the suitability of the merchantable stem for products such as poles. Stems with crook may have short grain or grain that has a greater slope than is permitted in many sawn structural members. Net volume may also be reduced.

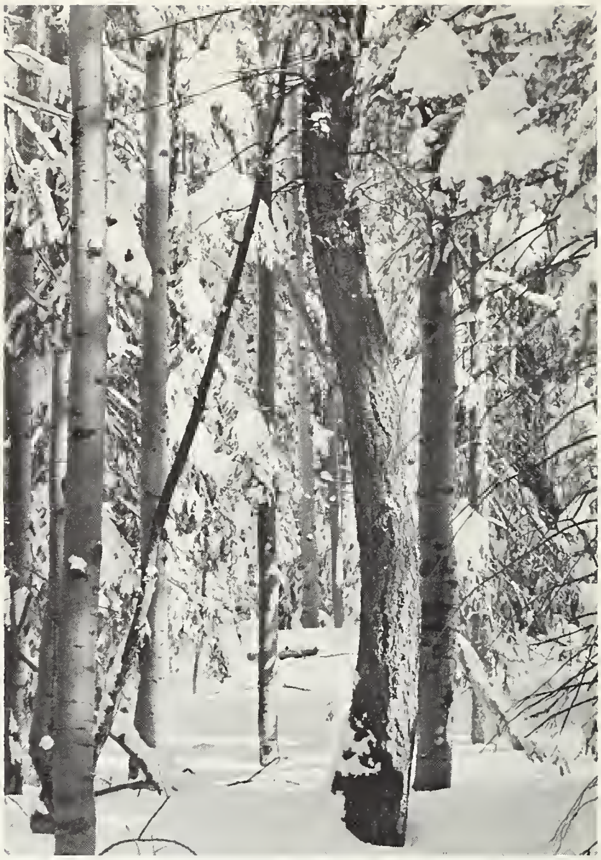

Figure 6.--Crook is defined as an abrupt bend in the merchantable stem.

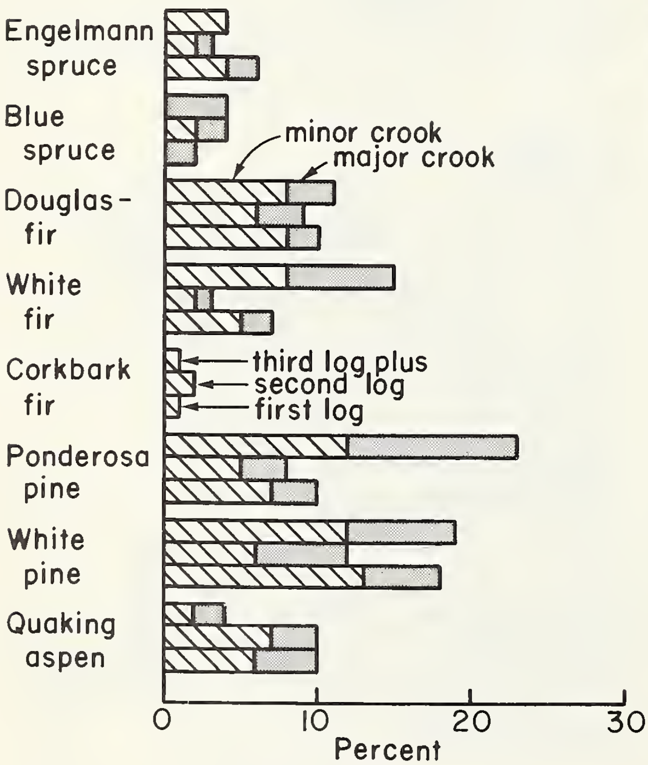

Figure 7.--Percentage of all sample trees with minor or major crook.

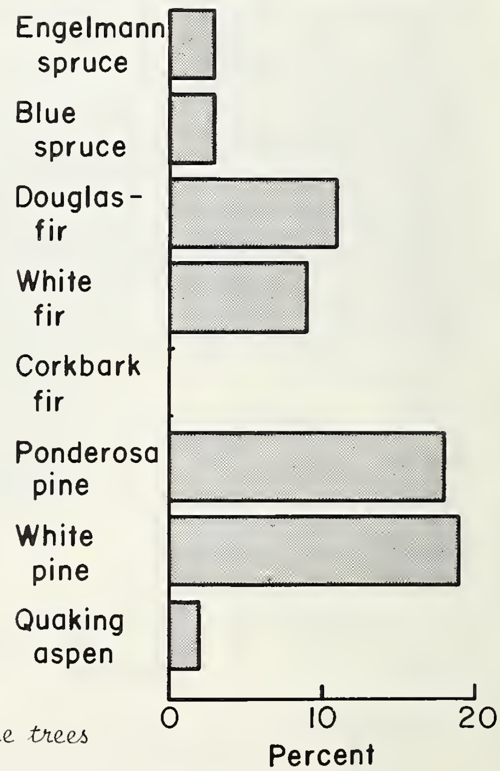

Figure 8.--Percentage of sample trees with multiple crooks.

