Status of Mississippi Gulf Coast Live Oak Trees after Hurricane Katrina

Julie Ann Dobbs[1], David W. Held[2] and T. Evan Nebeker[1]
[1]Department of Entomology & Plant Pathology, Mississippi State University, Mississippi State, MS 39762
[2]Coastal Research and Extension Center, Biloxi, MS 39532
jdobbs@entomology.msstate.edu

Index Words: *Quercus virginiana*

Significance to Nursery industry: Live oak trees, *Quercus virginiana*, have long been considered to be the symbol of the Old South. Part of the attraction of the Atlantic and Gulf Coasts is the stately live oaks. These majestic live oaks have weathered many hurricanes in their >200 yr life span. Most recently, on 29 August 2005 Hurricane Katrina, with sustained winds exceeding 160 miles per hour and a storm surge of 30 feet in some areas challenged the fortitude of the live oaks on the Mississippi Gulf Coast (17). In the aftermath, the Mississippi Forestry Commission reported an estimated $2.4 billion in timber damage including estimated urban tree damage at $1.1 billion (6). With an individual tree valued at >$31,300, arguably the economic impact of conserving existing trees and replacing severely damaged stands is an essential part of the recovery effort along the Mississippi–Louisiana Gulf Coast. Also, recovery efforts following major disturbances such as hurricanes are essential. A part of the recovery effort is to determine how trees are impacted by such events and what factors are important to aid the recovery of these native stands.

Nature of Work: Several studies are under way to determine the impact of Hurricane Katrina on the health of the aging population of live oaks, *Quercus virginiana*, in coastal Mississippi . A total of six research sites have been established in Harrison County with each site containing twelve study trees (n=72). All trees in the study are victims of wind stress and all are located in urban areas. The first site is located at Mississippi Gulf Coast Community College – Jefferson Davis Campus (JD) in Gulfport. The second site is the Veteran's Administration facility (VA) located on Pass Road in Biloxi. The third site is a recreational area on the west side of Keesler Air Force Base (wKAFB) in Biloxi.

Another variable being investigated is saltwater inundation. Soils that have been saltwater inundated have been determined to alter a variety of physical, chemical and biological processes in plant growth (10). For instance, it eliminates soil oxygen, decreases cambial growth and has been shown to inhibit formation of new leaves (13, 1, 16). The remaining three sites were saltwater inundated and include: site four, the University of Southern Mississippi (USM) Coastal Campus in Long Beach. The fifth site is Beauvoir, the historical home of Jefferson Davis in Biloxi. The sixth and final site is located on the east side of Keesler Air Force Base (eKAFB) also in Biloxi.

Different treatment regimens have been implemented in order to determine the best way to treat these mature trees after a catastrophic event, such as a hurricane. Control trees are monitored yet receive no treatment. A low maintenance, or homeowner regime, includes a one-meter ring of mulch and irrigation. A high maintenance, or professional regime, includes soil aeration, a three-meter ring of mulch, irrigation and insecticides, if deemed appropriate.

Results and Discussion: *Value of Trees.* Since the trees within the scope of the study cannot be replaced by transplanting a tree of like size, the Trunk Formula Method was used in calculating their values (3). The International Society of Arboriculture in their 9th edition of Guide for Plant Appraisal defines the Trunk Formula Method as:

$$\text{Basic value} = RC + [BP * (TAA - TAR)] * SR$$

Where:

RC is the replacement cost of the largest normally locally available tree

BP is the basic price (i.e. cost per square inch of trunk area of replacement tree)

TA_A is the area of the trunk of the appraised tree

TA_R is the area of the trunk of the replacement tree

SR is the species rating for the appraised tree

The second step is to determine the appraised value using the following formula.

$$\text{Appraised Value} = \text{Basic Value} * \text{Condition Rating} * \text{Location Rating} \quad (7)$$

The value of live oak trees at the JD site is $327,000. Values for the VA and wKAFB are $357,100 and $385,200, respectively. Saltwater inundated sites elicited values of $522,300, $310,500 and $349,300 for USM, Beauvoir and eKAFB respectively. The 72 trees in this study have an estimated appraisal value over $2.3 million. These estimates express financially the irreplaceable value of the live oaks in the Mississippi Gulf Coast landscape.

Canopy Cover. Canopy cover is an important aspect of measurement when looking at tree health. Prior studies have determined that repeated and severe defoliation effects on tree physiology are expected to cascade through an entire ecosystem by altering carbon, nitrogen, and water fluxes, and subsequently affecting nitrogen cycling and plant-herbivore interactions (15, 9).

