North American Dendroecological Fieldweek

5th Annual North American Dendroecological Fieldweek, 1994
Southwestern Research Station, Chiricahua Mountains, Arizona, USA
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Participant List

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Fritz H. Schweingruber, Swiss Federal Institute of Forest Research	*Look, Wonder, and Try to Understand*
Henri D. Grissino-Mayer, Laboratory of Tree-Ring Research, University of Arizona	*A Dendrochronological Study of Fire Regimes in the Chiricahua Mountains, Arizona*
Alex McCord, Laboratory of Tree-Ring Research, University of Arizona	Dendrochronological Methods to Determine Flood Frequency in Pinery Canyon
Edward Cook, Lamont-Doherty Earth Observatory, Columbia University Keith Briffa, University of East Anglia, United Kingdom	Standardization Trials on Douglas-fir Chronologies from Onion Saddle/Pinery Canyon

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1994 North American Dendroecological Fieldweek
Southwest Research Station Portal, Arizona
May 22nd - 29th

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Proceedings of the 5th North American Dendroecological Feildweek

American Museum of Natural History, Southwestern Research Station Portal, Arizona

May 22nd-29th

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Introduction:

Without question learning through experience has no equal. Participants in this years Dendroecological Fieldweek proved that given an opportunity to collect and analyze data of their own, under the guidance of an expert, an amazing amount of work can be accomplished. This work translates directly to knowledge, knowledge in the tools and skill associated with dendroecology, and knowledge of new facts and features of the local environment that have been uncovered. This is the strength of the Fieldweek and it's principle purpose.

This year in Portal, Arizona, fifty participants from around the world gathered for a week of intensive ecological research. Though the goals of the Fieldweek are not to produce journal quality publications nor startling scientific results, the integrity of the work performed in the following collection of individual group reports speaks for itself. To think that 50 people, who met for the first time in this remote location, could get together, develop a topic of research, formulate hypotheses, collect raw data, analyze their data, and test their hypotheses, in the short time provided, is truly impressive. The organizers of this years North American Dendroecological Fieldweek sincerely thank those who participated for they have shown us the power of enthusiasm in the quest for knowledge.

The Reports:

1 **Look, Wonder and try to Understand.** (Fritz Schweingruber, et, al.)

2 **Dendrochronological Study of Fire Regimes in the Chiricahua Mountains.** (Henri Grissino-Mayer, et, al.)

3 **Stand Dynamics in a Ponderosa Pine Forest in Rustler Park, Chiricahua Mountains (Southeastern, Arizona)** (Emilia Gutiérrez, et, al.)

4 **Standardization Trials on Douglas Fir Chronologies from Onion Saddle/Pinery Canyon Area, Chiricahua Mountains, Arizona.** (E.R. Cook, Keith Briffa, et, al.)

5 **Dendrochronological Methods to Determine Flood frequency in Pine Canyon, Chiricahua Mountains, Southeastern, Arizona** (Alex McCord et, al.

LOOK, WONDER AND TRY TO UNDERSTAND

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INTRODUCTION

Dendroecology uses tree rings to study ecological problems and the environment. It includes dendroclimatology, dendrohydrology, dendrogeomorphology, dendroglaciology, fire history, forest stand dynamics and anthropogenic effects. The purpose of our group was to survey as many dendroecological topics as could be encountered in the local area and explore a subset of these topics in detail. Our approach was to use wood samples to reconstruct the ecological history of trees.

METHODS

Our first morning Fritz Schweingruber led the group in a dendroecological exploration of the **woodpile** behind the kitchen which turned out to be a treasure trove of wood containing information on past ecological events. That afternoon we explored the ecology of the **riparian woodland** across the stream. There we took core and stem samples of various species including many that are not used in standard ecological studies. We also investigated the potential for dendroecological topics in the **oak woodland** on the south-facing slope south of the research station. Finally, we extended our playground and drove up to the **pine-oak belt** near Onion Saddle and collected samples from species not found at lower elevation.

VEGETATION

The Southwestern Research Station is located in the Chiricahua Mountains of southeastern Arizona at an elevation of 1,620 m. The surrounding mountains reach elevations of over 2,000 m. Thus there are belts of vegetation up the slopes. Around the research station the vegetation is an oak woodland consisting primarily of emory oak (*Quercus emoryi*) with alligator juniper (*Juniperus deppeana*). The Mexican pinyon pine (*Pinus cembroides*) and the Apache pine (*Pinus engelmannii*) occasionally are found within the community. Willow (*Salix* sp.), Arizona walnut (*Juglans major*) and box elder (*Acer negundo*) are present in the deciduous riparian woodland. The pine-oak belt is found at higher elevations and includes Apache pine, Mexican pinyon pine, ponderosa pine, Chihuahua pine (*Pinus leiophylla*) and southwestern white pine (*Pinus strobiformis*). It also includes gambel oak (*Quercus gambelii*), emory oak and silverleaf oak (*Quercus hypoleucoides*), time consuming. We applied this method to Apache pine but found in this slow-growing species, the scars remain visible up to 22 years after needle loss, thus making it improper for this method.

The needle trace method is particularly relevant to forest health inventories in Europe in the context of forest decline.

DENDROECOLOGICAL QUESTIONS

We know that this area has a highly variable abiotic and biotic environment, both spatially and temporally, and therefore provides a wide range of opportunities for dendroecological investigations. We studied the following dendroecological topics:

WOODPECKERS AND TREES

We noted two types of woodpecker damage to trees in this area. **Acorn woodpecker** (*Melanerpes formicivorus*) make big holes in wood and push acorns into these holes to keep them for the winter. If they make holes in dead wood, this cannot be dated. If they make holes in living wood, then healing and scarring results, and this can be dated in tree species that crossdate.

Sapsuckers drill evenly spaced rows of small holes in living trees, and visit these "wells" for sap and insects attracted to it. These holes cause scars in the bark and sometimes in the wood. The **red-naped sapsucker** (*Sphyricaus nuchalis*) is the only sapsucker common to this area, so it likely caused the damage we observed. Damage occurs at the boundary between latewood and earlywood. As time passes, the scar in the xylem is separated from the hole in the bark by additional growth rings. We observed sapsucker damage during four of the eleven years in Arizona cypress (*Cypressus arizonica*), a crossdatable species, and five generations of scars between 1969 and 1990 in alligator juniper (*Juniperus deppeana*), a species that is difficult to date because of false rings and wedging rings.

MISTLETOE DYNAMICS

Mistletoe affects growth by the formation of haustoria. With tree rings in the host and the semiparasite, it is possible to date the establishment and death of mistletoes.

Phoradendron sp. probably forms annual rings on *Quercus emoryi*. We found 8-year-old specimens. At lower elevations, *Q. emoryi* forms growth zones rather than annual rings.

Arceuthobium sp. on *Pinus ponderosa* has no annual rings. The age of the mistletoe can be derived from the distinct number of rings which overgrew the haustoria. We found 14-year-old living haustoria.

After the death of the mistletoe, the cambium grows over the dead mistletoe shoot.