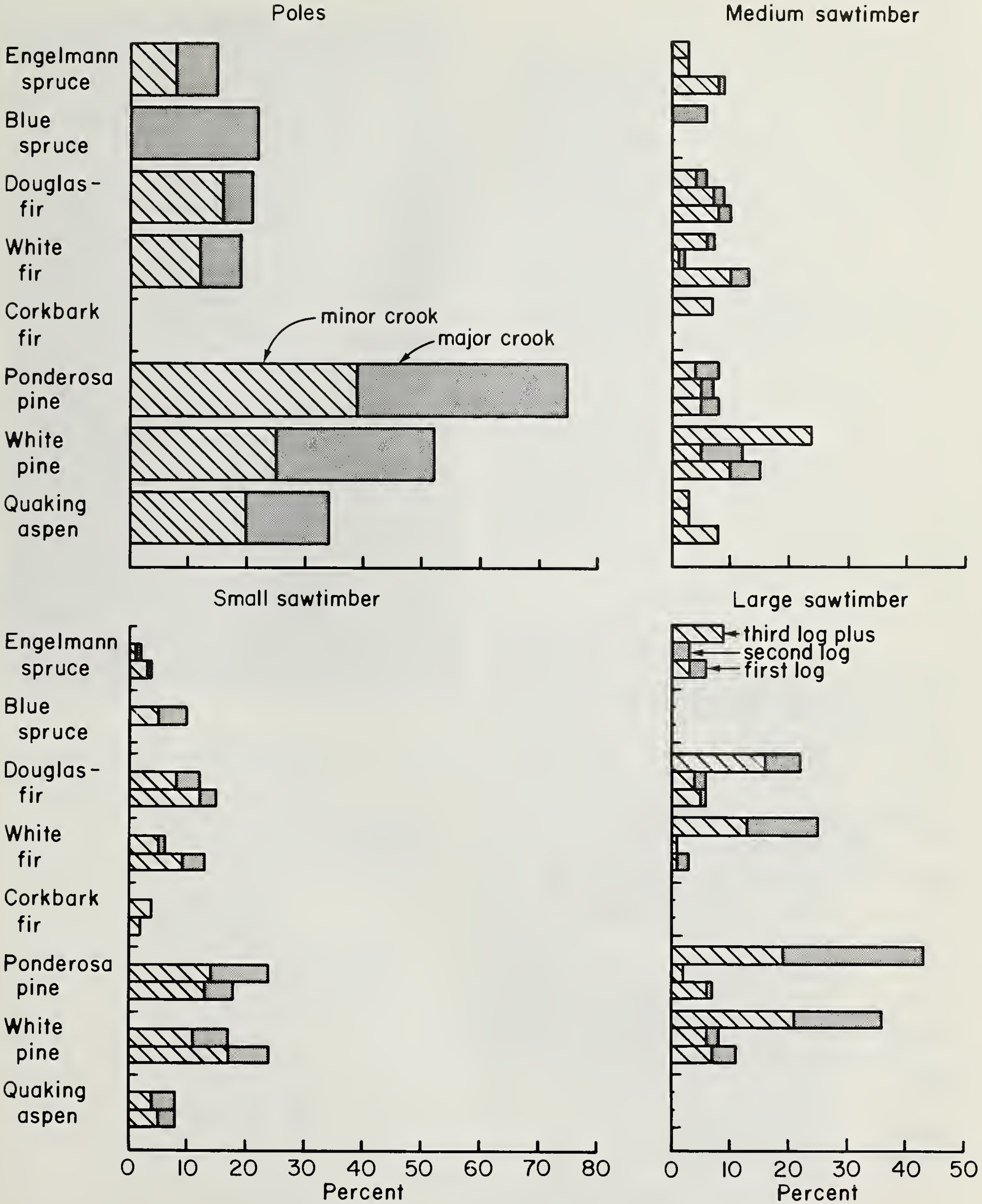

Figure 9.--Percentage of sample trees in four size-classes with minor or major crook.

LEAN:--Recorded as degree of lean, to the nearest 5 degrees.

Lean is an important form characteristic because of the development of compression wood in leaning boles. According to Pillow and Luxford[5] compression wood in coniferous species is usually found in stems with 5 degrees or more of lean.

[5] *Pillow, M. Y., and R. F. Luxford. Structure, occurrence and properties of compression wood. U. S. Dep. Agr. Tech. Bull. 546, 32 p., 1937.*

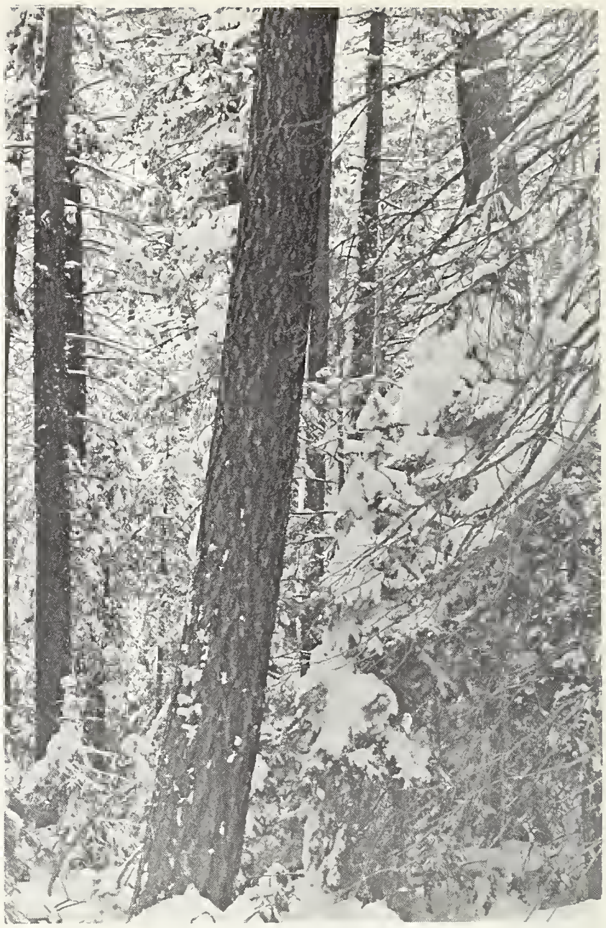

Figure 10.--Lean is defined as the deviation of the merchantable stem from vertical.

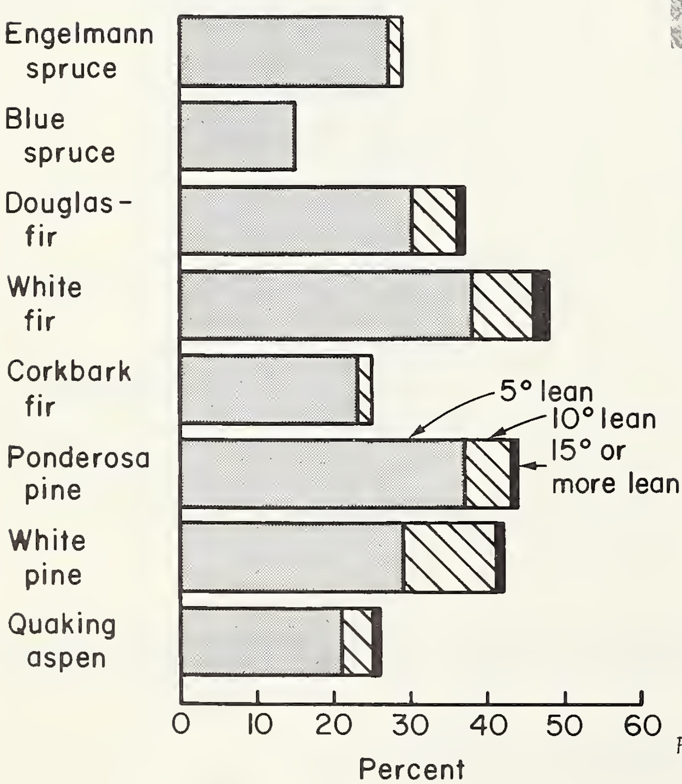

Figure 11.--Percentage of all sample trees with lean of 5°, 10°, or 15° or more.

