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Hardwood Log Defect Photographic Database Software and User's Guide

R. Edward Thomas

Abstract

Computer software and user's guide for Hardwood Log Defect Photographic Database. The database contains photographs and information on external hardwood log defects and the corresponding internal characteristics. This database allows users to search for specific defect types, sizes, and locations by tree species. For every defect, the database contains photos of the defect at 1-inch intervals as it penetrates the log and a brief summary of the defect's measurements and features. The defect data presented here was collected from three sites in West Virginia.

The Author

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Cover Photos

Top: Complication of photos of overgrown know from yellow-poplar log.
Photo by U.S. Forest Service.

Bottom: Log sorting in Princeton, WV. Photo by R. Edward Thomas, U.S. Forest Service.

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INTRODUCTION

This report contains the Hardwood Log Defect Photographic Database software and user's guide. It was developed to aid forestry personnel in identifying defects, determining the corresponding internal features, and understanding how these defects impact log grades and utility. The database consists mainly of yellow-poplar (*Liriodendron tulipifera* L.) and northern red oak (*Quercus rubra* L.) defect samples. However, the database also contains limited numbers of sugar maple (*Acer saccharum* L.), white oak (*Quercus alba* L.), black cherry (*Prunus serotina* L), and white ash (*Fraxinus americana* L.) samples.

The Hardwood Log Defect Photographic Database is composed of photos of surface indicators and corresponding internal defect features at 1-inch intervals inside a log. The photos of defects included in this database were collected as part of a research study that began in 2001. The study's goals are to develop methods of inferring internal defect attributes, such as size, shape, and penetration depth, based on surface indicator measurements of width, length, rise, and log section diameter at the defect.

Before a hardwood log is processed, it normally undergoes a subjective visual assessment by mill personnel. The differences between high and low quality logs are determined by defect type, frequency, size, and location. It is difficult to accurately and rapidly detect and measure defects, either mechanically or manually (Tian and Murphy 1997). For every surface indicator there is usually an associated internal defect. External defect indicators include bumps, splits, holes, and circular distortions in the bark pattern.

Bumps usually indicate overgrown knots, branches, or wounds. Some bumps have a cavity or hole in the middle, indicating that the overgrown material has decay or is rotten. Circular distortions, or rings around a central flattened area, indicate a branch that was overgrown years earlier. External defects progress from a pruned or broken branch to an overgrown knot characterized by a significant bump and then to a rotten knot or a distortion defect. For some classes of defects it is possible to accurately predict internal features based on external characteristics.

Previous studies have demonstrated that the use of external or internal defect data improves cutting strategies that optimize log recovery or yield, i.e., preserving the largest possible area of clear wood on a board face (Steele et al. 1994). The value of the lumber that can be recovered depends on the presence and location of defects. This is especially true for hardwood logs. In the production of hardwood lumber, boards are sawn to fixed thicknesses and random widths. The presence and placement of defects on the boards affect quality and value, so much attention is focused on log surface defects during processing.

During the past 50 years there has been a significant amount of research on the relationship between external hardwood log defect indicators and internal defect features. An excellent reference for studying the impact of the external hardwood log defects in this database on log quality, value, and grade yield is the "Guide to Hardwood Log Grading" (Rast et al. 1973). Several guides and pictorial reports have been published for various hardwood species illustrating external/internal defect features and their relationships (Marden et al. 1970; Rast et al. 1982, 1985 1988, 1989, 1990a, 1990b, 1990c). While these guides are useful references for providing insight on the external/internal relationship, only one or two examples of each defect type are provided for each species.

Previous studies have concentrated on a single species with specimen collection from a single site or from sites in close proximity. Of course, for a defect database to be valuable, it must reflect the natural range of the species. It should be expected that there will be variability in surface indicators when comparing samples from different geographic regions. Carpenter's[1] examination of surface indicators found that although the frequency and occurrence of surface indicators on the same species vary by region, the same internal features usually will be found for each external defect type. Thus, although certain defect types may be more prevalent in some regions, the internal manifestation of the defect will remain fairly consistent across regions.

Because growth rate varies among regions and sites, the rate of encapsulation for defects will also vary. Encapsulation is the process in which an external defect is grown over and absorbed into the log. However, the rate at which the encapsulation occurs and the degree to which the defect is occluded, or covered over by clear wood, is indicated in the bark pattern. Shigo and Larson (1969) discovered that the ratio of defect height to width indicates the depth of the defect with respect to the radius of the stem at the defect (Fig. 1). The faster the growth rate, the faster the defect is encapsulated, and thus the faster the bark distortion pattern changes. Wiemann[2] supports Shigo and reports that bark defect patterns are a good indicator of encapsulation depth as well as interior defect size and that growth rate mainly impacts how fast the ratio changes. In addition, the upper story of the tree is actively growing and defects located here are encapsulated more rapidly than in the lower story as the upper story diameter increases proportionately faster.[3]

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[1]Roswell D. Carpenter. The identification and appraisal of log defects in southern hardwoods from surface indicators. Unpublished information presented at annual meeting of Forest Products Research Society, Deep South Section; 1950 October 26; Memphis, TN.

[2]Mike Weimann, research forest products technologist, U.S. Forest Service, Forest Products Laboratory. Personal communication, February 11, 2002.

[3]Jeffrey Gove, research forester, U.S. Forest Service, Northern Research Station. 2002. Personal communication, February 14, 2002.

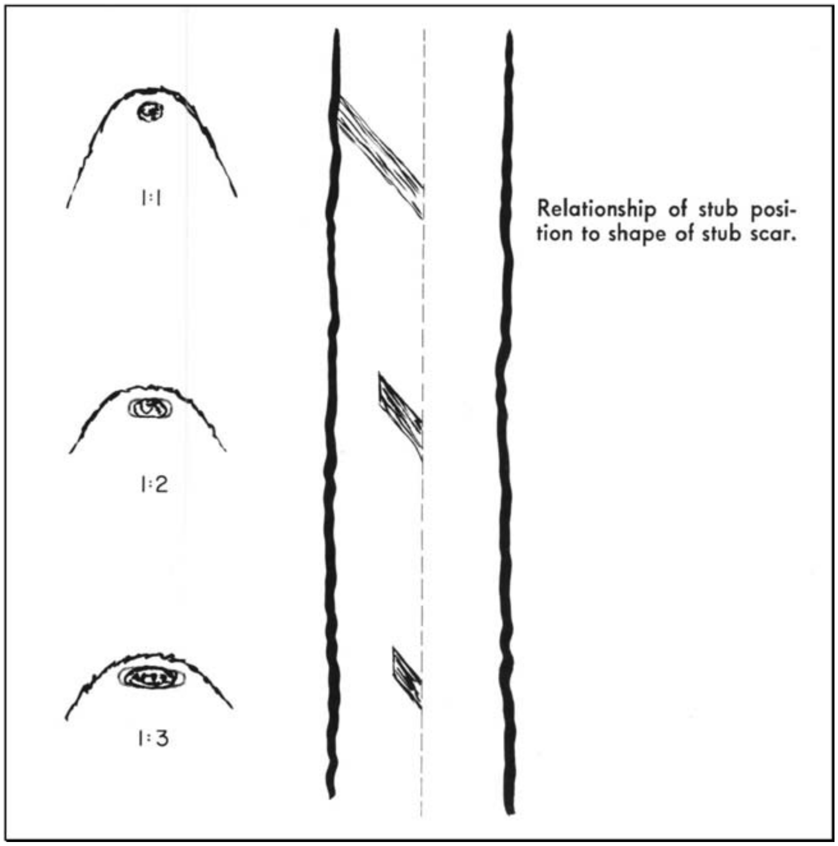

Figure 1.—Encapsulation depth and stub scar relationship ratio. Figure taken from Shigo and Larson (1969), page 16.

