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TREE-RING ANALYSIS AND FIRE HISTORY OF THE MCCLAIN ACQUISITION ON THE BIG RIVER STATE FOREST

by

Richard Guyette

TREE AGE

Many of the dominant black jack oak (Quercus marilandica) on the McClain Acquisition appear to be members of an even age stand. All the oldest trees I cored were from regeneration that occured between 1860 and 1900. It is difficult to assess the ages of the older stands because so many of the trees are hollow. Also, the regeneration of this species can die back to ground level and sprout back repeatedly before producing a annual ring at breast height. In an area of repeated fires this could lead to major difference between the age of the stem (bole) and the age of the organism. The upper size classes (9 inches DBH and above) all had 100 rings or more. The differences in bole diameters were more a function of site and crown differences than age. Note the difference between core BRF006 and crossection BRF020. These samples are both from trees of approximatly 115 years in age (ring count + 10 years to grow to DBH). The DBH of the tree of core BRF006 was 22 inches compared to 7 inches for crossection BRF020. Thus, the large tree, with a crossectional area of approximately 380 square inches and at least twice the height had 10 to 20 times the biomass of the smaller tree which had a crossectional area of 38 inches. Site differences account for much of this. The larger dominant tree was growing on a low slope with competition and considerable leaf litter. The slow growing tree was at the edge of a blowhole in a sandy prairie area but with no competition from trees. There were a few trees, maybe three, that could have been older than 120 years but they were hollow, as injured members of the black oak group so often are. Sample BRF025 illustrates this problem. Open vessel elements and a wood with a high moisture content contribute to the heart rot of this species.

In summary the oldest trees on this site could all be from an even age stand in which there was die back of seedlings or sprouts. The site was probably cut in the 1860-1870 period. The lack of old poor form remnant trees which would not have been suitable for lumber indicates that the forest may have been cut for firewood and railroad ties. On prairie flora areas the black jack oak are on the average younger than those in forest sites.

REGENERATION

The dominant trees in this stand appear in many cases to originate from sprouts. They are often in clumps or have basal swelling indicative of sprout regeneration. Several periods of regeneration have taken place since the dominant trees came in around the 1860's, probably in conjuction with grazing, burning and good acorn years. Much of the area now in young trees came from seedling sprouts during a regeneration period about 40 years ago. These trees range between 7 and 2 inches DBH. Since this period there has been considerable regeneration from seed. I

cored and cut very few trees from the period between 1900 and the 1930.

Species composition is now beginning to diversify. Young trees of eastern redcedar, black cherry, dogwood and pine were noted.

FIRE HISTORY

There is little doubt that the vegetation of this area is a fire sub-climax. Unfortunately I can only compare this area to others I have studied for the period before 1870 because of the lack of old trees and trees with solid wood. The homogeneous species composition is typical of pioneer species on frequently disturbed sites. Perhaps the best evidence of a fire sub-climax is the prairie-forest mosaic where the prairie is now being quickly colonized by trees. This rapid colonization of the prairie pockets indicates that much of this area could not have sustained prairie without frequent fires. Some prairie areas are being invaded by black jack oak much slower than others, however. This indicates there is a second limiting factor, probably a soil factor linked to the fire frequency of the past. The frequency of fire is an important factor in soil formation-especially on a sandy soil like those of the Big River area. Fire frequency is affected by topography. Hilly areas such as the forested areas of the McClain Aquisition often have a lower fire frequency because the slopes can break up the fire. This can result in a more developed soil profile which in turn supports faster tree growth which in turn creates a more nutrient rich soil. Hardwood forests are also somewhat less likely to burn than prairies because of ignition and humidity factors. Thus, topography, fire frequency and feedback factors play a very important role in defining the prairie-forest border.