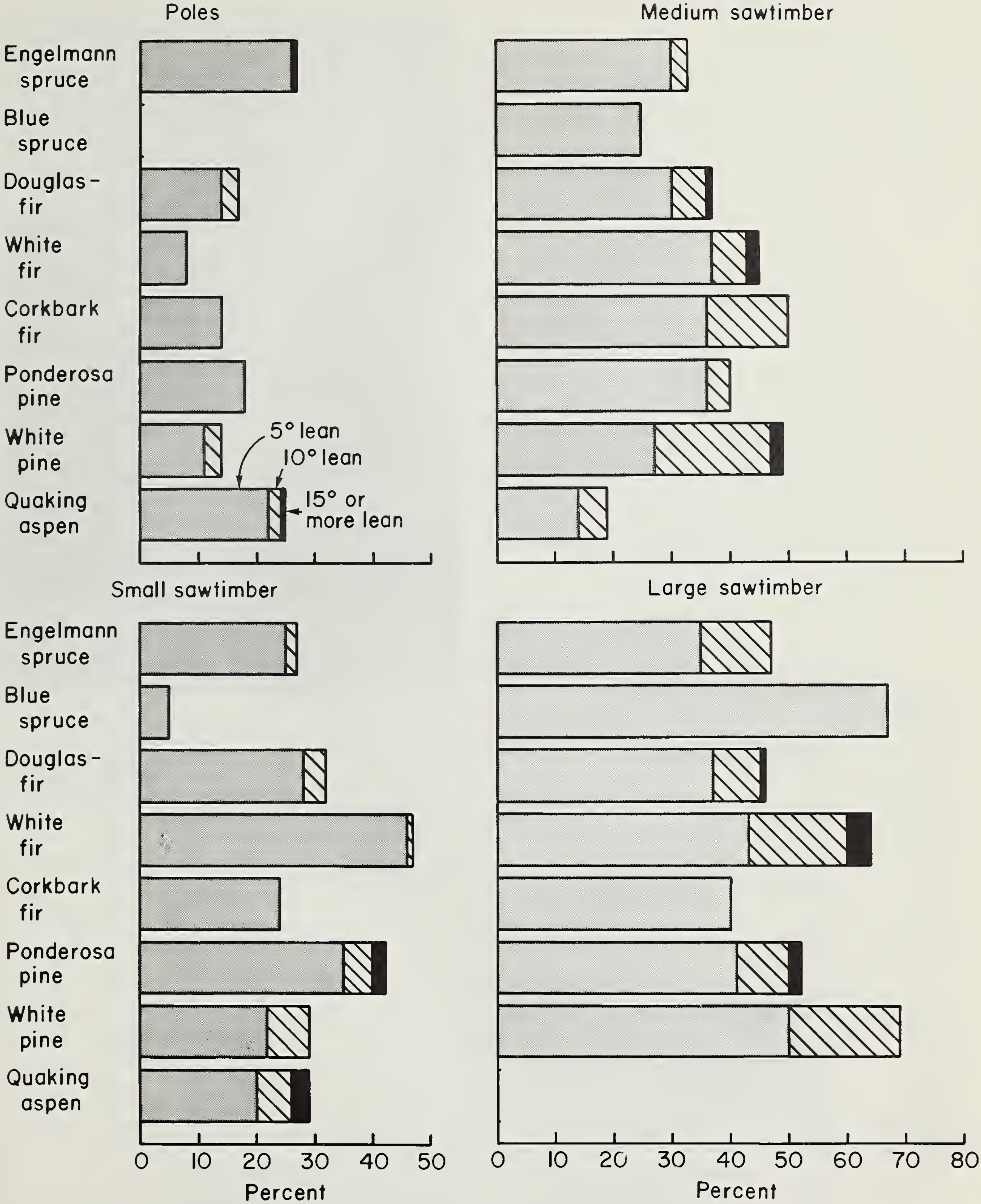

Figure 12.--Percentage of sample trees in four size-classes with lean of 5°, 10°, or 15° or more.

FORK:--Recorded as location of fork in stem, to nearest half-log.

The length of net scale of products obtained is limited by forking in the merchantable stem. The quality of adjacent material may also be lowered by the distorted grain accompanying a fork.

Figure 13.--Fork is defined as a point of division of the merchantable stem.

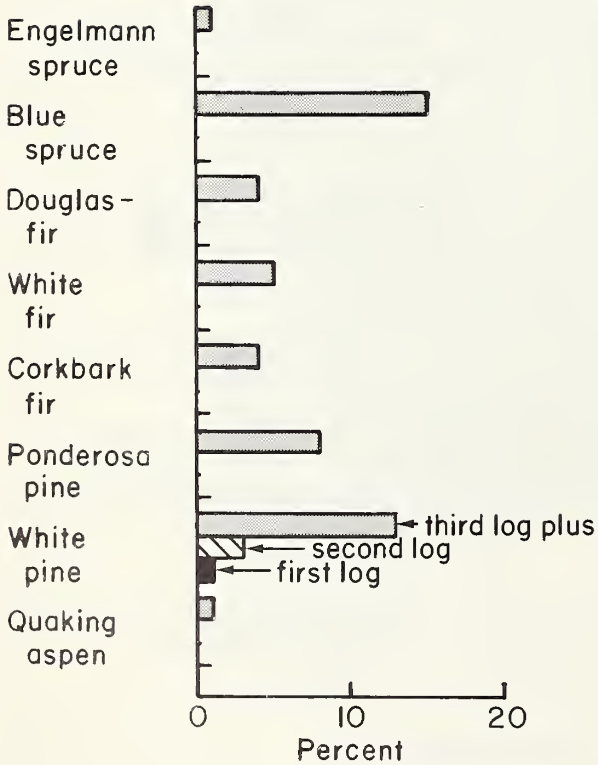

Figure 14.--Percentage of all sample trees with forked merchantable stems.