INSTALLING THE HARDWOOD LOG DEFECT DATABASE

The recommended computer requirements to run the Hardwood Log Defect Database (hereafter referred to as the defect database) are:

- PC with a 2.0 Ghz Pentium 4 processor or greater with a DVD drive
- Microsoft® Windows 2000, XP, or Microsoft Vista
- 1 GB of memory
- 4 GB of free hard drive space

The defect database is comprised of more than 10,000 photographs requiring more than four gigabytes of disk storage. You must first install the database on your computer before you can use it. To do this using Microsoft Windows, open "My Computer" then double click the icon for the drive containing the defect database DVD (Fig. 2). Next, find the file named "Setup.exe" and double click (Fig. 3). The defect database installer will begin expanding the database and preparing for the installation. (Fig. 4) will be displayed. When the install file is fully loaded the computer will display the main window for the database install application (Fig. 5).

At the main database install window (Fig. 5), you may also customize the location where the database will be installed. It is recommended that you create a link to the database application on your desktop. Select "Next" to continue the installation, or "Cancel" to halt the install.

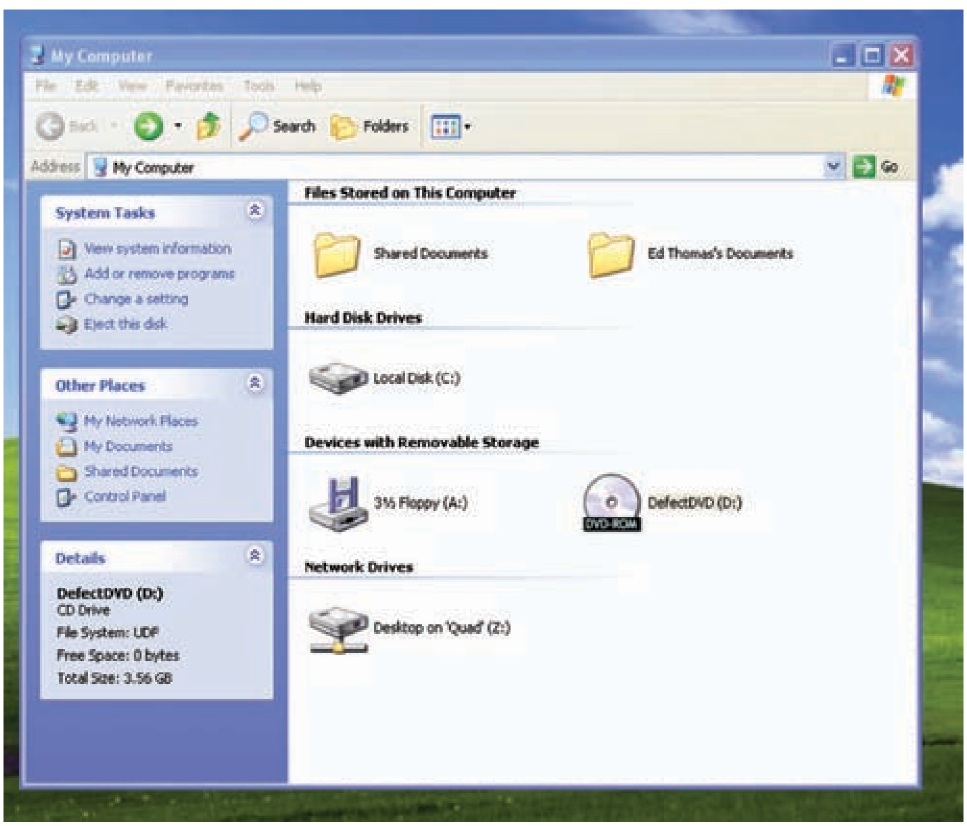

Figure 2.—Windows "My Computer" window showing the Hardwood Log Defect Database DVD as drive D.

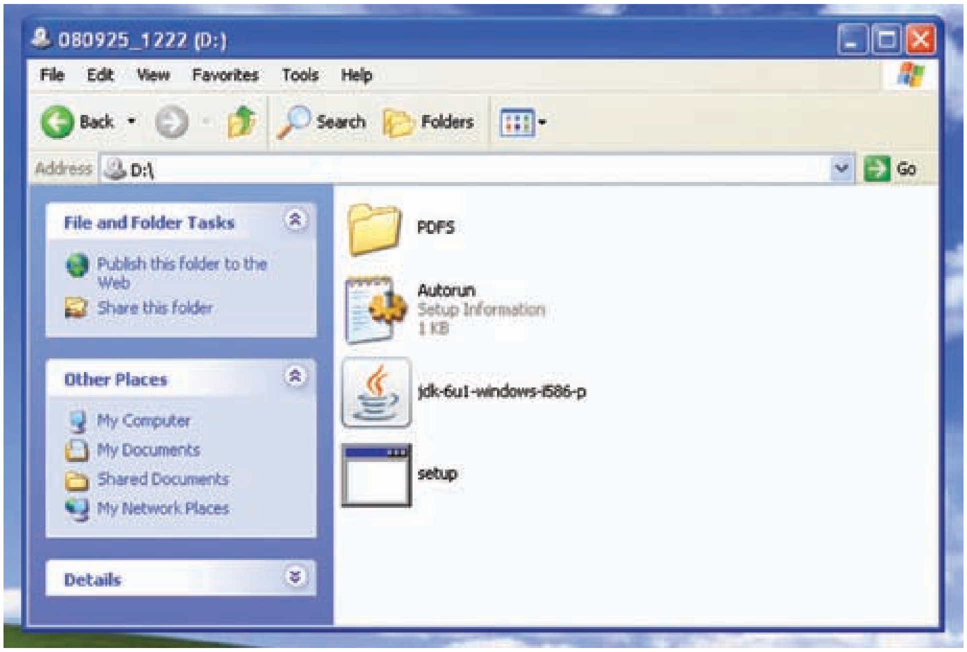

Figure 3.—File listing of the Hardwood Log Defect Database DVD.

