



UF/IFAS EXTENSION DISASTER HANDBOOK



UF | IFAS Extension
UNIVERSITY of FLORIDA

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Source: <http://blogs.ifas.ufl.edu/nassauco/2017/09/07/make-water-safe-storm/>

SAFE WATER FOR EMERGENCIES



Purifying Water

If, before or after the emergency, your water supply is contaminated, or if you are under a Boil Water Advisory, these are the most effective methods to purify water:

Boiling

- Bring water to a rolling boil for at least 1 minute.
- Allow it to cool before putting it into a clean, sanitized, tightly capped container.
- Water that is cloudy should be boiled between 3-5 minutes.

Iodine (tablets)

- Add 4 tablets iodine per each 1/2 gallon of water.
- Stir thoroughly.
- Allow the iodine and water mixture to stand for 30 minutes.

Iodine (tincture)

- Add 1 drop iodine (label concentration 2.0%) per 1/2 gallon of water.
- Stir thoroughly.
- Allow the iodine and water mixture to stand for 30 minutes.

Remember: Have available 1 gallon of drinking water, per person, per day—for at least 3 days.

Fuente: <http://blogs.ifas.ufl.edu/nassauco/2017/09/07/make-water-safe-storm/>

AGUA POTABLE PARA EMERGENCIAS



Purificando agua

Si, antes o después de una emergencia, su suministro de agua está contaminado o si están en una alerta de contaminación de aguas, estos son los métodos más efectivos para purificar el agua:

Ebullición

- Hierve el agua por un minuto.
- Permite que el agua se enfrié antes de ponerlo en un contenedor limpio, desinfectado y bien cerrado.
- Agua turbia se debe hervir entre 3-5 minutos.

Pastillas de yodo

- Añade 4 pastillas de yodo a cada medio galón de agua.
- Mézclalo bien.
- Permita que la mezcla de yodo y agua reposen por 30 minutos.

Tintura de yodo

- Añade una gota de yodo (con una concentración de 2.0%) a cada medio galón de agua.
- Mézclalo bien.
- Permita que la mezcla de yodo y agua reposen por 30 minutos.

Recuerdo: Asegúrense de tener un galón de agua potable por cada persona, cada día— por lo menos para 3 días.

Source: <http://blogs.ifas.ufl.edu/nassauco/2017/09/07/make-water-safe-storm/>

DLO POU W BWÈ LÈ GEN IJANS



Dlo trete

Si, anvan oswa aprè yon ijans, rezèv dlo w kontamine, oswa si otorite lokal yo konseye w pou w bouyi dlo, sa yo se metòd ki efikas pou trete dlo:

Bouyi

- Mete dlo a sou dife pou l bouyi pandan omwen 1 minit.
- Kite dlo a frèt anvan w mete l nan yon veso ki pwòp ki ka byen fèmen ak yon bouchon.
- Dlo ki twoub yo ta dwe bouyi pandan 3-5 minit.

Yòd (tablèt)

- Mete 4 tablèt yòd pou chak ½ galon dlo.
- Byen brase l.
- Kite melanj dlo ak yòd la poze pandan 30 minit.

Tentidyòd

- Mete yon gout tentidyòd (konsentrasyon sou etikèt la 2.0%) pou chak ½ galon dlo.
- Byen brase l.
- Kite melanj dlo ak yòd la poze pandan 30 minit.

Sonje : chak moun, dwe genyen yon galon dlo pwòp pou yo bwe pa jou, pou pi piti 3 jou.

Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-protect-family-foodborne-illness-hurricane-season/> or <http://edis.ifas.ufl.edu/fs131>

FOOD SAFETY



UF/IFAS Extension offers the following guidelines to determine what foods to keep and which to throw out after a disaster has caused loss of power:

- If the refrigerator has been kept closed, the food is good for approximately 4 hours.
- If the freezer is full and kept closed, the food is good for 48 hours.
- If the freezer is half-full and kept closed, the food is good for 24 hours.
- Frozen foods that have thawed need to be thrown away, even if they have re-frozen.
- Foods that were handled or partially eaten likely contain more bacteria and should be discarded.
- Don't give discarded foods to pets because they could become ill.

For more information, visit <http://edis.ifas.ufl.edu/fs131>

Fuente: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-protect-family-foodborne-illness-hurricane-season/> or <http://edis.ifas.ufl.edu/fs131>

SEGURIDAD ALIMENTARIA



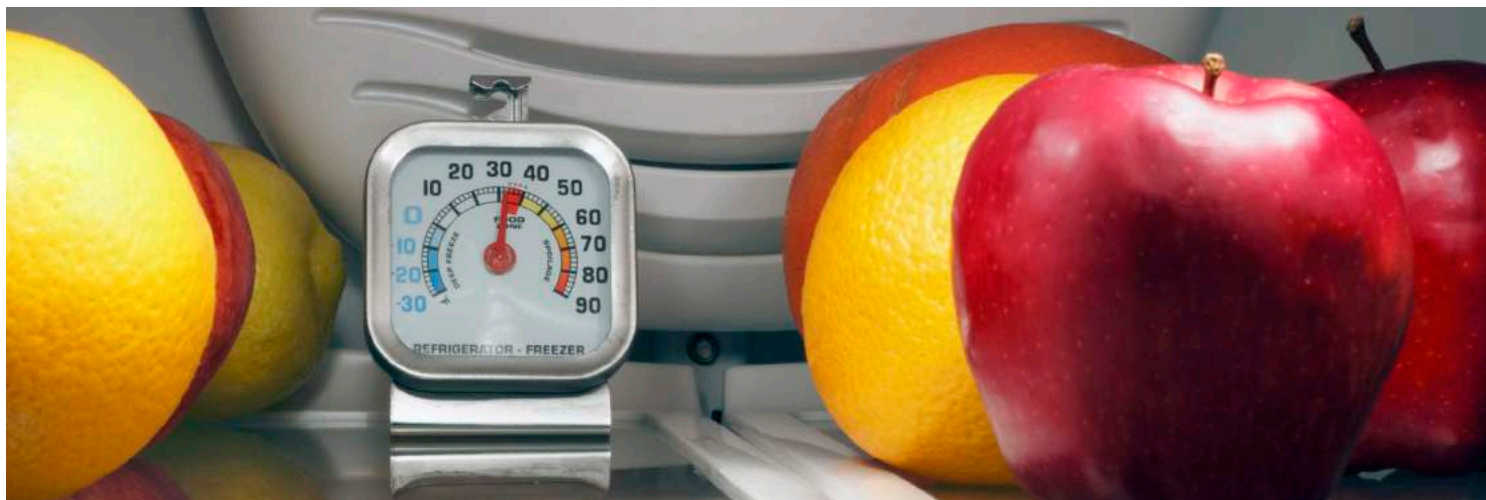
La extensión de UF/IFAS surgiere las siguientes directrices para determinar cuáles alimentos se deben guardar y cuales se deben botar después que un desastre natural causa que se vaya la luz:

- Si la nevera se ha mantenido cerrada, los alimentos duraran por aproximadamente 4 horas.
- Si el congelador está lleno y se mantiene cerrado, los alimentos duraran por 48 horas.
- Si el congelador esta medio lleno y se mantiene cerrado, los alimentos duraran por 24 horas.
- Los alimentos que han sido descongelados se tienen que botar, no se deben volver a congelar.
- La comida que ha estado fuera de su empaque o parcialmente comida, se debe desechar porque probablemente está contaminada.
- No les dé la comida desechada a mascotas porque ellos también se pueden enfermar.

Para más información, visite <http://edis.ifas.ufl.edu/fs131>

Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-protect-family-foodborne-illness-hurricane-season/> or <http://edis.ifas.ufl.edu/fs131>

SEKIRITE ALIMANTÈ



UF/IFAS ekstansyon pwopoze yon gid pou detèmine ki manje pou w kenbe oswa jete aprè yon dezas ki lakòz ou pa gen kouran:

- Si frijidè a te ret fèmen, manje yo bon pou apeprè 4 èdtan.
- Si frizè a plen epi li rete fèmen, manje yo bon pou 48 èdtan
- Si frizè a plen a mwatye epi li te rete fèmen, manje yo bon pou 24 èdtan.
- Jete manje ki defriz nan frizè a menm si li refriz ankò
- Manje ke w manyen oswa ou kòmanse manje ta dwe jete paske li ta gen plis bakteri ladann.
- Pa bay bèt manje ke w ta pwal jete paske yo ka vinn malad.

Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-offers-tips-tending-mental-health-hurricane/>

MENTAL HEALTH FOR ADULTS



UF/IFAS experts offer tips on taking care of your mental health after a disaster:

- Be gentle on yourself and others during this stressful time.
- Focus on self-care, such as eating regularly (and healthy foods, if possible), getting rest and exercise, and trying to take some time out for yourself daily.
- Try to maintain a normal routine, limiting demanding responsibilities on yourself and your family.
- Use existing support systems of family, friends and religious institutions for help and emotional support.
- Seek out a professional therapist or counselor.
- Children are looking at how you are responding as a cue to how they should feel about things. Giving them the message that you can get through this is comforting to them.

For more information, visit <http://edis.ifas.ufl.edu/fm001>

**Substance Abuse and Mental Health Services Administration
Disaster Distress Helpline, call 1-800-985-5990
or text TalkWithUs to 66746.**

Fuente: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-offers-tips-tending-mental-health-hurricane/>

SALUD MENTAL PARA ADULTOS



Los expertos de UF/IFAS ofrecen consejos en como cuidar su salud mental después de un desastre natural:

- Sea amable consigo mismo y hacia otros durante este tiempo de mucho estrés.
- Enfóquese en el cuidado personal. Come con frecuencia alimentos saludables (si posible), descanse y haga ejercicios y trate de separar un tiempo para usted mismo diariamente.
- Trate de mantener una rutina normal, limitando las responsabilidades exigentes suyas y la de su familia.
- Júntese a sistemas de apoyo familiares, amistades e instituciones religiosos para ayuda y apoyo emocional.
- Busca a un terapeuta profesional o consejero.
- Los niños siempre están observando como un reacciona a tiempos difíciles. Si usted le muestra que se puede superar la situación difícil, esto será de consolación para ellos.

Para más información, visite <http://edis.ifas.ufl.edu/fm001>

Línea de Ayuda para Desastre de la Administración de Abuso de Sustancias y Salud Mental, llama al 1-800-985-5990 o mande este mensaje de texto TalkWithUs al 66746.

Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-expert-offers-tips-tending-mental-health-hurricane/>

SANTE MANTAL POU GRANMOUN YO



Ekspè nan UF/IFAS bay kèk konsèy pou konn kijan pou pran swen sante mantal ou lè finn gen yon dezas:

- Pandan peryòd estrès sa a, pran swen tèt ou epi aji byen ak lòt moun.
- Konsantre sou swen tèt ou, tankou manje regilyèman (manje ki bon pou lasante, si sa posib), pran repo ak fè egzèsis, epi eseye pran ti tan pou epi rete pou kont ou chak jou.
- Eseye kenbe yon woutin nòmal, limite gwo responsabilite yo sou tèt ou ak fanmi w.
- Sèvi ak sipò nan fanmi w, zanmi w ak enstitisyon relijye yo pou ede w ak sipò emosyonèl.
- Al wè yon terapet pwofesyonèl oswa yon konseye.
- Ti moun yo ap gade kijan w ap reaji pou yo konn kijan pou yo ta santi yo. Li rekonfòtan pou yo lè w montre yo ou ka fè fas ak sitiyasyon an.

Pou plis enfòmasyon, vizite <http://edis.ifas.ufl.edu/fm001>

Sèvis Administrasyon dezas abi stipefyan ak sante mantal Liy asistans pou detrès, rele 1-800-985-5990 oswa tèks TalkWithUs nan 66746.

Source: <http://edis.ifas.ufl.edu/fm001>

MENTAL HEALTH FOR KIDS



- Spend more time with your children. Let them stick by your side.
- Do something fun and physical to relieve tension.
- Reassure children that you care about them and encourage older children to talk about their feelings and thoughts.
- Answer children's questions about the event.
- Keep regular schedules for meals, playtime and bed time as much as possible. This will help to restore order in the family's life.

For more information, visit <http://edis.ifas.ufl.edu/fm001>

**Substance Abuse and Mental Health Services Administration
Disaster Distress Helpline, call 1-800-985-5990
or text TalkWithUs to 66746.**

Fuente: <http://edis.ifas.ufl.edu/fm001>

SALUD MENTAL PARA NIÑOS



- Haga el esfuerzo de pasar más tiempo con sus hijos.
- Hagan algo divertido y manténgase activos para aliviar tensión.
- Asegúrenles que usted los ama y anime a sus hijos mayores que expresen sus pensamientos y sentimientos.
- Contesten cualquiera pregunta que sus hijos les hagan sobre el desastre natural.
- Mantengan un horario regular para comer, jugar y dormir cuando sea posible. Esto ayudara restaurar la rutina familiar.

Para más información, visite <http://edis.ifas.ufl.edu/fm001>

Línea de Ayuda para Desastre de la **Administración de Abuso de Sustancias y Salud Mental**, llama al **1-800-985-5990** o mande este mensaje de texto **TalkWithUs** al **66746**.

Source: <http://edis.ifas.ufl.edu/fm001>

SANTE MANTAL POU TIMOUN YO



- Pase plis tan ak timoun yo. Kite yo rete bò kote w.
- Fè yon bagay amizan ak yo epi jwe anpil ak yo pou yo pa strese.
- Rasire timoun yo ke w renmen yo epi ankouraje timoun ki pi gran yo pou yo pale de sa yo santi (santiman yo) ak sa yo panse.
- Reponn kesyon timoun yo sou sa kap pase yo.
- Kenbe yon orè pou yo manje, lè pou yo jwe epi lè pou y al dòmi otanke posib. Sa a pral ede kenbe lòd nan lavi fanmi an.

Pou plis enfòmasyon, vizite <http://edis.ifas.ufl.edu/fm001>

Sèvis Administrasyon dezas abi stipefyan ak sante mantal Liy asistans pou detrès, rele 1-800-985-5990 oswa tèks TalkWithUs nan 66746.

Parenting after a Natural Disaster¹

Donna Davis and Suzanna Smith²



Figure 1.
Credits: iStockphoto

Nobody ever said family life was a breeze . . . yet few are prepared for the gale force impact that hurricanes can pack on even the healthiest of families.

This is a stressful time, and it's common for all family members to show signs of stress. Right after a natural disaster, parents and children may be tense and nervous, restless, and have trouble calming down. They may also experience stomachaches, headaches, and dizziness. Many people who are under strain from natural disasters feel fatigued and low in energy.

An event like a hurricane is frightening to children and adults. Children may show their fear by refusing to go back

to school, misbehaving, and/or clinging to a parent. They may have trouble sleeping and want to sleep with a parent.

Family recovery will go more smoothly when the adults in the household can control their own feelings of stress, anxiety, and fear and do everything possible to help their children feel safe. A few suggestions may help parents at this difficult time:

Spend more time with your children. Let them stick by your side. Also, doing something fun and physical relieves tension. Reassure children that you care about them and encourage older children to talk about their feelings and thoughts. Answer their questions.

Keep regular schedules for meals, playtime, and bed time as much as possible. This will help to restore order in the family's life.

References

- Institute of Food and Agricultural Sciences. (1998). *The Disaster Handbook*. Gainesville, FL. University of Florida.
- American Psychological Association. (2004). Tips for recovering from disasters and other traumatic events.
- NSW Health. (2000). *Disaster Mental Health Response Handbook*. Centre for Mental Health. North Sydney Australia.

1. This document is FAR0001, one of a series of the Family Youth and Community Sciences Department, UF/IFAS Extension. Broadcast as program 020. Published September 2009. Reviewed January 2015. Revised July 2018. In the interest of time and/or clarity, the broadcast version of this script may have been modified. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
2. Donna Davis, senior producer, Family Album Radio, and Suzanna Smith, associate professor, Department of Family, Youth and Community Sciences, University of Florida, and executive producer, Family Album Radio, UF/IFAS Extension, Gainesville, FL 32611.

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Trauma and Adolescents¹

Ashley Eckes and Heidi Liss Radunovich²

The mention of the word trauma can bring about thoughts of war, rape, kidnapping, abuse, or natural disaster. However, trauma can also come from common events, such as sudden injury or an automobile accident (Costello, Erkanli, Fairbank, & Angold, 2002). In the United States, it is estimated that 5 million children are exposed to traumatic events yearly (Ruzek et al., 2007). Seventy to ninety percent of people will be exposed to a traumatic event at some time in their lives. One study found that by the age of 11, 11% of youth have experienced a traumatic event. By the age of 18, 43% of youth have experienced such an event (“Identifying and addressing trauma in adolescents,” 2007). This means that during adolescence, there is a dramatic increase in the exposure to trauma.

What is trauma?

Regardless of the source, emotional or psychological trauma develops from being exposed to an incident in which there is a threat to survival and adaptation (Silove, Steel, & Psychol, 2006). Researchers usually separate traumas into two different types: event trauma and process trauma. An event trauma is a sudden, unexpected, stressful event that is limited in its duration and location. A hurricane or a fire, for instance, is an event trauma. Process trauma is defined as continued exposure to a long-lasting stressor, such as war or physical abuse (Shaw, 2000).

The National Institute of Mental Health describes trauma as a normal reaction to an extreme event (Substance Abuse and Mental Health Services Administration, 2007). It is

important to remember that it is not necessarily the event itself that causes trauma, but a person’s thoughts, feelings, beliefs, and experience surrounding that event (Boscarino, 1996).

What happens when someone is exposed to a traumatic event?

It is often easy to know when another person is having a bad day or battling minor emotional distress. During these times, it may be easy to lend a helping hand or a listening ear to try to comfort this individual. When a disaster or traumatizing event takes place, there is nothing normal or routine about it. This type of event may affect many people, normal interactions may be strained, and daily routines are often disrupted (Boscarino, 1996).

Typical reactions to traumatic experiences include fear and anxiety, sleep disturbances, physical complaints (such as headaches or stomach pain), antisocial behavior, depression and sadness, and fear of separation from loved ones (Boscarino, 1996). In families with children and teens, the impact of the event will depend on the extent to which it disrupts family functioning (Boscarino, 1996). Research has shown that response to traumatic stress is not purely emotional; there are also physiological and neurological components (Saltzman, Holden, & Holahan, 2005). One study on children’s reactions to violence in their home showed that children who are exposed to violence had significantly higher heart rates than those who lived in nonviolent homes (Crane & Clements, 2005).

1. This document is FCS2280, one of a series of the Family, Youth and Community Sciences Department, UF/IFAS Extension. Original publication date October 2007. Revised August 2015. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Ashley Eckes, former graduate student, and Heidi Liss Radunovich, associate professor, Department of Family, Youth and Community Sciences; UF/IFAS Extension, Gainesville, FL 32611.

The impact of a traumatic event differs depending on the type of disaster or trauma, its suddenness, and its extent, as well as the person's social surroundings, his or her past experiences, and his or her culture (Silove et al., 2006). Children and teens may experience trauma in different ways depending on their stage of development. There is no way to predict how someone will react to a traumatic event because we are all so different.

Adolescents and Trauma

This article focuses on trauma during adolescence. We single out this stage of development because there are many active changes happening during this stage of life. Adolescents are especially vulnerable to the effects of trauma, and trauma can have a significant impact on their development.

First, adolescents are at high risk for experiencing traumatic events (Crane & Clements, 2005). In addition to the traumatic stressors encountered by adults, adolescents are also at risk of trauma related to bullying and embarrassment in school, violence in the home and community, experimentation with drugs, and other risky situations (Shaw, 2000). Adolescents are trying to define who they are. In the course of discovering their identities, some adolescents engage in risky behavior and power struggles with parents and experience wide-ranging emotions (Hales & Yudofsky, 2003). However, because of the behavioral issues that can occur during adolescence, people may overlook the emotional needs of this population (Crane & Clements, 2005). It is very important for parents, teachers, community leaders, and first responders to be aware of the needs of adolescents in times of crisis, stress, and trauma.

Second, trauma experienced by adolescents is particularly important because significant physical and emotional growth is occurring at this age (Hales & Yudofsky, 2003). The stressors that an adolescent encounters will help to shape his or her growth and perspective, and can have long-lasting impacts (Crane & Clements, 2005). For example, adolescence is a time of increased brain development (Hales & Yudofsky, 2003). There is evidence that the stress associated with traumatic events can change major structural components of the central nervous system and the neuroendocrine system (Shaw, 2000). Severe traumatic stress affects the chemicals in the brain and can change brain structures, leaving a lasting effect (Spear, 2000).

Furthermore, adolescence is also a time of social and emotional development. Struggling with the effects of a traumatic event during adolescence can lead to social isolation, declining school performance, behavioral problems,

and other issues that can impact both current quality of life and future functioning.

It has also been found that those adolescents who have experienced trauma as a child are more likely to develop anxiety-related disorders and fears and are more likely to show a pattern of risky sexual behaviors ("Identifying and addressing trauma in adolescents," 2007). An increase in risk-taking behaviors is sometimes seen in adolescents following trauma (Norwood, Ursano, & Fullerton, 2000).

The Special Case of Post-Traumatic Stress Disorder

Although not everyone who experiences a traumatic event develops Post-Traumatic Stress Disorder (PTSD), it is important to understand that there is a risk for developing this disorder after exposure to trauma. In order to get a diagnosis of PTSD, a person must be exposed to a traumatic event that involved a threat of serious injury or death and that caused the person to experience great fear and helplessness (American Psychiatric Association, n.d.). In addition to exposure to a traumatic event, the following symptoms must be experienced for more than 30 days and cause significant distress or impairment:

- Intrusive symptoms related to the traumatic events (e.g. repeated distressing thoughts, flashbacks, or recurring dreams about the event)
- Avoidance of related events or scenarios.
- Negative moods or thoughts related to the event
- Increased physiological arousal (e.g., easily startled, irritable, problems sleeping or concentrating); American Psychiatric Association, 2013).

It is thought that the two strongest predictors of PTSD are exposure to violence and the sudden or unexpected death of a loved one (American Psychiatric Association, 2013). Of these two, unexpected loss of a loved one is most associated with PTSD (American Psychiatric Association, 2013). It has also been found that human-caused traumas (such as terrorism or other violence) are more damaging to mental health than naturally occurring traumas (such as weather-related events or accidents) (Wiesaeth, 1995),

Exposure to trauma and the presence of PTSD affects memory and learning (Yasik, Saigh, Oberfield, & Halamandaris, 2007; Moradi, Doost, Taghavi, Yule, & Dalgleish, 1999). Because the brain continues to grow throughout adolescence and adulthood, it is important to consider the effects of PTSD on this developmental process. Adolescents

who have experienced trauma or have PTSD are more likely to have problems in school and with processing information.

It has been found that many health care providers overlook PTSD in adolescents (Crane & Clements, 2005). This may be due to the fact that some behavior that commonly occurs in adolescence (e.g., rebelliousness, withdrawal) can look very similar to symptoms of PTSD. Also, it may be hard to figure out whether a teen is suffering from PTSD or depression. PTSD is different from depression in that it is marked more by fear and agitation than moodiness and withdrawal (“Identifying and addressing trauma in adolescents,” 2007). Even though there are subtle differences between depression and PTSD, an adolescent could suffer from both of these conditions at the same time. If you are unsure about whether a child is experiencing a significant problem related to trauma, make sure to get assistance from a licensed mental health professional.

How to Help Adolescents Cope with Trauma

The way an adolescent adapts to stressors has a lot to do with how well his or her family is functioning (Stern & Zevon, 1990). It has been found that when adolescents lack parental support, they are more likely to have behavioral problems and emotional distress (Garber & Little, 2001).

Boys and girls also experience and respond to trauma differently. Although males are more likely to be exposed to traumatic stressors, females are more likely to experience PTSD (Shaw, 2000; Crane, & Clements, 2005; Stuber, Resnick, & Galea, 2006).

To help adolescents overcome a traumatic event, action should be taken as soon as possible. In the wake of a disaster, teachers, parents, and/or mental health professionals should:

- Explore ways to protect the adolescent from further harm and further exposure. Create a safe place away from onlookers and media.
- Kindly but firmly direct children away from the site of violence or destruction, the severely injured, and any continuing danger.
- Provide support to adolescents who are showing signs of panic and intense grief, such as trembling, agitation, refusing to speak, loud crying, or rage. Stay with them until they are stabilized.

- Help the adolescent feel safe with supportive and compassionate verbal and nonverbal communication. These reassurances are very important.
- Provide information about the traumatic event in language that the adolescent can understand. This will help the adolescent to understand what happened and feel more in control (American Psychological Association, n.d.).

It was once thought that providing debriefing right after a traumatic event could be helpful in recovery. One of the most popular types of debriefing, Critical Incident Stress Debriefing (CISD), was widely used after the attacks of September 11th (Villalba & Lewis, 2007). However, recent research suggests that this type of intervention may not only be ineffective, but can cause harm to certain individuals by disturbing the natural coping process (Roth & Fonagy, 2006). Therefore, it is suggested that this method of treatment be avoided.

If you know of an adolescent who has been exposed to a traumatic event, the first step is to identify whether there is a need for intervention. It is important to remember that everyone is different. Some people may be able to deal fairly well with the situation at hand, while others may take years to overcome the emotional pain. Sometimes individuals try to hide or mask the fact that they are hurting emotionally. Reassure adolescents that needing help does not mean that a person is weak, incompetent, or sick (American Psychological Association, n.d.). A feeling that it is safe to express emotions can help prevent negative reactions, such as becoming frozen or overwhelmed (American Psychological Association, n.d.). At the same time, some people cope best by using distraction and avoidance; forcing these people to talk could negatively impact their ability to heal naturally (Roth & Fonagy, 2006).

Those adolescents who respond to trauma by showing significant anxiety, depression, aggression, school difficulties, or extreme withdrawal should receive an evaluation from a licensed mental health professional. Many people who experience trauma and/or PTSD show improvement in their symptoms after receiving individual counseling (Villalba & Lewis, 2007). Cognitive behavioral therapy entails discussion of thoughts and emotions, as well as re-experiencing some of the traumatic event. This form of therapy has been found to be particularly effective in treating adolescents with PTSD or exposure to trauma (Villalba & Lewis, 2007). There is some evidence that Eye Movement Desensitization and Reprocessing (EMDR) also helps in recovery from trauma (Roth & Fonagy, 2006). Some people may also benefit from the use of medications, such as

antidepressant or anti-anxiety medication. Currently there is research being conducted on the use of propranolol in cases of trauma. Preliminary evidence suggests that this medication may be useful in trauma recovery (Vaiva et al., 2003).

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http://www.floridahealth.gov/_documents/newsroom/press-releases/2017/09/091817-mold2017sept.pdf

CLEANING MOLD AFTER A FLOOD



Here's how to get rid of mold when your home has been hit by a disaster:

- 1. Wear protective gear.** Gloves, goggles, pants, a long-sleeved shirt and a respirator rated N95 or higher are recommended to avoid breathing or touching spores.
- 2. If your insurance covers mold damages or cleanup costs, take photographs before cleaning up.**
- 3. Seal off moldy areas.** Cleaning up mold can cause a large release of spores into the air. Open windows, turn off the AC and tape plastic over air grilles to prevent their spread.
- 4. Remove moldy, porous materials.** These include:
 - Carpeting
 - Upholstery
 - Fabrics
 - Mattresses
- 5. Clean and disinfect nonporous materials.** Follow label directions and warnings, wear rubber gloves, and *never mix cleaning materials. Don't use bleach in the air conditioning system or with ammonia or acids.* Use a solution of ½-1 cup chlorine bleach per gallon of water on colorfast, nonmetal surfaces. Use alcohols and hydrogen peroxide on materials that may potentially be damaged by bleach.
- 6. Air out your home.** Use fans in windows to pull spores out.
- 7. Dry all wet materials as quickly as possible.** Close windows, turn on the AC and fans, and use a dehumidifier. If your home is without power, keep windows open.

For more information, visit <http://edis.ifas.ufl.edu/fy1044> or <http://www.lsuagcenter.com/profiles/kkramer/articles/page1487879426120>

Fuentes: <http://www.lsuagcenter.com/profiles/kkramer/articles/page1487879426120>
http://www.floridahealth.gov/_documents/newsroom/press-releases/2017/09/091817-mold2017sept.pdf

LIMPIANDO MOHO DESPUÉS DE UNA INUNDACIÓN



Así es como se quita el moho después de un desastre natural:

- 1. Usa equipo de protección.** Guantes, gafas de protección, pantalones, una camisa manga larga y un respirador de un índice de N95 o más para evitar respirar y tocar las esporas.
- 2. Si su seguro cubre el daño o la limpieza de moho en su hogar, tome fotos antes de limpiarlo.**
- 3. Sella todas las áreas que tenga moho.** Limpiando moho puede soltar bastantes esporas en el aire. Abre las ventanas, apague el aire acondicionado y pega con cinta adhesiva un plástico sobre las ventilaciones para evitar la propagación de las esporas.
- 4. Quita todo material mohoso y poroso.**
 - Alfombras
 - Telas
 - Tapicerías
 - Colchones
- 5. Limpia y desinfecte todo material que no es poroso.** Sigue las instrucciones de las etiquetas y sus avisos. Use guantes de goma y nunca mezcle productos de limpieza. No use lejía en el sistema del aire acondicionado ni amoníaco o ácidos.
- 6. Debe airear su casa.** Usa ventiladores en sus ventanas para sacar las esporas.
- 7. Seca todo material mojado lo más rápido posible.** Cierra las ventanas, apaguen el aire acondicionado y los ventiladores y usa un deshumidificador. Si no tiene luz, mantenga las ventanas abiertas.

Para más información, visite <http://edis.ifas.ufl.edu/fy1044> o <http://www.lsuagcenter.com/profiles/kkramer/articles/page1487879426120>

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http://www.floridahealth.gov/_documents/newsroom/press-releases/2017/09/091817-mold2017sept.pdf

NETWAYE MWAZI APRE YON INONDASYON



Men kijan pou w retire limon/mwazi nan kay ou aprè yon katastwòf:

- 1. Mete ekipman pwoteksyon.** Gan, gwo linèt, pantalon, chemiz manch long ak kachnen N95 oswa ki pi siperyè pou evite w respire oswa manyen spò yo.
- 2. Si asirans ou kouvri dega limon yo oswa depans netwayaj yo, pran foto anvan w netwaye.**
- 3. Bouche zòn oswa espas ki gen limon (mwazi) yo.** Louvri fenèt yo, etenn èkondisyone an epi tepe tout kote van èkondisyone an konn pase yo pou evite spò yo pwopaje.
- 4. Retire materyèl mouye yo ki gen mwazi sou yo tankou:**
 - Kapèt
 - Mèb ki gen twal sou yo
 - Twal
 - Matla
- 5. Netwaye epi dezenfekte materyèl ki pa mouye yo.** Swiv enstriksyon ak avètisman ki sou etikèt la, mete gan epi pa janm melanje pwodwi netwayaj yo. Pa itilize klowòks, amonyak oswa asid lè w yon kote ki gen èkondisyone. Itilize yon solisyon ½-1 tas klowòks pou chak galon dlo sou sifas ki pa an metal yo. Itilize alkòl ak dlo oksijene sou bagay klowòks ka gate. Kite van antre nan kay la. Itilize vantilatè, kite fenèt yo louvri pou retire spò yo.
- 6. Seche tout bagay kite mouye yo byen vit.** Fèmen fenèt yo, limen èkondisyone an ak vantilatè yo, epi itilize yon aparèy pou retire imidite nan kay la. Si kay la pa gen kouran, kite fenèt yo louvri.

Pou plis enfòmasyon, vizite <http://edis.ifas.ufl.edu/fy1044> or <http://www.lsuagcenter.com/profiles/kkramer/articles/page1487879426120>

Hurricanes and Mosquitoes¹

C. Roxanne Connelly²

Why does Florida experience such high numbers of mosquitoes after a hurricane?

Mosquitoes go through four developmental stages during their life: eggs, larvae, pupae, and adults. Dozens of species of mosquitoes reside in Florida, and the different species have differing means of surviving.

In addition to many environmental variables, there are two biological attributes related to mosquito egg-laying that contribute to the numbers of mosquitoes seen and felt during a post-hurricane period. The attributes separate mosquitoes on the basis of the conditions in which they lay their eggs. The two groups are floodwater mosquitoes and standing-water mosquitoes.

Floodwater Mosquitoes

Many people associate mosquitoes strictly with standing water, with the belief that mosquitoes have to have water to lay their eggs. The fact is, mosquito eggs need water to hatch—but some species lay their eggs in moist soil (not standing water) and actually the eggs need to dry out before they can hatch. These mosquitoes are the “floodwater” species.

As far back as one year from the time the floodwater mosquitoes are noticeable, the adult female mosquitoes were flying around, feeding on blood, and laying eggs (one

female floodwater mosquito has the potential to lay 200 eggs per batch) in moist areas of pastures, citrus furrows, salt-marsh, and swales. These moist areas eventually dry out, and the mosquito eggs also dry and become encased in the cracks and crevices of the dried mud. Because of their unique biology, the eggs need to dry out before they can hatch into larvae. The eggs survive in the dry soil through the winter and spring, and then with rains from storms or hurricanes, those areas are inundated with water. The water that reaches the eggs provides a cue to hatch.



Figure 1. Floodwater mosquito eggs (*Aedes epactius*).
Credits: S. McCann (UF/IFAS/FMEL)

One can consider the potential extent of this habitat by thinking about how much land in Florida is pasture, citrus grove, or large expanses of uninhabited flat land. There are estimates of the number of mosquito eggs in a floodwater habitat between 0.7 and 1.3 million eggs per acre. Yes—per acre. If only a small percentage of those eggs hatched and survived to the adult stage, the number of adult mosquitoes

1. This document is ENY719, one of a series of the Entomology and Nematology Department, UF/IFAS Extension. Original publication date October 2004. Revised July 2009, April 2013, and June 2016. Reviewed June 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

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flying around looking for blood at one time is almost incomprehensible.

Unfortunately, for those who are diligent about dumping water and cleaning up containers around their home, this type of local and small scale effort will not contribute much impact to reducing mosquitoes in the floodwater sites.

Standing Water Mosquitoes

Mosquitoes that are not in the floodwater group lay their eggs on standing water. Another difference between the two groups is that mosquito eggs in this category cannot withstand drying out. If the water dries up, or the egg gets stranded on the grass or soil, the egg dries and that will be the end; it will not hatch into a larva.

Females will lay their eggs on the water surface and the eggs will typically hatch in about 24 hours. Water is necessary to complete the life cycle, and soon the larva will change into a pupa and then emerge into an adult that will soon be hungry for blood. After the newly emerged female mates and finds a blood source, she can start the cycle all over again by laying her eggs on the standing water.



Figure 2. Standing water mosquito and eggs (*Culex quinquefasciatus*). Credits: S. McCann (UF/IFAS/FMEL)



Figure 3. An example of prime habitat for female mosquitoes to lay eggs.

The Double Whammy

The combination of the egg-laying habits of these two groups of mosquitoes provides for a double whammy put in place by activity that occurred with hurricanes and tropical storms. When dry areas flood, the floodwater mosquito eggs hatch. When the floodwater has nowhere to go, the standing-water mosquitoes have more places to lay their eggs.

What Can Individuals Do To Relieve Mosquito-Biting Pressure?

Draining water is recommended for reducing mosquito habitats. But just how are you going to drain an acre full of water? The recommendation to dump the water applies to mosquitoes that lay their eggs in water-holding containers that individual homeowners have control over, such as pet dishes, vases, and cans. The advice is good for average, everyday situations—that is, the times when Florida has not been in the path of a hurricane or tropical storm. The mosquito habitats resulting from the types of rain events from hurricanes are too vast for an individual homeowner to attempt to impact. It is best to leave the source reduction and treatment of such vast water sources to the mosquito control agencies.

In counties that have mosquito-control programs, help may not be immediate because there are such large areas that may need to be treated. And it may not be permanent—remember that mosquitoes fly. Even though an area may be treated to knock down the biting mosquitoes, there will likely be re-infestations from other areas due to the widespread flooding in the state.

The most effective way to stop a mosquito from biting is by wearing an effective mosquito repellent on the exposed portions of the body. Protective clothing is often mentioned as a deterrent, but during the very warm summer and fall evenings in Florida, especially for those who may not have electricity, long sleeves and long pants may not be practical.

The second best advice is to stay indoors. Check for damage to your home from the storms that may not be obvious. Look for holes in window and door screens; check for any newly formed open areas around your roof and windows where mosquitoes may gain access indoors; if you have pets that have access to both indoors and outdoors, brush their coats with your hands before they come inside to remove any mosquitoes that may be hanging on.

Cleaning Up After a Hurricane: Safety Comes First!¹

Eliana Kampf, Astrid Delgado, Carol Lehtola, and Mary L. Duryea²



Figure 1. Homeowners can clear debris to help professionals perform their specialized work.

I. General Safety Tips

Do Not Work Alone

Cleanup is dangerous. Always work with a partner.

Assemble a Well-Stocked First-Aid Kit

Learn how to use it and keep it nearby.

Avoid Overexertion and Stay Hydrated

Overexertion is the most common cause for injury. Avoid lifting over 50 pounds. Remember to lift with the legs and not the back and drink plenty of fluids.

Homeowner: Stay Safe!

Homeowners are seriously injured trying to do their own tree work. It is always a good idea to consult a professional before undertaking any major restoration or removal. Professional tree workers are required by law to wear personal protective equipment: hard hat, gloves, goggles, chaps, and appropriate footwear (see the *Personal Protective Equipment* section). If you decide to do some of the cleanup yourself, remember to follow these guidelines:

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- Do not use a chain saw if you are not experienced in operating it or if you are not physically fit.
- If you *must* use a chain saw, work only on the ground.
- Never do any tree work that involves felling trees, climbing of any kind, or using ropes. Get a professional to help you with these situations.

II. Create a Safe Work Zone

Survey the Site

Identify potential hazards and discuss where there is potential for injuries. Agree on communication signals before you start to work.

Mark a Perimeter Around the Work Area

Use tape or cones to mark an area that is two times the height of the tree, and keep non-workers safely outside this area. More distance is required when felling trees or dropping limbs.



Figure 2. Appoint a flagger or use barricades and warning signs to control traffic or onlookers.

Stay Away from Downed Power Lines

Call a professional to verify that the lines are not transmitting electricity.

III. Chain Saw Safety

Chain saws are considered the most dangerous hand tool available. The risk of injury increases during hurricane cleanup when chain saws are widely used to remove trees and branches. Use these guidelines to avoid injuries:

Keep Both Hands On the Handles

Many chain saw injuries affect the hands and are the result of using the saw with just one hand.

Follow Manual Instructions Carefully

This will ensure safe operation and proper equipment maintenance.

Take the Time to Do the Job Right

Most injuries affect the legs and feet and are the result of aggressive or careless cutting. Take breaks when needed, because most injuries occur when workers are fatigued.

Wear the Appropriate Personal Protective Equipment

Appropriate equipment includes: protective glasses and face shield, protective head gear, hearing protection, gloves, leg chaps, heavy work boots (see *Personal Protective Equipment* section for details).

Cut At Waist Level or Below

Chain saw injuries to the head often result from making overhead cuts (Figure 3).



Figure 3. Cut at waist level or below to avoid injuries.
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Take Extra Care When Cutting Limbs

Limbs that are bent, twisted, or caught under another object may snap back and hit you or pinch the saw.

Shut Off Equipment

Turn off chain saw when fueling it, carrying it a distance of more than 100 feet, or carrying it through slippery areas or heavy brush.

Be Sure the Chain Saw Operator Is Aware of Your Presence Before You Approach

Chain saw operators often cannot see or hear the approach of other people.

Do Not Cut with the Upper Tip of the Chain Saw

Kickback occurs when the upper tip of the guide bar contacts an object and causes the saw to come straight back at the operator. It happens so fast that there is no time for reaction.

To prevent kickback, cut with the part of the bar closest to the engine. Watch where the tip is at all times—do not let it contact the ground or other branches (Figure 4).



Figure 4. Do not cut with the upper tip of the saw—contact with other branches can cause kickback.

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IV. Personal Protective Equipment

The correct use of the personal protective equipment reduces the likelihood of injury by covering key areas of the body.

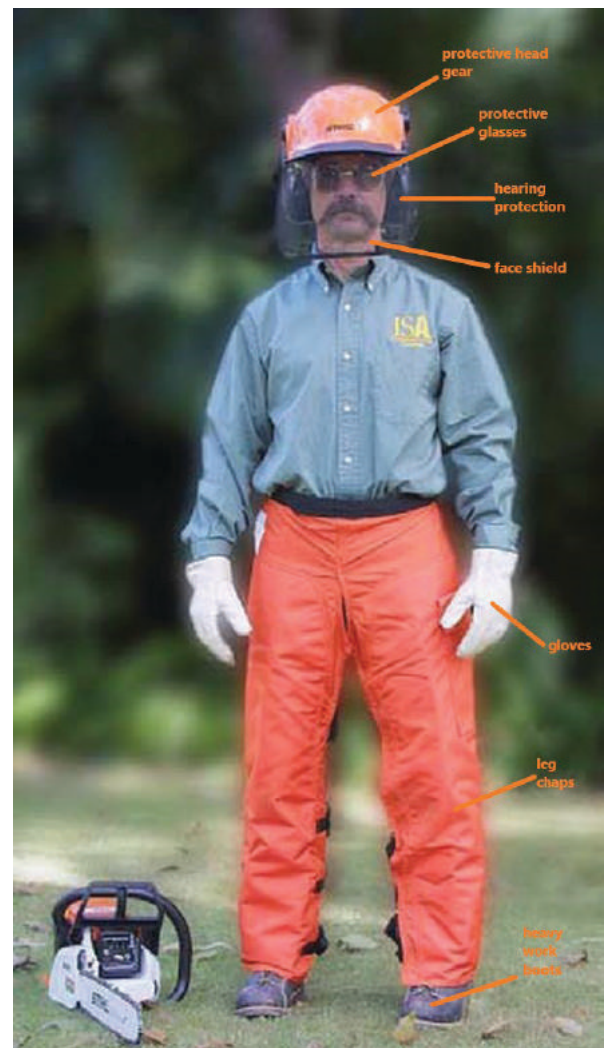


Figure 5. All tree workers should wear the appropriate clothing and footwear.

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LIMPIEZA DESPUÉS DE UN HURACÁN: ¡LA SEGURIDAD ES LO PRIMERO!



PUBLICACIÓN N°

FOR 115-SP

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UF UNIVERSITY of
FLORIDA
IFAS Extension

I. Sugerencias Generales en Seguridad

No trabaje solo

La limpieza después de un huracán es peligrosa. Trabaje siempre acompañado.

Prepare un buen botiquín de primeros auxilios

Aprenda a usarlo y manténgalo cerca.

Evite sobre esforzarse

Sobre esforzarse es la causa más común de las lesiones. Evite levantar más de 50 libras. Recuerde levantar con las piernas, no con la espalda.



Dueños de residencias: ¡Manténganse seguros!

Los propietarios de las residencias resultan seriamente lesionados tratando de hacer el trabajo ellos mismos. Una buena idea es consultar un profesional antes de empezar cualquier trabajo grande de restauración o remoción. Los trabajadores profesionales de árboles tienen que usar por ley el equipo de protección personal (PPE, *por sus siglas en inglés*): casco, guantes, gafas de seguridad, chaparreras y zapatos adecuados (vea la sección de Equipo de Protección Personal). Si decide hacer la limpieza usted mismo, recuerde seguir estas sugerencias:

- No use una motosierra si no tiene experiencia en su operación o si no está físicamente apto para hacerlo.
- Si tiene que usar una motosierra, trabaje solamente en el suelo.
- Nunca haga un trabajo que involucre la tala de árboles, cualquier clase de trepa o el uso de cuerdas. Consiga un profesional para que le ayude en estas situaciones.

Figura 1

Los dueños de residencias pueden limpiar los escombros para ayudar a los profesionales a ejecutar su trabajo especializado.

II. Cree una zona de trabajo segura

Inspeccione el sitio

Identifique los riesgos potenciales y discuta con su equipo al respecto. Acuerde señales para la comunicación con los demás antes de empezar a trabajar.

Asigne un perímetro alrededor del área de trabajo

Marque un área que sea del doble de la altura del árbol. Cuando hay árboles o ramas grandes cayendo se requiere de una distancia mayor.

Demarque el área

Use cinta o conos y mantenga seguras y fuera del sitio a las personas que no están trabajando (Figura 2).



Figura 2

Use barreras y fije una banderola y/u otras señales de advertencia para controlar el tráfico vehicular y los curiosos.



Figura 3

Corte a la altura de la cintura o por debajo para evitar accidentes.

III. Seguridad al usar la motosierra

La motosierra es considerada la herramienta manual disponible más peligrosa. El riesgo de accidentes se incrementa durante la limpieza después de un huracán cuando las motosierras son ampliamente usadas para remover árboles y ramas. Use esta guía para evitar accidentes:

Mantenga ambas manos en las manijas

Muchos de los accidentes que afectan las manos son el resultado de usar la motosierra con una sola mano.

Siga cuidadosamente las instrucciones del manual

Esto le garantizará una operación segura y un mantenimiento apropiado del equipo.

Tómese el tiempo para hacer un buen trabajo

La mayoría de las lesiones que afectan las piernas y los pies son el resultado de cortes agresivos hechos sin cuidado. Descanse cuando lo necesite, porque la mayoría de los accidentes ocurren cuando los trabajadores están fatigados.

Use el equipo apropiado de protección personal

El equipo adecuado incluye: gafas de seguridad y pantalla protectora para la cara, casco, protección para los oídos, guantes, cahaparreras y botas para trabajo pesado (Para más detalles, vea la sección de [Equipo de Protección Personal](#))

Corte a la altura de la cintura o por debajo

A menudo las heridas ocasionadas con la motosierra en la cabeza son el resultado de hacer cortes por encima de ésta (Figura 3).

Ponga especial cuidado cuando corte ramas

Las ramas que están inclinadas, torcidas o atrapadas debajo de otro objeto, pueden partirse y golpearlo repentinamente o trabar la motosierra.

Apague el equipo

Apague la motosierra cuando la esté llenando de combustible o cuando lo esté transportando a una distancia mayor de 30 metros (100 pies) o a través de áreas resbalosas con mucha maleza.

Asegúrese de que el operador de la motosierra sabe cuando alguien se le aproxima

Los operarios de la motosierra usualmente no pueden ver o escuchar cuando otras personas se les acercan.



No corte con la punta superior de la barra de la motosierra

El retroceso ocurre cuando la punta superior de la barra guía de la motosierra toca un objeto y hace que ésta se devuelva hacia el operador. El contragolpe sucede tan rápido que no hay tiempo de reaccionar.

Para prevenir el retroceso, corte con la parte de la barra más cercana al motor. Mire todo el tiempo dónde está la punta – no la deje tocar el piso u otras ramas (Figura 4).



Figura 4

No corte con la punta superior de la barra de la motosierra -su contacto con otras ramas puede ocasionar el retroceso.

IV. Equipo de Protección Personal

El uso correcto del equipo de protección personal reduce la probabilidad de accidentes al cubrir las partes claves de su cuerpo.



Figure 5

Todos los trabajadores deben usar la ropa y zapatos apropiados.

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Cleaning Up after a Hurricane: Get the Right Tree Care Professional¹

Eliana Kampf, Astrid Delgado and Mary L. Duryea²



Be Safe: Hire a Tree Expert Tree Care Professional

Tree care professionals with adequate equipment and insurance can handle these situations:

- Taking trees down in open areas.
- Removing dead or hazardous limbs.

Certified Arborist

Situations that require advanced training and are best handled by ISA certified arborists are:

- Removing a leaning tree or broken limb that is near a potential target.
- Reaching limbs that require climbing.
- Restoring a damaged tree that could be saved.
- Pruning to promote good structure.



Figure 1. If there is no room to safely fell a tree, the situation requires professional help.

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U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.



Figure 2. Certified arborists are trained to safely climb and restore damaged trees.

Hiring an Arborist

Hiring an arborist is a worthwhile investment. Trees increase property value when they are well maintained but can be a liability if poorly pruned or unhealthy.



Figure 3. Hire a certified arborist for major restoration and removal efforts.

Beware of scams!

Unqualified individuals wanting to make a quick dollar may bring chain saws and equipment to help clean up after the storm. However, qualified arborists from around the country also come to help. Learn to identify the qualified arborists because unqualified workers may get hurt or cause irreparable damage to trees.

Use These Questions to Help You Find a Qualified Arborist

INSURANCE

1. Are you insured for property damage, personal liability, and worker's compensation?

If you hire an uninsured company, you may be held responsible for medical bills and lost wages for injured workers.

CERTIFICATION AND TRAINING

2. Are you certified by the International Society of Arboriculture (ISA)?

Being certified requires professional experience and knowledge of the best techniques in the industry. Arborists attend training courses and continuing education classes to learn the latest research.

3. What are the ANSI Z133.1 and ANSI A300 guidelines?

The American National Standards Institute (ANSI) prints these two guidelines, with which all tree care professionals should be familiar. ANSI Z133.1 represents safety standards for tree care operations in the United States. ANSI A300 represents the best management practices in the industry for pruning and other tree care operations.

ESTIMATES

4. What are the procedures involved, equipment used, price, and time frame?

Get more than one written estimate. Keep in mind that specialized equipment, qualified skills, and insurance will cost more. Good tree work is worth the additional investment; poor work may cost more in the long run.

Homeowner: Stay Safe!

Homeowners are seriously injured trying to do their own tree work. It is always a good idea to consult a professional before undertaking any major restoration or removal. Professional tree workers are required by law to wear personal protective equipment: hard hat, gloves, goggles, chaps, and appropriate footwear. If you decide to do some of the cleanup yourself, remember to follow these guidelines:

- Do not use a chain saw if you are not experienced in operating it or if you are not physically fit.
- If you *must* use a chain saw, work only on the ground.

- Never do any tree work that involves felling trees, climbing of any kind, or using ropes. Get a professional to help you with these situations.



Figure 4. Homeowners can clear debris to help professionals perform their specialized work.

Electrical Hazards

Trees can uproot underground utilities and tear down power lines during hurricanes. The combination of electrical wires and flooding creates a hazardous environment that requires extreme caution.

- Only qualified line-clearance arborists are allowed to work near electrical lines.
 - Call the power company to report tree limbs that have fallen on a power line.
- Assume all power lines are energized and do not touch. improper use of generators may energize lines without warning.
 - Beware! Electrocutation may occur if any part of your body touches a conductor (water, tool, tree branch, fence, etc.) in contact with an energized power line.

To Find a Certified Arborist In Your Area, Contact:

International Society of Arboriculture (ISA)

<http://www.isa-arbor.com>

(217) 355-9411 or (888) 472-8733 (941) 342-0153 (in Florida)

UF/IFAS Extension Offices

<http://sfyl.ifas.ufl.edu/find-your-local-office/>



Figure 5. Only qualified line-clearance arborists can work on trees near power lines.

Limpieza Después de un Huracán: Consiga el profesional Correcto para el Cuidado de los Árboles¹

Eliana Kampf, Astrid Delgado, y Mary L. Duryea²



Esté Seguro: Contrate a un Experto en Árboles

Profesional en el Cuidado de los Árboles

Los profesionales en el cuidado de los árboles con un equipo adecuado y asegurados pueden manejar estas situaciones:

- Tumbar árboles en áreas abiertas.
- Remover ramas muertas y peligrosas.

Arboricultores Certificados

Las situaciones que requieren entrenamiento avanzado, son mejor manejadas por arboricultores certificados de la Sociedad Internacional de Arboricultura (ISA, por sus siglas en inglés):

- Remover un árbol inclinado o ramas partidas que están cerca de una casa u otro objetivo potencial.
- Alcanzar ramas que requieran trepar al árbol.
- Restaurar un árbol dañado que puede ser salvado.
- Podar para promover una buena estructura.



Figura 1. Si no hay espacio para cortar un árbol con seguridad, la situación requiere la ayuda de un profesional.

1. Este documento, FOR116-SP, es uno de una serie de publicaciones del School of Forest Resources and Conservation, Servicio de Extensión Cooperativa de la Florida, Instituto de Alimentos y Ciencias Agrícolas, Universidad de la Florida (UF/IFAS Extensión). Fecha de primera publicación: enero de 2008. Revisado febrero 2014. Revisado abril 2018. Visite nuestro sitio web EDIS en <<http://edis.ifas.ufl.edu>>.

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Figura 2. Los arboricultores certificados están entrenados para treparse a los árboles dañados y restaurarlos.

Cómo Contratar un Arboricultor

Contratar un arboricultor es una inversión que vale la pena. Los árboles incrementan el valor de las propiedades cuando están bien mantenidos, pero pueden ser un riesgo y representan una responsabilidad legal si están mal podados o enfermos.



Figura 3. Contrate un arboricultor certificado para los esfuerzos de restauración y remoción más importantes.

¡Tenga cuidado con los estafadores!

Individuos no calificados que desean hacer dinero rápidamente, pueden traer motosierras y equipo para ayudar en la limpieza después de una tormenta. Sin embargo, al mismo tiempo, arboricultores calificados de todo el país también se pueden presentar a ayudar. Aprenda a identificar los arboricultores calificados porque los trabajadores no

calificados pueden hacerse daño ellos mismos o causar daños irreparables a los árboles.

Haga éstas preguntas para ayudarse a encontrar un arboricultor calificado SEGURO

1. ¿Está usted asegurado por daño a la propiedad, responsabilidad civil y compensación laboral?

Si usted contrata una compañía no asegurada, podría tener que responder por las cuentas médicas y el salario perdido de los trabajadores accidentados.

CERTIFICACIÓN Y ENTRENAMIENTO

2. ¿Tiene usted una certificación de la Sociedad Internacional de Arboricultura (International Society of Arboriculture, ISA)?

Para estar certificado se requiere de experiencia profesional y conocimiento de la mejores técnicas en la industria. Los arboricultores asisten a cursos de entrenamiento y clases de educación continua para aprender lo último que se ha investigado.

3. ¿Qué son los procedimientos ANSI Z133.1 y ANSI A300?

El Instituto Nacional Americano de Normas (The American National Standards Institute, ANSI) edita estas dos guías con las cuales todos los profesionales del cuidado de los árboles deben estar familiarizados. ANSI Z133.1 representa los estándares de seguridad para las operaciones de cuidado de los árboles en los Estados Unidos. ANSI A300 representa las mejores prácticas en la industria para la poda y otras operaciones en el cuidado de los árboles.

ESTIMADOS

4. ¿Cuáles son los procedimientos involucrados, el equipo a utilizar, el precio y el cronograma de actividades?