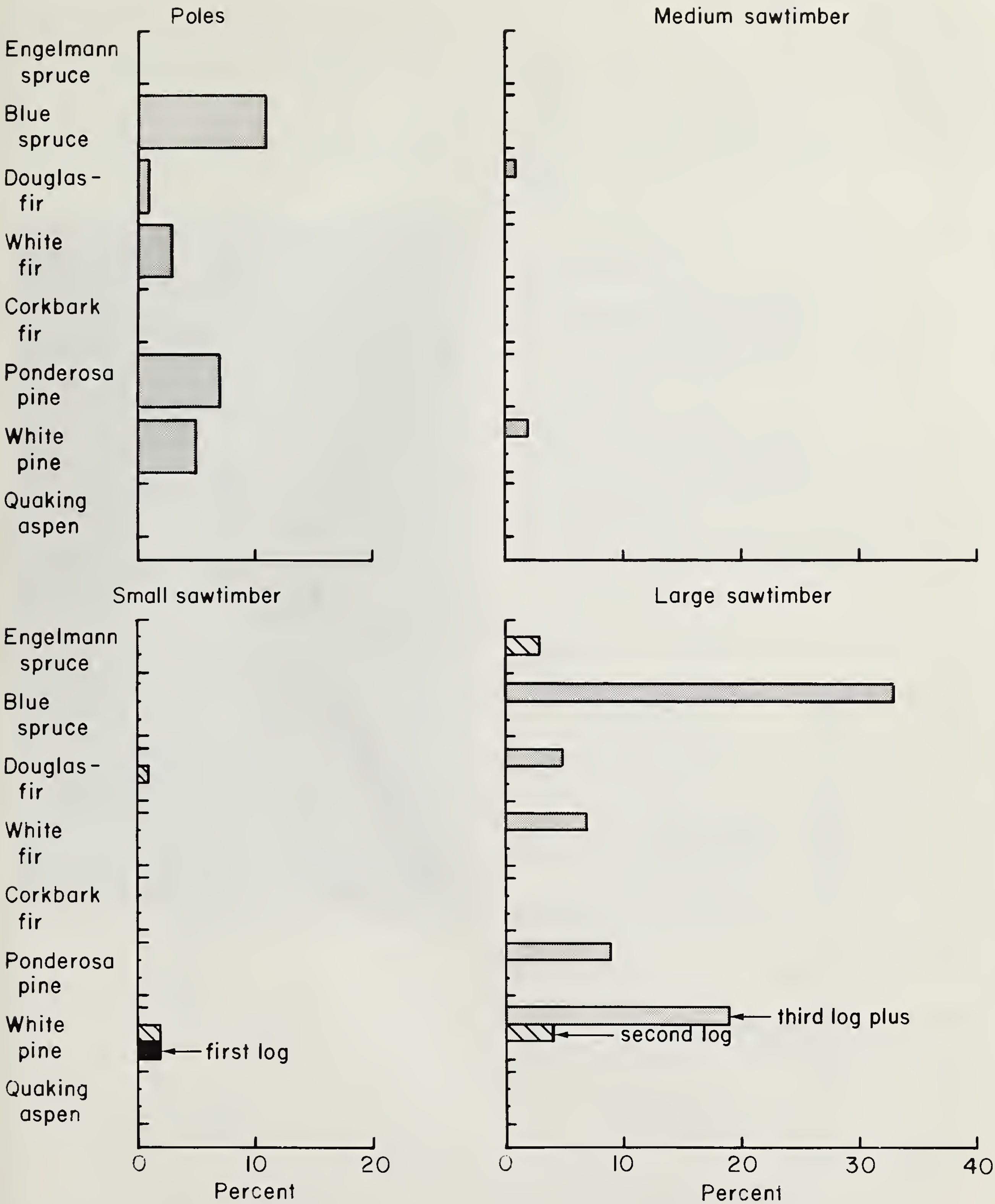

Figure 15.--Percentage of sample trees in four size-classes with forked merchantable stems.

Injury Features

Injuries can reduce the usable volume of the merchantable stem. Two of the more common injuries in standing timber are basal scars and lightning scars. Dead and broken tops are also considered injuries. Top damage is primarily attributable to lightning in the larger size classes, while snow breakage and porcupines may account for a substantial portion in the smaller size classes. Dead tops may also be caused by severe mistletoe infection.

Injury features are further described in figures 16 through 21.

SCAR:--Recorded as:

1. Minor--less than ¼ bole circumference affected.
2. Major--¼ or more bole circumference affected. Essentially a spiral injury in the case of lightning scars.

Basal scars are usually confined to the first half-log. Lightning scars often affect the entire merchantable stem. Scars are considered as secondary grading defects in determining timber quality for various products.

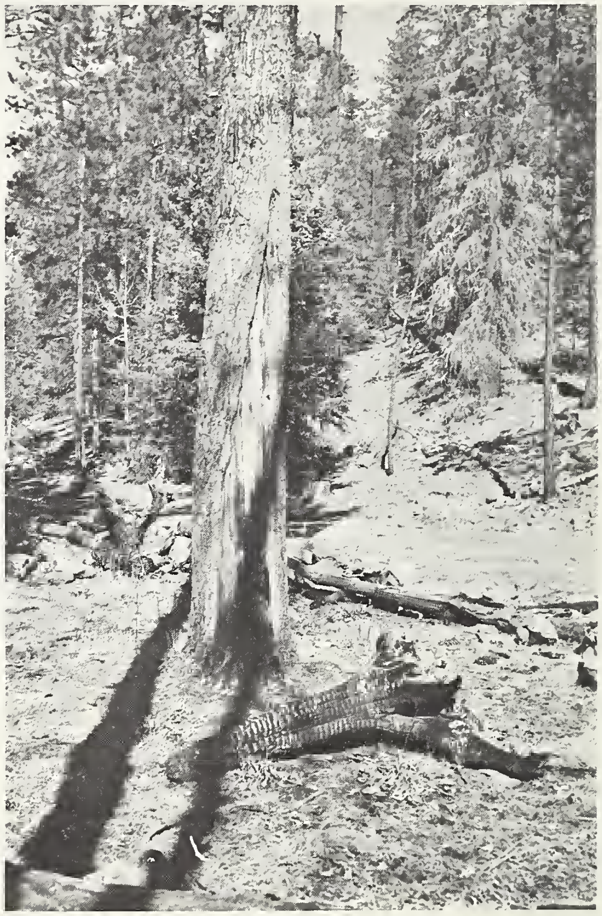

Figure 16.--A scar is an opening in the bark exposing the underlying wood.