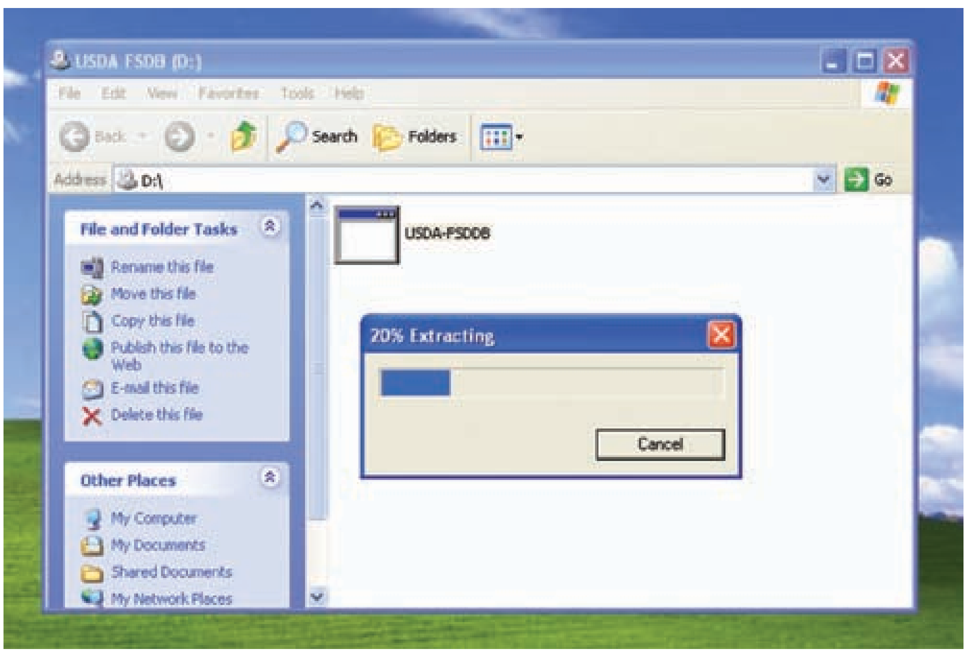

Figure 4.—Database extraction and preparing to install.

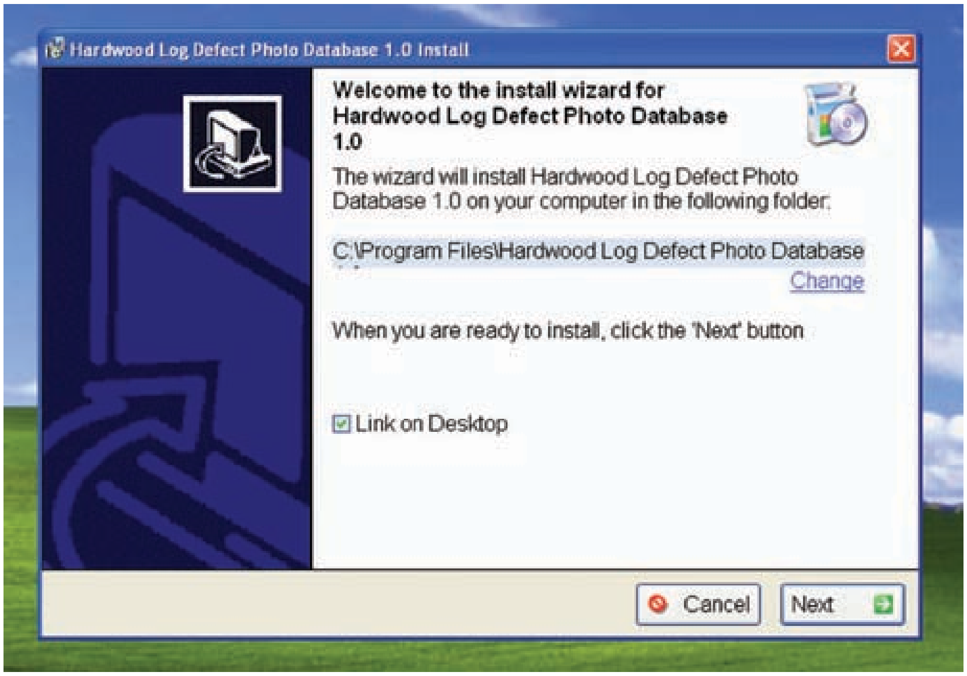

Figure 5.—Main database installation window.

Figure 6 displays the copyright and disclaimer notices for the defect database. To continue the installation, indicate your agreement and click next. At this point the installer will begin installing files to your hard drive (Fig. 7). When the installation is complete you will see the window shown in Figure 8. The installer creates links to the application on your desktop (Fig. 9) and in the "Start" menu (Fig. 10).

Figure 6.—Defect database notification and confirmation window.

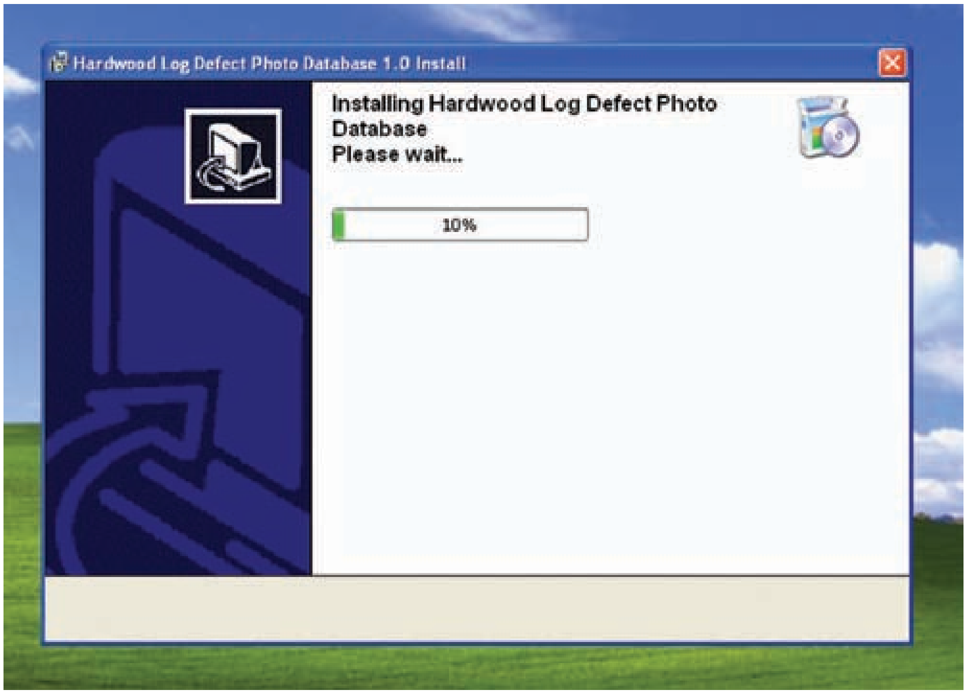

Figure 7.—Window showing install in progress.

