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Iowa's Oldest Oaks[1]

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Tree-ring analysis revealed 33 living white oaks (*Quercus alba*) in Iowa that began growing before 1700. We analyzed cores of wood 4 mm in diameter, each extracted from a radius of a tree trunk. The oldest white oak, found in northeastern Warren County, began growing about 1570 and is thus over 410 years old. We also found a chinkapin oak (*Quercus muehlenbergii*) over 300 years old. Ring widths from the white oaks are well correlated with total precipitation for the twelve months preceding completion of ring formation in July. Reconstructions of annual (August-July) precipitation for 1680-1979, based on the tree rings, indicate that the driest annual period in Iowa was August 1799-July 1800, and that the driest decade began about 1816. Climatic information of this kind, pre-dating written weather records, can be used to augment those records and provide a longer baseline of information for use by climatologists and hydrologic planners.

INDEX DESCRIPTORS: Oldest Trees, Tree Rings, Past Climate, Oak Trees, Dendrochronology

Several oaks approaching or exceeding 300 years of age have been discovered in Iowa as a result of studies aiming to reconstruct the climatic history of the region from tree-ring widths. Prior to this study, very few Iowa trees over 300 years old of any species have been noted. Landers (1977) has found living eastern red cedar (*Juniperus virginiana*) over 400 years old at Palisades-Kepler State Park and a living bur oak (*Quercus macrocarpa*) 400 years old near Sutherland in O'Brien County. Anderson (1938) reported an eastern red cedar dating from A.D. 1516.

White oak (*Quercus alba*) was selected as the primary species for our study because it is widely distributed and long-lived. The maximum age for this species is given by Harlow et al. (1979) as 400-500 years and by the U.S. Department of Agriculture (1965) as 600 years. However, we could find no documentation of the trees on which these estimates are based.

MATERIALS AND METHODS

Site selection was made primarily by canvassing state parks and other areas in central and northeastern Iowa. The oldest trees are often found on rugged terrain, where they have survived cutting because of their relative inaccessibility and their often contorted shapes (Fig. 1), which make them undesirable for lumbering. Old white oaks (older than about 200 years) can usually be distinguished from younger trees by the twisted and gnarled appearance of the crown and by the spiral bark contours and burls, or knots, on the trunk (Fig. 2). Although we have not searched outside of central and northeastern Iowa, old oaks could probably be found in other parts of the state, especially in eastern and southern Iowa where white oaks are common.

Ring-width data are obtained by using an increment borer to remove a core of wood about 4 mm in diameter from two or more radii of the trunk, at breast height, about 1.25 m above the ground. This procedure does not harm the tree, though pruning spray is often applied as an added precaution after a core is extracted. The tree core is preserved by gluing it into a fitted groove in one side of a core-mounting stick, a piece of wood about 1 cm^2 on the ends and cut a few mm longer than the core to be mounted. The cores are sanded down until the ring structure is clearly visible. The rings are dated by calendar year, measured, and analyzed for climatic information content. More detail on the sampling and laboratory procedures is found in Stokes and Smiley (1968). Further information on the tree-climate relationships and their applications is found in Fritts (1976).

RESULTS

Table 1 lists the 34 white oaks (and one chinkapin oak, *Quercus muehlenbergii*) for which the actual or estimated beginning of growth (pith date) is prior to 1700. Fig. 3 shows the locations of the nine sites where these trees are found.

The oldest white oak is located on a ridge top in northeastern Warren County. One core taken from this tree crosses the pith which formed in 1573. In that year the tree was a sapling about 1.25 m tall (the height at which the core was taken), so the acorn would have germinated several years earlier, probably before 1570. This living tree is now at least 410 years old. It grew quite slowly in its first 200 years and more rapidly after about 1780 when its competition for light and water may have been reduced by the death of neighboring trees.

Only one other white oak has been found which appears to have begun growing before 1600. This tree is in White Pine Hollow in northeastern Iowa. The center of this tree has unfortunately rotted, preventing determination of the exact pith date (this was also the case for several of the other trees listed). The earliest ring on a core from this tree was dated at 1630. The pith date was estimated to be 1580, using the curvature of the innermost rings and assuming a growth rate similar to that observed on the inner part of the core.

Fig. 1. The first author using a Swedish increment borer to extract a core of wood from a contorted white oak growing on a steep bluff slope.

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Fig. 2. Bole of a white oak over 340 years old showing burls, gnarled limbs, and spiral bark contours typical of old oaks.