In Missouri, where I have done considerable work in fire history the prairie-forest mosaic has undergone similar changes to those of the McClain tract. With the coming of European man the frequency, intensity and spacial distribution of fires changed. The two main factors influencing the change seem to be human population density and grazing. With the coming of European man the frequency of fire increased in the woods and decreased (or became much less intense) on prairie lands. Indians often set fire to the prairie areas to attract game. Heavy grazing by domestic stock often reduced fuels on the prairie to the point where fires would not spread. Outside of the human ignition factor grazing was the most imortant factor influencing fire and it affected the forest and the prairie differentially. European man burnt the woods in order to increase the edible biomass available to his stock. This burning increased both the area of the the prairie and the amount of vegetation avaiable at ground level in the forest. Thus, burning changed the spacial distribution of vegetation both vertically in the forest and horizontally in the prairies to accommodate grazing. For the biologist, farmer and Indian, burning in a prairie-forest mosaic has the effect of increasing the available vegetation for grazers and decreasing the annual increment of woody mass produced. The trade off was wood for meat, the two perennial biomass sinks, and fire was the mitigating tool. It was not until the advent of over grazing and erosion; industrial forestry and wood production that fire became of negative value to humans.

FIRE FREQUENCY

In order to obtain an idea of the fire frequency of the McClain Aquisition 20 trees were cut to estimate the number of fires and their dates by dating injuries to the bole using tree-ring analysis. Of these 20 trees only 14 were dateable and had disturbance information. Many others had been scarred but were too rotten or hollow to date. I have compiled the dated injuries and other disturbances in the figures of this report. Most of the trees I sampled were from the central south west area of the McClain Aquisition. From these trees I was able to date 33 fire scars and several other injuries.

Fire scar data can be tricky to interpet. All scars are not necessarily fire scars. However the vast majority of scars in most forests are. Characteristic of fire scars in hardwoods are; large (40%-20%) basal injuries, injury to thin barked areas of callous tissue, crossdated injuries between trees (this is not always the case) and the occasional presences of charcoal on dead dry wood that has been exposed to fires. In the case of black jack oak the callous tissue on the many radial frost checks can be injured much more easily than the thick barked bole and thus can provide an record of fire injury. These longitudial-radial splits are not always caused by frost. I have included part of some work done by John Phelps (now with the National Forest Service in Carbondale, Ill.) who examined radial frost checking in black oaks.

The scar dates I use represent the calendar year of the first anomolous growth ring at the site of an injury to the bole. This means, for instance, that a scar date of 1923 could be the result of a fire which occured any time after the season of wood formation (May to July) in 1922 to the beginning of the season of wood formation in 1923. Occasionally fires occur during the season of wood formation and these can be dated as such, however I did not find evidence of this in these black jack oak. This period is usually the least likely fire period in eastern forests because of climate and moist green vegetation.

The data represented in the figures can be viewed in many different ways and has many potential biases. I'll try to present these biases as I go and let you be the judge. The first might be sample size, how representative are these trees? I sample and cored many more than these and found much the same story as these tell with the exception that many were much more hollow. From what I have seen working in the area these are a representative sample of the older trees and I think more effort would yield much the same data. The first thing that is apparent in the data is the frequency of scarring in the 1920's and 1930's. One might expect this in the 1930's because it was a time of extreme drought. But what of the 1920's and the few scars before then? The later part of the 1920's was a period of very good tree growth, both on the McClain Aquisition and elsewhere in Illinois.

The period before the 1920's is difficult to assess because of possible biases in sampling. The obvious one is the diminishing sample size back into time. There is however adequate sample depth back to 1900 during which time (1900 to 1919) there are only 3 fire scars compared to 21 fire scars in the 1920 to 1939 period. It is my opinion that there may well be a sampling bias here in that the trees I sampled with solid cores were the

only trees to have been missed by early fires and this is why they are solid in comparison to so many hollow trees. Thus, I may have biased the sample by selecting trees which were uninjured early in their lives and thus not rotted. Many of the hollow trees I sampled as well as those I did not sample may well have had scars with dates before 1919 at one time. On the other hand there may well be an ecological explanation. For instance, any change in grazing practices could account for this. Intensive grazing could have decreased the number and intensity of fires by reducing fuel loads and fire spreading. One might expect more mechanical injury during this period from grazers, this however was not evident. Other possible explanations for the lack of fire scars during the 1900 to 1919 period might have to do with the changing age of the forest stand, climate and changes in ownershhip; none of which I find very plausable. One thing that does point to a high fire frequency during the 1900 to 1920 period besides the number of hollow trees is the lack stems dating from this period and the next 20 years.