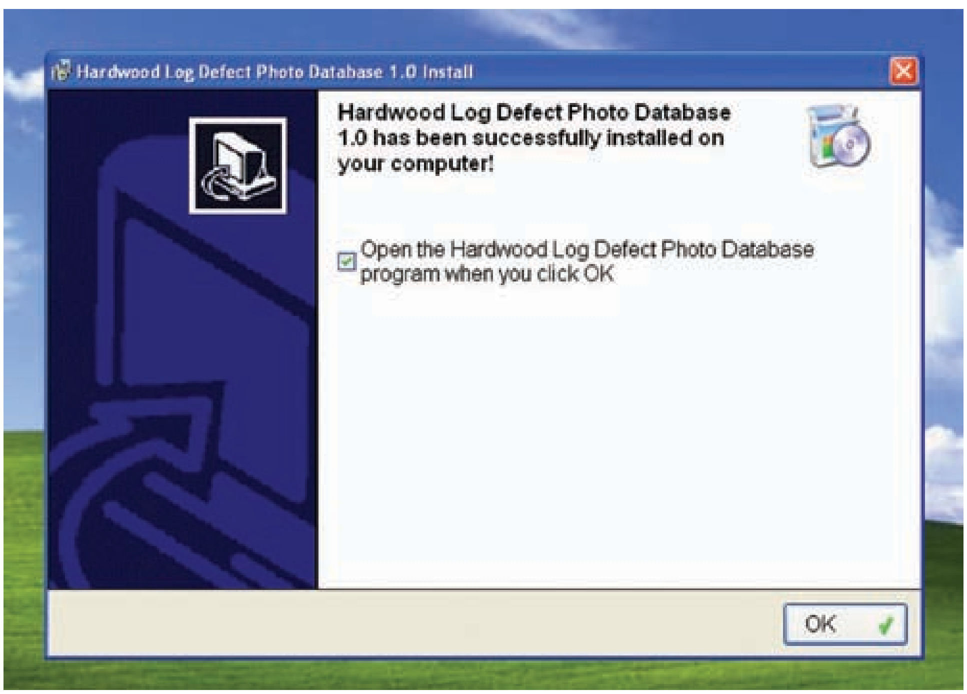

Figure 8.—Window shown when database install is complete.

Figure 9.—Windows XP Desktop showing the desktop shortcut icon for the log defect database.

Figure 10.—Windows “Start” menu item for the log defect database.

USING THE HARDWOOD LOG DEFECT DATABASE

To start the defect database application, click the desktop shortcut shown in Figure 9 or select the database application menu item using the start menu (Fig. 10). The database application will start and display the main application window (Fig 11). From this window choose which of the four sections of the defect database you want to explore: Advanced Search, Research Results Browser, Sample Site Information, or Research Study Information (Fig. 11). These options are described in detail below.

Figure 11.—Hardwood log defect database main window.

Advanced Search

Advanced Search is accessed from the main page (Fig. 11) and allows the user to search the defect database for defects with specific features. The "Search" tab is displayed on the window "Search and Browse Log Defects" (Fig. 12).

Using the "Search and Browse" window (Fig. 12), the various criteria can be used to locate photos and summaries for defects: tree species, defect type, size of defect, and location of defect. The search option buttons use pull-down menus to display the valid search criteria for each feature. Figure 13 shows the pull-down menu for defect type. Scroll through the menu items and select the item that you want. When you have configured all the search items, click the "Find Defects" button at the bottom of the screen (Figures 12 and 13). The program will begin searching for defects matching your criteria. When the search is complete, you will be switched automatically to the "View Matches" tab (Fig. 14).

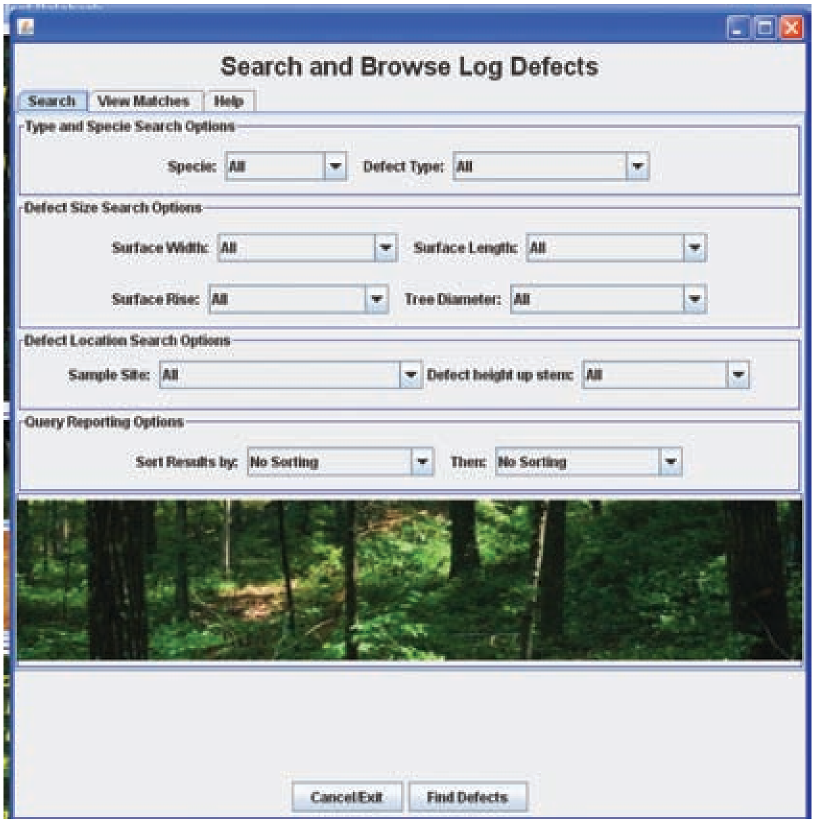

Figure 12.—Defect database “Search and Browse” main window.

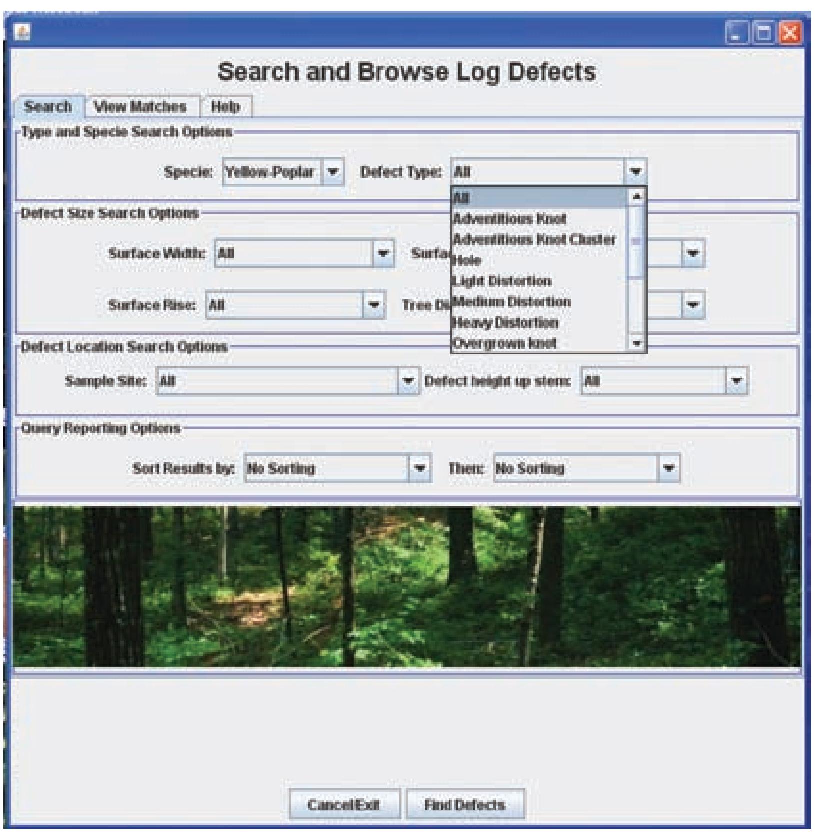

Figure 13.—Defect database “Search and Browse” window showing pull-down menu for defect type selection.