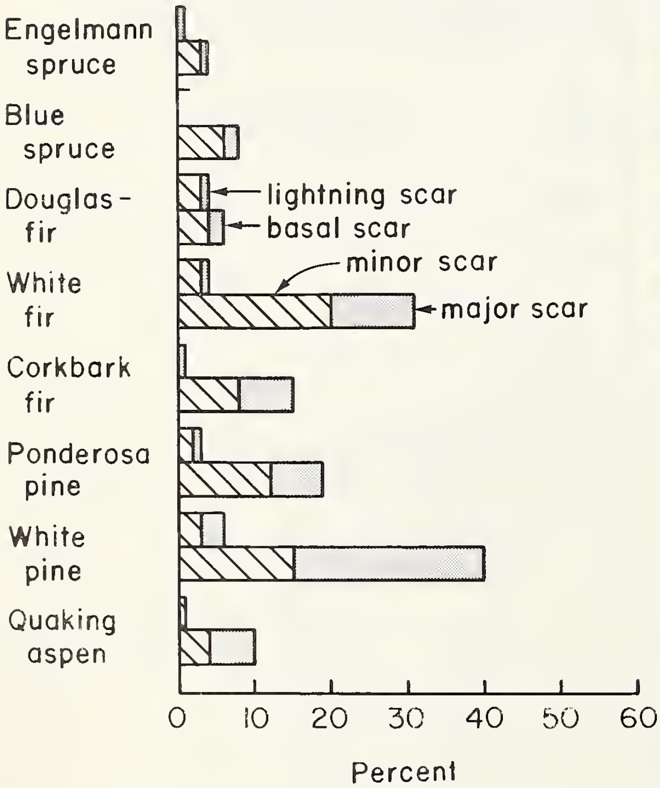

Figure 17.--Percentage of all sample trees with basal or lightning scars.

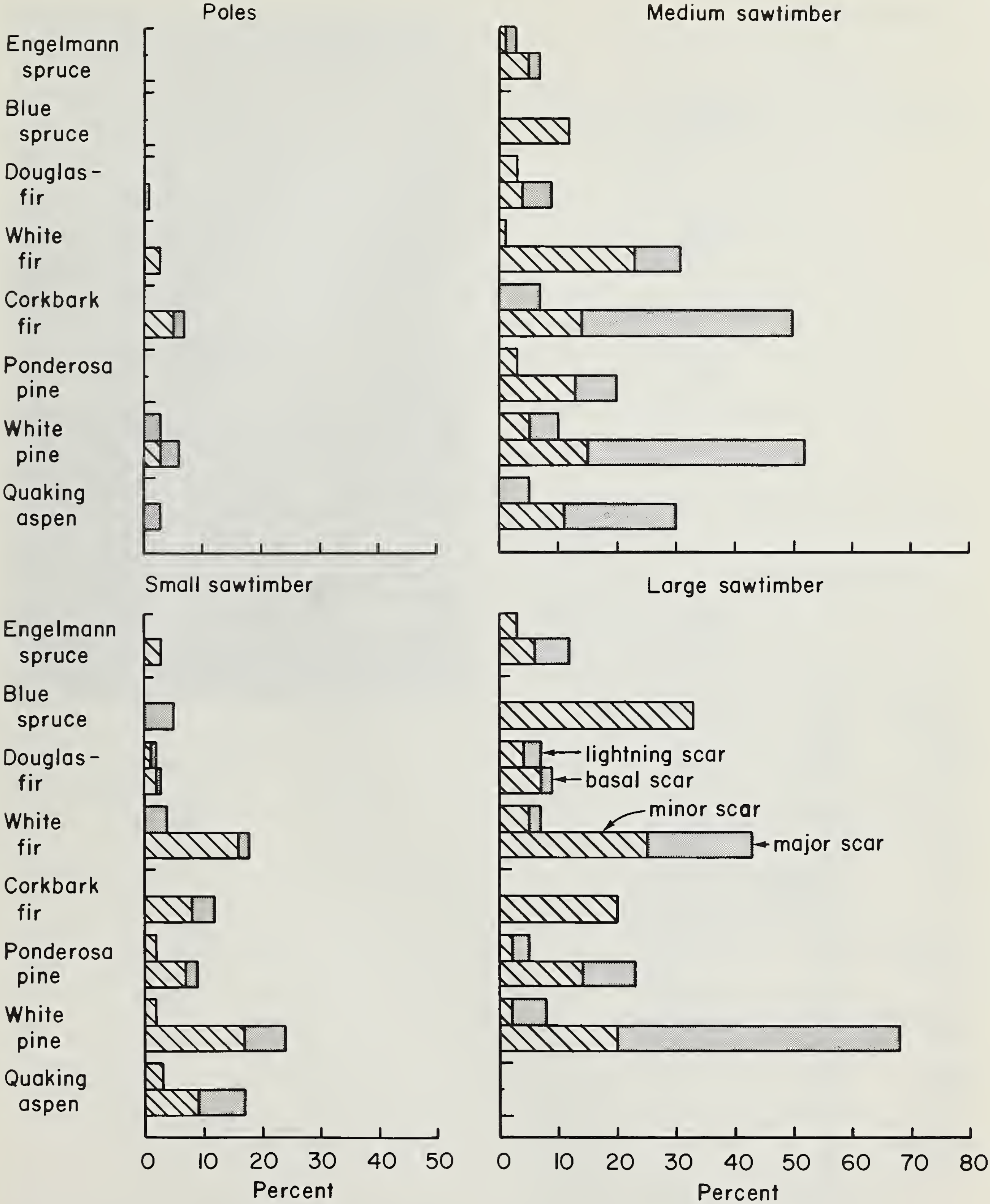

Figure 18.--Percentage of sample trees in four size-classes with basal or lightning scars.

TOP DAMAGE:--Recorded as:

1. Broken top.
2. Dead top.

Top damage is usually the result of lightning in the mixed conifer stands in the Southwest.

