BLUE STORMS DEPRESS GROWTH OF SHORTLEAF PINE IN WESTERN ARKANSAS AND EASTERN OKLAHOMA

Douglas J. Stevenson, Thomas B. Lynch, and James M. Guldin

Climate and weather, especially storms, have major effects on trees. Fast moving "Alberta Clippers," or Blue Storms, that produce extreme cold and little precipitation happen each year on the Great Plains in association with Chinook winds in the Northern and Central Rockies. When these storms occur between February 13th and March 10th when shortleaf pines on the Ouachita National Forest are becoming active, characteristic narrow growth rings are left in the wood. Prior to February 13th, growth is not affected by cold temperatures; after March 10th when trees are fully active, a frost ring is produced. Only between these two dates is growth reduced without the production of a frost ring.

The objective of the study was to identify the cause of a number of narrow, or "marker" rings in shortleaf pine increment cores from the Cold Springs District of the Ouachita National Forest and develop a prediction model for recovery of radial growth.

Forty-six increment cores from thinned and unthinned plots in an ongoing shortleaf pine growth and yield study near Booneville, Arkansas were read and cross-dated. After age and autocorrelation effects were removed from the data, precipitation in all months contributed significantly to ring width at a 95.0% confidence level. Precipitation "explained" 23.9% of the variation. Extreme winter low and summer high temperatures did not correlate with ring width, but temperatures below -12 degrees Celsius in the February 13th - March 10th interval coincided with narrow rings and the occurrence of Blue Storms on the Great Plains. Rings took from 1 to 3 years to recover. A logistic model of precipitation, climate and storm effects "explained" 37.5% of total variation at the 95% level.

Blue storms were identified as the cause of narrow (<0.760mm) growth rings in 1905, 1910, 1920, 1936, 1943, 1963, 1978, 1980, 1993, and 2002. All of these storms produced temperatures below -12 degrees C. at Booneville. Drought was identified as contributing to the narrow ring in 1980 and was the cause of narrow rings in 1933, 1947, 1954, 1956 and 1997. A narrow ring in 2001 was caused by damage from the Christmas Ice Storm of 2000. Ice storms may have contributed to the narrow rings in 1963 and 1993. There were no other years with ring widths less than 0.760 mm. Dates of storms and low temperatures produced were obtained from *Monthly Weather Reports*, available from the National Oceanographic and Atmospheric Administration.

Monthly precipitation and monthly values of the Palmer Drought Severity Index (PDSI) were used to create the following climate model:

W = 0.5012 + 0.0166*Oct + 0.04*Nov + 0.0247*Apr + 0.0194*Aug + 0.0228*Sept
+ 0.0826*OctPDSI + 0.0815*NovPDSI – 0.0716*DecPDSI + 0.0533*JanPDSI
- 0.115*FebPDSI + 0.0394*MarPDSI + 0.0428*JunePDSI – 0.0555*JulyPDSI
+ 0.0421*AugPDSI – 0.0745*SeptPDSI

Where,
W = Estimated ring width (mm)
Month abbreviations are monthly precipitation in inches at the Cold Springs Work Center, and
Month abbreviations followed by "PDSI" are monthly values of the Palmer Drought Severity Index for Arkansas Division 4.

Estimated ring width was subtracted from measured ring width and average measured ring width added back in to create the declimatized data set (D). A logistic growth model for each of the five most-recent storms was developed:

f(Storm) = Ave5/(1-exp(b*(Year-StormYear)))

Where,
f(Storm) = modifier (mm) added to ring width predicted by climate model,
Ave5 = average ring width over all sample trees of five rings immediately preceding the StormYear,
Year = the calendar year of the individual ring,
StormYear = the calendar year of the storm
(Five dummy variables were used to "zero" out growth rings in years prior to the particular storm year.).

Douglas J. Stevenson, Senior Research Specialist and Thomas B. Lynch, Professor,
Dept. of Natural Resources and Environmental Management, Oklahoma State University, Stillwater, OK 74078 and
James M. Guldin, Supervisory Ecologist and Project Leader, Southern Research Station, USDA Forest Service, Hot Springs, AR 71902

This produced values of:
Ave5(1963) = 1.109
Ave5(1978) = 0.896
Ave5(1980) = 0.758
Ave5(1993) = 1.118
Ave5(2002) = 0.589

Each of the five terms was included in the final model:

D = 1.109/(1-exp(b1*(2007-1963))) +
0.896/(1-exp(b2*(2007-1978))) +
0.758/(1-exp(b3*(2007-1980))) +
1.118/(1-exp(b4*(2007-1993))) +
0.589/(1-exp(b5*(2007-2002)))

This produced the following values of b:

b1 = 1.589 (1963)
b2 = 1.749 (1978)
b3 = 1.326 (1980)
b4 = 2.254 (1993)
b5 = 1.615 (2002)

The resulting correlation coefficient (r^2) was 0.043. The F-value with 5 and 2799 degrees of freedom was 25.13 ($p<0.0001$). The standard error of the ring width was 0.305 mm, high for a shortleaf pine chronology. This is probably due to the sample containing trees from both thinned and unthinned plots and because broken, branch-damaged and undamaged trees from the 2000 ice storm were all included in the data set (When the climate signal was removed from 31 broken trees from the same site, the resulting standard error was 0.262 mm.).

Narrow growth rings (<0.760 mm) in shortleaf pine on the Cold Springs District that were not produced by drought or ice storm damage, resulted from extreme cold events, or Blue Storms, occurring in the latter half of February and first half of March while pine trees are just beginning to become active.

LITERATURE CITED

Lafon, Charles W. and James H. Speer. 2002. Using dendrochronology to identify major ice storm events in oak forests of southwestern Virginia. *Climate Research*, Col 20:41-54.

National Oceanic and Atmospheric Administration. 1890-2010. *Monthly Weather Reports and Division Summaries* and *Palmer Drought Severity Index*. National Climate Data Center.

Stambaugh, M. C. and R. P. Guyette. 2004. Long-term growth and climate response of shortleaf pine at the Missouri Ozark Forest Ecosystem Project. Yausey, D. A., D. M. Hix, R. P. Long, P. C. Goebel, eds. *In* Proceedings of the 14th Central Hardwoods Forest Conference. 16-19 March 2004. Northeast Forest Experiment Station, General Technical Report NE-316:448-458.