The fire of 1923 scarred not only the most trees in the time of record but also left some of the largest scars. It must have been extensive and hot. This fire is also probably responsible for many of the hollow trees whose record stopped about this time. There is only one growth "shutdown" (reduction in mean ring width) in this year-an indication that the fire was hot but did little crown or root damage to the majority of larger trees. The ring width index has only a slightly narrow ring value for 1923 - a sign of mild drought.

The 1920 to 1939 period had 11 fire scar years or an average of 1 fire every 1.8 years. I think that this figure probably represents a slighty higher fire frequency than was the case for the previous 200 years because of increased population density and the droughts of the 1930's. Studies I am now conducting have shown a positive correlation between population density and fire frequency. In much of the eastern non-coniferous forest human ignition factors are much more important than natural ones. The presettlement fire frequency of the McClain Aquisition was probably dependent on the number of people in the area. Estimates of presettlement fire frequency on Ozark glades is 1 fire every 3.2 years. I would suspect that the presettlement frequency of the McClain Aquisition may have been very similar to this.

DROUGHT

The ring width index in the figures was created from 9 trees selected for climaticly sensitive growth and ring sequences free from growth anomalies. Ring widths were crossdated and combined in a standardized index. This index is probably correlated with drought. The black oak group has some of the most drought sensitive ring widths of the tree species of eastern north America. This ring width index is highly correlated with a white oak tree ring index from 150 km east south east of the Big River State Forest at Lincoln's New Salem. The most consistently narrow rings in the index were 1890, 1931, 1934, 1936 and 1963. Many of these are know drought years throughout much of the Midwest. These narrow rings provide good control in crossdating. In general there was no tendency for scar years and narrow ring years to coincide. The exception to this was the dry decade of the 1930's, but even then I did not find many multipule fire scars

during the years of the most intense drought, 1931,1934 and 1936. This reflects the situation in much of the Midwest where fuel loading, ignition sources and the short dry periods that occur almost every year are the main factors in fire frequency.

DISTURBANCES

The growth trends in the ring-widths of many of the dominant trees I sampled both in forest and savannah sites approximated a negative exponential growth curve or a negative straight line fuction. This type of growth trend is typical for trees grown in open areas. There was no evidence of growth trends typical of climax forest regeneration such as narrow rings in the early part of a tree's life and wider rings later on when the tree breaks into the canopy. Some of the regeneration from after 1940 do show increasing ring widths with age as the young trees overcome the competition for light and come into dominant positions in the canopy. There were some black jack oak of smaller diameter (<7 inches) and heighth (<5 m) that had very narrow rings possibly resulting from crown damage and the effects of competition. In general however there was remarkably little disturbance effect in the ring width series of the dominant trees I sampled. There were only four slight growth "shutdowns" and no releases in all the trees I examined. This is interesting in light of the number of fire scars on the trees. It indicates that despite the number of fires in the area that there was little crown or root damage to the trees. There is also no evidence in the ring widths of short term growth responses to fire such as release. This data should be used with caution, however, in any management plans because conditions now may be considerably different than in the past - especially in the fuel structure of the forest edge where a hot fire might climb a fuel "ladder" into the canopy of dominant trees.

