FIRE SCAR DATES

FROM

WALNUT CANYON NATIONAL MONUMENT, ARIZONA

Final Report to

National Park Service
Southern Arizona Group Office
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INTRODUCTION

Eighteen samples of fire-scarred ponderosa pine (*Pinus ponderosa* Laws.) from Walnut Canyon National Monument (Fig. 1) were delivered to the Laboratory of Tree-Ring Research in September 1989. These partial cross section samples were prepared and dendrochronologically dated. This report contains a brief description of the methods used in this project, and a detailed listing of the dating results. Some preliminary observations of the character of the fire history are offered.

METHODS

The samples delivered to the Tree-Ring Lab had already been surfaced and the rings counted by K. M. Davis of the National Park Service. All samples were resectioned on a band saw to obtain fresh surfaces below the original surface observed by Davis. The new sections were sanded with belt sanders (belt grits 80 to 400). Crossdating of all annual rings was accomplished using the skeleton plot technique (Stokes and Smiley 1968, Swetnam et al. 1985). A recently compiled tree-ring width chronology from the Walnut Canyon area (Graybill and Rose 1989) was used as a crossdating control.

The rings and fire scars of many of the samples were difficult to observe because of the presence of numerous beetle galleries (tunnels) caused by the boring activities of the larvae (family Buprestidae ?). These larvae feed primarily on the resinous heartwood and the galleries cut across ring boundaries and fire scars. Careful tracing of individual rings and ring patterns on both sides of the galleries usually allowed accurate dating of the fire scars.

Fire scars were dated by observing their position within dated annual rings. The relative position of fire scars within annual rings (i.e., earlywood, latewood, dormant, etc.) were also noted where possible. Fire scar positions may be used to infer seasonal timing of past fires (Swetnam et al. 1989). All fire dates and fire-scar positions for individual specimens are listed in the Appendix in Table 1. The ring counted fire-scar dates marked on the original surfaces of the specimens delivered to the Tree-Ring Lab are also noted in Table 1. A description of the coding system precedes the tables.

RESULTS

The fire-scar dates are illustrated in a master fire chronology chart (Fig. 2). Specimens are ordered by groups occurring on the north or south sides of the canyon (Fig. 1). Tree numbers 20, 21, 3, 5, 7, 24, 25, 26, 11, 12, and 14 were on the north side, while 6, 8, 34, 35, 23, 31, and 32 were on the south side. The scar index (Fig. 2) is the percentage of fire-scar susceptible specimens scarred per year. A fire-scar susceptible tree is a tree that has already been scarred at least once by fire (Romme 1980). This index is a useful measure of the combined fire occurrence record for a site, and may be considered a relative measure of area burned per year. However, the values are inflated at low sample depths. For example, before 1680 when only one or two trees were recording fire scars the index is useful only as an indicator of timing and not relative area burned.

Scar indices for the two sides of the canyon and all samples combined are shown in Figure 3. Major fire years when many of the trees incurred a scar are labeled (years 1700 and 1727 were recorded only on the north side). Table 2 in the Appendix lists fire scar indices for all fire years on north, south, and both sides of the canyon.