Consiga más de una cotización por escrito. Tenga en cuenta que el equipo especializado, los servicios calificados y el seguro costarán más. El buen trabajo en los árboles merece la inversión adicional. Un trabajo barato puede costar más a largo plazo.

Dueños de casa: ¡Manténgase!

Los dueños de las casas a menudo resultan seriamente lesionados al intentar ejecutar ellos mismos el trabajo con los árboles. Siempre es una buena idea consultar con un profesional antes de abordar cualquier trabajo de

remoción o restauración. Los trabajadores profesionales de los árboles, por ley deben usar el equipo de protección personal: casco protector, guantes, escudo protector para la cara, gafas de seguridad, chaparreras y botas para trabajo pesado. Si usted decide hacer algunas labores de la limpieza, recuerde seguir las siguientes sugerencias:

- No use una motosierra si no tiene experiencia en ello
- Si no está físicamente preparado para hacerlo.
- Si tiene que usar la motosierra, trabaje solo en el suelo.
- Nunca haga ningún trabajo que involucre de alguna manera la tala o la trepa de árboles, o el uso de cuerdas. Consiga un profesional para que le ayude en estas situaciones.



Figura 4. Los dueños de las casas pueden despejar los escombros para ayudar a los profesionales a realizar el trabajo especializado.

Peligros Eléctricos

Durante los huracanes, los árboles pueden desenterrarse y arrancar los cables eléctricos subterráneos, tumbar los postes de servicios públicos y tirar al suelo las líneas eléctricas. La combinación de cables eléctricos e inundaciones crea un ambiente peligroso que requiere de muchísima precaución.

- Sólo arboricultores calificados en la restauración de líneas eléctricas, están autorizados para trabajar cerca de los suministros de servicios públicos.
- Llame a la compañía de electricidad para reportar las ramas de los árboles que han caído sobre las líneas eléctricas.
- Asuma que todas las líneas eléctricas están energizadas y no las toque. el uso inapropiado de generadores puede energizar las líneas sin previo aviso.

- ¡Esté alerta! La electrocución ocurre si alguna de las partes de su cuerpo toca un conductor de energía (agua, herramientas, ramas de árboles, cercas de metal, etc.) que esté en contacto con una línea eléctrica energizada.



Figura 5. Sólo arboricultores calificados en la restauración de líneas eléctricas, pueden trabajar en árboles cerca de los suministros de servicios públicos.

Para encontrar un arboricultor certificado en su área contacte:

International Society of Arboriculture (ISA)

(Sociedad Internacional de Arboricultura)

<http://www.isa-arbor.com>

(217) 355-9411 o (888) 472-8733

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ASSESSING HURRICANE-DAMAGED TREES AND DECIDING WHAT TO DO



PUBLICATION N°

FOR 117

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Introduction

Right after a hurricane, communities and homeowners need to decide what to do with storm-damaged trees. Although damaged trees may seem to be dying, some trees can be restored, others will need to be removed, and still others will not require any special treatment and can be left alone.

The factors that should be considered when deciding whether to remove or restore storm-damaged trees are discussed in detail in this fact sheet. Use this information to help you make an informed decision about how to treat your damaged trees after a storm.

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I	Setting Priorities Immediately after the Storm	p. 1
II	Factors to Consider When Deciding Whether to Remove or Restore a Tree	p. 5
III	When to Remove a Tree	p. 10
IV	When to Restore a Tree	p. 12
V	Assessing Pines	p. 16
VI	Assessing Palms	p. 16

I. Setting Priorities Immediately after the Storm

Immediately following a storm, trees need to be sorted out into priority groups. We will discuss situations that require immediate attention as well as those that can be treated later.

The most important priority is to determine if the tree poses a safety hazard to humans or animals or is endangering property. Trees become a potential hazard when a target—a structure, vehicle or a person—could be struck by a falling tree or any of its parts. Therefore, a hazard tree is any tree that if it falls would result in damage to property, people or other valuable trees.

Trees That Do Require Immediate Attention



Figure 1

This tree requires urgent attention because it is leaning on power lines. Trees or branches hanging over power lines are also of immediate concern.

Figure 2

Trees or parts of trees that are blocking driveways or roads need to be taken care of as quickly as possible.

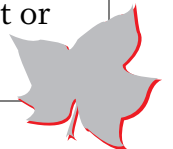
Figure 3

Damaged trees in public places and highly trafficked areas, such as this parking lot, are of immediate concern. The broken limbs hanging above the ground are hazardous to cars and pedestrians.

! Immediate Attention

The situations depicted in these photos are highly dangerous and should be taken care of immediately. The trees shown in Figures 1 and 2 need to be removed, while the tree in Figure 3 needs to be pruned as soon as possible.

In these situations, the work should be performed by a certified arborist or properly trained professional.



Trees That Do Not Require Immediate Attention



Figure 4

Since there is no target, this tree can be removed later.

Figure 5

This tree can be removed later since it is not blocking any thoroughfare.

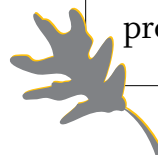
Figure 6

This tree can be treated later since it is not located in a highly trafficked area and does not pose an immediate threat.



Follow-Up

Keep in mind that many trees can be saved with appropriate treatment. There is no need to rush out and remove trees that do not pose an immediate safety hazard. Trees can recover from substantial damage, and what looks awful at first may be judged as much less serious by an experienced professional.



Who Should Clean Up after the Storm?

Now that we have discussed setting up priorities, it is important to get the right tree care professional for the job. Homeowners should not attempt to do all the work themselves, like the man in Figure 7.

Certain situations require advanced training and are best handled by arborists certified by the International Society of Arboriculture (ISA). These include removing a leaning tree or broken limb near a house or other target, restoring a damaged tree that could be saved, evaluating a tree hazard potential, reaching limbs that require climbing and pruning. Likewise, only qualified line-clearance arborists should work near electrical utilities. Call the power company to report tree limbs that have fallen on or are hanging over a power line.

Keep in mind that storm damage cleanup is extremely dangerous, even for professionals. Numerous injuries and deaths occur during cleanup after storms. When working with trees in the aftermath of a hurricane, it is essential to look up, down and around. Beware of dangerous broken limbs that are hanging or caught in other branches overhead and may fall. Safety should be a priority.

FOR MORE INFORMATION »		
ON SAFETY	CH 1	Cleaning Up after a Hurricane: Safety Comes First!
ON HOW TO HIRE A TREE-CARE PROFESSIONAL	CH 2	Getting the Right Tree Care Professional



Figure 7

Chain saw use should be left to the professionals. If homeowners decide to use a chain saw, they should only work on the ground and with proper protective equipment. What is wrong with this picture?

Not All Trees Need to Be Cut Down!

A common reaction after a wind storm is to remove all trees to avoid future problems (Figure 8), especially if a tree has fallen on a home or other valued property. However, not every tree poses a high risk. Unfortunately, few communities and decision-makers realize that the benefits of trees in the urban forest in the long term far outweigh the costs needed to pay arborists to care for trees.

It has been observed that a grouping of well-placed, healthy trees may actually help redirect winds and serve as a protective barrier for homes (Figure 9). Communities with a well-maintained urban forest may suffer less damage after hurricanes than those without maintenance. Having an active management program reduces the losses from winds and establishes a restoration plan when damage does occur.

FOR MORE INFORMATION »		
ON DEVELOPING A TREE-CARE PLAN	CH 14	Developing an Urban Forest Management Plan for Hurricane-Prone Communities



Figure 8

A common reaction after hurricanes is the removal of all the trees to avoid future problems.

Figure 9

A healthy urban forest with well-placed and well-maintained trees may redirect winds.

II. Factors to Consider When Deciding Whether to Remove or Restore a Tree

After all the safety concerns have been addressed, the most difficult part of responding to a storm is deciding which damaged trees should be pruned back to health and which trees should be removed. The eight items below are interrelated and together will help you determine the amount of care a tree will need after a storm. They will guide the decision of what trees should be removed and which ones can be restored.

a	Amount of Damage	p. 5
b	Tree Size and Age	p. 5
c	Tree Species	p. 6
d	Tree Health	p. 7
e	Tree Structure	p. 8
f	Previous Cultural Practices	p. 9
g	Site Conditions	p. 9
h	Cultural Value	p. 10

a. Amount of Damage

Trees with more damage will require more work than those with less damage.

What parts of the tree were affected, how much of the canopy is gone and how big the wounds are will determine the amount of care needed. The larger the wound is in relation to the size of the limb, the more vulnerable the tree is to decay, diseases and pests (Figures 10 and 11).

b. Tree Size and Age

Younger and smaller trees will take less time to restore than more mature and larger trees.

Younger and smaller trees survive winds better and suffer less damage than older trees, making them better candidates for restoration pruning (Figure 12).

On the other hand, older, more mature trees may have accumulated multiple defects (e.g., bark inclusions, cracks, and extensive decay) over the years, often making them very susceptible to damage in storms.



Figure 10

This tree is only defoliated with a few broken branches. The only action that needs to be taken is to prune its broken branches.



Figure 11

If over half of the canopy is gone (including the main leader) with several broken stems, the tree should be cut down.



Figure 12

This small tree sustained damage but because it is young it can be pruned over the next few years to help it recover.

c. Tree Species

Trees that resist decay are better candidates for restoration than those prone to decay.

Trees that resist the spread of decay into their wood are called good compartmentalizers, and are more easily restorable. Examples include live oak (*Quercus virginiana*), mahogany (*Swietenia mahogani*), false tamarind (*Lysiloma latisiliquum*), winged elm (*Ulmus alata*) and buttonwood (*Conocarpus erectus*) (Figure 13).

On the other hand, poor compartmentalizers are trees prone to decay, such as African tuliptree (*Spathodea campanulata*), Hong-Kong orchid (*Bauhinia blakeana*), redbay (*Persea borbonia*), laurel oak (*Quercus laurifolia*) and water oak (*Quercus nigra*) (Figure 14). These species may be problem urban trees since large pruning cuts, trunk injuries and root damage can result in hollows and extensive internal decay in their roots and trunks.

FOR A LIST OF	
GOOD AND POOR COMPARTMENTALIZERS	http://hort.ifas.ufl.edu/woody/compartimentalization.html



Figure 13
Buttonwood is an example of a good compartmentalizer.



Figure 14
Water oak is an example of a poor compartmentalizer.

Short-lived species may not be worth restoring.

Every tree species has an inherent life span and some tree species live longer than others do.

Longevity should be considered when evaluating whether a tree is worth restoring or should be removed (Figure 15). Usually short-lived trees also do not compartmentalize decay well. Keep in mind that risk of failure increases with age.



Figure 15
The laurel oak lives up to about 50 years and begins to decay as it reaches 40 years old. The laurel oak in this photo is now 45 years old and suffered moderate to extensive wind damage. Is it worth restoring this tree or should it be replaced? It is probably more cost-effective to plant another species in its place.

Table 1. Life span of some species in the forest *

Short-lived (< 50 years old)	Medium-lived (50-100 years old)	Long-lived (> 100 years old)
laurel oak	African tuliptree	live oak
red bud (<i>Cercis canadensis</i>)	paradise tree (<i>Simarouba glauca</i>)	sweetgum (<i>Liquidambar styraciflua</i>)
bottle brush (<i>Callistemon</i> spp.)	red maple (<i>Acer rubrum</i>)	southern magnolia (<i>Magnolia grandifolia</i>)
Hong-Kong orchid tree	gumbo limbo (<i>Bursera simarouba</i>)	baldcypress (<i>Taxodium distichum</i>)
jacaranda (<i>Jacaranda mimosifolia</i>)	sea grape (<i>Coccoloba uvifera</i>)	mahogany

* Note that urban trees have a shorter life span.

d. Tree Health

Healthy trees will recover better after storms than unhealthy ones.

Decay, a major cause of tree failure, is caused by fungi that weaken wood as they grow. Cracks, seams, butt swell, cankers, dead branch stubs and large, older wounds suggest internal decay and increase the likelihood of tree failure in wind. Decay is often present without obvious signs (Figures 16 and 17).

Mushrooms at the base of the tree trunk can be the sign of *Armillaria* or other fungi that can decay roots and create unstable trees (Figure 18). Root rot (Figure 19) can be identified with careful, regular inspections by accomplished arborists.

Did you know?

Decay is often present without obvious signs, but can be identified with careful, regular inspections by accomplished arborists.



Figure 16

Before the storm: this tree appeared intact.



Figure 17

After the storm: the tree turned out to be hollow.



Figure 18

Before the storm: presence of *Armillaria*.



Figure 19

After the storm: extensive root rot contributed to this tree toppling over.

e. Tree Structure

Trees with good remaining tree structure are worth saving and will be more easily restored.

One trunk up through the canopy, branches considerably smaller in diameter than the trunk, evenly spaced branches, balanced canopies, absence of codominant stems and bark inclusions are all signs of a strong tree. These characteristics make trees better able to resist storms (Figure 20). Certified arborists are able to create and maintain such strong structure by appropriate pruning techniques, especially if they begin early in the tree's life.

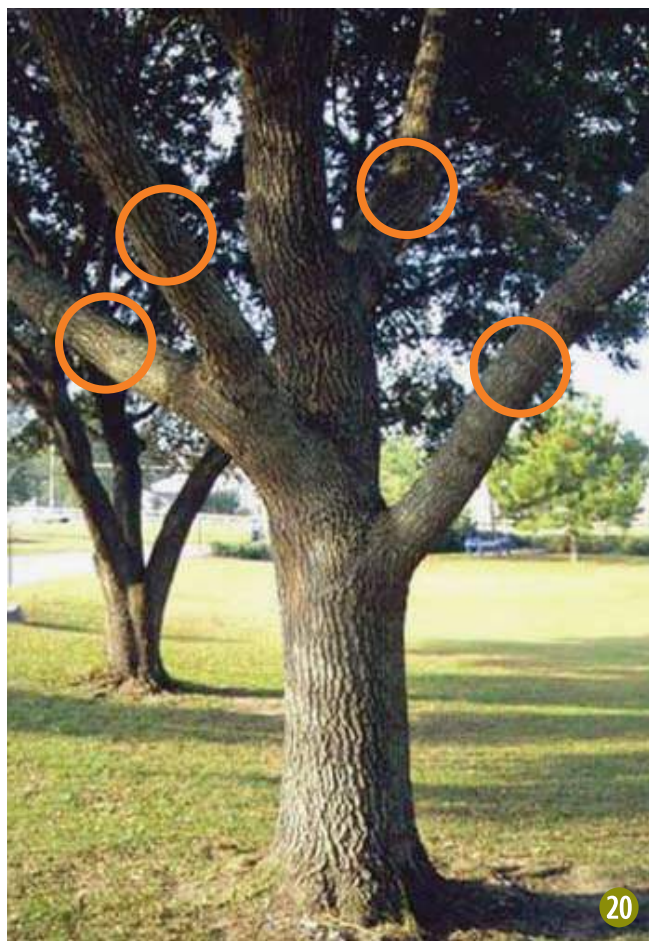


Figure 20

This tree has a strong structure and it is a good candidate for restoring. There are four evenly spaced branches, smaller in diameter than the trunk.

FOR MORE INFORMATION »		
ON TREE STRUCTURE	CH 12	Developing a Preventive Pruning Program in Your Community: Young Trees
	CH 18	Developing a Preventive Pruning Program in Your Community: Mature Trees

f. Previous Cultural Practices

Poor pruning practices make trees susceptible to failure and breakage.

Removing large branches results in large pruning cuts that can serve as entry points for fungi that begin the decay process (Figure 21). Topping is also a poor pruning practice that should be avoided. Sprouts that grow from topped trees are poorly connected to the cut stub, making them susceptible to breakage in storms (Figure 22).



Figure 21

A large pruning cut several years ago caused decay and created a weak spot where the tree eventually broke.



Figure 22

This tree was topped a year ago and the several sprouts that grew from the cut stem broke in the wind.

Poor root management practices will affect tree stability.

The importance of root integrity and health cannot be overemphasized. In addition to absorbing water and essential elements, roots anchor the tree. If roots are damaged in any way, the likelihood of failure increases (Figure 23). Construction activities within about 20 feet of the trunks of existing trees can cause the trees to blow over more than a decade later.



Figure 23
Construction is especially damaging to roots, such as these roots cut during curb repair.

g. Site Conditions

Trees need adequate soil space and good soil properties to be stable.

Trees with root systems confined to relatively small soil spaces are not as stable as trees allowed to develop more extensive root systems (Figure 24).

Soil compaction, shallow soils, hardpans and a high water table restrict roots to shallow depths and can result in unstable trees (Figure 25).



Figure 24
These roots were deflected by the curb and the compacted soil, making them very susceptible to blowing over in the direction away from the curb.

Poorly located and/or chosen tree species may not be worth restoring.

The importance of selecting the right tree for the right location has been greatly stressed, and yet selection of inappropriate trees is one of the most common mistakes observed. For example, the white oak (*Quercus alba*) in Figure 26, which can grow to 100 feet and will develop wide-spreading crowns and numerous horizontal branches.

If the tree is in the wrong location (such as a tall tree beneath a power line), or if it is an undesirable species for the property (messy fruit, not drought-tolerant, etc.), it may be best to remove it if the tree sustained serious damage.



Figure 25
The high water table at this site restricted root depth and saturated soil allowed roots to slide in the soil, making these pines topple over during a hurricane.

h. Cultural Value

How valuable the tree is to you and the community will determine the amount of restoration effort needed.

In addition to the economical value and ecological services that trees provide to the owner and community, the tree in question might be a memorial tree, or it may have a historical significance or some other cultural attribute associated with it (Figure 27).



Figure 26
These white oak roots were confined by the buildings around them, probably damaged by construction and compaction, resulting in a root system too small to support such a large tree canopy.



Figure 27
This live oak is part of a historical 1900s hotel, as shown by the owner, located in the Bagdad Village Historic District, Milton, FL.

III. When to Remove a Tree

In general terms, these are the situations when a tree requires removal after safety concerns have been addressed. Remember, the priority is to remove trees that represent a hazard to people and property.

1. The lower main trunk is cracked or broken

Trees with cracks in the main trunk and branches are very dangerous, since limbs with this type of damage are not well-secured to the tree. Cracks well into the trunk (Figure 28) will not close and represent a severe defect that makes such trees a high risk in the landscape.

2. A large stem has split from the tree

Figure 29 shows a tree that needs to be removed because of the large codominant stem that split from the trunk. Notice the dark area at the top of the split—it is a bark inclusion (Figure 29). Bark inclusions are weak unions between branches and are very susceptible to breakage.

3. The tree is leaning towards a target

If a leaning tree is likely to fall on a person, building, power line, roadway or other valuable target, it should be removed immediately after the storm. However, *all* leaning trees should have their roots carefully examined for breakage, exposure or lifting out of the soil (Figure 30). Pay close attention to leaning trees with unbalanced canopies, cracks in the trunk and bark inclusions.

4. The remaining tree structure is highly susceptible to breakage

The tree shown in Figure 31 should be removed! It suffered major structural damage and the remaining tree structure is compromised. All the mass is on one side of the tree, and the trunk is very weak because of the two splits. The cause of both splits was a bark inclusion.



Figure 28
This tree should be removed since its broken stem is very large and the trunk is cracked, as shown by the circle. If the tree were not cracked into the trunk, the broken limb could be carefully removed and the tree might be restorable.



Figure 29
The circle shows a bark inclusion which broke during a tropical storm. The tree should be removed.



Figure 30
This leaning tree needs to be removed since major structural roots were broken and lifted.



Figure 31
One split occurred 8 years ago (lower injury) and one occurred about 2 weeks before this photo was taken. The tree should be removed.

5. The major roots are severed or broken

Fallen or leaning medium-aged and mature trees usually suffer severe major root breakage. Once cut or broken, these roots will not reconnect well into the soil and are unlikely to develop the root structure needed to keep the tree erect (Figure 32). The reason for that seems to be that severed large-diameter roots do not regenerate new roots as well as small-diameter roots (one-inch-diameter or less). Also, large broken roots can decay or rot, making the tree unstable (Figure 33).

6. Large limbs are broken

Remove trees with most of the canopy damaged due to large-diameter (greater than 8 inches) branch breakage (Figure 34). Trees with small-diameter broken branches have a better future and can be restored (Figure 35).

7. Girdling roots are causing dead spots and cracks in the trunk

Roots circling the trunk are often referred to as girdling roots, and tree death could occur when the root encircles most of the trunk (Figure 36). Trees with circling roots and cracks in the trunk will be less stable than trees without these characteristics and should be removed.

Remember:

If you remove a tree, plant another one in its place!



Figure 32

Medium-aged and mature trees should not be re-staked if they have failed at the roots. Large trees need large roots for structural support.



Figure 33

Roots on this tree were rotted, so they will not generate new roots.



Figure 34

This tree needs to be removed.

Figure 35

This tree can be restored.



Figure 36

These roots are circling around the trunk and crossing other major roots, causing trunk dead spots and cracks.

IV. When to Restore a Tree

Even after experiencing high winds, many trees can be restored. However, only restore trees with major limbs, trunk and roots intact (Figures 37 and 38). To be a good candidate for restoration, a tree should have no cracks in major limbs or the trunk, no decayed wood, and no bark inclusions. Roots should not be exposed, lifted out of the soil, or girdle around the trunk. Make sure the branch and trunk structures were good prior to the storms.

These are general guidelines that will explain in detail when a tree should undergo restoration pruning:

1. Trees are young

Young trees less than 10 inches in diameter, such as this live oak (Figure 39), make good candidates to restore because there are fewer branches to prune, the canopy is closer to the ground, and they can tolerate having more of their canopy removed than older trees.

2. The canopy is defoliated

Trees that lose their leaves in a hurricane usually are not dead. Many trees generate new foliage in the weeks following the storm*. Research has shown that for some species, such as gumbo limbo and live oak (Figure 40), defoliation is usually a strategy for survival since it reduces wind resistance. Defoliated trees that were healthy before the storm with no major branch breakage require no special treatment. Wait. Time is the best treatment for this type of damage. There is no need to apply fertilizer or other chemicals.

Trees and palms that were inundated with salt water often lose leaves due to root damage. In this case, trees need to be irrigated to wash salts through the soil.



Figure 37

This tree is restorable. It has one stem well up into the canopy with no codominant stems, well-spaced limbs, and no bark inclusions. Its roots are well-distributed around the trunk, and there are no girdling roots.



Figure 38

Restoration is difficult for this tree because of its poor initial structure. This young 20-year-old multi-trunk live oak has codominant stems with bark inclusions that will be a real challenge to fix.



Figure 39

Younger trees survive winds better and suffer less damage than older trees because they are easier to prune and maintain.



Figure 40

Live oak loses most of its leaves during a wind storm.

*Note: Some species, such as pines, may not recover their foliage after hurricanes. See Pines (page 16) for more information.

Many new sprouts will eventually emerge on hurricane-damaged trees. Some trees wait to produce new foliage the following spring. Sprouts should be allowed to grow because they provide the energy the tree will need to recover (Figure 41) and they can be pruned later.

FOR MORE INFORMATION »		
ON SPROUT MANAGEMENT	CH 4	Restoring Trees after a Hurricane

3. Small branches are broken or dead

Trees with small broken or dead branches (less than 4 inches diameter) can easily be pruned from the canopy and have a good chance of recovering. Trees with small branches have a better chance of recovering than large-diameter branches (greater than 8 inches diameter). If small, codominant stems are broken in the upper canopy without damage to the main trunk, the tree can also be restored (Figure 42).

4. Most of the canopy is damaged in decay-resistant species

Trees that resist decay well can lose much of their canopy and still recover from a storm. Even with $\frac{3}{4}$ of their small branches (less than 4 inches diameter) broken or removed by a hurricane, many decay-resistant trees can be restored (Figure 43).

5. Some major limbs are broken in decay-resistant species

Many species good at resisting decay after they are wounded can be restored even with some major branch breakage (Figure 44).



Figure 41

Managing sprouts over time can create reasonably good structure and a nice looking tree canopy. Sprout management should be carried out by professional arborists.



Figure 42

To remove a small branch, cut at the base of the tear or remove the entire damaged branch if it is not the main trunk.



Figure 43

Mahogany can be restored even with some major branch damage.



Figure 44

This decay-resistant tree can be restored even though it lost most of its canopy foliage.

6. Leaning or fallen trees are small or recently planted

Trees that have a trunk diameter smaller than 4 inches should be stood up as quickly as possible to prevent roots from drying out (Figure 45). Such small trees have a better chance of developing the proper root structure to keep them firm in the soil than bigger trees.

Recently planted trees can be uprighted at any size because they usually do not have large broken roots (Figure 46). These trees should be treated as a new planting and staked with the help of a professional.

FOR MORE INFORMATION »		
ON HOW TO STAND, STAKE, AND IRRIGATE FALLEN TREES	CH 4	Restoring Trees after a Hurricane



Figure 45
This leaning elm (*Ulmus spp.*) could be stood up and staked.



Figure 46
Recently planted trees, such as this red maple, should be treated as a new planting by staking and watering properly.

What Tree Size Can Be Uprighted?

Experienced arborists who have stood trees up after storms are finding that those greater than 4 inches trunk diameter are more susceptible to falling over in subsequent storms than smaller trees. The reason for this appears to be due to lack of generation of new roots on large severed roots when compared to regeneration on small roots (one inch diameter or less). Also, large severed roots can decay or rot more easily.

Table 2 shows general basic guidelines based on arborists' and other tree professionals' observations. Keep in mind, however, that there is no published research or definitive answers on this topic yet.

Table 2. Guidelines for standing up trees based on trunk diameter.

Trunk diameter	Action
Less than 4 inches	Stand up and stake
From 4 inches to 8 inches	Maybe stand up and stake Could be a hazard later
More than 8 inches	Not recommended Likely to be a hazard later

Look for Circling Roots in Small Leaning or Downed Trees

Before deciding whether to stand small leaning or downed trees up, look for the presence of circling roots. Some circling roots can be removed and the tree will respond with increased vigor (Figure 47). Other trees will need to be removed (Figure 48). If roots circle around most of the tree trunk, the tree is not restorable because girdling roots inhibit secondary growth and the movement of water and photosynthates.



Figure 47

This tree can be restored since it only has one root circling the trunk. Before uprighting the tree, cut the circling root at the point just before it begins to circle, as indicated by the dotted line. This will allow new roots to grow away from the trunk, thus increasing the likelihood the tree will regain support.



Figure 48

This tree should be removed. Too much of the root system originates from the roots that are circling the trunk, making treatment impractical.

V. Assessing Pines

Pines are very sensitive to wind damage. Pines can snap, uproot or lean after storms. A pine still standing after a hurricane may have internal damage that is not visible. Before making a decision to remove or restore, wait and see if the tree lives, considering these points:

- Pines often die over a period of 6 months to 2 years after wind storms.
- Some may remain green for a year or even longer, then suddenly turn yellow (Figure 49) and progress to brown needles in a very short period.
- Pines with all brown needles are dead and should be removed.
- Monitor pines carefully for insects. Weakened pines may be more susceptible to beetles and diseases.

What causes yellowing of the needles and pine death?

The causes are not completely understood, but it is likely due to hidden damage produced by bending and twisting the trunk during hurricane-force winds. Prolonged winds may also rupture smaller roots without breaking the larger support roots. The injured stems and roots are unable to supply the water and nutrients needed in the crown, resulting in yellow needles and decline.



Figure 49

Six months after a hurricane, this pine has suddenly turned yellow and may die.

VI. Assessing Palms

Palms grow differently from other trees. The growing point of a palm is at the top of each trunk, surrounded by leaves (fronds). All fronds originate from this one point (bud). If the bud is severely damaged or killed, new leaves fail to develop and single-stemmed palms will die. On multi-stemmed palms, the undamaged trunks could recover if their buds are not damaged. If the trunk is snapped in half, the palm is dead. However, for palms left standing, the bud is often not accessible, making it difficult to determine whether it is damaged. For these palms, follow these guidelines:

- Allow at least 6 months for palms to put out new growth. New leaves may be stunted, discolored or abnormally shaped.
- It may take 1 to 2 years or more before palms appear normal with a full canopy.
- Irrigate 3 times a week for 6 weeks if there is not sufficient rainfall; longer if drought persists.



Figure 50

The royal palms (*Roystonea elata*) circled in the back are dead since their buds are clearly destroyed. The palms in the front, however, can be restored by simply allowing them to grow.

Recovery from a storm is not a quick process, so have patience with your palms.

Final Considerations

Right after a storm it is important to sort out trees into priority groups, acting immediately in situations that require urgent attention and selecting trees to be monitored and treated later on. Remember that even though hurricanes can be devastating to communities and urban forests, not all storm-damaged trees need to be removed and many trees can be treated and saved.

When assessing damage, think about it in terms of tree function and your objectives. Management actions will depend on observing the interrelated points below when deciding what trees to remove or restore:

- Soil space and soil properties
- Tree health, size and age
- Previous cultural practices
- Previous tree structure
- Amount of damage

Always observe safety procedures. Storm damage cleanup is extremely dangerous, even for professionals. Hire a certified professional to help with post-hurricane recovery and to implement a restoration pruning program.

FOR MORE INFORMATION »	
ON PROPER RESTORATION TECHNIQUES	CH 4 Restoring Trees after a Hurricane
ON HOW TO IMPLEMENT A RESTORATION PRUNING PROGRAM	

Suggested Reading

Duryea, M.L., E. Kampf, and R. C. Littell. 2007. Hurricanes and the Urban Forest: I. Effects on Southeastern United States Coastal Plain Tree Species. *Arbor. & Urban Forestry*, 33(2):83-97

Duryea, M.L., E. Kampf, R. C. Littell and C.D. Rodríguez-Pedraza. 2007. Hurricanes and the Urban Forest: II. Effects on Tropical and Subtropical Tree Species. *Arbor. & Urban Forestry*, 33(2):98-112

Additional Resources

Trees and Hurricanes

<http://treesandhurricanes.ifas.ufl.edu/>

International Society of Arboriculture (ISA)

<http://www.isa-arbor.com/>

Florida AgSafe

<http://www.flagsafe.ufl.edu/>

Urban Forestry South Expo

<http://www.urbanforestrysouth.org/>

USDA Center for Urban Forest Research

<http://www.fs.fed.us/psw/programs/cufr/>

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EVALUACIÓN DE LOS ÁRBOLES DAÑADOS DURANTE UN HURACÁN Y TOMA DE DECISIONES



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Introducción

Inmediatamente después de un huracán, las comunidades y los propietarios de casas necesitan decidir qué hacer con los árboles dañados por la tormenta. Aunque muchos de los árboles dañados parecen estar muertos, algunos se pueden restaurar, otros necesitarán ser removidos y habrá otros que no requieran de ningún tratamiento.

En esta publicación se discuten detalladamente los factores que deben ser considerados cuando se trata de decidir si remover o restaurar los árboles dañados durante una tormenta. Use esta información para ayudarse a tomar una decisión informada acerca de cómo tratar los árboles dañados después de un huracán.

Contenido

I	Establecimiento de prioridades inmediatamente después de una tormenta	p. 1
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VI	Evaluación de palmas	p. 16

I. Establecimiento de prioridades inmediatamente después de una tormenta

Inmediatamente después de una tormenta, los árboles deben ser clasificados en grupos por prioridades. A continuación se hablará de situaciones que requieren de atención inmediata, así como también las que pueden ser tratadas posteriormente.

Es prioritario determinar si el árbol es un riesgo para la seguridad de personas o animales, o si puede dañar alguna propiedad.

Los árboles se convierten en un peligro potencial cuando hay un objetivo—una estructura, vehículo o una persona—que puede ser golpeado si un árbol o partes de éste se caen. De ahí que, un árbol riesgoso es cualquier árbol que de caer dañaría propiedad, personas u otros árboles valiosos.

Árboles que Requieren de Atención Inmediata



Figura 1

Este árbol requiere de atención inmediata porque está inclinado sobre las líneas eléctricas. Los árboles o ramas que están colgando de líneas eléctricas también deben atenderse inmediatamente.

Figura 2

Los árboles o sus partes que estén bloqueando carreteras o caminos necesitan de atención lo más pronto posible.

Figura 3

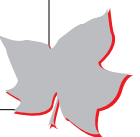
Árboles dañados en lugares públicos y en áreas muy transitadas, como parqueaderos, requieren de atención inmediata. Las ramas quebradas que cuelgan son peligrosas para carros y peatones.



Atención inmediata

Las situaciones representadas en estas fotografías son altamente peligrosas y deben ser atendidas inmediatamente. Los árboles en las Figuras 1 y 2 necesitan ser removidos, mientras que el árbol en la Figura 3 necesita ser podado tan pronto como sea posible.

En estas situaciones el trabajo debe ser ejecutado por un arboricultor certificado con adecuado entrenamiento profesional.



Árboles que NO Requieren de Atención Inmediata



4



5



6

Figura 4

Ya que no hay un objetivo en riesgo, este árbol puede ser removido más tarde.

Figura 5

Este árbol puede ser removido después, ya que no está bloqueando ninguna vía.

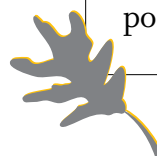
Figura 6

Este árbol puede ser tratado después, ya que no está ubicado en un área de mucho tráfico y no representa una amenaza inmediata.



Seguimiento

Tenga en cuenta que muchos árboles pueden ser salvados con el tratamiento adecuado. No hay necesidad de apresurarse a remover árboles que no representan un riesgo inmediato para la seguridad. Los árboles se pueden recuperar de daños graves y lo que parece horrible en un principio, puede ser juzgado menos serio por un profesional con experiencia.



¿Quién debe hacer la limpieza después de una tormenta?

Después de discutir el establecimiento de prioridades, es importante conseguir el profesional correcto para el cuidado de los árboles. Los dueños de las propiedades no deben intentar ejecutar el trabajo por ellos mismos, como el hombre en la Figura 7.

Ciertas situaciones requieren un entrenamiento avanzado y son manejadas mejor por arboricultores certificados de la Sociedad Internacional de Arboricultura (International Society of Arboriculture–ISA). Estas incluyen remover un árbol inclinado o una rama quebrada cerca de una casa u otro objetivo, restaurar un árbol dañado que puede ser salvado, evaluar el riesgo potencial de un árbol y podar. Así mismo, solamente arboricultores calificados en el despeje de líneas eléctricas pueden trabajar cerca de los servicios públicos. Llame a la compañía de electricidad para reportar las ramas de los árboles que han caído o están colgando sobre cables eléctricos.

Tenga presente que la limpieza después de un huracán es una actividad extremadamente peligrosa aun para profesionales. Muchos accidentes y muertes ocurren durante la limpieza después de las tormentas. Cuando se trabaja con árboles después de un huracán es esencial mirar arriba, abajo y alrededor. Tenga precaución con ramas peligrosas que están partidas, colgando, retorcidas o atrapadas debajo de otros objetos o en otros tallos arriba y pueden caer en cualquier momento. La seguridad debe ser lo primero.



Figura 7

Los propietarios solo pueden operar la motosierra en el suelo usando equipo protector ¿Qué errores hay en esta fotografía?

PARA MÁS INFORMACIÓN »		
SOBRE SEGURIDAD	CAP 1	Limpieza después de un huracán: ¡La Seguridad es primordial!
SOBRE CÓMO CONTRATAR UN PROFESIONAL DEL CUIDADO DE LOS ÁRBOLES	CAP 2	Contrate el profesional correcto en el cuidado de los árboles

¡No todos los árboles necesitan ser tumbados!

Una reacción común después de una tormenta es remover todos los árboles para evitar futuros problemas, especialmente si un árbol se ha caído sobre una casa u otra propiedad (Figura 8). Sin embargo, no todos los árboles son peligrosos. Desafortunadamente pocas comunidades y sus líderes se percatan de que los beneficios de los árboles del bosque urbano a largo plazo sobrepasan los costos necesarios del pago de un arboricultor para tratar los árboles.

Se ha observado que un grupo de árboles saludables, localizados correctamente puede ayudar a dirigir vientos fuertes y servir como una barrera protectora para las casas y otras estructuras (Figura 9). Las comunidades con un programa activo de manejo de su bosque urbano pueden reducir las pérdidas debidas al viento y establecer un plan de restauración cuando hay daños después de los huracanes.



Figura 8

Una reacción común después de una tormenta es tumbard todos los árboles para evitar problemas en el futuro.

Figura 9

Un bosque urbano saludable con los árboles bien localizados puede desviar el viento.

II. Factores que se deben considerar al decidir si remover o restaurar un árbol

Una vez considerado todo lo concerniente a la seguridad, la parte más difícil después de una tormenta es decidir cuáles de los árboles dañados deben ser podados para que recuperen su bienestar y cuáles deben ser removidos. Los ocho puntos siguientes están relacionados y pueden ayudar a determinar la clase de cuidado que un árbol necesita después de una tormenta. Ellos pueden servir de guía en la toma de la decisión de cuáles árboles deben ser removidos y cuáles pueden ser restaurados.

a	Magnitud del daño	p. 5
b	Tamaño y edad del árbol	p. 5
c	Especie del árbol	p. 6
d	Salud del árbol	p. 7
e	Estructura del árbol	p. 8
f	Prácticas culturales previas	p. 9
g	Condiciones del sitio	p. 9
h	Valor cultural del árbol	p. 10

a. Magnitud del daño

Los árboles con mayor daño requerirán de más trabajo que aquellos con daño menor.

Las partes afectadas del árbol, cuánto se ha perdido de la copa y cuán grandes son las heridas, determinará el cuidado que el árbol necesita. Entre más grande sea la herida con relación al tamaño del tallo, más vulnerable es el árbol a la pudrición, las enfermedades y las plagas (Figuras 10 y 11).

b. Tamaño y edad del árbol

Los árboles pequeños y jóvenes toman menos tiempo para restaurarse que los más grandes y maduros.

Los árboles jóvenes y pequeños sobreviven mejor al viento que los más viejos. Por lo tanto, son mejores candidatos para una poda restaurativa (Figura 12).

Por otra parte, los árboles más viejos y maduros pueden tener acumulados por muchos años defectos múltiples (por ejemplo corteza incluida, grietas y pudrición extensiva) que los hacen muy susceptibles al daño en las tormentas.



Figura 10

Este árbol está defoliado solamente un poco, con algunas ramas quebradas. Lo único que necesita es que se le poden esas ramas.



Figura 11

Si el árbol ha perdido más de la mitad de la copa (incluyendo el tronco principal) con varias de sus ramas quebradas, debe ser tumbado.



Figura 12

Este árbol pequeño está dañado, pero como está joven puede ser podado para ayudarle a recuperarse en unos pocos años.

c. Especie del árbol

Los árboles que resisten la pudrición son mejores candidatos para la restauración que aquellos que son propensos a ella.

Los árboles que resisten la diseminación de la pudrición en su madera se consideran que compartimentan bien y son más fáciles de restaurar. Algunos ejemplos incluyen el roble perenne (live oak, *Quercus virginiana*), la caoba (mahogany, *Swietenia mahogany*), el tamarindo falso (false tamarind, *Lysiloma latisiliquum*), el olmo alado (winged elm, *Ulmus elata*) y el mangle botón (buttonwood, *Conocarpus erectus*) (Figura 13).

Por otra parte, los árboles que no compartimentan bien son propensos a la pudrición. Algunos ejemplos de especies que no compartimentan bien son el tulipán africano (African tuliptree, *Spathodea campanulata*), la orquídea de Hong Kong (Hong Kong orchid, *Bauhinia blakeana*), el laurel rojo (redbay, *Persea borbonia*), el roble-laurel (laurel oak, *Quercus laurifolia*) y el encino negro (water oak, *Quercus nigra*) (Figura 14). Estas especies pueden ser un problema en los bosques urbanos ya que los cortes grandes de poda, las heridas en el tronco y el daño en las raíces pueden resultar en cavidades y pudrición interna extensiva.

PARA VER UNA LISTA »	
DE ÁRBOLES QUE COMPARTIMENTAN BIEN Y OTROS QUE COMPARTIMENTAN MAL	http://hort.ifas.ufl.edu/woody/compartimentalization.html

No vale la pena restaurar especies de vida corta.

Cada especie tiene una duración de vida inherente y algunos árboles viven más que otros (Tabla 1). La longevidad debe ser considerada cuando se evalúa si vale la pena restaurar un árbol o si se debe remover. Usualmente los árboles de vida corta, tampoco compartimentan bien y no resisten la pudrición. Tenga en cuenta que el riesgo de la caída se incrementa con la edad (Figura 15).

Tabla 1. Longevidad de algunas especies en el bosque*		
Vida Corta (< 50 años)	Vida Media (50 a 100 años)	Vida Larga (> 100 años)
roble-laurel (<i>Quercus laurifolia</i>)	tulipán africano (<i>Spathodea campanulata</i>)	roble perenne (<i>Quercus virginiana</i>)
ciclamar (<i>Cercis canadensis</i>)	árbol del paraíso (<i>Simarouba glauca</i>)	liquidámbar (<i>Liquidambar styraciflua</i>)
cepillo de botella (<i>Callistemon</i> spp.)	arce rojo (<i>Acer rubrum</i>)	magnolia sureña (<i>Magnolia grandifolia</i>)
orquídea de Hong Kong (<i>Bauhinia blakeana</i>)	almácigo (<i>Bursera simarouba</i>)	ciprés (<i>Taxodium distichum</i>)
jacaranda (<i>Jacaranda mimosifolia</i>)	uva playera (<i>Coccoloba uvifera</i>)	caoba (<i>Swietenia mahogany</i>)

* Tenga en cuenta que los árboles urbanos son de longevidad corta.



Figura 13

El mangle botón es un ejemplo de un árbol que compartimentan bien.



Figura 14

El encino negro es un ejemplo de una especie que no compartimenta bien.



Figura 15

El roble-laurel vive cerca de 50 años y empieza a podrirse tan pronto alcanza los 40 años. El roble-laurel en esta fotografía tiene 45 años y ha sido dañado moderada a gravemente por el viento. ¿Vale la pena restaurar este árbol o debe ser reemplazado? Probablemente es más efectivo, en cuanto a costos, plantar otra especie en su lugar.

d. La salud del árbol

Los árboles sanos se recuperan mejor después de una tormenta que los árboles enfermos.

La pudrición, una de las causas principales de fallas en los árboles, es causada por hongos que debilitan la madera a medida que van creciendo. Grietas, cicatrices, hinchazones, canchales, tocones y ramas muertas, y heridas grandes antiguas, sugieren pudrición interna y aumentan la probabilidad de la caída del árbol. La pudrición frecuentemente está presente sin signos obvios (Figuras 16 y 17).

Los hongos en la base del tronco de un árbol pueden ser signo de Armillaria u otro hongo que puede causar pudrición de las raíces creando inestabilidad en los árboles (Figura 18). La descomposición de la raíz (Figura 19) puede ser diagnosticada con inspecciones regulares cuidadosas hechas por arboricultores entrenados.

e. Estructura del árbol

Los árboles con buena estructura remanente en su tronco serán más fáciles de restaurar.

Los árboles con un tronco individual hasta la copa, con ramas espaciadas de manera uniforme y de diámetro considerablemente menor que el del tronco, copa balanceada, ausencia de tallos codominantes e inclusiones en la corteza, son signos de un árbol fuerte. Estas características determinan que el árbol sea capaz de resistir las tormentas (Figura 20). Los arboricultores están capacitados para crear y mantener estructuras fuertes mediante técnicas apropiadas de poda, en especial si se empieza desde temprano cuando los árboles están jóvenes.



Figura 16

Antes de la tormenta: este árbol parece estar en buen estado.



Figura 17

Después de la tormenta: el árbol mostró que estaba hueco.



Figura 18

Antes de la tormenta: presencia de *Armillaria*.



Figura 19

Después de la tormenta: la pudrición grave de la raíz contribuyó a la caída de este árbol.

¿Sabía usted?

La pudrición a menudo se presenta sin signos obvios pero puede ser identificada con cuidadosas inspecciones regulares hechas por un arboricultor.

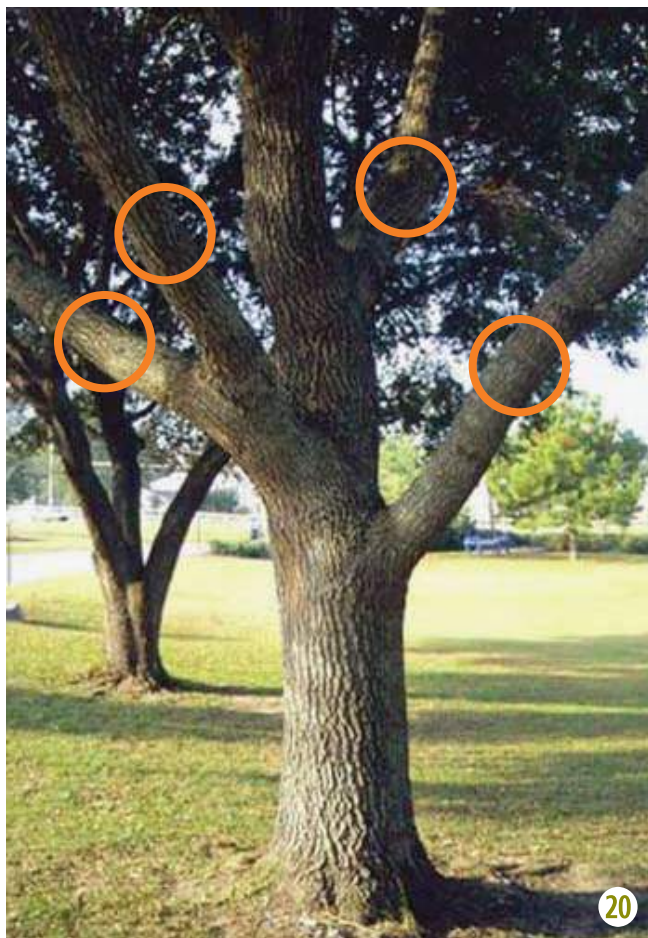


Figura 20

Este árbol tiene una buena estructura por lo que es un buen candidato para la restauración. Tiene cuatro ramas uniformemente espaciadas y de menor diámetro que el tronco principal.



Figura 21

Un corte de poda grande hecho hace varios años causó pudrición y creó puntos débiles por donde el árbol puede eventualmente quebrarse.



Figura 22

Este árbol fue desmochado hace un año y los rebrotes que crecieron en los cortes de las ramas se quebraron con el viento.

f. Prácticas culturales previas

Las prácticas indebidas de poda ocasionan la caída y ruptura de los árboles

De la remoción de ramas grandes resultan grandes cortes de poda que pueden servir como puntos de entrada para hongos que empiezan el proceso de pudrición (Figura 21). El desmoche es también una práctica incorrecta de poda que debe evitarse. Los rebrotes que crecen de los árboles desmochados están mal conectados a la rama, lo que los hace más susceptibles a quebrarse en las tormentas (Figura 22).

Las prácticas incorrectas de manejo de las raíces afectarán la estabilidad del árbol.

No se puede descuidar la salud y la integridad de las raíces. Además de la absorción del agua y los minerales esenciales, las raíces son el anclaje del árbol. Si las raíces están de alguna manera dañadas, las probabilidades de caída del árbol aumentan (Figura 23). Las actividades de construcción cerca de 6 metros (20 pies) alrededor del tronco de un árbol existente pueden causar la caída del árbol hasta más de una década después.

g. Condiciones del sitio

Los árboles necesitan un espacio adecuado y buenas propiedades del suelo para mantener su estabilidad.

Los árboles con su sistema radicular confinado a espacios con poco suelo no son tan estables como los que se les permite desarrollar su sistema radicular más ampliamente (Figura 24).

Los suelos compactos, mal drenados o con alto nivel freático pueden restringir el crecimiento en profundidad de las raíces, lo cual puede resultar en árboles inestables (Figura 25).

La localización incorrecta y la selección errada de la especie pueden no justificar la restauración de un árbol.

La importancia de la selección correcta del árbol para el sitio adecuado ha sido muy enfatizada. Sin embargo, la selección inapropiada de los árboles es uno de los errores más comunmente observados. Por ejemplo, El encino blanco (white oak, *Quercus alba*) en la Figura 26 puede crecer hasta 30 metros (100 pies) con una copa extendida ampliamente y muchas ramas horizontales

Si el árbol está en el lugar equivocado (como lo sería un árbol grande debajo de líneas eléctricas) o si es una especie inadecuada para la propiedad (con frutos que manchan o ensucian, etc.), lo mejor será removerlo si además representa un daño potencial serio.

h. Valor cultural del árbol

El esfuerzo que se necesite en la restauración de un árbol, estará determinado por el valor que éste tenga para usted o su comunidad.

Además del valor económico y los servicios ecológicos que el árbol suministra a su dueño y a la comunidad, el árbol en cuestión puede tener un valor sentimental, ser un memorial o tener una significancia histórica o un atributo cultural. (Figura 27).



Figura 23

La construcción en particular daña las raíces de los árboles, como estas raíces cortadas cuando se reparó el borde de la acera.



Figura 24

Las raíces en éstos árboles fueron limitadas por el borde de la acera y el suelo compactado, haciéndolas susceptibles a caerse en la dirección contraria al borde.



Figura 25

En este sitio, el alto nivel freático restringió la profundidad de las raíces y el suelo saturado les permitió desarraigarse haciendo que el pino se cayera durante un huracán.



Figura 26

Las raíces de este encino blanco fueron restringidas por las edificaciones y probablemente dañadas por la compactación del suelo resultándoles difícil soportar un árbol grande como éste.



Figura 27

Este roble perenne es parte de un hotel histórico de 1900, como lo muestra su dueña, localizado en la Villa Distrital Histórica de Bagdad, en Milton, FL.

III. Cuándo remover un árbol

En términos generales, éstas son las situaciones en las cuales un árbol requiere ser removido una vez se han manejado las situaciones referentes a la seguridad. Recuerde, la prioridad es remover árboles que representen un peligro a la gente y a las propiedades.

1. Cuando la parte baja del tronco está partida o agrietada

Los árboles con grietas en el tronco y las ramas principales son muy peligrosos, ya que las ramas con este tipo de daño no están bien aseguradas al árbol. Las grietas profundas en el tronco (Figura 28) no cierran y representan un defecto grave que hace que esos árboles sean un gran riesgo en los paisajes y jardines.

2. Si una rama grande se ha desgarrado del tronco

La figura 29 muestra un árbol que necesita ser removido porque su tallo grande codominante se desgarró del tronco principal. Observe el área oscura en la parte superior del desgarre — es una inclusión en la corteza (Figura 29). Las inclusiones en la corteza son uniones débiles entre las ramas y son muy susceptibles a rupturas.

3. Cuando el árbol está inclinado hacia un objetivo

Si un árbol inclinado tiene posibilidad de caer sobre una persona, edificio, línea de servicio público, vía u otro objeto valioso, éste debe ser removido inmediatamente después de la tormenta. Sin embargo, primero que todo se debe revisar si las raíces de los árboles inclinados están quebradas, expuestas o levantándose por fuera del suelo (Figura 30). Preste atención a los árboles inclinados con copas desequilibradas, grietas en el tronco e inclusiones en la corteza.

4. Si la estructura remanente del árbol es muy susceptible a partirse

¡El árbol que se muestra en la Figura 31 debe ser removido! El árbol sufrió un daño estructural grande comprometiendo el resto



Figura 28

Este árbol debe ser removido ya que la rama que se le quebró es muy grande y el tronco principal está agrietado, como se muestra en el círculo. Si el árbol no se hubiera desgarrado en el tronco, la rama grande rota se hubiera podido remover con cuidado y el árbol pudiera haber sido restaurado.



Figura 29

El círculo muestra la inclusión en la corteza que hizo que la rama se partiera durante una tormenta tropical. El árbol debe ser removido.



Figura 30

Este árbol inclinado necesita ser removido ya que las raíces principales estructurales están quebradas y por fuera del suelo.



Figura 31

Un desgarro ocurrió hace 8 años (daño ligero) y el otro alrededor de 2 semanas antes de que la fotografía fuera tomada. Este árbol debe ser removido.

de su estructura. Toda la masa está a un lado del árbol y el tronco está muy débil debido a los dos desgarres. La causa de los dos desgarres fue la inclusión en la corteza.

5. Si la raíces principales están arrancadas

Los árboles maduros y de mediana edad que se han caído o están inclinados, usualmente sufren un daño severo en sus raíces. Una vez las raíces se parten, no enraizan de nuevo en el suelo y tienen poca probabilidad de desarrollar el sistema radicular necesario para mantener el árbol derecho (Figura 32). La razón de esto parece ser que las raíces de gran diámetro no se regeneran como las de diámetro pequeño (de 1 pulgada o menos de diámetro). Además, las raíces grandes dañadas se pueden descomponer o podrir causando inestabilidad al árbol (Figura 33).



Figura 32

Los árboles maduros y de mediana edad no deben ser resembrados si se han desarraigado. Los árboles grandes necesitan de un sistema radicular grande para su soporte estructural.



Figura 33

Las raíces de este árbol estaban podridas, por lo tanto no se regenerarán.

6. Cuando las ramas grandes se han quebrado

Remueva los árboles que tienen la mayoría de la copa dañada debido a la ruptura de ramas grandes (de diámetro mayor de 8 pulgadas) (Figura 34). Aquellos árboles con ramas de diámetro pequeño quebradas tienen mejor futuro y pueden ser restaurados (Figura 35).



Figura 34

Este árbol necesita ser removido.

Figura 35

Este árbol puede ser restaurado.

7. Cuando hay raíces estranguladoras causando puntos muertos o grietas en el tronco

Las raíces circulares alrededor del tronco a menudo son raíces estranguladoras que cuando rodean la mayoría del tronco pueden causar la muerte del árbol. (Figura 36). Los árboles con raíces circulares y grietas en el tronco serán menos estables, por lo tanto deben ser removidos.



Figura 36

Estas raíces están rodeando el tronco del árbol y se han entrecruzado con otras raíces principales causando grietas y manchas donde el tronco ha muerto.

IV. Cuándo restaurar un árbol

Muchos árboles pueden ser restaurados a pesar de haber sufrido el golpe de vientos fuertes. Sin embargo, solo restaure los árboles que tengan las ramas principales, el tronco y las raíces intactos (Figuras 37 y 38).

Para ser un buen candidato para restauración, un árbol no debe tener grietas en sus ramas principales o en el tronco, ni pudrición de la madera ni inclusiones en la corteza. Las raíces no deben estar expuestas, por fuera del suelo o alrededor del tronco. Asegúrese de que la estructura del tronco y las ramas estaban bien antes de la tormenta.

Estas son guías generales que explicarán en detalle cuándo un árbol debe someterse a una poda restaurativa.

1. Cuando el árbol está joven

Los árboles jóvenes de menos de 10 pulgadas de diámetro como este roble perenne (Figura 39), son buenos candidatos para la restauración porque tienen menos ramas para podar, la copa está más cerca del piso y toleran mejor la remoción de la mayoría de la copa que los árboles viejos.