In addition, we recognized the following topics:

Climate

Table 1. Species characteristics and tree-ring formation

OAK WOODLAND

species	elevation	habitat	anatomy	evidence of growth May 24, 1994
Quercus emoryi	1,000 - 2,700 m	dry foothills moist canyons	ring-porous but mostly with growth zones, not annual rings	not sampled
Juniperus deppeana	1,500 - 2,700 m	dry hills and mesas	conifer with annual rings that have a narrow band of latewood	NO
Pinus cembroides	1,700 - 2,500 m	dry hills and mesas	conifer with annual rings	not sampled
Pinus leiophylla var. *chihuahuana*	1,700 - 2,500 m	dry slopes and benches	conifer with annual rings	not sampled
Pinus engelmannii	1,700 - 2,750 m	dry sandy ground	conifer with annual rings	not sampled
Robinia neomexicana	1,350 - 2,850 m	canyons streambanks	ring-porous distinct ring boundaries	one layer of vessel cells

RIPARIAN AREA

species	elevation	habitat	anatomy	evidence of growth May 24, 1994
Acer negundo	1,150 - 2,850 m	stream banks	diffuse-porous with somewhat apparent growth rings	NO
Rhamnus betulaefolia	1,350 - 2,350 m	stream banks	diffuse-porous	in portions around the stem
Juglans major	670 - 2,350 m	stream banks	diffuse-porous with annual growth rings	NO
Salix sp.	1,350 - 3,200 m	stream banks	diffuse porous with annual growth rings	one layer of vessel cells

DENDROCHRONOLOGICAL STUDY OF FIRE REGIMES IN THE CHIRICAHUA MOUNTAINS

A Preliminary Fire History of the Rustler Park Area, 1800 - Present

A Study conducted during the 5th Dendroecological Field Week
May 22 - May 28, 1994
Southwestern Field Center, Portal, Arizona

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the vicinity of the Rustler Park Campground. Rustler Park is located approximately 4 kilometers (2.4 miles) from Onion Saddle on Forest Service Road 42D.

The Rustler Park site (RPK) is located in the same area as a concurrent study on stand dynamics (Gutierrez, et. al. 1994), approximately one kilometer south of a forest service work station at Long Park on the upper SE facing slope.. This site is in a *Pseudotsuga menziesii/Muhlenbergia virescens* habitat type with a multi-age overstory of predominantly *Pinus ponderosa* (ponderosa pine). Other overstory trees include *Pseudotsuga menziesii* (Douglas fir) and *Pinus strobiformis* (southwestern white pine). The understory is a patchy mosaic dominated by *Muhlenbergia virescens* (screwleaf muhly), a bunch grass, with local dominance of needle mats (under trees).

The Rustler Park North site (RPN) is located on a bench on the north facing slope above the Long Park area. The habitat type is a *Abies concolor/ Berberis repens* h.t. This type is widespread throughout the southwest (U.S.F.S. 1987) with the diagnostic feature being a sparse understory in late successional stands. At this site, tree cover was dense and very few understory plants were observed. In openings, *Pteridium aquilinium* and *Thermopsis pinetorum* dominated the understory.

The Rustler Park South site (RPS) included two different habitat types. Following the general pattern of the area, the southeast facing slope is in a *Pseudotsuga menziesii/Muhlenbergia virescens* habitat type. Samples RPS 1 to 3 were collected in this site. Samples 4 and 5 were collected on the ridge of this slope, and the remaining samples were at the top of the slope on the north facing aspect in a *Abies concolor/Berberis repens* habitat type. These samples came from southwestern white pine logs, which is a seral species in this habitat indicating this stand was in a late successional stage. The tree cover at RPS was denser overall than at RPK, therefore the understory was dominated by a pine needle mat, with few herbs. Although these sites are both Douglas-fir/screwleaf muhly h.t., the difference in understory expression is due to stand density, possibly related to differences in logging history in this century.

METHODS

Cross sections were obtained from living trees, snags, dead and downed trees, and stumps from 23 individuals in the Rustler Park area using techniques described by Arno and Sneck (1977). All sections were labeled and wrapped with strapping tape to prevent breakage. For each sampled tree, a field form was completed containing a description of the tree, sample, and microsite characteristics. Each cross section was then tions had 10 or more fire scars. Disk RPS-03, taken from a living ponderosa pine, had 264 rings and indicated 15 fire events between 1757 and 1886. The final master fire chronology showed that major fires (in which at least four trees were scarred) occurred in 1817, 1835, 1838, 1847, 1851, 1856, 1867, 1877, 1886.

We found over 80% of fires occurred during two ring structural phases, the period of dormancy (41.3%) and the middle-early phase (40.0%), suggesting most fires occurred prior to and early in the growing season. The Rustler Park seasonality pattern contrasts with that for the Mt. Graham area where the majority of fires occurred in the early-early phase with proportional reductions in percentage of events in the adjacent dormant and middle-early phases with the early-early period being most prominent. The middle early phase generally corresponds with summer monsoon events and is often reflected in a significant false ring.

The Mean Fire Interval (MFI) of all trees at the three sites was 3.0 years and the MFI of each individual tree was 8.7 years. At the RPS site the MFI of all trees was 5.0 years and 14.3 years for each individual tree. That means that the fires were mostly of small size with a patchy in distribution. At the RPK site the MFI of all trees was 3.3 years and 5.0 years for individual trees, suggesting fires were more extensive. This is supported by the coincidence of fire dates and the greater number of scars.

A number of fire history studies for the southwestern United States suggest that fire regimes during the past three centuries are associated with climatic variables, principally precipitation. Does this study support these conclusions?

When the Chiricahua data set, which at present only encompasses 13 samples, is compared with the 90 samples from a fire history study of Mt. Graham, some 50 miles to the northwest of the Chiricahua study sites, the respective Mean Fire Intervals of 3.0 years and 4.2 years indicate significantly different frequencies in the number of fire events at each study area. The extremely high number of events in the small Chiricahua data set suggests some factor other than fire and climate variables are at play.

The Chiricahua Range is a 'sky island' reposing in a desert sea. Covering an area of approximately 40 miles by 20 miles, the area contains substantial evidence of aboriginal occupation dating back 10,000 years. Renowned for its abundant game, including the white tailed deer, the forested slopes and canyons of the Chiricahua Mountains would have been an attractive homeland for the Apache Indians. The data show that no fires occurred after 1886, the year in which the two renegade Chiricahua Apache chiefs,

