

CROWN ENCROACHMENT ON SOUTHERN LIVE OAKS IN SUBURBAN SETTINGS: TREE STATUS AND HOMEOWNER CONCERNS

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Abstract. We recorded the status of the crowns of 50 southern live oaks (*Quercus virginiana*) in each of four suburban neighborhoods in Gainesville, Florida, U.S. We focused on the extent to which the crowns of formerly open-grown live oaks were encroached on by other trees. Once the crowns of live oak trees develop their characteristic open-grown form, they are very susceptible to trees overtopping them from the side or even piercing up through their crowns from below. Unfortunately, severely shaded mature live oaks seldom recover, even if the encroaching tree crowns are removed. Few (7.5%) of the live oaks surveyed were not crowded. On the basis of stem growth rates and stem-crown diameter relations of the principal encroaching species, we predict that unless the encroached live oaks are provided with space to grow, approximately half of them will succumb to crowding within the next 5 to 13 years, depending on the neighborhood. Although the 23 homeowners surveyed valued their live oaks highly (mean assigned value \$6,887), only about half said that they plan to provide them growing room even after they were informed of the encroachment threat.

Key Words. Crown competition; *Quercus virginiana*; savanna trees; tree architecture.

Although Southern live oaks (*Quercus virginiana*) are venerated as shade trees (Meyer 2001; Orso 1992), a recent study carried out in rural settings in Florida, U.S., revealed that due to widespread suspension of grazing, mowing, and burning, as well as pine plantation establishment, live oaks are succumbing to crown competition from other tree species (Spector 2001). The biological basis of this problem is that mature live oaks with the broad, open-grown crowns by which they are characterized do not extend upward in response to lateral competition and instead are overtopped. This lack of architectural plasticity is surprising given the wide variability in height:diameter ratios observed in this species in forests and planted stands. Whatever the reason, based on the liberation of the crowns of several dozen live oak crowns (Putz, unpublished), live oaks generally do not recover if released and slowly die once their crowns are more than about 50% covered by other trees.

Open-grown live oaks, often festooned with Spanish moss and other epiphytes, have iconic status in the U.S. South. In colonial times, live oak wood was essential for shipbuilding due to its high tensile strength and decay resistance, and its natural arching branches made it ideal for

the joints and braces needed for shipbuilding (Wood 1981). Earlier, Native Americans depended on live oak trees for food and shelter (Bartram 1791). The acorns were turned into meal and bread, and the oil from the acorns was used for cooking. Today, live oak trees are appreciated because they cast ample shade, are long-lived, mostly disease resistant, at least until recently, and provide habitats for wildlife (Keator and Bazell 1998), which are just a few of the reasons for maintaining them as a component of the suburban landscape.

Given the benefits of maintaining suburban live oaks, we undertook a study to determine the extent to which they are threatened by encroachment. To predict the fates of live oaks if the encroachers are not removed, we developed a simple model for estimating rates of crown encroachment based on measurements of the stems, crowns, and growth rates of the principal encroaching species. Finally, after asking suburban homeowners how much they valued their trees and informing them that their live oaks were in jeopardy due to crown encroachment, we asked them whether they planned to take action to save them.

METHODS

We assessed the status of live oak trees on the grounds of 50 suburban homes in each of four neighborhoods in Gainesville, Florida (29°30'N, 82°15'W). The neighborhoods varied both in home ages and property values by a factor of three (Table 1). This substantial variation in house prices allowed us to test whether willingness to act to protect threatened live oaks varies with apparent economic status of the homeowners. The live oaks we studied represented a combination of naturally regenerated trees that are the remnants of former pastures and the trees planted when the older neighborhoods were developed.

An initial "walk by" survey was conducted to determine the proportion of properties on which the crown of the principal live oak tree was encroached on by the crowns of other trees. A live oak was considered to be encroached if its crown was pierced by the crown of another tree, if any tree crowns extended above its crown, or if lateral expansion of its crown was prevented by the proximity of other trees. In the latter case, we also looked for obvious distortion in the shape of the live oak crown, indicating a history of impeded growth. For each property on which there was a

live oak tree > 26 cm dbh (diameter at breast height, 1.3 m), we measured the dbh of the principal live oak, estimated the proportion of its crown that was encroached, and identified the species of the encroachers.