The longer term affects of fire on growth are considerably harder to document. Many of the older trees sampled have very narrow rings for the last 20 years. This could be in part due to increased competition caused by less frequent ground fires. The ring width and tree form evidence of past open stand development is not being repeated in the present regeneration. There are several other possible explanations for recent narrow rings however. Changes in soil acidity and slower nutrient cycling are two possiblities. Lower fire frequency can increase soil acidity. Also anthropogenic factors such as increased pH of precipitation could be a contributing factor. I think these soils would be extremely sensitive to changes from any variables affecting soil pH. Obvious growth reductions were not seen in younger trees, however, but they would be harder to detect. Another possible explanation for the recent narrow rings is the species. The black oak group is not known for longevity. I have only rarely seen individuals of this species over 150 years. Dieback of the crown and subsequent reduced ring width are a good sign these older trees have had a negative net energy balance brought on by age and/or the root competition of a changing site.

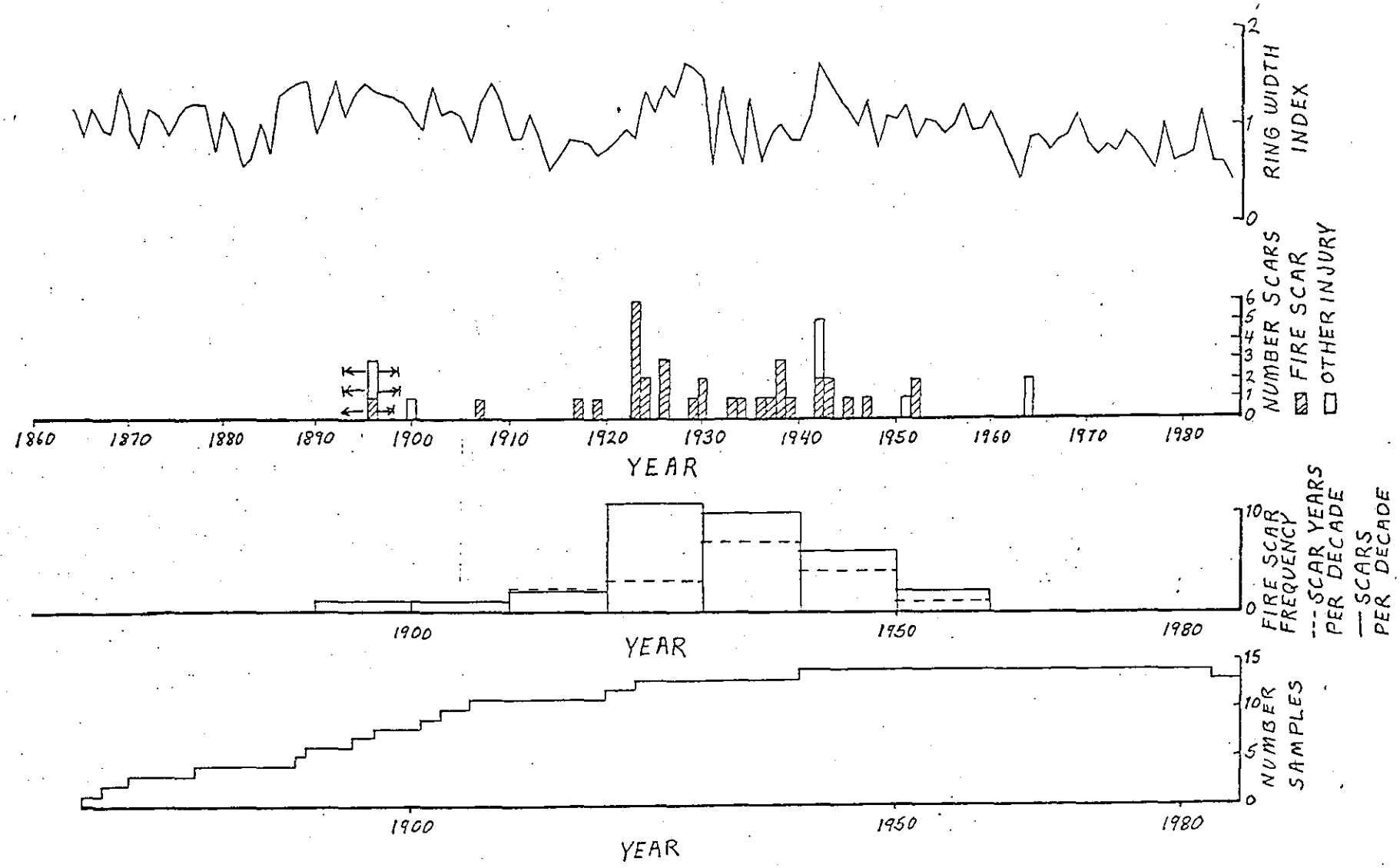
It would be interesting to monitor the decline in growth of these trees in relation to competition, soil changes and pathogens. I am reminded in some ways of the red spruce decline in the east when I look at this forest. There is a considerable amount of research effort is going into the causes of this decline

in the east and in Europe where the problems are worse. Although I have little reason to believe anthropogenic factors are the sole reason for the decline in growth on the McClain Aquisition, if I was looking for a sight that might be sensitive to the effects of acid precipitation, this would be one of the first.

WILDLIFE HABITAT

Although not strictly in the realm of tree ring analysis I did make some interesting observations concerning the wildlife and the trees present. Crossection BRF021 was taken from a tree at breast height. Originially the tree had a small hole from an insect and/or woodpecker. In the following years the tree's attempts to heal over the wound were thwarted by squirrels which gnawed at each successive years new cambium. Note teeth marks and frequency (almost every year). Why they do this I do not know. It is, however one of the few places on the bole where the cambium is not covered by the thick bark of this species.

In this area where earthen den sites are rare because of the loose sandy soil den site in the black jack oak are numerous. With out them the area would have much less wildlife. Small water holes were present in the bases of many trees in an otherwise dry area. Mice, insects, foxes and birds inhabited the holes-most of which began with fire injury.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FIRE SCAR
OTHER INJURY
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5
4
3
2
1
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1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
YEAR
FIRE SCAR FREQUENCY
SCAR YEARS PER DECADE
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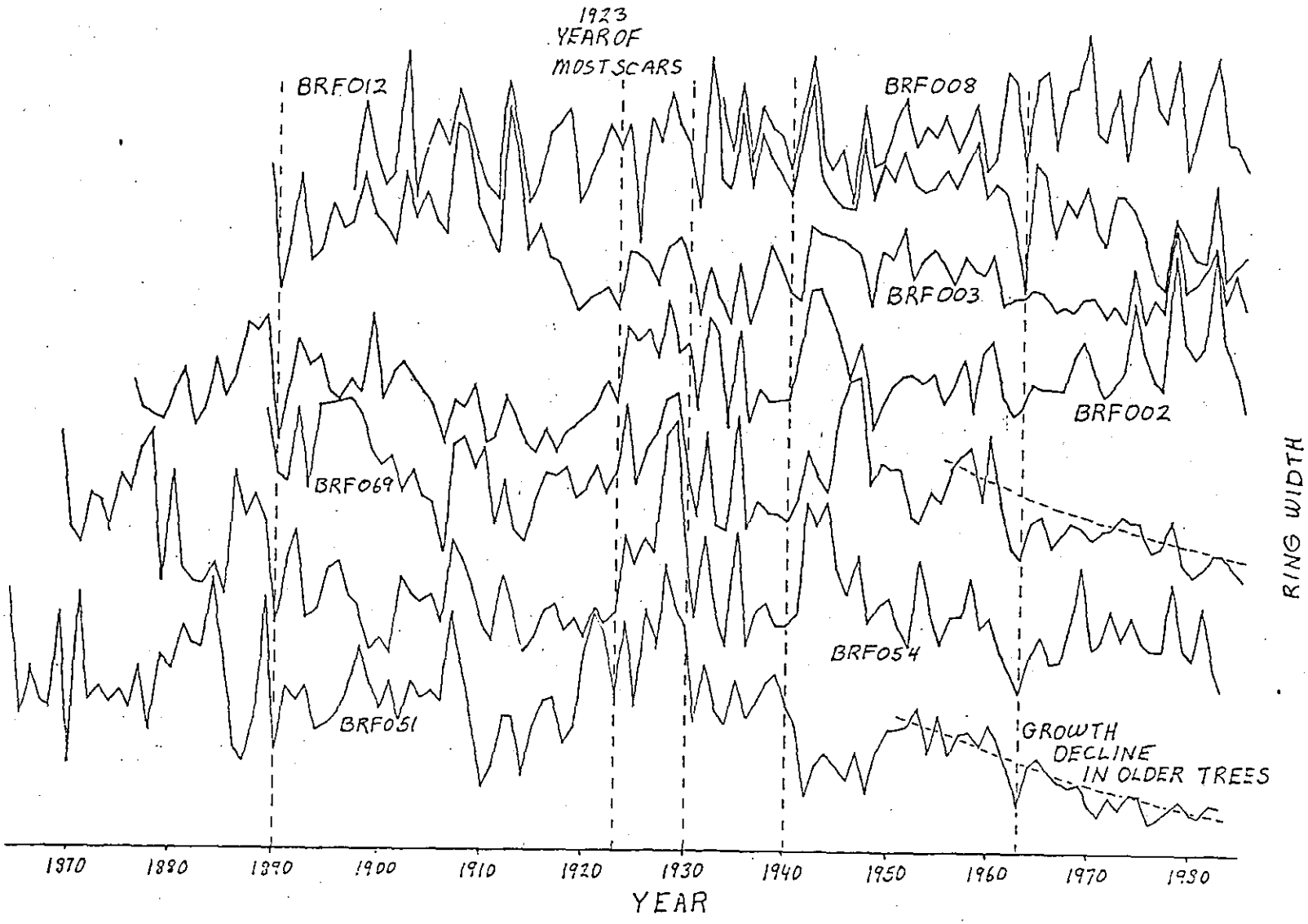
YEAR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YEAR OF
MOST SCARS
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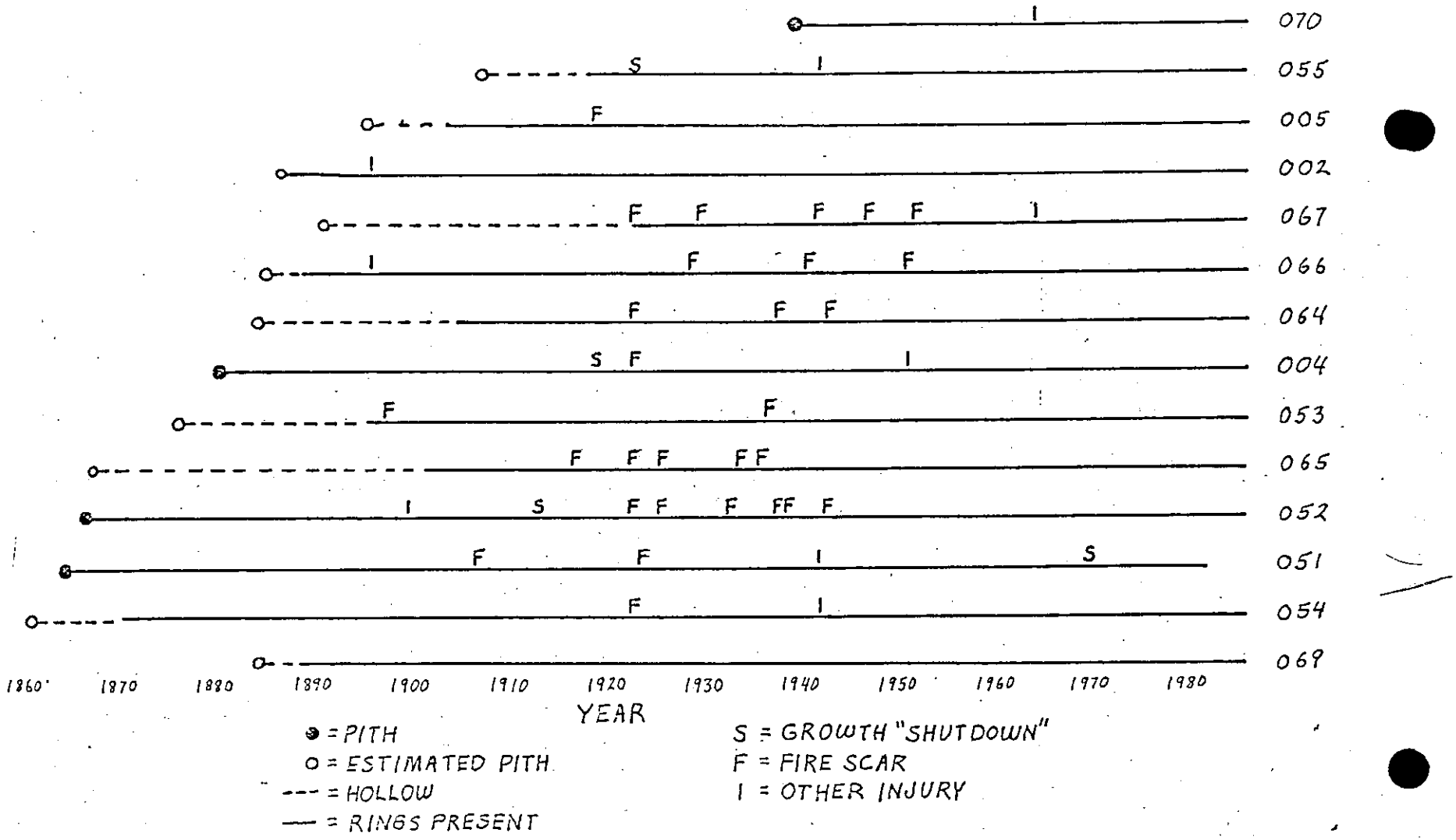
BRF008
BRF003
BRF002
BRF069
BRF054
BRF051
GROWTH
DECLINE
IN OLDER TREES
RING WIDTH
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
YEAR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052
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1870
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1890
1900
1910
1920
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1940
1950
1960
1970
1980
YEAR
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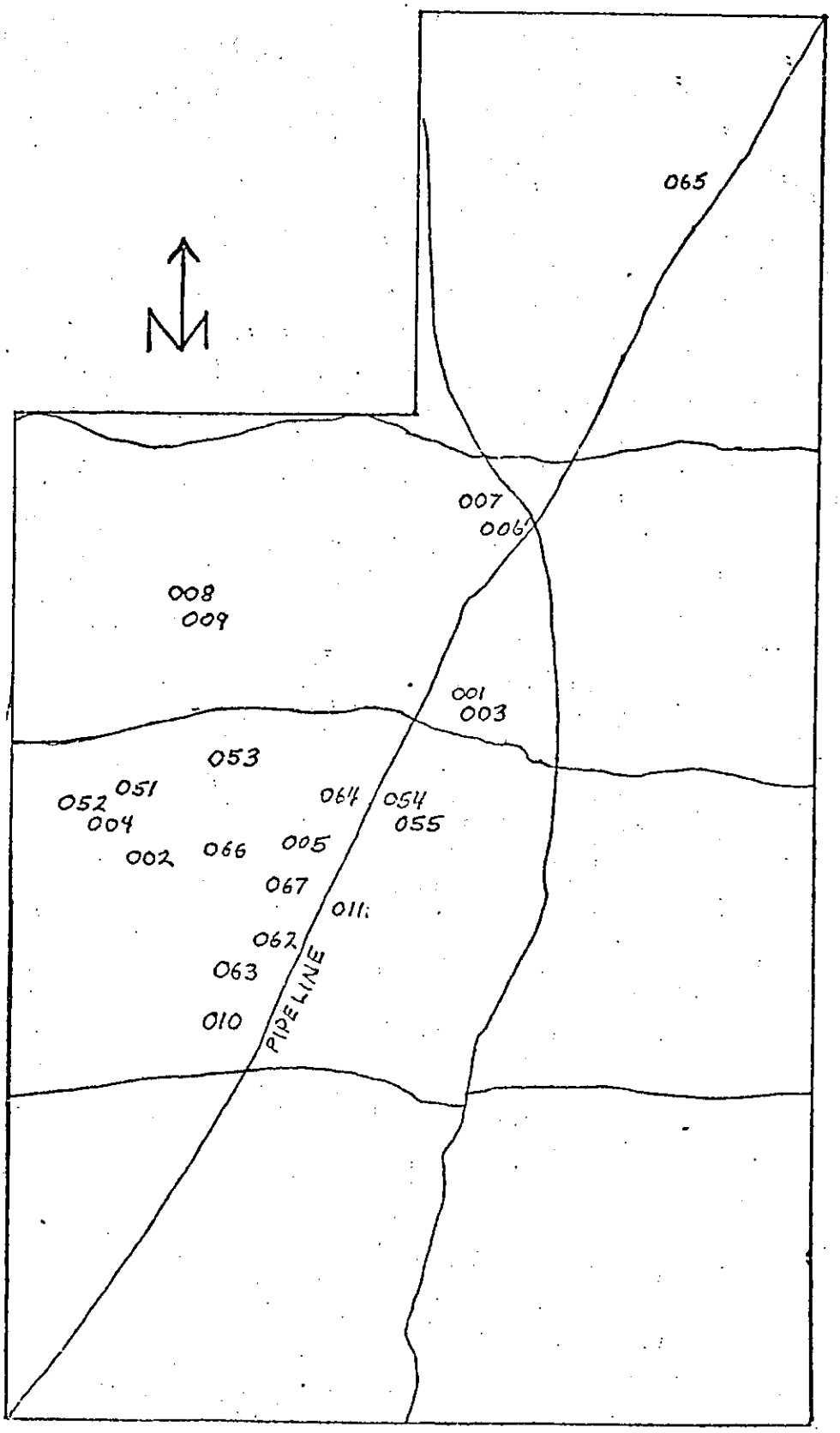
O = ESTIMATED PITH
--- = HOLLOW
— = RINGS PRESENT
S = GROWTH "SHUTDOWN"
F = FIRE SCAR
I = OTHER INJURY



MCCLAIN ADDITION

Some Sample Locations

86-112

Richard Guyette
Route 2, Ashland, Mo 65010

Don McFall
Illinois Dept. of Conservation

Don,

Here's the bill, some samples and some preliminary observations from a tree ring perspective for straters. I almost have the fire history done. It will be in the mail before Sept. 12, 1986. I was able to obtain some data for the 1986-1880 period on fires. The problem has been not a lack of fire scarred trees (almost all the older growth trees have scars), but the difficulty of finding trees that have been scarred and are not too hollow or rotten to date. In this sense the samples I'm sending are a little unusual and hard to find. In any case, I have at least 12 trees now with fire scars that should give an idea of the disturbances over the last 100 years. Although I could only find 12 in the time allowed I do believe from what I've seen that they are representative and that further sampling would reveal little more. More samples will follow along with the final report. Call if you have any questions.

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In summary the oldest trees on this site form an even age stand. The site was probably cut in the 1860-1870 period. The lack of old poor form remnant trees which would not have been suitable for lumber indicates that the forest may have been cut for firewood and railroad ties. On prairie flora areas the black jack oak are on the average younger than those in forest sites.

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