2. Si la copa está defoliada

Usualmente los árboles que pierden sus hojas durante un huracán no están muertos. La mayoría de los árboles regeneran follaje nuevo en las semanas siguientes a la tormenta*. Las investigaciones han mostrado que en algunas especies como el almácigo (gumbo limbo, *Bursera simarouba*) y el roble perenne (Figura 40), la defoliación es por lo regular una estrategia de supervivencia ya que esto reduce la resistencia al viento. Los árboles defoliados sin muchas ramas quebradas, que estaban sanos antes de la tormenta, no requieren de un tratamiento especial. Espere. El tiempo es el mejor tratamiento para este tipo de daño. No hay necesidad de aplicar fertilizantes u otros químicos.

Los árboles y las palmas que fueron inundados con agua salada a menudo pierden su follaje debido a daño en sus raíces. Es estos casos, el árbol necesita ser regado para lavar la sal del suelo.

Eventualmente muchos rebrotes emergen en árboles dañados por un huracán. Algunos árboles esperan para producir nuevo follaje hasta la



Figura 37

Este árbol es restaurable. Tiene un tronco principal hasta la parte alta de la copa sin tallos codominantes, ramas bien distribuidas y no tiene inclusiones en la corteza. Sus raíces están bien distribuidas alrededor del tronco, sin presencia de raíces circulares



Figura 38

La restauración se dificulta en este árbol por su estructura inicial pobre. Este roble perenne joven con múltiples troncos, tiene ramas codominantes con inclusiones en la corteza. Sería todo un reto arreglarlo.



Figura 39

Los árboles jóvenes sobreviven mejor y sufren menos daño que los viejos porque son más fáciles de podar y mantener.



Figura 40

El roble perenne pierde la mayoría de sus hojas durante una tormenta.

*Nota: Algunas especies, como los pinos, pueden no recuperar su follaje después de un huracán. Vea Pinos (página 16) para mayor información.

primavera siguiente. A los rebrotes se les debe permitir crecer porque ellos proveen al árbol de la energía que necesitará para recuperarse (Figura 41). Estos pueden ser podados después.

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3. Si las ramas pequeñas están quebradas o muertas

Los árboles con ramas pequeñas quebradas o muertas (de menos de 4 pulgadas) pueden ser fácilmente podados de la copa con buena posibilidad de recuperarse. Las ramas pequeñas tienen un mejor chance de recuperarse que las de diámetros grandes (8 pulgadas o más). Si tallos codominantes pequeños están quebrados en lo alto de la copa sin daño en el tronco principal, el árbol también puede ser restaurado (Figura 42).

4. Si la mayor parte de la copa está dañada y el árbol es de una especie resistente a la pudrición.

Los árboles de especies resistentes a la pudrición pueden perder mucho del follaje de su copa y todavía recuperarse después de una tormenta. Aun con $\frac{3}{4}$ de sus ramas pequeñas quebradas (menores de 4 pulgadas) o partidas por un huracán, muchos de los árboles resistentes a la pudrición pueden ser restaurados (Figura 43).

5. Algunas de las ramas principales están quebradas y el árbol es de una especie resistente a la pudrición.

Muchas especies que resisten la pudrición después de que han sido dañadas, pueden ser restauradas, aun con algunas de sus ramas grandes quebradas (Figura 44).



Figure 41
Manejar los rebrotes con el tiempo puede crear un árbol con una estructura razonablemente buena y una copa que se vea bonita. El manejo de los rebrotes debe ser hecho por arboricultores profesionales.



Figure 42
Para remover una rama pequeña, corte en la base del desgarro o remueva la rama dañada entera si no es el tronco principal.



Figure 43
La caoba puede ser restaurada aun con algunas de sus ramas grandes quebradas.



Figure 44
Este árbol de una especie resistente a la pudrición puede restaurarse aunque perdió la mayoría del follaje de la copa.

6. Si el árbol inclinado o partido es pequeño o fue plantado recientemente

Los árboles que tienen un diámetro de tronco menor de 4 pulgadas deben ser levantados lo más pronto posible para prevenir que las raíces se mueran (Figura 45). Esos árboles pequeños tienen un mejor chance de desarrollar una estructura de raíces apropiada para mantener el árbol firme en el suelo que los árboles más grandes.

Los árboles de cualquier tamaño, que fueron plantados recientemente pueden ser resembrados porque por lo regular no tienen raíces grandes dañadas (Figura 46). Estos árboles deben ser tratados como si fueran recién plantados y tutorados con la ayuda de un profesional.



Figura 45

Este olmo (elm, *Ulmus* spp.) inclinado pudo haber sido levantado y tutorado.



Figura 46

Los árboles recién plantados como este arce rojo, deben ser tratados como recién plantados poniéndoles estacas y regándoles apropiadamente.

¿De qué tamaño puede ser levantado un árbol?

Los árboles recién plantados como este arce rojo, deben ser tratados como recién plantados poniéndoles estacas y regándoles apropiadamente.

Los arboricultores con experiencia en levantar árboles después de tormentas han encontrado que los mayores de 4 pulgadas de diámetro de tronco son más susceptibles a caer nuevamente después de otras tormentas que los árboles más pequeños. La razón de esto parece ser que en comparación con las raíces más pequeñas (de una pulgada o menos de diámetro) las raíces grandes que han sido gravemente dañadas no se regeneran. Además, las raíces grandes dañadas se pudren y quiebran más fácilmente.

La tabla 2 muestra una guía básica general basada en las observaciones de arboricultores y otros profesionales del cuidado de los árboles. Tenga en cuenta sin embargo, que no hay todavía investigaciones publicadas o respuestas definitivas en este tema.

Table 2. Guía para el levantamiento de árboles basada en el diámetro del tronco

Diámetro del tronco	Acción
Menor de 4 pulgadas	Levante y ponga estacas
De 4 a 8 pulgadas	Puede levantar y poner estacas Podría ser un riesgo más tarde
Más de 8 pulgadas	No se recomienda Es un riesgo potencial

Asegúrese de que no haya raíces circulares en árboles pequeños caídos o inclinados

Antes de decidir resembrar árboles pequeños que estén caídos o inclinados mire si hay raíces circulares. Algunas de las raíces circulares pueden ser removidas y los árboles responderán con mayor vigor (Figura 47). Otros árboles tendrán que ser removidos (Figura 48). Si las raíces circulares rodean la mayoría del tronco, el árbol no es restaurable porque las raíces estranguladoras impiden la fotosíntesis, el crecimiento de otras raíces y el movimiento de agua.

Recuerde:

¡Si remueve un árbol, plante otro en su lugar!



Figura 47

Este árbol puede restaurarse ya que solo tiene una raíz circular alrededor del tronco. Antes de levantar un árbol así, corte cualquier raíz circular en el punto donde ésta comienza a rodear el tronco, como se indica en la línea punteada. Esto permitirá el crecimiento de raíces nuevas hacia afuera del tronco incrementando la posibilidad de que el árbol recobre el apoyo.



Figura 48

Este árbol debe ser removido. Mucho de su sistema radicular proviene de raíces circulares que están rodeando completamente el tronco y hacen que ningún tratamiento sea práctico.

V. Evaluación de pinos

Los pinos son muy susceptibles al daño de los vientos. Pueden partirse, desenterrarse o inclinarse durante las tormentas. Un pino que todavía permanece de pie después de un huracán puede sufrir algún daño interno que no sea visible en ese momento. Antes de decidir si remover o restaurar, espere y mire si el árbol está vivo considerando los siguientes puntos:

- A menudo los pinos mueren en un período de 6 meses a 2 años después de una tormenta.
- Algunos pueden permanecer verdes hasta por más de un año, luego de repente sus acículas se ponen amarillas (Figura 49) y progresivamente, en poco tiempo se vuelven marrón.
- Los pinos con todas las acículas marrón están muertos y deben ser removidos.
- Busque cuidadosamente si hay presencia de insectos. Los pinos débiles pueden ser más susceptibles a las plagas de insectos y a las enfermedades.

¿Qué causa el amarillamiento y la muerte de los pinos?

Las causas aún no se entienden por completo, pero es probablemente debido al daño interno producido por el doblamiento y el retorcimiento del tronco por la fuerza de los vientos huracanados. Los vientos prolongados



Figura 49

Seis meses después de un huracán, este pino de repente se volvió amarillo y puede ser que muera.

también pueden producir la ruptura de raíces pequeñas, sin que se dañen las raíces grandes de soporte. Las ramas y las raíces dañadas son incapaces de suplir el agua y los nutrientes necesarios a la copa, lo que resulta en amarillamiento de las acículas y el decaimiento del pino.

VI. Evaluación de palmas

Las palmas crecen de manera diferente a los demás árboles. El punto de crecimiento de una palma está localizado en la punta de cada tronco, rodeado por hojas (llamadas frondas). Todas las frondas se originan en este punto (llamado “yema”). Si la yema se ha dañado severamente o está muerta, las nuevas hojas no se desarrollarán y si la palma tiene un solo tronco, ésta morirá (Figura 50). En palmas con varios troncos, los troncos que no se han dañado se pueden recuperar siempre y cuando las yemas no estén dañadas. Si el tronco de una palma está partido por la mitad, la palma está muerta. Sin embargo, en las palmas que permanecen de pie, la yema no siempre es accesible o visible, lo que hace difícil determinar si está o no dañada. Para estas palmas siga las siguientes recomendaciones:

- Dé al menos 6 meses a la palma para volver a crecer. Las hojas nuevas pueden estar atrofiadas, descoloridas o de forma irregular.
- Para tener de nuevo una palma normal con la copa llena de frondas, se puede tomar de 1-2 años.
- Riegue 3 veces semanalmente por 6 semanas si no hay suficiente lluvia; riegue más a menudo si la sequía persiste.



Figura 50

Estas palmas reales (royal palm, *Roystonea elata*) en círculos en la parte posterior de la fotografía están muertas, ya que sus yemas están destruidas. Las palmas en el frente, sin embargo, pueden ser restauradas con sólo permitirles continuar con su crecimiento.

La recuperación después de una tormenta no es un proceso rápido, por lo tanto tenga paciencia con sus palmas.

Consideraciones finales

Inmediatamente después de un huracán es importante separar los árboles en grupos por prioridades, actuando rápido en situaciones que requieren atención urgente y seleccionando los árboles que se monitorearán y tratarán más tarde. Recuerde que aunque los huracanes pueden ser devastadores para las comunidades y el bosque urbano, no todos los árboles dañados por tormentas necesitan ser removidos y muchos de ellos pueden ser salvados y tratados.

Cuándo evalúe el daño piense acerca de la función de los árboles y sus objetivos. Las acciones de manejo para decidir si un árbol debe ser removido o restaurado, dependerán de las observaciones hechas basadas en los puntos expuestos a continuación:

- Espacio y propiedades del suelo
- Salud, tamaño y edad del árbol
- Prácticas culturales previas
- Estructura del árbol previa
- Magnitud del daño

Siga siempre los procedimientos de seguridad. La limpieza después de un huracán es extremadamente peligrosa, aun para los profesionales. Contrate un arboricultor certificado para ayudar con la recuperación después del huracán y para implementar un programa de poda restaurativa.

PARA MÁS INFORMACIÓN »

SOBRE TÉCNICAS DE RESTAURACIÓN APROPIADAS

SOBRE CÓMO IMPLEMENTAR UN PROGRAMA DE PODA RESTAURATIVA

CAP

4

Restauración de árboles después de un huracán

Lecturas sugeridas

Duryea, M.L., E. Kampf, y R. C. Littell. 2007. Hurricanes and the Urban Forest: I. Effects on Southeastern United States Coastal Plain Tree Species. *Arbor. & Urban Forestry*, 33(2):83-97

Duryea, M.L., E. Kampf, R. C. Littell y C.D. Rodríguez-Pedraza. 2007. Hurricanes and the Urban Forest: II. Effects on Tropical and Subtropical Tree Species. *Arbor. & Urban Forestry*, 33(2):98-112

Fuentes adicionales

Trees and Hurricanes

<http://treesandhurricanes.ifas.ufl.edu/>

International Society of Arboriculture (ISA)

<http://www.isa-arbor.com/>

Florida AgSafe

<http://www.flagsafe.ufl.edu/>

Urban Forestry South Expo

<http://www.urbanforestrysouth.org/>

USDA Center for Urban Forest Research

<http://www.fs.fed.us/psw/programs/cufr/>

Este documento es el FOR 117-SP, de la serie de publicaciones del Programa de Recuperación del Bosque Urbano Afectado por Huracanes, de la Escuela de Recursos Forestales y Conservación y el Departamento de Horticultura Ambiental, Servicio de Extensión Cooperativa de la Florida, Instituto de Alimentos y Ciencias Agrícolas, Universidad de la Florida. Fecha de Publicación Original: Enero 2008. Revisado febrero 2014. Visite la red de EDIS: <http://edis.ifas.ufl.edu> Y el sitio: <http://hort.ifas.ufl.edu/treesandhurricanes/>.

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Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-experts-offer-tips-tree-lawn-survival-post-irma/>

HURRICANE-DAMAGED TREES



- Broken tree limbs in or near electrical wires need to be reported to the utility company as soon as possible. Only trained utility line clearance crews should attempt to do such work.
- For all other damaged trees, get input from a certified arborist before deciding what to do.
- Remove broken, cracked limbs and those that are dangling in the canopy, waiting to fall.
- Uprooted palms and trees should be reset only after they have been examined for safety and deemed healthy enough for replanting.
- Only hire tree-care professionals who can provide proof of licensing and insurance.

For more information, visit http://edis.ifas.ufl.edu/topic_tree_care

Fuente: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-experts-offer-tips-tree-lawn-survival-post-irma/>

ÁRBOLES DAÑADOS POR EL HURACÁN



- Ramas de árboles quebrados en o cerca de cables eléctricos necesitan ser reportados a las empresas de servicio público lo más pronto posible. Solo los equipos de servicio público calificados deben de intentar este tipo de trabajo.
- Para todos los otros árboles dañados, consulta a un arborista acreditado antes de tomar una decisión.
- Quiten las ramas quebradas y todos aquellos que están colgando del árbol ya para caerse.
- Todas la palmas y árboles arrancados deben de ser examinados para ver si son seguros y saludables antes de ser replantados.
- Solo contraten arbolistas profesionales quienes puedan mostrar prueba de licencia y seguro.

Source: <http://blogs.ifas.ufl.edu/news/2017/09/19/uf-experts-offer-tips-tree-lawn-survival-post-irma/>

PYEBWA KI TONBE LÈ GEN SIKLÒN



- San pèdi tan, ou dwe rele konpayi kouran an pou w di l ke gen branch pyebwa ki kase tou pre fil kouran yo. Sèlman yon pwofesyonèl ki gen fòmasyon pou sa dwe fè travay sa a.
- Pou tout lòt pyebwa ki sibi domaj yo, mande yon pwofesyonèl avi li anvan w deside sa pou w fè.
- Retire branch ki kase ak sa ki pandye ki preske tonbe yo.
- Yo dwe verifye si palmye ak lòt pyebwa ki derasinen yo bon anvan yo plante yo ankò.
- Anplwaye sèlman pwofesyonèl ki gen lisans ak asirans

RESTORING TREES AFTER A HURRICANE



PUBLICATION Nº

ENH 1054

EDWARD F. GILMAN

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Introduction

The step-by-step outline provided in this document summarizes the process for restoring trees so that they will bring shade and beauty back to the community with reduced risk. Restoration typically requires more than one pruning to develop strong tree structure, so remember that patience is a virtue when dealing with storm-damaged trees.

Various factors determine the period of time necessary for recovery: age and health of tree, size, species, and extent of damage. These factors are interrelated, and together determine the amount of care a tree will need after a storm. A restoration pruning program typically lasts from two to five years and perhaps much longer for large and severely damaged mature trees.

Know what trees can be restored. The structure of the tree should be intact, without any visible cracks or large wounds on the main trunk, limbs, or main roots. Trees can recover from complete leaf loss or significant damage to the canopy, including several broken limbs, but major trunk damage is often irreparable.

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I. Response Plan for Immediately after a Storm

After a storm, removing hazards and cleaning tree canopies of broken limbs and dead stubs should be the focus of treatment. Major pruning to alter the tree's structure should not be done at this time. Trees use energy stored in the wood to recover from damage and produce new growth; therefore, during the clean up process, the least amount of live wood possible should be removed. (Think of the stored energy in trees as the limited funds in a bank account. After paying for repairs on the house due to hurricane damage, homeowners usually do not rush out to buy a new sailboat. Similarly, this is not the time to further reduce the already limited "funds" of the tree by removing live wood.)

Be very careful not to cause additional stress to the tree by injuring trunk, branches, or roots. Do not top your trees or cut the entire canopy back to stubs (Figure 1). Many communities in Florida outlaw or discourage topping because it leads to decay and reduces its vigor.

Step 1

Get help with removing potential hazards.

If a limb has fallen near power lines, make sure that a qualified line-clearance arborist treats the situation. Working near electricity is highly dangerous, and may result in a fatality for workers who do not follow proper safety procedures. Other hazardous situations include large hanging limbs or leaning trees that could fall on a person, hit a house, or damage other potential targets if they go down. These situations should be taken care of by a professional before anything else.

Step 2

Stand up and stake small fallen trees, and provide irrigation as needed for stressed trees.

Standing up small fallen trees is a priority because the roots dry out quickly. Experienced professionals have observed from past hurricanes that staked trees with a trunk diameter greater than about 4 inches tend to blow down again in later storms, and may not be worth the time and expense for restanding. The reason for this appears to be that severed roots on bigger trees do not regenerate new roots as well as small (one inch diameter or less) roots do. Also, large severed roots can decay or rot, making the tree unstable. The exception is recently planted trees, which can be restaked at any size because they do not have large broken roots. These trees should

be treated as new plantings and staked with the help of a professional.

Staking methods

Research and experience on the effectiveness of different staking methods show that some systems work better than others. Root ball anchorage systems work very well to stabilize trees in the soil (Figure 2). Rigid systems can work, but they need to be adjusted or removed within six months (Figure 3).



Figure 1
Topping is detrimental to tree health.



Figure 2
Root ball anchorage systems work nicely.



Figure 3
Rigid staking systems may cause significant trunk damage. This system is less problematic for palm trees because their trunks expand very little at the point where the stakes are secured.

Steps for standing up trees that have fallen

1. Keep roots moist.
2. Excavate a hole to accommodate roots.
3. Use sharp tools to make clean cuts on jagged or torn roots.
4. Pull the tree up as straight as possible, taking care to not damage the trunk or roots.
5. Fill the hole with soil from the site, but avoid burying the area where the trunk meets the top main root (Figure 4).
6. Irrigate the tree with the same frequency as for newly planted trees, approximately three times/week for the first several months. Also, apply water during dry periods. Do not fertilize for one year.
7. Install staking system. Remove or adjust stakes after six months to one year.

Irrigation for stressed trees

Root growth is necessary for tree recovery after the storm, and keeping the soil moist will encourage formation of new roots. During the dry period of October through mid-May in Florida, trees should be irrigated as needed to help them recover from storm damage. When irrigating staked trees, two to three gallons per inch of trunk diameter should be sufficient. Efficient irrigation systems apply water directly to the root ball, rather than spraying overhead. Irrigation is not needed if the root ball is already saturated or wet from heavy rains.

Significant tree dieback due to salt damage can occur in coastal areas that receive storm surge from hurricanes. These trees may require irrigation treatments to remove salts from the soil by flushing with water.

Step 3

Clean tree canopies.

The purpose of canopy cleaning is to remove potential hazards like dead and cracked branches and broken limbs. Canopy cleaning also includes making smooth pruning cuts behind broken branch stubs to allow the proper development of new tissue to close over wounds (Figure 5). Remember that stressed trees need to access energy stored in their limbs in order to recover. The stored food is necessary for the tree to sprout, produce new leaves, and defend itself against organisms that cause decay. It is better to leave the tree looking unbalanced and misshapen than to remove large portions of the live canopy at this time. Shaping can be done later as part of the restoration process.

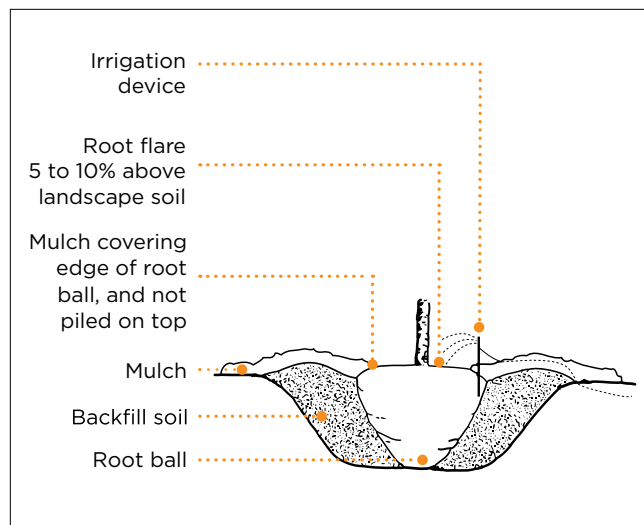


Figure 4

Drawing of correct technique for tree planting.

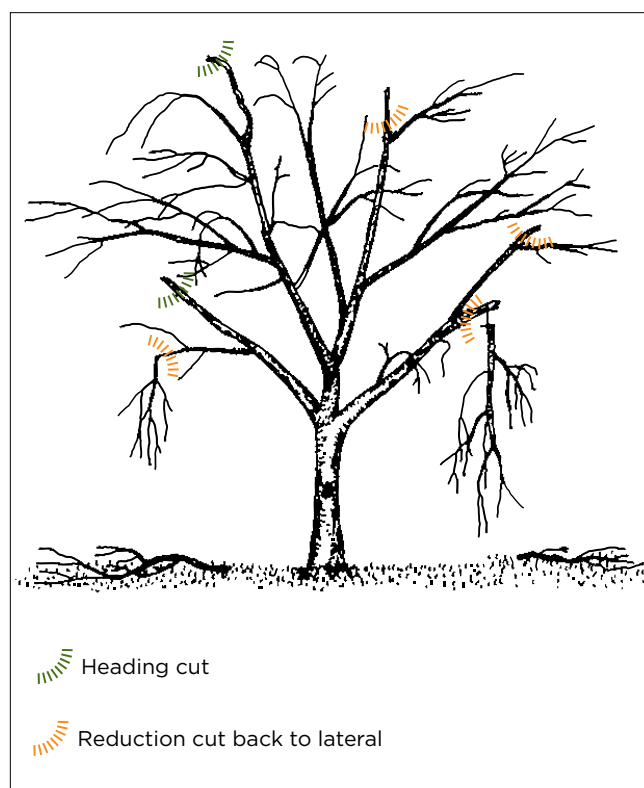


Figure 5

Cleaning the canopy on a storm-damaged tree. Lines indicate where to make pruning cuts.

Removal cut

A removal cut removes a branch back to the trunk or parent branch (Figures 6 and 7). After a hurricane, this type of cut is used to remove broken, cracked, and hanging limbs. Hanging and detached limbs should be removed first so that branches do not fall and cause injury. Be sure there are no cracks along the large, main branches; use binoculars to get a closer look if needed. Arborists can climb trees to check for cracks and other structural defects. A branch with a crack can be a hazard, and should be removed if there is a target nearby.

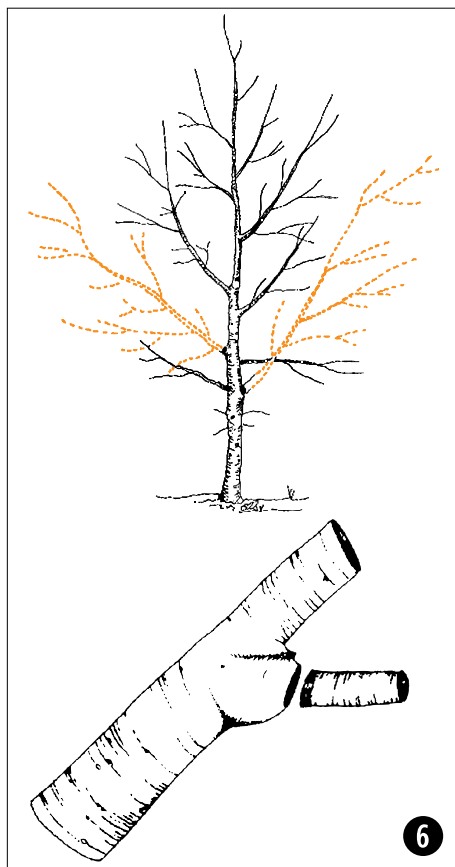


Figure 6

Drawing of a removal cut. After a hurricane, removal cuts are used to remove broken, cracked, and hanging limbs back to parent stems.

Reduction cut

A reduction cut shortens the length of a stem by pruning back to a smaller limb, called a lateral branch (Figures 8 and 9). Ideally, the lateral should be at least $\frac{1}{3}$ the diameter of the stem being cut. This type of cut is used for making clean cuts behind jagged tips of broken branches.

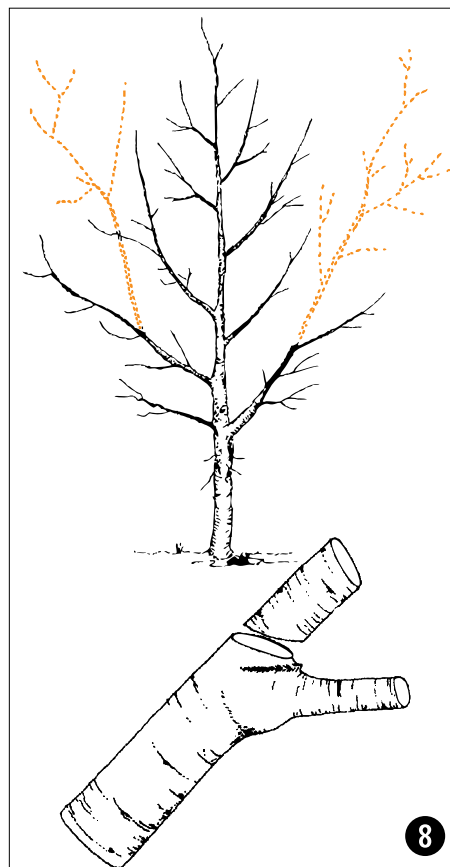


Figure 8

Drawing of a reduction cut. This type of cut is used for making clean cuts behind jagged tips of broken stems and branches.



Figure 7

Photograph of a removal cut. Branch is pruned back to the trunk, leaving the branch collar intact. A good pruning cut is round. Cuts that are too close to the trunk are oval-shaped.



Figure 9

Photograph of a reduction cut. Branch is correctly pruned back to a lateral that is at least $\frac{1}{3}$ the diameter of the broken stem.

Heading cut

A heading cut is made at a node along the stem and leaves a stub (Figures 10 and 11). A node is the bud area from which branches arise, sometimes visible as a line around a stem or a slight swelling. When there is not a live lateral branch present for making a reduction cut, a heading cut could be a better choice than removing a large limb back to the trunk during canopy cleaning. Removal of large limbs can take away too much live wood, causing decay and disrupting canopy balance. This can result in poor health or tree failure in the years to come.

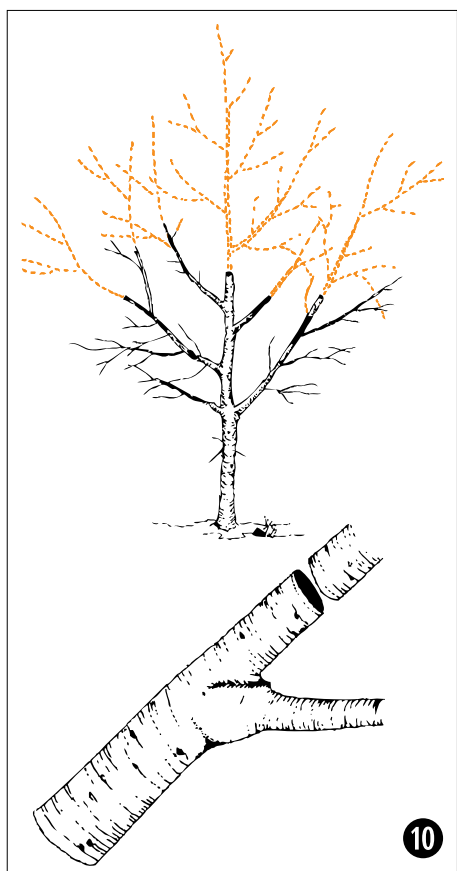


Figure 10

Drawing of a topped tree with several heading cuts. A heading cut may be used instead of a reduction cut if there is not a live lateral branch to reduce back to. Heading cuts should be used only as a last resort.

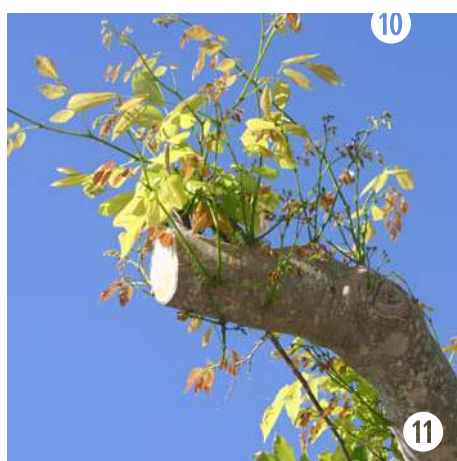


Figure 11

This branch was pruned back to a node, and sprouts are emerging. Over time, one of these sprouts can be trained to replace the broken tip on branches 4 inches or less in diameter.

Heading cuts are allowed in the American National Standards Institute's national pruning standard [1] as part of restoration pruning. A heading cut used to clean the canopy could look like topping, which is a harmful method of pruning trees, but the practice is dramatically different. Topping severely reduces the entire canopy of a tree (Figure 10, top), whereas heading cuts used in restoration are made only when necessary. Otherwise, heading cuts should not be used as a standard practice on healthy, undamaged trees.

Summary of Actions after a Storm

Contact the power company if a tree is down near power lines.

Determine whether the tree is personal or municipal property to avoid unnecessary expenses.

Protect roots of fallen trees from drying out by watering them and covering them with a tarp, not clear plastic.

Hire a professional to help with staking fallen trees to avoid causing trunk damage.

Before pruning, assess damage and make sure the tree is restorable.

Hire an ISA-certified arborist for restoration pruning. Be familiar with the steps of restoration so that you know what to expect.

Look up! Use binoculars to check for broken branches in the upper canopy, and look for cracks along limbs.

Broken, hanging limbs are removed first.

Jagged tips of broken branches should be removed with a smooth pruning cut.

Unless limbs are cracked and pose a hazard, excessive amounts of live wood should not be removed.

Reduction cuts are preferable on broken limbs, but if there is not a lateral to reduce back to, heading cuts are sometimes appropriate.

II. Allow Time for Recovery

Wind damage from hurricanes often strips the leaves from a tree. This interrupts the tree's ability to photosynthesize and store energy. In response to the damage, the tree sends out epicormic shoots, typically referred to as sprouts, found mostly along the top and at the tips of branches. To produce the sprouts, the tree uses energy (starch) stored in the living wood, which temporarily weakens the tree. Allowing sprouts to grow will rebuild the starch reserves and other energy-storing compounds, increasing strength of the tree over time.

BROADLEAF EVERGREEN AND DECIDUOUS TREES

Wait until spring of the following year before determining if a tree is dead. If it does not sprout by the spring or early summer following the hurricane, it is not likely to recover.

PINES

Pines sprout very little or not at all. When all of the needles are brown, or if there are no needles, the pine is dead.

PALMS

All leaves come from one bud located near the top of the palm. On palms with multiple trunks, each stem has a bud near the top. After a storm, it is difficult to determine whether the bud was damaged unless some obvious injury has occurred, like the trunk snapping in half.

Allow at least six months to see whether new growth emerges from the bud. New fronds could be stunted or yellow—leaves may be smaller and abnormally shaped—and it may take 2 years or more before the palm regains its full set of leaves [2].

Factors Affecting Recovery

Several factors determine the recovery period needed before initiating restoration pruning.

Tree Age

This is an important factor—young trees have a higher ratio of live to dead wood, which allows a faster recovery. This means you can begin restoring young trees sooner after the storm, within one to two years. Older trees may need two years or longer for sprouts to grow before you remove live branches.

Tree Size

Small maturing trees (less than 30 feet tall at maturity) take fewer pruning visits because structural defects are

not as critical. A falling crapemyrtle limb will not inflict as much damage as a falling live oak limb, for example. Large trees take priority during hurricane recovery. However, small trees still need time to recover properly. Trying to prune too much live wood at one visit will be just as problematic for the health of a small tree as it would be for a large one.

Tree Species

Knowing the species of a tree is particularly important in forming a pruning plan. Some species are short-lived because they are prone to decay. Therefore, it may be more efficient to focus restoration efforts on trees that resist decay and are more likely to live longer. Common examples in Florida are live oak and buttonwood, which resist decay and recover from damage much better than laurel oaks, which often have severe internal decay.

Tree Health

Health of the tree prior to the hurricane will affect its ability to recover. Healthy trees recover faster than those in poor health. Old trees with decayed root systems, stem decay, and large dead branches are more likely to decline or die than recover. These preexisting conditions might make it more appropriate to remove the tree instead of restoring it.

Extent of Damage

The extent of damage to the tree will also determine the length of time to wait before pruning live branches. The more damage to the tree, the longer you should wait before pruning. Severely damaged trees should be monitored to determine whether they are recovering or declining. Recovering trees will sprout aggressively, while declining trees have fewer, slow-growing sprouts and few leaves.

FOR MORE INFORMATION »

ON FACTORS AFFECTING
TREE RECOVERY

CH
8

[Assessing Hurricane-Damaged Trees and
Deciding What to Do](#)

III. Restoration Pruning Program: Sprout management

Once a tree has been determined to be worth restoring, its canopy cleaned, and the appropriate length of time has passed for recovery, it is time to begin sprout management. Sprout management is the training of sprouts so that they will grow into strong branches and build structure back into the tree.

First pruning visit

Two or more years after storm

Dead portions of branches that did not sprout and any other dead branches and stubs in the canopy should first be removed. Sprouts on recovering trees grow aggressively, and competition for light and space can lead to long, weak sprouts. Therefore, the goal for the first pruning visit is reduce some sprouts, remove some, and leave some (Figures 12 and 13). The most vigorous sprouts often develop side branches, and these are the ones that should be left. Leave all lower side branches on developing sprouts that will remain in order to encourage strength. Remove sprouts located near the selected sprouts to allow space for growth. Ideally, the selected sprouts should be spaced approximately 12 inches or more apart. Some sprouts should be reduced rather than removed because they will continue to build energy reserves and increase the strength of the damaged branch. The reduced sprouts will be removed at a later pruning visit, or they may be shaded out and die naturally.

Keep in mind that if the first visit is several years after the storm, there may be touching and crossing sprouts. Restoration pruning should remove or reduce these sprouts to ensure none are touching. Space them apart so each develops properly.

Second and third pruning visits

Allow about a year between pruning visits. The objective for the second and third visits is to continue sprout management, keeping the most vigorous sprouts to be the new branches, and reducing or removing competing sprouts. Large and severely damaged trees may need more pruning visits, while young or moderately damaged trees may only need a second visit to complete sprout management. Again, patience is important in this process. If sprouts are removed too soon and enough time is not allowed for building starch back into the wood, the tree will resprout, causing a decline in health. If pruning cuts made during the canopy-cleaning process left stubs that are sprouting poorly, consider removing these. Also, remove any dead branches at this time.

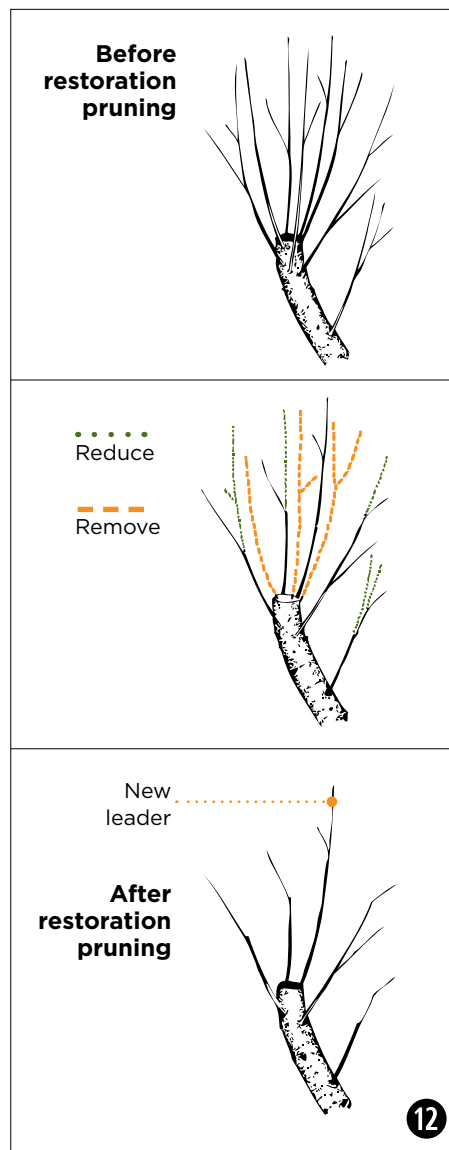


Figure 12

Illustration showing sprout management.

Reduce some: Shorten (reduce) 1/3 of the sprouts (dotted). They will continue to store energy, but will eventually be removed.

Remove some: Remove 1/3 of the sprouts (dashed) to allow space for the most vigorous ones to grow.

Leave some: These will develop into the new branches.

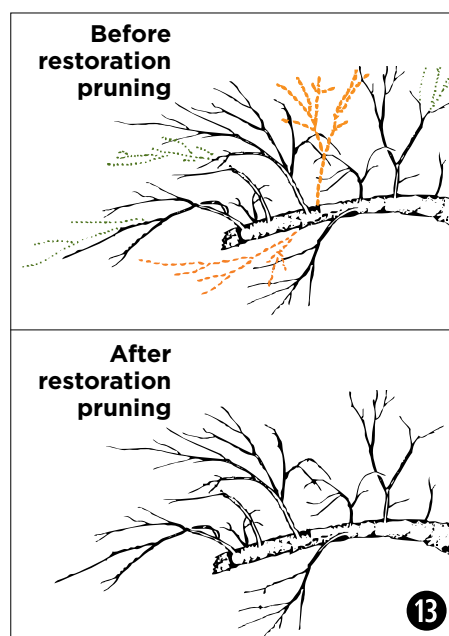


Figure 13

Sprout management on a damaged horizontal branch. Reduced sprouts are indicated by dotted lines, and removed sprouts by dashed lines. The arrow in the illustration on the left points to a dead stub that was removed back to a live branch.

The goal of sprout management is for a sprout to become the new branch leader and close over the pruning cut at the branch tip. Large (4 or more inches in diameter) branches are less likely to close over than smaller branches. A new branch leader can be established within a year or two when the diameter of the broken tip is 1–2 inches (Figure 14). For larger branches, it could take many years for a sprout to grow over the pruning cut, with more visits needed for reducing and removing sprouts.

Later pruning visits

Four or more years after storm

Once the canopy has been pruned several times and new leaders and branches have been reestablished on broken branches, it is time for structural pruning. The priority of structural pruning is to reduce limbs that are larger than half the diameter of the main trunk. Trees fail in storms at areas in the canopy where there are structural weaknesses like codominant stems, bark inclusions, and unbalanced and overextended canopies.

IV. Restoration of Palms

As with hardwood trees, the priority when restoring palms is to eliminate hazards and minimize removal of live tissue. Irrigation two to three times per week can also help palms recover if rainfall is lacking.

Step 1

Remove dead fronds that could fall and hit a target.

As with canopy cleaning on trees, the priority when cleaning palms is to remove potential hazards. The palm in the foreground of Figure 15 has brown, hanging fronds that should be removed. However, not all hanging fronds need to be pruned (see Step 3).



Figure 14
Young magnolia tree after the top broke in a hurricane (top). The broken stub was removed with a reduction cut back to a lateral branch (middle). A sprout emerged from just behind the pruning cut and is now closing over the cut after one year of restoration pruning (bottom). The lateral branch was removed once the sprout grew larger.



Figure 15
Remove dead fronds. Leave green fronds, even those that are bent, unless they pose a hazard.

Step 2

Remove fronds that are smothering the bud.

When broken fronds cross over the top of the palm, they may suppress new growth from the bud (Figure 16). These fronds should be removed.



Figure 16

Remove fronds crossing over the bud.

Step 3

Leave bent green fronds attached to palm until new fronds emerge.

Fronds become bent and will droop down along the trunk in a hurricane. Many of these remain green and are still well connected to the palm (Figure 17). These fronds should be kept until new foliage fully emerges because they photosynthesize and help the palm regain energy reserves and aid recovery.



Figure 17

Leave bent green fronds.

Step 4

Leave fronds that are yellowing or have brown tips.

Establish a fertilization program to correct nutrient deficiencies, but wait until palms begin growing new leaves before applying fertilizer. This may mean waiting up to six months after storm damage. The palm pictured in Figure 18 is showing severe yellowing or chlorosis on the lower fronds because it lacks nutrients like potassium and magnesium. Yellowing or browning fronds still provide energy for growth, and removing too much of this foliage reduces the palm's vigor, possibly even killing it.



Figure 18

Leave yellowing fronds. Prevent further yellowing by starting a fertilizer program specially designed for palms.

Avoid overpruning palms.

The two most common mistakes made with palms are using the wrong fertilizer and overpruning (Figure 19). In fact, using the wrong fertilizer often leads to overpruning because

typical palm maintenance (though potentially harmful) removes all leaves that are yellowing or have brown tips. Arborists report that overpruned palms suffered more damage in hurricanes than palms that were not pruned. This points to the importance of pruning appropriately. Removing too many fronds exposes the delicate bud to more wind and more potential damage. Remember, palms need older fronds to protect the bud and provide nutrients for growth.

V. Start a Tree Management Program

With a team of professionally trained commercial and municipal arborists who provide routine tree maintenance, including appropriate pruning, communities recover much faster after a hurricane. The continued growth of the profession is encouraging, as more communities recognize the need for allocating resources for the care of trees.

FOR MORE INFORMATION »

ON TREE MANAGEMENT PLANS	CH 14	Developing a Tree Management Plan for Your Community
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- [1] American National Standards Institute. 2001. American National Standard for tree care operations—Tree, Shrub, and Other Woody Plant Maintenance—Standards practices (Pruning). ANSI A300 (part 1). New York: American National Standards Institute.
- [2] Broschat, T. and M. Elliott, “Hurricane-Damaged Palms in the Landscape: Care after the Storm,” 30 May 2006, Palm Production and Culture Resources at the Fort Lauderdale Research and Education Center, University of Florida/Institute of Food and Agricultural Sciences.

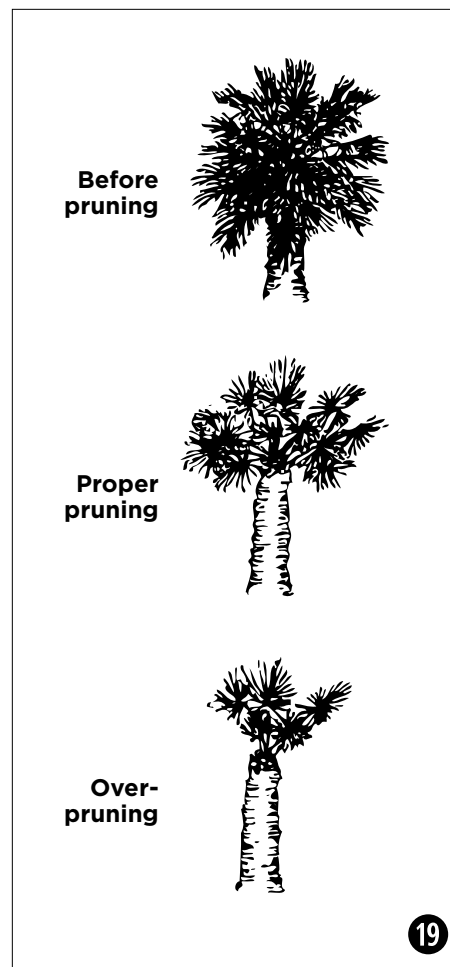


Figure 19
Illustration
showing
proper pruning
of palms vs.
overpruning

Additional Resources

Trees and Hurricanes

<http://treesandhurricanes.ifas.ufl.edu/>

American National Standards Institute (ANSI)

<http://www.ansi.org/>

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RESTAURACIÓN DE ÁRBOLES DESPUÉS DE UN HURACÁN



PUBLICACIÓN N°

ENH 1054-SP

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Introducción

La guía detallada que se suministra en este documento resume el proceso de restauración de los árboles de tal manera que puedan brindar de nuevo sombra y belleza a la comunidad, con menos riesgo. Generalmente la restauración requiere más de una poda para desarrollar una estructura fuerte en el árbol, por eso recuerde que la paciencia es una virtud especialmente cuando se trata de árboles muy dañados después de una tormenta.

Varios factores determinan el período de tiempo necesario para la recuperación: la edad y el estado de salud, el tamaño, la especie y la magnitud del daño. Estos factores están relacionados entre si y juntos determinan el cuidado que un árbol necesita después de una tormenta. Un programa de poda restaurativa generalmente toma de dos a cinco años y algunas veces mucho más tiempo para los árboles adultos con daños graves.

Reconozca los árboles que pueden ser restaurados. La estructura del árbol debe estar intacta, sin heridas visibles o cicatrices grandes en el tronco principal, las ramas o las raíces principales. Los árboles se pueden recuperar cuando han perdido todas sus hojas o han sufrido un daño significativo en sus copas, incluyendo varias ramas quebradas, pero el daño al tronco principal es frecuentemente irreparable.

Contenido

I	Plan de respuesta inmediata después de una tormenta	p. 2
II	Permita un tiempo para la recuperación	p. 6
III	Programa de poda restaurativa	p. 7
IV	Restauración de palmas	p. 9
V	Comienzo de un programa de manejo de los árboles	p. 10

I. Plan de respuesta inmediata después de una tormenta

Después de una tormenta, el tratamiento debe empezar con la eliminación de peligros para las personas y propiedades, y la limpieza de la copa de los árboles mediante la remoción de las ramas partidas o muertas. En ese momento no se debe hacer una gran poda que altere la estructura del árbol. Los árboles usan la energía almacenada en la madera para recuperarse del daño y producir nuevo crecimiento, es por esto que durante el proceso de limpieza solo se debe remover la menor cantidad posible de madera viva. (Compare la energía almacenada en los árboles con los ahorros limitados de una cuenta bancaria). Después de pagar para reparar los daños hechos por el huracán en la casa, los propietarios usualmente no se apresurarán a comprarse un bote nuevo. De la misma manera éste no es el momento de reducir los recursos limitados del árbol, removiendo madera en buen estado

Tenga mucho cuidado de no causar estrés adicional al árbol haciendo daño en el tronco, las ramas o las raíces. No desmoche sus árboles ni les corte toda la copa dejando solo muñones. (Figura 1). Muchas comunidades en la Florida prohíben el desmoche por que éste puede producir pudrición y reducir el vigor de los árboles.

Paso 1

Consiga ayuda en la remoción de peligros potenciales.

Si una rama ha caído cerca de las líneas eléctricas, asegúrese de que un arboricultor calificado en limpieza de éstas, se encargue de la situación. Trabajar cerca de líneas eléctricas es muy peligroso y puede ser mortal para aquellos que no sigan los procedimientos con seguridad. Otras situaciones peligrosas incluyen aquellas en las cuales hay ramas grandes partidas colgando o árboles inclinados que pueden caer en cualquier momento sobre una persona, golpear una casa o dañar otro objetivo. Estas situaciones, antes que todo deben ser manejadas por un profesional.

Paso 2

Levante y póngales estacas a los árboles pequeños que se han caídos y suminístreles riego según sea necesario.

Enderezar los árboles pequeños caídos es una prioridad porque las raíces se secan rápidamente. Profesionales con experiencia en los huracanes pasados han observado

que los árboles con troncos de diámetro mayor de 4 pulgadas que han sido enderezados, tienden a caer otra vez en tormentas posteriores. Por lo tanto no vale la pena invertir tiempo y dinero en levantarlos. La razón de ésto parece ser que las raíces partidas en los árboles grandes no se regeneran tan bien como en los árboles pequeños (de 1 pulgada o menos de diámetro). También las raíces partidas del árbol pueden pudrirse o causar pudrición al árbol haciéndolo inestable. La excepción son los árboles recién plantados de cualquier tamaño, a los cuales se les puede poner estacas por que no tienen raíces grandes partidas. Se debe conseguir la ayuda de un profesional para enderezar, poner estacas y tratar estos árboles como si fueran recién plantados.



Figura 1

El desmoche perjudica la salud del árbol.



Figura 2

Los sistemas de anclaje del cepellón trabajan muy bien.



Figura 3

Los sistemas de estacado rígidos pueden causar un daño significativo al tronco. Este sistema es menos problemático en palmas por que su tronco se expande mucho menos a la altura donde se aseguran las estacas.

Métodos para poner estacas

La investigación y la experiencia han mostrado que algunos métodos para estacar son más efectivos que otros. Los sistemas de anclaje del cepellón trabajan muy bien en la estabilización del árbol en el suelo (Figura 2). Los sistemas rígidos pueden trabajar pero necesitan ser ajustados o removidos a los seis meses (Figura 3).

Pasos para levantar un árbol caído

1. Mantenga las raíces húmedas.
2. Excave un hueco para acomodar el cepellón.
3. Use herramientas afiladas para hacer cortes precisos en las raíces rotas o desgarradas.
4. Levante el árbol hacia arriba lo más derecho posible, tomando medidas para proteger al tronco y las raíces.
5. Llene el hoyo con suelo del sitio, evitando enterrar el área del tronco donde se encuentra la raíz principal más superficial (Figura 4).
6. Riegue el árbol con la misma frecuencia que a un árbol recién plantado, aproximadamente tres veces por semana en los primeros meses. Aplique riego también durante los meses secos. No fertilice por un año.
7. Instale un sistema de estacado. Remueva o ajuste las estacas entre los seis meses y el año.

Riego para árboles estresados

Mantener el suelo húmedo promueve la formación de las raíces nuevas, lo cual es necesario para la recuperación de un árbol después de una tormenta.

Durante el período seco de octubre a mediados de mayo en la Florida, los árboles se deben regar tanto como sea necesario para ayudarlos a recuperarse del daño. Cuando se riegan árboles que han sido levantados y tienen estacas, dos a tres galones, por pulgada del diámetro del tronco, deben ser suficientes. Los sistemas de riego eficientes aplican el agua directamente al cepellón de las raíces, en vez de regar el árbol por encima. El riego no es necesario si el cepellón está saturado o ha sido húmedecido por lluvias fuertes. La muerte regresiva (dieback) debida al daño por la sal puede ocurrir en las áreas costeras inundadas con agua durante los huracanes. Estos árboles pueden requerir tratamientos de riego para remover la sal del suelo mediante el lavado con agua.

Paso 3

Limpieza de la copa de un árbol.

El propósito de la limpieza de la copa es remover el peligro potencial, que presentan las ramas grandes muertas y tallos quebrados. También en la limpieza se hacen cortes de poda precisos en los tocones de las

ramas quebradas, que permitan al nuevo crecimiento cerrar las heridas (Figura 5). Recuerde que los árboles estresados necesitan recurrir a la energía almacenada en sus tejidos para recuperarse. El alimento almacenado en los tallos es necesario para que el árbol rebrote, produzca nuevas hojas y se defienda de organismos que producen

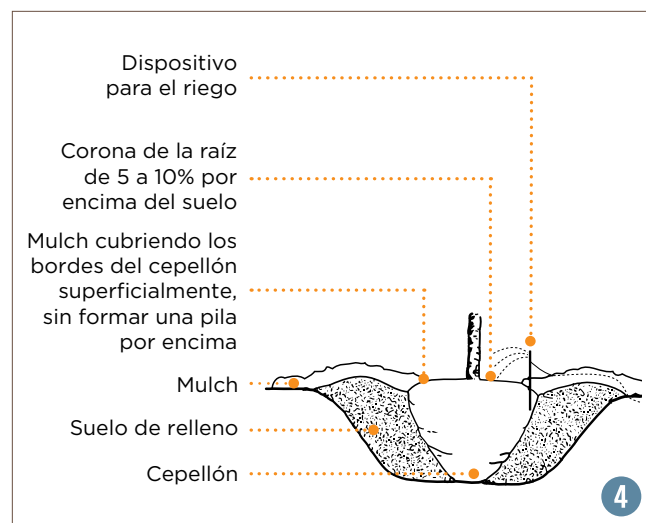


Figura 4

Dibujo con la técnica correcta de siembra de un árbol.

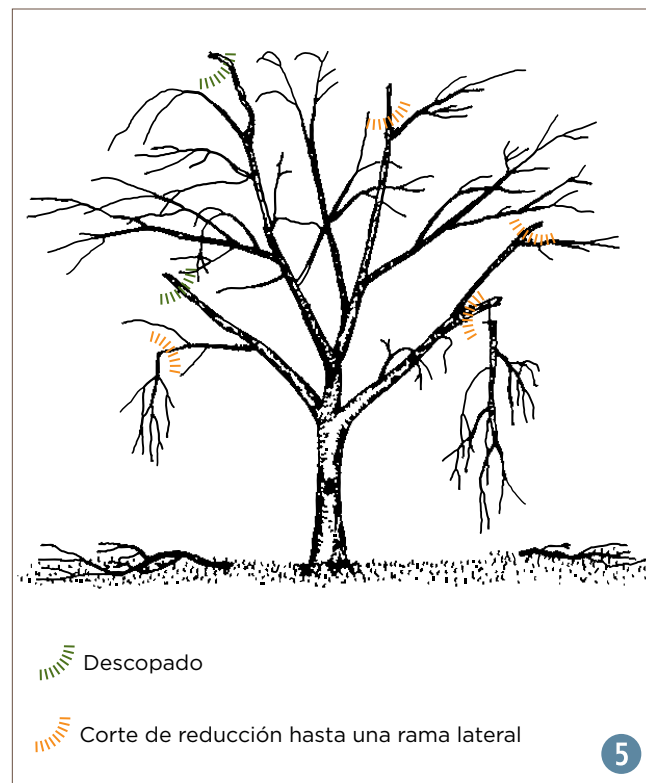


Figura 5

Limpieza de la copa de un árbol dañado por una tormenta. Las líneas indican donde hacer los cortes de poda.

la pudrición. Es mejor dejar que la copa del árbol se vea sin balance y de forma irregular a remover grandes partes vivas en este momento. Más tarde se le puede dar forma a la copa, como parte del proceso de restauración.