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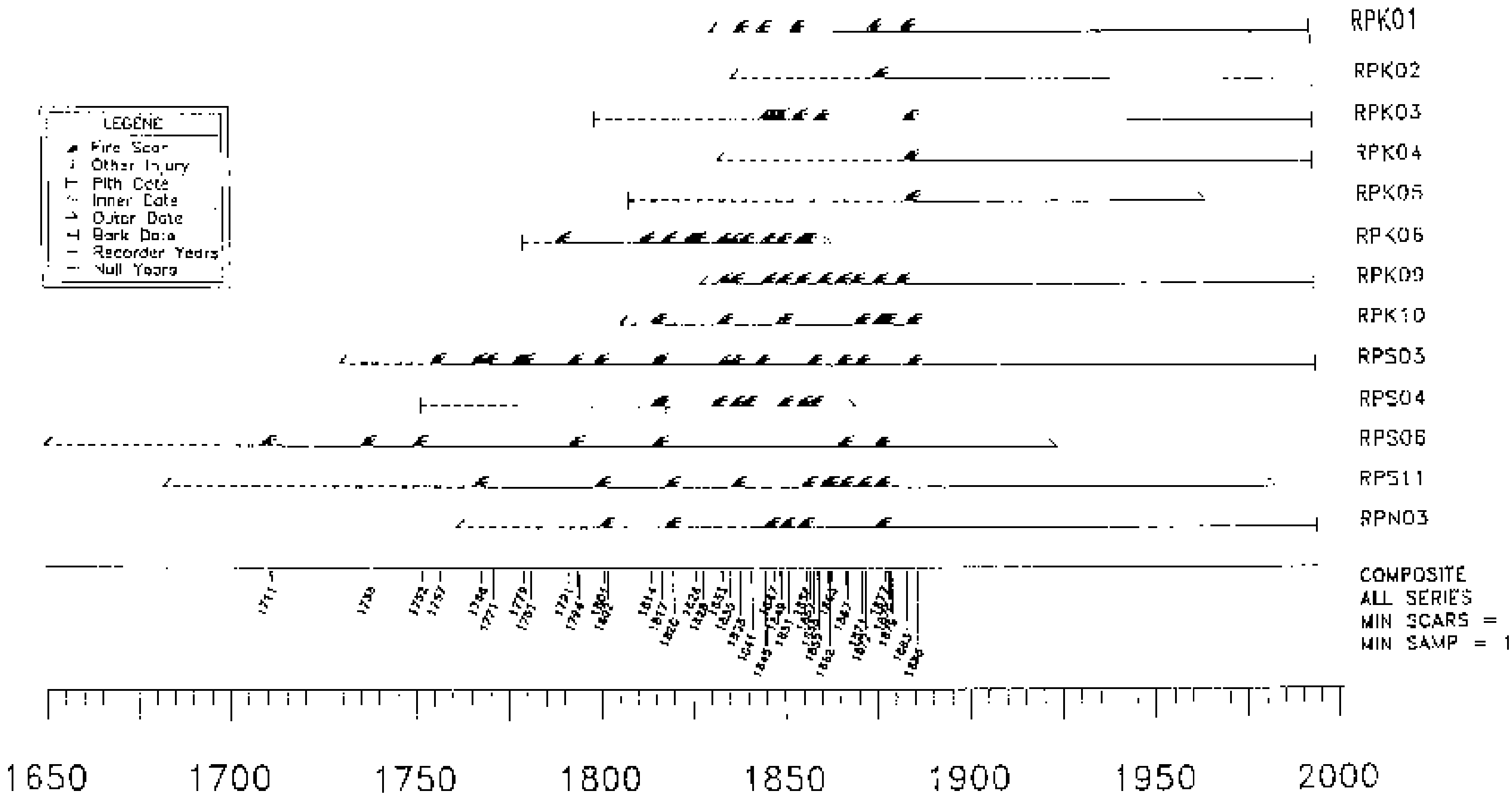
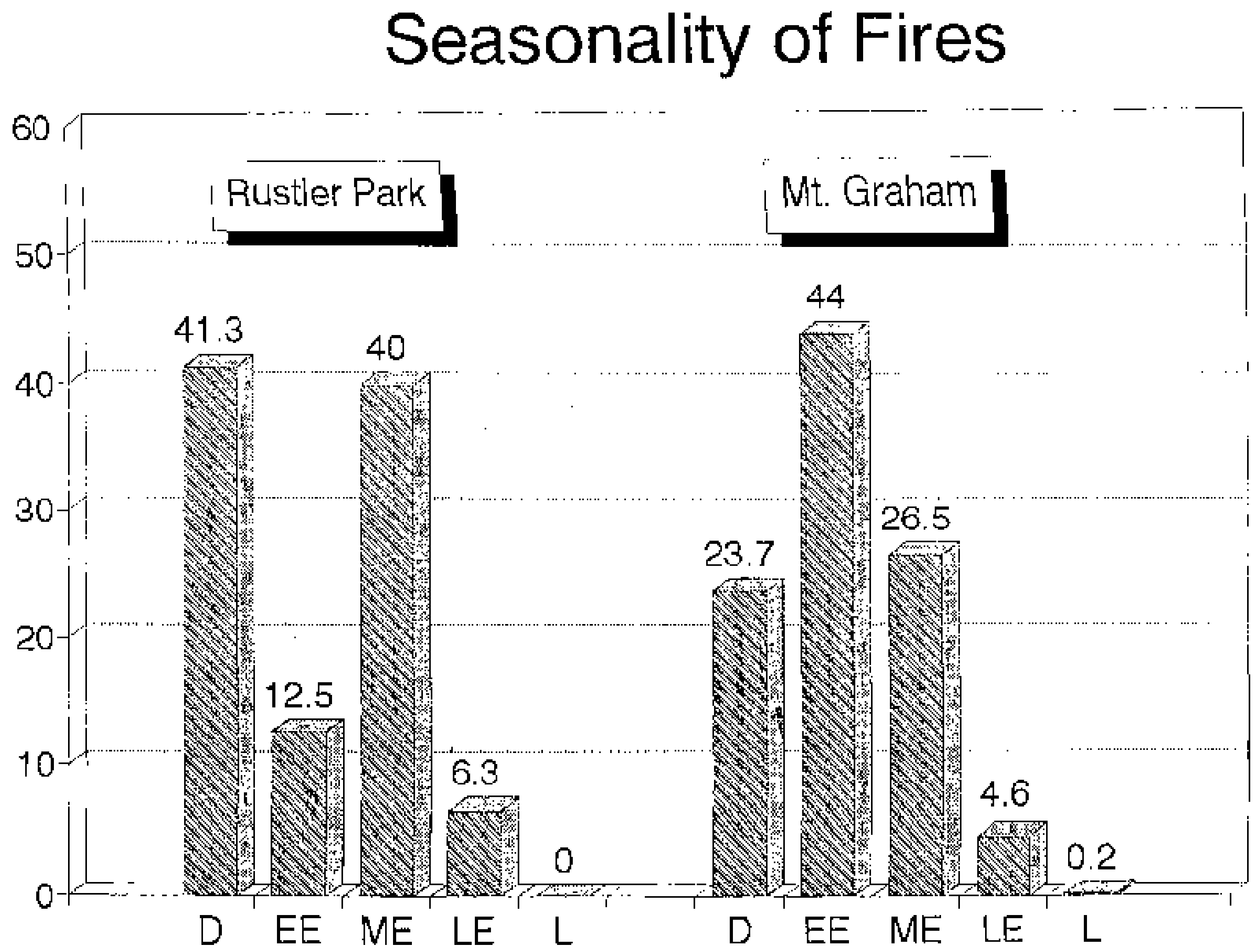
Rustler Park Preliminary Fire Chronology





Seasonality of Fires
60
50
40
30
20
10
0
Rustler Park
Mt. Graham
41.3
12.5
40
6.3
0
23.7
44
26.5
4.6
0.2
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STAND DYNAMICS IN A PONDEROSA PINE FOREST IN RUSTLER PARK, CHIRICUAHUA MOUNTAINS (SOUTHEASTERN ARIZONA)

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causing reduced fire frequency and magnitude, and
(2) fire suppression further reduced fire frequency and magnitude.

The apparent consequences of these environmental changes are increased density of trees, particularly in the smaller sapling and pole-size classes, and a shift in tree species composition, with reduced importance of ponderosa pine and increased importance of more shade-tolerant species (e.g., _Pinus strobiformis_). When fire does occur in such stands, there is a much higher probability of catastrophic crown fires that destroy the ponderosa pine overstory and the important seed source of ponderosa pine regeneration. This interaction of competition and altered fire regime may well result in significant alteration of forest structure and composition in the southwestern U.S.

Successful regeneration of ponderosa pine requires the coincidence of appropriate seedbed conditions (exposed mineral soil), seed source, and a complex set of climatic conditions (moist summers, moderate winters, and a brief fire-free interval) (Cooper 1960). Fire suppression and grazing may reduce ponderosa pine reproduction by allowing a thick litter layer to develop and the invasion of shade-tolerant tree species into the understory. These shade-tolerant species out-compete ponderosa pine seedlings for light, water, and nutrients.

The objectives of this study were:
(1) to describe the age and size structure, stand history, species composition, and environmental conditions of a ponderosa pine woodland, and
(2) to evaluate the temporal and spatial relationships between environmental factors (including past fires) and tree regeneration.

The hypotheses tested by this study were:
(1) in the absence of fire, ponderosa pine fails to regenerate and is replaced by shade-tolerant tree species (e.g. _Pinus strobiformis_), and
(2) failure of ponderosa pine regeneration is due more to competition from saplings of shade-tolerant species and lack of suitable seedbed than to shading from overstory trees.

DESCRIPTION OF STUDY SITE

of decay and location in relation to the slope were recorded.

Canopy cover and soil surface cover were sampled every meter along the main transect line.