The “View Matches” window (Fig. 14) displays thumbnails and a brief summary that reports the species, harvest site, and surface indicator size of the defects. Near the top of the window, a status bar indicates how may defects were found by the search and which ones are currently being displayed. In the sample window, shown in Figure 14, 80 defects were found and the first eight are displayed.

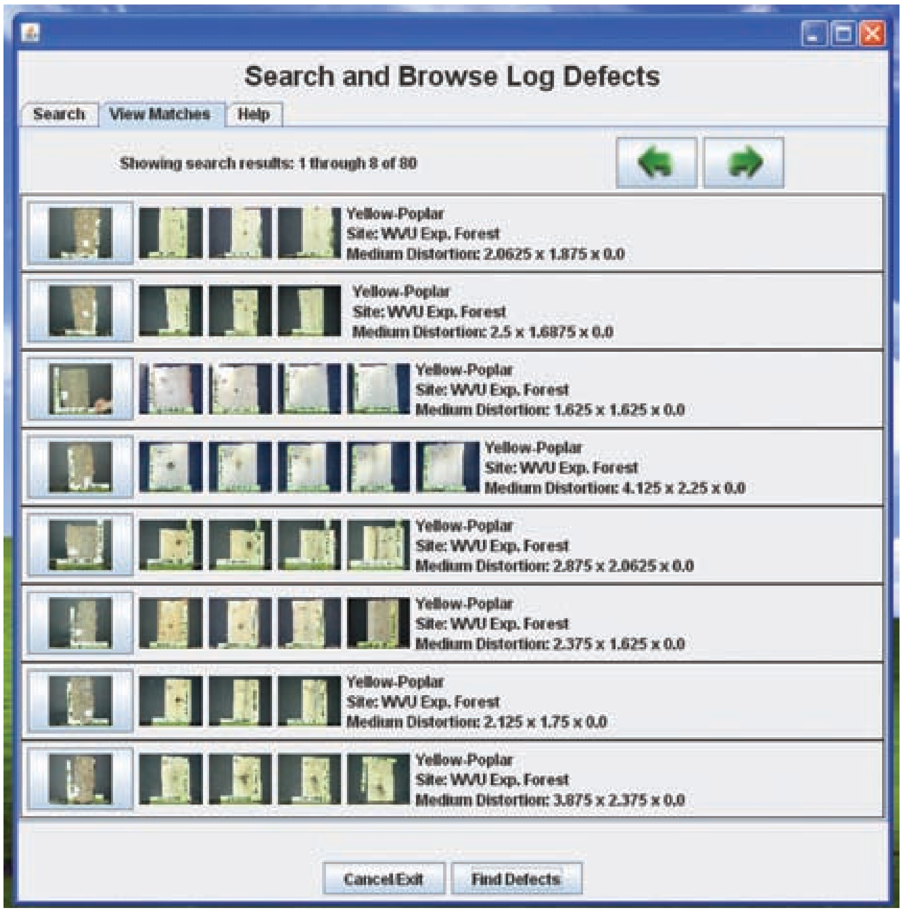

Figure 14.—Defects that match search criteria are displayed in a thumbnail view.

Clicking the thumbnail picture of a defect from "View Matches" window (Fig. 14) will open the "Defect Viewer" window (Fig. 15) for that defect. The "Defect Viewer" window shows a photo of the surface indicator. Click the tabs across the top of the window, labeled Slice 1, Slice 2, etc., to see photos of the internal features (Fig. 16) or a summary of the defects information (Fig. 17). The photos show the features at 1-inch intervals in the log.

Figure 15.—View of the surface indicator for a defect.

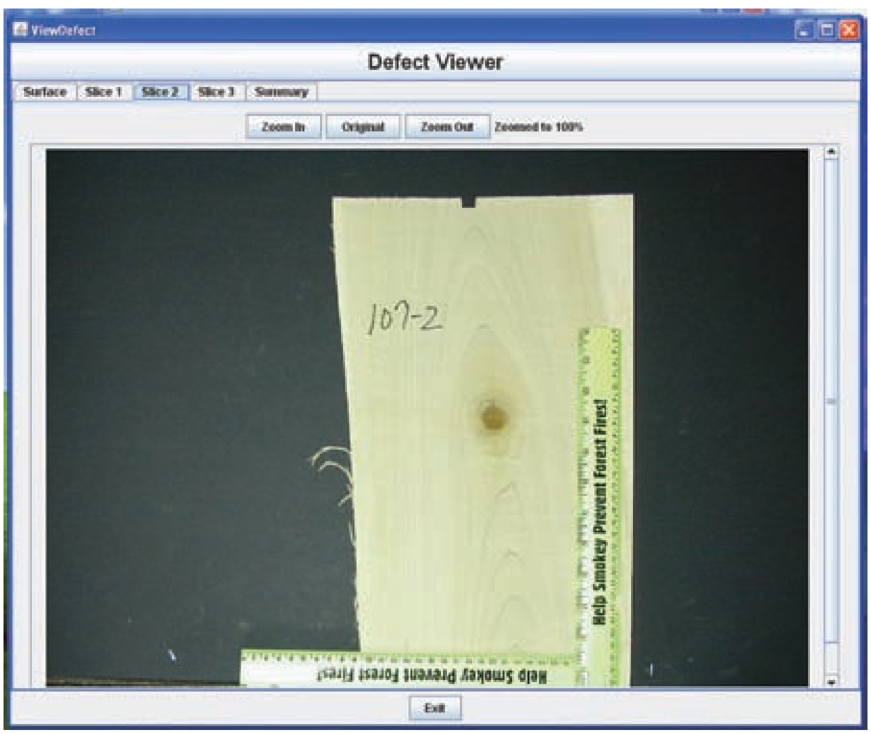

Figure 16.—Second internal 1-inch slice of the defect shown in Figure 15.

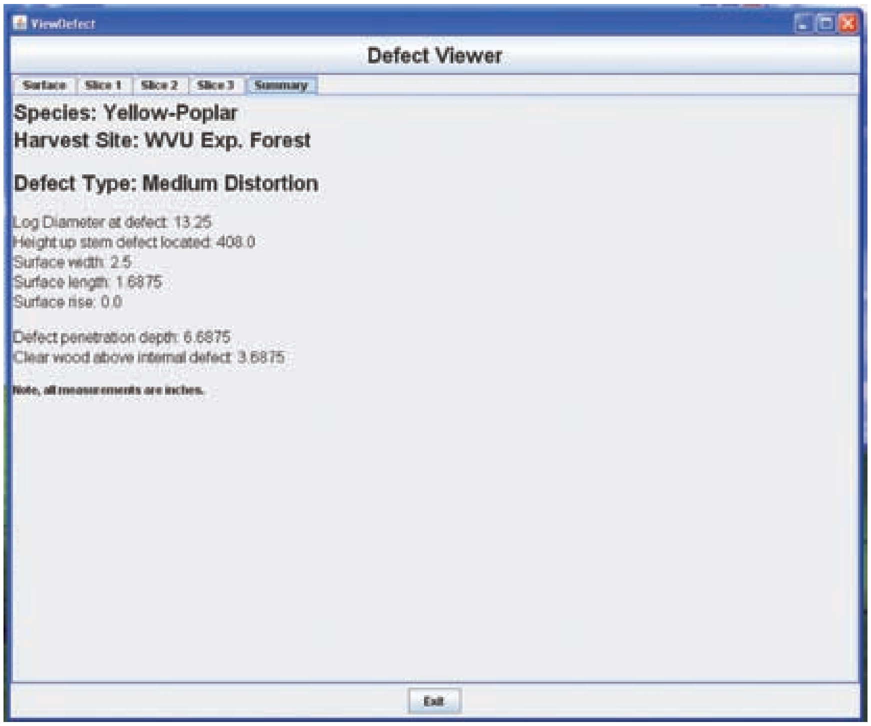

Figure 17.—Information summary of the defect shown in Figures 15 and 16.