From the homes with encroached live oaks, we used a stratified random method based on live oak dbh and degree of encroachment to select a subset to be used in the second, more intensive portion of the study. We did not include live oaks that were encroached on by other live oaks (n = 18) or by trees growing over from a neighbor's property (n = 16). For the remaining trees on the properties of willing homeowners (n = 23), we measured the stem and crown diameters of the principal live oak and all encroaching trees and mapped their locations. To predict how long it will take each live oak to be 50% covered by the crowns of encroaching trees, which we take as the "point of no return," we measured growth rates of the principal encroacher species (laurel oak, *Quercus hemisphaerica*). [It should be noted that the arbitrariness of the 50% cutoff point is recognized, and trees might recover better if selectively pruned, but it is the best estimate we have to date.] Growth rates of the encroachers are based on the five most recent growth rings of 12 canopy-dominant laurel oaks (20 to 40 cm dbh) felled as part of a savanna restoration project in Gainesville. To predict crown diameter growth from dbh increments, we measured the stem and crown diameters of 30 open-grown laurel oaks on the campus of the University of Florida and in nearby suburban neighborhoods. Trees showing evidence of pruning were not included.

In an effort to gain an understanding of the importance of live oaks to suburbanites, a series of questions were addressed to each of the participating homeowners. They were shown fresh branches of live oak, laurel oak, water oak (*Q. nigra*), and black cherry (*Prunus serotina*) and asked to identify the species and select the one they preferred as a yard tree. The homeowners were then asked to estimate how much their live oak added to their property value and how long they expected their live oak to live if they did not intervene to prevent further encroachment. Later, after we informed the owner how long we expected the live oak to survive based on our studies of growth dynamics and how

much we estimated it would cost to remove the encroachers, we asked if they would likely remove the encroaching tree to help save their live oak.

RESULTS

The crowns of most suburban live oaks in Gainesville were suffering some degree of encroachment (Table 1). At the time of our survey, average encroachment was fairly consistent in the four neighborhoods (28% to 33%), but some live oaks with badly encroached crowns had recently been liberated by felling of the encroaching trees. The tree species most commonly found to be encroaching on live oaks in the suburbs of Gainesville was laurel oak (*Quercus hemisphaerica*, 44%). Other common encroaching species included slash pine (*Pinus elliottii*, 9%), loblolly pine (*P. taeda*, 8%), water oak (*Q. nigra*, 6%), southern magnolia (*Magnolia grandiflora*, 4%), longleaf pine (*P. palustris*, 4%), sweetgum (*Liquidambar styraciflua*, 4%), eastern red cedar (*Juniperus silicicola*, 2%), southern red oak (*Q. falcata*, 2%), persimmon (*Diospyros virginiana*, 1%), black cherry (*Prunus serotina*, 1%), and red maple (*Acer rubrum*, 1%).

Homeowner knowledge of dendrology and arboriculture was generally quite limited. Only three of the 23 homeowners to whom branches of live oak, laurel oak, water oak, and black cherry were shown identified them all correctly. Water oak was selected by 39% of the homeowners when asked which species they preferred as a shade tree, reportedly on the basis of the unique shape of its leaves, even though water oak is a short-lived tree species in north-central Florida. After water oak, live oak was the most often preferred species (30%). Black cherry and laurel oak were selected by 13% and 17% of the interviewed homeowners, respectively. There was also a positive relationship between median neighborhood house prices and extent of encroachment (Table 1; r = 0.94, n = 4, P = 0.01), but not with reported willingness to remove encroaching trees for the benefit of live oaks (Table 1; r = -0.21, n = 4, n.s.).

Based on the mean width of the five most recent annual growth rings of 12 felled laurel oak trees, we estimated that canopy trees of this species in Gainesville grow an average of 1.69 cm per year in stem diameter (standard deviation = 0.57). We also found a strong relationship between stem

Table 1. The status of 50 live oaks in each of four suburban neighborhoods in Gainesville, Florida. Live oaks were judged to be endangered when encroachers covered more than 50% of their crown.