RESULTS

Canopy gaps comprise 27.5% of the Rustler Park stand. Ponderosa pine is in the canopy of 39.5% of the stand, followed by southwestern white pine (27.5%), Douglas-fir (4.5%) and Gambel oak (1%). The density of living trees is 357 stems/ha. The stand basal area is 31 m^2/ha.

Organic matter covers 82.5% of the ground surface. Dead wood covers 11.5% of the surface, followed by rocks (8.5%), grasses and herbs (4%) and bare ground (0.5%).

The stand is a mature forest stand, with some trees older than 170 years (Fig. 1). Ponderosa pine dominates the older age classes. There is some regeneration by ponderosa pine, but the younger age classes are overwhelmingly dominated by southwestern white pine. The age class distribution is indicative of poor reproduction. Southwestern white pine has an inverse-J shaped age class distribution, usually indicative of a self-sustaining population. Three cohorts can be identified: an old cohort of ponderosa pine (170 to 220 years old); an intermediate aged cohort (40 to 120 years), comprised of southwestern white pine and ponderosa pine; and a young cohort (0 to 30 years), predominantly of southwestern white pine. The oldest cohort established between 1770 and 1820. There is a distinct gap in the age distribution between 1820 and 1860. None of the sampled trees established during this period. This period generally corresponds with a high frequency of fires, as determined by the analysis of fire scars (Grissino-Mayer et al. 1994). Tree establishment gradually increases after 1900, with the appearance of southwestern white pine at this time. Large numbers of southwestern white pine established after 1960. While the samples include a number of ponderosa pine seedlings in the 0 to 10 years age class, virtually no ponderosa pine in the 10 to 30 year age class were found.

An inspection of all individual tree-ring series of ponderosa pine found a common growth pattern in all trees, i.e.,

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Figure legends:

Fig. 1.- Stand age structure and fire regime (triangles) for the studied area in Rustler Park, Chiricahua Mnts. (Arizona).

Fig. 2.- Example of raw ring widths curve for a ponderosa pine (1 radius) showing the typical age trend for a tree growing without competition.

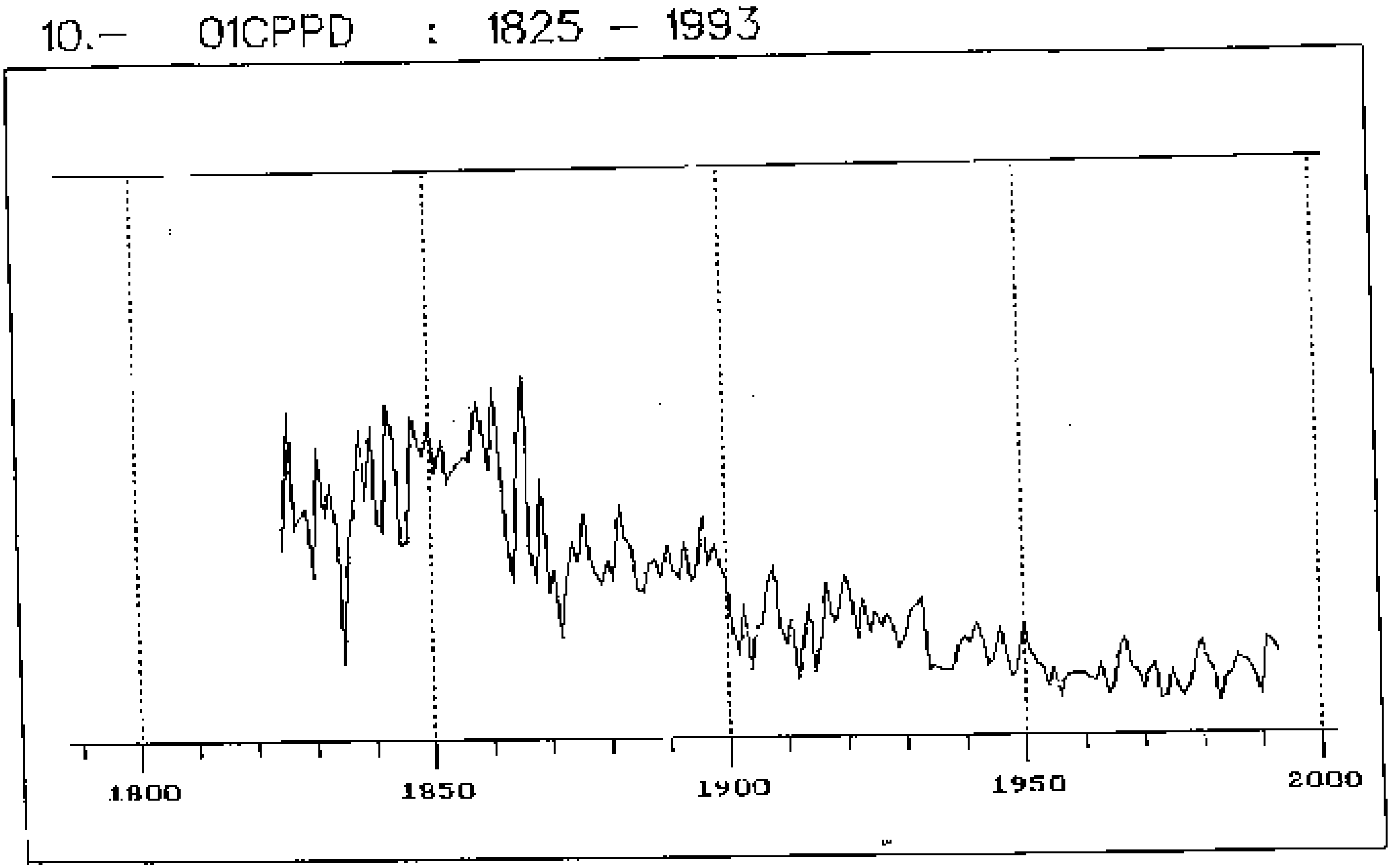

Fig. 2.- Example of raw ring widths curve for a ponderosa pine (1 radius) showing the typical age trend for a tree growing without competition.

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Chronology Development

Three initial chronologies were developed using either negative exponential or straight line standardization with no second detrending [Figure 6]. The first two chronologies were based on data collected and analyzed during the fieldweek; the third was based on ITRDB data.

+Chronology One [young trees]
29 cores: pith post-1879 [28 post-1914]

+Chronology Two [medium-aged trees]
16 cores: pith 1663 to 1878 [10 post-1772]

+Chronology Three [old trees]
48 cores: pith 1594 to 1777 [36 post-1675]

Palmer Drought Severity Indices for Tombstone, Arizona are shown as Figure 7.

Comparisons of chronologies for the 'old' and 'young' trees over the period 1880 to 1992.

To illustrate the effects of standardization on trees of different ages, Figures 8 and 9 compare the results for the old and young trees. Figure 8 compares standard chronologies [negative exponential or straight line fit]. Figure 9 compares chronologies standardized with a 30-year filter.

In both figures 8 and 9 the upper figure shows the two chronologies with a smoothing curve; the lower diagram shows the difference between the index values of the 'old' and 'young' chronologies. Positive values indicate the chronology for old trees has larger index values than the chronology for the young trees. Figure 8 shows the temporal patterns of systematic differences in the standard chronologies between the two age classes. These differences may reflect genuine differences in the medium frequency climate response between these two groups of trees. Figure 9 indicates that the 30-year filter removes most long term trend for these series and the differences between the series show no systematic trend over time. Therefore, if the signal in the standard chronologies is a real climate signal, incautious application of standardization techniques may remove this signal.