Research Results Browser

The research "Results Browser" window (Fig. 18) presents citations and abstracts of published research concerning the detection, modeling, and characteristics of hardwood log defects. For publications that are available online, a link for downloading the publication will be shown below the abstract.

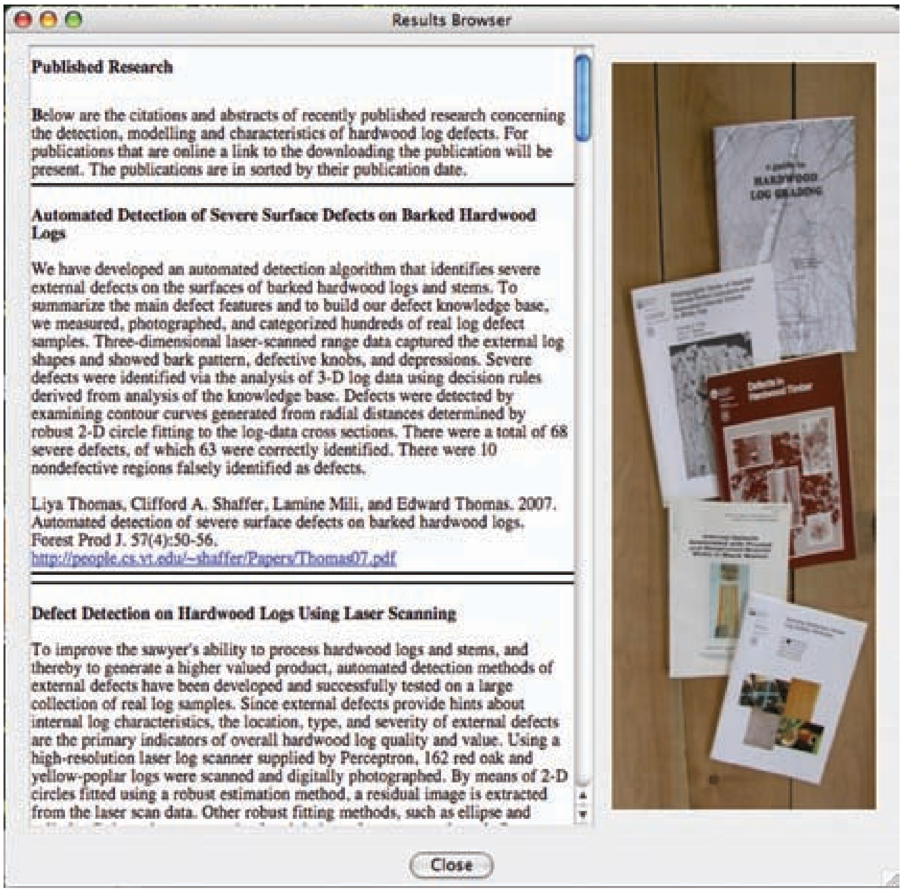

Figure 18.—Research "Results Browser" window.

Sample Site Information

The "Sample Site Information" window describes the harvest sites of the trees used in this study (Fig. 19). In addition, a brief summary of the types of defects as well as the number of defects in the database by species, type, and harvest site. This information is presented in greater detail in the Sample Collection section of this report.

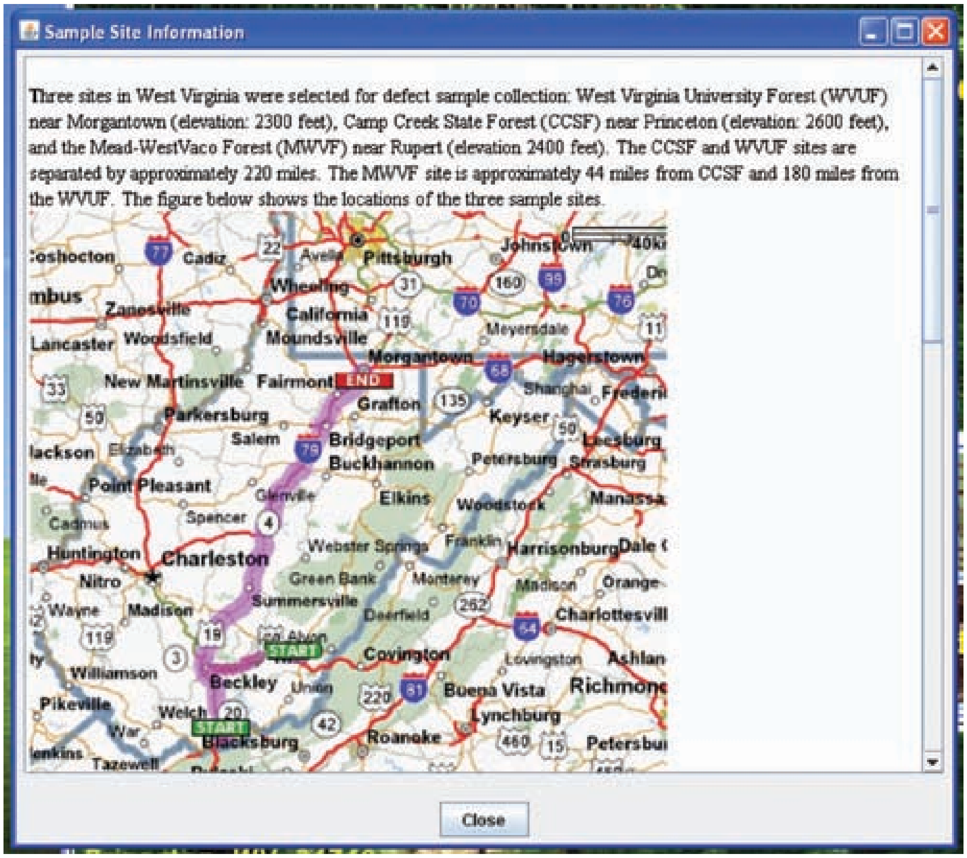

Figure 19.—"Sample Site Information" window showing location of sample sites.

Research Study Information

The “Research Study Information” window provides background about the hardwood defect database and the processing of the data samples (Fig. 20). This section also discusses historical photographic log defect photo guides and provides references to them. An expanded description of these and other log defect related publications can be seen by clicking the “Research Results” browser button from the main window (Fig. 11).