In our study, a spherical densiometer was used to determine percent canopy cover (8). Saltwater inundated sites averaged around an 82% defoliation rate with 65.5%, 89.2%, and 90.2% for eKAFB, Beauvoir, and USM, respectively. The lower percentage in eKAFB could be easily explained by proximity to the Gulf. Where Beauvoir and USM are located directly on the beach, eKAFB is closer to the Back Bay in Biloxi. Non-saltwater inundated sites averaged about 64% defoliation. The JD campus was determined to have a 65.7% defoliation rate while wKAFB and the VA were measured at a 66.3% and 59.8% loss of canopy cover, respectively. Seven months after the storm, 22% (n = 16) of the study trees have yet to put on any new growth. Half of the trees are located at wKAFB, one at USM and the remainder at Beauvoir.

Foliar Nitrogen. Studies have determined that plant foliar chemistry is influenced by nutrient availability, soil conditions, and can influence plant fitness (2, 11, 19). Also, in flooded areas, the leaf nutrient contents of *Quercus* species have been determined to decrease markedly, especially nitrogen (4).

For this study, foliage was collected from branches in the four cardinal directions. Only the ten newest leaves were harvested from each branch. A total wet weight of 50g per tree was collected. Leaves were placed on ice in a cooler and returned to the lab. They were immediately weighed and placed in an oven for 48 hours at 60˚C. Samples were then re-weighed and ground to pass a 20-mesh screen. Like Fridgen and Varco, total foliar nitrogen was determined on 4 to 6 mgs of oven-dried samples using a Carlo Erba N/C 1500 dry combustion analyzer (5). As seen in Figure 1, foliar percent nitrogen was not different for trees when compared by site ($F = 1.64$, $P = 0.16$). However, mean foliar percent nitrogen for all inundated sites was significantly greater than those on non-inundated sites, 1.9582 and 1.8511, respectively (orthogonal contrasts, $t = 2.07$, $P = 0.04$).

It is well known that the amount of nitrogen in plants varies enormously with species, organ, season, and other environmental factors. Some data shows that the growth efficiency of a variety of insects is closely related to plant nitrogen content. As the nitrogen content of their food increases, insects become more efficient in converting plant material into body tissue (14). Even though some conflicting data exists (18, 12), it is agreed upon that a total change in foliar nitrogen content affects insect growth and establishment.

Future Research. The current data combined with on-going research will help to establish baseline information that will be useful in providing the best available care to live oak trees after a hurricane. On-going research includes: soil compaction analysis, stem water potential, root starch analysis, callus formation, and surveys of insects in the canopy and surrounding soil.

Literature Cited:

1. Broadfoot, W.M. 1967. Shallow-water impoundment increases soil moisture and growth of hardwoods. Soil Science Society of American Proceedings 31:562-564.
2. Chapin, F.S., III. 1991. Effects of multiple environmental stresses on nutrient availability and use, pp. 67-88. *In* H.A. Mooney, W.E. Winner, and E.J. Pell [eds.], Response of plants to multiple stresses. Academic, New York.
3. Cullen, Scott. 2000. Tree Appraisal: What is the Trunk Formula Method (9th Edition)? http://www.tree-tech.com/reports/tree_appraisal.xhtml.
4. Dreyer, E., Colin-Belgrand, M., and P. Biron. 1991. Photosynthesis and shoot water status of seedlings from different oak species submitted to water logging. Ann. Sci. For. 48:205-214.
5. Fridgen, J.L. and J.J. Varco. 2004. Dependency of Cotton Leaf Nitrogen, Chlorophyll, and Reflectance on Nitrogen and Potassium Availability. Agronomy Journal 96:63-69.
6. Grizzard, Kent. 2005. Forestry Commission reports $2.4 billion of tree damage. http://www.mfc.state.ms.us/pdf/katrina/timberdamage.pdf.