	TREE #	TREE HGT	1ST YEAR	PITH CORREC	TREE AGE	COHH AGE	DBH	BARK	DBH CORREC
0	1.0000	12.000	1949.0	0.0000	45.000	45.000	17.500	0.50000	16.500
1	2.0000	15.000	1933.0	0.0000	61.000	61.000	26.000	2.0000	22.000
2	3.0000	13.000	1933.0	0.0000	61.000	61.000	28.500	2.0000	24.500
3	4.0000	18.000	1916.0	2.0000	78.000	80.000	39.500	3.0000	33.500
4	5.0000	16.000	1936.0	8.0000	58.000	66.000	34.000	3.5000	27.000
5	6.0000	21.000	1916.0	5.0000	78.000	83.000	51.000	7.0000	37.000
6	7.0000	22.000	1850.0	5.0000	144.00	149.00	65.000	7.0000	51.000
7	8.0000	25.000	1830.0	10.000	164.00	174.00	85.000	9.0000	67.000
8	9.0000	23.500	1858.0	3.0000	136.00	139.00	69.000	8.0000	53.000
9	10.000	21.500	1838.0	6.0000	156.00	162.00	71.500	7.5000	56.500
10	11.000	21.000	1683.0	20.000	311.00	331.00	108.50	8.0000	92.500
11	12.000	23.500	1782.0	4.0000	212.00	216.00	102.00	9.0000	84.000
12	13.000	23.000	1709.0	20.000	285.00	305.00	95.000	9.0000	77.000
13	14.000	24.000	1820.0	0.0000	174.00	174.00	83.500	9.0000	65.500
14	15.000	21.500	1800.0	5.0000	194.00	199.00	77.000	8.0000	61.000
15	100.00	16.000	1958.0	7.0000	36.000	43.000	36.500	5.0000	26.500
16	101.00	20.000	1918.0	0.0000	76.000	76.000	41.500	5.0000	31.500
17	16.000	24.000	1836.0	15.000	158.00	173.00	85.000	4.0000	77.000
18	17.000	21.000	1834.0	5.0000	160.00	165.00	73.000	6.0000	61.000
19	18.000	20.500	1953.0	0.0000	41.000	41.000	24.800	1.0000	22.800
20	19.000	22.000	1914.0	0.0000	80.000	80.000	50.700	2.5000	45.700
21	20.000	18.500	1919.0	0.0000	75.000	75.000	39.000	1.5000	36.000
22	21.000	19.500	1923.0	5.0000	71.000	76.000	42.000	2.0000	38.000
23	22.000	21.000	1814.0	0.0000	180.00	180.00	90.500	6.0000	78.500
24	23.000	25.500	1826.0	1.0000	168.00	169.00	77.200	5.0000	67.200
25	24.000	21.500	1818.0	1.0000	176.00	177.00	93.400	6.0000	81.400
26	25.000	21.000	1923.0	2.0000	71.000	73.000	47.700	3.0000	41.700
27	26.000	20.000	1802.0	3.0000	192.00	195.00	88.000	5.0000	78.000
28	27.000	22.500	1760.0	10.000	234.00	244.00	76.300	5.0000	66.300
29	28.000	25.500	1761.0	5.0000	233.00	238.00	111.30	6.0000	99.300
30	29.000	26.000	1837.0	3.0000	157.00	160.00	66.800	5.0000	56.800
31	30.000	18.500	1926.0	5.0000	68.000	73.000	56.500	4.0000	48.500
32	31.000	17.000	1949.0	1.0000	45.000	46.000	43.000	3.0000	37.000
33	32.000	20.000	1937.0	4.0000	57.000	61.000	42.500	3.0000	36.500
34	33.000	21.500	1948.0	8.0000	46.000	54.000	39.500	2.0000	35.500
35	34.000	29.000	1847.0	4.0000	147.00	151.00	108.50	6.0000	96.500
36	35.000	23.000	1831.0	3.0000	163.00	166.00	83.000	6.0000	71.000

Figure 2: Occurrence of double rings in young Douglas fir sampled at the Onion Saddle site. The height of each bar is proportional to the degree of development of the double ring. Note that the susceptibility to double ring formation appears to decrease with age, e.g. the 1980s in sample 4 through 6.