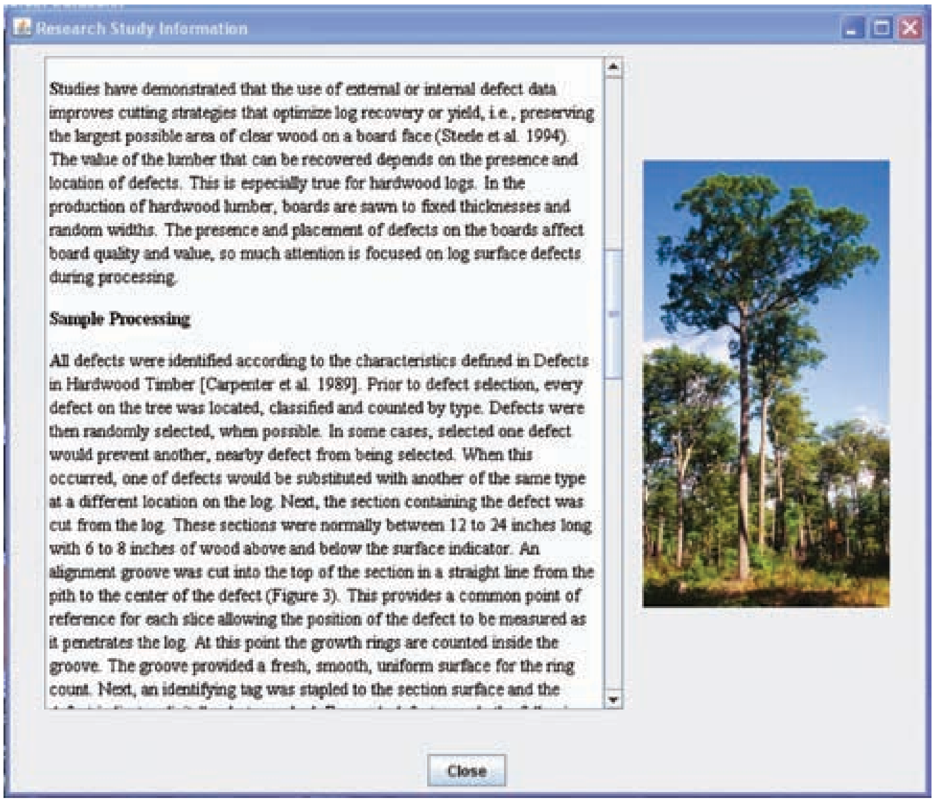

Figure 20.—“Research Study Information” window describing the processing of the wood samples.

SAMPLE COLLECTION

Three sites in West Virginia were selected for red oak and yellow-poplar defect sample collection: West Virginia University Forest (WVUF) near Morgantown (elevation: 2,300 feet), Camp Creek State Forest (CCSF) near Princeton (elevation: 2,600 feet), and the MeadWestvaco forest (MWVF) near Rupert (elevation 2,400 feet). The CCSF and WVUF sites are about 220 miles apart. The MWVF site is approximately 44 miles from CCSF and 180 miles from the WVUF. Figure 21 shows the locations of the sample sites.

Samples were obtained from 33 yellow-poplar trees randomly selected from the CCSF and WVUF sites. Similarly, 33 red oak trees were randomly selected from the WVUF and MWVF sites to provide samples for this study. A total of 132 trees were harvested and dissected for the red oak and yellow-poplar samples. In addition, approximately 20 trees were sampled for the remaining species in the database.

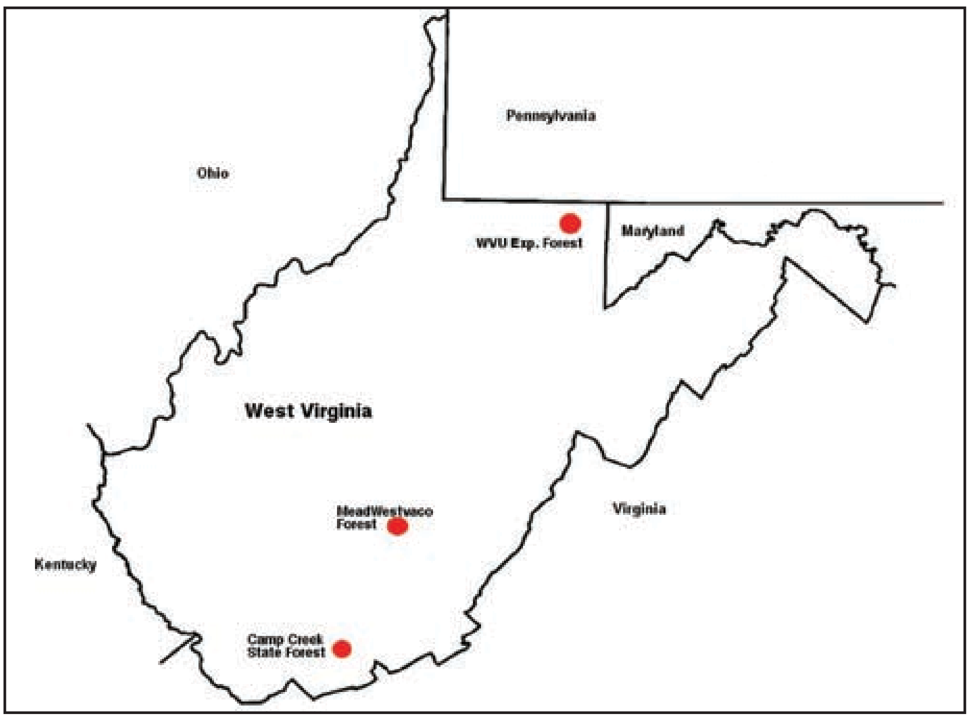

Figure 21.—Wood sample collection sites in West Virginia.

Table 1.—Numbers of defects by species, sample site, and defect type

Defect type	Yellow-Poplar			Red Oak			Total for both species
	WVU Experimental Forest	Camp Creek State Forest	Total	WVU Experimental Forest	Mead Westvaco Forest	Total	
Adventitious knot	76	76	152	54	51	105	257
Adventitious knot cluster	68	59	127	27	47	74	201
Ant damage	0	0	0	0	8	8	8
Bump	1	3	4	0	4	4	8
Heavy distortion	58	74	132	53	46	99	231
Hole	0	0	0	0	2	2	2
Light distortion	6	96	102	2	37	39	141
Medium distortion	80	86	166	70	62	132	298
Overgrown knot	79	89	168	43	115	158	326
Overgrown knot cluster	1	20	21	0	48	48	69
Sound knot	46	47	93	19	36	55	148
Sound knot cluster	0	2	2	1	12	13	15
Unsound knot	33	7	40	30	31	61	101
Unsound knot cluster	0	0	0	0	12	12	12
Wound	13	13	26	0	43	43	69
Total all types	461	572	1033	299	554	853	1886

The number of defects obtained from each site, by defect type for the red oak and yellow-poplar samples are shown in Table 1. Approximately equal numbers of each type of defect on yellow-poplar were obtained from each site with two exceptions: light distortion (LD) and unsound knot (UK) defects. We did not collect LD defects from the WVUF. UK defects occurred in much fewer numbers at CCSF than at WVUF.