Corte de remoción

El corte de remoción remueve la rama hasta el tronco principal o hasta una rama mayor. (Figuras 6 y 7). Después de un huracán, este tipo de corte es usado para remover ramas grandes que están partidas, agrietadas o colgando del árbol. Remueva primero las ramas que cuelgan para que no caigan y

causen daño. Asegúrese de que no haya grietas en las ramas grandes principales; use binóculos cuando sea necesario, para ver con más detalle. Los arboricultores pueden trepar los árboles para ver si hay grietas y otros defectos estructurales. Las ramas partidas deben ser removidas por que pueden ser un peligro si hay otros objetos cerca.

Corte de reducción

En el corte de reducción se poda la rama principal hacia una más pequeña llamada rama lateral (Figuras 8 y 9). Idealmente, la rama lateral debe ser al menos

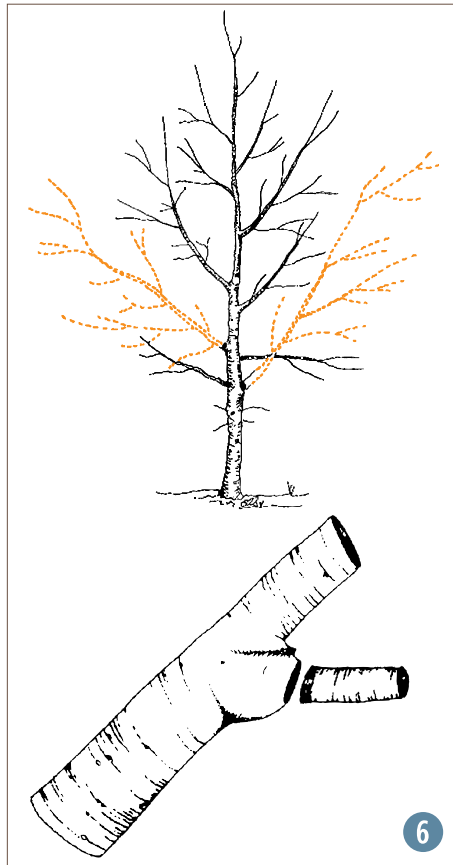


Figura 6
Representación de un corte de remoción. Después de un huracán los cortes de remoción hasta el tronco principal o hasta una rama parental se usan para eliminar ramas partidas, agrietadas que están colgando del árbol.

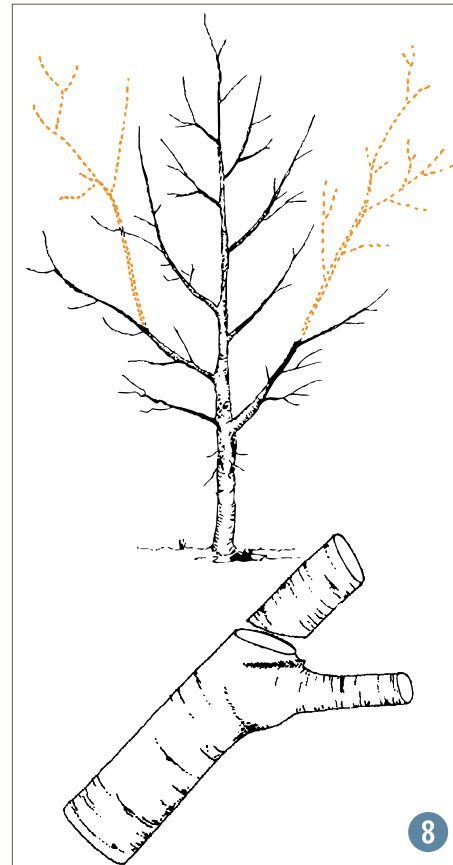


Figura 8
Representación de un corte de reducción. Este tipo de corte se usa para pulir los bordes en los muñones que quedan después de que las ramas se han partido o desgarrado.



Figura 7
Fotografía de un corte de remoción. La rama fué podada hasta el tronco dejando el cuello de la rama intacto. Un buen corte de poda es redondo. Los cortes demasiado cercanos al tronco son de forma ovalada

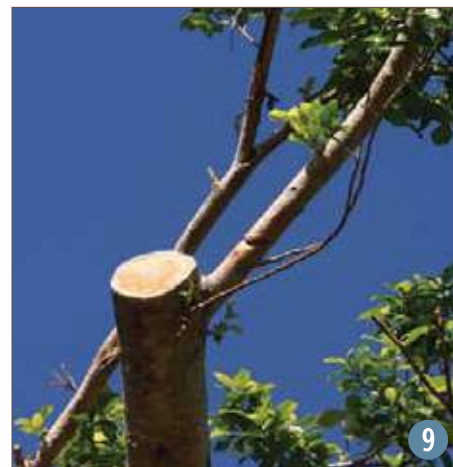


Figura 9
Fotografía que muestra un corte de reducción. La rama está podada correctamente hacia una lateral que es al menos 1/3 del diámetro de la rama partida.

1/3 del diámetro de la rama que se está podando. Este tipo de corte se usa para cortar las puntas que quedan desgarradas después de que las ramas se han quebrado.

Descopado

El descopado es hecho en un nudo a lo largo de la rama dejando un muñón (Figuras 10 y 11). Un nudo es el área donde rebrotan las hojas; algunas veces es una línea visible alrededor de la rama o una leve protuberancia. Cuando durante la limpieza de la copa no hay ramas laterales cercanas para hacer un corte de reducción, el descopado puede ser una mejor opción antes de remover una rama grande hasta el tronco principal. Con la remoción de las ramas grandes se elimina demasiado

tejido vivo causando pudrición y alterando el balance de la copa. Ésto puede menguar la salud del árbol en los años venideros y provocar defectos posteriores.

El descopado es permitido por el Instituto Nacional Americano de Estándares (American National Standards Institute) como parte de la poda restaurativa [1]. El descopado usado en la limpieza de la copa puede tener una apariencia como la del desmoche, el cual es un método de poda muy dañino para el árbol, pero en la práctica es realmente diferente. En el desmoche severo se reduce la copa entera de un árbol (Figura 10, arriba), mientras que el descopado es usado en la restauración y se hace solamente donde sea necesario. Por otra parte,

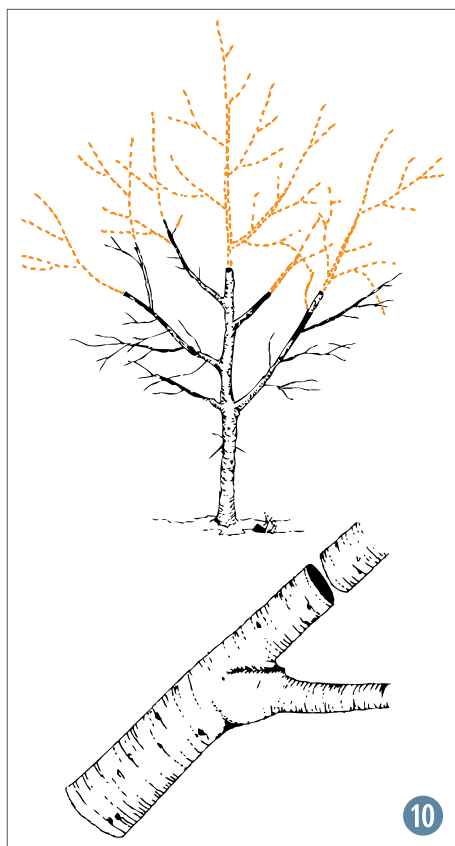


Figura 10

Representación de un árbol descopado. Los cortes de descope pueden usarse en lugar de los cortes de reducción, siempre y cuando no haya una rama lateral cercana con la que se pueda hacer la reducción de la rama a podar. El descopado solo debe ser usado como último recurso.



Figura 11

Esta rama fué podada hasta el nudo, donde los rebrotes están emergiendo. Con el tiempo, uno de esos rebrotes puede ser manejado para reemplazar la rama partida, siempre que ésta tenga 4 pulgadas o menos de diámetro.

Resumen del qué hacer después de la tormenta

Contacte a la compañía de electricidad si un árbol ha caído cerca a los cables de eléctricos.

Determine si el árbol es de propiedad privada o pública para evitar gastos innecesarios.

Proteja las raíces de los árboles caídos para que no se sequen, riéguelos y cúbralos con una lona, no con plástico de color claro.

Contrate un profesional para que le ayude con el estacado de los árboles caídos y evitar que se dañe el tronco.

Antes de podar, evalúe el daño y asegúrese de que su árbol se puede restaurar.

Contrate un arboricultor certificado por ISA (Sociedad Internacional de Arboricultura) para la poda restaurativa. Familiarícese con los pasos de la restauración para que sepa que esperar.

¡Observe! Use binoculares para ver las ramas quebradas en la parte alta de la copa y busque heridas o roturas a lo largo de las ramas.

Las ramas partidas que estén colgando se remueven primero.

Las puntas de las ramas partidas que están desgarradas se deben remover con cortes de poda apropiados.

No se debe remover mucho tejido vivo a no ser que las ramas estén partidas y representen un peligro.

Los cortes de reducción son preferibles en las ramas quebradas, pero si no hay ramas laterales hacia las cuales hacer el corte; en algunos casos, el descopado es apropiado.

el descopado no debe ser usado como una práctica estándar en árboles sanos sin daño alguno

II. Dele tiempo a la recuperación

El viento de los huracanes frecuentemente deja sin hojas a los árboles. Esto interrumpe su capacidad de fotosintetizar y almacenar energía. Como respuesta al daño, el árbol normalmente desarrolla rebrotes a lo largo y en la punta de las ramas. Para producir los rebrotes, el árbol usa energía (almidón) almacenada en la madera viva, debilitándolo temporalmente. Si se permite que los rebrotes crezcan, las reservas de energía tales como el almidón y otros componentes se recuperarán, fortaleciendo el árbol con el tiempo.

ÁRBOLES DE ESPECIES LATIFOLIADAS SIEMPREVERDES Y DECIDUAS

Espere hasta la próxima primavera para determinar si su árbol está muerto. Si no rebrota para la primavera o el comienzo del verano siguiente al huracán posiblemente no se recuperará.

PINOS

Los pinos rebrotan muy poco o no rebrotan. Cuando todas las acículas están cafés, o si no hay acículas, el pino está muerto.

PALMAS

Todas las hojas de la palma emergen de la yema localizada al final del tallo. En las palmas con tronco múltiple, cada tallo tiene una yema. Después de una tormenta, es difícil determinar si la yema se ha dañado a no ser que el daño sea obvio como que el tronco se haya partido por la mitad.

Dé a la palma al menos seis meses para ver si nuevo crecimiento emerge de la yema. Las hojas nuevas pueden estar atrofiadas o amarillas — las hojas pueden ser más pequeñas o de formas anormales — y puede tomar hasta más de dos años para que la palma recupere sus hojas por completo[2].

Factores que afectan la recuperación

Varios factores determinan el período de recuperación necesario antes de empezar la poda restaurativa.

Edad del árbol

Este es un factor importante—los árboles jóvenes tienen una mayor proporción de madera viva/muerta, lo cual

les permite una rápida recuperación. Esto significa que usted puede empezar la restauración de los árboles jóvenes tan pronto pase la tormenta entre el primero y el segundo año. Los árboles más viejos pueden necesitar dos años o más para rebrotar antes de que usted le remueva ramas vivas.

Tamaño del árbol

Los árboles adultos pequeños (de menos de 30 pies de altura en su madurez) necesitan menos visitas para la poda por que no tienen defectos estructurales críticos. Una rama caída de un Crape myrtle por ejemplo, no causa tanto daño como una rama caída de un Live oak. Los árboles grandes son prioridad durante la recuperación de un huracán. Sin embargo, los árboles pequeños necesitan tiempo para recuperarse. Tratar de podar mucha madera viva en una visita, solo sería un problema para la salud tanto de un árbol pequeño, como lo sería para uno grande.

Especie del árbol

Conocer las especies de los árboles es particularmente importante en la formulación de un plan de poda. Algunas especies son de vida corta por que son propensas a la pudrición. Por lo tanto, puede ser más eficiente enfocar los esfuerzos de restauración en árboles resistentes a la pudrición y que tienen más probabilidades de vivir por más tiempo. Ejemplos comunes en Florida son el Live oak y el Buttonwood, los cuales resisten a la pudrición y se recuperan mucho mejor del daño que el Laurel oak, el cual a menudo tiene mucha pudrición interna.

Estado sanitario del árbol

El estado sanitario del árbol previo al huracán afecta su habilidad para recuperarse. Los árboles saludables se recuperan más rápido que aquellos con salud pobre. Los árboles más viejos con sistemas radiculares podridos, tallos podridos y ramas grandes muertas tienen más probabilidades de deteriorarse o morir que de recuperarse. Estas condiciones preexistentes pueden hacer más apropiado remover el árbol en vez de recuperarlo.

Magnitud del daño

La magnitud del daño sufrido por el árbol también determinará el tiempo de espera antes de podar las ramas vivas. A mayor daño del árbol, más larga debe ser la espera antes de la poda. Árboles gravemente dañados deben ser observados para determinar si se están recuperando o deteriorando. Los árboles en

recuperación rebrotan agresivamente, mientras que los árboles en proceso de deterioro tienen unos pocos rebrotes, con pocas hojas creciendo lentamente.

FOR MORE INFORMATION »		
EN FACTORES QUE AFECTAN LA RECUPERACIÓN DE LOS ÁRBOLES	CAP 3	Evaluación de los árboles dañados durante un huracán y toma de decisiones

III. Programa de Poda Restaurativa: Manejo de Rebrotos

Una vez se ha determinado que vale la pena restaurar un árbol, que se ha limpiado su copa y que ha pasado un tiempo apropiado para su recuperación, es hora de empezar con el manejo de los rebrotes. El manejo de los rebrotes se hace para que éstos crezcan como ramas fuertes y así reconstruir la estructura del árbol.

Primera visita de poda

Uno o dos años después de la tormenta

Las partes muertas de las ramas que no rebrotaron y cualquier otra rama muerta y muñón muertos en la copa deben ser removidos primero. Los rebrotes en los árboles en recuperación crecen rápidamente y debido a la competencia por luz y espacio se pueden generar rebrotes largos y débiles. Por esto la meta para la primera visita de poda es reducir algunos rebrotes, remover otros y dejar los demás (Figuras 12 y 13). Frecuentemente, los rebrotes más fuertes se desarrollan en ramas laterales, por lo tanto son los que se deben dejar. Deje todas las ramas laterales más bajas con rebrotes en desarrollo, los cuales permanecerán para fomentar su fortalecimiento. Remueva otros localizados cerca a los rebrotes seleccionados para permitirles a éstos espacio para su crecimiento. Idealmente, los rebrotes seleccionados deben estar espaciados entre ellos aproximadamente a 12 pulgadas o más. Algunos rebrotes deberán ser reducidos en vez de removidos para que continúen con la formación de las reservas de energía y aumenten la solidez de las ramas dañadas. Si no han muerto naturalmente, los rebrotes reducidos se removerán en una visita posterior de poda.

Tenga en cuenta que si la primera visita de poda se hace varios años después de la tormenta, puede ser

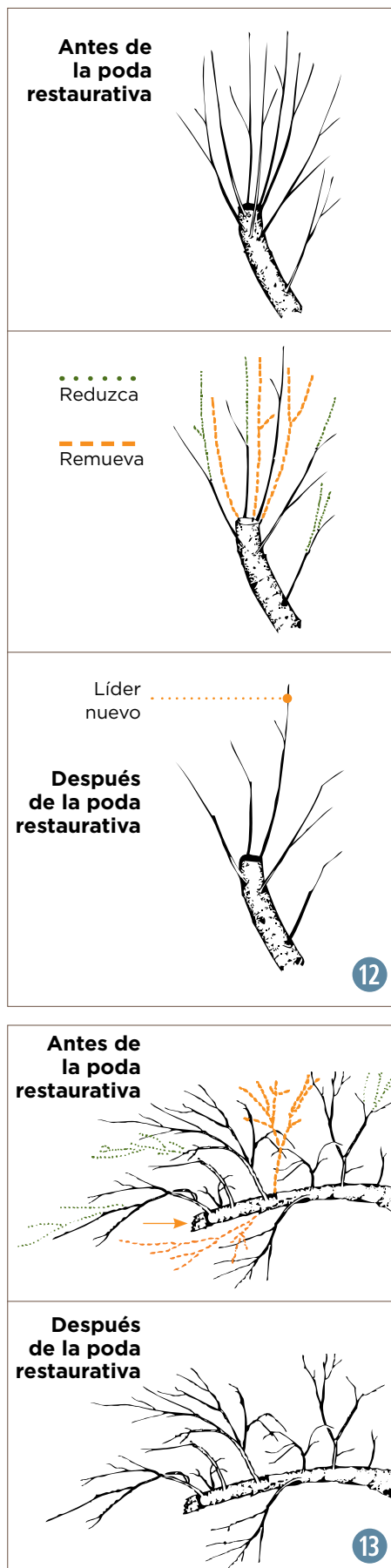


Figura 12

Ilustración mostrando el manejo de los rebrotes.

Reduzca algunos:

Recorte (reduzca) 1/3 de los rebrotes (línea punteada). Ellos continuarán almacenando energía, pero eventualmente serán removidos.

Remueva algunos:

Remueva 1/3 de los rebrotes (línea discontinua) dando así espacio a los más fuertes para su crecimiento.

Deje algunos: Éstos se convertirán en las ramas nuevas

Figura 13

Manejo de rebrotes en una rama horizontal dañada.

Los rebrotes reducidos son señalados con líneas punteadas y los rebrotes removidos con líneas discontinuas. La flecha en la ilustración superior señala un muñón muerto que fué recortado hasta una rama viva.

que haya rebrotes en contacto, entrecruzados. En la poda de restauración se deben remover o reducir estos rebrotes para asegurar que no estén en contacto. Sepárelos para que cada uno se desarrolle apropiadamente.

Segunda y tercera visitas de poda

Deje un tiempo de aproximadamente un año entre las visitas de poda. El objetivo de la segunda y tercera visitas es continuar con el manejo de los rebrotes, conservando los rebrotes más fuertes para que sean las ramas nuevas, y continuar también con la reducción y remoción de los rebrotes que estén compitiendo con éstos. Los árboles más grandes y más dañados pueden necesitar más visitas de poda, mientras que los árboles jóvenes o moderadamente dañados pueden necesitar solo una segunda visita para que se complete el manejo de sus rebrotes. Una vez más, la paciencia es importante en este proceso. Si los rebrotes se remueven demasiado rápido y no se da suficiente tiempo para la acumulación de almidones en la madera, el árbol rebrotará débilmente. Si en los cortes de poda hechos durante el proceso de la limpieza de la copa, se dejaron muñones que están rebrotando pobremente, considere su remoción. También remueva cualquier rama muerta que haya en ese momento.

La meta del manejo de rebrotes es convertir un rebrote en una rama nueva líder que cicatrice sobre el corte de poda en la punta de la rama. Las ramas grandes (de 4 o más pulgadas de diámetro) tienen menos posibilidades de cicatrizar que las ramas más pequeñas. Una rama nueva puede establecerse en un período de tiempo de entre uno o dos años cuando el diámetro de la punta partida es de 1-2 pulgadas (Figura 14). Las ramas más grandes pueden llevar años para que un rebrote crezca cicatrizando el corte de poda lo que hará necesarias más visitas para reducir y remover rebrotes.

Visitas de poda posteriores

Cuatro o más años después de la tormenta

Una vez que la copa ha sido podada varias veces y se hayan establecido los líderes y las ramas nuevas en las ramas quebradas, es el tiempo para la poda estructural. La prioridad de la poda estructural es reducir los tallos que son mayores que la mitad del diámetro del tronco principal. Los árboles se quiebran en las tormentas en las áreas de la copa que son estructuralmente débiles como tallos codominantes, corteza incluída y desbalance en copas demasiado extendidas.



Figura 14

Árbol joven de magnolia con la punta partida después de un huracán (arriba).

El muñón partido fue removido con un corte de reducción hasta una rama lateral (en el medio). Un rebrote salió justo por detrás del corte de poda y ahora está cerrando por encima del corte de poda después de un año de la poda restaurativa (abajo). La rama lateral fue removida una vez que el rebrote creció en longitud.



Figura 15

Remueva las frondas muertas. Deje las frondas verdes, aunque estén dobladas a no ser que representen un peligro.

IV. Restauración de palmas

Como con los árboles de madera dura, la prioridad cuando se restauran palmas es eliminar el peligro y minimizar la remoción de tejido vivo. El riego una a tres veces por semana también puede ayudar a la recuperación si hay falta de lluvia.

Paso 1

Remueva las frondas muertas que puedan caer y golpear un objetivo.

Al igual que con la limpieza de la copa en árboles, la prioridad cuando se limpian las palmas es remover el peligro potencial que pueden causar. La palma en primer plano en la Figura 15 tiene frondas cafés colgando que deben ser removidas. Sin embargo, no todas las frondas que estén colgando necesitan ser removidas (vea Paso 3).

Paso 2

Remueva las frondas que estén cubriendo la yema.

Cuando las frondas partidas están cruzadas cubriendo la yema de la palma, pueden estar deteniendo el nuevo crecimiento de la palma (Figura 16). Esas frondas deben ser removidas.

Paso 3

Deje en la palma las frondas verdes colgando hasta que salgan las nuevas.

Después del huracán, las frondas que quedan colgando pegadas al tronco de la palma caerán de éste. Muchas de ellas permanecen aún verdes, conectadas a la palma (Figura 17). Esas frondas se deben mantener hasta que el follaje nuevo salga ya que ellas fotosintetizan y ayudan a recobrar las reservas de energía y a recuperarse.



Figura 16

Remueva las frondas que estén cruzadas cubriendo la yema.



Figura 17

Deje las frondas verdes que estén colgando.



Figura 18

Deje las frondas amarillas. Prevenga el amarillamiento potencial de las frondas empezando un programa de fertilización diseñado especialmente para las palmas.

Paso 4

Deje las frondas que se están poniendo amarillas o tengan las puntas cafés.

Para corregir las deficiencias nutricionales, espere hasta que las hojas nuevas empiecen a crecer y establezca un programa de fertilización adecuado para la palma. Esto significa que hay que esperar hasta seis meses después de la tormenta. La palma de la Figura 18 muestra un amarillo intenso o clorosis en las frondas inferiores debido a la falta de nutrientes como el potasio y el magnesio. Las frondas amarillentas o tornándose marrón todavía suministran energía para el crecimiento, por lo tanto remover demasiado follaje reduce el vigor de las palmas y hasta es posible que las mate.

Evite podar demasiado las palmas

Los dos errores más comunes con las palmas son el uso equivocado de fertilizantes y la poda excesiva (Figura 19). Es más, el uso de un fertilizante equivocado a menudo lleva a la poda excesiva, ya que durante el mantenimiento usual de la palma (aunque sea potencialmente perjudicial) se remueven todas las hojas que estén amarillas o que tengan las puntas marrón. Los arboricultores reportan que, con una poda excesiva, las palmas sufren más daño durante los huracanes que cuando no han sido podadas. Esto muestra la importancia de la poda apropiada. La remoción de muchas frondas sobreexpone la yema apical muy delicada al viento y al daño potencial. Recuerde, las palmas necesitan las frondas viejas para proteger su yema, así como para suministrar nutrientes para el crecimiento.

V. Empezar un programa de manejo para el árbol

Las comunidades se recuperan mucho más rápido después de un huracán con el apoyo de un equipo de arboricultores comerciales y municipales entrenados profesionalmente que suministren mantenimiento rutinario a los árboles incluyendo la poda apropiada. A medida que más comunidades

reconozcan la necesidad de destinar recursos para el cuidado de los árboles, se promoverá el crecimiento de la profesión.

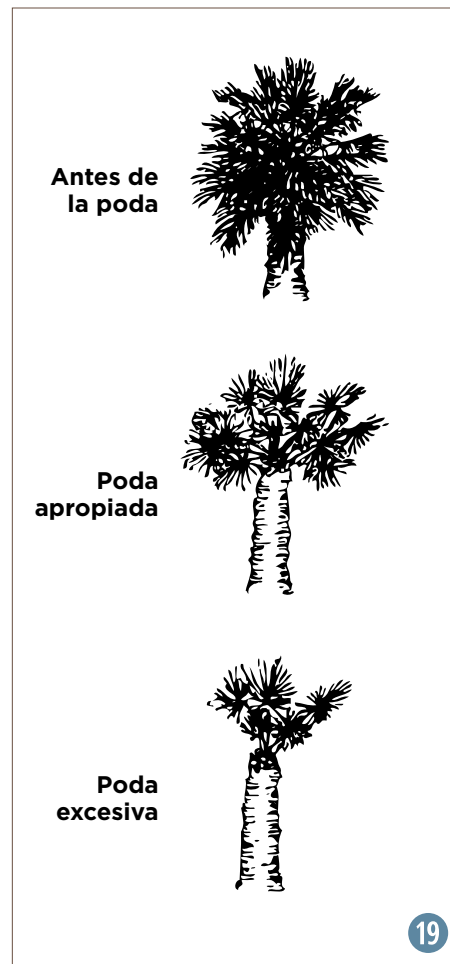


Figura 19

Ilustración que muestra la poda apropiada para palmas vs. la poda excesiva

Fuentes Adicionales

Trees and Hurricanes

<http://treesandhurricanes.ifas.ufl.edu/>

American National Standards Institute (ANSI)

[http://www.ansi.org/](http://www ansi.org/)

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Palms in the Landscape: Care after the Storm,” 30
May 2006, Palm Production and Culture Resources
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Hurricane-Damaged Palms in the Landscape: Care after the Storm¹

Monica L. Elliott and Timothy Broschat²

While many palm species are adapted to windstorms, a hurricane can damage even the most tolerant palms. This publication provides suggestions about what to do after a windstorm has occurred once it is safe to venture outside to care for the landscape.

It is important to understand how a palm grows. The growing point of a palm is the apical meristem, often referred to as the palm bud or palm heart. It is located at the top of the trunk, surrounded by the leaf bases. All new leaves come from this bud. If the bud is severely damaged, new leaves fail to develop, and the palm eventually dies.

Unless the palm trunk is broken or it is otherwise obvious that the bud has been damaged, there is no way to predict which palms will survive wind damage and which ones will not, as the bud is not visible or accessible for inspection. However, it is apparent after several years of hurricanes in Florida that certain palm species are more tolerant of high winds than others. The native sabal palm (*Sabal palmetto*) and royal palm (*Roystonea regia*) both tend to survive high winds, but in very different ways. While sabal palms lose very few leaves, royal palms (which have a crownshaft) shed most of their leaves.

The following are some suggestions on caring for palms after a hurricane. **The main point to note (and inform clientele) is that it will be at least 6 months (and probably longer) before it is apparent that a palm will recover.**

Recovery consists of new leaves emerging from the bud. In some cases, the new leaves will not look normal—they may be abnormally shaped and/or shorter than normal, or the leaflets or leaf segments may have necrotic (dead tissue) edges. However, over time, each successive new leaf should appear a little more normal until eventually, normal leaves appear. Again, this takes time, so patience is required. It is recommended to monitor damaged palms carefully during the next 1–2 years.

It is also important to understand that because of the storm, people are examining their landscape more closely than they probably did before the storm. Thus, they may not realize that the palms had problems (such as nutrient deficiencies—see <http://edis.ifas.ufl.edu/ep273>) prior to the storm. The challenge is to determine which problems existed before the storm (and address them accordingly) as opposed to those that developed because of the storm.

Broken Palms

If the trunk of a single-stemmed palm is broken, it should be cut at the base and removed. It will not recover. However, a clustering palm has a lateral meristem at the soil line. Thus, new stems will emerge, and the palm should recover in most cases. Cut the broken stems as close to the soil line as possible. If possible, the stumps of single-stem palms should be removed or ground up. If the stumps are left in place, they should be monitored for *Ganoderma zonatum*

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conk (shelf-like mushroom) development. As soon as a conk starts to form, it should be removed, placed in a bag and the bag placed in garbage that will be incinerated or buried. The fungus is not harmful to people or pets, but it may kill the other palms in the landscape if it spreads. See *Ganoderma Butt Rot of Palms* (<http://edis.ifas.ufl.edu/pp100>).

Uprooted Palms

Palms should be stood upright as soon as possible and replanted at the same depth at which they were planted previously. Bracing is necessary and should be kept in place for at least 6 months. These “replanted” palms should be treated as if they were being installed for the first time.

Thus, water management is the most important component of a management program in the first 6 months.

The root zone should be irrigated as necessary during the re-establishment period. Refer to *Transplanting Palms in the Landscape* (<http://edis.ifas.ufl.edu/ep001>) for more information about caring for transplanted palms.

Leaf Removal

If the broken leaves are still green, it is recommended to leave them attached, as they will provide photosynthetic capability for the palm as it recovers. However, if only a few leaves are broken, then removing these leaves (and only these leaves) may be acceptable. See *Pruning Palms* (<http://edis.ifas.ufl.edu/ep443>) for more information about how to remove palm leaves.

Fertilization

For palms that are not uprooted, maintain the same fertilization program that was in place prior to the storm. For replanted palms, no extra fertilizer should be applied to the root zone until the palm exhibits new growth (i.e., new leaves). This will take a month or longer in many cases. There is no known benefit to applying a micronutrient spray to the canopy, and it may be harmful if applied incorrectly. See *Fertilization of Field-Grown and Landscape Palms in Florida* (<http://edis.ifas.ufl.edu/ep261>) for more information about proper fertilization of landscape palms.

Fungicides

There is no research to document the benefits of using fungicides after a hurricane. The theory behind this common recommendation is that if the apical meristem (bud) has been damaged, then it is possible that fungal pathogens (primarily *Phytophthora* or *Thielaviopsis*) or secondary bacterial pathogens may become established in the bud

and cause a bud rot (see *Bud Rot of Palm* [<http://edis.ifas.ufl.edu/pp144>]). The only chemical pesticides that may have an effect on both fungi and bacteria are copper-based fungicides (not copper nutrient sprays). These fungicides should be applied as a drench to the bud, not to the soil, as these fungicides do not translocate from the soil to the bud area where they are needed.

All fungicides must be used in accordance with the label.

Do **NOT** mix fungicides together or with a nutrient spray unless the label indicates it is safe to do so. There is no research to indicate copper-based fungicides will help wind-damaged palms, but they probably will not hurt the palm if used according to the label. The normal recommendation is not to use copper-based fungicides more than twice because they are not prone to degradation in the environment.

Based on observations from previous hurricane seasons, it is obvious that many palms, especially native palm species, survive windstorms without any fungicide applications. Thus, it may be best to reserve fungicide use for those palms that are highly valuable or severely damaged.

Yellow New Leaves Immediately after the Storm

Although this phenomenon has been observed on other palms, it is most commonly seen on royal palms. The youngest leaf of a palm is the spear leaf, which is actually an unopened leaf. It is normally upright (ramrod straight) in the center of the canopy. Under normal circumstances, it opens slowly from the tip to the leaf base. As each portion of the leaf expands, it becomes the normal color associated with mature leaves. In a windstorm, it is not uncommon for this spear leaf to be forced open prematurely. If this occurs, the leaf appears chlorotic (pale green or yellow) because it was not fully developed. Typically, these leaves assume a normal green color after a few days. As stated previously, as long as the bud (from which all subsequent new leaves emerge) is not damaged, the palm will produce a new canopy to replace the one that was lost in the hurricane. It will take at least a year (and usually longer) for the entire canopy to be replaced.

Soluble Salts in the Soil

If the landscape has been flooded with salt water, the salts from evaporated or percolated salt water can cause serious injury to many species of palm. This is especially true if the salt water remains on the landscape for more than a few hours, or if there is no significant rainfall after the salt water

recedes. In the latter case, it may help to heavily leach the soil around palms with fresh water as soon as possible. Salt injury typically causes tip necrosis on leaves throughout the canopy. See *Physiological Disorders of Landscape Palms* (<http://edis.ifas.ufl.edu/ep263>) for more information about soil-soluble salt injury.

Preparation for and Recovery from Hurricanes and Windstorms for Tropical Fruit Trees in the South Florida Home Landscape ¹

Jonathan H. Crane, Jeff Wasielewski, and Carlos F. Balerdi²

Pre-Hurricane Planning and Prevention

Well in advance of the hurricane season an assessment of the location and size of the fruit trees in the home landscape should be made. Ideally, fruit trees with a potential to become large (e.g., avocado and mango) and not regularly pruned should be planted 25 ft or more away from the home, other structures (e.g., garages and toolsheds), power lines, and other trees. If, however, a large fruit tree is already in place, a certified arborist should be contacted to reduce tree height and properly prune the tree to open the canopy to wind movement. Alternatively, large, potentially hazardous fruit trees may be transferred to a new location or removed completely and a new fruit tree established at a greater distance from the home, structure, or power lines. Before work begins, check with local county agencies on regulations for pruning and/or removing fruit trees from the home landscape.

The most effective cultural practice to reduce the potential for tree toppling and major damage is managing tree height and spread. Ideally, fruit trees in the home landscape should be pruned annually or biannually beginning soon after planting to develop a strong tree structure and later to remove dead wood, reduce tree height and spread (if needed

occasionally), and open the tree to wind movement. Small fruit trees such as guava and sugar apple may be kept at 3 to 12 ft and 6 to 12 ft high, respectively. Potentially large trees like avocado may be kept at 10 to 15 ft, and mango at 6 to 15 ft high, with judicious but regular pruning (Table 1).

Proper planting of fruit trees will reduce the potential for storm-related toppling and uprooting in the future. The deeper and more extensive the lateral root system the less likely the tree will topple, uproot, or lean after a windstorm. Root growth and establishment will be facilitated by loosening a large area of soil during the planting process. In sandy-type soils found throughout much of Florida, the planting hole should be 3 times the size of the container the tree came in. In Miami-Dade and Monroe Counties where the soil is often a rocky, limestone-based material, augering or excavating large holes or multiple holes is essential in establishing a root system with some ability to anchor trees in place.

Flooding potential before planting is an important factor to consider in south Florida. If there is a possibility of flooding, then consider bedding or mounding the soil, and choose flood-tolerant fruit species.

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Tools to have on hand include a lopper, a hand clipper and a hand saw, a pole saw, a shovel, a pick and a digging bar, and, if possible, a chainsaw with extra chains and fuel.

Before a storm, photographs of the landscape may be useful documentation, especially if the landscape is insured. Place a person in the photograph to show the size of the trees before the storm.

Post-Hurricane Practices Documentation

Post-storm documentation may be valuable for insurance claims where fruit trees cause damage to the home and the landscape, if the landscape is insured. Take photos of the damage to the home structures and fruit trees and, as with the pre-storm photographs, have someone stand in the pictures to provide scale. Write down the type of damage to each tree, e.g., toppled, wind-thrown, major limb damage, flooded, etc.

Immediate Sun Protection

Overheating of sun-exposed tree trunks and limbs (commonly called sunburn) is potentially a severe problem encountered when fruit trees are toppled or leaning after a storm. Immediately covering the upper, sun-exposed surface of the tree trunk, major scaffold limbs and exposed roots with detached (fallen) limbs and/or other debris will shade them from sunlight. Alternatively, immediately painting the exposed areas with a 50/50 mixture of white latex paint and water will reflect sunlight and keep the exposed surfaces from overheating due to excessive sun exposure.

Toppled Trees

Fruit trees that have fallen over but still have some root system in the ground and have leaf canopy remaining can be saved but are in danger of drying out (drought stress). Pruning to remove some but not all the canopy (maybe $\frac{1}{3}$ of what remains) will reduce the water demand of the tree by reducing the water loss from the tree.

Resetting Trees

Resetting large (15 ft tall or greater) trees requires large equipment such as a tractor or backhoe and may not be feasible for most home owners to do themselves. Hiring a licensed arborist or landscape contractor may be appropriate.

To stand up toppled trees that have part of the root system in the ground, reset the trees back to the same soil level they were before falling. Resetting steps include a) pull back the

soil from the area where the roots came out of the ground so the tree will reset at or near the soil level at which it grew before it toppled; b) remove badly broken roots (but try to leave as many as possible) and any tap roots that prevent the tree from resetting at or near the same soil level as before and; and c) cut back the top of the tree (the larger the tree the more you may need to cut in order to reduce the tree's top weight) in order to pull the tree up. It may also be appropriate to remove some (not all) canopy to reduce water demand and loss. When using equipment (truck, tractor, or backhoe) to stand a tree upright, use only cloth or rope slings because cable-wire or chain slings damage tree bark, and if they snap, they are very dangerous. Once the tree is standing, place one or more Y-shaped braces against the trunk to steady it. Braces may be made out of limbs pruned off or broken off damaged trees. Finally, after applying water to fill the excavated hole, fill in the reset tree with soil to cover the roots and again soak the root area with plenty of water. This should work for most large fruit trees.

Large trees that remain standing after the windstorm and that have retained some of their leaves may not need to be protected from sun exposure, or only parts of the tree may need to be covered or painted. However, even though these trees may have only a few broken limbs here and there and may look relatively sound, the root system most likely has been damaged to some extent, and you may begin to see drought stress symptoms, e.g., leaf wilting, fruit drop, stem and limb dieback. We recommend that a) if the tree has fruit, remove most or all of it, and b) remove $\frac{1}{3}$ to $\frac{1}{2}$ the canopy to reduce the water demands of the canopy on the reduced root system. In general, trees showing signs of drought stress that have fruit tend to decline and die at a greater rate than those with little or no fruit.

Recommendations for small trees that have fallen over include covering the trunk and major limbs with debris, removing $\frac{1}{3}$ to $\frac{1}{2}$ of the canopy, and resetting the tree to an upright position as soon as possible. Follow the same procedure for resetting used for large trees. Small trees that have not fallen over and that have retained their leaves and/or fruit should be monitored closely for signs of drought stress, an indication of root and/or trunk damage. As with large trees, it may be prudent to remove some or all of the fruit first, and if the tree continues to show signs of further decline, remove some of the canopy.

Flooded Trees

The tolerance to flooding or saturated soil conditions of tropical and subtropical fruit trees varies (Table 2). Some

fruit trees such as avocado and papaya may not withstand more than a day or two of saturated or flooded soil conditions. In contrast, mango trees may withstand several weeks and guava trees a week of saturated or flooded soil conditions.

Symptoms of flooding stress include dead roots, leaf and stem wilting, leaf yellowing and browning, leaf drop, stem and limb dieback, fruit shriveling and/or drop, and tree death. Fruit should be removed from trees with little to no tolerance to saturated soil conditions, and trees showing signs of flooding stress should have up to ½ the leafy tree canopy removed to reduce the stress imposed by soil conditions. Reducing the size of the canopy will improve the chances for tree survival.

Effect of Post-Storm Weather Conditions

The hurricane and tropical storm season in Florida lasts from June through November. The minimum and optimum temperatures necessary for tree growth of tropical and subtropical fruit trees vary (Table 3), but warm to hot weather with periodic rainfall after early and mid-season windstorms is generally conducive to new shoot and leaf growth and rapid recovery of the tree canopy, whereas cooler temperatures and less frequent rainfall after late-season windstorms, i.e., those in October through November, result in less canopy recovery and/or nutrient-deficient regrowth.

Weather conditions after a late-season hurricane may not provide enough hours above the minimum temperatures required for root, shoot, and leaf growth from November through March (Table 3 and Table 4). Water and nutrient uptake for many tropical/subtropical fruit crops are slowed or inhibited during cool weather thus making tree growth less vigorous and potentially nutrient deficient. Recovery from late windstorms may take 4 to 8 months longer than from early and mid-season windstorms.

Watering

Trees that remained standing after the storm with most of their canopy intact should be watered regularly (e.g., 2 to 3 times per week) to keep an adequate soil moisture level, especially during prolonged dry periods. Only trees showing drought symptoms should have ⅓ to ½ of the canopy removed to reduce tree water loss. For trees that have few to no leaves or that toppled and were reset, reduce watering until new shoots and leaves begin to emerge, and then resume regular watering. Do not overwater.

Fertilizing

Trees that remain standing after a storm with ⅓ or more of the canopy remaining should be fertilized frequently with small amounts of complete (nitrogen, phosphate, potash, magnesium) fertilizers. Once leaves emerge and are about half-grown, foliar micronutrients (zinc, manganese), and soil drenches of chelated iron materials should be made every 2nd or 3rd month until the leaves are full-grown. Once the new growth has matured, fertilize trees normally.

Trees with few to no leaves or with some of the canopy cut off by pruning should be fertilized with a reduced amount of fertilizer (e.g., if half the leaves are gone, reduce the rate by 50%). However, as the new shoots and leaves begin to emerge, use small amounts of fertilizer frequently. Trees that toppled and were reset should only be fertilized with a small amount of fertilizer as new shoots and leaves begin to emerge. Once the new growth has matured, fertilize trees normally.

Tree growth and recovery will be much slower after late-season hurricanes or tropical storms. To encourage healthy regrowth, more frequent light applications of complete fertilizers, foliar micronutrients, and soil drenches of chelated iron may be necessary.

Insect and Disease Control

Beetles that bore into the bark of damaged trees may be a problem after a tropical storm or hurricane. Typically trees undergo drought stress after a storm due to root damage. These beetles can sense trees under drought stress and attack the tree. The beetles inoculate the tree with a fungus that then colonizes the tree and kills it. Symptoms of bark-boring beetles include small holes along major limbs and/or the trunk with frass (excrement that resembles sawdust). Prune off dead or dying branches infested with borers and remove the debris from the landscape. The best remedy is to reduce the potential for tree damage and the chances of water and heat stress on the trees. That means annual pruning to reduce tree size and potential toppling and covering the exposed trunks and limbs of fallen trees as quickly after the storm as possible.

Weed Control

Due to the loss of tree canopy and the subsequent increase in soil light exposure, weeds may proliferate after a windstorm or hurricane. Weeds should be controlled manually or with approved herbicides to reduce the competition between the recovering tree and weeds for water and nutrients. Do not use residual herbicides because they may cause damage to the trees. Four to 6 inches of mulch

applied several inches from the trunk outward to the previous drip-line will assist in suppressing weed growth and help maintain soil moisture. Do not place mulch against the tree trunk. The bark and wood may rot if the mulch touches the tree trunk.

Hurricane Tolerance of Selected Tropical Fruit Trees

Abiu

There is very limited experience with abiu, but its hurricane tolerance may be similar to that of mamey sapote and caimito.

Atemoya and Sugar Apple

Strong winds generally result in leaning or toppled atemoya and sugar apple trees, and attempts to reset trees to an upright position are frequently unsuccessful. Generally, tree regrowth is slow and nutrient deficient, and trees may decline slowly over a long period of time. Replanting may be a better option if trees begin to decline.

Avocado

Avocado trees usually reset and recover well from hurricane wind damage and historically have resumed fruit production in 1 to 3 years after a storm. Avocado trees harvested before a storm event generally had less damage than those with fruit. Avocado trees exposed to flooding for more than a day or two generally declined or died.

Banana

In general, banana plants with fruit topple and the fruit is damaged or lost. However, banana plants recover well from hurricane damage because they regrow new pseudostems from the underground growing points.

Black Sapote

Black sapote trees tend to reset and recover well from hurricane damage. Fruit production generally resumed 1 to 2 years after a storm.

Cocoa

Those cocoa plants adjacent to structures for cold protection may be damaged but appear to regrow and resume pod production in 2 to 3 years.

Coffee

Coffee plants may be damaged by overhanging trees or limbs that fall. However, coffee plants tend to regrow and resume bean production in 2 to 3 years.

Canistel

Canistel trees generally reset and recover well from hurricane damage, and fruit production resume 1 to 2 years after a storm.

Carambola

Most carambola trees reset and regrow vigorously after a storm. Historically carambola trees resumed fruit production in 6 to 9 months.

Guava

Guava trees that were kept small typically remained standing after hurricane wind damage and resumed production in 6 to 9 months. Guava trees that toppled and were reset grew well and resumed fruit production in 1 to 2 years.

Jackfruit

The results of resetting jackfruit trees after hurricane damage have been mixed; some recover well, while others decline slowly. Severe dieback of branches should be expected.

Longan

Longan trees generally reset and recover well from hurricane wind damage and resume fruit production in 1 to 3 years. In some cases, regrowth occurs from the roots at the base of the tree, resulting in multiple trunks. Select one strong new shoot and eliminate the rest.

Loquat

Most loquat trees recover well from hurricane damage and resume fruit production in 1 to 2 years.

Lychee

The limb structure of 'Mauritius' is weak and brittle, and historically 'Mauritius' lychee trees sustain more limb damage than 'Brewster' trees. Results of resetting have been mixed, with some trees regrowing well and resuming fruit production in 1 to 2 years. Trunk splitting to the ground level is common. It causes severe damage and requires tree removal.

Mamey Sapote

Mamey sapote trees generally reset and regrow well after hurricane damage. However, those trees with major limb damage may not resume production for 4 to 5 years.

Mamoncillo

Most mamoncillo trees reset and regrow well after hurricane damage. However, those trees with major limb damage may not resume production for 5 to 6 years.

Mango

Resetting toppled mango trees has historically resulted in very mixed results; some trees declined, but others regrew well. This is because mango trees appear to be highly susceptible to sunburn. Fruit production may not resume for 1 to 3 years.

Pitaya

Pitaya vines may sustain damage along with the trellis system upon which they grow. Free-standing supports appeared to be more damaged than trellis systems. However, they appear to regrow from those plant parts left after the wind-storm.

Sapodilla

Sapodilla trees have historically withstood hurricane-force winds well. They usually resume fruit production in 1 to 2 years.

Summary

Hurricane damage to tropical and subtropical fruit trees in the home landscape may be minimized by annual or biannual pruning to reduce tree size and open the canopy to wind movement. Reset trees as soon as possible to reduce the potential for sunburn along the trunk, which results in weak tree regrowth, tree decline, or tree death. Keeping in mind their ultimate size, plant new fruit trees away from buildings, structures, and power lines to minimize damage to these structures. When deciding whether or not to reset a tree, base the decision on the size of the tree, and get professionally licensed arborists to handle medium to large trees. Trees exposed to flooding may need some of their canopy removed to increase the chances for tree recovery.

Adjust fertilizer practices when trees are damaged, emphasizing frequent, light applications of all plant nutrients. Adjust watering to the amount of tree damage and the weather conditions. Control insects to reduce further damage to the tree after a storm. Control weeds to prevent

competition between the tree and weeds for water and nutrients.

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Table 1. Recommended plant height for tropical fruit trees grown in the home landscape in Florida.

Common Name	Scientific Name	Recommended Maintenance Tree Height (ft)
Abiu	<i>Pouteria caimito</i>	8–12
Atemoya	<i>Annona cherimola</i> x <i>A. squamosa</i>	8–12
Avocado	<i>Persea Americana</i>	10–15
Banana	<i>Musa hybrids</i>	---
Black sapote	<i>Diospyros digyna</i>	12–15
Caimito (star apple)	<i>Chrysophyllum cainito</i>	8–12
Canistel (egg fruit)	<i>Pouteria campechiana</i>	10–12
Carambola	<i>Averrhoa carambola</i>	6–12
Cashew	<i>Anacardium occidentale</i>	10–12
Citrus	<i>Citrus</i> species	10–14
Cocoa	<i>Theobroma cacao</i>	6–8
Coconut	<i>Cocos nucifera</i>	---
Coffee	<i>Coffea arabica</i> , <i>C. canephora</i>	5–15
Guava	<i>Psidium guajava</i>	3–12
Jaboticaba	<i>Myrciaria cauliflora</i>	8–12
Jackfruit	<i>Artocarpus heterophyllus</i>	8–14
Longan	<i>Dimocarpus longana</i>	10–15
Loquat	<i>Eriobotrya japonica</i>	6–12
Lychee	<i>Litchi chinensis</i>	10–15
Macadamia	<i>Macadamia integrifolia</i> and <i>M. tetraphylla</i>	12–14
Mamey sapote	<i>Pouteria sapota</i>	12–15
Mamoncillo	<i>Melicocus bijugatus</i>	12–15
Mango	<i>Mangifera indica</i>	6–15
Pineapple	<i>Annanas comosus</i>	---
Pitaya	<i>Hylocereus undatus</i> and hybrids	---
Sapodilla	<i>Manilkara zapota</i>	12–15
Soursop	<i>Annona muricata</i>	8–12
Spondias	<i>Spondias</i> species	8–12
Sugar apple	<i>Annona squamosa</i>	8–12
Tea ^a	<i>Camellia sinensis</i>	5–6
White sapote	<i>Casimiroa edulis</i> and <i>C. tetrameria</i>	10–15

^a Not grown for its fruit; grown for its leaves.

Table 2. Flooding tolerance of selected tropical and subtropical fruit crops in the home landscape.

Tolerant	Moderately tolerant	Not tolerant
Caimito	Abiu	Atemoya ¹
Coconut	Banana ²	Avocado
Grafted citrus ¹	Canistel	Canistel ⁴
Guava	Carambola ¹	Cashew ⁴
Mango ⁵	Cocoa ⁶	Coffee ⁶
Sapodilla	Tahiti Lime	Jaboticaba
Spondias species ⁴	Longan ¹	Jackfruit
Soursop ⁷	Lychee ¹	Loquat ⁴
Black sapote ⁴	Macadamia ⁴	Mamey sapote
	Mamoncillo	Papaya
		Passion fruit ¹
		Pineapple
		Pitaya ⁹
		Sugar apple (anon)
		Tea ^{6z}
		White sapote

Sources:

¹ Syvertsen and Llyod;

² Stover and Simmonds;

³ Schaffer and Whiley;

⁴ Verheij and Coronel;

⁵ Whiley et al.;

⁶ Willson;

⁷ Núñez-Elisea et al.;

⁸ Bartholomew; and

⁹ Mejía Ruíz and Múnica.

^z Not grown for its fruit; grown for its leaves.

Table 3. Minimum temperatures for vegetative growth and optimum range of temperatures for growth of selected tropical fruits.

Crop	Range in Temperatures (°F) for	
	Shoot Growth	Optimum Shoot Growth
Abiu ¹	65	68–95
Atemoya ²	55	72–90
Avocado ³	55	65–82
Banana ⁴	65	78–86
Black sapote	60	70–90
Caimito (star apple)	65	72–90
Canistel (egg fruit)	65	70–90
Carambola ²	65	68–95
Cashew	65	70–95
Cocoa ⁵	60	65–90
Coconut ⁸	50	55–80
Coffee ⁵	55	59–75
Guava ²	60	73–82
Jaboticaba	55	60–86
Jackfruit	68	72–86
Longan ²	65	70–95
Loquat	50	60–80
Lychee ²	52	68–86
Macadamia ²	50	68–24
Mamey sapote	65	72–90
Mamoncillo	65	72–90
Mango ⁶	55	75–91
Papaya ³	65	70–90
Passion fruit ³	60	65–86
Pineapple ⁹	59	68–86
Pitaya ⁷	60	65–77
Sapodilla	55	70–86
Soursop	65	70–90
Spondias	65	70–90
Sugar apple ³	60	73–94
Tea ^{5z}	57	65–86
White sapote	50	60–80

Sources:

¹ Lim

² Schaffer and Andersen

³ Schaffer and Whiley

⁴ Stover and Simmonds

⁵ Willson

⁶ Whiley and Schaffer

⁷ Noble and Bobich

⁸ Romney

⁹ Malézieux, Côte, and Bartholomew

^z Not grown for its fruit; grown for its leaves

Table 4. Mean range and average ambient temperatures from September to August in the Homestead, Florida, area.

Homestead Area ^z	Ambient Temperatures (°F)	
Month	Range	Average
September	72–89	81
October	68–86	78
November	58–78	68
January	54–76	66
February	55–77	67
March	59–81	70
April	62–84	73
May	67–87	78
June	71–89	80
July	72–90	81
August	73–90	82

Sources: Data from July–Dec., FAWN site Homestead (<http://fawn.ifas.ufl.edu>) and the Southeast Regional Data Center, National Weather Service (<http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?fl4091>) 30-year ranges and averages for Homestead, FL (1971–2000).



PUBLICATION N°

ENH 1061

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Introduction

Planting and establishing trees is all about managing air and moisture in the soil. Manage these correctly and trees will grow quickly following planting. Three of the most common causes of poor plant establishment or tree death are planting too deep, under watering, and over watering. If appropriate trees are planted at the right depth and they are irrigated properly, the planting has a good chance of success. As simple as this appears to be, problems often arise that lead to poor establishment or plant failure.

Ten steps to proper tree planting

1. Look up for wires and lights
2. Dig shallow and wide hole
3. Find the topmost root and treat root defects
4. Carefully place tree in hole
5. Position top root 1-2 inches above landscape soil
6. Straighten tree
7. Remove synthetic materials
8. Add and firm backfill soil
9. Add mulch
10. Stake and prune if needed

Ten Steps to Planting Trees

Step 1

Look up

If there is a wire, security light, or building nearby that could interfere with proper development of the tree canopy as it grows, plant elsewhere or plant a tree that has a small canopy or a narrow canopy at maturity. Although small trees remain below the wires, they often have a short life span. If large trees are planted too close to wires, it increases costs of providing electrical service and reduces reliability. Consider moving wires or lights so a larger tree can be planted.

Step 2

Dig shallow and wide planting hole

To estimate the depth of the planting hole, measure the distance between the point where the topmost root emerges from the trunk and the bottom of the root ball. Then dig a hole slightly shallower than this distance (Figure 1). No more than about 2 or 3 inches of the root ball needs to be above the soil unless the site is poorly drained. If the soil is poorly drained, plant even higher. If the hole was inadvertently dug too deep, add soil to the bottom of the hole and compact it with your foot. If the hole fills with water as you dig it, position the bottom of the root ball above the water and mound soil to cover the sides of the ball.

Make the hole at least 1.5 times the diameter of the root ball (Figure 2). Wider holes should be used for compacted soil and wet sites. This helps roots from becoming deformed by the edge of the hole in compacted or clayey soils. Breaking up compacted soil in a large area (out to the drip line of the tree) around the tree provides the newly emerging roots room to expand into loose soil. This will hasten root growth translating into quicker establishment. Do not underestimate the positive effect this technique has on tree establishment in hard soils.

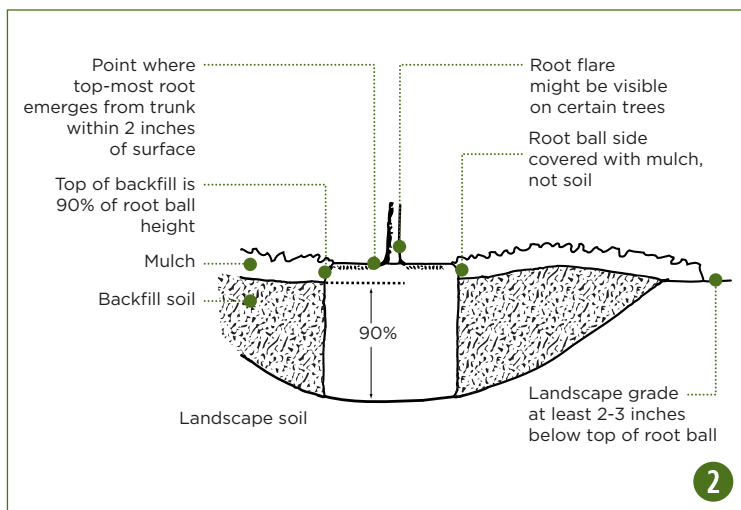


Figure 1

In well-drained soils, the planting hole depth should be 90-95% the distance between the topmost root and the bottom of the root ball.