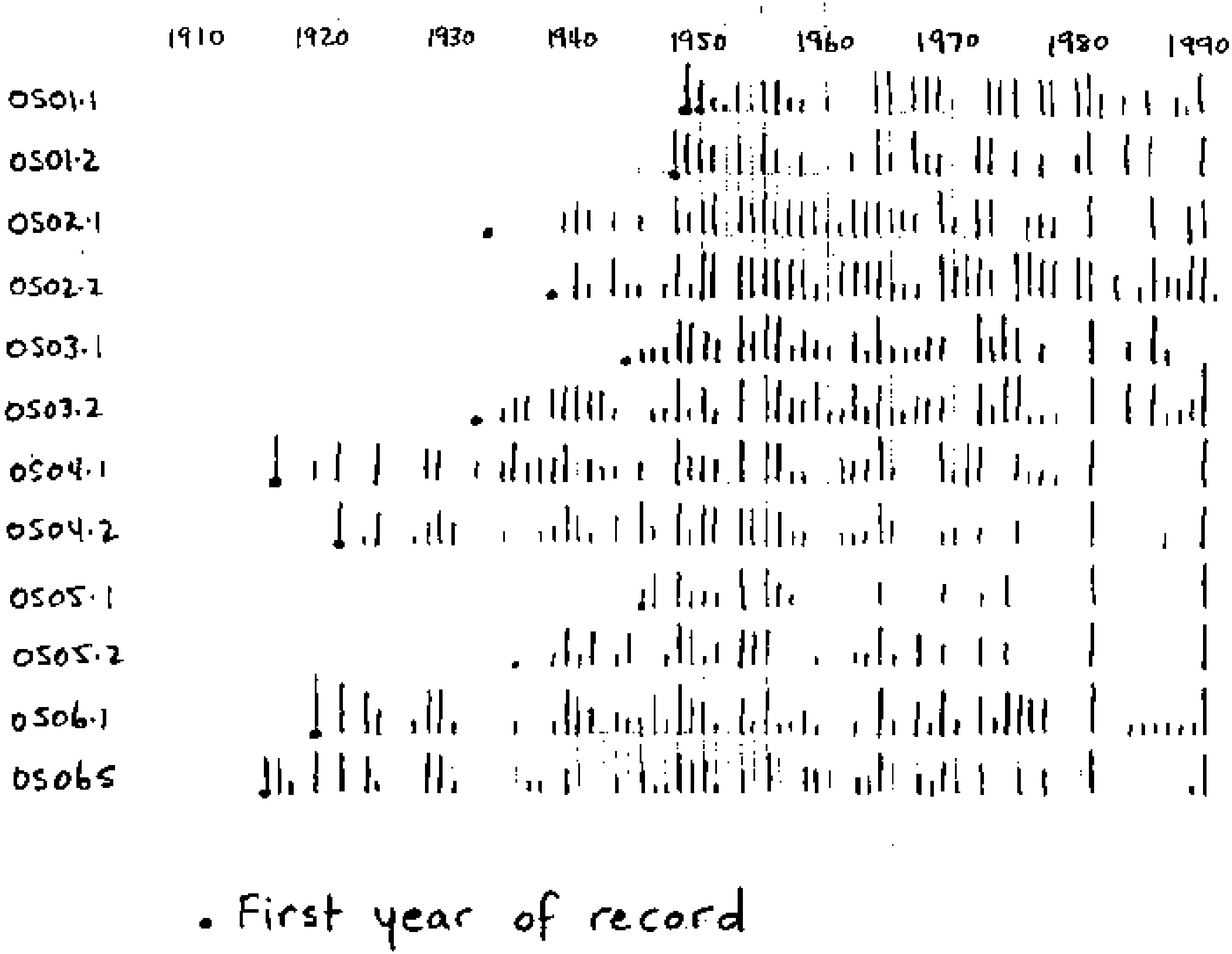


FIGURE 4. AGE VS. HEIGHT RELATIONSHIPS

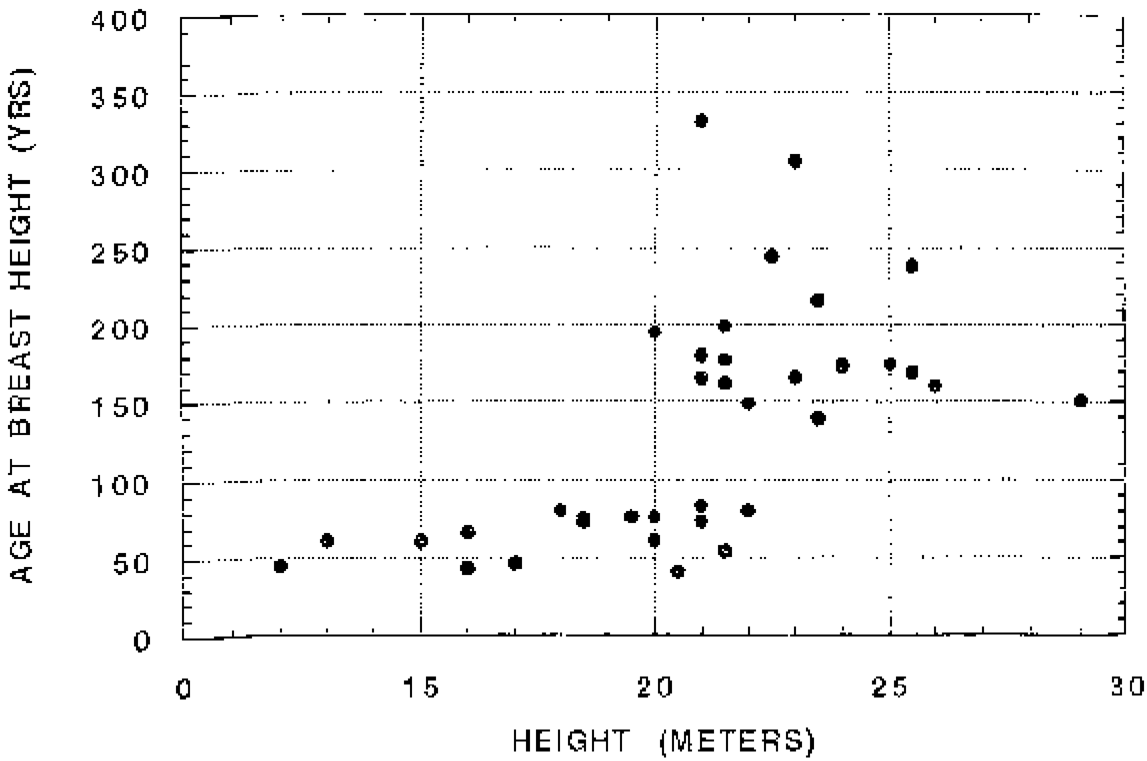


FIGURE 6. THREE CHRONOLOGIES FROM ONION SADDLE SITE

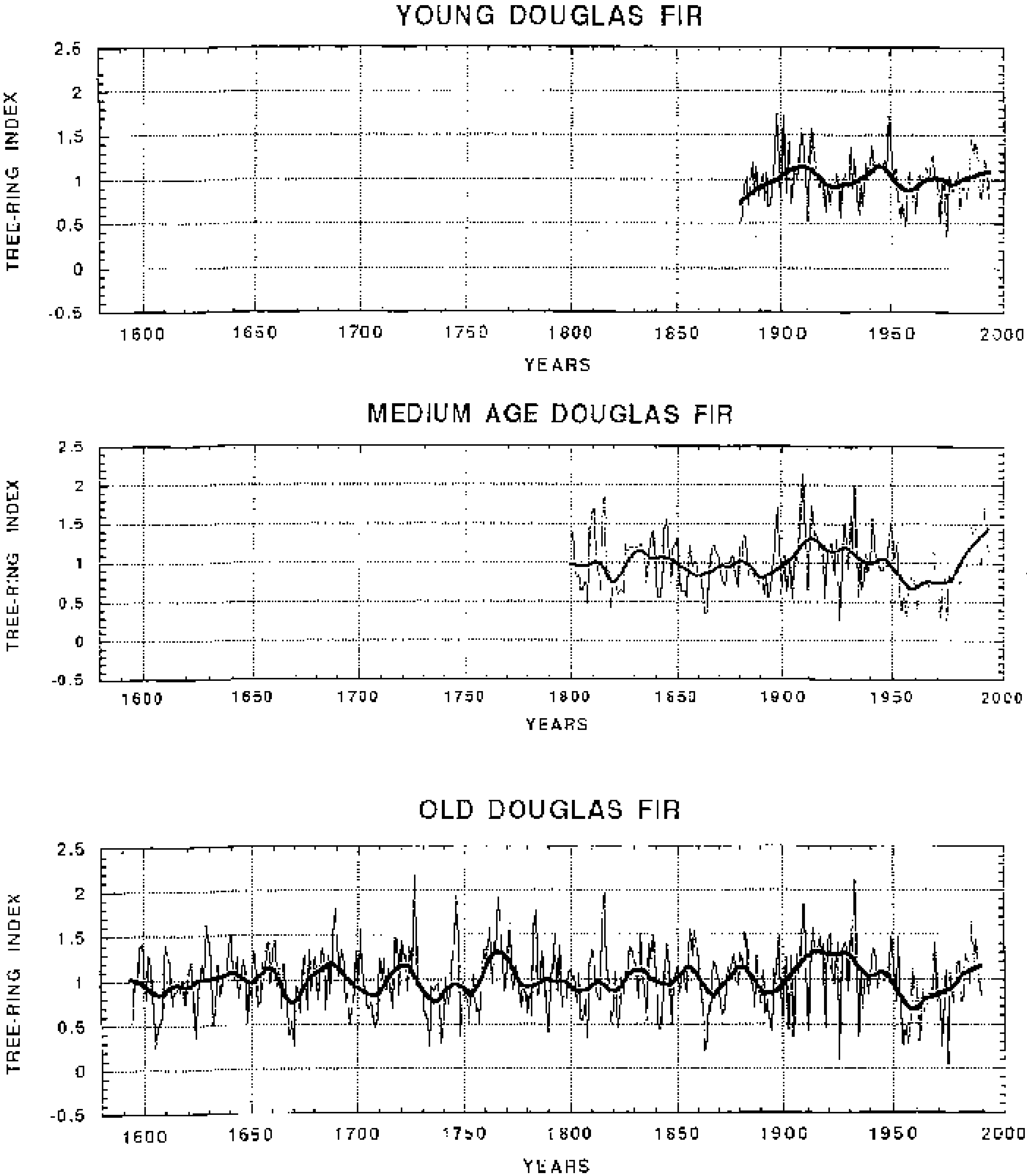


FIGURE 8. ONION SADDLE OLD VS. YOUNG DOUGLAS FIR