*Figure 19.--
Top damage is considered a mechanical stem injury.*

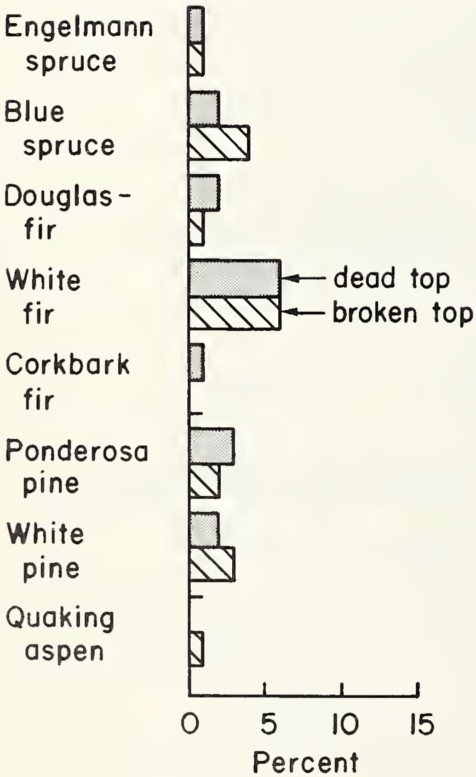

Figure 20.--Percentage of all sample trees with broken or dead tops.

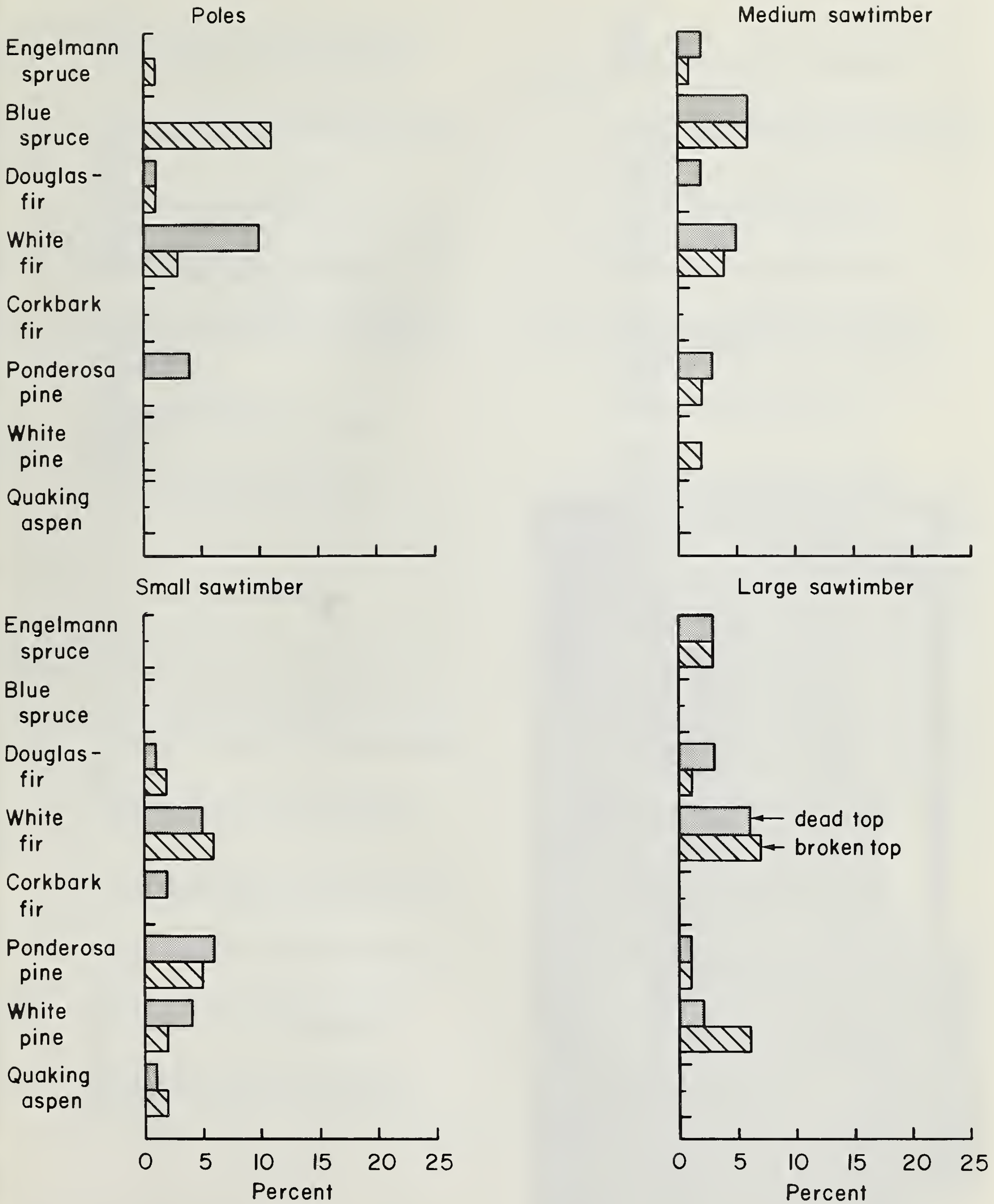

Figure 21.--Percentage of sample trees in four size-classes with broken or dead tops.

Log Knot Configurations

The distribution of clear surface area, and the number and size of log knots, are important indicators of primary product potential (fig. 22). The knot features of all coniferous sample trees 11.0 inches d.b.h. and larger were characterized in two ways: (1) presence of clear surface area in the first two 16-foot logs, and (2) number and size of knots in the first 16-foot log. Specific information recorded included:

A. Clear 8-foot faces (panels 8 feet by 1/4 bole circumference), recorded by position within each succeeding 8-foot stem section, to 32 feet height or to a 10-inch top diameter.

B. Log knots and knot indicators, recorded as:
   1. Number of knots in each full face of first 16-foot log.
   2. Diameter of largest knot in each log face, to nearest inch.
   3. Condition of largest knot in each log face (live or dead).

The occurrence of clear 8-foot faces in the butt 16-foot logs is presented in figure 23. Practically all clear faces observed were contained in the first 16-foot log of the larger size classes.

The number and size of log knots in the butt 16-foot logs are presented in figures 24 and 25, respectively.

Potential Use of Quality Information

Stem quality information forms the basis for most primary product grading systems. Such information provides a basis for inter-product comparisons and utilization decisions. The data presented here may be used to estimate the product potential of mixed conifer timber in Arizona. The extent to which a limiting stem defect may be expected to occur may also be estimated. Even if present grading systems should change, the stem quality information would continue to provide a basis for evaluating product potential without the need for an additional inventory.