| Approximate neighborhood age | Number of encroached live oaks (n = 50) | Percentage of live oak crown encroached | Property size (ha) | | Property value | | Mean time before encroachers endanger the live oaks | Owner likely to remove encroachers? | |
|------------------------------|---|---|--------------------|-------------|----------------|----------------------|---|-------------------------------------|----|
| | | | median | range | median | range | | yes | no |
| 15 years | 47 | 33.3% | .186 | .081 – .291 | \$136,965 | \$86,330 – \$187,600 | 4.8 years | 3 | 4 |
| 52 years | 45 | 31.2% | .162 | .080 – .247 | \$133,145 | \$53,180 – \$213,110 | 12.9 years | 3 | 3 |
| 49 years | 45 | 29.3% | .117 | .081 – .227 | \$87,665 | \$37,130 – \$138,200 | 7.2 years | 4 | 1 |
| 43 years | 47 | 7.8% | .121 | .057 – .186 | \$53,250 | \$39,100 – \$67,400 | 11.8 years | 2 | 3 |

diameter and crown size of laurel oaks (crown radius = $0.85 + 8.91\text{dbh}$, all units in meters, $n = 30$, $P < 0.0001$, $R^2 = 0.73$). Using the simple growth projection model we constructed using stem diameter growth rates, the mathematical relationship between stem diameter and crown radius, and distances from live oak trees to their encroachers, we predict that unless the encroachers are removed, live oaks will be seriously endangered, as defined by half of the trees being more than 50% covered by encroaching tree crowns, in 5 to 13 years, depending on the neighborhood (Table 1). Live oaks are in greatest apparent jeopardy in the youngest neighborhood with the largest yards and most expensive houses, apparently because a minimal number of trees were removed when the area was developed.

DISCUSSION

Our finding that the crowns of the majority of open-grown live oaks in Gainesville, Florida, were suffering from encroachment indicates that the encroachment issue deserves serious attention from local arborists and property owners. Given that savannas and open-canopied woodlands are widespread in many different parts of the world where they are being encroached on by suburban sprawl and forest expansion, as they are in Florida, we suspect that this arboricultural problem is also widespread. The trees of these savannas, from the oaks of California and Europe to the acacias of Africa and the legumes of tropical America, are all likely to suffer when forest trees encroach on their crowns. While environmentalists justifiably worry about deforestation and forest degradation, the loss of more open-canopied communities, such as oak savannas, also deserves attention.

With increased attention to the threat of crown encroachment on formerly open-grown savanna trees, we hope that action will be taken. Fortunately, for the particular trees we studied in Florida, there is still time for property owners to remove the endangering encroachers. Even in the neighborhood with the most dense tree canopy, the average live oak was only 33% encroached, still well below the 50% level at which many live oaks will be damaged beyond their capacity to recover. Nevertheless, without arboricultural intervention, live oak growth and crown development will be impeded, and their survival will be increasingly threatened as encroachment continues (Figure 1).



Figure 1. A suburban Southern live oak in Gainesville, Florida, showing the impacts of stand crowding on crown form.

Some city and neighborhood ordinances designed to protect urban forests may inadvertently contribute to the demise of highly valued savanna trees, such as live oaks. For example, Gainesville regulates tree removals and mandates that removed trees be replaced, both of which steps are important for maintaining the urban forest. Unfortunately, if these regulations are followed in areas immediately adjacent to mature live oaks with wide-spreading crowns, these trees are likely succumb to encroachment. The basis of this problem is perhaps that we usually refer to and envision urban “forests” and not the urban “savannas” that might better match some of our environmental preferences (Gobster 1994). Arborists should at least avoid recommending the planting of savanna trees that require a great deal of space, such as live oaks, if open conditions are not going to be maintained. We may venerate trees with 30 to 50 m wide crowns, but growing such trees is not compatible with closed-canopy urban forestry.

The homeowners interviewed were mostly unaware of the encroachment problem but generally expressed concern when it was pointed out to them. After being made aware of the threat, two participating homeowners had the encroaching trees removed. Unfortunately, these homeowners may have acted too late to save their live oaks. Over the next several years, we plan to revisit all of the properties to monitor the fates of the live oaks and especially to determine whether the owners remove the encroaching trees.

In Gainesville, as in many other cities, great measures are taken to promote urban forestry. One consequence of promoting urban forestry is that a great deal of public education about arboriculture will be needed before many tree-loving suburbanites will accept that if they desire live oaks of the iconic, open-grown form, they will have to provide them space to grow, which may require removing and not replacing some trees or planting them elsewhere. To some extent, this problem can be avoided by spacing trees more widely at the time of planting, but the desire for rapid canopy closure is also understandable. In any event, it seems important to inform planners and developers about the crown encroachment issue so that live oak trees are more likely to maintain healthy crowns in suburban settings.