7. International Society of Arboriculture and Council of Tree & Landscape Appraisers. 2000. Guide for Plant Appraisal, 9th Ed. Champaign, IL.
8. Keane, R.E., Reinhardt, E.D., Scott, J., Gray, K, and J. Reardon. 2005. Estimating forest canopy bulk density using six indirect methods. Canadian Journal of Forest Research 35:724-739.
9. Kosola, K.R., Dickmann, D.I., and E.A. Paul. 2001. Repeated insect defoliation effects on growth, nitrogen acquisition, carbohydrates, and root demography of poplars. Oecologia 129:65-74.
10. Kozlowski, T.T. 1997. Responses of woody plants to flooding and salinity. Tree Physiology Monograph 1:1-29.
11. Kramer, P.J., and T.T. Kozlowski. 1979. Physiology of woody plants. Academic, New York.
12. Matsuki, S. and T. Koike. 2006. Comparison of leaf life span, photosynthesis and defensive traits across seven species of deciduous broad-leaf tree seedlings. Annuals of Botany 97:813-817.
13. Pezeshki, S.R. and J.L. Chambers. 1985. Stomatal and photosynthetic response of sweet gum (*Liquidambar styraciflua*) to flooding. Canadian J of Forest Research 15:371-375.
14. Schoonhaven, L.M., van Loon, J.J.A., and M. Dicke. 2005. Insect-Plant Biology. 2nd Edition. Oxford University Press. New York.
15. Schowalter, T.D., Hargrove, W.W., and D.A. Crossley. 1986. Herbivory in forested ecosystems. Annual Rev. of Entomology 31:177-196.
16. Tang, Z.C. and T.T. Kozlowski. 1982. Some physiological and growth responses of *Betula papyrifera* seedlings to flooding. Physiol. Plant. 55:415-420.
17. Thompson, Richard. 2005. Mississippi tackles a tough one. American Planning Association. Dec. 71(11):6-11.
18. White, T.C.R. 1984. The abundance of invertebrate herbivores in relation to the availability of nitrogen in stressed food plants. Oecologia 63:90-105.
19. Whitham, T.G., and S. Mopper. 1985. Chronic herbivory: impacts on tree architecture and sex expression of pinyon pine. Science 227: 1678-1683.

Status of Mississippi Gulf Coast Live Oak Trees after Hurricane Katrina

Julie Ann Dobbs[1], David W. Held[2] and T. Evan Nebeker[1]
[1]Department of Entomology & Plant Pathology, Mississippi State University, Mississippi State, MS 39762
[2]Coastal Research and Extension Center, Biloxi, MS 39532
jdobbs@entomology.msstate.edu

Index Words: *Quercus virginiana*

Significance to Nursery industry: Live oak trees, *Quercus virginiana*, have long been considered to be the symbol of the Old South. Part of the attraction of the Atlantic and Gulf Coasts is the stately live oaks. These majestic live oaks have weathered many hurricanes in their >200 yr life span. Most recently, on 29 August 2005 Hurricane Katrina, with sustained winds exceeding 160 miles per hour and a storm surge of 30 feet in some areas challenged the fortitude of the live oaks on the Mississippi Gulf Coast (17). In the aftermath, the Mississippi Forestry Commission reported an estimated $2.4 billion in timber damage including estimated urban tree damage at $1.1 billion (6). With an individual tree valued at >$31,300, arguably the economic impact of conserving existing trees and replacing severely damaged stands is an essential part of the recovery effort along the Mississippi–Louisiana Gulf Coast. Also, recovery efforts following major disturbances such as hurricanes are essential. A part of the recovery effort is to determine how trees are impacted by such events and what factors are important to aid the recovery of these native stands.

Nature of Work: Several studies are under way to determine the impact of Hurricane Katrina on the health of the aging population of live oaks, *Quercus virginiana*, in coastal Mississippi . A total of six research sites have been established in Harrison County with each site containing twelve study trees (n=72). All trees in the study are victims of wind stress and all are located in urban areas. The first site is located at Mississippi Gulf Coast Community College – Jefferson Davis Campus (JD) in Gulfport. The second site is the Veteran's Administration facility (VA) located on Pass Road in Biloxi. The third site is a recreational area on the west side of Keesler Air Force Base (wKAFB) in Biloxi.

Another variable being investigated is saltwater inundation. Soils that have been saltwater inundated have been determined to alter a variety of physical, chemical and biological processes in plant growth (10). For instance, it eliminates soil oxygen, decreases cambial growth and has been shown to inhibit formation of new leaves (13, 1, 16). The remaining three sites were saltwater inundated and include: site four, the University of Southern Mississippi (USM) Coastal Campus in Long Beach. The fifth site is Beauvoir, the historical home of Jefferson Davis in Biloxi. The sixth and final site is located on the east side of Keesler Air Force Base (eKAFB) also in Biloxi.