Figure 22.--Clear log faces indicate suitability and high quality for most primary products.

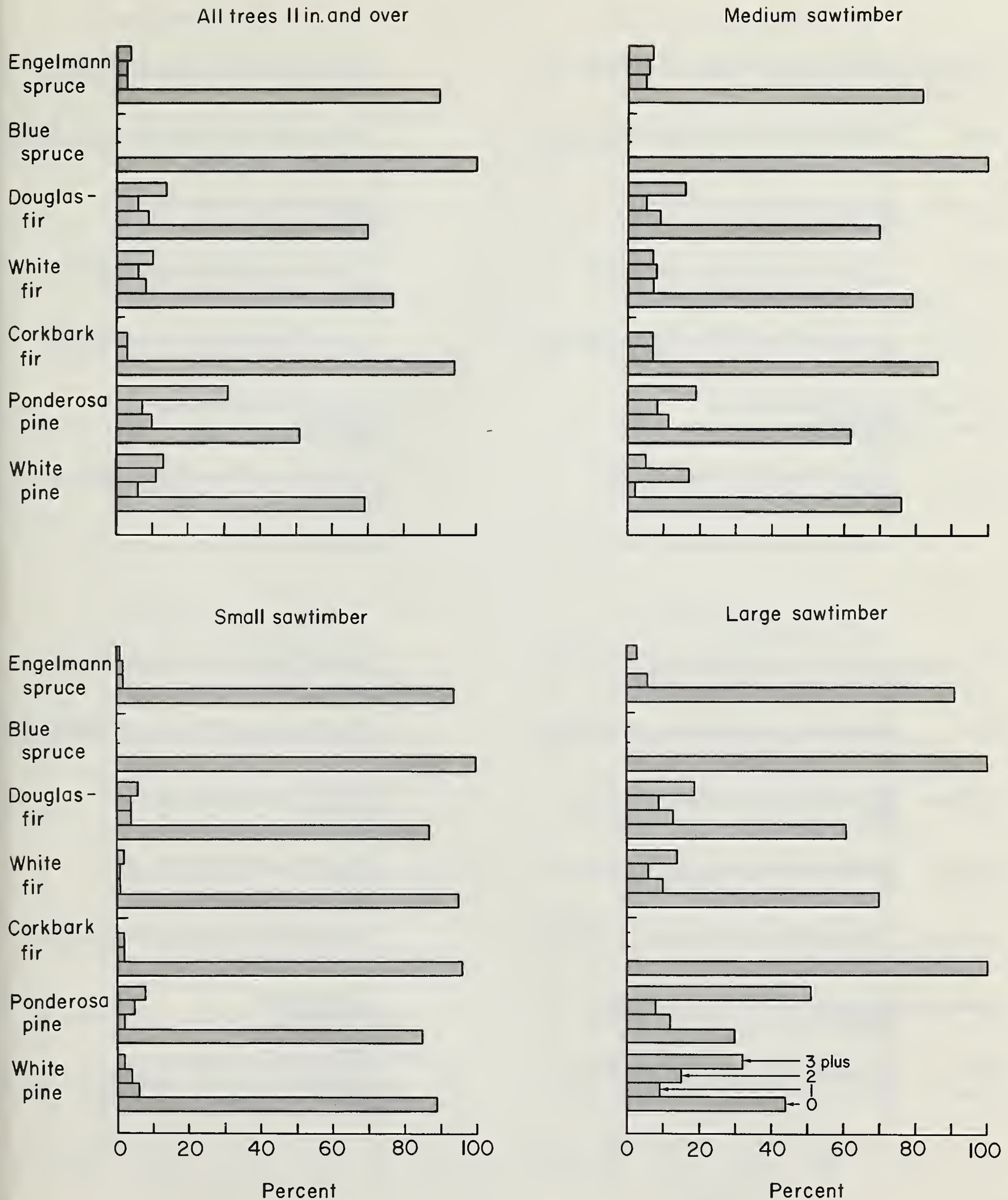

Figure 23.--Percentage of coniferous sawtimber stems with zero, one, two, and three or more clear faces in the butt 16-foot log.