SAMPLE PROCESSING

All defects were identified according to the characteristics defined in Defects in Hardwood Timber (Carpenter et al. 1989). Prior to defect selection, every defect on the tree was located, classified, and counted by type. Defects then were selected randomly. In some cases, selecting one defect would prevent another, nearby defect from being selected. When this occurred, one of the defects would be substituted with another of the same type at a different location on the log. Next, the section containing the defect was cut from the log. These sections were between 12 to 24 inches long with 6 to 8 inches of wood above and below the surface defect indicator. An alignment groove was cut into the top of the section in a straight line from the pith to the center of the defect (Fig. 22). This provides a common point of reference for each slice allowing the position of the defect to be measured as it penetrates the log. At this point the growth rings are counted inside the groove. The groove provided a fresh, smooth, uniform surface for the ring count. Next, an identifying tag was stapled to the section surface and the defect indicator photographed. For each defect sample, the following information was recorded: surface indicator width, length and rise; defect type; diameter inside bark; growth rate (rings per inch); bark thickness; height above ground; and distance from defect center to bottom center of alignment groove. All measurements were recorded to the nearest 1/16 inch, with the exception of height above ground, which was measured to the nearest quarter-inch.

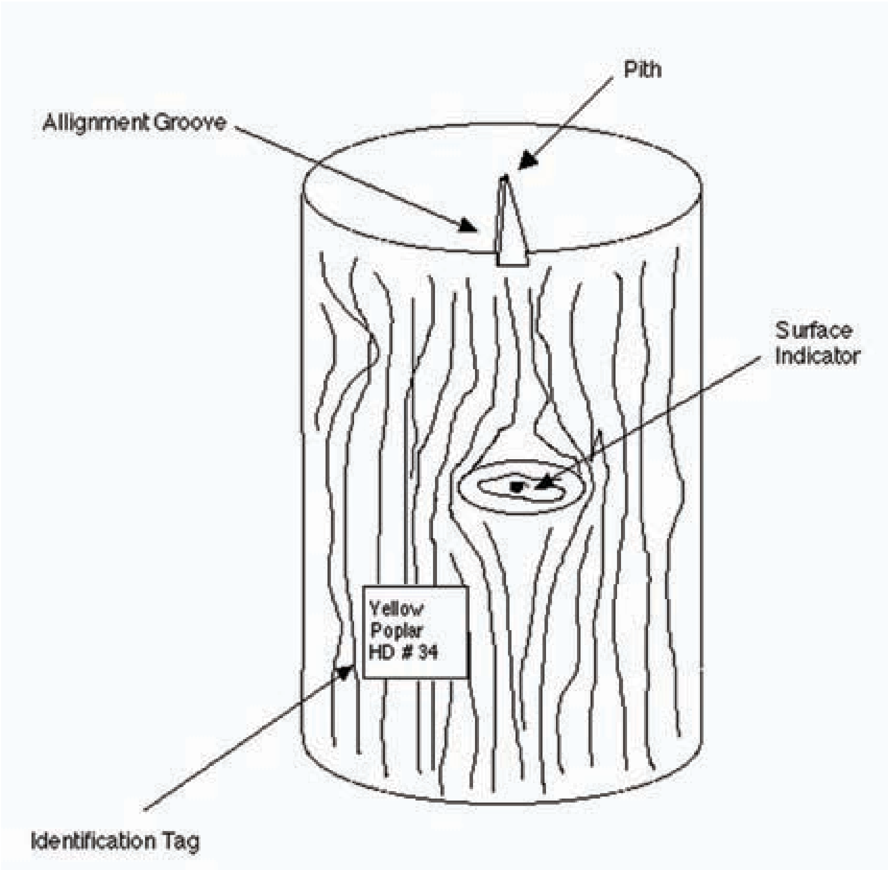

Figure 22.—Illustration of routed defect alignment groove with respect to pith and external indicator.

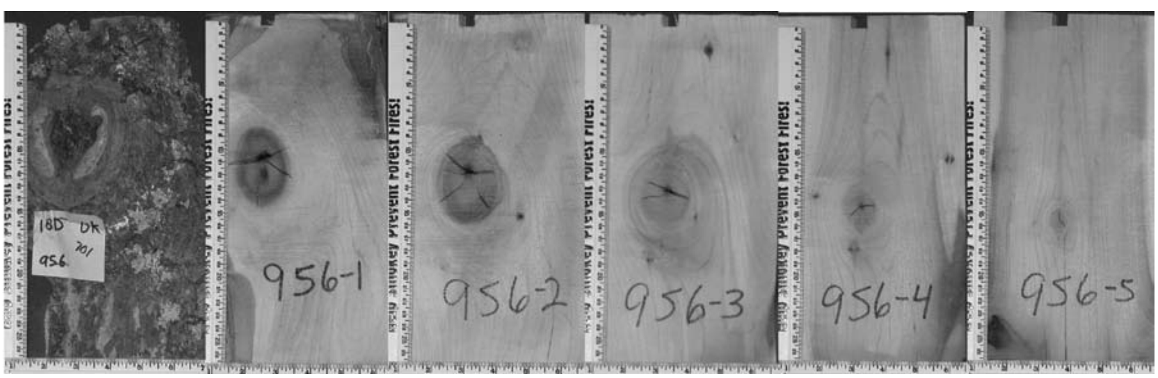

Figure 23.—Defect sample after sawing showing labeled surface indicator and the series of 1-inch slabs.

After the defect section data was recorded, the section was sawn into 1-inch-thick slices. The slices were sawn so that the defect under consideration is perpendicular to the saw lines. A sawn defect sample is shown in Figure 23. The slices show the internal features of the defect as well as the change in shape, position, and characteristics it experiences before it terminates (usually at the pith.)

SUMMARY

I have assembled a database containing photos of representative samples of log defects commonly found on hardwood trees in the Central Appalachian forest. Although the population percentage of some defect types will vary by region, altitude, and site quality, the surface indicator usually will remain constant. However, in better sites the surface indicator will grow over more quickly, encapsulating the internal feature faster and deeper compared to poorer sites. However, even with site variability, the internal defect manifestation will remain relatively constant (Thomas 2008).

It is planned that this database will be continually expanded as defect collection continues for the defect modeling and internal prediction study.

ACKNOWLEDGMENTS

The author would like to acknowledge the assistance of Al Waldron and the West Virginia Division of Forestry for assistance in sample collection on the Camp Creek State Forest. I would also like to thank Mead Westvaco and West Virginia University for their assistance with sample collection. A special thanks is in order to Jeff Palmer for his review of the database and help with setting up the installation program.

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Computer software and user's guide for Hardwood Log Defect Photographic Database. The database contains photographs and information on external hardwood log defects and the corresponding internal characteristics. This database allows users to search for specific defect types, sizes, and locations by tree species. For every defect, the database contains photos of the defect at 1-inch intervals as it penetrates the log and a brief summary of the defect's measurements and features. The defect data presented here was collected from three sites in West Virginia.

KEY WORDS: yellow-poplar, red oak, internal, external, features

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