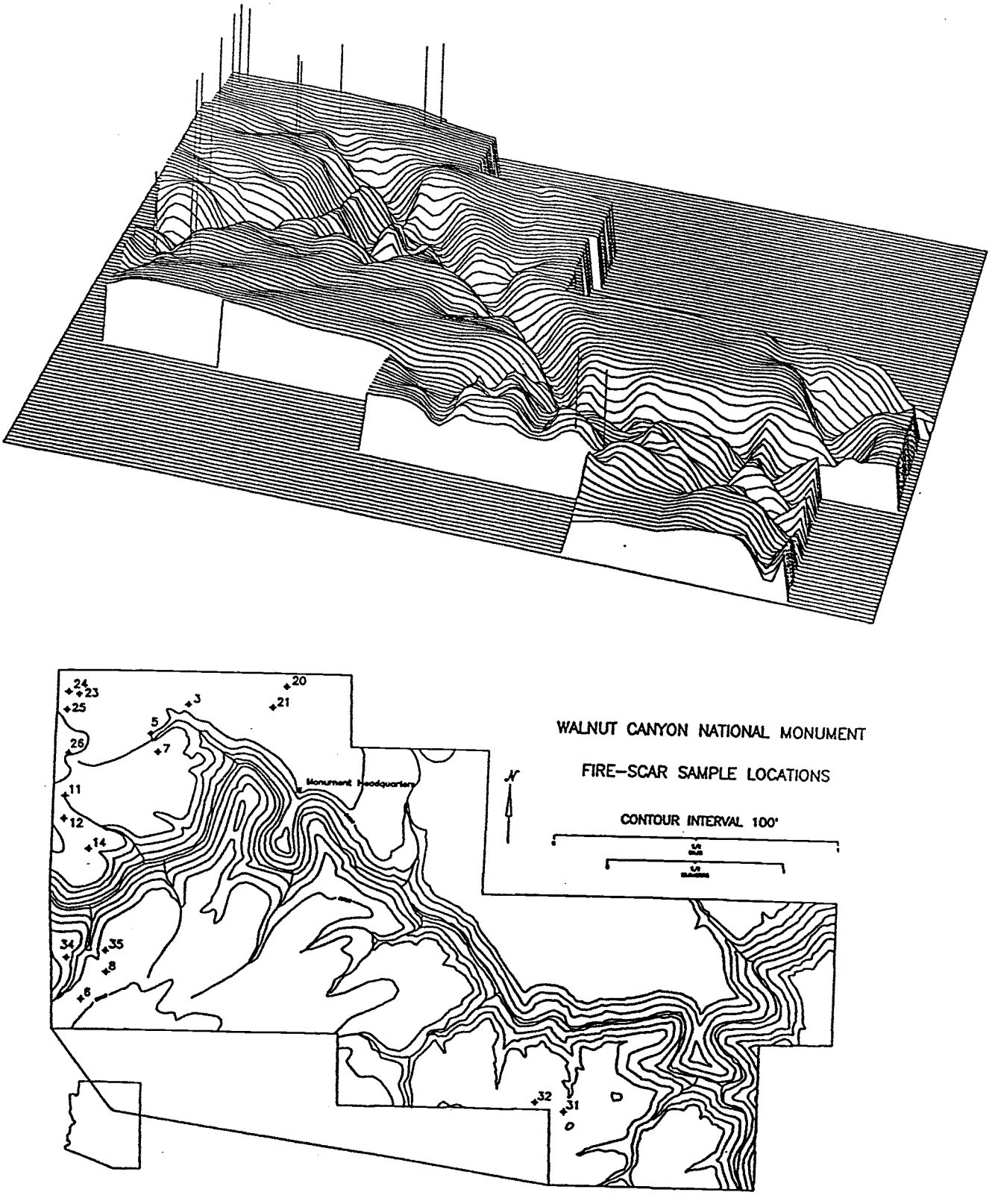

Figure 1. Walnut Canyon National Monument, Arizona and locations of fire scar samples.

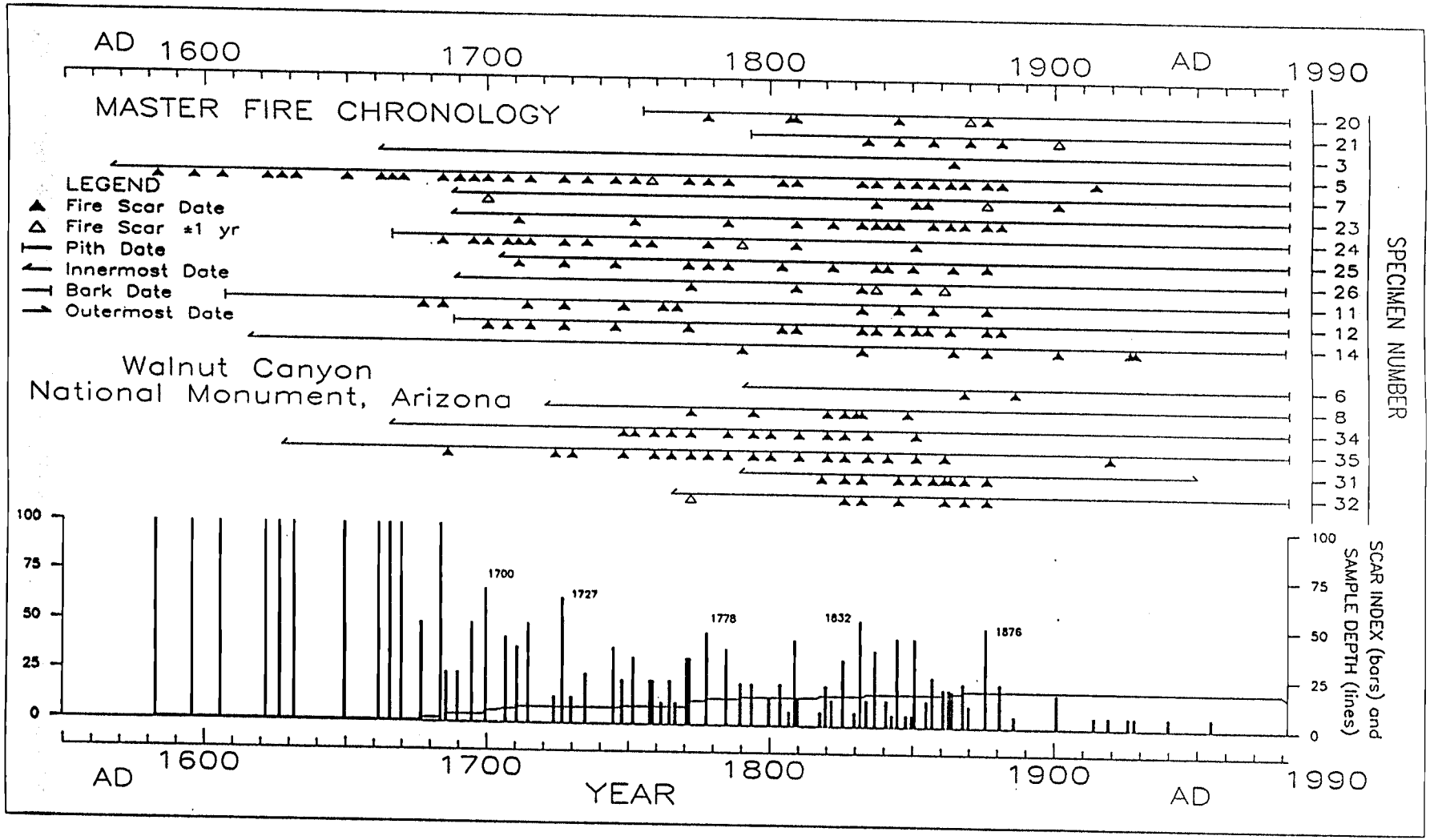

Figure 2. Master fire chronology for Walnut Canyon National Monument, Arizona.