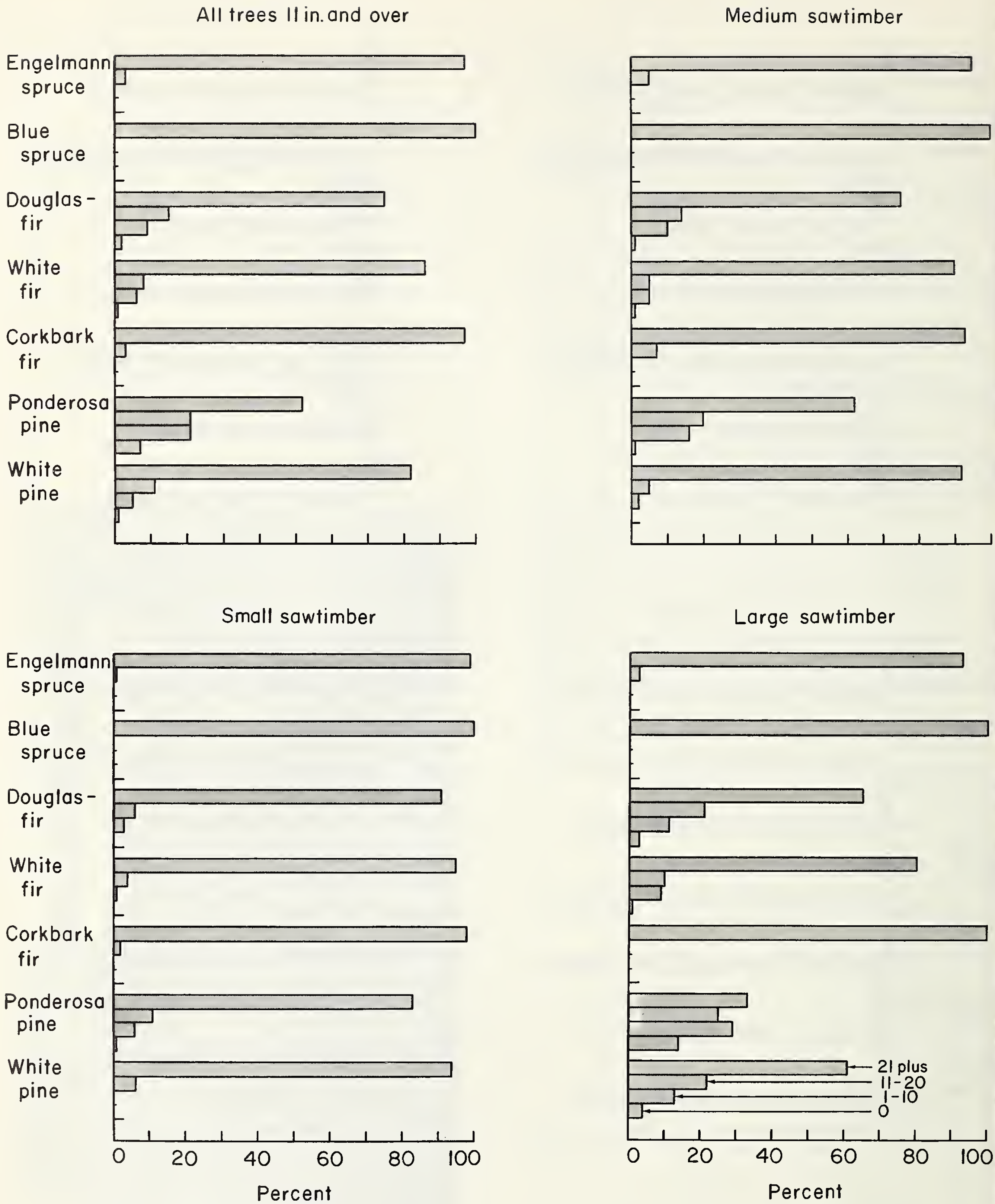

Figure 24.--Percentage of coniferous sawtimber trees with 0, 1 to 10, 11 to 20, and 21 or more knots in the butt 16-foot log.

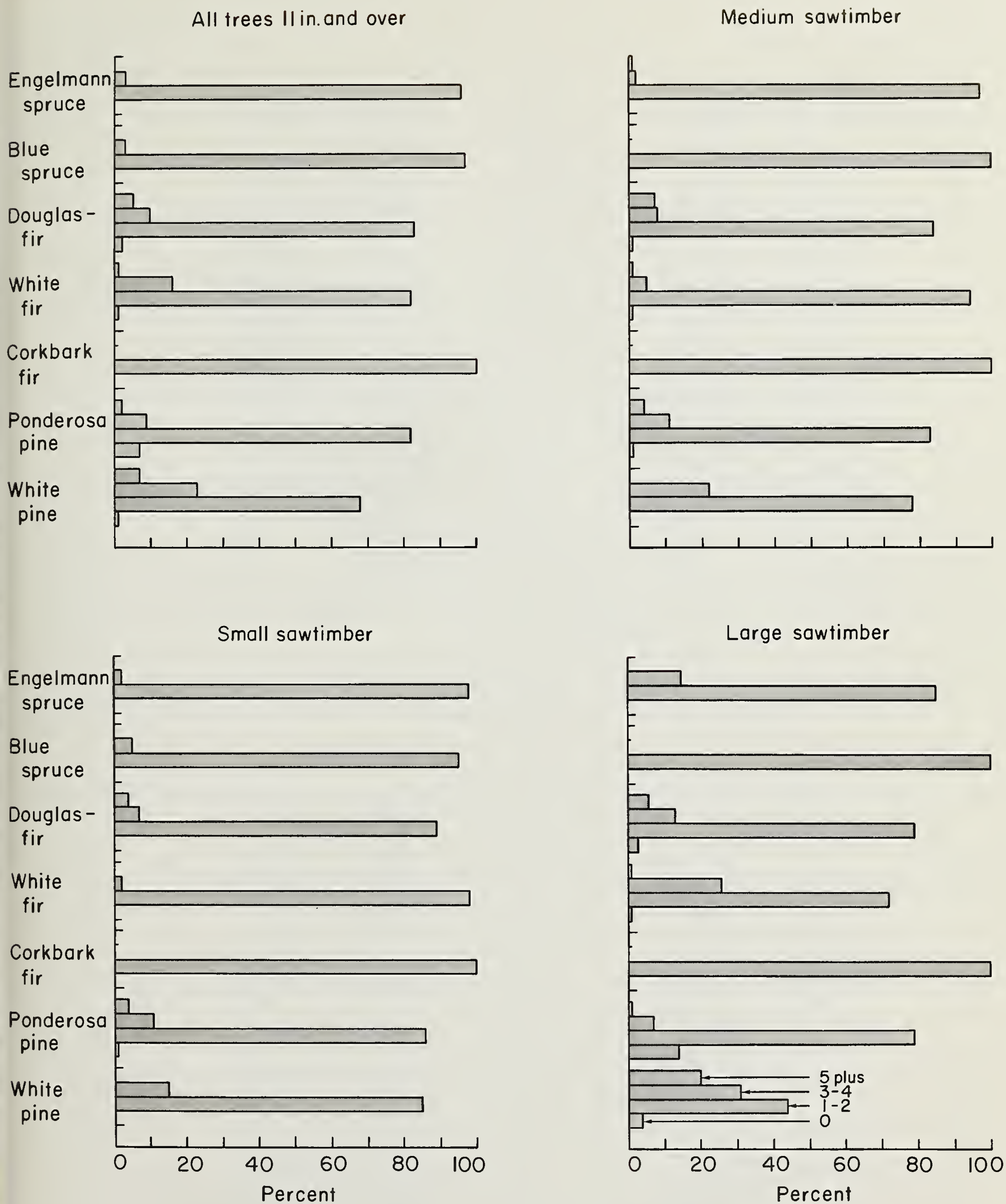

Figure 25.--Percentage of coniferous sawtimber stems in which the maximum knot size in the butt 16-foot log is 0, 1 to 2 inches, 3 to 4 inches, and 5 inches or more.

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1971. Frequency of stem features affecting quality in Arizona mixed conifers. USDA Forest Serv. Res. Pap. RM-70, 19 p., illus. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80521.

Frequency of occurrence of visual stem features that affect end-product quality and yield is presented by species and size-class. Data were obtained in an overstory inventory of 1,800 acres of mixed conifer forests in the Arizona White Mountains.

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