NEGATIVE EXPONENTIAL/LINEAR STANDARDIZATION

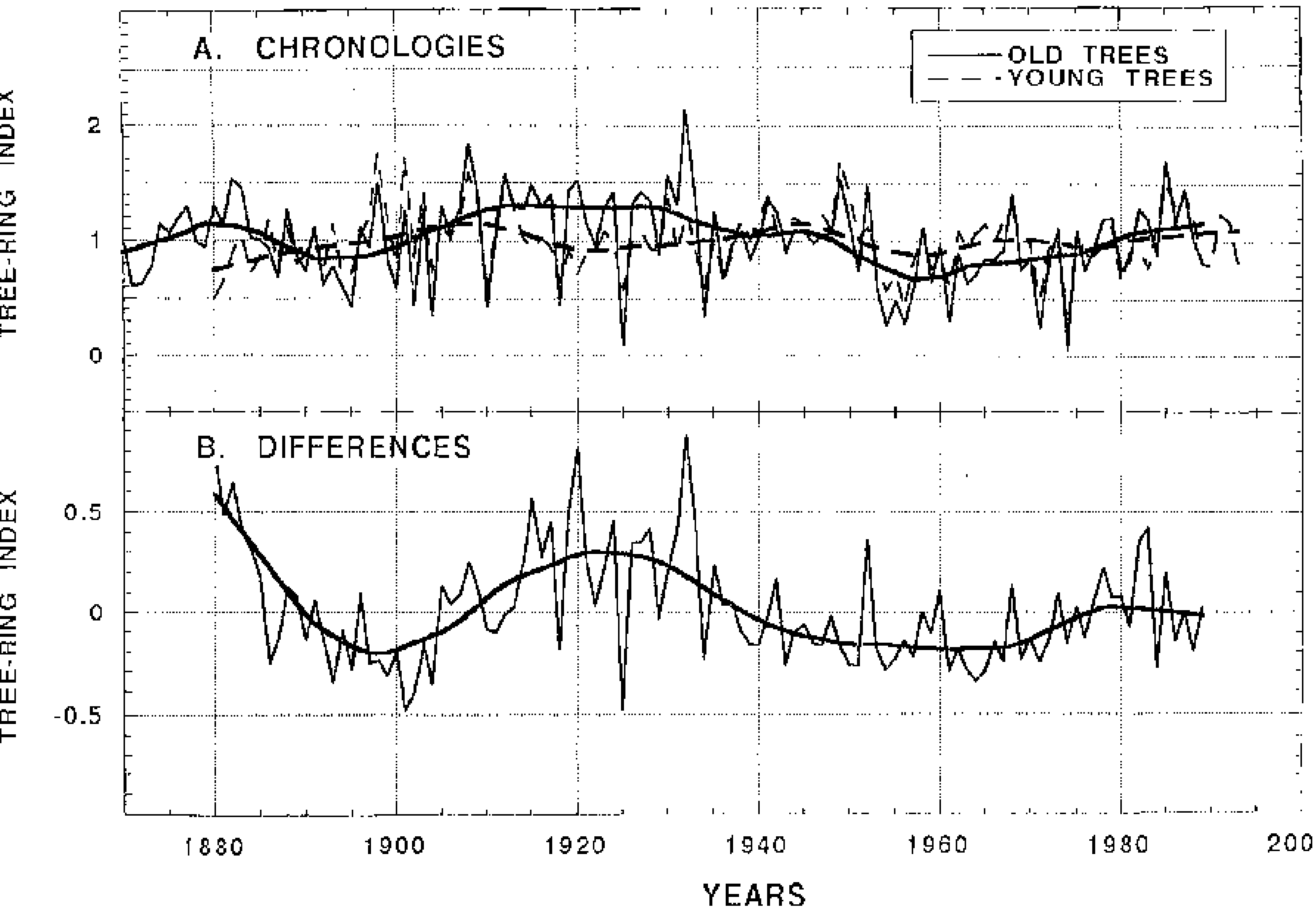
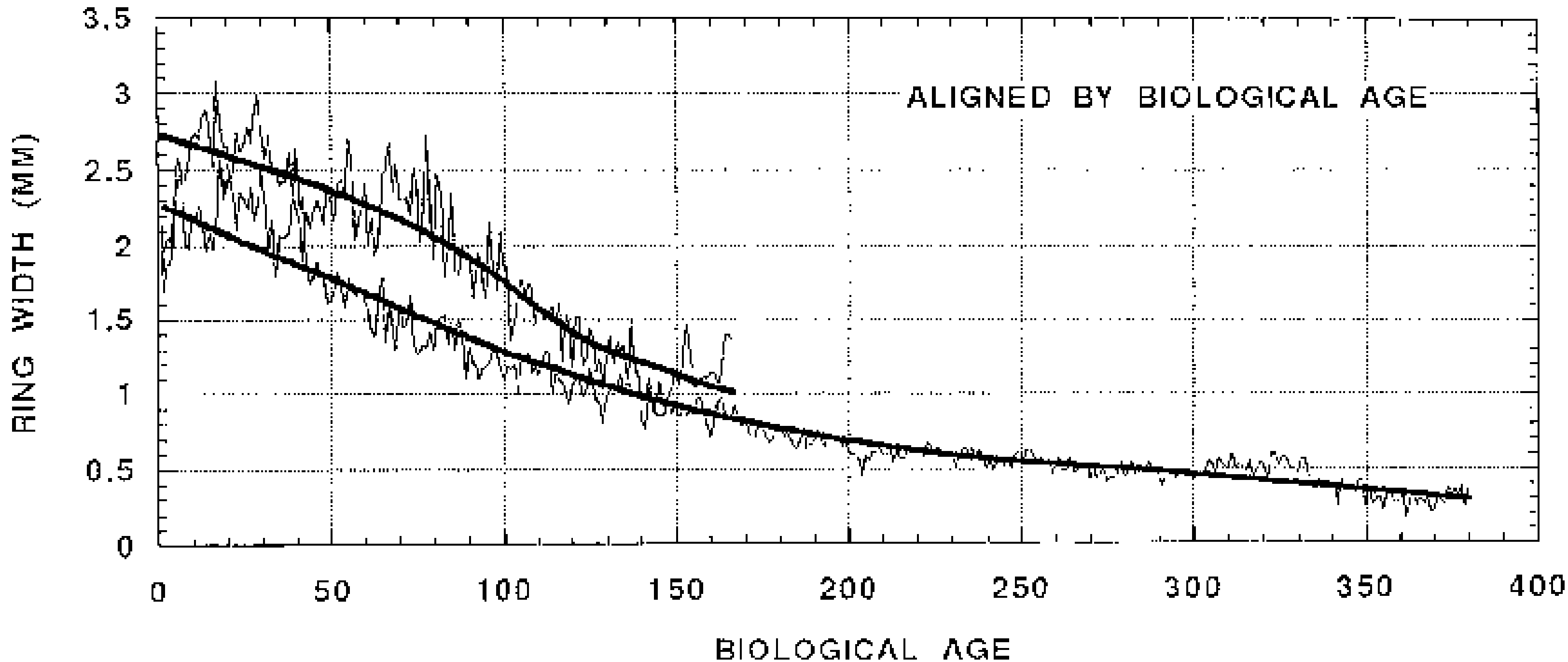


FIGURE 10. ONION SADDLE YOUNG AND OLD DOUGLAS FIR



PPENDIX 1. COFECHA output for young Onion Saddle/Upper Pinery Canyon Douglas Fir.

						CORR	//----- UNFILTERED	----\\			//-------- FILTERED	--------\\			
SEQ	SERIES	INTERVAL	NO. YEARS	NO. SEGMT	NO. FLAGS	WITH MASTER	MEAN MSMT	MAX MSMT	STD DEV	AUTO CORR	MAX VALUE	MEAN SENS	STD DEV	AUTO CORR	AR ()
1	os1-1	1949 1993	45	1	0	.818	1.53	2.63	.455	.180	1.52	.347	.271	.000	1
2	os1-2	1949 1993	45	1	0	.508	2.02	3.88	.700	.360	1.59	.371	.312	.006	1
3	os2-1	1933 1993	61	2	0	.843	1.71	2.69	.524	.359	1.52	.265	.267	-.006	1
4	os2-2	1939 1993	55	2	0	.797	1.96	3.43	.571	.253	1.64	.317	.269	.003	1
5	os3-1	1945 1993	49	1	0	.822	1.87	2.98	.575	.200	1.62	.340	.284	.001	1
6	os3-2	1933 1993	61	2	0	.835	1.76	3.18	.604	.389	1.68	.304	.277	.001	1
7	os4-1	1916 1993	70	3	0	.857	1.74	4.42	.692	.475	1.81	.330	.324	-.034	1
8	os4-2	1922 1993	72	3	0	.800	1.97	4.04	.669	.469	1.91	.302	.303	.007	1
9	os5-1	1945 1993	49	1	0	.858	2.34	5.42	.990	.260	1.93	.424	.387	.007	1
10	os5-2	1936 1993	58	2	0	.718	1.37	2.88	.554	.112	1.95	.447	.373	.000	1
11	os6-1	1919 1993	75	3	0	.814	2.54	5.79	1.136	.677	1.87	.318	.340	.010	1
12	os06s	1916 1993	78	3	0	.790	2.42	5.08	.923	.627	1.65	.316	.316	-.063	1
13	os09n	1858 1993	136	5	0	.887	1.87	4.60	.834	.610	1.84	.352	.337	.023	1
14	os09e	1875 1993	119	4	0	.918	2.44	7.11	1.234	.630	2.05	.384	.373	.004	1
15	os09s	1874 1993	120	5	0	.896	1.75	4.32	.896	.641	1.82	.378	.327	.014	1
16	os10n	1838 1993	156	6	0	.788	1.58	4.48	.982	.689	2.60	.400	.403	.014	1
17	os10s	1880 1993	114	4	0	.536	1.16	4.39	.817	.616	2.19	.449	.433	-.017	1
18	os11-2	1683 1993	311	9	1	.616	1.19	5.25	.902	.801	2.47	.362	.403	.007	1
19	os12-2	1782 1993	212	8	0	.712	1.78	6.27	1.278	.828	2.08	.358	.339	.019	1
20	os100-1	1958 1993	36	1	0	.783	3.70	6.40	1.149	.284	1.57	.321	.294	.022	1
21	os101-3	1918 1993	76	3	0	.809	2.64	5.19	.962	.526	1.73	.286	.265	-.011	1
22	os101s	1927 1993	67	2	0	.883	2.50	4.72	.828	.395	1.84	.311	.399	-.030	1
23	os18n	1953 1993	41	1	0	.617	2.55	7.03	1.074	.305	2.16	.303	.313	-.002	1
24	os19s	1914 1993	80	3	0	.801	2.23	5.12	1.080	.739	1.60	.319	.284	.005	1
25	os19n	1924 1993	70	3	0	.882	2.73	4.96	1.056	.614	1.50	.316	.268	.000	1
26	os20n	1923 1993	71	3	0	.812	2.18	3.36	.590	.305	1.51	.272	.246	.022	1
27	os20s	1919 1993	75	3	0	.788	2.01	4.05	.623	.470	1.58	.274	.252	.008	1
28	os21n	1932 1993	62	2	0	.914	2.46	5.01	.832	.357	1.62	.328	.277	.001	1
29	os21s	1923 1993	71	3	0	.855	1.93	3.64	.638	.229	1.64	.369	.297	-.001	1
30	os24e	1818 1993	176	7	0	.783	2.41	6.53	1.309	.671	2.27	.406	.375	.002	4
31	os25w	1923 1993	71	3	0	.504	2.04	4.93	1.037	.603	2.02	.427	.402	-.003	2
32	os28e	1772 1993	222	9	0	.796	1.73	6.00	1.285	.815	2.24	.350	.365	.019	1
33	os28s	1761 1819	59	2	0	.769	3.26	6.88	1.383	.693	2.05	.269	.326	-.008	2
34	os29n	1880 1993	114	4	0	.811	1.57	3.14	.597	.366	1.79	.359	.307	-.003	1

Frequency can be defined as the recurrence interval of events over a given observation period (Dunne and Leopold 1978), and is the reciprocal of the probability of occurrence (Benson 1962). Magnitude will be defined as instantaneous peak discharge, determined by measuring channel morphometry and flood scar height above the present channel.

Study Site and Methods

The study site is located along a 2 km stretch of Pine Canyon (31° 55' N, 109° 20'W). The selection of this site was based upon its proximity to a rain gauge station at Rhyolite Canyon, about 8 km to the northwest, and the presence of several flood scarred trees. Sampled trees ranged in elevation from about 1800 to 2000 m. All sampled trees were either Ponderosa Pine (*Pinus ponderosa*) or Apache Pine (*Pinus engelmanii*)

Wedges were collected using a chainsaw from six flood scarred trees at the base of the bole where the injury occurred. Previous research has demonstrated that this sampling strategy rarely results in the death of the tree. Cores were collected from undamaged portions of the same trees to aid in crossdating of flood scars. An additional five flood scarred trees were sampled using only an increment corer. Multiple cores were extracted around the injured region of the trees to precisely date the scar. Nine unscarred trees located in the vicinity were cored to create a site chronology.

Two additional trees probably recorded the same flood event but the dating is uncertain. A further six trees recorded a flood event between November 1952 and the onset of growth in Spring 1953.

Height measurements of six scars suggest that the 1952/53 event may have been of greater magnitude than the 1943 event. A t-test, however, indicated no significant difference between the height of scars between two events at $P \leq 0.1$. The flood velocity was calculated to be 1.7 ms^{-1}, resulting in a peak discharge of 40 m^3s^{-1} for the 1952/53 event.

Discussion and Conclusion

Rainfall records are available for Rhyolite Canyon from 1949 to present. An above-average daily rainfall of 30.4 mm was recorded on the 17th November 1952. This may have led to the flood event.

Only floods that exceed a certain discharge and thus shear stress threshold are able to scar trees. Therefore, the calculated flood frequency distribution is truncated at the point of a critical discharge. Based on a well replicated 70 year record a tentative "extreme flood" recurrence interval of 35 years can be assigned to Pine Canyon. Due to the short length of the observation period this value must be considered very carefully and requires further investigation.

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Conclusion:

The North American Dendroecological Fieldweek is a live and learn program that relies on the self motivation of it's participants. Its' purpose is to advance the field of dendrochronology by actively involving as many contributions by scientists and students from various fields and schools as possible. By relocating each year it presents participants with new and different ecological circumstances to test their problem solving skills. This interdisciplinary and ecological diversity combine to make the Fieldweek the attractive program it has become.

Acknowledgments:

The organizers of the 5th Dendroecological Fieldweek wish to thank the following people and institutions for their gracious donation of time and resources in order to make this program possible. We wish to start with the the individuals who gave willing their time and effort to share information and expertise beginning with the six invited group leaders, Alex McCord; Laboratory of Tree-Ring Research (LTRR), University of Arizona, Henri Grissino-Mayer; (LTRR), Fritz Schweingruber; Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, Switzerland, Edward R. Cook; Tree-Ring Lab, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, Emilia Guttiérez; Universitat de Barcelona, Spain, Keith Briffa, University of East Anglia, Norwich, UK.

We also extend our personal thanks to Tom Swetman and Chris Baisan (LTRR) who came to spend a day with our group showing us interesting attributes of the local environment and basic skills in increment core collecting. We gratefully acknowledge and appreciate the support of Hal and Miriam Fritts who shared so much valuable information with our group and provided additional support in the form of demonstrating various ways to analyze and access tree-ring data. Dave Lawerence, University of Virginia, for helping out with picking up supplies and people and getting everyone to meals and seminars on time. To Wade, Emily and Skylar Sherbrooke, the Directors family of the Southwestern Research Station, and all the staff at Portal who made our stay a most pleasurable one, we express our sincerest thanks.

We would like to thank the following institutions and their staff for providing us with support both logistical and economic beginning with our own: The Glacier Research Group, of the University of New Hampshire, and The USDA Forest Service, Rocky Mt. Research Station. Finally our gratitude goes to all the people and friends at the following labs and offices, The Laboratory of Tree-Ring Research, of the University of Arizona, The Tree-Ring Lab, Lamont-Doherty Earth Observatory of Columbia University, and the Office of Cooperative Science and Technology, US. State Department. Thank you all very much.

Paul J. Krusic　　　　　　　　Peter M. Brown

June 6, 1994