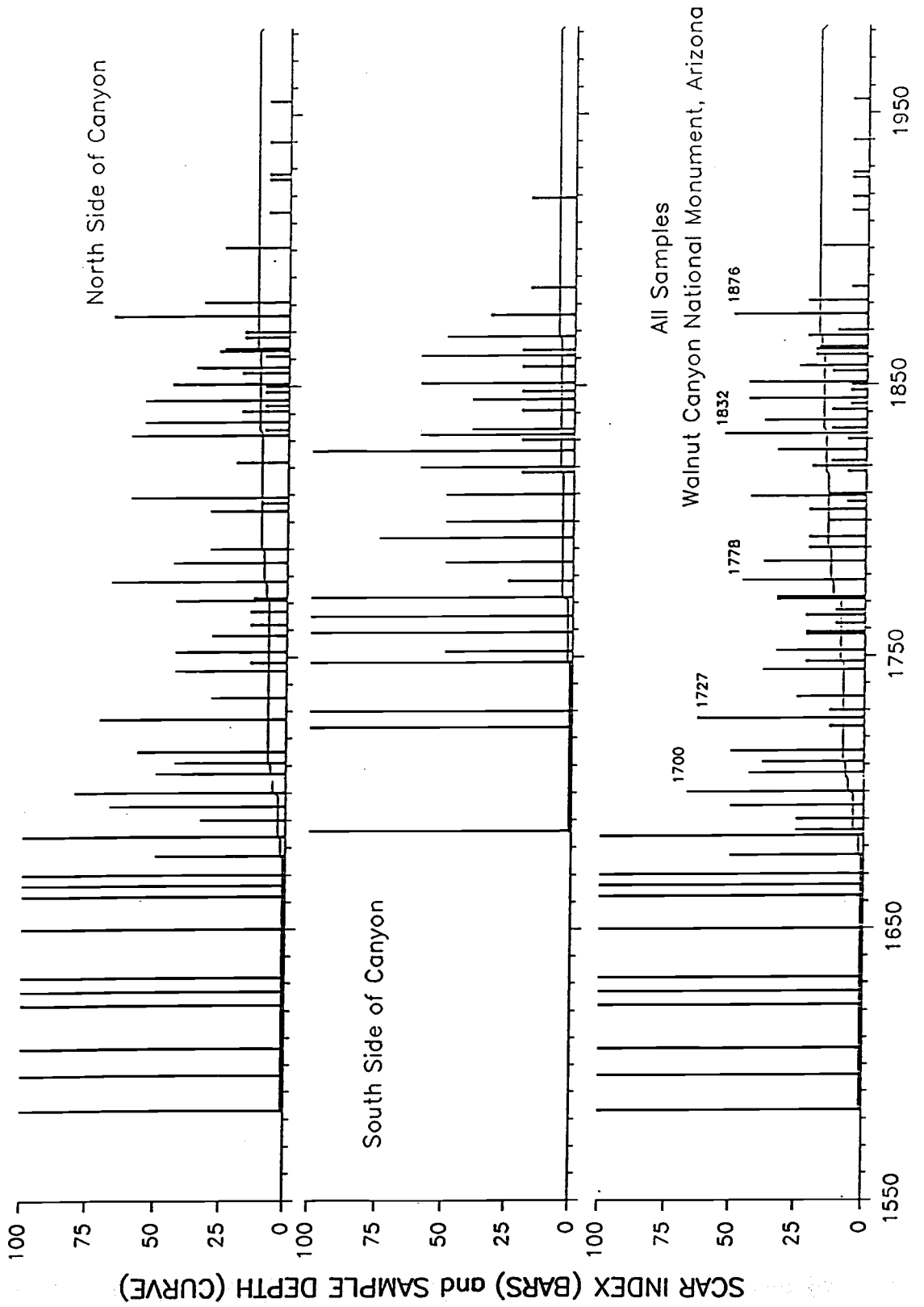

Figure 3. Fire scar indices for north, south, and both sides of Walnut Canyon.

In general, the fire regime at Walnut Canyon appears to be similar to others that have been documented in northern Arizona ponderosa pine forests (Dieterich 1980a, 1980b, Savage 1989, Dieterich and Hibbert 1990). Fires apparently occurred at short intervals (Table 2). Numerous two-year intervals were recorded among the north and south groups. Three one-year intervals were recorded on the north side (all of these one-year intervals were recorded by different trees). Such short intervals suggest that fine fuels, such as grasses and pine needles, were especially important in this fire regime. Fire spread patterns were probably patchy since there were only a few years when fires were common to most trees (five fire years from 1700 to 1876 have index values greater than 50%). In contrast, ponderosa pine forests of central and southern Arizona and southwestern New Mexico usually burned at longer intervals (approximately 5 to 10 years) and fires were often widespread (i.e., fire-scar chronologies often show a striking synchroneity of fire dates among sample trees) (Swetnam 1990).

As observed in nearly all southwestern fire-scar chronologies (with the exception of one site in Sonora, Mexico [Swetnam 1990]), the episodic surface fire regime at Walnut Canyon was essentially eliminated around 1900. The last large fire year was 1876, which also was the founding date of the nearby city of Flagstaff. It is likely that removal of fine grassy fuels by livestock grazing was initially and primarily responsible for elimination of the natural episodic fire regime.

Although the pre-1900 fire regime was relatively patchy, some fires did occur on both north and south sides of Walnut Canyon in the same year. With the current sample it is not possible to determine if these represent fires that spread from one side to the other, or were fires that ignited separately. Examination of the position of fire scars for years of fire common to both sides may provide some insight on whether these fire scars were incurred during the same part of the growing season (or dormant season). Additional samples (if possible) from the canyon bottom as well as from the rim areas might help answer this question. A recent fire-scar study at Bandelier National Monument in northern New Mexico (Frijoles Canyon watershed) revealed that many fire years were common to the riparian canyon bottoms and the surrounding ponderosa pine and mixed-conifer uplands (Allen 1989).

CONCLUSIONS

The fire-scar chronology from Walnut Canyon reveals that before 1900 surface fires burned at relatively short intervals. The general non-synchronous timing of fire dates among sampled trees, with the exception of a few dates, also indicates that fires were probably patchy. Since fire scars are readily formed on previously scarred pine trees, even when the fire is of very low intensity, the inferred patchiness probably represents spatially discontinuous fire spread patterns within the ponderosa pine stands of this area.

Additional sampling of fire scarred material in the monument is needed to answer other questions regarding timing of fires on the two sides of the canyon, within the canyon bottom, and within adjacent piñon-juniper stands.

APPENDIX

Codes for table 1:

SITE DATA

I) **Tree** - Numeric value for individual trees from a particular location (either a site or group within a site). Use values from 0 to 99 with decimal values for trees from which more than one sample was taken.

II) **Group** - Numeric value used to designate a particular site or a subset of trees within a site. Allows analyses to be run on these groups as separate areas. Use values from 0 to 99.

TREE DATA

III) **Inside Date** - Date of innermost ring dated on the sample (more rings may be present but undatable).

IV) **Inside Date Type** - Innermost rings are designated as; 1) pith date (P), 2) innermost ring present on sample (I), 3) innermost dateable ring though more rings are present (+).

V) **Outside Date** - Date of outermost ring dated on the sample (more rings may be present but undatable).

VI) **Outside Date Type** - Outermost rings are designated as; 1) bark date (B), 2) last ring present on sample if not bark date (L), 3) last dateable ring on sample though more rings may be present (+).

FIRE DATE DATA

VII) **Fire Date** - Date at which fire occurred. This may be a date based on a fire-scar (best evidence) or based on some other proxy evidence such as occurrence of a release/suppression and presence of injured tissue (resin ducts). When a fire date is based on a release/suppression the fire is usually assumed to have occurred 1 year prior to the release/suppression.

VIII) **Scar Present** - Note whether a scar occurred at the fire date given above with an 'X'.

IX) **Questions** - [Questionable date or data.] Numeric code values (0 to 9) used to indicate additional information on fire dates. Values are arranged in hierarchical order of importance. These are only to be used when an uncertainty exists about the fire date; otherwise no value is given.

0 - Unquestionable fire date: Fire date for which no questions exist (This is the default value automatically entered into field with current value being replaced by a 0 if no new value is typed into space).

1 - Dormant season scars: Fire date based on fire scar is questionable because of dormant/latewood problem (scar occurring at ring boundary, date may be one year off). Alternative date must be given in comments. As a convention, dormant scars are assigned to the date of adjacent earlywood cells in southwestern material, and to date of adjacent latewood in giant sequoia. This convention may not be justifiable for material from other geographical areas.

2 - Uncertain fire-scar date: Fire date based on fire scar is questionable for reasons other than noted in option (1). Reason why date is questioned given in comments.

9 - A value of 9 is given for any questions not fitting into the above categories with an explanation about question made in comments.

X) Position of Scar - [Relative position of fire-scar (lesion) within a dated ring.] Scar positions are indicated using the following general terminology (specific criteria given below); position unknown (U), occurrence in latewood (L), during the dormant season (D), and in the earlywood (E) with the latter subdivided as early in the earlywood (EE), mid earlywood (ME), and late in earlywood (LE).

U - Position of a scar within an annual ring could not be determined though the scar was datable. This could be due to decayed wood, insect damage, small rings in scar area, or other problems associated with crossdating ring patterns.

D - Scars occurring at latewood/earlywood boundary between two years of ring growth. This could mean the fire occurred in the year of latewood (previous year) but after tree growth had ceased, or in the year of the earlywood, but prior to initiation of ring growth at that site and tree. By convention dates given for dormant position scars are assigned to the year of adjacent earlywood for the "Southwest" and to year of latewood for "Sequoia" samples.

L - Scars occurring within latewood type cells of the ring but prior to cessation of a years growth.

E - Scars occurring anywhere within the earlywood of a ring. This classification is usually given when a further subdivision of scar position within earlywood (i.e., EE, ME, LE) cannot be determined. Scars occurring within false rings (diffuse latewood type bands) are also defined as earlywood scars.

EE - Scars occurring within approximately the first third of the earlywood portion of ring.

ME - Scars occurring within approximately the middle third of earlywood.

LE - Scars occurring in approximately the last third of earlywood (just before the appearance of latewood cells).

XI) **Clarity of Scar** - Categorization of how clearly the scar appears with particular reference to position of scar. The following alpha values may be used;

U - Clarity unknown.
E - Scar and position of scar very clear, photographic quality -excellent.
G - Scar and position of scar clear, no doubts - good.
F - Date discernable but quality of observation only fair - fair.
P - Scar and position of scarring difficult to determine, doubt about season - poor.
B - Ability to determine position of scaring very difficult or impossible - bad.

XII) **Unspecified Injury** - An 'X' is given in this field if unspecified injuries are noted which relate to the fire date given. These may occur 1 or 2 years after a fire so date of occurrence should be noted in comments.

XIII) **Comments** - A 30 character space in which any comments about the fire date or related information can be made. Because of its limited size abbreviations may be necessary.

Abbreviations used:

KD	- Kathy Davis
BC	- Initials of Other Fire Scar Analyst
NN	- Not Noted by KD or BC
X-S OR X-SECT	- Cross Section
SUPP	- Suppression
INJ	- Injury
ORIG	- Original
REACT WD	- Reaction Wood
EXTR	- Extreme
DK CLL LINE	- Dark Cell Line
MISS	- Missing
P	- Poor
DIST	- Distortion
LOB GRTH	- Lobate Growth
RUPT CLLS	- Ruptured Cells
BG	- Beetle Galleries
CHAR	- Charcoal

Table 1.

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
20	1	1755 P	1982 B	1778	X	0	G	LE		KD=1796
				1807	X	0	P	ME		KD=1805 OR 1807(?)
				1809	X	0	P	LE		KD=1805 OR 1807(?)
				1845	X	0	P	EE		KD=1856
				1870	X	2	B	U ?		RING DIST-KD=NN
				1876	X	0	E	ME		KD=1881
				1892		9			X	NEW LOB GRTH
21	1	1793 P	1982 B	1834	X	0	E	LE		(BC=1823)
				1845	X	0	G	ME		(BC=1840?)
				1857	X	0	E	L		(BC=1856)
				1863		9	B		X	DK CLL LINE
				1870	X	0	P	EE		(BC=NN)
				1881	X	0	P	ME		(BC=1885)
				1889		9	B	EE	X	RESIN CELLS-EARLY WOOD
				1901	X	2	B	U ?		BG(BC=1905)
				1917		9			X	RESIN CELLS & DEFORMITY
				1919		9			X	RESIN CELLS & DEFORMITY
				1955	X	2	B	U ?		SUPP 1953-56(BC=NN)
3	2	1661 I	1982 B	1864	X	0	P	EE		KD=1864
5	2	1566 +	1982 B	1571		9			X	RUPT CLLS
				1573		9			X	ON ORIG X-SECT.
				1583	X	0	E	ME		
				1584		9			X	DK CLL LINE-RUPT CLLS
				1596	X	0	P	LE		
				1606	X	0	G	LE		
				1622	X	0	P	ME		
				1627	X	0	B	U ?		
				1632	X	0	P	LE		
				1650	X	0	B	LE		ON ORIG X-SECT.
				1662	X	0	P	ME		
				1666	X	0	G	ME		
				1670	X	0	B	U ?		
				1684	X	0	G	ME		
				1690	X	0	G	LE		
				1695	X	0	G	ME		
				1700	X	0	G	ME		
				1706		9	P		X	DK CLL LINE
				1707	X	0	G	ME		
				1715	X	0	P	ME		
				1727	X	0	P	ME		
				1733		9			X	NOT FIRE INJ-CHARCOAL?
				1735	X	0	P	EE		
				1745	X	0	G	ME		

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
5	2	1566 +	1982 B	1752	X	0	P	EE ?		
				1758	X	2	B	ME		BG
				1767		9			X	DK CLL LINE-FADE FROM EDGI
				1771	X	0	G	ME		ORIG X-SECT.
				1778	X	0	G	ME		ORIG X-SECT.
				1785	X	0	B	U ?		
				1804	X	0	P	ME		ORIG X-SECT.
				1809	X	0	P	LE		ORIG X-SECT.
				1832	X	0	G	ME		
				1837	X	0	P	LE		
				1839		9	B		X	RED RESIN CELLS
				1842		9	B		X	DK CLL LINE
				1845	X	0	P	ME		
				1851	X	0	E	ME		
				1857	X	0	G	LE		
				1863	X	0	G	ME		
				1868	X	0	P	L		
				1876	X	0	P	ME		
				1881	X	0	G	ME		
				1890		9	P		X	RED RESIN CELLS
				1914	X	0	B	LE		
7	2	1687 I	1982 B	1700	X	2	B	L ?		REACT.WD.-KD=1689?
				1735		9			X	EXTR. SUPP.
				1740		9	B		X	EXTR. SUPP.
				1742		9	B		X	EXTR. SUPP.
				1745		9	B		X	EXTR. SUPP.
				1751		9	B		X	EXTR. SUPP.
				1757		9	B		X	EXTR. SUPP.
				1764		9			X	EXTR. SUPP.
				1776		9			X	EXTR. SUPP.
				1837	X	0	P	L		KD=1820
				1851	X	0	P	LE		KD=1835
				1855	X	0	P	ME		ORIG X-SECT.
				1876	X	2	B	U ?		ORIG X-S,BG,KD=1859
				1896		9	B		X	RED RESIN CELLS
				1901	X	0	B	U ?		ON ORIG X-S KD=NN
				1911		9	B		X	RED RESIN CELLS
23	3	1687 I	1982 B	1705		0	B	LE	X	KD=NN
				1711	X	0	P	ME		KD=1681
				1716		9			X	EXTR. SUPP.-KD= NN
				1752	X	0	P	ME ?		KD=1724(BC=1725)
				1785	X	0	G	ME ?		KD=1765(BC=1764)
				1809	X	0	P	ME		KD=1795(BC=1793)
				1822	X	0	G	EE		KD=1809(BC=1808)
				1832	X	0	P	ME		KD=1820(BC=1820)-ORIG X-S

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
23	3	1687 I	1982 B	1837	X	0	G	LE		KD=1827(BC=1828)
				1841	X	0	E	LE		KD=1832(BC=1832)
				1845	X	0	G	ME ?		KD=1837(BC=1836)
				1857	X	0	E	L		KD=1854(BC=1851)
				1863	X	0	E	ME		KD=1862(BC=1860)
				1866					X	KD=1867
				1868	X	0	G	LE		KD=1868(BC=1866)
				1876	X	0	G	ME		KD=1875(BC=1873)
				1881	X	0	G	ME		KD=1881(BC=1878)
24	3	1666 P	1982 B	1679		9			X	DK CLL LINE
				1684	X	0	E	LE		KD=1682
				1695	X	0	E	LE		KD=1693
				1700	X	0	P	L		KD=1698
				1707	X	0	G	LE		KD=1707
				1711	X	0	B	LE		KD=1711
				1715	X	0	G	LE		KD=1715
				1727	X	0	P	LE		KD=1728
				1735	X	0	P	EE ?		KD=1732
				1752	X	0	G	EE		KD=1753
				1758	X	0	P	ME		KD=1757
				1778	X	0	G	LE ?		KD=1783
				1790	X	2	P	U		BG,KD=NN
				1809	X	0	P	ME ?		KD=NN
				1847					X	RESIN POCKET
				1848	X	0	B	EE ?		KD=1849-ORIG. X-S
				1851	X	0	P	EE ?		ORIG. X-S-KD=NN
				1901		9	B		X	DK CLL LINE
				1921		9	B		X	DK CLL LINE
				1933		9	B		X	DK CLL LINE,KD=1938
25	3	1704 I	1982 B	1711	X	0	B	EE ?		
				1715		9				DK CLL LINE,SUPP TO 1716
				1727	X	0	E	LE		KD=1730
				1745	X	0	E	ME		KD=1750
				1757		9			X	RED RESIN CELLS
				1762		9			X	SLITS IN CHARCOAL
				1765		9			X	LOBATE GROWTH IN CHARCOAL
				1771	X	0	B	LE ?		KD=1764
				1778	X	0	B	LE ?		KD=1772
				1785	X	0	B	ME		KD=1780
				1804	X	0	B	L		KD=1802
				1822	X	0	P	EE		KD=1822
				1837	X	0	B	LE ?		KD=1838
				1841	X	0	G	LE		KD=1843
				1843					X	
				1850	X	0	G	ME		KD=1852

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
25	3	1704 I	1982 B	1864	X	0	P	EE		KD=1867
				1876	X	0	E	EE		KD=1880
26	3	1688 I	1981 B	1772	X	0	P	L		KD=1798?
				1809	X	0	P	L		KD=1824
				1832	X	0	G	ME		NN
				1837	X	2	P	U ?		DIST RINGS,NN
				1851	X	0	P	U ?		NN
				1861	X	2	P	U ?		DIST RINGS,NN
				1942		9			X	BARK DAMAGE?
11	4	1607 P	1982 B	1660		9	G	ME	X	RESIN POCKET
				1677	X	2	B	L ?	X	OR 1678,KD= NN
				1683					X	
				1684	X	0	G	ME		KD=1662
				1686					X	
				1688					X	
				1701		9				SUPP. FROM 1701 FOR 3 YRS
				1708		9			X	CHARCOAL ALONG LATE WOOD
				1714	X	2	P	D ?		OR 1715,KD= NN
				1727	X	0	P	U ?		ON ORIG. X-SECT.
				1748	X	0	B	U ?		ON ORIG. X-SECT.
				1762	X	0	P	EE		KD= 1752
				1763					X	
				1764					X	
				1767	X	0	P	LE		KD= NN
				1778	X	2	B	U ?		SUPP,UNCLEAR,KD= NN
				1797					X	
				1832	X	0	G	ME		KD= 1837
				1845	X	0	P	ME ?		KD= 1850?
				1857	X	0	P	EE ?		KD= NN
				1876	X	0	G	EE		KD= 1882?
				1925		9			X	SUPP,RED RESIN CELLS
12	4	1688 P	1982 B	1700	X	0	G	LE		KD=1704 (BC=1700)
				1707	X	0	G	LE		KD=1712
				1709		9			X	DARK BAND IN LE WOOD
				1715	X	0	G	ME		KD=1720 (BC=1722)
				1722		9			X	DK CLL LINE,ORIG
				1724		9			X	DK CLL LINE,ORIG
				1727	X	0	G	EE		KD=1734
				1745	X	0	P	ME		NN PREVIOUSLY
				1771	X	0	B	U ?		KD=NN (BC=1777);WOOD MISS
				1778	X	2	B	U ?		KD=1787; WOOD MISS
				1785	X	2	B	U ?		SUPP 1786,DIST
				1789	X	2	B	U ?		DK CLL LINE,CHAR
				1804	X	0	P	LE		KD=1809 (BC=1811)

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
12	4	1688 P	1982 B	1809	X	0	G	ME		KD=1814 (BC=1815)
				1813					X	RESIN CELLS
				1832	X	0	G	ME		KD=1837 (BC=1838)
				1837	X	0	P	L		KD=1842 (BC=1844)
				1845	X	0	G	EE		KD=NN (BC=1849)
				1851	X	0	B	EE		KD=1858
				1855	X	0	P	EE		OTHER X-S;KD=1860
				1863	X	0	G	ME		KD=1867
				1876	X	0	P	ME		KD=1881
				1881	X	0	P	EE		KD=NN; RED RESIN CELLS
				1930		9	B		X	RED RESIN CELLS,NEAR SCAR
				1937		9	B		X	RED RESIN CELLS,NEAR SCAR
14	4	1615 I	1982 B	1790	X	0	P	EE		KD=1792
				1832	X	0	E	ME		KD=1832 (BC=1843)
				1855		9	P	L	X	KD=NN -SLIGHT SPLIT
				1864	X	0	P	EE		KD=1865 (BC=1874)
				1876	X	0	G	ME		KD=1879 (BC= 1889)
				1901	X	0	P	EE		KD=1903 (BC=1910)
				1926	X	0	P	LE		KD=1928 (BC=1934)
				1928	X	0	P	LE		DAMAGE RING-SPLIT ORIG.X-
				1930		9	B	L	X	EXT.NARROW,KD=1935(BC1944)
				1940	X	2	P	U		
6	5	1790 I	1982 B	1868	X	0	G	ME		KD=1862
				1886	X	0	B	EE ?		SLIGHT CHARCOAL CRESCENT
8	5	1720 I	1982 B	1772	X	0	E	L		KD=1774
				1794	X	0	E	LE		KD=1796
				1820	X	0	E	ME		KD=1821
				1826	X	0	P	ME		KD=1828
				1830	X	0	P	ME		KD=NN
				1832	X	0	G	EE		KD=1833
				1848	X	0	P	EE		KD=1849
				1852		9				SUPP-3 YRS FROM 1852
34	5	1665 I	1982 B	1748	X	0	G	ME		KD=1760(BC=1763)
				1752	X	0	P	U		(BC=1767)
				1759	X	0	P	LE		KD=1772(BC=1774)
				1765	X	0	P	LE		KD=1777(BC=1780)
				1769		9	B	LE	X	DK CLL LINE,KD=NN
				1772	X	0	E	LE		KD=1784(BC=1787)
				1785	X	0	P	L		KD=1798(BC=1801)
				1787		9	B		X	CURL IN SCAR
				1794	X	0	G	ME		KD=1807(BC=1809)
				1800	X	0	G	L		KD=1813(BC=1815)
				1810	X	0	P	ME		KD=1823(BC=1825)

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
34	5	1665 I	1982 B	1820	X	0	P	L		KD=1833(BC=1835)
				1826	X	0	P	ME		KD=NN
				1834	X	0	P	LE		KD=1846(BC=1847)
				1851	X	0	B	U ?		KD=NN
				1865	X	2	B	U ?		EXTR P-SOMETIME IN 1860S
35	5	1627 I	1982 B	1666		9	B	U ?	X	SUPP 1666-1676
				1686	X	0	E	ME		KD=1678
				1724	X	0	E	ME		KD=1721
				1730	X	0	P	EE ?		KD=1726
				1748	X	0	G	LE ?		KD=1744
				1759	X	0	G	L		KD=1756
				1765	X	0	G	L		KD=1762
				1772	X	0	P	L ?		KD=1768
				1778	X	0	P	U ?		KD=1774
				1785	X	0	P	L ?		KD=1780
				1794	X	0	G	LE ?		KD=1789
				1800	X	0	G	L		KD=1795
				1810	X	0	P	LE ?		KD=1805
				1820	X	0	P	EE		KD=1815
				1826	X	0	B	LE		KD=1824
				1834	X	0	G	LE		KD=MARKED, BUT NOT DATED
				1841	X	0	G	LE		KD=1836
				1851	X	0	G	ME		KD=1845
				1861	X	0	P	ME		KD=1865
				1919	X	0	P	EE ?		KD=1921
				1926		9			X	RED RESIN CELLS
				1932		9			X	CURL IN SCAR
31	7	1789 I	1950 +	1818	X	0	E	ME		KD=1828
				1826	X	0	P	L		KD=1836
				1832	X	0	B	ME		KD=1842
				1845	X	0	B	ME		KD=NN
				1851	X	2	B	EE ?		KD=1857
				1857	X	0	B	ME		KD=1867
				1861	X	0	B	L		KD=NN
				1863	X	0	P	ME		KD=NN
				1868	X	0	P	LE		KD=NN
				1876	X	0	P	EE		KD=1882
				1906		9			X	CELL DAMAGE,COLOR CHANGE
32	7	1765 I	1982 B	1772	X	2	B	LE		LOB GRTH,BG,KD=NN
				1775		9			X	DIST,KD=NN
				1805		9	B		X	DK CLL LINE
				1826	X	0	B	L		KD=1815
				1832	X	0	B	ME		KD=1824
				1845	X	0	E	ME		KD=1836?

Site Data		Tree Data		Fire Date Data						
Tree	Group	Inside Date	Outside Date	Fire Date	Scar	"?"	Clarity	Season	Other Injury	Comments
32	7	1765 I	1982 B	1861	X	0	G	L		KD=1859
				1868	X	0	E	ME ?		KD=1867
				1876	X	0	E	EE		KD=1876
				1890		9	B	L ?	X	THICK,DARK CELLS
				1919		9	B		X	THICK,DARK CELLS
				1926		9			X	THICK,DARK CELLS

Table 2. Fire scar indices for Walnut Canyon; all trees sampled, trees sampled on north side of canyon, and trees sampled on south side of canyon. Index is the percent of previously scarred trees showing a scar in a given year. # Trees is the number of samples at a given year. The number of scarred trees is found by multiplying INDEX/100 x # TREES.

Scar Date	All Trees		North		South	
	Index	# Trees	Index	# Trees	Index	# Trees
1583	100	1	100	1	0	0
1596	100	1	100	1	0	0
1606	100	1	100	1	0	0
1622	100	1	100	1	0	0
1627	100	1	100	1	0	0
1632	100	1	100	1	0	0
1650	100	1	100	1	0	0
1662	100	1	100	1	0	0
1666	100	1	100	1	0	0
1670	100	1	100	1	0	0
1677	50	2	50	2	0	0
1684	100	3	100	3	0	0
1686	25	4	0	3	100	1
1690	25	4	33	3	0	1
1695	50	4	67	3	0	1
1700	67	6	80	5	0	1
1707	43	7	50	6	0	1
1711	38	8	43	7	0	1
1715	50	8	57	7	0	1
1724	13	8	0	7	100	1
1727	63	8	71	7	0	1
1730	13	8	0	7	100	1
1735	25	8	29	7	0	1
1745	38	8	43	7	0	1
1748	22	9	14	7	100	2
1752	33	9	43	7	50	2
1758	22	9	29	7	0	2
1759	22	9	0	7	100	2
1762	11	9	14	7	0	2
1765	22	9	0	7	100	2
1767	11	9	14	7	0	2
1771	33	9	43	7	0	2
1772	33	12	13	8	100	4
1778	46	13	67	9	25	4
1785	38	13	44	9	50	4
1790	21	14	30	10	0	4
1794	21	14	0	10	75	4
1800	14	14	0	10	50	4
1804	21	14	30	10	0	4
1807	7	14	10	10	0	4
1809	43	14	60	10	0	4
1810	14	14	0	10	50	4

Appendix 2 continued.

Scar Date	All Trees		North		South	
	Index	# Trees	Index	# Trees	Index	# Trees
1818	7	15	0	10	20	5
1820	20	15	0	10	60	5
1822	13	15	20	10	0	5
1826	33	15	0	10	100	5
1830	7	15	0	10	20	5
1832	53	15	60	10	60	5
1834	13	16	9	11	40	5
1837	38	16	55	11	0	5
1841	13	16	18	11	20	5
1843	6	16	9	11	0	5
1845	44	16	55	11	40	5
1848	6	16	9	11	20	5
1850	6	16	9	11	0	5
1851	44	16	45	11	60	5
1855	13	16	18	11	0	5
1857	25	16	36	11	20	5
1861	19	16	9	11	60	5
1863	19	16	27	11	20	5
1864	18	17	25	12	0	5
1868	22	18	17	12	50	6
1870	11	18	17	12	0	6
1876	50	18	67	12	33	6
1881	22	18	33	12	0	6
1886	6	18	0	12	17	6
1901	17	18	25	12	0	6
1914	6	18	8	12	0	6
1919	6	18	0	12	17	6
1926	6	18	8	12	0	6
1928	6	18	8	12	0	6
1940	6	18	8	12	0	6
1955	6	18	8	12	0	6

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