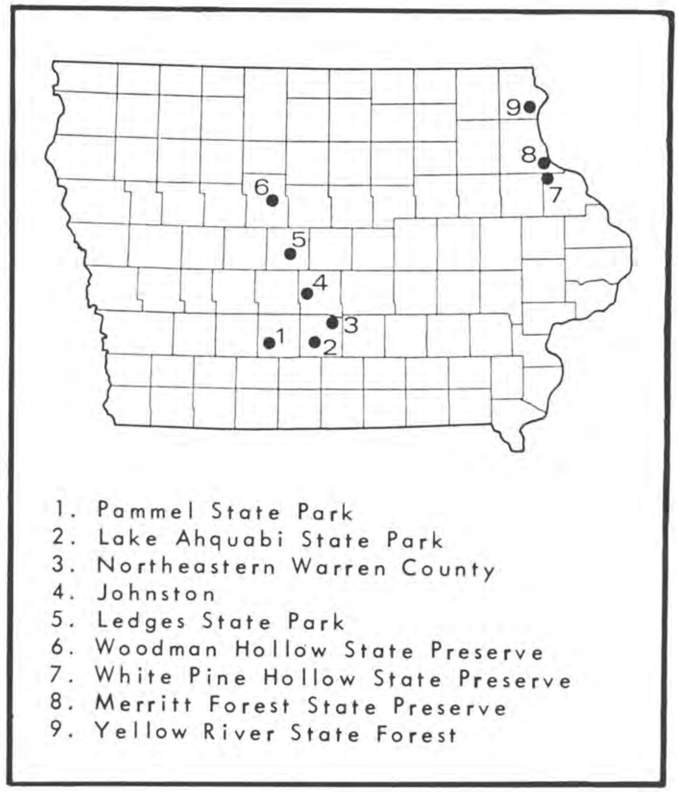

Fig. 3. Sites in Iowa containing old oaks.

Cores passed through the piths of only four of the trees listed in Table 1 (those with the first ring indicated as "pith"). Only one of the white oaks was dead when sampled (tree no. 9, Table 1). The pattern of wide and narrow rings near the outermost edge of the core was compared with recent rings of cores from living trees to obtain a cross-match to determine the year in which the dead tree put on its last ring. In this way we determined that the tree died after the growing season of 1975 but prior to the growing season of 1976.

Of the nine Iowa sites where we found trees dating to before 1700, the largest numbers of old trees were in Ledges (ten trees) and Pammel (eight trees) State Parks. At these parks, as well as at many of the other sites, the oldest trees were on ridge tops and upper slopes of rugged, ravine-dissected uplands bordering major river valleys. The area at Pammel where the oldest trees were found was described as a virgin forest by the park ranger.

One chinkapin oak represents the only species besides white oak included in our list. This was the only chinkapin oak sampled, but several other potentially old chinkapin oaks were seen at the Ledges site.

The scarcity of old oaks in Iowa is largely due to the fact that most of Iowa's forests have been cut since the state was settled in the mid-1800's. Numerous stands were found in which many of the trees sampled had pith dates that clustered between 1850 and 1885. At that time the original forest may have been clearcut, or nearby settlers put out prairie fires, allowing the trees to invade former prairie areas (Thomson and Hertel, 1981). In some cases, isolated trees over 200 years old were found surrounded by stands of younger trees that began growing shortly after settlement, and the older trees show a sharp increase in ring width about the same time. These older trees, which were left after the original forest was cut, grew more rapidly in the absence of competition from neighboring trees.

RECONSTRUCTING PAST CLIMATE

The width of each year's ring is strongly influenced by the total amount of precipitation during the 12-month period preceding completion of ring formation (roughly from the preceding August through the concurrent July). In a dry year, reduced soil moisture can slow the tree's physiological processes, resulting in less radial growth, while in a wet year more growth occurs. High temperatures in spring and summer reduce growth by causing increased respiration which consumes photosynthate and by increasing water loss through evapotranspiration. Thus, the narrowest rings are usually formed in hot dry years.

Ring-width chronologies developed from cores taken at the Pammel, Ledges, and Johnston sites in central Iowa were used by Duvick and Blasing (1981) to estimate annual (August-July) precipitation for Iowa, for each year since 1679-80. (Hereafter, the latter calendar year of the 12-month period is given. Thus, 1680 would imply August 1679 through July 1680.) In that study the ring-width series from

Table 1. Iowa oaks growing before 1700 (all white oaks except as indicated)

Rank	Estimated pith date	First ring on core	Location
1	1573 (Actual)	1573 (Pith)	N.E. Warren County
2	1580	1630	White Pine Hollow
3	1630	1650	Yellow River Forest
4	1630	1657	Yellow River Forest
5	1634 (Actual)	1634 (Pith)	Pammel State Park
6	1640	1642	Pammel State Park
7	1640	1647	Pammel State Park
8	1640	1652	Pammel State Park
9	1645 (Died 1975)	1654	Johnston
10	1650	1653	Pammel State Park
11	1650	1654	Johnston
12	1650	1662	Ledges State Park
13	1670	1676	Ledges State Park
14	1670	1680	Pammel State Park
15	1673 (Actual)	1673 (Pith)	Ledges State Park
16	1673 (Actual)	1673 (Pith)	Ledges State Park
17	1675	1687	Yellow River Forest
18	1675 (Chinkapin Oak)	1692	Ledges State Park
19	1675	1695	Woodman Hollow
20	1676	1677	Pammel State Park
21	1680	1683	Ledges State Park
22	1680	1685	Yellow River Forest
23	1680	1694	Ledges State Park
24	1680	1694	Ledges State Park
25	1680	1694	Johnston
26	1680	1698	White Pine Hollow
27	1680	1700	Johnston
28	1680	1710	Pammel State Park
29	1685	1698	Woodman Hollow
30	1685	1687	Ledges State Park
31	1690	1702	Lake Ahquabi
32	1690	1706	White Pine Hollow
33	1690	1714	Merritt Forest Preserve
34	1695	1705	Merritt Forest Preserve
35	1698	1704	Ledges State Park

each core was first statistically filtered to remove low-frequency variations due to factors such as tree age and competition effects.

The climatic reconstruction indicated that droughts have occurred regularly throughout the last 300 years, with about the same frequency in presettlement and postsettlement times. Since 1874, the first year of statewide precipitation records, the five driest years in both the actual and reconstructed series have been, in chronological order, 1894, 1931, 1934, 1956, and 1977. The reconstruction indicates that the 10 driest years since 1680, listed from driest to least dry, were 1800, 1934, 1894, 1736, 1743, 1977, 1704, 1956, 1931, and 1940. For the most recent dry year, 1977, the estimated value of 60.0 cm compares with a measured value of 55.7 cm. The estimated precipitation for 1800 was 51.3 cm, or at least 4 cm less than either the estimated or actual values for 1977. Normal annual precipitation (1920-1979) for Iowa is 80.2 cm.

The driest decade in Iowa in the 20th century, in both the actual and reconstructed precipitation series, was 1931-40 which includes the dust bowl years. Five decades comparable to or drier than the 1930's are indicated between 1680 and 1979. These are 1696-1705, 1735-1744, 1791-1800, 1816-1825, and 1886-1895. Actual climatic records indicate that 1886-95 was about as dry as 1931-40. In even the driest decades, drought years are often separated by occasional moist years (e.g., 1932 and 1935).

Precipitation for the very wet years appears to be estimated less accurately than for dry years because excess rainfall runs off and factors other than moisture become limiting to tree growth. However, the widest rings are usually formed during wet years. Periods indicated to have been especially wet include 1726-1733, 1745-1747, 1774-1781, 1802-1807, 1831-1837, 1875-1885, 1902-1909, and 1941-1947. The actual precipitation records covering the last three of these periods confirm that they were in fact wetter than normal. Further details and comparisons of reconstructed and recent climate are given by Duvick and Blasing (1981).

Analysis of annual rings of Iowa's oldest trees has contributed to a better understanding of the region's hydrologic history, providing long-term estimates of the expected frequencies of extreme events (e.g., dust bowl type situations). However, dust-bowl droughts or other extreme events may become more, or less, frequent in future centuries if, for example, the global climate warms in response to increasing amounts of atmospheric carbon dioxide.

Extending the climatic record back in time can also help scientists identify the mechanisms which cause the climatic fluctuations we observe. Solar activity, for example, has been indirectly measured (by sunspot numbers) since before 1700. Dates of large volcanic eruptions (e.g., Tambora in 1815) have also been recorded for hundreds of years. Both of these mechanisms are suspected of influencing climate on time scales of decades to centuries. However, continuous written records of climate are available in most places for only about the last hundred years. Therefore, if we are to substantiate or refute these hypothesized causes of climatic change, we must extend the climatic record by indirect means. Ring widths of old trees are extremely useful for this purpose.

The climatic study outlined above provides an example of how the preservation of our oldest trees has more than just aesthetic value. These trees are living records of their environmental histories, and we can learn nothing from those histories if the records are destroyed.

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