Figure 2

The planting hole should be at least 1.5 times the diameter of the root ball, but a wider hole is better.

Step 3

Find the topmost root and treat defects

Choose a tree whose topmost root emerges from the trunk visibly, at or slightly above the surface. Not all root balls come from the nursery like that. In the highest-quality root balls, the point where the topmost root emerges from the trunk should be within 2 inches of the surface (Figure 3). The topmost roots and root flare (if present) in poorer quality root balls are buried down inside the root ball. Trees whose topmost roots are too deep in their root balls have less of a root system than trees whose topmost roots emerge near the surface. If you cannot see the topmost root, remove excess soil to expose it before you plant the tree. As the distance between the topmost root and the soil surface increases, the percentage of the root system harvested from the field nursery decreases.

To check for root defects such as circling and kinked roots in containers or field-grown trees, you might have to displace or remove soil and media from the top of the root ball, especially near the trunk. Cut or spread out any circling or kinked roots growing up above the topmost root. This will prevent these roots from strangling the trunk in the future.

Circling roots can be found on container-grown trees, field-grown (balled-in-burlap, or B&B) trees, or bare-root trees. Eliminate this defect by cutting roots at planting. This can be accomplished on B&B or container trees with pruners before trees are placed in the hole (Figure 4) or by slicing the edge of a container root ball from top to bottom with a balling spade after trees are in the hole. Cut roots that are kinked or any that circle the top of the root ball. If these cut roots are large (larger than about 1/3 trunk diameter), the tree might shock and could die. Be sure to look for roots that circled when trees were in a smaller container. These are difficult to cut because they are hidden in the interior of the ball. Buy from a quality grower to avoid this.

Circling roots do not always result in trunk girdling, however trees may develop a severe lean after a wind storm due to an issue with circling roots (Figure 5). Because few, if any, branch roots develop on the outside of a circling root there may be no support on that side of the



Figure 3

In high-quality root balls, the topmost root emerges within 2 inches of the surface. In the tree shown above, the topmost root is visible at the surface.



Figure 4

Cut roots that circle the outside of the ball. This will not stress the tree if roots are small or if the tree is not overgrown in its container. New roots will grow quickly into backfill soil following cutting, and stem-girdling roots are less likely to form. Roots can be cut with pruners or a balling spade.



Figure 5

This elm tree developed a lean after a storm due to lack of support roots. Support roots have a difficult time stabilizing the tree when circling roots are present.



tree. Cut the circling root at the point before it begins to circle. This will prevent new roots that emerge from the cut from circling the trunk again.

Step 4

Carefully place tree in planting hole

To avoid damage when setting the tree in the hole, lift the tree with straps or rope around the root ball. Do not lift it by the trunk. Special strapping mechanisms need to be constructed to carefully lift trees out of large containers and to handle large B&B trees to prevent bark damage on the trunk and branches. B&B trees should be handled by the root ball. Remove any plastic wrapped around the root ball before planting. If you measure carefully, the root ball will not have to be removed from the planting hole to adjust hole depth. Trees planted from containers may settle more than B&B trees, so you may want to position these an inch or two higher. Larger containers appear to settle more than smaller containers.

Step 5

Position the topmost root 1 to 3 inches above the landscape soil

Position the topmost root about even with or slightly above (about 2 inches above) the top of the landscape soil in well-drained soil. Plant even higher in soil that drains poorly.

Most horticulturists agree that it is better to plant the tree too high than to plant it too deep. Lay a shovel across the top of the planting hole to check root ball depth. If the tree is too deep in the hole, remove it from the hole and firmly pack soil in the bottom of the hole to raise the root ball. If it is only a little bit too deep, tip the ball to one side and slide some soil under it; then tip it back the other way and slide some more soil under the ball. Continue this until it is set at the appropriate depth. Once it is at the appropriate depth, place a small amount of soil around the root ball to stabilize it. A large body of research and experience shows that soil amendments are usually of no benefit. The soil removed from the hole makes the best backfill unless the soil is poor or contaminated.

Step 6

Straighten the tree in the hole

Before you begin backfilling have someone view the tree from two directions perpendicular to each other to confirm the tree is straight. Fill in with some more backfill soil to secure the tree in the upright position.

Once you add large amounts of backfill, it is difficult to reposition the tree.

Step 7

Remove synthetic materials

String, rope, synthetic burlap, strapping, plastic, and other materials that will not decompose in the soil must be removed at planting. Synthetic burlap melts into plastic goo, while real burlap flames and turns to ash when lit. If burlap is synthetic, be sure to remove all of it with a pruner, knife or other sharp blade. Roots grow through artificial burlap with little difficulty, but as the roots attempt to expand in diameter, they become girdled or strangled (Figure 6). Artificial and synthetic burlap is not commonly used in the southeastern U.S.

Many contractors leave the treated burlap commonly used by field growers pinned in place. This seems to be all right as long as the topmost root is not too deep and there are no root defects to treat. However, removing burlap from the top of the ball allows you to check for root defects including deep planting in the root ball and circling roots.

Baskets made from wire are typically used to help keep a root ball intact during shipping and handling. Some people attempt to remove some or all of the wire from wire baskets before backfilling; this may void any guarantee that came with the tree. There is no research documenting the detrimental effects of wire baskets on trees. If you decide to remove wire, do so after the tree is positioned in the hole. Stake the tree to stabilize it.



Figure 6

This synthetic burlap is still intact 10 years after planting. Each of these roots is very easy to break off at the burlap because there is very little wood that developed through the synthetic material. Roots grow easily through natural treated burlap so this does not need to be removed from the sides of the ball. Never use synthetic burlap.

Step 8

Add backfill and firm the backfill soil

Slice a shovel down into the backfill 20 to 30 times all around the tree as you add backfill soil. Attempt to break up large soil clumps as much as possible. Do not pack the backfill, instead step firmly on the backfill soil to help stabilize the root ball (Figure 7). When the planting hole is filled with soil, the root ball should remain 1 inch (small trees) to 3 inches (larger trees) above the backfill soil. Do not over-pack the loosened soil, especially when soil is wet.

Add 10 to 20 gallons of water to the root ball and backfill. Fill in any holes or depressions with additional backfill soil. Do not firmly pack backfill soil in an attempt to eliminate air pockets because this could cause too much soil compaction, especially in clay soil. The water infiltrating the backfill soil will eliminate many of the large air pockets. The presence of small air pockets could even be of benefit because they could allow more air to reach the roots.



Figure 7

The root ball is now surrounded by about 18 inches of loose soil on all sides. No soil was placed over the root ball (top). Never place soil over the root ball (bottom). This places the tree too deeply.

Step 9

Cover sides of the root ball with mulch

Provide a 3-inch-deep layer of mulch around the tree (Figure 8). Mulches reduce soil temperature fluctuations, prevent packing and crusting, conserve moisture, help control weeds, add organic matter to the soil, and improve the appearance of the landscape. Generally, a 2 to 3 foot diameter circle of mulch per inch of tree trunk caliper will give adequate mulch area for newly planted trees (Figure 9). A thin (1 inch) layer of mulch can be placed over the root ball for aesthetic reasons, but deep layers on the root ball can prevent adequate irrigation and rain from reaching roots. Keep turf as far away from the trunk as possible with mulch or herbicides to aid tree establishment, to prevent mower damage to the trunk, and to prevent soil compaction.

Common mulch materials include leaves, pine needles, compost, bark, and wood chips. Peat and cypress chips should not be used since once dry they are very difficult to wet and may restrict water movement into the soil. Inorganic materials such as gravel and crushed stone have been used. They provide no organic matter, are

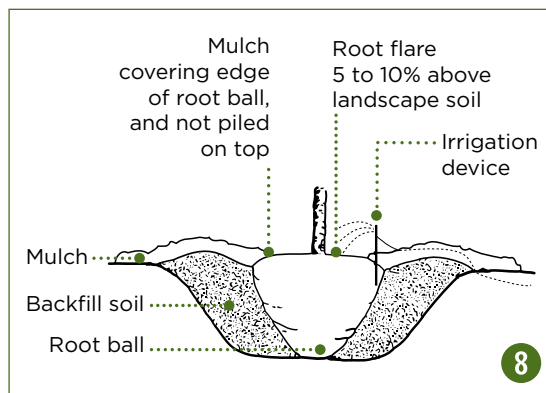


Figure 8

Proper installation showing recommended position of mulch and irrigation device.



Figure 9

Note that the edge of the mulch is beyond the edge of the canopy. This allows for the tree roots to expand without competition from turf roots. This also prevents soil compaction, which restricts root growth.

difficult to keep tidy and clean, and often work their way into the soil.

If turf grass grows up to the trunk, trees often perform poorly. Turf and weeds rob trees of moisture and nutrients and some produce chemicals that inhibit tree growth. Lawn mowing equipment often damages the trunk when mowing turf close to the trunk. This is a good way to kill trees.

Never pile mulch in a volcano-like manner against the trunk (Figure 10). This can rot the trunk, cut off oxygen to roots, keep vital irrigation and rain water out, and can keep roots too wet in poorly drained soils. Roots grow up into this pile of mulch because it is very well aerated and moist. Stem-girdling roots form from this on some trees and cause stress and decline.

If you believe a berm is needed to hold water from a high volume delivery system such as a hose or water truck, use mulch, not soil to construct a berm at the edge of the root ball. If soil is used to construct the berm, it can wash over the root ball and bury the roots too deeply. Plastic edging has also been used to keep water in so it all percolates through the root ball. The berm will ensure that water penetrates to where it is needed most, i.e. in the root ball. If soil is sandy or very well drained, a berm may not be needed. The berm should be removed once the tree is established. Do not push the berm onto the root ball and trunk since this can cause root defects.

Step 10

Stake and prune if needed

Stake the tree if necessary to hold the root ball firmly in the soil. If the root ball moves in the wind, emerging roots could break and trees will establish slowly. Staking to hold a thin, weak trunk upright should not be necessary on trees with a trunk diameter more than about 1.5 inches. If large trees require staking to prevent the trunk from bending, it probably indicates a lesser quality tree. Smaller trees might require staking until enough trunk strength develops.

Figure 11 shows traditional staking systems. The system shown on top consists of three short stakes (2 shown) attached to the trunk with straps. The center system consists of three short



Figure 10

Never mulch in this manner. Deep mulch on the root ball and against the trunk leads to poor establishment, root defects, stress, decline, and in some cases death. Some rodents, such as voles, can also cause damage to the trunk easily if mulch is piled there. Trees could decline from this problem.

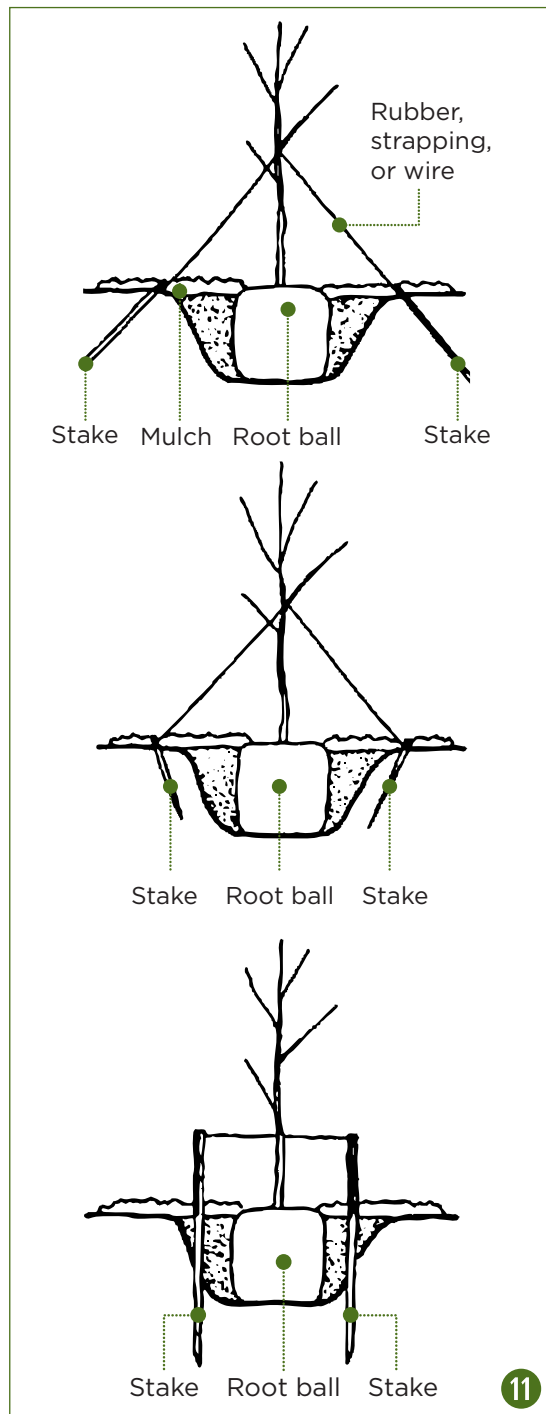


Figure 11

Traditional staking systems require removal within one year after planting. They do not appear as effective as newer designs.

stakes (2 shown) driven into soil in a traditional manner attached to the trunk with stretchable material. The system shown on bottom consists of two or three two-inch by two-inch wood stakes driven through the backfill soil. Recent research shows that stakes driven straight into the ground, not at an angle as shown in Figures 12 (left and center), are most secure in the soil. All three traditional systems require removal within about one year after planting. Figure 12 shows a stiff staking system. These hold trees upright in strong winds, but can restrict growth below the securing point if left on too long.

Root stabilization systems do not need to be removed because they decay within a few years (Figure 13). One system consists of one horizontal two-by-two screwed to two vertical, four-foot-long two-by-twos against the side of the root ball (Figure 13; top and center). Our research shows that these root stabilization systems work very well and are better able to hold trees against strong winds than traditional systems shown in Figure 11.

Prune to remove or reduce stems that compete with the main leader if no pruning is planned in the next couple years. Wait until later if there is pruning planned in the next two years. Broken branches should also be pruned, but do not over-prune to compensate for root loss.

Establishing Trees

Irrigation and Mulch

The establishment period is the time it takes for a tree to regenerate enough roots to stay alive without irrigation. During this period, shoots and trunk grow slower than they did before transplanting. When their growth rates become more or less consistent from one year to the next, the tree is considered established.

In moist climates, by the end of the establishment period a tree has regenerated enough roots to stay alive without supplemental irrigation in a landscape where roots can expand uninhibited by urban structures. In the drier parts of central and western US, the turf and landscape irrigation system may have to supplement rainfall to provide enough water for survival after establishment. Establishment rate is determined by a number of factors (Table 1).

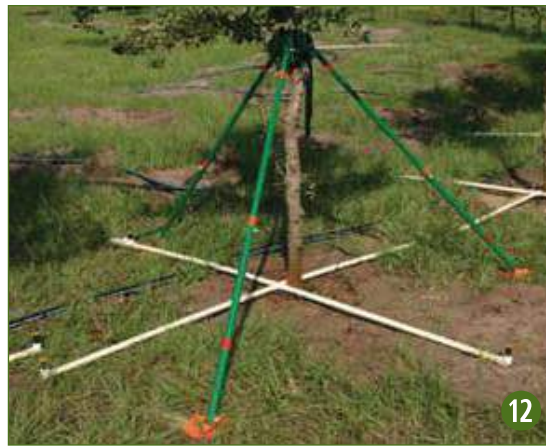


Figure 12

Stiff stabilization systems such as the Brooks Tree Brace work better than systems in Figure 11. Do not leave these on too long since trunk diameter may develop poorly below the securing point.

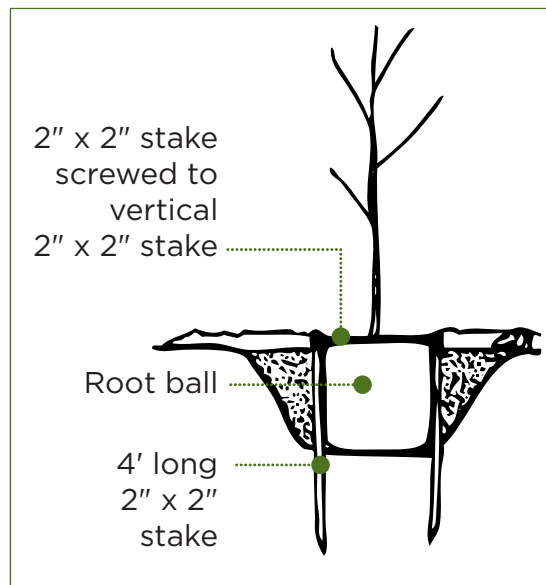


Figure 13

A simple system comprised of untreated two-by-two lumber is inexpensive, easy to install, and a very effective way to stabilize trees in strong winds (top and middle). The Terra Toggle system (bottom) is also very effective for stabilizing trees. There is no danger of trunk girdling in these systems since nothing is attached to the tree.



Table 1. Establishment rate is determined by many factors.

ENCOURAGES GROWTH	LIMITS GROWTH	LITTLE OR NO EFFECT
loose soil	compacted soil	peat or organic matter addition as backfill
proper irrigation management	little or no irrigation	root stimulant products
mulch 8 feet in diameter or more around planting hole	grass and weeds close to trunk	fertilizing at planting
root flare slightly above soil surface	planting too deeply	adding spores of mycorrhizae*
leaving top of tree intact	pruning at planting	water absorbing gels

* Can enhance growth on seedlings under certain circumstances, but does little for landscape-sized trees.

During establishment, trees should be irrigated 2-3 times weekly with 2 gallons per inch trunk caliper. All this water should be applied only to the top of the root ball. Daily irrigation will keep trees healthier. Research shows that frequency of irrigation has a greater affect than irrigation volume (Table 2). This means that you can not make up for lack of frequency by adding large volumes less frequently. Daily irrigation may or may not be necessary when planting in winter, cool climates, or during rainy weather. Irrigation frequency can be reduced to 2-3 times each week instead. Never apply irrigation if the soil is saturated.

Table 2. Irrigation schedules depend on size of nursery stock and desired objective*.

SIZE OF NURSERY STOCK	IRRIGATION SCHEDULE FOR	
	VIGOR	SURVIVAL
Less than 2 inch caliper	Daily: 2 weeks Every other day: 2 months Weekly: until established	Twice weekly for 2-3 months
2-4 inch caliper	Daily: 1 month Every other day: 3 months Weekly: until established	Twice weekly for 3-4 months
greater than 4 inch caliper	Daily: 6 weeks Every other day: 5 months Weekly: until established	Twice weekly for 4-5 months

* Establishment takes approximately 3 months (hardiness zones 10-11) to 4 months (hardiness zones 8-9) per inch trunk caliper.

During establishment mulch should be maintained to control weeds and protect the trunk. Weeds can also be controlled with herbicide. Increase mulch diameter over time to keep pace with root growth for best establishment. Roots normally grow 3 to 10 feet

in length the first year after planting. Soil compaction should also be minimized during establishment to allow adequate root expansion. This is best accomplished with wide mulch areas. If staking systems have not been removed, remove them about one year after planting to prevent trunk girdling but keep mulch off the root ball (Figure 14).



Figure 14

Keep mulch off the root ball to discourage formation of stem girdling roots. The trunk flare should be visible as in this photograph.

Root Management

Trees with roots that are touching or circling the trunk (Figure 15, bottom) instead of growing straight away (Figure 15, top) stress the tree by reducing or eliminating vascular flow where the root contacts the trunk. Stress increases with time and can lead to trunk or root decay, or a decline in health.

This can be corrected by removing the root defect, but root removal also stresses the tree. But the stress from root removal will only last for a relatively short period and will decrease with time as the tree recovers from lose of roots. If the cambium has not been permanently damaged where the root touched the trunk then normal vascular flow can return. Irrigation management during this recovery time is likely to reduce stress and help the tree recover in dry soil. You must judge whether eliminating stress by removing the defect outweighs the temporary increase in stress brought on by root removal. Typically, removing the defect is best for the tree.

Certain species such a maple, magnolia, holly, mahogany, gumbo limbo, and tabebuia appear especially sensitive to this defect; however, any tree can be affected by circling or stem girdling roots. Some arborists routinely remove roots that might be one-quarter of the

trunk diameter, or even larger. Cut roots at the point where they begin to circle so new roots that grow from the cut will point more-or-less away from the trunk.

If the defective root circles more than half the trunk diameter and is embedded into the trunk (Figure 16) give careful consideration to whether removal will help the tree. Some defects are so severe that removal may not be possible; or the defect might have already killed the cambium on that side of the tree. Check by carefully penetrating the trunk tissue just above the root defect to see if the tissue is green or brown. If you find no live green tissue on a large portion of the circumference of the trunk then that portion of the trunk is dead and treatment may be futile.



Figure 15

(Top) Roots should grow straight from the trunk for the best health and stability. (Bottom) This trunk will become girdled causing decline and tree death if this root is not removed. Cut it just behind the point where it begins to circle the trunk. Following pruning, the remaining root segment should be straight out from the trunk.

Figure 16

A severe stem girdling root such as this one will be difficult to remove. Portions of it can be cut without removing it.



Additional Resources

Landscape Plants

<http://hort.ifas.ufl.edu/woody/planting.html>

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SELECTING QUALITY TREES FROM THE NURSERY



PUBLICATION N°

ENH 1060

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Introduction

Tree selection does not end with choosing the appropriate species or cultivar for the planting site. Suitable nursery stock must be chosen based on planting site conditions and intended after-care, which should dictate maximum tree size at planting, root ball characteristics, appropriate tree production method, and tree structure.

Nursery stock must be inspected carefully to pick high quality trees. Pay particular attention to roots. Trees of poor quality may be inexpensive, but might perform poorly in the landscape. Quality factors to evaluate include root ball defects, size, shape, and

structure of the canopy, nursery planting depth, presence of included bark, trunk form and branch arrangement, pruning cuts, presence of pests and disease, leaf color, top die-back, clear trunk length, and canopy uniformity.

Important considerations for selection

There are advantages to selecting good quality nursery trees. Good quality trees are more likely to survive post-planting, establish more quickly, and live longer in the landscape. Choosing a good quality tree also can reduce the likelihood of failure from structural defects during a hurricane. Defects in the trunk and branch structure are easier to correct than defects in the root system. This makes it very important to choose trees from a grower with a demonstrated capacity to produce good root systems. Smart buyers evaluate root systems thoroughly.

Production method

To ensure greater transplant survival, choose trees grown in the nursery production system best suited for the characteristics of the planting site. Under ideal conditions, i.e. well-drained and irrigated soil, production methods perform about equally well. However, if irrigation capabilities will be limited, the production method best suited for the site is an important consideration.

There are three main types of production methods: container, field-grown (balled-in-burlap or B&B), and bare root (Figure 1). Container trees are grown above ground in plastic, metal, wood, or fabric; pot-in-pot in the ground; or in fabric containers in the ground. B&B trees are grown in field soil, then dug with a tree spade and secured in wire and burlap. Bare-root trees are rarely marketed in the southeastern U.S. including Florida. Bare-root deciduous trees are dug from field soil and receive no media covering on the roots; they are usually available only when dormant and in a limited size range.

Table 1 compares production methods with typical root ball weights and staking requirements. For example, trees produced in containers typically have a light root ball and frequently require staking, whereas B&B trees have heavy root balls, so they require staking less frequently.



Figure 1

Container-grown trees (top) and B&B trees (bottom) are the main types of nursery production methods in the southeastern U.S. Several different container types are shown; roots growing through burlap in the field-grown tree indicate a high-quality hardened-off tree.

Table 1. Choose among tree production methods based on weight and staking capabilities.

PRODUCTION METHOD	ROOT BALL WEIGHT	NEED FOR STAKING
Container above ground or pot-in-pot	light	frequently
Fabric containers in ground	light	usually
B&B* not root pruned	heavy	sometimes
B&B* root pruned	heavy	sometimes
Bare root	very light	usually

*B&B = field grown

Trees perform best when irrigated frequently after planting. If irrigation can be applied to the root ball twice weekly or more often, the production method may have little impact on tree survival. For landscapes where irrigation is less frequent, much of the research shows that it is best to install B&B trees that were root pruned during field production and dug at least several weeks before planting to the landscape (Table 2). These trees are referred to as “hardened off” (Figure 1, bottom) and frequently have new roots growing through the burlap. Root pruning live oak and some other trees during production provides a product that is slightly smaller, has a denser, more fibrous root system, has a more uniform root system (Figure 2), and transplants more successfully. Oaks grown in certain soil types may need less frequent root pruning than in other soil types, although this has been not been thoroughly documented.

Certain trees that are dug from sandy, well-drained soil without prior root pruning suffer more shock in the landscape, especially when not sufficiently watered. Some trees such as crape myrtles, maples, birches, hollies, and others are not routinely root pruned like oaks. In many instances, these seem to perform fine without root pruning due to their naturally dense root system.

Table 2. Live oak¹ survival in the landscape can depend on the production method and irrigation practices after planting.

PRODUCTION METHOD	SURVIVAL WITH FREQUENT IRRIGATION AFTER PLANTING	SURVIVAL WITH INFREQUENT IRRIGATION AFTER PLANTING
Container above ground or pot-in-pot	very good to excellent	fair
Fabric containers in ground	very good to excellent	poor to fair
B&B not root pruned	fair to good	poor to fair
B&B root pruned	very good to excellent	good
Bare root	very good to excellent	good

¹ Research performed on live oak in sandy, well-drained soil. Other species and trees grown in different soil types may perform differently.

Maximum size at planting

The maximum size nursery stock suited for a particular planting site should be determined by the irrigation capabilities after planting, as well as the climate and site drainage. Smaller nursery stock should be used where irrigation can not be provided for the recommended period of time. Nursery trees larger than 2 inch caliper can be poorly suited for wet sites because roots in the bottom of the root ball can become submerged in water. This may stress the trees by killing the deeper roots in the root ball, which can prevent the tree from growing for several years after planting. Smaller nursery stock is the better option for poorly drained sites because they have a shallow root ball. If large trees are necessary, then trees with shallow root balls (trees grown in low-profile containers, Figure 3) should be selected, or trees can be planted 10 to 30% above grade and soil gently mounded to cover sides of the root ball. Smaller trees can be better suited than larger trees to compete with weeds for limited water availability, especially when weeds are not controlled with mulch or chemical applications.



Not root pruned



Root pruned one year



Root pruned two years



3

Figure 2

Root pruning can dramatically increase the amount of fine roots and reduce the size of the largest roots in live oak. This combination results in trees that are less stressed when they are planted into the landscape. More research is needed for other species.

Figure 3

These shallow and wide (low profile) root balls are well suited for planting in poorly drained and compacted soil because all roots are shallow and will be positioned mostly above standing water in the landscape. Trees grown in these containers should have fewer root defects than traditionally shaped root balls.

Smaller nursery stock (Figure 4, top) has a shorter establishment period because roots come into balance with the top in the first 6-12 months after planting. Large nursery stock such as the 6-inch-caliper tree pictured in Figure 4 (bottom) requires much more time to become established. This makes it susceptible to dying from drought for a longer period after planting. It can take up to three years for a 6-inch-caliper tree to become established. Unless plenty of water can be supplied, it may be best to plant smaller nursery stock.

Root ball dimensions

The shape and depth of the root ball may be an important consideration for poorly drained soils. Root balls of any shape perform equally well in well-drained soil. Tall root balls help keep deeper roots moist. Wide and shallow root balls are better suited for planting in poorly-drained and compacted sites but dry more quickly on well-drained sites (Figure 3). Again, irrigation and site drainage are important considerations. A tall root ball may be more appropriate if irrigation will be infrequent or the site soil drains quickly because the deep roots stay moist longer.

Root collar location

The area where the topmost roots meet the trunk is referred to as the root collar or root flare. If it is buried too deeply in the root ball, the tree could decline over time due to lack of oxygen for the root system. Trees can also decline from roots growing over the flare and forming stem-girdling roots. If the trunk emerges from the soil like a telephone pole, without any swelling or root flare, then soil should be excavated away from the trunk base to determine where the root flare is located (Figure 5). Remove soil or media around the base of the trunk until you locate the root flare or the area where the top most roots emerge from the trunk. The topmost major root should be no deeper than one inch from the surface of the root ball (Figure 5, bottom).

Do not purchase trees that were planted too deeply (Figure 6). If you have already purchased one, soil, media, and roots growing above the original topmost root should be mostly removed prior to planting.



Figure 4

Smaller nursery stock (top), have a shorter establishment period than larger nursery stock (bottom).



Figure 5

The point where the topmost root attaches to the trunk in the top photo is slightly above the soil surface. This is fine and indicates that the tree is not planted too deeply in the root ball. Root flare can be under the surface an inch or so; but problems can arise if it is much deeper (bottom). Root flare needs to be at or above landscape grade when planted.

Root defects

Root ball defects can occur on any tree regardless of the production method. Once formed, these severe defects close to the trunk are time consuming or impossible to correct and can reduce the capacity of landscape plants to survive and grow. These problems are difficult to spot because they can be buried inside the root ball (Figure 7). Types of root defects include circling roots, kinked roots, stem girdling roots, and root-bound trees.

Trees with severe circling roots should not be planted (Figure 7). Roots circling close to the trunk can eventually slow growth and girdle the trunk. Circling roots at the top of the root ball are especially troublesome. Few roots grow from the outside edges of circling roots, making the tree unstable and more likely to blow down during hurricane-force or even lesser winds.

Kinked roots are roots that have been deflected and turned back on themselves almost 180 degrees. They occur mostly when roots are folded into a propagation tray or container at the liner stage. Water and sugars have a difficult time passing this severe turn in the root, and kinked roots do not provide the mechanical support straight roots do. Kinks in small roots are much less of a concern than kinks in a large root (Figure 8).

Stem-girdling roots are formed when new roots grow perpendicular to a cut root, or when the tree is growing in a container too long. As the trunk increases in diameter, these roots may meet the trunk and begin to strangle it, hence the term stem-girdling roots. The trunk may become severely indented where the root was girdling it; this can cause trunk and root decay, which reduces the tree's ability to stand up, especially in a hurricane (Figure 9).

Root-bound trees have many roots circling around the outside of the root ball (Figure 10), which causes a physical barrier, sometimes preventing the tree from spreading roots into the landscape soil after planting. All these roots should be cut when trees are potted to a larger container and when planting to the landscape.

Examples of poor root systems



Figure 6

This tree is planted too deeply in the root ball. The root flare is 5 inches below the surface. The many roots growing over the root flare will cause problems later.



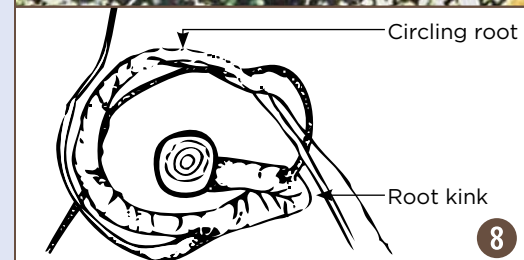
Figure 7

Circling roots develop when trees are grown in containers for too long, causing roots to be deflected by the container wall and to circle the outside of the root ball (top). Roots that circle when trees were in a smaller container are more difficult to detect because they are not on the edge of the current root ball (bottom).



Figure 8

Kinked roots can slow growth or even kill the tree as it grows.



A quick test can be performed to check root quality. When you push the trunk back and forth, the trunk on a good quality tree will bend along its length and will be firm in the soil or medium. The trunk on a tree with a defective root system will often pivot at its base and will lean over quite a way before it bends (often caused by circling roots when a tree was in a smaller container) (Figure 11). While passing this test does not eliminate trees with root defects, it is a good way to determine if there are severe defects close to the trunk.

Root ball caliper: height relationship

The American National Standards Institute and Florida Grades and Standards for Nursery Stock recommend minimum root ball sizes for nursery-grown trees based on trunk diameter or tree height, and the different kinds of containers they were grown in (Table 3). For instance, a field-grown tree with a trunk caliper of 3 inches should have a minimum 32-inch-diameter root ball and should be between 12 and 16 feet tall. Adhering to these standards helps trees to establish successfully in the landscape.

Table 3. Minimum root ball diameter and minimum/maximum tree height for trunk caliper.

TRUNK CALIPER ¹ (INCHES)	1	2	3	4	5
MIN. BALL DIAMETER ON FIELD-GROWN SHADE TREES	16	24	32	42	54
MIN. BALL DIAMETER ON FABRIC- CONTAINER- GROWN TREES	12	18	20	30	36
MIN. CONTAINER SIZE (GALLONS)	5	20	45	95	95
MIN. TREE HEIGHT ON STANDARD TREES	6	10	12	14	--
MAX. TREE HEIGHT	10	14	16	18	--

¹ Caliper is trunk diameter 6 inches from soil surface unless diameter is greater than 4 inches, in which case it is measured at 12 inches from soil surface.



Figure 9
A stem-girdling root (bottom) caused this pine tree to blow down during a tropical storm. The root caused all roots on that side of the tree to die, resulting in trunk decay. There were few roots to hold this tree up in 60-mph winds.



Figure 10
There are too many roots circling the root ball edge (left). Cut before planting by making 6 slices with a sharp blade from the top of the root ball to the bottom several inches deep inside the ball (right). This will slice through roots circling the outer edge of the root ball and will cut through larger roots circling from when the tree was in a smaller container. If defects are severe, it may be difficult to cut roots.



Figure 11
This quick test checks for root quality defects close to the trunk.

Trunk form and branch structure

Choosing a nursery tree with good structure can postpone future pruning and maintenance. Trees with poor structure could require more pruning cuts, and a greater portion of the canopy will have to be removed to correct defects.

Shade trees of lesser quality have two or more trunks. Best quality shade trees have one dominant trunk (Figure 12). Multiple leaders represent weakness and can cause the tree to split apart as it grows. Some smaller ornamental trees such as crapemyrtle, ligustrum, wax myrtle, and others naturally have multiple trunks and this does not have to be corrected. Major branches and trunks should not touch, and branches should be less than $\frac{2}{3}$ trunk diameter (Figure 13).

Other factors influencing tree quality

Though the qualities of the root ball and tree structure are the main considerations, there are some other important factors. Tree wrap should be removed so that the trunk can be inspected for hidden wounds. The trunk can be rewrapped after inspection to prevent wounding during shipping. Trees with large trunk injuries should be avoided.

Canopy uniformity is less important than trunk form and branch arrangement. However, a uniform canopy represents a detail accomplished by attentive growers. Trees with an irregular canopy, one dominant trunk, and good branch arrangement are far better than trees with a uniform canopy and a double trunk with included bark (Figure 14). The canopy on well-structured trees will fill in as the tree grows. Canopy fullness depends on the tree species or cultivar in question. Thin canopies do not necessarily mean that the trees are poor quality, diseased, or infested with insects, since species and cultivars vary greatly in this characteristic. Some trees, such as trumpet tree, Shumard oak and gumbo limbo, are naturally thin when they are young.

Evaluate pruning cuts to determine the quality of the nursery stock. Properly made pruning

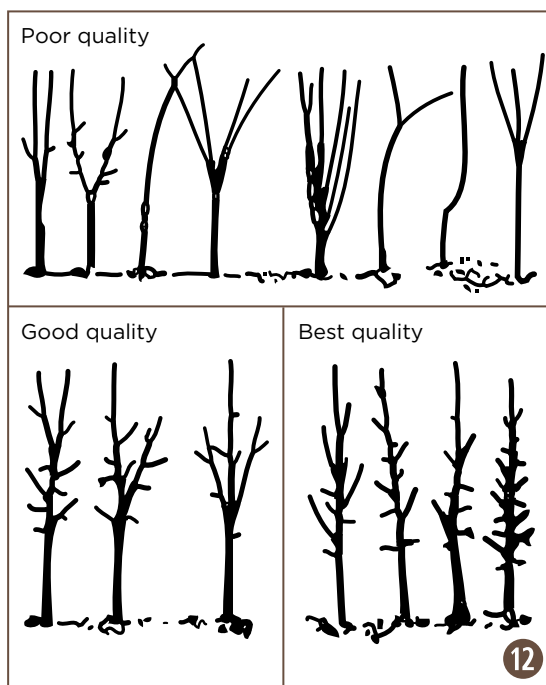


Figure 12

Poor quality shade trees have multiple leaders that weaken the strength of the tree. This makes the tree susceptible to hurricane-force winds (only trunk and main branches are shown).

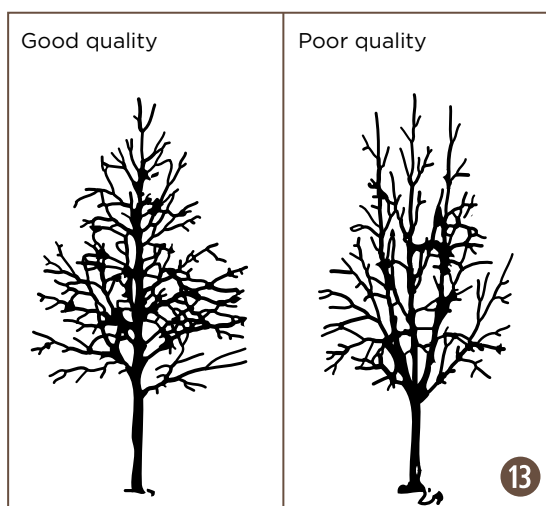


Figure 13

Trees with one dominant trunk (left) are better quality than trees with multiple upright trunks (right).

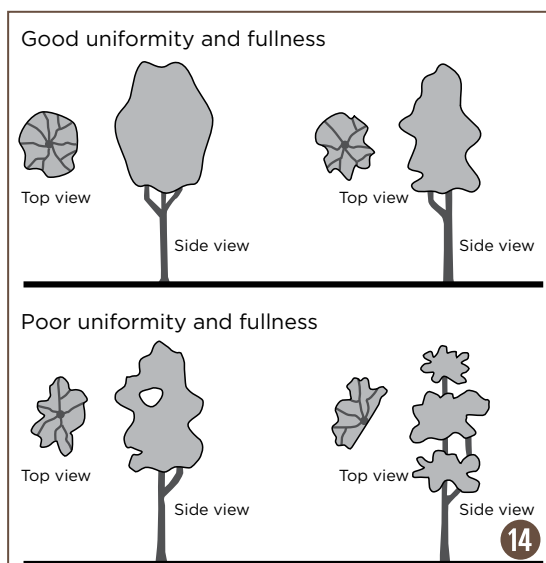


Figure 14

Trees with inferior canopy uniformity may have poor branch structure and may grow poorly in the landscape. However, some trees such as mahogany and trumpet tree are naturally more open and thin.

cuts indicate that the nursery has high pruning standards and is capable of growing high-quality trees (Figure 15). Improper cuts indicate a poor understanding of tree care and biology.

FOR MORE INFORMATION »	
ON PROPER PRUNING CUTS	CH 12 Developing a Preventive Pruning Program in Your Community: Young Trees

Trees propagated from plants in the same area as the planting site are likely to be perfectly adapted to the climactic conditions of the site; such trees are rarely available. Tree cultivars have been developed and varieties have been selected for tolerance of cold temperatures, high soil pH, drought, pests and diseases, etc. that are well suited to a wide range of planting sites.

Other concerns are foliage color and staking. Foliage can be discolored for a number of reasons. Discoloration can be a result of nutrient deficiencies. Stakes should be removed from trees before purchasing to assure that the trees can stand unassisted if caliper is more than 1.5 inches.

Figure 16 shows good quality field and container trees. Trees have one dominant trunk, the branches are not crossing, and the canopies are full and uniform. Trees of good quality are more likely to withstand strong winds in the event of a hurricane or tropical storm.

For more information, visit:

American National Standards Institute (ANSI)

<http://www.ansi.org/>

Florida Grades and Standards

<http://www.doacs.state.fl.us/pi/pubs.html>



Figure 15

A proper pruning cut is made along the line drawn next to the word “yes” just outside the branch collar (top). An improper cut made through the collar (next to word “no”) results in a flush cut and an elongated wound (bottom) that begins to callus from the sides only. Flush cuts cause decay.



Figure 16

These are examples of quality nursery trees well worth their price.

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URBAN DESIGN FOR A WIND RESISTANT URBAN FOREST



PUBLICATION Nº

ENH 1056

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Introduction

Researchers who visited post-hurricane sites found that many incidents of tree failure could have been prevented with appropriate design and management. Many trees that grow to a large size had been placed too close to curbs, sidewalks, foundations, and pavement. Roots on mature trees had been deflected, decayed or been cut close to the trunk. These conditions resulted in trees toppling in high winds.

A strong root system is one of the most critical factors that allow trees to withstand hurricane-force winds in urban landscapes, where space for root growth is often limited. Limited rooting space presents a challenge to creating sustainable landscapes. Strategies for developing strong root systems on newly planted trees and preserving the roots of existing trees will be discussed in this document. Other elements of wind-resistant design such as tree grouping and species selection will also be introduced.

Research shows that the more rooting space trees have, the less likely they are to fall. Root systems that grow without being deflected by curbs, sidewalks, pavement and other urban soil structures have a chance to develop a strong supporting base for the tree. Main roots close to the trunk should be straight. If these roots are deflected or cut during construction, then risk of failure increases significantly. Trees growing in groups have a higher rate

of survival than trees that stand individually. Groups of trees also divert wind so they offer more protection for nearby buildings compared to isolated trees. See [Chapter 5—Wind and Trees: Lessons Learned from Hurricanes](#) for more details on the design factors that have affected tree failure in past hurricanes, based on the research and observations of experienced professionals.

Good design means designing the underground soil space to support trees and selecting the right tree. However, many landscapes are already established. So it is important to first address design solutions for existing situations where trees are in conflict with the landscape.

Existing Design Situations

Every day people pass by trees that are growing in conflict with the existing landscape: the parking lot of the grocery store, the sidewalks downtown, the front yards of their homes, and so on. In each of these situations, when trees have a limited space to grow, pavement begins to interfere with root expansion 10 to 20 years after planting (Figure 1). The problem can begin as a crack in the surface of the pavement, which attracts growing roots and eventually results in an entire section being lifted. This can present a trip hazard to pedestrians passing by. Large maturing trees grown in small spaces will do one of two things: grow and disturb the hardscape, or decline and eventually

die. The latter outcome is wasteful and impractical because the cost of planting a tree in an urban area can range from five hundred to thousands of dollars. Tree removal and replanting is yet another expense, and still the design objective is not fulfilled. In the former scenario, in which the tree continues to grow in conflict with the hardscape, often the large anchoring roots are cut when the hardscape is repaired (Figure 2). Many urban tree managers have learned from experience that cutting roots is a poor decision because it makes the tree unstable. Trees with cut roots have fallen over and damaged homes and vehicles. They have even killed people. It should be clear that for the sake of wind resistance, cutting or damaging the root system that anchors the tree is not an option! Trees that lack their main support roots are hazards in the landscape.

When root pruning is necessary, the general guideline is to preserve all roots within an area about five times the trunk diameter. For example, if the trunk diameter is two feet, then do not prune roots within ten feet of the trunk. Although this will not guarantee that tree will remain erect, it is better than cutting closer to the trunk.



Figure 1
Sidewalk located too close to the root flare of a large tree.



Figure 2
Main supporting roots were cut. These trees, once of value to the landscape, are now at high risk for failure and should be removed before they fall over.

Design solutions for situations where roots are in conflict with the landscape

Rather than cutting the roots, there are many different techniques that have been used that do not interfere with the root system of the tree. Several of these are discussed below. Look for more detailed information on our Web site: <http://treesandhurricanes.ifas.ufl.edu/>.

Install different surface material

Materials other than concrete can be used as a wearing surface for sidewalks. Some examples are crushed granite, gravel, wood decking, brick-in-sand and asphalt. Porous pavers and porous asphalt have been used for parking lots with success. A potential benefit to these alternate surface materials is that they provide some aeration to the soil beneath, versus concrete, which traps moisture and can encourage roots to grow directly under and break the pavement. Most of these materials are flexible, so they are less likely to crack from root growth than a rigid surface like concrete. Repairing these alternate surface materials can also be less expensive than traditional hard surfaces.

Stone dust

Surface materials like gravel, limestone, or stone dust allow continued root growth and expansion (Figure 3). The surface can be easily repaired as roots continue to expand in diameter. Crushed rock is inexpensive and easy to install, and the surface is porous. It is best used on fairly flat surfaces because rain can cause erosion on sloping ground. The use of brick pavers, shown in the picture, provides a route for pedestrians walking from the parking lot to the other side of the street. Displaced stones will need to be replaced occasionally, and may be a nuisance when using equipment such as a leaf blower (Gibbons, 1999).



Figure 3
Stone dust is placed around the root flare of the tree in cutouts along this brick sidewalk. This technique is attractive and allows for easy repair as roots expand in diameter.

Porous pavers

This solution is most commonly used for paved areas such as parking lots (Figure 4). Porous surfaces are a good idea for areas prone to flooding because they allow some water to permeate for more even distribution, and can help reduce runoff problems. This is an especially important design detail for Florida and the Gulf coast, which is prone to heavy tropical rains.

Soil should be added around the roots to prepare a base for the pavers. Coarse sand works nicely as a sub-base for the porous pavers because it compacts, yet allows enough air space between particles for air movement. Be sure that the soil grade is not lowered during the construction process, because this will damage roots.

Fill and re-pour sidewalk

Like many of the other solutions, this can be a short-term solution that often requires repair in the future. Perhaps using an alternate sub-base material like gravel or rubber chips (instead of soil) and then re-pouring will prevent roots from growing directly under the pavement and lifting it. Reinforcing the concrete with rebar can extend the life of the sidewalk or driveway by forcing the expanding roots to lift the entire slab. This can prevent cracking because the root can deform and become flattened under the slab instead of lifting it.



Figure 4

Porous pavers can be installed around existing trees where roots have lifted the pavement or sidewalk. This makes it easy to repair damage in the future and can potentially reduce water runoff.

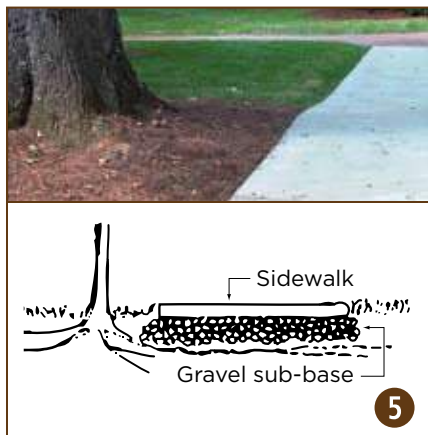


Figure 5

After adding soil over the roots that are causing the walk to lift, re-pour the sidewalk. Use a sub-base material like gravel, or reinforce the concrete with rebar to deter roots from lifting the pavement.

Bridging

Surface materials such as interlocking concrete pavers, wood decking, rubber sidewalks, or metal (Figure 6) can be used to bridge over roots.

Reroute

Where possible, redirecting the sidewalk is a great option if there is space (Figure 7). This solution is used for many trees in urban areas. Be sure to put a mechanism in place that prevents contractors from damaging the main support roots during sidewalk repair.



Figure 6

Materials such as metal can be used to bridge over roots that are lifting an existing sidewalk. The tree can be seen at the extreme top of photo.



Figure 7

When there is space available, re-routing the sidewalk is the recommended option.

New Design/Construction: Designing the Right Place

A good design should provide enough soil space to support root growth of the tree. The volume of soil required depends on the expected size of the tree. Unfortunately, many trees are squeezed into soil spaces that are large enough for the root ball at planting but way too small for future root growth. This is a main reason for poor growth and instability of trees in hurricanes. Current design practices will have to change significantly in order to give trees the appropriate amount of soil space. A typical design specification can call for a volume of 200 cubic feet of soil for trees, whereas 2,000 to 3,000 cubic feet would be an ideal amount. This is a drastic difference! The table and design solutions presented here attempt to strike a compromise between these two extremes.

Soil requirements

For situations where the planting area is surrounded by paved surfaces, Table 1 provides guidelines for the minimum amount of soil to provide based on tree size at maturity. There are two components to soil space: 1) the total soil volume needed to sustain a tree for a reasonable period of time, and 2) the open soil area needed immediately surrounding the trunk to accommodate trunk flare growth. *Open soil space* is soil that is not covered by a solid hard surface such as a sidewalk, pavement, or a building.

Table 1. Soil requirements for trees based on their size at maturity.

TREE SIZE AT MATURITY	TOTAL SOIL AREA*	DISTANCE FROM PAVED SURFACE
SMALL Height: shorter than 30 ft	10 ft x 10 ft	2 ft
MEDIUM Height or spread: lesser than 50 ft	20 ft x 20 ft	6 ft
LARGE Height or spread: greater than 50 ft	30 ft x 30 ft	10 ft

* Measurements for when rootable soil depth is 3 feet or greater. For soil less than 3 feet deep, smaller maturing trees are recommended.

The soil guidelines in Table 1 are minimum recommendations intended for good quality, well-drained soils. When the soil has limitations such as compaction, high water table, poor drainage, etc., either provide more space, or choose small maturing trees. Although these recommendations are significantly different from a typical specification, much more rooting space is necessary for trees to be more stable in the landscape and to be appropriately considered a wind resistant design.

Design solutions for urban situations where space is limited

There are many options for increasing soil area for trees in downtown landscapes, malls, and other urban situations where pavement is in very close proximity to the trunk. This section will list options for increasing soil area in this type of environment, or making better use of existing site soil.

Step 1—Plant trees in the open space available.

Study Figure 8 carefully—notice the large space provided for turf. Compare this to the limited size of the sidewalk cutouts that the trees are planted in. If planted in the open lawn, the trees have a better chance to become large, to provide shade for people using the space, and reduce cooling costs for nearby buildings. Instead, they will have a shorter lifespan due to the limited growing space. The tree grates shown in Figure 8 cause more harm than good. Don't use them, pavers are a better option.

Figure 8

Locate trees on the site so they have access to the most soil space. These trees would thrive better if planted in the open space on the right. Root paths or suspended sidewalks could increase access to rootable soil.



We are accustomed to seeing trees planted in a thin strip of lawn between the sidewalk and street (Figure 9). Sidewalks often become displaced and broken as roots expand in diameter. Not only is damage to the sidewalk from root expansion expensive to repair, but trees would be more stable if they were planted in the open space on the other side of the walk. This is a simple solution that can reduce incidences of trees blowing over. When fewer curbs surround the tree, the tree grows faster and has a more balanced root system. The tree becomes more stable because the root flare is able to fully develop without obstruction from the sidewalk and curb.

Step 2—If there is no open space, provide more rootable soil.

Sidewalks in high traffic, downtown areas must be designed to support emergency vehicle weight. Hence, the soil beneath the sidewalk is compacted to prevent settlement and cracking of the sidewalk. However, trees thrive best in loose, porous soil that encourages root growth. These two objectives—stable walks and loose soil for roots—typically conflict with each other unless we design the space appropriately. So how do you create a stable wearing surface and space for trees to grow?

Root paths

Root paths are narrow channels of loose soil that provide a small path for air that encourages root growth under pavement (Figure 10). A trenching machine is used to cut a trench through the compacted soil. Aeration mats are then placed in the trenches, which are backfilled with loose soil once the mat is in place. Roots tend to follow the paths because they provide a channel for airflow adjacent to the mat; roots follow the air. Encouraging roots to spread under the pavement can help to prevent roots from circling around in the small cutout in the sidewalk, which is a common cause for trees blowing over during hurricanes. This method is preferred over just providing a cutout or box of soil, though it does not significantly increase the amount of soil space.



photo courtesy of Chuck Lippi

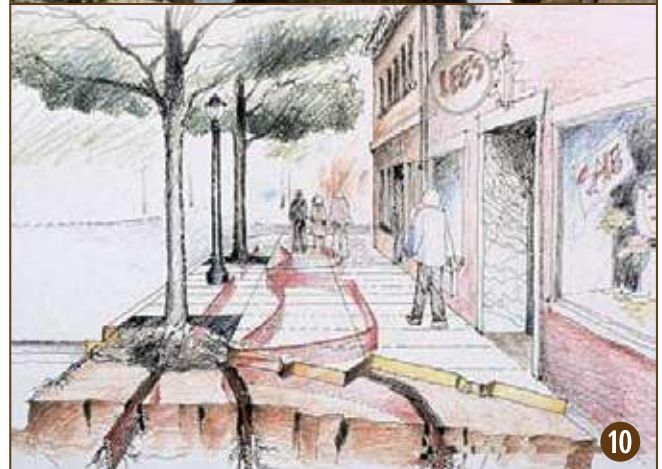


photo and illustration courtesy of Jim Urban, Urban and Associates

Figure 9

Rather than planting in the thin strip of soil space between the sidewalk and street (top), plant trees in the open space on the other side of the walk (bottom).

Figure 10

Root paths provide channels for air beneath the sidewalk to allow roots to spread beyond the planting pit.

Planting strips

Planting strips are long sections of soil without pavement on top that provide much more soil volume for trees than root paths. Notice the sidewalks bisecting the strips of turf in the right photograph (Figure 11). This is a necessary design consideration because it is important to keep pedestrian traffic off of the open soil around these trees to prevent soil compaction. Given this consideration, planting strips may be more practical in areas that are less busy. Planting turf and flowers at the base of the tree make it far more likely that the trees will receive adequate irrigation and could improve tree growth, though this may attract people to sit or walk on the turf. Never pile soil on top of the root ball or on the trunk.

Structural soil

Structural soil is designed to support the weight of walks, roads, pedestrians and vehicles, as well as provide a well-aerated soil substrate for tree root growth (Figure 12). In structural soil, weight is transferred from one aggregate (rock) to another, with enough soil to almost fill the space between the aggregates. The aggregates are angular rocks that are typically about 1 inch in diameter. Roots grow well in the soil between the aggregates, which is not compacted because load is transferred to the rocks.

This technique is being used in urban areas due to its effectiveness at supporting heavy traffic and allowing tree growth in tough urban situations. The process of mixing the soil can be labor intensive and needs to be done very carefully. Because 80% of the volume of structural soil is comprised of rocks, a large amount is needed to meet adequate root volume requirements.

Figure 11

Planting strips increases the soil area significantly, but the soil can become compacted in high traffic areas. Consider using paths to direct traffic (top). Planting in narrow strips (bottom) can cause walks to lift prematurely; gravel under the walk can help reduce sidewalk lifting

Figure 12

Structural soil can be used beneath paved surfaces that bear heavy traffic. The weight on the surface is transferred to the rocks, while the soil between the rocks is not compacted and provides space for roots to grow. Soil typically represents about 20% of the volume of structural soil.



photo courtesy of Dr. Jason Grabosky, Rutgers University

Suspended sidewalk

Sidewalk suspension or cantilever can allow a great deal of soil volume for trees and addresses the issue of compaction (Figure 13). There is no contact between the bottom of the sidewalk slab and the soil; the slabs rest on supports and pilings. This allows the planting pit to be filled with well-aerated, quality soil. Suspending the sidewalk avoids issues with soil compaction so that roots can spread without interrupting the hardscape. One product that has been recently introduced to the market, Silva Cells®, is an example of the suspended sidewalk technique.

Step 3—Plant trees in groups.

In addition to root space, a key design consideration for a wind-resistant landscape is to plant trees in groups (Figure 14). The definition for a grouping is five or more trees sharing the same soil space. The goal is to create a healthy urban forest with a mixture of young and mature trees that provides benefits such as canopy cover and protection from high winds. Damage to buildings and other structures is usually less severe on properties with high tree density than on properties with isolated trees spaced far apart.

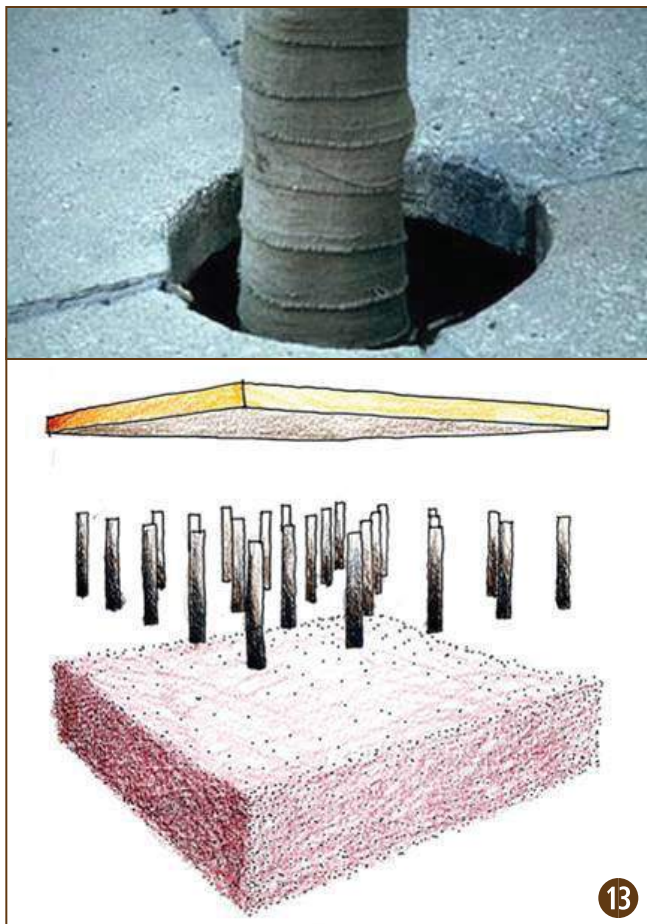


Illustration courtesy of Jim Urban, Urban and Associates



Figure 13
Suspending the sidewalk on vertical supports stabilizes the walk and allows roots to grow well in uncompacted soil.

Figure 14
A historic neighborhood a few blocks from the downtown area of a small city has large trees due to large soil spaces (top). New trees positioned far apart in small soil spaces will take many years to form a canopy cover, if ever (middle). Merging soil into long wide strips allows roots to share space, resulting in successful urban designs (bottom).

A sustainable approach to designing parking lots

We have become accustomed to seeing large areas of land stripped to make a parking lot, and all the large trees clear cut to be replaced by a few small saplings. A more sustainable approach would be to evaluate the mature trees, remove the ones that are in decline or have poor structure or poor root systems, and design the parking lot around the existing, healthy trees. Replace the trees removed with groupings of young trees, rather than small islands that can only support one or two trees for a short period of time. Consider that large healthy trees, even if confined to one area, will shade a greater portion of a parking lot than lots of little islands with small, short-lived trees providing little to no shade. Trees in islands frequently have to be replaced and rarely fulfill the design intent.



Figure 15

Contrast the typical planting island (top) where trees rarely become large with a buffer strip of trees (bottom). Grouping trees together in one large area is a sustainable design practice. These kinds of plantings will last many years.

New Design/Construction: Selecting the Right Tree

When soil space is limited, or the soil is shallow (less than 2 or 3 feet), rocky, or of poor quality, plant small maturing trees (those that mature at less than about 35 feet). There is an exciting variety of small trees that is currently underused for urban plantings but some of them are not available in large sizes. Although they are shorter than large maturing trees, small trees still provide some shade benefits (Figure 16). Rather than planting a large tree in a confined space, where much damage could occur from the tree blowing down during a hurricane, the preferred option is to go with the smaller tree which is more likely to survive a hurricane (see *Chapter 7—Choosing Suitable Trees for Urban and Suburban Sites: Site Evaluation and Species Selection*). Research has found that certain tree species, including many native species and palms, tolerate hurricanes (see *Chapters 8 and 9—Selecting Species for Wind Resistance*).



Figure 16

Small trees planted in a small space can help preserve the sidewalk but small trees provide very little canopy or shading unless planted close together as shown here.

Literature Cited

Gibbons, J. 1999. Pavements and Surface Materials. University of Connecticut Cooperative Extension System Technical Paper 8. Haddam, CT. 7 pp.

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CHOOSING SUITABLE TREES FOR URBAN AND SUBURBAN SITES: SITE EVALUATION AND SPECIES SELECTION



PUBLICATION N°

ENH 1057

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Introduction

Selecting the right tree for a particular place can avoid costly disappointments later. Trees adapted to the planting site are more likely to remain standing in hurricanes. Thorough site evaluation can ensure that the chosen tree will survive conditions inherent to the location.

Proper site evaluation, planning, and execution can result in a successful urban forest that resists hurricanes. Figure 1 shows a successful canopied street. These live oak trees were chosen for their wind-resistant structure and ability to provide shade, but they were only able to thrive given the adequate open soil space and distance from above-ground structures, such as street lights and wires.

A simple way to begin a site evaluation is to drive around town to find out which species grow well in landscapes with similar site attributes. It is important to keep in mind that no two sites are exactly alike; various conditions both above and below the ground affect the success of a particular tree species. Visiting a local public garden or nursery is also a great way to learn about all the different species that are available and being grown locally. A wide variety of books and web materials can provide specific information about growing and selecting trees in the area.

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Figure 1

Proper planning can produce successful canopied streets and a healthy urban forest when enough soil is available.

Site Evaluation

Site evaluation is the first step in selecting proper trees for a planting site. It is important to consider both above-ground and below-ground site attributes during this assessment. Many people skip the site evaluation process, which explains why trees planted in urban areas are so often short-lived.

Hardiness

Tree adaptations to regions of the country are designated by their hardiness zones. The hardiness zone map, developed by the United States Department of Agriculture, specifies the average lowest winter temperature expected for regions in North America. When choosing trees for a planting site, first note the hardiness zone number of the planting site on the hardiness map. Trees with a hardiness zone range that includes this number are best suited for the site.

Above-Ground Site Analysis

In the above-ground evaluation, many elements should be taken into account. Environmental factors such as light and slope exposure, wind, salt and existing tree presence should be considered, as well as urban conditions such as overhead wires, street and security lights, buildings, signs, vandalism and regulations.

Light Exposure

Note how many hours of direct sun the planting site receives in the summer. Remember to account for the seasonal change in the sun angle when evaluating sites in other seasons. Trees such as crape myrtle that require full sun need at least six hours of direct sun, though all-day sun produces the best form and growth. Trees suited for full sun to partial sun/partial shade will adapt to a site receiving three to six hours of direct sun. Trees that require some shade are adapted to sites receiving less than three hours of direct sun. Most large trees grow best in full sun.

Sunlight reflected from glass or a wall on buildings can increase the heat load on a tree planted near a building. Drought-tolerant trees that grow in full sun are best suited for this kind of site. In addition, providing a large area of soil for roots to explore often helps trees withstand reflected light because the trees have access to more soil from which to absorb water. Irrigation helps these trees as well.

Slope Exposure

Trees with thin bark (i.e., cherries, plums, maples) can transplant poorly on southern and western slopes. Transpiration and evaporation from the soil are enhanced on south and west slopes, making it more difficult to maintain adequate soil moisture. Because of this, plan on providing more irrigation to southern and western exposures to help prevent desiccation; drought-tolerant trees are best adapted to these exposures. Northern slopes are more protected from direct sun exposure, and the soil here stays moist longer.

Wind

Wind increases the amount of water lost from a tree to the atmosphere. Therefore, in areas exposed to higher winds (i.e., near the beach), consider choosing only drought-tolerant trees. Otherwise, special provisions should be made to increase the availability of irrigation or to protect the site from direct wind. If the site has poorly drained soil, trees will need to be both wet and drought-tolerant.

Salt

Airborne salt affects trees by burning back twigs and foliage, or through roots after it is deposited on the ground and penetrates into the soil. Salt-tolerant trees are often deformed by direct exposure to salty air, but they survive and grow just fine. Foliage on salt-sensitive trees burns, and trees become deformed and grow poorly when exposed to salty air. Trees with one-sided canopies near the coast can be very susceptible to hurricane-force winds that impact the canopy from the heavy side, but this is unavoidable.

Other Trees

Young trees that tend to develop broad canopies and that require full or at least partial sun (oaks, mahoganies, etc.) often bend toward the sunlight and develop a one-sided canopy when they are planted under a canopy of established trees. Trees planted between existing established trees may grow slowly or not at all due to root competition and lack of water and shade.

Overhead Wires and Street/Security Lights

Look up before you plant. Trees are often planted too close to power lines and security lights. When branches reach wires, the utility company must prune them to ensure uninterrupted utility service. Unfortunately, this costs utility companies (and ultimately the customers) billions of dollars each year in the United States. We could greatly lower costs and minimize damage in

hurricanes by planting only properly sized trees near wires (Table 1). It is best to plant trees as far away from wires as possible (Figure 2).

Table 1. These are suggestions for planting trees within 40 feet of wires or street lights.

DISTANCE FROM WIRES OR LIGHT	TREE SIZE AT MATURITY
0–6 feet	Planting is not recommended unless trees remain under 25 feet tall
6–40 feet	Height should be 10 feet or shorter than wire/light or canopy diameter should be less than twice the distance to wire/light
more than 40 feet	Any tree can be planted

Trees are often located in the same parking lot island as overhead security lights. Eventually the tree canopy will grow into the structure, blocking the desired light. This requires regular pruning to clear the light, which results in a deformed canopy. Good planning locates trees and security lights away from each other, positions lights about 12 feet from the ground so the tree canopy can grow over the light, or selects trees that remain small at maturity so that they remain under the light.

Buildings

Trees are most stable in the ground when they develop a uniform root system with straight roots distributed more or less evenly around the tree. If a tree is close to a building, the root system can become one-sided and unbalanced. Unbalanced root systems result in tree failure in strong winds. A tree with a narrow canopy may be a good choice within 10 feet of a building, although tree canopies can adapt by growing more on the side away from the building. If shade is desired, consider planting several small-stature trees to create a closed canopy (Figure 3).

Figure 2

Planting trees far from overhead wires (top) reduces costly maintenance and service outages in storms. Trees located under wires (bottom) are costly to maintain and can bring down the wires in strong winds. Some communities plant large trees under wires and prune to keep them clear of wires.



Figure 3

Plant small-stature trees in groups if shade is desired near buildings. Canopies catch the wind, and trees can blow over when they grow substantially above the roof line.



Signs

Signs and trees frequently conflict with each other due to poor planning. To help prevent this, plant large trees near low signs and small trees near tall signs. Large-maturing trees could be in the way of a low sign for several years after planting, but if the tree is grown with a single trunk, lower limbs can be reduced and eventually removed so the sign remains visible. Many communities have implemented a landscape code requiring signs be no more than 8–10 feet from the ground, eliminating this potentially costly problem. The best ordinances place signs 3–4 feet from the ground.

Vandalism

People sometimes intentionally destroy or injure trees, or they may be unintentionally injured if they are planted in vulnerable sites such as sidewalk cutouts, where people walk close to the trees. If vandalism is a concern, consider not planting trees with thin bark (e.g. red maple), or choose trees at least 4 inches in trunk diameter.

Below-Ground Site Analysis

Important soil attributes that affect tree selection are pH, drainage, depth, salinity, distance to the water table, and obstacles to root growth such as curbs. Many plantings fail because these factors are improperly evaluated or ignored. Early evaluation will allow you to identify good soil and make provisions to remove and stockpile it. Good soil is precious and should not be wasted. It can be brought back to the site once the job is complete to promote tree growth. Pre-construction planning also gives you the opportunity to work with your contractors to prevent excessive soil compaction in areas where trees will be preserved and planted. Isolate these areas from heavy equipment and other vehicles using sturdy fences, and levy fines on contractors for violations.

Rooting Space Restrictions

Match ultimate tree size to the soil volume available for root growth. This strategy helps keep trees healthy and stable in storms. It also prevents damage to surrounding sidewalks, curbs and pavement (Figure 4). Soil under pavement is typically poorly aerated and compacted, a situation that is considered inhospitable for roots, unless soil is coarse sand and well drained. Roots will be mostly confined to the soil space not covered by pavement or the space between the soil and bottom of the pavement. This will inhibit development of a strong root system and

can result in the tree becoming unstable in hurricanes. Some wet-site-tolerant trees (e.g. baldcypress) are adapted to produce roots under pavement, and they can remain upright in strong winds.



Figure 4

Small-maturing trees should be planted where soil space is limited to keep them healthy and stable in winds, and to prevent damage to surrounding structures.

Soil pH

Soil pH governs availability of nutrients to plants and also affects activity of soil microorganisms. A pH test should be conducted in several areas of the site, wherever soil color or texture appear different. Site pH may vary too much to plant the same species across the entire job.

To collect samples for testing from an open area such as a lawn where soil may be fairly uniform, dig about 10 small holes five to ten feet apart with a trowel or shovel. Remove a slice of soil from the side of each hole from the surface down to 12 inches deep. You might choose to use a portable soil coring device to collect the samples if one is available. Mix soil together in a clean plastic bag or clean bucket or jar and take or mail a sub-sample (about a pint) to a lab to be tested.

Most trees can grow in soils with a pH between 4.8 and 7.2. If the soil is less than 4.8, select trees tolerant of acidic soils. If the soil is greater than 7.2, select trees tolerant of alkaline soils. Few trees grow well in soils with a pH above 9.0.

Compacted Soil, Poor Drainage, and Low Oxygen

Urban soils are often compacted and poorly drained; even sandy soil can compact. These soils contain little oxygen—a gas that tree roots need to survive and grow. Only species and cultivars tolerant of wet sites can survive in the difficult soils (e.g. baldcypress, sweetbay, pond apple, etc.). Use of trees with aggressive root systems (e.g. ficus and oak) should be considered carefully because large surface roots often form. These can disrupt lawn mowing operations and can damage curbs, sidewalks, pavement, and other nearby structures. Large shade trees often fall over in hurricane-force winds because inhospitable soil prevented their establishing deep, stabilizing root systems. Plant small- to medium-sized trees (under 40 feet tall at maturity), for a more hurricane-resistant landscape.

To check for compaction and drainage, dig several holes at least 18 inches deep around the site. If soil is very difficult to dig with a shovel, it may be compacted. If soil is fairly easy to dig into with a shovel, it is probably not compacted. Drainage can be determined by filling these holes with water (Figure 5).

If soil is very compacted and hard all the way down to the bottom of the planting hole, then wet-site-tolerant trees are most appropriate. Expect many roots to develop at the surface. Occasionally, soil is loose underneath and compacted only on the surface. If you can break up the compacted layer on the surface for 15 feet or more around the tree before planting, drainage and tree growth may improve. In this case, trees can be chosen regardless of their wet-site tolerance.

Subsurface Compacted Layers

Soil loosely spread over compacted subsoil creates special challenges. Roots often grow only in the loose soil and will not penetrate the compacted subsoil (Figure 6). Small to medium-sized trees are recommended if less than 2 feet of loose soil will be spread over a compacted subsoil. This is because large-maturing trees could become unstable and hazardous due to shallow root systems (Figure 7).

Figure 5

Checking soil drainage is important to determine species selection for a site.

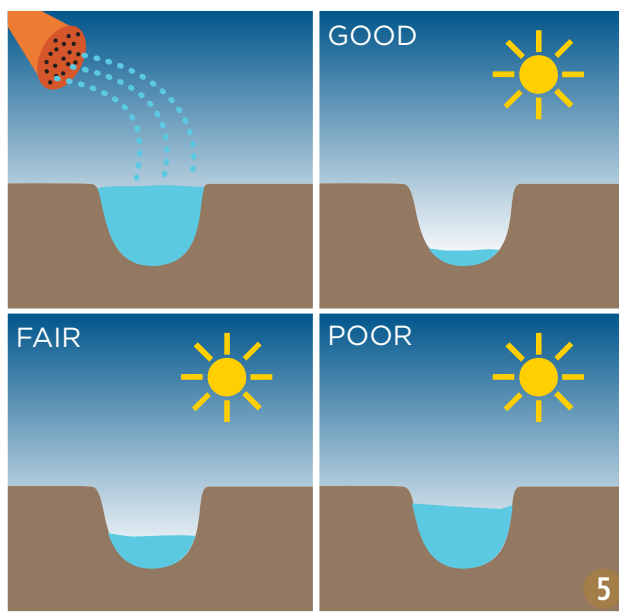
Figure 6

Note how the roots of this tree grew only in the top layer of soil.

Figure 7

Large-maturing trees are not suitable for shallow soils because they lack deep roots and blow over easily in hurricanes.

Dig hole 18 inches deep and fill with water. Check drainage after one hour.



Soil Depth and Distance to the Water Table

If bedrock comes close to the surface or if there is little soil, plant only small to medium-sized trees. Large-maturing trees in soil less than two feet deep could topple over in storms as they grow older because they lack deep roots. Roots on some trees can grow in solution holes in oolitic limestone to secure the tree firmly.

Dig several holes two to three feet deep and wait two to four hours if necessary. Any tree can be planted if no water appears in the hole. If water appears in the hole, select trees that tolerate wet sites. If the distance to the water table is less than 2 feet, plant small- to medium-sized trees. Possible exceptions are baldcypress and tupelos, especially if they are planted in groups.

Distance to the water table often varies during the year. It might be several inches below the surface in the cooler season and drop several feet in the growing season because transpiration pulls it from the soil. Special weather events can influence water table depth also. Sites with varying conditions should be considered poorly drained. To help avoid making erroneous conclusions about depth to the water table, determine depth during the coolest or wettest season. Consult local soil experts for this.

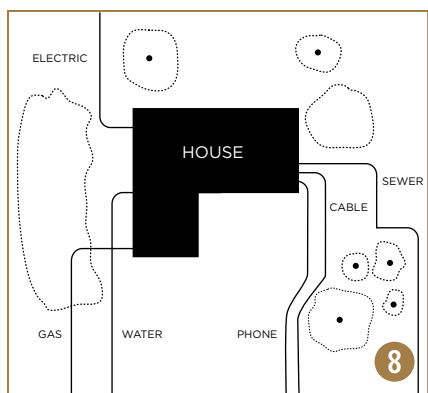


Figure 8

Locate underground utility lines before digging planting holes.

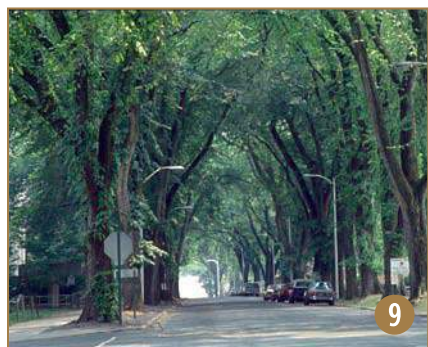


Figure 9

Low security lights are a modification that allows tree canopies to develop above.

Underground Utilities

Do not plant a tree before determining where underground utilities are located (Figure 8). Consult local cable companies, water/sewer departments, electric utilities, and telephone and gas companies before digging. Many states have a hotline to call before digging, such as the Sunshine State One Call of Florida (1-800-432-4770). Roots of large-maturing trees planted within ten feet of underground utility lines could be damaged when the utility is serviced. For this reason, some communities restrict planting near these utilities. Roots usually will not penetrate well-designed, properly installed utilities that do not leak water. Roots sometimes grow in the trench dug to hold the utility because it may be less compacted than surrounding soil.

Potential Site Modifications

Modifications made to the site can help accommodate a wider variety of tree species. When made before planting, site modifications such as moving wires or street lights, grading, improving drainage, and incorporating soil amendments over broad areas can have an impact on soil conditions that will affect tree growth and species selection.

Moving Lights and Wires

Street lights and overhead power lines can be moved or modified to make room for trees. Though this is not commonplace, it is surprising how often it's done once the suggestion is made. In many instances, it is a more permanent solution to a design problem, allowing trees to be planted along a street in an area where they should not be planted without moving or modifying fixtures (Figure 9). Some communities design utility corridors which contain utilities within a specific area and allow trees to be planted away from the corridor without interference.

Changing Soil pH

It is better to plant trees adapted to the existing soil pH than to change soil pH. Applications of sulfur or limestone to soil usually provide only a temporary pH change. Regular applications must be maintained to adjust the pH levels. It is best to plant species that are tolerant of the pH at the site, or replace the soil.

Improving Drainage and Reducing Runoff

Water running off a site can carry soil, pesticides, and fertilizers that contribute to environmental degradation. Soil is often graded (shaped) to keep as much water on the site as possible. To reduce runoff and sedimentation, redirected water should stay on site, rather than being channeled into streets or streams. Highway and other linear spaces surrounded by curbing can be designed to retain water if drainage is adequate.

Use a trencher to dig four or more trenches out from the planting hole, then loosely backfill with the soil from the trench (Figure 10). This provides channels for root growth in a compacted site, improves drainage a little, increases water percolation, and reduces runoff.

Other Soil Improvements

Some soil modification techniques can improve soil conditions for root growth. These include adding fill soil, replacing soil, and adding inorganic or organic matter over a large area. Modifying the small area in backfill soil adjacent to the root ball does not benefit trees. Site design and modification is covered in much detail in [Chapter 6—Urban Design for a Wind Resistant Urban Forest](#).

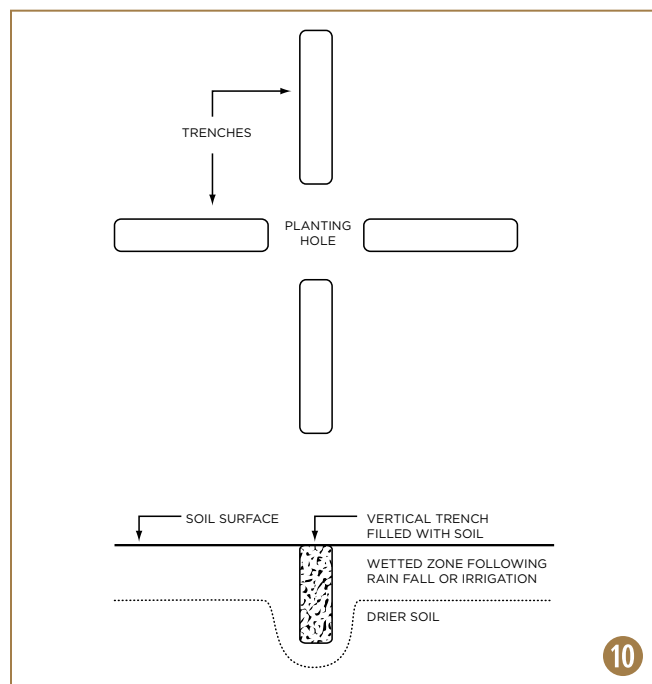


Figure 10

Trenching is a simple site modification that could improve tree growth and reduce drainage issues.

Evaluate Maintenance Practices

Understanding how the site will be managed after planting is a critical factor in tree selection. Maintenance issues such as irrigation, pruning, fertilization, and pest control can affect whether a tree is able to thrive. For example, if the planner knows that trees will not receive any pruning once they are in the landscape, then a tree with a naturally good structure (e.g. excurrent growth habit) is preferred.

Irrigation

The ability to deliver irrigation determines which species and nursery stock sizes are best suited for the site. If trees can be irrigated regularly only until they are established, drought-tolerant trees should be chosen, and nursery stock of any size can be planted. If trees receive irrigation during establishment and then regularly during the life of the tree, or if you are planting in the plant's native range and soil type, any tree regardless of drought tolerance can be planted (Table 2). If irrigation cannot be supplied for the period of time shown in Table 2, then plant smaller-sized nursery stock.

Table 2. Irrigation schedules depend on size of nursery stock and desired objective. Establishment takes approximately 3 to 5 months per inch of trunk caliper.

SIZE OF NURSERY STOCK	IRRIGATION SCHEDULE FOR VIGOR	IRRIGATION SCHEDULE FOR SURVIVAL
<2 inch caliper	Daily: 2 weeks Every other day: 2 months Weekly: until established	Twice weekly for 2-3 months
2-4 inch caliper	Daily: 1 month Every other day: 3 months Weekly: until established	Twice weekly for 3-4 months
>4 inch caliper	Daily: 6 weeks Every other day: 5 months Weekly: until established	Twice weekly for 4-5 months

Note: Some irrigation is needed in extended droughts to keep trees alive in the first 2-3 years after planting even after establishment.

Pruning

Trees should be pruned regularly to maintain good health and longevity. An effective pruning program helps trees resist hurricane-force winds. An effective urban forestry program makes this necessary pruning an integral part of the budget. These programs budget for structural pruning for the first 25 years after planting (see [Chapter 12—Designing a Preventive Pruning Program in Your Community: Young Trees](#) for detail). Unfortunately, tree pruning budgets are often too low to allow pruning every 3 to 5 years following planting. If this is the case, consider planting those species that require only a moderate amount of pruning to develop and maintain good structure. This list can be found on the website listed at the end of the document. It is a short list!

If there will be infrequent or no pruning, or if no one knows when or how trees will be pruned, then do not plant large-maturing trees if there is a structure (i.e., streetlight) that may conflict with tree growth. For maximum wind firmness in hurricanes, it is best to plant hurricane-resistant trees (see [Chapter 8—Selecting Southeastern Coastal Tree Species for Wind Resistance](#) and [Chapter 9—Selecting Tropical and Subtropical Tree Species for Wind Resistance](#)), including those with a naturally good structure, such as magnolia or baldcypress.

Fertilization

Fertilization is mostly an issue in alkaline soils that cause micronutrient deficiencies. If a tree that is not tolerant of alkaline soil (e.g. queen palm) must be planted in a soil with alkaline pH for historic or other special reasons, then be prepared to conduct a regular monitoring and treatment program designed to prevent micronutrient deficiencies. See the Florida Trees website listed at the end of this document for a list of trees tolerant of alkaline soils.

Cleanup

Trees with large fruit (royal poinciana), hard fruit (hickory or mahogany) or very fleshy fruit (fig, seagrape, cocoplum, or queen palm) can create a mess or hazard on sidewalks and pavement beneath the canopy. Pedestrians can slip and fall on the fruit, and it can be unsightly. If cleanup budgets are low, consider planting trees without this type of messy fruit, such as the fruitless ‘Rotundiloba’ cultivar of sweetgum, in areas with high pedestrian traffic. Ethephon sprays can be used on some species to halt fruit production, but proper timing is crucial.

Choose Desirable Tree Attributes

Up to this point in the evaluation process, trees have been chosen primarily for their ability to grow at the site. While this is the most crucial criterion for tree selection, desired tree attributes such as function, size, form, and longevity are also important when choosing a species.

Function

Healthy trees provide us with many benefits. They give shade, produce oxygen, control erosion, protect our water resources, increase asphalt durability, support wildlife, and stabilize stream banks. The function we would like a tree to provide may dictate its size, shape (form), life span, canopy density, color, growth rate, fruit characteristics and other attributes.

Mature Size

Large trees (>50 ft at mature height) are the obvious choice for providing shade to large open spaces and for planting along streets if there is proper space above and below ground. Medium or large trees will cast the most shade onto a building, which can reduce air conditioning bills when the trees are placed properly. Keep in mind, however, that larger trees are more likely to be damaged and cause damage than small trees. Prudent managers weigh the advantages and disadvantages of planting large-sized shade trees.

Small trees (<30 ft at mature height) are often suggested for planting in downtown areas where soil space is limited, but they provide little shade. Small or medium-sized trees may be good choices for planting near a deck or patio, or in areas exposed to potential hurricane-force winds. Bear in mind, however, that the benefits small trees provide are small compared to large trees.

Form

Tree form can have a big impact on tree maintenance requirements. There are many urban landscape situations that call for trees near pavement. Small, spreading trees that are multi-trunked require regular pruning if they are planted too close to a sidewalk, whereas a small, upright tree or a larger tree can be trained to grow over the walk or street (Figure 11). Trees with a pyramidal form usually require less pruning to develop strong, wind-resistant branch structure than

those with other forms. Trees with rounded, oval or spreading canopies often need periodic pruning in the first 25 years after planting to ensure good structure and to provide clearance.

Longevity

It would appear that large, long-lived trees might be the logical choice for planting in most landscape situations, since they would provide for a lasting effect. However, with reasonable placement and care, long-lived trees will probably outlast many of today's streets, homes and buildings. Many structures are renovated or expanded 30 to 50 years after construction. The renovation is often so extensive that it becomes difficult to provide the needed protection for a large, long-lived tree's extensive root system in order to keep the tree alive. For this reason, concern about tree longevity may be less important in highly urbanized landscapes unless special provisions are undertaken to protect the tree.

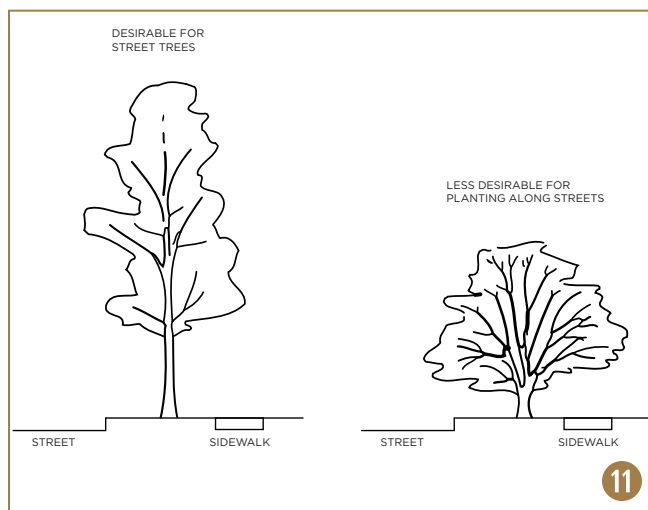


Figure 11

Upright trees usually require less pruning to keep branches clear of traffic, but they typically need regular pruning to develop wind-resistant structure. See [Chapter 12—Developing a Preventive Pruning Program in Your Community: Young Trees](#) for details on pruning young trees.

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Tree Selection

It is important to plant and maintain a diversity of tree species throughout the community. This helps spread the risk of damage in storms. It may require more work and creativity to find a variety of trees that can withstand urban conditions, but it is well worth the effort. Species diversity allows a landscape to withstand devastation by insect or disease outbreaks, and if executed appropriately can provide a more aesthetic appeal. However, species selection alone will not prevent danger in storms. Trees must be positioned and maintained appropriately in order to create hurricane resistant urban forests.

Additional Resources:

For Final Selection of Northern Trees

<http://orb.at.ufl.edu/TREES/index.html>

For Final Selection of Florida Trees

<http://orb.at.ufl.edu/FloridaTrees/index.html>

These links will take you to two sites with extensive information on trees. Using the conclusions from your site evaluation, you will be able to specify the characteristics of the planting site (i.e. poor drainage, dry soil, alkaline soil, etc.), and create a list of appropriate trees for your site conditions.



DEVELOPING A PREVENTIVE PRUNING PROGRAM: YOUNG TREES



PUBLICATION N°

ENH 1062

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Introduction

Trees growing in urban and suburban landscapes offer many benefits to the community. However, when a tree or part of a tree breaks, it can cause extensive damage to people and or property (Figure 1). A preventive pruning program is an important tool to minimize the risks of tree defects. The most common defects are codominant stems and aggressive low branches that either split from the tree or result in large pruning cuts upon removal (Figure 2). Problems such as these result in tree stress, reduce the life span of the tree, and place people and property at risk. Preventive pruning helps to promote good structure, making trees more resistant to storms and other natural forces. A research study in 2006 suggests that pruning trees significantly reduces trunk movement and damage when exposed to 120-mph winds.

Trees with good structure are characterized by a single dominant leader, strong branch unions without bark inclusions and a balanced canopy (Figure 3). Preventive or structural pruning is a process that can help to promote these attributes in trees.



Figure 1

A large limb fell on this car and broke the windshield during a storm. Pruning may have prevented this damage.

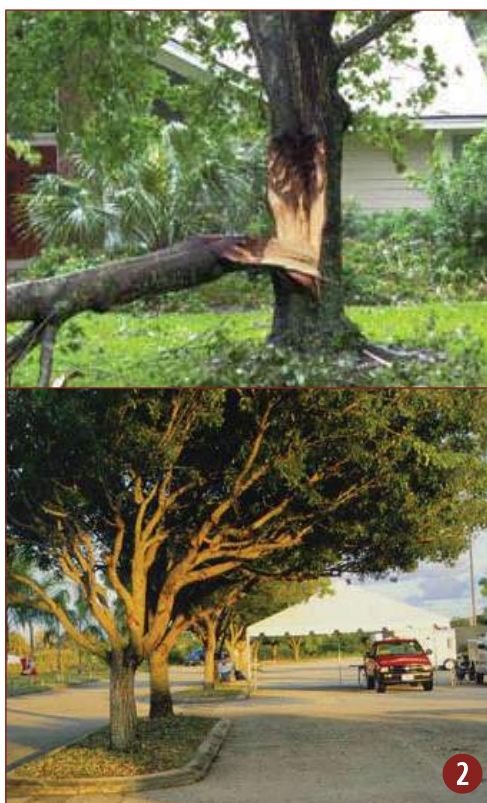


Figure 2

The codominant stem (top) split from the tree because of a weak branch connection and included bark. Proper structural pruning could have prevented this defect from failing. The large lower limbs (bottom) of these mahogany trees are too close to the ground and will have to be removed soon to provide for clearance under the canopy. Removing large branches like this can initiate decay and slows growth. Prune earlier to prevent this poor form from developing.

Figure 3

A good structure (top) is characterized by a single dominant leader, and branches that are spaced and not touching throughout the canopy. A bad structure (bottom) has many dominant stems and branches clustered together.



Determine Your Objectives

The major objective of preventive structural pruning is to direct the growth of the tree so that it forms a sustainable structure. This is accomplished by pruning stems and branches that are not growing in the correct direction or position.

Structural issues that cause trees to fail

Codominant stems

Included bark

Unbalanced canopy

Lions-tailing or over-lifting

Large lower limbs

Correction of Structural Issues

Codominant Stems and Included Bark

Codominant stems are stems of equal size originating from the same point on the tree. Included bark is bark pinched between two stems creating a weak union. Codominant stems with a 'V' shaped union are often accompanied by included bark (Figure 4). This union is weak because the bark inclusion prevents any physical connection between the two stems. Instead of overlapping wood creating a strong connection, the two stems push each other apart as they grow and a crack develops. Researchers at the University of Florida have visited several hurricane sites, and found time and time again that trees failed due to structural issues like codominant stems and bark inclusions.

Strong branch unions are ‘U’ shaped and have a prominent collar (Figure 5). The collar is a swelling formed by overlapping trunk and branch wood. This forms a strong union resistant to breakage.

Unbalanced Canopy

An unbalanced canopy occurs when one side of the tree canopy is much heavier than the other, or when most of the canopy weight is at the tips of branches. The latter is a product of lions-tailing or over-lifting, a poor pruning practice that removes all of the live foliage along the lower and interior parts of the main branches (Figure 6). Lions-tailing is generally accepted by professionals as a poor pruning practice that makes trees more susceptible to wind damage. Lions-tailing encourages more growth at the tips of the branches, resulting in a taller and wider tree. This results in foliage exactly where it is unwanted; that is, higher off the ground. Lions-tailing is often performed as a type of thinning; however, this type of pruning routinely encourages sprouting along the main branches and the canopy quickly fills back in with foliage. These sprouts often have weak connections to the stems and break easily in storms. In addition, lions-tailed trees that are damaged in storms are difficult to restore because the branches arborists would normally cut back to have already been removed.

Large Lower Limbs

Removal of lower limbs is important in order to provide clearance for pedestrian and vehicular traffic. Too often lower limbs are removed only when they have become large and have started to droop, many years after planting. Removal of large branches can initiate decay in the trunk, especially in species prone to decay (Figure 7). Large limbs left to grow may also develop structural defects such as excessive end weight. This defect can increase the likelihood of branch failure. It is important to keep in mind that low branches on young trees are temporary and will have to be removed in the future. Manage lower branches to prevent structural defects from forming.



Figure 4
Codominant stems with included bark have weak connections and often split apart in storms (inset).



Figure 5
Strong branch connections have a ‘U’ shaped union (top) and a prominent branch collar. Some species also show a very distinct branch bark ridge (bottom).



Figure 6
Lions-tailed trees have an unbalanced canopy since all of the foliage is at the tips of the branches. These trees are more susceptible to storm damage and difficult to restore once they are damaged.

Pruning to Promote Strong Structure

Developing a preventive pruning program requires that managers be familiar with the techniques of structural pruning. Structural pruning should be practiced for the first 15 to 25 years of a tree's life. This is the amount of time required to establish strong structure in the canopy and will help to make the tree more resistant to storm damage (Figure 8). In structural pruning, reduction and removal cuts are used to slow the growth of large or rapidly growing branches that compete with the leader. This encourages the one stem you chose as the leader to grow faster.

Components of Structural Pruning	
1	Develop or maintain a dominant leader
2	Identify the lowest branches in the permanent canopy
3	Prevent branches below the permanent canopy from growing too large
4	Keep all branches less than one half the trunk diameter
5	Space main branches along one dominant trunk
6	Suppress growth on branches with included bark

Component 1

Developing or Maintaining a Dominant Leader

Developing a dominant leader starts by identifying the stem that will make the best leader; typically it is the largest stem. This might be easy for some trees and more difficult in others. If all stems are about the same diameter, pick the one that is closest to the center of the canopy as the leader. Then determine which stems are competing with that leader, and decide where to shorten these competing stems (Figures 8 and 9).



Figure 7

Large pruning cuts can initiate pockets of decay in the trunk.

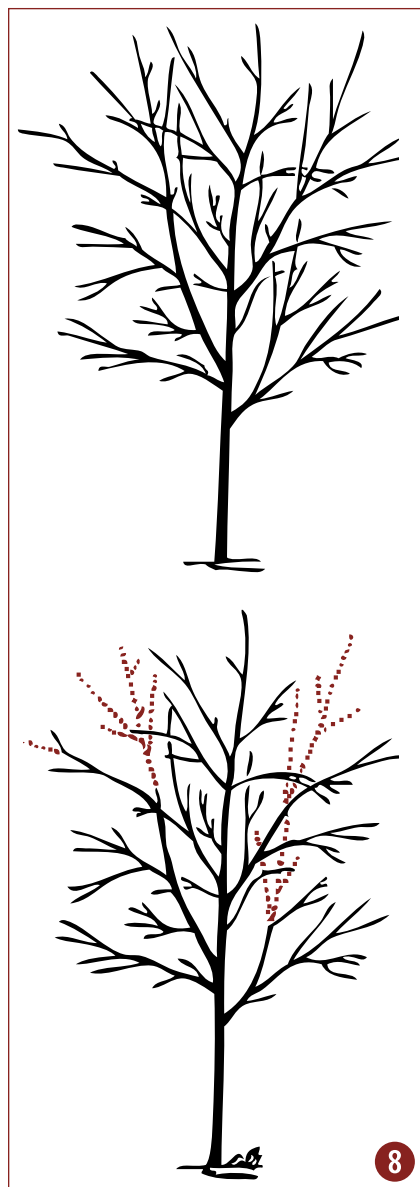


Figure 8

Pruning the stems represented by the dotted lines shortens two of the three codominant stems. This helps establish a single dominant leader in this young shade tree.

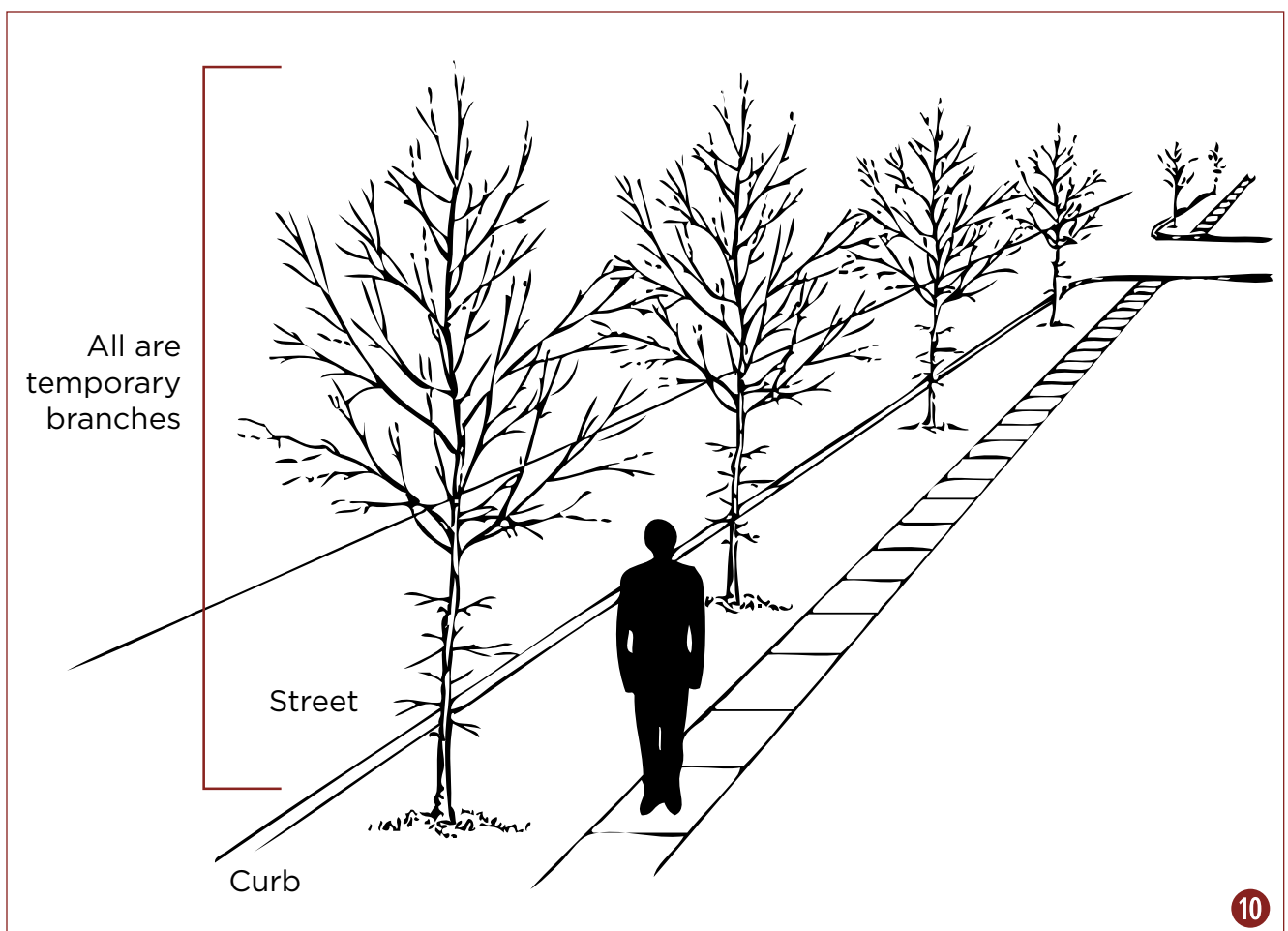


Figure 9

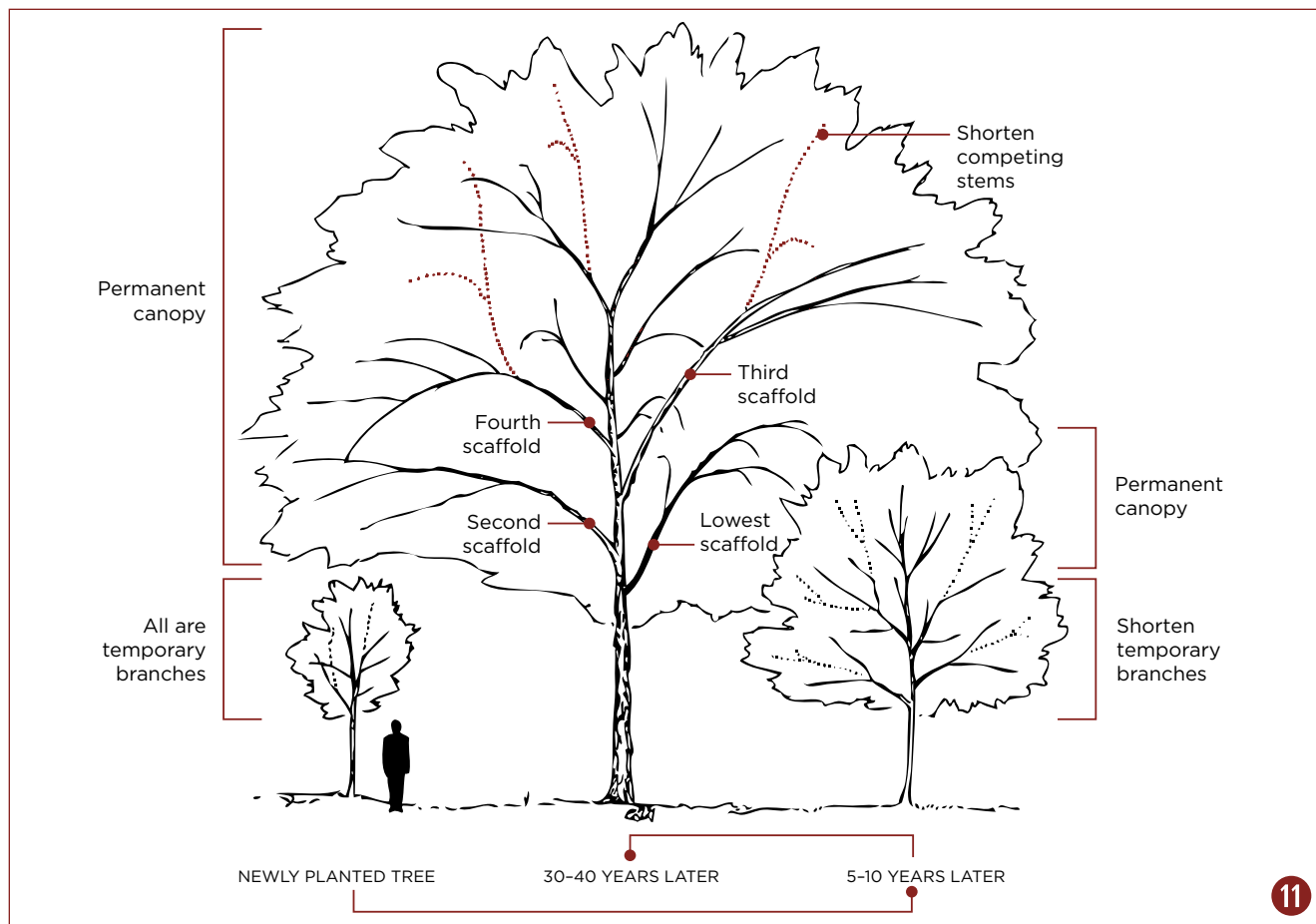
Before and after structurally pruning a young live oak. Notice the arrow indicating where the stem on left side of the leader has been reduced.

Figure 10

All existing branches on these recently planted trees along a street will eventually have to be removed in order to provide clearance for buses, garbage trucks, and tractor trailers.



10



Component 2

Identifying the Lowest Branches in the Permanent Canopy

First, recognize that branches do not change their position on the trunk as the tree grows. In fact, it may be surprising for some to realize that all branches on trees with less than about 4" caliper will eventually be removed. Identifying the lowest branches in the permanent canopy will facilitate management of lower temporary branches (Figures 10 and 11).

Component 3

Prevent Branches below the Permanent Canopy from Growing Too Large

The lowest permanent branch on many shade trees should be at least 15 to 20 feet off the ground; all lower branches are eventually removed under ideal management. Lower branches should be subordinated (reduced) early to prevent them from becoming too large. This prevents the tree manager from having to make large pruning wounds on the trunk. We do this with reduction cuts to slow growth on these aggressive low branches. This helps to push new growth higher up in the canopy, and will minimize the amount of large cuts that need to be made on the trunk.

Figure 11

Structural pruning cycle over a period of 40 years. Notice how all of the branches on a newly planted tree and half of the branches on a 5- to 10-year-old tree are temporary. These branches are managed with reduction cuts to slow their growth and encourage more growth in the upper canopy, which is the part of the tree that will be around for a long time. In the maturing permanent canopy (center), the large scaffold branches have been identified and spaced evenly along the trunk by shortening or removing nearby branches.

Component 4

Keep All Branches Less than Half the Trunk Diameter

Branches more than one-half the diameter of the trunk lack a branch protection zone. This zone inside the branch union is rich in chemicals that inhibit spread of organisms and decay from the pruning wound into the trunk. Keeping branches less than half the trunk diameter ensures that the branch collar and branch protection zone remain intact.

Component 5

Space Main Branches along One Dominant Trunk

Ideally, main branches (also called scaffold limbs) should be spaced along the dominant leader in two or more rotations around the trunk so that no branch is directly above another (Figure 12). Spacing scaffold limbs allows for the trunk and leader to develop properly, gives the canopy a more balanced form, and reduces wind resistance.

Component 6

Suppress Growth on Branches with Included Bark

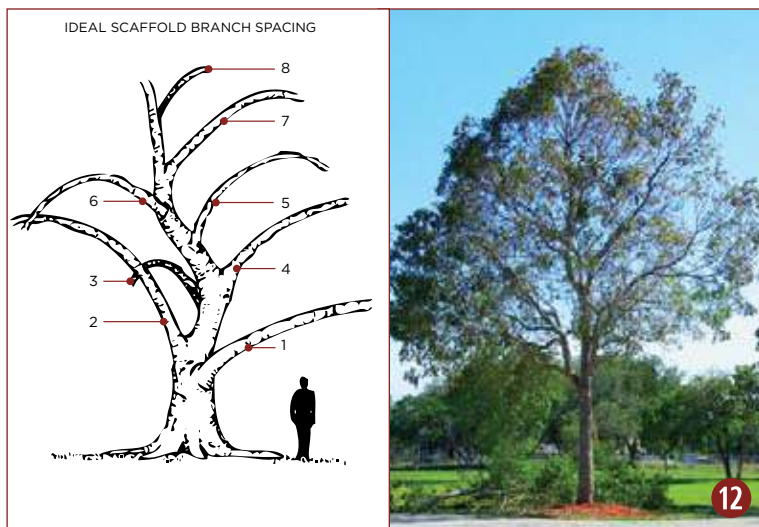
Suppress growth on branches with included bark (Figure 13) to minimize the chance of breakage. As mentioned earlier, included bark is a structural defect that causes the union between branch and trunk to be very weak. Reduce branches with included bark to slow their growth until you are ready to remove them.

Figure 12

Major scaffold branches on this mahogany tree (right) have been spaced evenly throughout the canopy so that no branch is directly above another, making the tree more structurally sound (left).

Figure 13

Variations of included bark on four different trees.



Determining Pruning Cycle and Pruning Dose

Pruning Cycle

The next step in developing a preventive pruning program is to determine the pruning cycle and pruning dose. A pruning cycle is the interval of time between each pruning event. The interval is affected by many factors. For instance, trees coming from a nursery with sound pruning practices will have a better structure to start out with than trees coming from a nursery with poor pruning practices. These low quality trees may require more pruning at a higher interval than the high quality trees.

Pruning cycles are also affected by growth rate, climate and species. In warm climates where trees grow faster, the intervals between pruning events should be shorter. Species that are prone to decay should also be pruned more often so that the need to make large cuts can be avoided. A typical pruning cycle for an active, preventive urban forestry pruning program in Florida is about three years. If the pruning cycle is too long, defects may become more severe. This results in having to make large pruning cuts, which can initiate pockets of decay in the trunk and branches. A pruning cycle of 3-5 years will require a higher pruning dose to achieve pruning objectives. Conversely, a pruning cycle of 1-2 years will require a smaller dose.

Suggested minimum pruning cycle

At planting
Year 2 or 3
Year 5 or 6
Year 8 to 10
Year 13 to 15

Pruning Dose

The pruning dose is the amount of live tissue removed from the entire tree at one pruning. More than this can be removed from any particular stem or branch. Typically, arborists estimate this by evaluating how much foliage was removed by the pruning. Customer expectations, size of stems and pruning cycle can influence the pruning dose (Table 1).

With a large pruning dose, you create large pruning wounds and a large void in the canopy, greatly encouraging growth in unpruned portions of the tree. Conversely, a small pruning dose creates smaller pruning

wounds and a smaller void in the canopy, encouraging modest growth in the unpruned portions of the tree. Large pruning doses are typically employed only on young trees. Municipalities often use larger pruning doses where aesthetics is less of a concern. A smaller pruning dose along with a shorter pruning cycle is nicely suited for residential and commercial properties where aesthetics are more of a concern. Pruning dose on mature trees should be less than 10% unless there is a good reason (e.g. a major defect) to remove more.

Table 1. Uses of high and low pruning doses

LOW PRUNING DOSE (5-20% of foliage removed)	HIGH PRUNING DOSE (>20% of foliage removed)
Mature or recently planted	Young, established trees
Cooler climates with short growing seasons	Warm climates with long growing seasons
Decay-prone species (poor compartmentalizers)	Decay-resistant species (good compartmentalizers)

Good compartmentalizers of decay (i.e. trees that resist decay following pruning) are those trees such as live oaks and mahogany that resist decay following an injury such as a wound or a pruning cut. When planning a pruning dose for your tree, you might want to set the maximum diameter of pruning cut smaller for a more decay-prone species (Table 2). The limit should be set for both reduction and removal cuts (Figures 14 and 15). Ideally, limit pruning cuts to 2-3 inches on decay-prone trees and 4-6 inches on decay-resistant trees. Large trees that are capable of forming heartwood will begin forming it as branch size increases to 8 inches or more. Exposing heartwood can initiate decay in certain species of trees. Professional arborists keep records of when species begin forming heartwood. This should help them decide when low interfering branches should be removed from trees.

Table 2. Guidelines for determining maximum branch diameter to prune.

BRANCH SIZE	CONSEQUENCE OF REMOVAL	RECOMMENDED ACTION
Less than 1/3 trunk diameter	Not many	Remove if needed
1/3 to 1/2 trunk diameter	Minimal	Shorten instead of removing
More than 1/2 trunk diameter	Some decay	Shorten instead of removing
Large enough to have heartwood	Defects more likely	Shorten instead of removing

Executing the Pruning Plan

Making Proper Pruning Cuts

An important component of a good preventive pruning program is making proper pruning cuts. There are two types of pruning cuts; these are reduction cuts (Figure 14), and removal cuts (Figure 15).

A good pruning cut begins with an undercut about 12 inches from the trunk (Figure 16). A top cut is then made further out from the limb or directly above the undercut. The majority of the limb is safely removed in this step without causing any damage to the tree. (Disregarding these first two steps could cause damage to the trunk because the branch is often too heavy to hold itself up causing tissue to tear down through the collar.) The last step is to remove the remaining stub with a final cut, being careful not to cut flush against the trunk. It is very important to leave the collar intact (Figure 17). A branch collar is a swollen area at the base of the branch where it joins the trunk. The tissue is rich in energy reserves and chemicals that hinder the spread of decay. Good pruning cuts avoid cutting into the collar and typically leave a round-shaped wound, whereas flush cuts are oval-shaped (Figure 18). The branch bark ridge is where trunk bark pushes up into the union as it grows against branch bark (Figure 19). This indicates a strong union. Never cut off the branch bark ridge since this removes the branch protection zone inside the collar. The protection zone helps prevent decay organisms from entering the trunk.

Bad cuts are called flush cuts and are unacceptable in a preventive pruning program (Figure 20). Flush cuts remove the top of the branch bark ridge, and prevent the wound from sealing over properly. Flush cuts typically expose more bark on top of the cut than on the sides and bottom. These cuts typically close first on the sides then on the top and bottom. Severe decay can occur behind flush cuts, especially when they are large in diameter.

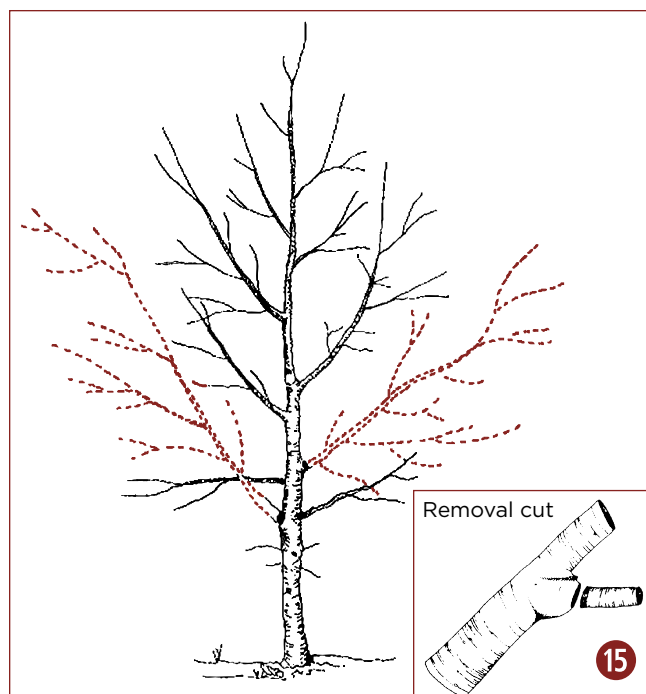
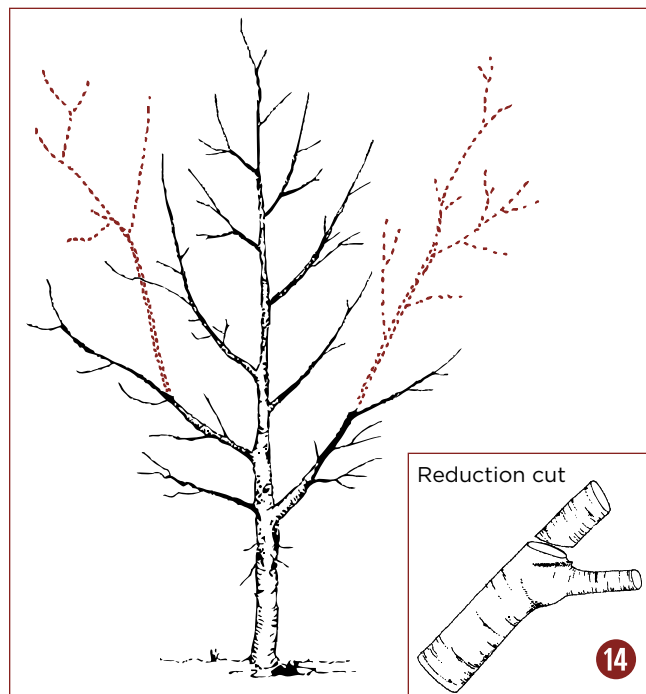


Figure 14

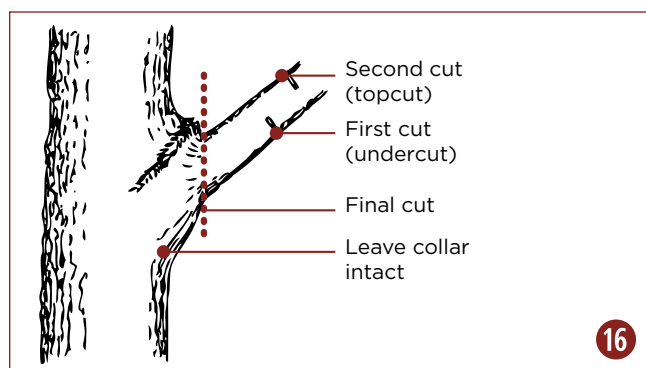
A reduction cut shortens the length of a stem by pruning back to a smaller limb large enough to assume dominance.

Figure 15

A removal cut prunes a branch back to the trunk or parent branch.

Figure 16

There are three steps to making a proper pruning cut that will minimize damage to the tree.



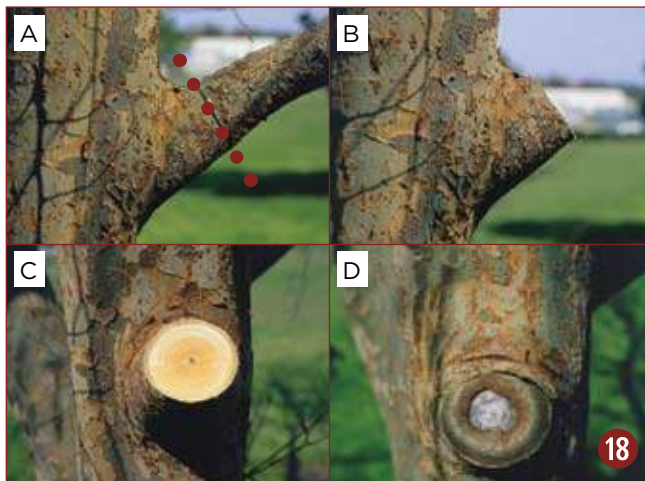
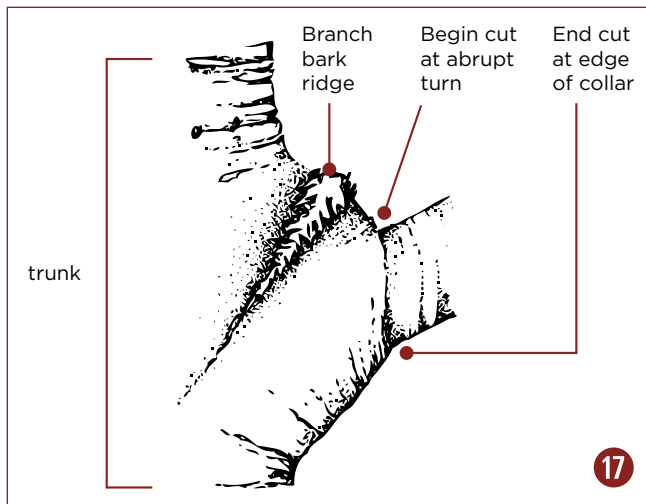


Figure 17

A close-up illustration showing where to make a removal cut.

Figure 18

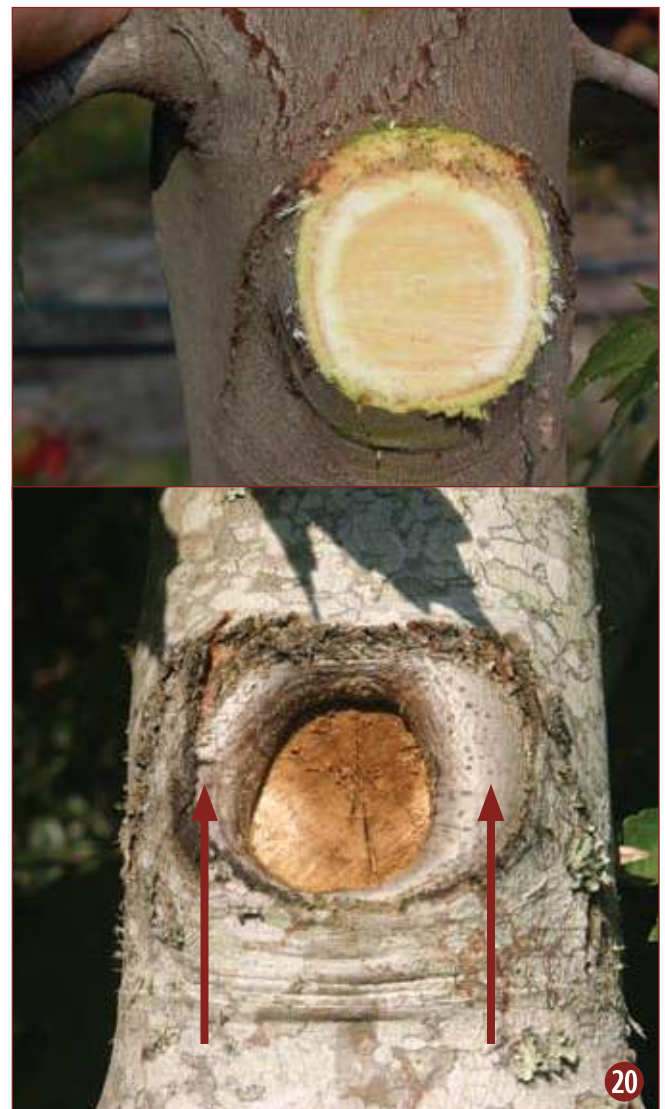
A proper removal cut is made by cutting on the dotted line (A). When done correctly, a removal cut leaves the collar intact (B). The wound from a removal cut should be round in shape (C). Callus formation around a proper removal cut wound should be symmetrical (D). A good way to teach yourself and others how to properly prune is to practice making cuts to look like C and D.

Figure 19

The “yes” (dotted) line represents an appropriate removal cut. Cutting through the “no” (solid) line cuts through the collar and represents a flush cut.

Figure 20

Flush cuts remove the top of the branch bark ridge, and typically expose more bark on top of the cut than on the sides and bottom (top). Flush cuts prevent the wound from sealing over properly, and typically close first on the sides then on the top and bottom (bottom). Severe decay can occur behind flush cuts, especially large ones.



Pruning Plans

With six to seven pruning events in the first 25 to 30 years after planting, a good structure can be developed that will place the tree on the road to becoming a permanent fixture in the landscape. Less frequent pruning may be required if good quality nursery trees were planted with a dominant leader and trees were irrigated appropriately until established. However, even well structured nursery trees will require regular pruning after planting. The following is an example pruning program for the first 30 years of a tree's life.

First Five Years after Planting

In the first five years after planting, most of the branches are temporary; however, do not remove more than 35% of the live foliage at any one pruning visit. This will minimize any stress the tree may experience from loss of foliage. Reduce all branches greater than 1/2 the diameter of the trunk. Select one stem to be the leader, and reduce or remove all branches competing with it. Reduce and/or remove large, vigorous branches low in the canopy, and remove any broken, cracked, or severely damaged branches. The pruning cycle and dose for these first five years should be determined individually for each tree type and size—for example, a pruning visit could be scheduled for year two and year four, or only one visit may be necessary during this period.

Five to Twenty Years after Planting

During this portion of the pruning program do not remove more than 25-30% of the live foliage at one time. Select the lowest permanent limb in the canopy and reduce/remove branches lower than this. Continue to reduce all branches greater than 1/2 the diameter of the trunk. Identify the largest scaffold limbs of the permanent canopy and reduce all branches within 18 inches of these. Reduce branches with included bark,

and reduce or remove competing leaders. This can be done in stages if there are more than three competing leaders. Again, the pruning cycle will vary. At least three pruning visits should be scheduled during this period.

Twenty to Thirty Years after Planting

Remove all branches below the first permanent limb by twenty to thirty years after planting. Identify 5-10 permanent scaffold limbs, and reduce branches within 18-60 inches of these to avoid clustered branches. Continue to prevent the development of defects by reducing branches with included bark and those branches competing with the main leader.

Additional Reading

Illustrated Guide to Pruning

Gilman, E. F. 2002. , 2nd edition. Delmar Publishers, Albany NY.

Landscape Plants

<http://hort.ifas.ufl.edu/woody/pruning>



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DEVELOPING A PREVENTIVE PRUNING PROGRAM IN YOUR COMMUNITY: MATURE TREES



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ENH 1063

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Introduction

A preventive pruning program should be designed to create structurally sound trunk and branch architecture that will sustain a tree for a long time. The goal with mature trees is to develop and maintain a sound structure to minimize hazards such as branch failure. This task is easier provided a good structure was established earlier in the tree's life.

When properly executed, a variety of benefits are derived from pruning. Benefits include reduced risk of branch and stem breakage, better clearance for vehicles and pedestrians, improved health and appearance, and enhanced view. When improperly performed, pruning can harm a tree's health, stability, and appearance. Several consequences occur when pruning is not performed at all (Figure 1). These consequences include development of low limbs; weak, codominant stems; defects such as included bark; and accumulation of dead branches. Formation of codominant stems and defects such as included bark can lead to increased risk of breakage.

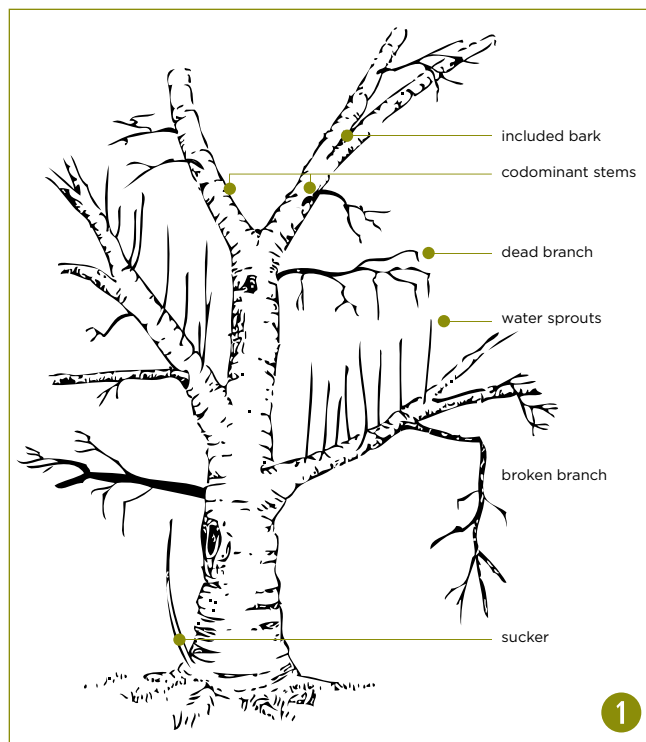


Figure 1

Problems that can develop on trees include codominant stems, included bark, broken and dead branches and large removed limbs that result in trunk decay.

One of the most common defects in planted trees is formation of large, low limbs. Branches of this nature could overextend and break, or they may droop under their own weight and have to be removed later, leaving a large pruning wound. Removal of large branches and those more than about half the trunk diameter is more likely to initiate decay than removal of smaller branches (Figure 2). Measures should be taken to avoid the occurrence of this defect.

With mature trees it is important to minimize hazards such as branch failure. Failures not only hurt the tree, but can also cause damage to people and property. Live branch removal is less desirable on mature trees, but it is sometimes necessary, for instance to remove a cracked live branch over a house. Hidden cracks often have elongated swellings such as seen at the arrows in Figure 3. A horizontal crack greatly affects the structural integrity of this branch. As such, it is a good candidate for reduction and/or thinning. The goal is to alleviate forces at the base of the branch. This is accomplished by reducing weight at the end of the branch so that the risk of breaking is minimized. Cleaning the crown by removing dead, diseased, or broken branches is a highly recommended practice on mature trees.

When planning a pruning program, it is essential to first evaluate the tree and the customer's needs. This will aid in determining which objectives should be accomplished with pruning. Appropriate pruning methods can be chosen to meet these objectives. The arborist then enters the tree and makes appropriate pruning cuts for the chosen pruning methods. This decision is based on an understanding of branch attachment and tree biology.



Figure 2

Large low branches (top) are starting to get in the way of traffic and will need to be removed. Removal of large branches can cause decay in the trunk (bottom). It is best to keep low branches small by regularly reducing their length should they have to be removed later.

Figure 3

Cracks in branches (top and bottom) and dead spots can result in branch failure, damage to structures, and injury to people. Dead spots often occur on top of branches.

Determine Pruning Objectives

No tree should be pruned without first establishing clearly defined objectives. Seven main objectives are described below, along with pruning methods that help meet those objectives. These objectives serve as examples and can be expanded or shortened to meet site conditions and customer expectations. Removing the correct stems and branches to accomplish specified objectives is as important as making correct pruning cuts. Even with proper pruning cuts, if the wrong branches or too many branches are removed, nothing of merit has been accomplished.

a	Reduce risk of failure	p. 3
b	Promote human safety	p. 3
c	Allow for safe passage	p. 4
d	Increase sun penetration to the ground	p. 4
e	Maintain health	p. 4
f	Influence flowering or fruit production	p. 4
g	Improve aesthetics	p. 4

a. Reduce Risk of Failure

Reduce failure risk by learning to recognize the structural problems in trees that can lead to failure (Figure 4). Risk of tree failure can be reduced by establishing a structural pruning program that begins at planting and could carry through the first 25 years or more, depending on species. This program should be designed to create structurally sound trunk and branch architecture that will sustain the tree for a long period. Some structural pruning can be conducted on older trees as well. Medium-aged and mature trees can be cleaned, thinned, reduced, raised, or restored to manage risk. The choice among these pruning methods depends on the tree and the situation. See Chapter 12 for a more detailed description on structural pruning.

b. Promote Human Safety

Pruning can prevent expensive damage to people and or property (Figure 5). If hazardous structural issues in trees can be recognized prior to a storm, pruning can help to mitigate their damaging effects. Developing a preventive pruning program for mature trees will help to reduce the likelihood of serious damage from trees.



Figure 4

The codominant stem (top) broke because of a bark inclusion at the branch union. Trees with decayed or severed roots fall over in storms (bottom).

Figure 5

If hazardous structural issues in trees can be recognized prior to a storm, pruning can help to mitigate their damaging effects.

c. Allow for Safe Passage

Growth can be directed away from an object such as a building, security light, or power line by reducing or removing limbs on that side of the tree. However, trees often grow back to fill the void created by pruning. Regular pruning is required to maintain artificial clearance. Shortening or removing low branches can raise the crown. Crown reduction or pollarding helps maintain a tree smaller than it would be without pruning. Utility pruning keeps limbs clear of overhead wires and other utility structures (Figure 6).

d. Increase Sun Penetration to the Ground

A lawn, ground covers, or shrubs can receive more sunlight when live foliage is removed from the crown of large overstory trees (Figure 7). The tree's resistance to wind can also be reduced with pruning. Thinning, reduction, and pollarding are used to accomplish this.

e. Maintain Health

Health can be maintained by cleaning the crown, especially in medium-aged and mature trees. Removing dead, diseased, and rubbing branches in the crown of young trees also is important.

f. Influence Flower or Fruit Production

Pruning can influence the number and/or size of flowers or fruit. Fruit size can be increased on certain plants, such as peach, by removing some of the developing fruit or flowers. Flower cluster size can be increased on certain species, such as crape myrtle, by heading. Fruit production can be eliminated by removing flowers or developing fruit.

g. Improve Aesthetics

A tree can be pruned to improve appearance. Cleaning, reducing, thinning, pollarding, and restoring can be used to meet this objective.



Figure 6

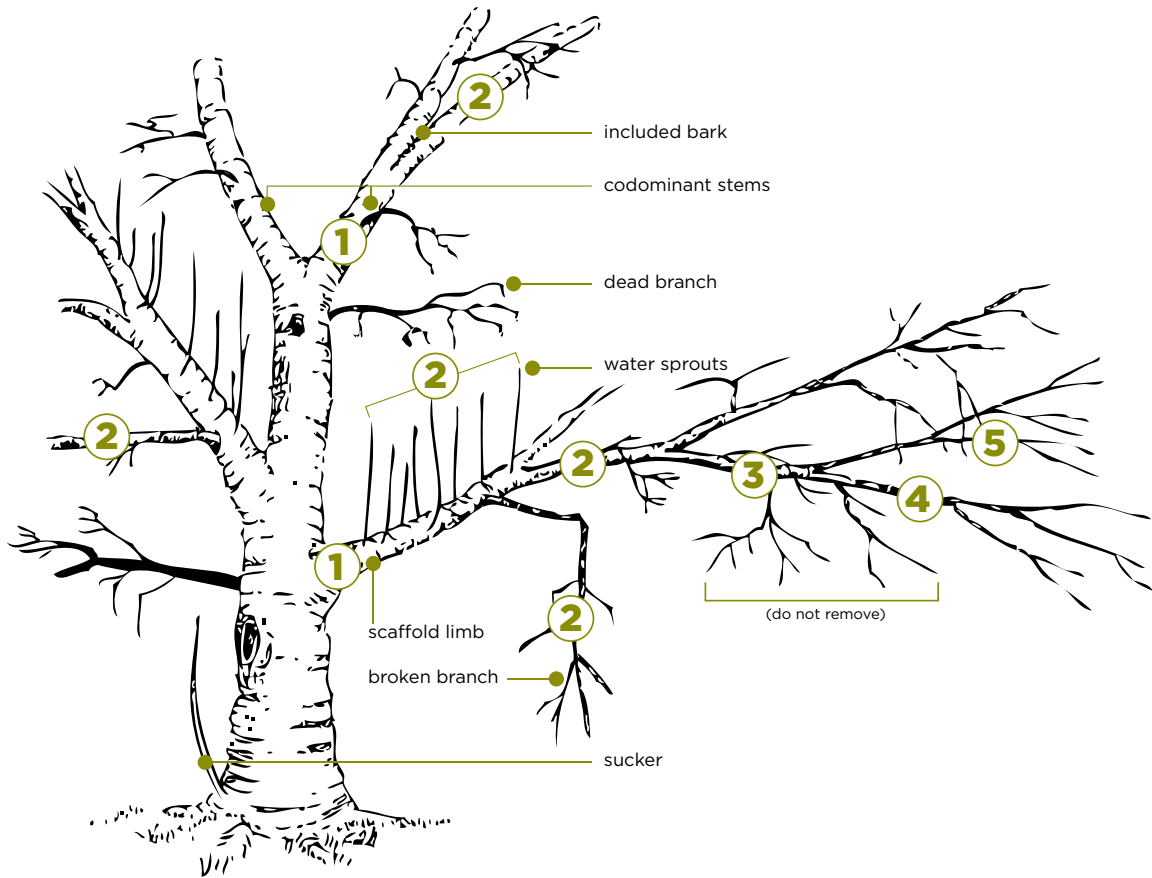
This live oak will have to be pruned often to provide clearance from the power lines. A better less expensive option is to plant a lower-growing species.

Figure 7

Before (top) and after thinning (bottom). The circle shows the area that has been opened up for more light and air to pass through. This can reduce likelihood of breakage in storms. Note interior branches were NOT removed.



Pruning Guidelines for Mature and Over-mature Trees



- ① Primary branches—do not remove
- ② Secondary branches—almost never remove
- ③ Tertiary branches—careful consideration
- ④ Quaternary branches—could remove some
- ⑤ Quinary branches—could remove several

The most important defect in this tree is the included bark in the upper right side of the crown. Shorten or remove the stem with the number 2 over it.

The other defect is the long limb on the lower right. This can be shortened by removing the branch with the number 4 over it.

There is no need to remove water sprouts, however some can be shortened to allow others to grow correctly.

8

Determine Pruning Cycle and Dose

Energy reserves (starch, sugars, and oils) are stored in branches, stems, trunk, and roots. Energy reserves can be preserved by removing the fewest number of live branches necessary to accomplish the desired objective. Excessive branch removal depletes these reserves and reduces the ability of the tree to photosynthesize more energy. There needs to be a good reason to remove live branches on mature and over mature trees (Figure 8). Many trees generate adventitious sprouts in response to over pruning as they attempt to replace the stored energy. Live branch pruning, however, is an essential ingredient to forming good structure, so it is a necessary procedure in an urban tree care program.

Figure 8

Only the lower right branch on this tree has been drawn to completion. The rest have been truncated for illustration purposes. When pruning an old tree, make cuts primarily on smaller branches toward the canopy edge only. Removing primary branches such as scaffold limbs may leave large pruning wounds and remove too much live tissue. Large old branches may have poor ability to restrict spread of decay following removal. Consider shortening or thinning the limb by removing tertiary and smaller branches instead of removing the branch entirely.

Execute the Preventive Pruning Plan

Make Proper Pruning Cuts

Three general types of cuts are used in arboricultural pruning: branch removal cuts, reduction cuts, and heading cuts. Removal cuts are the preferred type of cut because they leave the branch protection zone intact. The maximum and/or minimum diameter of pruning cuts should be stated before the work begins. Such specifications define the size of parts to be removed and the size of pruning wounds that result from the pruning to be performed.

Use Appropriate Pruning Methods

Pruning strategies for mature trees are quite different than those used for young trees. Often, it may be too late to make drastic structural changes to a mature tree. Good structure is something that should have been instilled in the beginning years of the tree's life. For mature trees your preventive pruning strategies are to 1) minimize hazardous conditions by cleaning and reducing weight where needed, 2) raise canopy where needed, and 3) maintain small-diameter interior branches for health and vigor.

These strategies are achieved through structural pruning, cleaning, thinning, raising, reducing, and balancing. Other important pruning tactics include root pruning, palm pruning, and restoration pruning.

Pruning for Structure

Structural pruning is the removal of live branches and stems to influence the orientation, spacing, growth rate, strength of attachment, and ultimate size of branches and stems (Figure 9). Structural pruning is used on young and medium-aged trees to help engineer a sustainable trunk and branch arrangement. If young trees are pruned to promote good structure, they likely will remain serviceable in the landscape for more years than trees that have not been structurally pruned. Waiting until the tree grows larger makes structural pruning much more difficult.

Structural pruning of large-maturing trees such as maples and oaks reduces certain defects and spaces main branches along one dominant trunk. It also reduces branches so they remain smaller than half the trunk diameter, which helps prevent structural failure later. In some cases, it may be too late to make meaningful structural changes to an already mature tree (Figure 10).



Figure 9

Structural pruning shortens stems and branches (indicated by bracket) that are competing with the leader or main trunk. Pruning cuts range in size from 1–3 inches for trees that are prone to decay. Pruning cuts can be up to 6 inches or more for trees that resist decay. A medium aged tree such as this one can withstand up to about 25 percentage of foliage at one pruning. More can be removed on any individual branch.



Figure 10

Structural pruning of young trees can correct defects as shown by the tree on the top which was pruned twice in the last three years. Note the dominant leader. If structural pruning is not performed when trees are young, defects can become severe and are unable to be fixed. Trees with massive codominant stems and included bark can become hazardous and can split apart unexpectedly in storms. These trees can be reduced in size to minimize likelihood of failure in storms.



FOR MORE INFORMATION »		
ON PRUNING CUTS	CH 12	Designing a Preventive Pruning Program In Your Community: Young Trees



Structural pruning can be summed up as: subordinate or remove codominant stems. Four procedures should be considered when structural pruning. The first procedure is to clean the canopy by removing dead, broken, diseased, and dying branches. The second procedure is to choose and develop a dominant leader (Table 1). Multiple prunings over time (for example, 15 to 25 years) usually are required to develop a dominant leader. For medium aged and mature trees, it is important to maintain the leader that has been established (Figures 11 and 12). To do this, competing stems and branches are subordinated (reduced in length or thinned) or removed. Subordination is usually preferred over removal, especially if the problem stem (or stems) is larger than half the trunk diameter. Subordination of large stems may cause less trunk decay than removal, and the offending stem can always be removed later, if necessary.

Table 1. Steps to establish and maintain a dominant leader.

1. Choose the one stem that will make the best leader.
2. Identify which stems and branches are competing with this leader.
3. Decide how much to shorten these competing stems.
4. Prevent branches from growing larger than half the trunk diameter by regular pruning.

Figure 11

Competing stems in the upper right canopy were too long and heavy with foliage (top). Several cuts were made to subordinate some of the competing stems (center). The cuts can be easily seen in the following winter (bottom). Note that lower branches were not pruned.

Figure 12

This is the size of the branch that was removed with the first reduction cut shown in Figure 11. Three of these were removed from the upper right side of the canopy.

The third procedure is to select and establish the lowest permanent scaffold limb if the tree is old enough. Establish the lowest permanent limb by shortening vigorous branches below it and reducing any lower branches that grow up into the crown (Figure 13). The height of the lowest limb is determined by the location and intended function of the tree. For example, the lowest permanent limb on a street tree might be higher than that on a tree in your yard.

The fourth procedure is to select and establish scaffold limbs by subordinating or removing competing stems/branches. Scaffold selection can take 10 to 20 years or more depending on climate, the type of tree, and its location. Scaffold limbs are located above the lowest permanent limb and provide the base on which to build the permanent crown. Scaffold limbs should be free of serious defects such as included bark and cracks, should be among the largest on the tree, and should be appropriately spaced apart. Vertical spacing should be at least 18 inches or more for large-maturing trees and about 12 inches for smaller trees.

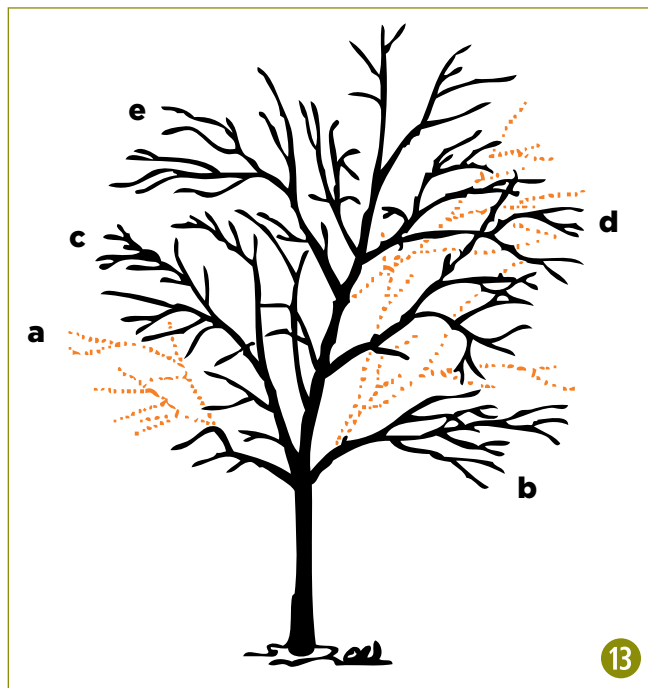


Figure 13

1) Cut back on branches *a* and *b* so branch *c* will become the scaffold branch at this position on the trunk. The portion of *b* was removed because it was growing up into the canopy; 2) remove or cut back (removal is shown) the main branch opposite *e* so *e* can become the scaffold branch at this point on the trunk. Branches *c*, *d* and *e* are now spaced along the trunk. The two small branches left on the trunk opposite branch *d* can remain because they are not likely to grow fast to compete with *d*.

Pruning to Clean

Cleaning is the selective removal of dead, diseased, detached, and/or broken branches (Figure 14). This method of pruning is done to reduce the risk of branches falling from the tree and to reduce the movement of insects and diseases from dead or dying branches into the rest of the tree. It can be performed on trees of any age but is most common on medium-aged and mature trees. Cleaning is the preferred pruning method for mature trees because it does not remove live branches unnecessarily. Cleaning removes branches with cracks that may fail when the interior wood dries.



Figure 14

Although dead branches normally cause less damage in hurricanes than live branches with defects, removing dead branches represents good tree care. Any damage caused by these small broken branches would be minimal compared to the threat of damage from larger branches.

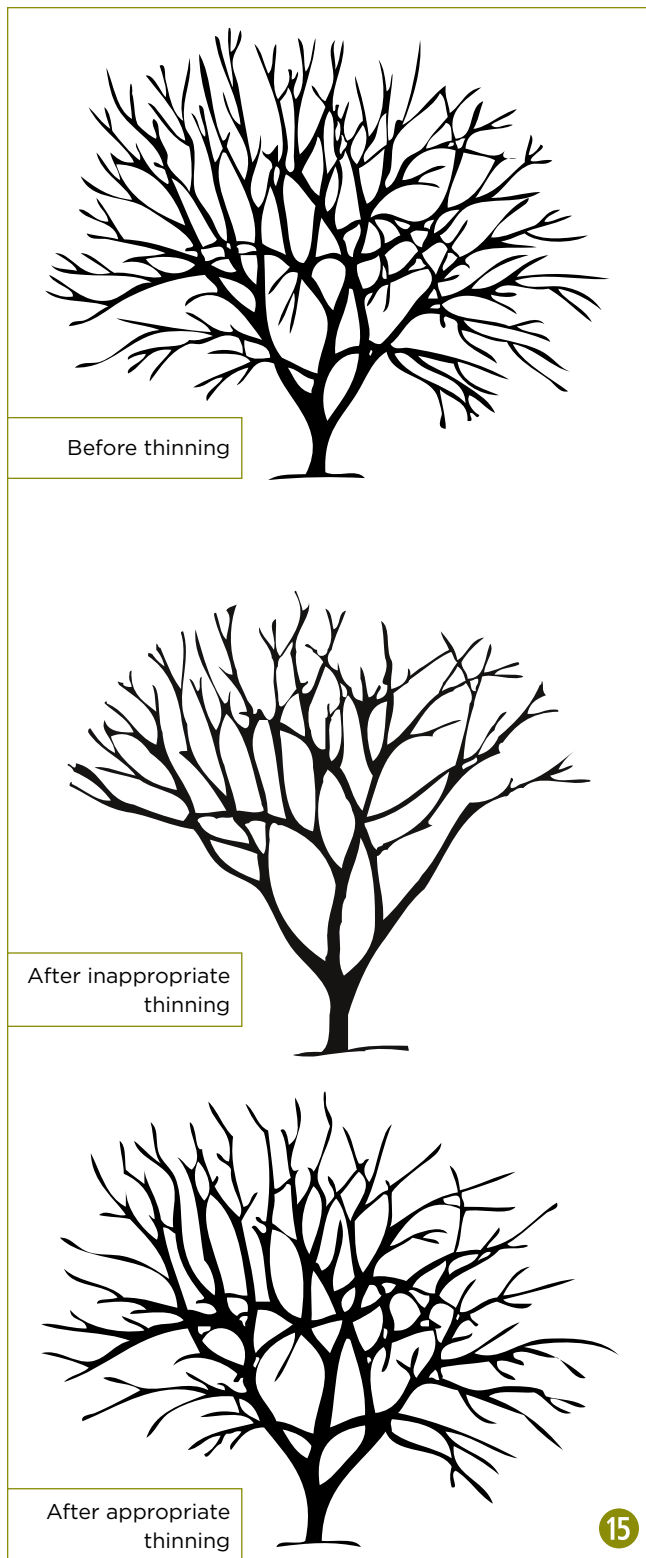


Figure 15

Inappropriate thinning only leaves branches at the edge of the crown, making trees more vulnerable to wind damage. Appropriate thinning leaves live branches distributed all along the limbs by removing branches primarily from the edge of the crown.

Pruning to Thin

Thinning is the selective removal of small live branches to reduce crown density (Figure 15). Because the majority of small branches are at the outside edge of the crown, thinning is focused in that area. Proper thinning retains crown shape and should provide an even distribution of foliage throughout the crown (Figure 16).

Thinning increases sunlight penetration and air movement through the crown. Increased light and air stimulates and maintains interior foliage, which can encourage taper on scaffold branches. Thinning can reduce the wind-sail effect of foliar clumps in the crown, and it can reduce the load on branch unions. Thinning a limb should be considered if cabling would be performed. Thinning also can remove suckers from the base of the tree and some water sprouts on the interior. Excessive removal of water sprouts often produces more water sprouts, so it is not recommended. Vigorous production of water sprouts on interior limbs often is a sign of overthinning or lion tailing (Figure 17).



Figure 16

Proper thinning retains crown shape and should provide an even distribution of foliage throughout the crown.

Photos courtesy of C. Way Hoyt



Excessive branch removal on the lower two-thirds of a branch or stem (lion tailing) can have adverse effects on the tree and therefore is not an acceptable pruning practice (Figure 17). Lion tailing transfers weight to the ends of branches and may result in sunburned bark tissue, water sprouts, cracks in branches, reduced branch taper, increased load on branch unions, and weakened branch structure. Lion tailing also changes the dynamics of the limb and often results in excessive branch breakage and sprouting.

Pruning to Raise (Elevate, Lift)

Raising is the selective removal of branches to provide vertical clearance (Figure 18). Crown raising shortens or removes lower branches of a tree to provide clearance for buildings, signs, vehicles, pedestrians, and vistas.

Excessive removal of lower limbs can slow development of trunk taper, can cause cracks or decay in the trunk, and transfers too much weight to the top of the tree (Figure 19). Mature trees could become stressed if large-diameter lower branches are removed. Clearance can sometimes be achieved by shortening some of the low branches rather than removing them to prevent these problems. Structural pruning should be considered along with raising.

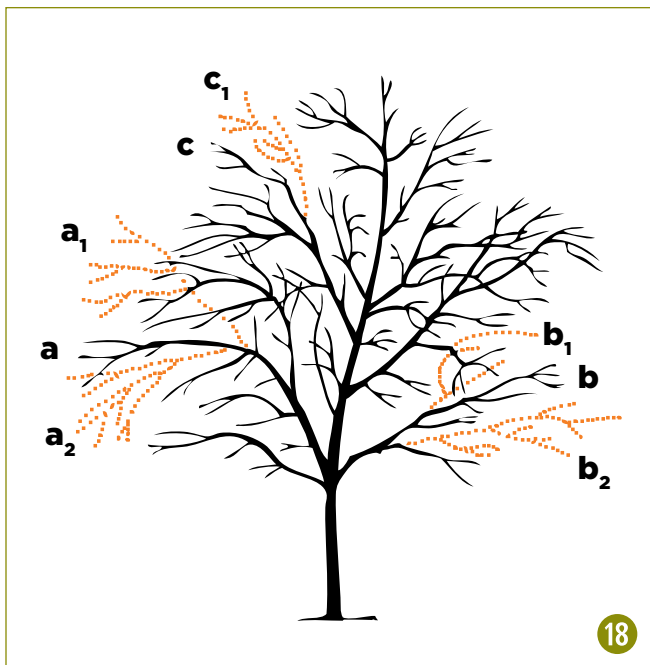


Figure 17

A lion-tailed tree (left) is stripped of foliage on the interior of the canopy. This produces excessive end weight at branch tips and makes the trees more susceptible to breakage in storms. Water sprouts (right) often result from breakage in years following lion tailing.

Figure 18

Lower branches *a* and *b* can be removed to raise the crown. However, subordinating branches *a* and *b* by removing upper and lower branches *a-1*, *a-2*, *b-1*, and *b-2* will cause less stress for the tree. Removing *a-2* and *b-2* helps raise the crown. Removing *a-1* and *b-1* ensures that the branches will not grow up to become part of the permanent canopy. Left unpruned, these branches are likely to remain vigorous and form low, codominant stems. Because structural pruning is important as well, branch *c* should be reduced to keep it from competing with the leader.

Figure 19

Over raising (left) often results in large pruning cuts and stress, leading to the production of water sprouts (right).

Pruning to Reduce (Shape, Drop-Crotch)

Reduction is the selective removal of branches and stems to decrease the height and/or spread of a tree or shrub (Figure 20). This type of pruning can be used to make the entire tree or portions of the tree smaller, which can reduce the likelihood of failure and direct branch growth away from buildings or signs. Portions of the crown, such as individual limbs, can be reduced to balance the canopy, provide clearance, or reduce likelihood of breakage on limbs with defects (Figure 21). Occasionally, the entire crown is reduced (Figures 22 and 23). Reducing or thinning should be considered if cabling is to be performed. Crown reduction should be accomplished with reduction cuts, not heading cuts.

Not all tree and shrub species can be reduced. Therefore, the species and plant health should be considered before starting work. Old, stressed, or mature trees could decline or become more stressed as a result of this treatment. When a limb on a mature tree is cut back to a lateral, no more than one half of its foliage should be removed. More can be removed on a young tree to accomplish particular objectives. More decay can enter the tree following reduction than following other pruning methods.

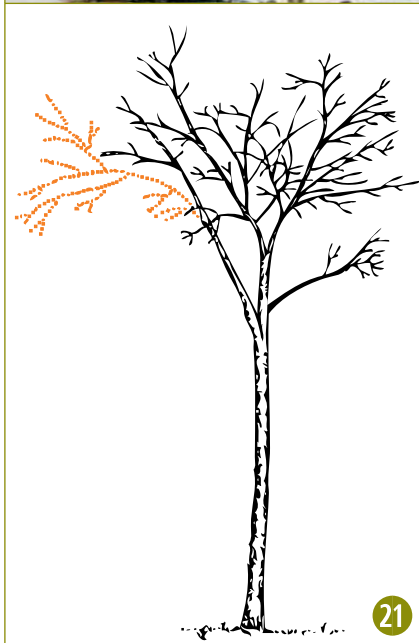
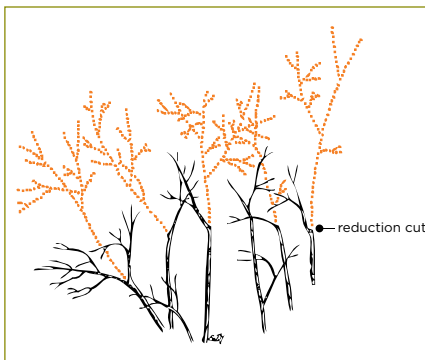


Figure 20

Reduction shortens stems and branches back to live lateral branches. (Left: removed stems and branch sections as shown by the dotted lines.) Notice that live, un-pruned branches remain on the edge of the new, smaller canopy, and no heading cuts were used. Properly done, this technique provides a more pleasing, un-pruned natural look to the tree compared to topping. Compared to topping, less decay is likely to enter the tree following reduction.

Figure 21

Reduction can be used to prevent the likelihood of failure on branches with excessive end weight (top). Branches may need to be shortened to balance the canopy or to prune it away from a structure or a sidewalk. This can be accomplished with small or large doses of reduction (bottom).

Figure 22

Clumped trees form a nice symmetrical canopy (top) but each individual tree is very one-sided. These individual trees are leaning away from the others as they grow. They are often lacking symmetry in their root systems as well. Roots on the opposite side of a lean play a large role in keeping a tree upright. Trees that lack roots to one side are prone to falling over (bottom). These trees are good candidates for canopy reduction and cabling to help prevent breakage.

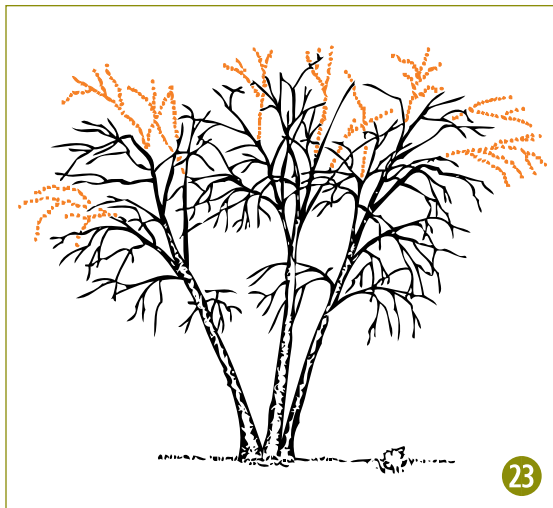


Figure 23

Use reduction cuts on clumped trees to reduce the weight of each tree, especially leaning ones. Consider installing hardware (cables or braces) to help hold the stems together.

Photo courtesy of Norm Easey



Figure 24

Restoration after a storm will take time, but it is possible.

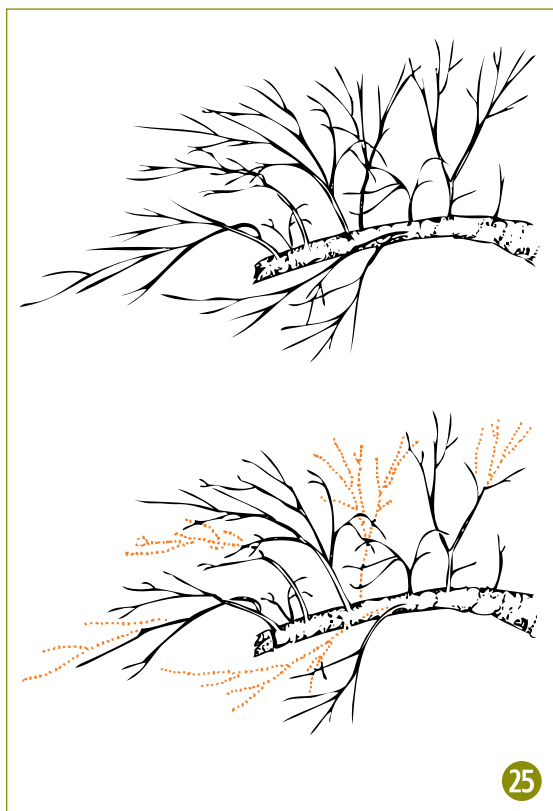


Figure 25

Many sprouts form from the cut ends of topped or storm-damaged trees (top). Some sprouts also develop below the cuts. Initially they are poorly attached to the tree and can break easily. Begin by removing dead stubs, removing some sprouts completely, and shortening others using reduction cuts (dotted lines bottom). This leaves several unpruned sprouts to grow into branches. The shortened branches help protect the sprouts that remain (bottom).

Pruning to Restore

Restoration is the selective removal of branches, sprouts, and stubs from trees and shrubs that have been topped, severely headed, vandalized, lion tailed, broken in a storm, or otherwise damaged (Figure 24). The goal of restoration is to improve a tree or shrub's structure, form, or appearance.

On trees with many sprouts originating at the tips of branches, one to three sprouts on main branch stubs are selected to become permanent branches and to re-form a more natural-appearing crown. To accomplish this, consider shortening some sprouts, removing others, and leaving some untouched (Figure 25). Some vigorous sprouts that will remain as branches may need to be shortened to control growth and ensure adequate attachment for the size of the sprout. Lion-tailed trees can be restored by allowing sprouts to develop along the interior portion of limbs for one to three years depending on size, age, and condition of the tree (Figure 26). Then remove and shorten some of



Figure 26

Newly emerging sprouts developing along the interior portion of a limb (top). Remove and shorten some so untouched ones are spaced apart (bottom).

the sprouts along the entire length of the limbs so the untouched sprouts are evenly spaced apart. Restoration usually requires several prunings over a number of years.

Pollarding

Pollarding is a training system that involves severe heading through small stems the first year followed by annual sprout removal to maintain trees or shrubs at a predetermined size or to maintain a “formal” appearance (Figure 27). Pollarding is not topping (Figure 28).

Pollarding historically was used for shoot generation for fuel, shelter, and various products because of the abundance of adventitious sprouts that a tree or shrub produces in this process. The pollarding process should be started on deciduous trees when the tree is young by making heading cuts through stems and branches no more than about three years old. Severe heading (topping) through older tissue may kill or start a decline syndrome on some tree species (Figure 28).

To pollard a tree, make heading cuts at strategic locations so that the sprouts from all cuts have access to sunlight. After the initial cuts are made, no additional heading cuts should be necessary. After a few pruning cycles, pollard heads (also called knuckles or knobs) develop, and the tree produces sprouts from these knuckles. Sprouts that grow from knuckles should be removed during the dormant season, taking care not to cut into or below the knobs. The knobs are the key differentiating factor between pollarding and topping. If knobs are damaged or removed in subsequent pruning, the branches react as they would on a topped tree.

Pruning Conifers

Some pruning methods are not appropriate for all conifers. For example, branch spacing and scaffold limb development in conifers usually is not necessary. Few conifers respond well to pollarding or reduction.

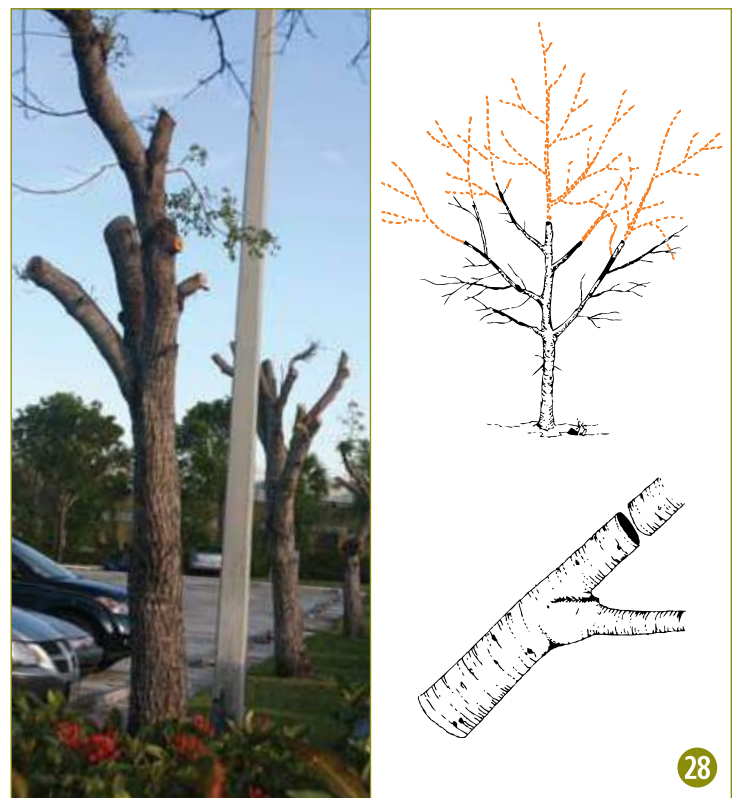


Figure 27

Sprouts pruned back to pollard heads (left). Pollarded trees flushing out with new sprouts (right). All sprouts are removed annually, typically in the dormant season.

Figure 28

Topping (left) is an inappropriate way to reduce a canopy. This type of pruning uses heading cuts (right) and can result in more problems in the future such as decay and structural defects. Large heading cuts are made between branches and result in stubs.

When to Prune

The best time to prune live branches depends on the desired results. Removal of dying, diseased, broken, rubbing, or dead limbs can be accomplished at any time with little negative effect on the tree.

Growth is maximized and defects are easier to see on deciduous trees if live-branch pruning is done in the winter or before growth resumes in early spring. Pruning when trees are dormant can minimize the risk of pest problems associated with wounding and allow trees to take advantage of the full growing season to close and compartmentalize wounds.

The timing of pruning can be an important part of a plant health care program. For example, one of the ways to reduce the spread of oak wilt fungus is to prune during the dormant season and avoid pruning susceptible species during April, May, and June.

Plant growth can be reduced if live-branch pruning takes place during or soon after the initial growth flush. This is the period when trees have just expended a great deal of stored energy to produce roots, foliage, and early shoot growth so pruning at this time usually is not recommended because of the potential stresses. Do not prune live branches from stressed trees at this time because they need all their live foliage to help recover.

Flowering can be prevented or enhanced by pruning at the appropriate time of the year. To retain the most flowers on landscape trees that bloom on current season's growth, such as crape myrtle (*Lagerstroemia* spp.) or linden (*Tilia* spp.), prune these trees in winter, prior to leaf emergence, or in the summer just after bloom. Plants that bloom on last season's wood, such as crabapples (*Malus*) and cherries (*Prunus*), should be pruned just after bloom in order to preserve the flower display. Fruit trees can be pruned during the dormant season to enhance structure and distribute fruiting wood, and they are pruned after bloom to thin fruit.

Certain species of trees, such as maples (*Acer* spp.) and birches (*Betula* spp.), drip sap (bleed) when pruned in the early spring when sap flow is heavy. Although unattractive, sap drainage has little negative effect on tree growth or health, and some of it can be avoided by pruning in summer or at other times of the year.

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DEVELOPING AN URBAN FOREST MANAGEMENT PLAN FOR HURRICANE-PRONE COMMUNITIES



PUBLICATION Nº

FOR 121

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Introduction

This chapter brings together the information and tools from previous chapters and changes the focus to the community rather than the homeowner, and from individual trees to the urban forest. The urban forest is the collective sum of all trees and vegetation in and around an urban area. Urban forests are an integral part of a community's well-being, so a management plan for its urban forest is essential to a community. An urban forest management plan should consider public and private trees as part of the urban ecosystem. An urban forest management plan does not allow a community to tell each individual or homeowner how to manage their property, but it does allow a community to take trees on private property into account so that planners can look at the entire forest as a resource to manage.

Communities (e.g. neighborhoods, homeowner associations, towns, or cities) can manage their tree resources to meet common goals using a management plan. By working together rather than as individuals, communities can maintain or enhance their urban forests and improve their

well-being. This chapter along with preceding chapters can be used as a guide for citizen and tree care professional participation in managing the community's urban forest and for community leaders in developing a plan for their urban forest.

The process outlined in this chapter is dynamic and adaptable and can be used by any community, regardless of type or size. All the components of this process are related and are part of the overall objective of achieving a healthy, wind-resistant urban forest. A healthy urban forest is composed of trees that maximize ecosystem benefits and withstand natural and anthropogenic stresses and disturbances, such as wind from hurricanes and tropical storms, flooding, pollution, etc. Several urban forest management and street tree master plans were reviewed in preparation of this chapter. Additionally, conversations with urban foresters from across the Southeastern US and elsewhere were used to develop this outline to help a community start its own process.

Why Develop an Urban Forest Management Plan?

An effective urban forest management plan¹ should be developed and implemented before damage from a windstorm or hurricane occurs. It also can be used as a blue print for post-hurricane response to damages after a storm. Developing a management plan can:

- Create a safe and attractive environment.
- **Maintain or enhance public and private urban forest cover.**
- Provide ways of responding to the community's needs and requests.
- **Maximize the well-being of residents and visitors.**
- Minimize the costs of managing your trees and hazards to life and property.
- **Improve coordination of management activities with other associations, neighborhoods, departments or offices.**
- Establish measurable and long-term goals and objectives.



Figure 1

The process of developing an urban forest management plan for hurricane-prone communities.

¹ An urban forest management plan outlines day to day management activities, or the who, what, when and how, that need to be accomplished to achieve a community's goals and objectives regarding their public and private trees. This is different from a street tree master plan, which involves specific goals and objectives and management related to public trees along streets and public rights of way (Hubbard 2000).

How to Develop an Urban Forest Management Plan for Hurricane-Prone Communities?

In general, a community urban forest management plan for hurricane-prone communities needs to be viewed as a process and not a product (Figure 1).

Figure 1 outlines a process that will answer four basic questions using seven general approaches:

What does the community want from its urban forest?

- Creating a vision (p. 2)
- Setting visions, goals and objectives (p. 3)
- Getting community participation (p. 3)

What is the community's urban forest resource?

- Assessing the community's tree, fiscal, and human resources (p. 5)

How can the community achieve the urban forest it wants?

- Developing goals and objectives (p. 4)
- Implementing a plan to meet the goals and objectives (p. 7)

Is the community achieving the urban forest it wants?

- Monitoring and evaluating (p. 8)

Creating a Vision

At the beginning of this process, the community should identify a vision for its urban forest to achieve a functional management plan (Figure 1). A vision statement will help define the goals and objectives, which lay the framework for the management plan. A vision is the desired future condition of the urban forest, and it should be concise and meaningful (Hubbard 2000). This vision needs to be created by and accepted by the community. Community consensus is critical in defining what goals are most important because the time and resources available to implement those goals are limited. For example, the vision of the Urban Forest Hurricane Recovery Program might be to promote a healthy and wind-resistant urban forest. It could be aimed at helping citizens and communities to restore an urban forest after storm damage and to set better urban forest management practices so that future storms are less devastating.

Setting Visions, Goals and Objectives

Goals

Goals are the general statements about what your community is trying to accomplish. Each goal statement then has its own set of objectives. A goal for hurricane-prone communities could be to maintain or increase tree cover, wind resistance, and tree diversity.

Objectives

Objectives are focused, measurable, result-oriented activities that support the completion of a goal and help the community meet its vision. Some example objectives for a wind-resistant urban forest might be to remove hazardous trees, initiate a pruning program, and plant wind-resistant trees of different ages and sizes in groups in appropriate locations.

Different goals do not have to be exclusive or independent of one another. They often can be linked to achieve multiple benefits. If other goals for a wind-resistant urban forest are to reduce storm water runoff and energy use, specific objectives could be to 1) use porous surfaces in parking lots and 2) plant groups of wind-resistant trees for shade. These combined objectives could result in reduced storm water runoff and increased urban forest cover in your community. So, by selecting species that are wind-resistant and planting them in groups in appropriate areas to reduce storm water runoff, the community increases its tree canopy and shade, improves wind resistance, reduces energy and thereby achieves all three goals (Figure 2). In the following sections we will explain how this publication can be used to help you select some goals and objectives toward creating a more wind-resistant urban forest.

Community Participation

To be effective, the vision statement and well defined goals and objectives should be a community activity (Figure 1). Establish a broad-based community working group or team (Letson, 2001). A meeting facilitator is often needed to ensure that everyone is heard and that all concerns are identified. The group should meet periodically. For example, the working group could consist of:

- Private citizens
- **Community and urban foresters**
- Tree care professionals
- **Parks and recreation, planning, zoning, and extension service representatives**
- Emergency management services
- **Media contacts**
- Public utility providers
- **Engineers**
- Local non-profit organizations, and
- **Other public entities depending on the characteristics of your community**

An example of a working group was the one that helped develop Miami-Dade County's Street Tree Master Plan which establishes the direction for planting and managing trees along streets and highways for beauty and environmental benefits. The group consisted of The Community Image Advisory Board, Department of Environmental Resources Management, Public Works, Planning and Zoning, Cooperative Extension, Office of Strategic Business Management, Parks and Recreation, Office of Emergency Management, among others (Miami-Dade County, 2007).

If the community has not participated in the development of the management plan from its outset, the plan should at least be presented to the community before it is implemented so that residents



Figure 2
Combining different species and surfaces to meet multiple objectives.

and community planners can participate in the decision-making process and, if necessary, help develop alternative management options if initial proposals are not acceptable (Figure 1). Involving the community in the decision-making process will give the management plan a greater chance of acceptance and success:

- The community can help identify and develop alternative management options.
- **The team can discover new information relevant to the community and urban forest.**
- The plan and its actions will demonstrate fairness for all the members of the community.

Some ways of increasing community participation include:

- Discussing the plan with friends and neighbors.
- **Organizing outreach activities such as news releases and public meetings.**
- Developing educational programs for schools and other community groups.
- **Establishing your city as a Tree City USA.**

Developing Goals and Objectives

It is important to narrow down: (1) who will be responsible for implementing the plan; and (2) what and how and when the plan's activities will be carried out (establishing a timeline). The information, lessons, and strategies from previous chapters can be included directly as objectives in your plan. For example:

- An objective to reduce or prevent the number of tree wind failures can use information from [Chapter 6—Urban Design for a Wind Resistant Urban Forest](#), which presents appropriate design and plan management strategies. This chapter and [Chapter 5—Lessons Learned from Hurricanes](#) also present urban design strategies for increased wind resistance, such as planting trees in groups rather than individually and giving trees enough rooting space for their size (Figure 3).
- Specific post-hurricane restoration objectives and activities in your plan can use information from [Chapter 4—Restoring Trees after a Hurricane](#), which explains specific tree pruning activities necessary for restoring trees after hurricanes. Also [Chapter 12—Developing a Preventive Pruning Program: Young Trees](#) and [Chapter 13—Developing a Preventive Pruning Program: Mature Trees](#) outline preventative pruning programs for young and mature trees. These can be used as multi-year objectives that can reduce damage from future storms for new and existing trees.

- Use of wind-resistant tree species is one objective for achieving a wind-resistant urban forest. [Chapter 8—Selecting Southeastern Coastal Plain Trees Species for Wind Resistance](#) and [Chapter 9—Selecting Tropical and Subtropical Trees Species for Wind Resistance](#) list tree species that have been determined to be wind resistant.
- Objectives can also incorporate lessons from past hurricanes. [Chapter 5—Lessons Learned from Hurricanes](#) for example mentions removing hazard trees before the wind does and being careful not to damage or cut main support roots during construction, since this will damage the tree's anchoring system.
- After Hurricane Andrew, more trees were damaged as a result of hurricane debris clean up (Burban and Andersen 1994). By designating areas for debris storage and temporary housing, communities can avoid causing further damage to their urban forests.
- Additional goals and strategies to reduce your risk from tree damage can include maintaining diversity in your community by planting a mixture of species, ages, and layer tree and shrub canopies (Miller 1997).



Photo courtesy of the National Oceanic and Atmospheric Administration

Figure 3

Aerial view of the effects of a hurricane. Would proper species selection and planting trees in groups have prevented this?

Developing Goals and Objectives Specific to Your Climate

Among its urban forest master plan objectives, Rochester NY determined to select trees with strong branch structure to minimize ice storm damage, prohibit the planting of ash trees to minimize damage from emerald ash borer, and establish a database to identify and separate street segments covered by Federal Highway Administration reimbursement from those covered by Federal Emergency Management Agency (City of Rochester 2005). Other cities such as Urbana, Illinois have tree emergency response plans that closely follow their snow removal plan (Personal Communication, Mike Brunk, City Arborist).

Using the example from northern cities, hurricane-prone communities could develop emergency management goals as part of their plan (Letson, 2001). The draft urban forest management plan for Pineville, Louisiana, for example, calls for developing "storm plan" objectives to be followed when a storm occurs (City of Pineville, 2006). Although an objective like this might be complex for large metropolitan areas affected by the severe 2004-2005 hurricane season, it might be simple for smaller communities.

The working group needs to determine which goals and objectives are the highest priority and which can be achieved within current fiscal and resource limitations and then develop action items and specific steps necessary to achieve every objective. In fact, most objectives in a management plan need alternative options because of changes in funding, personnel, and community concerns (Figure 1). Objectives can also be presented as alternatives or designed to accommodate several goals and contingencies. For example, three alternative objectives for removing hazard trees in order to achieve the goal of a wind-resistant urban forest are:

Objective 1

Remove all hazard trees at once

This represents an improved efficiency and lower cost since work crews need to visit a neighborhood only once to remove undesirable trees. On the other hand, a significant portion of the canopy would be removed and this might upset residents who value these trees.

Objective 2

Remove hazard trees and wind-prone species as opportunities become available

This gradual change to the canopy might be less disruptive to the community but it will be less efficient and cost more than Objective 1 because crews will need to visit a neighborhood several times to complete the objective before a hurricane affects the community.

Objective 3

Leave hazard trees in place

This objective will prove catastrophically costly and inefficient if a storm strikes, but it may nevertheless be the most appealing to the community if it does not have any resources to allocate to tree removal.

As with most things in life, there will be trade-offs and these need to be assessed by the more specialized members of the working group (e.g. tree care specialists) and reviewed and accepted by the community. If the team and the community review the trade-offs together, there will be a greater chance of finding a compromise or solution acceptable to most of the community.

Assessing the Community's Tree, Fiscal, and Human Resources

Most communities will need some information to help develop the vision, goals and objectives. Some key questions this information should answer are:

- What should the urban forest look like and provide for the community?
- **How much urban forest do we want and need now and in the future?**
- Why do we want to manage the urban forest?
- **How will we respond in case of a hurricane?**

The information needed for your plan can come from several sources (Letson, 2001). Historical records, lessons learned from past hurricanes, library resources, and other community groups can have tree-related

information needed for developing your plan. *Chapter 4—Restoring Trees after a Hurricane* and *Chapter 5—Lessons Learned from Hurricanes* in this series can be especially useful for this. A systematic inventory of trees in your community is particularly useful for assessing, establishing, and measuring your goals and objectives. Keep in mind that data collection is expensive; measure only what is needed. Chapters 7 through 10 in this series and Miller (1997) will provide you with ideas for selecting appropriate trees including tree species, size, condition, location, growing space, and site history (see <http://orb.at.ufl.edu/FloridaTrees/> for more information).

The working group needs to identify what information is necessary to accomplish the goals and objectives. This will help to identify problems and issues. But once the team has had community input, specialists should begin to lead the process (Figure 1). An urban forester or arborist on the team can determine what data to collect during an inventory to meet management objectives. Remember, there is no right or wrong type of assessment or inventory; this will depend on your community's vision, goals, objectives, and resources.

Information on current or past management practices (e.g., pruning history) and canopy characteristics is also useful for developing your objectives. For example, *Chapter 3—Assessing Hurricane-Damaged Trees and Deciding What to Do* indicates that species suffering high branch loss during hurricanes will need pruning and long-term monitoring. Reviewing current practices (such as tree planting, pruning and removal) and plans (such as street tree management, emergency response plans, ordinances, etc.) can also identify common goals and help to explore ways to integrate efforts (Letson, 2001). The urban forester or arborist in the working group can assess tree risk and pruning programs and prioritize areas for tree removal.

A Lesson Learned

Hurricane Andrew (Figure 4) revealed that unwise urban forest composition and planting practices resulted in extensive and unnecessary urban forest loss and associated damage to property (Burban and Andersen, 1994). Additionally, in many cases more trees were damaged as a result of hurricane clean up. Trees were used as brace posts to load debris and natural areas, and undamaged trees were bulldozed to make room for debris and temporary housing. Lessons from past experiences such as these can be used to assess the history of your tree resources and provide your community with insights on what is likely to happen after a hurricane (Letson, 2001). Chapters 1 through 3 in this series present tree-related hurricane response activities you might expect after a hurricane; some of these recommendations can be included in your plan as objectives.

Figure 4

Hurricane effects on palms in southern Florida: Hurricane Wilma (top) and Hurricane Andrew (bottom).



An Ecosystem Approach to Assess Your Urban Forest

The city of Tampa, Florida assessed their entire urban forest ecosystem (public and private trees) rather than just focusing on trees in streets and parks. The information gained through this city-wide assessment of Tampa's urban forest ecosystem will help the community develop a more comprehensive and effective management plan because public and private trees are included in the analysis (Figure 5). This ecosystem approach could also be used as baseline information for monitoring and assessing hurricane effects on trees and to provide information for emergency management agencies. Other cities such as Houston, Texas and Minneapolis, Minnesota have also used this approach for promoting and raising awareness of their urban forest (www.itreetools.org).



Figure 5

Aerial view of an urban forest ecosystem.

The team needs to assess the resources available—people, funding, and time—to manage the urban forest. Unfortunately, many activities that need to be done to create a wind-resistant urban forest might not be feasible. For example, species listed in *Chapter 8—Selecting Southeastern Coastal Plain Tree Species for Wind Resistance* and *Chapter 9—Selecting Tropical and Subtropical Tree Species for Wind Resistance* might not be available, or initiating preventative pruning programs from *Chapter 12—Developing a Preventive Pruning Program in Your Community: Young Trees* and *Chapter 13—Developing a Preventive Pruning Program in Your Community: Mature Trees* might be limited by budgets. An assessment of your resources will identify what can and cannot be done, thus defining the scope of the plan and its timeline (Figure 1).

Resource assessment is a critical step because it identifies limitations as well as potential avenues to minimize those limitations. For example, if funding is a critical issue, the team may want to apply for an urban community forestry grant to help offset costs. Similarly, if personnel is a critical issue, the team may want to hire a consulting firm specializing in urban forestry to do the inventory and data synthesis. Planners and working group members with fiscal experience can help assess available fiscal and human resources.

The state and private forestry organization of the USDA Forest Service and State Forestry Agencies, in partnership with national and local organizations, provide financial and technical assistance to plan, protect, and manage trees. Most states have urban and community forestry grant programs that can be used to fund tree inventories, management plan development, and other activities. For more information see <http://www.arboday.org/programs/urbanforesters.cfm>.

After assessing your urban forest and community resources, review the management plan's goals and objectives to ensure that they are still relevant in light of the information generated by your assessment or inventory (Figure 1).

Implementing the Goals and Objectives of the Plan

Once the community has selected objectives, it's time to carry them out to meet the agreed-upon goals.

Implementation is a continuing process in the long-term care of the urban forest, and should not be seen as the "last step" of a finite project (Figure 1). All of the planning and building of consensus up to this point

will help to ensure that the plan runs as smoothly as possible. But you should expect implementation to be an ongoing learning experience, and anticipate the need for contingency planning.

Some objectives can be achieved within a certain timeline, but this process needs to be updated regularly because your community, environment, resources and urban forest will change. Information from Chapters 4 through 13 of this publication series present several strategies that can be incorporated into your plan. In Florida, hurricane-prone areas are experiencing tremendous growth, and many new communities are being created every year. People and trees are constantly undergoing changes, and hurricanes will continue to strike Florida. It is essential for communities to plan as they grow to be in the best shape possible to withstand hurricanes. At this point in the urban forest management plan process, participation of team members representing emergency management services, public utilities, and municipal/county personnel is crucial.

It's Important to Adapt Your Plan

The city of Plantation, Florida developed its urban forest management plan in 2003. A tree inventory of over 5,000 trees served as the baseline information for developing their goals and objectives (City of Plantation, 2003). However, the 2004-2005 hurricane seasons affected the city's tree cover substantially. As a result, the inventory could no longer provide the information necessary for meeting the goals established in the plan. Rather than continuing with the original plan, the community will adapt their goals and objectives after conducting a new tree inventory. This type of change is inevitable and the ability to adapt is necessary in any hurricane-prone community.

Figure 6
Monitoring urban trees after and before a hurricane.

Monitoring and Evaluating the Plan

During the implementation your plan, it will be necessary to establish procedures for monitoring and adapting your plan. A management plan should be viewed as a living document continually changing to reflect changes in resources and funding, and the needs of the community. In most existing urban forest management plans, monitoring is the most neglected step. Yet, it is one of the most critical elements of any plan because it will determine if the plan's goals and objectives are being met.

Monitoring is the collection of information to determine if the plan's goals and objectives are being met – in other words, is your plan effective? When monitoring the objectives and goals of your plan, the working group should ask the question “What are we doing to meet our goals and vision?” It is important to determine what your monitoring indicators or milestones will be. You can observe and collect information on many indicators. For instance, number of tree plantings, increases in tree cover, and number of trees pruned per year (use Chapters 11 through 13 to help you select indicators). Select indicators that are easily measured and repeatable so that the community can measure progress. Avoid collecting too much data and focus instead on the objective's relevancy to your goals. Make your monitoring efforts as explicit and simple as possible, and be sure they are clear to everybody on the team (Figure 6).



Monitoring allows you to evaluate how well your activities are achieving your plan's objectives. Evaluate your monitoring information as a team, learn from other team members and modify or improve goals if necessary (Figure 1). Development of a management plan is a continual process and will not end with the writing of the plan. Monitoring will also provide feedback on how to improve your plan.

Evaluation May Mean Learning and Changing Your Plan

As part of their urban forestry management plan, the city of Charleston, South Carolina monitored and evaluated its tree maintenance operations. Charleston's urban forestry division's tree maintenance activities were compared to those of six other municipal forestry departments from other parts of the United States to determine how effectively the Charleston division was fulfilling its objectives (City of Charleston, 2000). Although Charleston was highly responsive to its citizens, it did not have a proactive pruning program. Initiating a proactive pruning program will allow the city to care for a greater number of trees and keep them maintained, reducing the need for "repair work" as the trees grow, which should in turn reduce the number of citizen complaints. Chapter 12 and 13 can be used to develop pruning program objectives in your plan.

The town of Leesburg, Virginia also evaluated its current tree management organization and determined that they needed to develop a clear urban forestry policy, improve the organizational structure and staffing levels, and provide adequate financial resources for urban forest management (Town of Leesburg, 2006).

Every community is different, and the task of balancing community needs with urban forest and budget needs is complex. But the results of monitoring and evaluation can also provide reasons to celebrate. Change is inevitable and not always bad. It's important to identify successes in your plan. When a milestone is met, this is reason to show the community the improvements to their environmental. Celebrate with press releases, arbor days, park openings and other publicity efforts to involve and educate the public. Keep in mind that a visible program results in more community support in both times of budget expansion and tightening.

Final Considerations

This publication series can provide you with a tool kit of information on how to develop and execute your urban forest management plan. Management is a continual process of learning and adapting to change (Figure 1). Reviewing the community management plan's vision, goals, objectives, and activities should be an important and on-going component of any management plan. A plan and its vision should not have a shelf life of 5, 7 or 10 years. If the ecological, economic or social assumptions that directed the initial plan change or become questionable, then the plan needs to be adjusted to meet the new realities.

In the aftermath of a hurricane, the health of a community's trees is about the last thing on anyone's mind. Urban forests will be secondary to ensuring public safety, mitigating hazards to property, cleaning debris, and restoring public services and utilities (Burban and Andersen 1994). In fair weather, however, urban forests should be a primary community concern. Careful planning for the allocation of resources to the urban forest will provide a community with a healthy, strong, wind-resistant forest that will help it withstand a hurricane. This fact should remind you of the need to consider hurricanes during your planning process and in fact, it makes considering hurricanes in your plans critical.

Things to Remember:

- Objectives can have time lines but the plan itself should allow for change.
- **A clear vision, community participation, monitoring, and the ability to adapt your plan for an eventual hurricane or other event is good fiscal policy and ensures the sustainability of the urban forest and its services.**
- By considering the approaches and information presented in this chapter and integrating the tools from previous chapters, communities can develop objectives that will help prepare them to effectively respond to a hurricane.
- **The lessons learned from previous hurricanes and the tools in this series can be used to design objectives that will help communities develop pre-hurricane goals, objectives, and activities and restore their urban forests after hurricanes**
- Success of an urban forest management plan will require the members of a community to cooperate with each other. Include on your team anyone with a stake in maintaining a healthy urban forest: public agencies, businesses, institutional landowners, green industry contractors, and emergency management services. Cooperation will create a common vision that values the urban forest and a community that works together to restore itself after a hurricane.

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Sample urban forest management plans, street tree master plans, and other documents

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2002 Community Forest Management Plan

City of Miami Beach, Florida
Hurricane preparedness fact sheet

Georgia Forestry Commission
2001 Model urban forest book

City of Horn Lake, Mississippi
2004 Tree Inventory Management Plan

State of Mississippi
2005 Urban and Community Forestry Management Manual

Charlotte, North Carolina
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Knoxville: Street Tree Master Plan

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2006 Community Forestry Management Plan

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1992 Urban Forest Management Plan

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Wind and Trees: Lessons Learned from Hurricanes¹

Mary L. Duryea and Eliana Kampf²

Introduction

Hurricane-force winds can be extremely damaging to communities and urban forests. Without question, trees can become hazardous and pose risks to personal safety and property. As destructive as these storms are, it is important not to forget that trees provide many environmental benefits, such as providing shade and energy conservation, reducing the well known “heat island” effect in cities caused by concrete and pavement, and increasing property values. Also, there are opportunities to better prepare for the next hurricane season by rebuilding a healthy urban forest. Valuable lessons can be learned from knowing more about how, when, and why trees fail in storms. A key issue facing communities is how to manage the urban forest from an ecological standpoint so urban forests are healthier and more wind-resistant.

A healthy urban forest is composed of trees that maximize ecosystem benefits while being able to withstand natural and anthropogenic stresses and disturbances, such as wind from hurricanes and tropical storms, flooding, pollution, etc.

This fact sheet reports on the lessons learned from research conducted after 10 hurricanes by scientists at the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS). It also includes valuable field observations from professionals, such as urban foresters, scientists, and arborists.

Our goal is to promote a healthy and more wind-resistant urban forest. This publication is aimed at citizens and communities who seek to rebuild and set better urban forest management practices so that future storms are less devastating.

The Study

Since 1992, when Hurricane Andrew struck south Florida, researchers at UF/IFAS have been studying the impacts of hurricanes on the urban forest (Duryea et al. 1996). Hurricane wind damage to urban neighborhoods was measured again in 1995 when two hurricanes struck the Pensacola, FL area (Duryea 1997) and once more in 1998 when Hurricane Georges crossed over the entire island of Puerto Rico. In 2004, four hurricanes (Charley, Jeanne, Francis, and Ivan) struck Florida with maximum sustained winds ranging from 105 to 145 mph. In 2005, Hurricanes Dennis, Katrina, and Rita struck the Gulf Coast of the US (Figure 1).

The impacts of these hurricanes gave us the opportunity to study over 150 urban tree species and their comparable responses to hurricanes (Duryea et al. 2007).

Our goal was to answer the question, *what makes a tree more wind resistant?* Our main objective was to determine what biological, site, and cultural factors make trees more or less wind resistant. By evaluating these factors, we can understand the difference between species (i.e., whether they defoliate quickly in wind) and between certain practices (such as planting trees in groups compared to

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individual tree planting). This fact sheet describes the lessons and recommendations about the urban forest, trees (i.e. species and structure), and soil and rooting conditions.



Figure 1. In the UF/IFAS study, urban trees were measured in neighborhoods following the 9 hurricanes striking Florida and the Gulf Coast and 1 hurricane in Puerto Rico. For each hurricane, the year and maximum sustained wind speed (mph) are included.

I. Lessons about the Urban Forest

Lesson 1

THE HIGHER THE WIND SPEED OF THE HURRICANE, THE MORE LIKELY TREES WILL FAIL

In the 10 hurricanes we studied, we measured standing, leaning, or fallen trees in yards. Standing trees were considered survivors of the wind. Trees were considered not surviving if they had fallen or were leaning at less than a 45 degree angle.

From these numbers we calculated the percent of urban forest lost in each hurricane, which ranged from 11% in Hurricane Erin to 21% in Hurricane Rita to 23% in Hurricane Katrina to 38% in Hurricane Andrew (Figure 2). As wind speed increases, trees are more likely to suffer damage (i.e. uproot, break, or lean), resulting in greater urban forest loss, as the graph shows.

However, it is important to point out that in addition to wind intensity and speed, other factors influence urban forest damage during hurricanes:

- Conditions accompanying the hurricane, such as precipitation and the time it takes to move through an area
- Tree species, age, health, and structure
- Site characteristics, such as soil conditions (e.g., soil depth, water table, soil compaction) and soil composition
- Urban forest conditions, such as overall tree canopy density and composition

These factors together will determine whether a tree will fail during winds. Biological factors such as tree species, age, health and condition are related to the urban forest composition and structure. For example, Pensacola, FL has a denser tree canopy composed of older trees and these trees suffered considerably more damage during hurricanes when compared to Miami, FL, with less canopy cover and younger tree species.

Conditions accompanying the hurricane also influence tree fall. For instance, a slower-moving storm with a lot of precipitation will mean more water accumulating in the soil and less friction between roots and soil to hold trees up.

Trees growing in shallow soils, such as in Miami-Dade County with soils no more than 1 foot deep, will also behave differently from those planted in deeper soils. Trees in shallow soils are more prone to blow over than trees rooted more deeply.

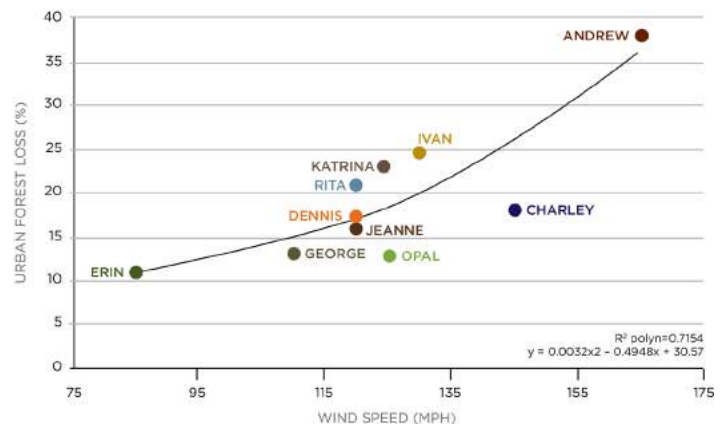


Figure 2. Urban forest loss (%) at different wind speeds (mph) in 10 hurricanes.

RECOMMENDATION

Establish and manage a healthy urban forest to improve wind resistance by:

- Having a comprehensive tree management plan for your community.
- Beginning a structural pruning program for young and mature trees.
- Choosing more wind-resistant species.
- Selecting the right species and designing the right place.
- Planting high-quality trees with central leaders and good structure.

Lesson 2

TREES IN GROUPS SURVIVE WINDS BETTER THAN TREES GROWING INDIVIDUALLY

In Hurricanes Ivan and Jeanne, our research showed that trees growing in groups survived the winds better than individual trees (80% versus 70% in Hurricane Ivan, and 88% versus 78% in Hurricane Jeanne.) A group was defined as 5 or more trees, each growing within 10 feet of another tree, but not in a row, as shown in Figure 3.

Our research has also shown that the more rooting space trees have, the less likely they are to fail (see section *Lessons Learned about Soil and Rooting Conditions* for more details). Only if they have adequate soil space can trees develop a strong supporting root system.



Figure 3.

RECOMMENDATION 1

Plant trees in groups of at least 5 trees (Figure 4) as opposed to individually (Figure 5).



Figure 4.



Figure 5.

RECOMMENDATION 2

Plant a variety of species, ages, and layers of trees and shrubs to maintain diversity in your community (Figure 6).



Figure 6.

II. Lessons about Trees

Lesson 1

SOME SPECIES RESIST WIND BETTER THAN OTHERS

In our measurements of trees after 10 hurricanes, we have seen that some tree species are more resistant to wind than others. Wind resistance is defined as the ability or capacity of a tree to survive (remain standing and living)

hurricane-force winds, which means that they do not easily uproot or break in the winds.

One of the main objectives of this study was to develop lists of wind-resistant tree species. To complement our findings, we conducted a survey of arborists, scientists and urban foresters who ranked wind resistance of urban tree species they observed after hurricanes. We used these ratings along with our research results and the available scientific literature to classify broad-leaved, conifer, palm, and fruit tree species into highest, medium-high, medium-low and lowest wind resistance. The recommended tree species are divided into the Southeastern Coastal Plain region (including USDA hardiness zones 8 and 9) and Tropical and Subtropical regions (USDA hardiness zones 10 and 11).

RECOMMENDATION 1

Plant tree species that have been shown to be more wind resistant.

RECOMMENDATION 2

Consider removing over-mature and hazardous tree species that have demonstrated poor survival in hurricanes. This is especially true if trees are over-mature, endangering lives and property, and belong to the lowest wind resistance list. Some of these species can be seen below and include sand pine, pecan, laurel oak, and water oak in north Florida and queen palm, Australian pine, melaleuca, weeping banyan, and Washington palm in south Florida. For borderline species, consult a professional urban forester or a certified arborist.

RECOMMENDATION 3

When a tree fails, plant a new tree in its place. In the streets of Bagdad, Florida, laurel oaks such as the one on the house in the background are being replaced with more wind-resistant, longer-living street tree species, such as live oaks (Figure 7). The healthy urban forest this will create, with its mixture of young and mature trees, will provide benefits such as good canopy cover, diversity, and mitigation of high winds. When possible, remember to replace individual trees with groups of trees. Doing so can improve wind resistance.

ANOTHER FINDING: OAKS

When comparing survival of sand live oak, live oak, and laurel oak in 4 panhandle Florida hurricanes (Erin, Dennis, Opal, and Ivan), laurel oak had poorer overall survival than both live oak and sand live oak (Duryea et al. 2007) (Figure 8). However, in 2 south Florida hurricanes (Jeanne and Charley), both survival and branch loss for these oaks were similar. Speculations about the reasons for this lack of

difference include: (1) Laurel oak in south Florida may be a different cultivar or variety than those in north Florida and (2) Sandier soils in south Florida and their accompanying lower site quality may result in laurel oaks with shorter heights or lower height-to-diameter ratio (as occurs between the north Florida and south Florida varieties of slash pine (*Pinus elliottii* var. *elliottii* and var. *densa*)). Still, many



Figure 7.

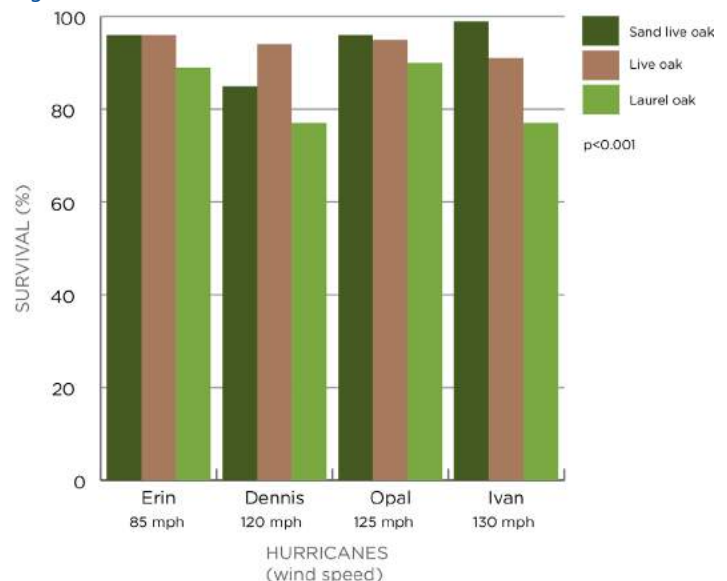


Figure 8.

authors point to live oak as a tree with strong wood and little failure in hurricanes (Touliatos and Roth 1971; Swain 1979; Hook et al. 1991; Barry et al. 1993).

RECOMMENDATION

Become familiar with the recommended tree species and how they perform in natural and urban ecosystems in your community. The same species in different locations may behave differently due to soils, climate, local disease problems, and other factors.

Lesson 2

AS A GROUP, PALM SPECIES SURVIVE HURRICANES BETTER THAN BROAD-LEAVED AND CONIFER TREES

When compared to broad-leaved and other conifer trees (such as pines), palms have often been observed to be more resistant to winds. Palms grow differently than other trees because they have one terminal bud. If that bud is not



Figure 9.

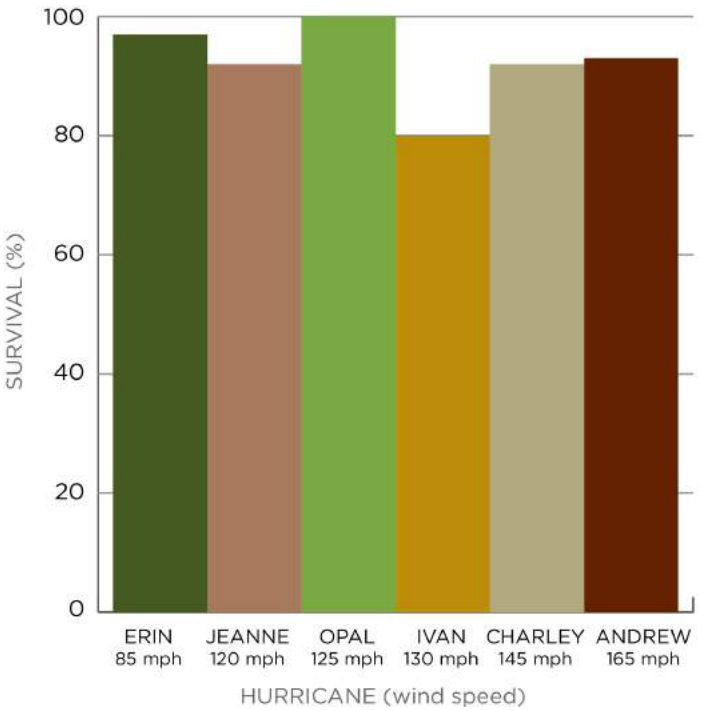


Figure 9a.



Figure 10.

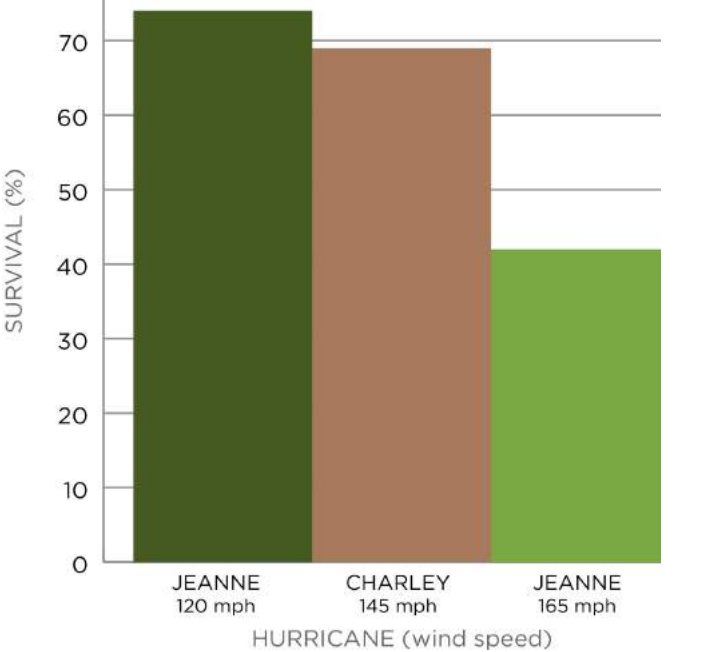


Figure 10a.

damaged, palms may lose all their fronds (leaves) and still survive. Our research shows that palms in the coastal plain and tropical and subtropical regions are often more resistant to winds (Figure 9). However, individual palm species do vary in their responses to wind. Examples would be queen and Washington palms which have exhibited poor survival in south Florida during hurricanes (Figure 10).

RECOMMENDATION 1

Consider planting wind-resistant palm species. Examples include sabal palm, Canary Island date palm, and manila palm.

RECOMMENDATION 2

Monitor palms carefully after storms. Bud damage may not show up immediately after the storm. Allow at least 6

months for palms to put out new fronds. Palms should also be checked for hidden root, stem, or bud damage.

Lesson 3

PINES MAY SHOW NO IMMEDIATE VISIBLE DAMAGE AFTER HURRICANES, BUT MAY DECLINE OVER TIME

In our study, we measured pines right after hurricanes, when they looked green and healthy (Figure 11). However, we went back 3 months after Hurricane Charley and found that 27% of the standing south Florida slash pines and 48% of the standing longleaf pines had died. Pines have been observed to be very sensitive to wind damage. They may show no immediate visible damage after high winds but may die sometime later. They can die slowly over a period of 6 months to 2 years after wind storms. Some may remain green for a year or more, and then suddenly turn yellow (Figure 12) and quickly progress to brown needles in a very short period. The causes of yellowing of the needles and pine death are not completely understood. It is likely due to hidden damage produced by bending and twisting during hurricane-force winds. Prolonged winds may also rupture smaller roots without breaking the larger support roots. The injured stems and roots are unable then to supply the water and nutrients needed in the crown, resulting in pine decline and death.



Figure 11.

RECOMMENDATION

Monitor pines carefully. Sometimes there is hidden damage and the tree declines over time. Look for signs of stress or poor health. Check closely for insects. Weakened pines may be more susceptible to beetles and diseases.



Figure 12.

Lesson 4

TREES THAT LOSE ALL OR SOME OF THEIR LEAVES IN HURRICANES ARE NOT NECESSARILY DEAD

The greater the wind speed, the more leaves trees lose during hurricanes, and leaf loss may help trees to survive. Trees can lose all or some of their leaves in most hurricanes. However, leaf loss does not mean the tree is dead; rather it means the tree is temporarily unable to photosynthesize (produce food) and store energy. With time, the tree will produce new leaves which are a sign of recovery, since they restore the tree's ability to photosynthesize and bring the tree back to health. Some species defoliate (lose leaves) easily during winds. Losing leaves may be a good strategy, helping the tree to better resist winds. Our research in Hurricane Ivan found that trees that lost their leaves survived the winds better. Live oak (in north Florida) (Figure 13) and gumbo limbo (in south Florida) are examples of trees which readily lose leaves and small branches and stand up well to winds.

RECOMMENDATION

Wait, watch for leaves, and monitor the tree's health. Most trees will leaf out again in a few months or in the spring of the following year. If the tree does not grow new leaves by the spring or early summer following the hurricane, it is not likely to recover. Note that some species, such as pines, may not recover if defoliated.



Figure 13.

Lesson 5

NATIVE TREE SPECIES SURVIVED BETTER IN SOUTH FLORIDA HURRICANES (JEANNE, ANDREW, AND CHARLEY)

In our research, native trees survived better in south Florida hurricanes but not in north Florida (Hurricane Ivan) (Figure 14). Native species also lost fewer branches than exotic species in Jeanne (36% versus 21%) and Charley (39% versus 36%) in south Florida. Some of the exotic species with low survival in south Florida were melaleuca, Australian pine, and queen palm as compared to native species with high survival, such as live oak, gumbo limbo, and sabal palm. In tropical and subtropical areas, exotics represent a large proportion of the urban forest (for Hurricane Jeanne, exotics made up 38% of the trees in the urban forest, for Hurricane Charley, 42%, and for Hurricane Andrew, 64% were exotics). In the southeast coastal plains (Hurricane Ivan), exotic tree species make up 9% of the trees in the urban forest. The major exotic species were crape myrtle, Chinese tallow (a prohibited invasive species), camphor tree (an invasive species), Bradford pear, and palms such as pindo and Washington. These differences in the composition of the urban forest may explain why, with fewer exotics in their population, natives did not survive better in the coastal plain during Hurricane Ivan. Native trees also survived winds better in south Florida hurricanes when compared to Puerto Rico (Hurricane Georges) (Figure 15). Out of the 35 tree species measured in Puerto Rico, only 4 were native to the island. The lighter winds and conditions of Hurricane Georges showed no differences between native and exotic species.

RECOMMENDATION

Consider native tree species when selecting trees for planting. Native trees should receive strong consideration when selecting trees for the urban forest. Additional benefits of using native species include their values for wildlife and native ecosystem conservation.

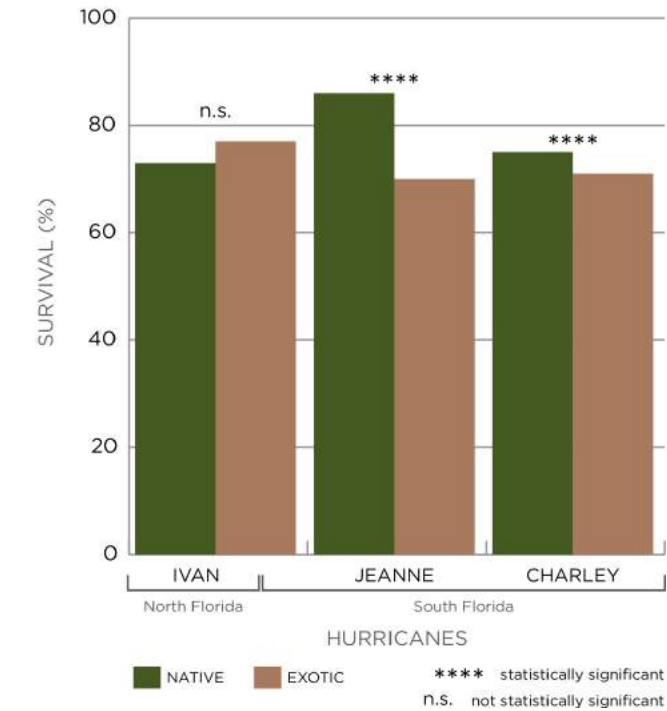


Figure 14.

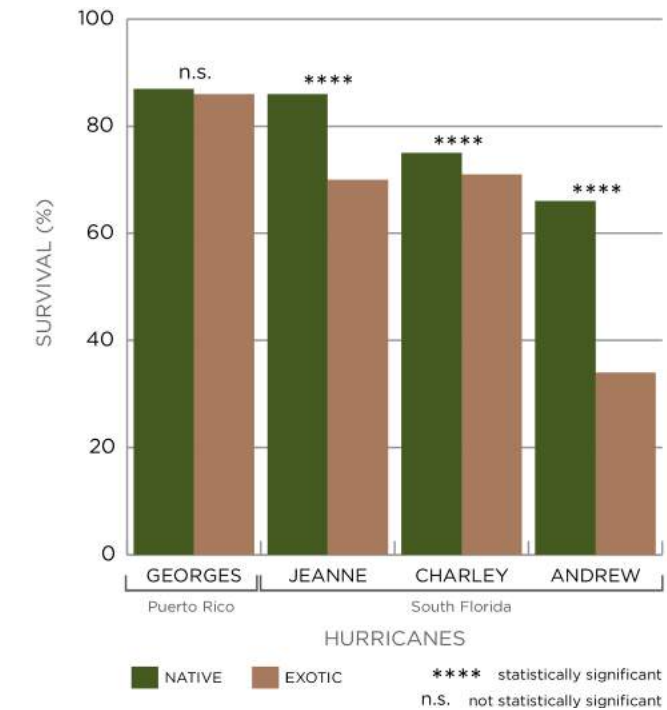


Figure 15.

Lesson 6

OLDER TREES ARE MORE LIKELY TO FAIL IN HURRICANES

As trees grow and age, they become more susceptible to insects and diseases, branches and parts of the tree begin to die, they become less flexible, and they may be more vulnerable to winds. Our research shows that larger and older trees lose more branches in hurricanes. Larger trees (40 to 79 inches in diameter) lost a greater percentage of their branches compared to small trees (less than 8 inches

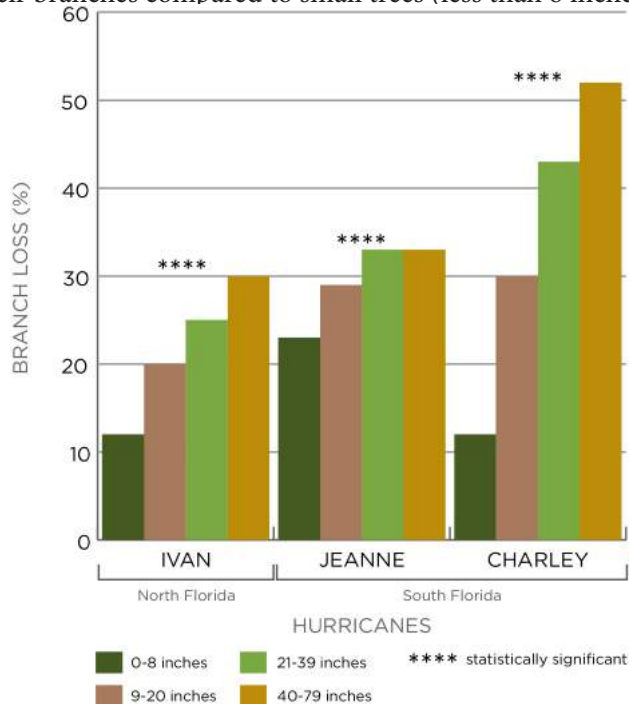


Figure 16.

in diameter) (Figure 16). Every tree species has an inherent life span. Some tree species live longer than others (Table 1). It is important to keep in mind that risk of failure in wind increases with age. For example, the life span of laurel oak is 50 years; it begins to decay and show signs of diseases as it reaches 40 years. The older a tree gets, the greater the likelihood of diseases and pathogens, breakage during winds, and the greater the risk of it causing damage when it fails.

RECOMMENDATION 1

Consider life span when managing urban forests for wind resistance (Table 1).

RECOMMENDATION 2

Over-mature trees that present a hazard to people and property should be removed and replaced by new trees (Figure 17). These trees should be monitored regularly for

structural defects. Consult with a certified arborist or urban forester.



Figure 17.

Lesson 7

UNHEALTHY TREES ARE PREDISPOSED TO DAMAGE

Old trees with decayed root systems, stem decay, or large dead branches are vulnerable to hurricanes. Decay, a major cause of tree failure, is caused by fungi that weaken wood (Figure 18). Cracks, seams, butt swell, dead branch stubs and large, older wounds suggest internal decay. They can be weak points on a trunk and increase the likelihood of tree failure. Mushrooms at the base of the tree trunk might also indicate root problems. They can be the sign of Armillaria or other fungi than can decay roots, creating unstable trees (Figure 19). Root rot can be diagnosed with careful, regular inspections by qualified arborists.



Figure 18.



Figure 19.

RECOMMENDATION

Remove hazard trees before the wind does. Have a certified arborist inspect your trees for signs of disease and decay. They are trained to advise you on tree health.

Lesson 8

TREES WITH POOR STRUCTURE OR INCLUDED BARK ARE MORE VULNERABLE IN THE WIND

A tree with two or more trunks or stems of equal size originating from the same point on the tree is said to have co-dominant stems. Co-dominant stems may develop bark inclusions, which are weak unions between branches, and are very susceptible to breakage (Figure 20). To develop strong structure, trees need to be managed with structural pruning.



Figure 20.

RECOMMENDATION 1

For a more wind-resistant, sustainable landscape, plant high-quality trees with central leaders and good form.

RECOMMENDATION 2

Follow with a preventive structural pruning program of young and mature trees.

Lesson 9

WELL-PRUNED TREES SURVIVE HURRICANES BETTER THAN POORLY PRUNED OR UNPRUNED TREES

Poor pruning practices, such as topping or removing large branches, make trees more susceptible to wind failure. Old, large pruning cuts can become an entry point for fungi that begin the decay process (Figure 21). In our study of Master Gardeners after Hurricane Andrew in 1992 (Duryea et al. 1996), we found that trees that had been pruned properly (not topped and with more open and well-distributed crowns) survived high winds better than unpruned trees (Figure 22). We re-analyzed this data using more broad-leaved tree species—black olive, gumbo limbo, bottlebrush, royal Poinciana, live oak, West Indian mahogany, and white cedar. Survival for pruned trees was 73% compared to 47% for unpruned trees, showing that overall, pruned trees are less likely to fail in hurricanes.



Figure 21.

RECOMMENDATION 1

Begin a preventive pruning program for both young and mature trees. The main goal of preventive pruning is to reduce the length of branches competing with the main trunk.

RECOMMENDATION 2

Select the right tree for the right location to avoid poor pruning practices. To allow healthy crown development, plant considering the aerial space needed for a mature-sized tree (Figure 23). Under power lines, the preferred option is to plant smaller trees that will better fit the space (Figure 24).

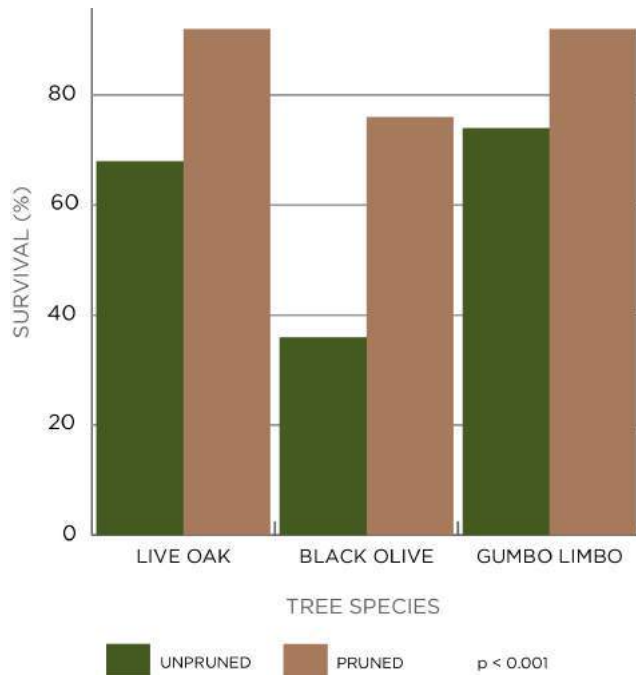


Figure 22.



Figure 23.



Figure 24.

III. Lessons about Soil and Rooting Conditions

Lesson 1

TREES WITH MORE ROOTING SPACE SURVIVE BETTER

The most important factor in designing a healthy urban landscape is also probably the one most often overlooked—that is providing enough soil space for tree roots to grow. In Hurricane Georges (Puerto Rico), we measured rooting space for trees and found that with more rooting space, tree survival during winds was higher (Table 2).

Soil should provide plenty of open space to allow growth of the trunk and development of the main flare roots. To provide anchorage for the tree, roots need to spread beyond the edge of the canopy and grow deep into the soil. Sidewalks, curbs, buildings, parking lots, driveways, and other urban structures restrict root development. A strong supporting root system with adequate rooting space is the most critical factor to the ability of trees to withstand hurricane-force winds in urban landscapes.

RECOMMENDATION

Give trees enough rooting space based on their mature size:

- Small trees need at least 10 feet by 10 feet .
- Medium trees need 20 feet by 20 feet.
- Large trees need at least 30 feet by 30 feet.

Lesson 2

GOOD SOIL PROPERTIES, SUCH AS ADEQUATE SOIL DEPTH, A DEEP WATER TABLE, AND NO COMPACTION, HELP WIND RESISTANCE

Trees without deep roots can become unstable and fall over in strong winds. Trees in shallow soils are more likely to blow over than trees rooted more deeply (Figure 25). Trees planted in compacted soil grow very poorly and are weak and unhealthy. This is especially true when the soil is poorly drained or the water table is high (Figure 26).

RECOMMENDATION 1

Make sure that planting sites have 3 feet of soil depth with a deep water table to allow healthy root system development.

RECOMMENDATION 2

Keep soil compaction to a minimum.



Figure 25.



Figure 27.



Figure 26.

Lesson 3

DAMAGED ROOT SYSTEMS MAKE TREES VULNERABLE IN THE WIND

Roots anchor the tree. It is important that roots under the canopy are not cut because many roots are located just below the surface of the soil. Tree roots need to extend out from a tree in all directions in order to stabilize it against wind throw. When roots under the canopy are cut, trees are more predisposed to falling over (Figure 27).

RECOMMENDATION

Do not damage or cut main support roots during construction. Never cut roots closer than the distance of 5 times the trunk diameter. Be aware that when tree roots are cut, the anchoring system of the tree may be harmed and compromised.

IV. Final Considerations

A healthy and more wind-resistant urban forest depends on managing existing trees well, and, at the same time, establishing new trees properly. Follow these recommendations when managing older trees or planting new trees.

Older Tree Management

- Consider life span when managing urban forests for wind resistance. Over-mature trees should be removed and replaced by new trees.
- Remove hazard trees before the wind does. Have a certified arborist inspect your trees for signs of disease and decay in trees.
- Consider removing tree species that have demonstrated poor survival in hurricanes, especially if they are over-mature and endangering lives and property.
- Be careful not to damage or cut main support roots during construction. Be aware that when the tree roots are cut, the anchoring system of the tree may be harmed and compromised.
- Establish a preventive structural pruning program of both young and mature trees.

Planting

- When a tree fails, plant a new tree in its place.
- Plant tree species that have been shown to be more wind resistant.

- To reduce your risk, maintain diversity in your yard and community by planting a mixture of species, ages and layers of trees and shrubs.
- Plant trees in groups as opposed to individually.
- Give trees enough rooting space based on their mature size: small trees need at least 10 feet by 10 feet, medium trees 20 feet by 20 feet, and large trees 30 feet by 30 feet.
- To allow healthy root system development, make sure that planting sites have 3 feet of soil depth with a deep water table. Keep soil compaction to a minimum.
- To allow healthy crown development (instead of misshapen pruning) under power lines, plant small trees such as buttonwood, dogwood, crape myrtle, and wax myrtle.
- For a more wind-resistant, sustainable landscape, plant high-quality trees with central leaders and good form. Begin a structural pruning program for young trees.

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Table 1.

Life Spans of Tree Species in the Forest*		
Short-lived (<50 years old)	Medium Lived (50-100 years old)	Long-lived (>100 years old)
laurel oak	African tuliptree	live oak
red bud	paradise tree	sweetgum
bottle brush	red maple	southern magnolia
Hong-Kong orchid tree	gumbo limbo	baldcypress
jacaranda	sea grape	mahogany
*Note: Trees in urban areas have shorter life spans than trees in the forest.		

Table 2.

Rooting Space and Survival Rate		
Tree Location	Survival Rate	Rooting Space
Streets Parking lots Yards	64%	0 to 3m ² (0 to 39 ft ²)
Yards Parks	73%	4 to 7 m ² (40 to 75 ft ²)
Campuses Parks Yards	91%	> 7m ² (>75 ft ²)

Table 3.

Southeastern Coastal Plain Tree Species			
Highest Wind Resistance	Medium-High Wind Resistance	Medium-Low Wind Resistance	Lowest Wind Resistance
Dicots			
Carya floridana, