

FIRE AND CLIMATE INTERACTIONS IN LEFT HAND CANYON, COLORADO

A Dendroecology Fieldweek Project  
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by

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INTRODUCTION

Wildfire is a fundamental ecosystem process. Reconstructions of fire history provide estimates of past spatial and temporal changes in fire regimes. Documenting the historic patterns of these changes, and their interactions with climate variations and human land use practices is an important contribution to improving our understanding of forest dynamics. For example, accurate interpretations of the developmental history, current age structure, and species composition of forest stands depends upon knowledge of past fire history. Furthermore, fire histories in "near-urban" landscapes can provide an important historical and educational perspective for land managers and home owners. A parallel exists between the lack of foresightedness in the building of homes within fire-prone forests and along flood-prone river courses. In this regard, fire (and flood) histories offer some insights on potential hazards and changing conditions.

Detailed fire histories of past surface fire regimes in ponderosa pine (Pinus ponderosa Laws) stands can be reconstructed using tree-rings and fire scar analysis (see for example Baisan and Swetnam 1990 and Goldblum and Veblen 1992). These are typically "case studies" that offer unique insights into the

Disks or wedges were sawn from six stumps, eight dead and down logs, one standing snag, and three live trees that exhibited fire scars. The method described by Arno and Sneek (1977) was used to remove the partial sections from the live trees. Fragmented samples were glued onto plywood sheets. All samples were sanded with belt sanders using 40-400 grit belts. Skeleton plots of the ring widths were prepared for each specimen (Swetnam et al. 1985) along selected radii, away from the fire scarred areas if possible. Tree-ring index chronologies from nearby Boulder Canyon (International Tree-Ring Data Bank No. CO521) and Chicago Creek (ITRDB No. CO060) were used to crossdate the ring series on the skeleton plots and the wood. Fire scars and other fire indicators were then dated by observing their relative positions in the dated tree-ring series. "Other indicators" included obvious growth releases or suppressions, traumatic resin ducts, and ring separations. Intra-ring positions of fire scars were also determined where possible (Dieterich and Swetnam 1984, Baisan and Swetnam 1990) (see Figure 2). Fire scar dates, relative positions, and other indicator dates were compiled and mean fire intervals, standard deviations, and ranges were calculated. Fire dates were listed on a master fire chronology chart.

Spatial and temporal climate patterns associated with fire dates were investigated. The program DIFMAP (Fritts 1991) was used to estimate spatial anomalies of precipitation and temperature in the United States during fire years recorded by fire scars in Left Hand Canyon. The anomalies were computed as the percent normalized differences between eleven fire years and the remaining non-fire years during the period 1602-1911. Temporal patterns were studied using a superposed epoch analysis and reconstructed precipitation time series for Cañon City, Colorado meteorological station (Fritts 1991), which was the closest station with reconstructed precipitation data available to us.

of confidence we can assign to the possible fire dates recorded only by other indicators. Goldblum and Veblen (1992) also found that the use growth releases for determining fire dates was "problematic" because of variable delays in growth responses of trees following fires. They did not identify or discuss growth suppressions or the other kinds of indicators we observed.

Among the 41 fire scar dates we identified on our samples 17 of these scars were classified as "dormant" season scars (Table 1), although two of these scars (LHC 5 - 1860; LHC 15 - 1748) may have been early-earlywood (i.e., within the first one third of the early wood). This "split-decision" was necessary because some earlywood tissue may have been present preceding the scar, but certain visual identification of this was not possible with these samples and the microscopes that were available. The remaining scars were classified as: early-earlywood - 2, middle-earlywood - 2, late earlywood - 5, latewood - 0, and unknown or unidentified (because of decay, small rings etc.) - 10. There appeared to be some consistency of these fire scar positions among the different trees recording the same fire date. For example, the 1748 fire probably occurred early in the growing season since two trees were classified as earlywood (no sub-classification within the earlywood was possible because of smallness of this ring) and the third tree (LHC 15) recorded a dormant season or early-earlywood scar. The 1860 fire was recorded primarily by dormant season scars, but one tree (LHC 2) clearly showed an earlywood scar and another tree (LHC 5) had either a dormant season or early-earlywood scar (as mentioned above).

In most cases dormant season scars were assigned the annual date of the adjacent earlywood. This is a convention we have followed in southwestern North America studies (e.g., Arizona, New Mexico and northern Mexico) (Dieterich and Swetnam 1984, Baisan and Swetnam 1990), and it may be appropriate in

crossdated. Despite the fact that the Front Ranges were heavily impacted by logging, mining, and fires in the late 1800s and early 1900s (Veblen and Lorenz 1991) it is still possible to locate old remnant material and living trees. This point is further illustrated by our sampling and dating of several ancient Douglas-fir trees on Frankenberger Point (see Figure 1). We cored at least 4 living trees here that are over 500 years old, and one tree had an inner ring date of 1336. The Douglas-fir were in a very rocky site, and both these trees and the old living ponderosa pines we sampled for the fire scar analysis were rather stunted and had many branches. We speculate that the low lumber value of these trees is the reason why they were not harvested during the settlement era. Nevertheless, our success at finding and dating remnant material suggests that even where intensive harvesting did take place, it may still be possible to reconstruct very long fire and climate histories in this region.

Our reconstruction documents a reduced fire frequency in the 19th and 20th centuries relative to earlier centuries. This is in contrast to the Goldblum and Veblen (1992) (G & V) study (see comparison in Table 2). They found higher fire frequencies during the settlement era (post-1840) and attributed this to active burning by settlers, and miners, and accidental fires set by railroad locomotives. Interestingly, our study recorded three of the largest fires documented by G & V (1894, 1860, and 1721), but not their smaller fires of the late 1800s and early 1900s. Direct comparisons of G & Vs and our fire frequency estimates are probably not valid because we sampled a much smaller area and fewer trees. The relative temporal changes in these different estimates (Table 2) may be a more valid comparison, so long as site differences are kept in mind. For instance, besides being smaller, our area was located down slope from the old railroad grade, whereas their site was crossed

the consistency of the spatial analysis, despite the lack of statistical significance, suggests that fire occurrence in ponderosa pine forests of the Colorado Front Range may be associated with larger scale climatic patterns. One synoptic scale pattern that may relate to the consistent fire-associated dry contours shown in previous seasons (fall through spring) in the Central Rockies and to the west (Figure 4) could be the Great Basin High. This pattern is sometimes responsible for powerful Chinook Winds that can rapidly dry out Front Range forests prior to or early in the fire season. This may set the stage for large fires during the fire season. The superposed epoch analysis also suggests that some year-to-year climatic patterns, such as persistent dry conditions, may be associated with historic fire events. However, these results were not conclusive because the means were not statistically significant. It is possible that more locally specific climate reconstructions from tree-ring sites closer to fire history study areas would provide clearer and more conclusive evidence of a climate-fire associations. Given that very old and sensitive pines and Douglas-fir can be found here, it seems likely that such reconstructions could be developed. Additional well-dated fire history reconstructions in other watersheds in the region would also be useful in providing a network of sites, from which synchronized fire dates (if they exist) could be used to study regional fire climatologies.

#### ACKNOWLEDGEMENTS

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Table 1. Fire scar and fire indicator dates for sampled trees in Left Hand Canyon, Colorado. Fires recorded by fire scars (FS) include an estimate of relative position within the annual ring. See codes below the table.

Fire	Tree Identification Number															
	1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18
1531												FS-U				
1542						FS-U					FS-EE	FS-E				
1579						FS-LE		FS-LE							S	
1608														FS-E		
1611											RS					
1620													S		S	
1622								S								
1638						FS-U	FS-ME									
1642											RS					
1648						R										
1654												FS-U	FS-EE	FS-LE		
1681						FS-LE										
1710					?		S									
1713																S
1721						FS-LE			FS-U	FS-ME				S	S	
1728								?								
1735					RD											
1748					FS-E		FS-U			FS-U		FS-E	FS-D/EE			
1760																FS-U
1791																FS-U
1809			S													
1818				S									S			
1860	FS-D	FS-E	FS-D	FS-D	FS-D/EE	FS-U	FS-D					FS-D	FS-D		FS-D	
1876							?									
1894	FS-D	FS-D	FS-D	FS-D	FS-D							FS-D				FS-D
1911	FS-D															

D - Dormant Period, ME - Mid Earlywood, E - Earlywood, LE - Late Earlywood, EE - Early Earlywood, U - Unknown  
 S - Suppression, R - Release, RD - Resin Duct, ? - Uncertain, or unknown type of injury, RS - Ring Separation

Figure 1. Map of Left Hand Canyon, Colorado and fire scarred tree sample locations. The larger scale map shows the study area location relative to the Goldblum and Veblen (1992) study area.

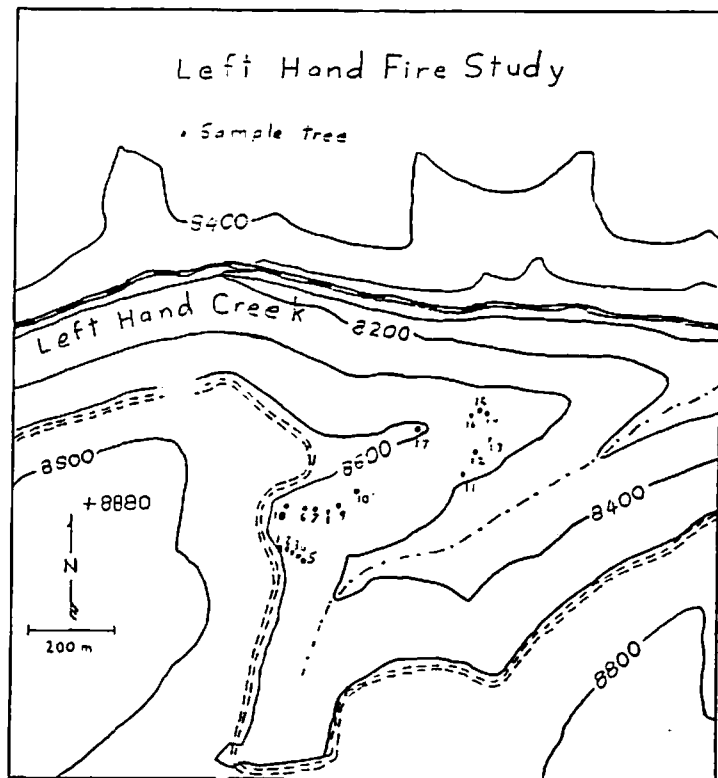
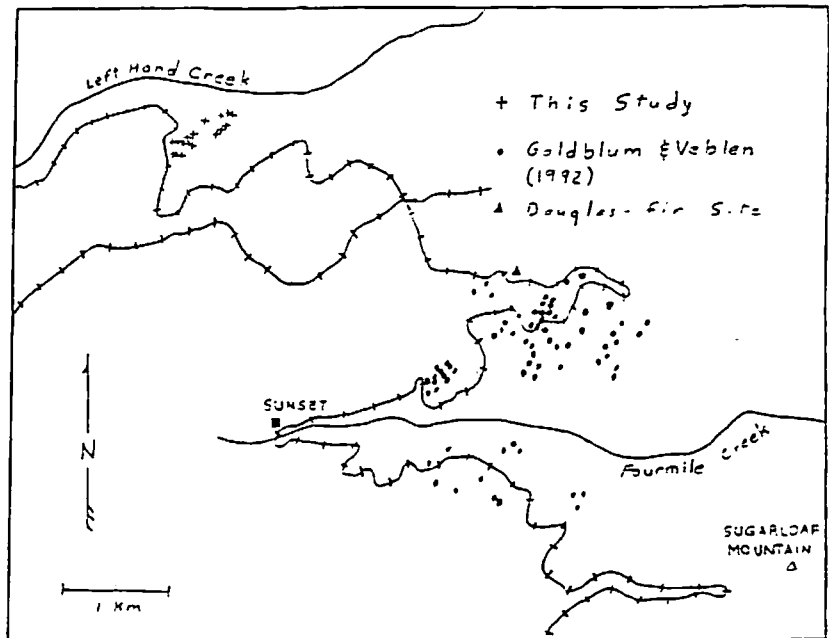


Figure 3. Master fire chronology chart for Left Hand Canyon, Colorado.

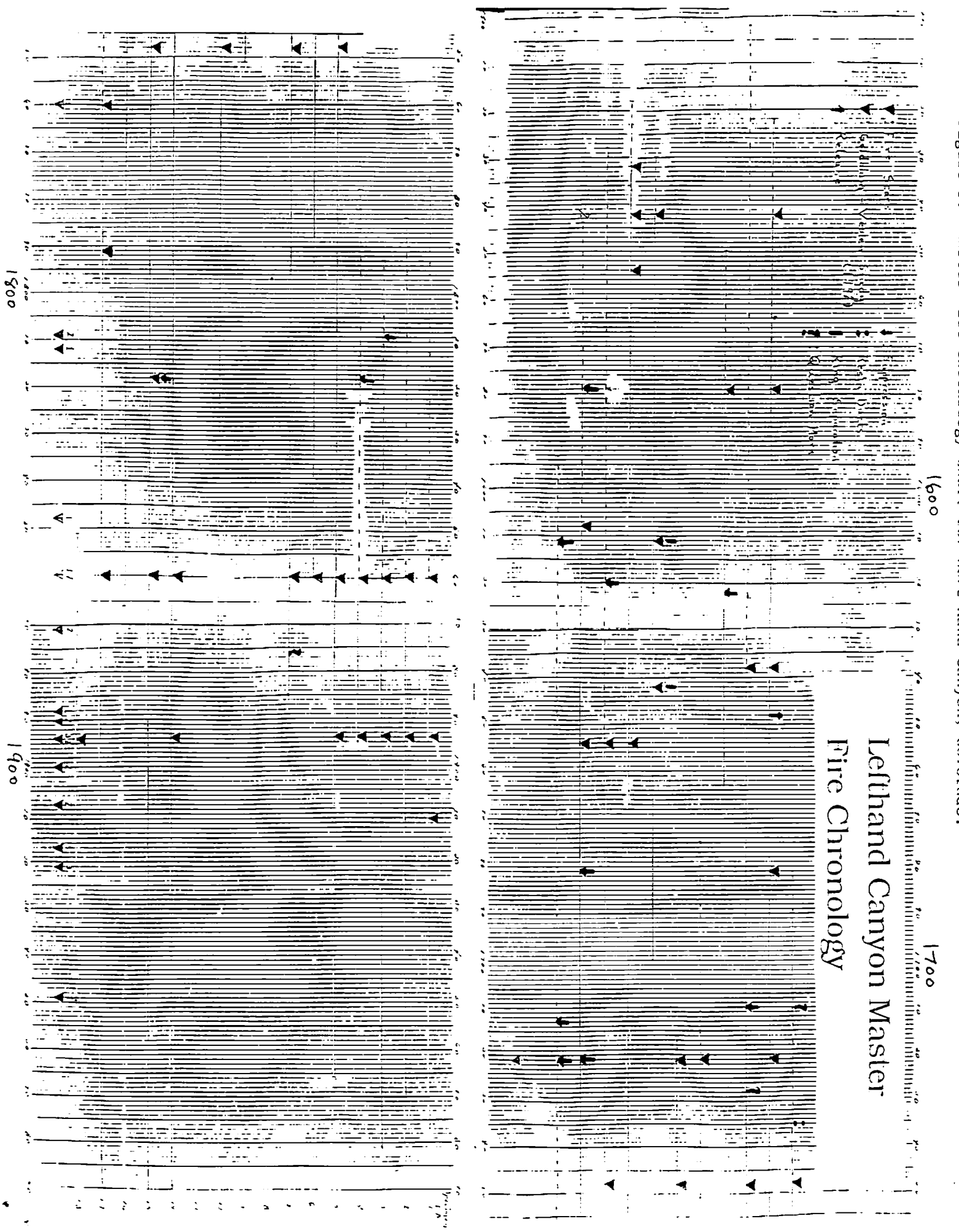
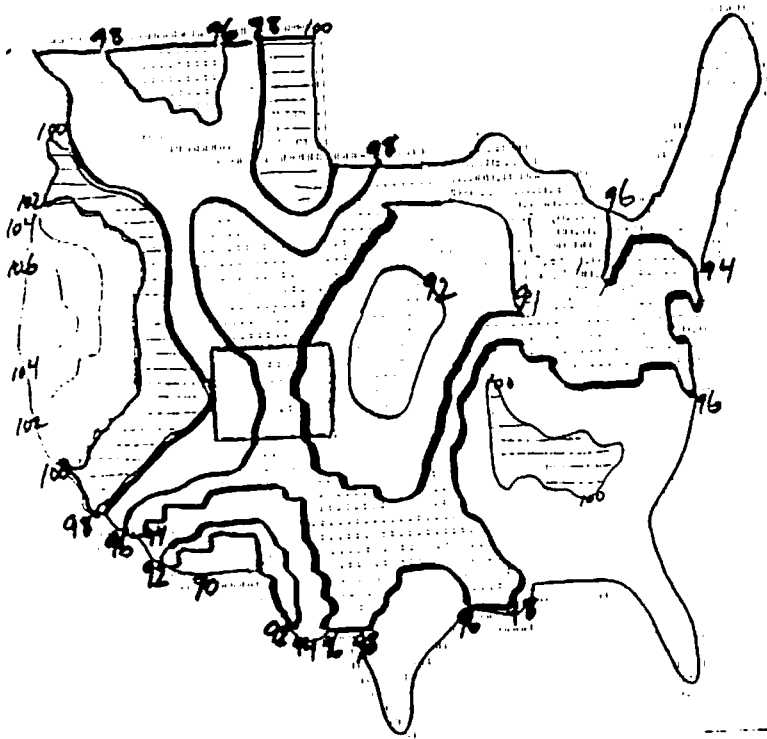
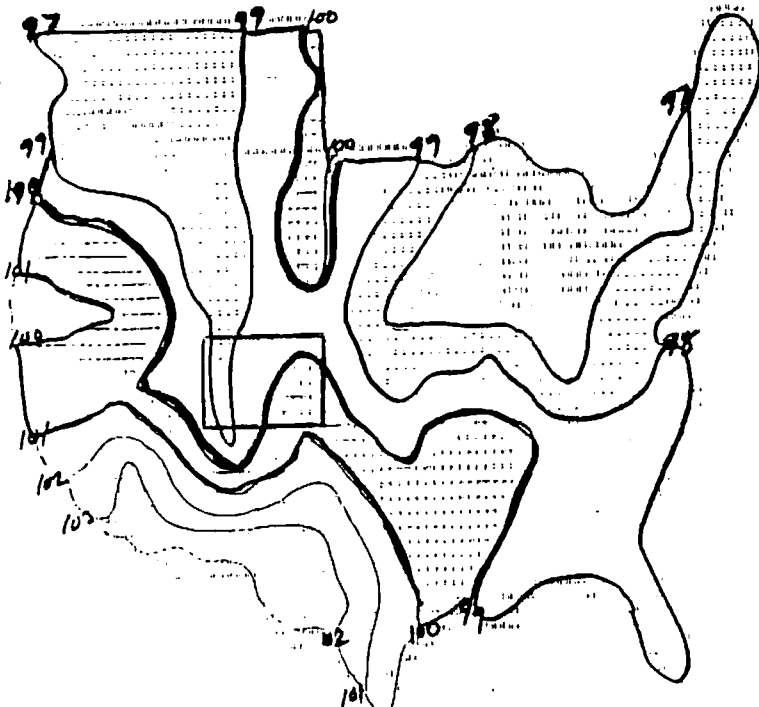


Figure 4 (continued).



March - May



Annual -  
January -  
December