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Résumé. Nous avons étudié l'état de la cime de 50 chênes verts (*Quercus virginiana*) dans chacune des quatre banlieues de Gainesville en Floride. Dans cette ville américaine verte, avec son couvert arboré imposant, nous avons mis l'accent sur l'étendue que prennent les cimes des autres arbres qui s'entrecroisent et interfèrent avec celles des chênes verts alors que ces derniers se développaient autrefois de manière isolée. Une fois que les cimes des chênes verts ont développé leur pleines caractéristiques de croissance en forme ouverte, ils deviennent alors très susceptibles à être supplantés par d'autres arbres sur leurs flancs ou même à voir leur cime être traversée par d'autres arbres localisés en dessous. Malheureusement, les chênes verts sévèrement ombragés parviennent peu fréquemment à survivre, et ce même si les arbres interférents sont enlevés. Peu (7,5%) des chênes verts étudiés n'étaient pas étouffés. Sur la base des taux de croissance des troncs et des relations tronc/largeur de cime chez les principales espèces interférentes, nous pouvons prédire qu'à moins que les chênes verts susceptibles d'être interférés aient plus d'espace pour se développer, approximativement la moitié d'entre eux vont mourir d'étouffement dans les 5 à 13 années qui suivent, et ce dépendant de l'environnement immédiat autour de l'arbre. Même si les 23 propriétaires résidentiels accordaient beaucoup de valeur à leurs chênes verts—la valeur moyenne étant US\$ 6887, seulement la moitié environ d'entre eux nous ont dit qu'ils planifiaient de donner plus d'espace de croissance, et ce même lorsque ces derniers ont été avisés des risques dus à l'étouffement.

Zusammenfassung. In jeder von vier Nachbarschaftslagen in Gainesville, Florida, haben wir den Status der Kronen von 50 Eichen (*Quercus virginiana*) aufgezeichnet. In dieser Baumstadt mit ihren mächtigen Baumkronen fokussierten wir auf die Einschränkung der vormals offenen großen Eichenkronen durch die benachbarten Bäume. Wenn die Kronen der Eichen erst mal ihre charakteristische offene Form entwickelt haben, sind sie sehr anfällig dafür, dass andere Bäume sie überragen bzw. durch die offene

Krone sogar hindurchwachsen. Unglücklicherweise erholen sich ausgewachsene Eichen nicht mehr von der Beschattung, auch nicht nach einem Freischnitt. Nur wenige der untersuchten Bäume (7,5 %) waren nicht bedrängt. Auf der Basis von Stammwachstumsraten und Stamm-Kronendurchmesser-Verhältnis für die betreffende Baumart können wir vorher-sagen, dass, wenn die bedrängten Bäume nicht freigeschnitten werden, schätzungsweise die Hälfte von ihnen in den nächsten 7-13 Jahren in Abhängigkeit von der Nachbarschaft eingehen wird. Obwohl die 23 untersuchten Baumbesitzer ihre Eichen hoch bewerteten (durchschnittlicher Wert: US\$ 6,887) sagten nur rund die Hälfte, dass sie ihnen nun, nachdem sie über die Auswirkungen informiert wurden, genug Platz zum wachsen schaffen würden.

Resumen. Se registró el estado de la copa de 50 encinos (*Quercus virginiana*) en cada uno de cuatro suburbios en Gainesville, Florida. En esta "Tree City" de los Estados Unidos, con su densa cobertura arbórea, el estudio se enfocó en la extensión abierta de la copa de los encinos invadida por otros árboles. Una vez que la copa de los encinos desarrolla su característica copa de forma abierta, son muy susceptibles a árboles que los cubran de lado o aún los atraviesan desde abajo. Desgraciadamente, los encinos maduros severamente sombreados rara vez se recobran, aún si son removidas las ramas que los estorbaban. Muy pocos (7.5%) de los encinos evaluados no estuvieron invadidos. Con base en la tasa de crecimiento del tronco y la relación tronco-diámetro de la copa de las especies invadidas, se hace la predicción de que a menos que los encinos se les provea del suficiente espacio para crecer, aproximadamente la mitad de ellos sucumbirá a la sobre posición en los siguientes 7-13 años, dependiendo del vecindario. Aunque los 23 propietarios evaluados valoraron altamente sus encinos (valor medio asignado de \$6,998 U.S.), solamente cerca de la mitad dijeron que planean proveerlos de espacio para crecer, aun después de ser informados del problema de sobre densidad que los amenaza.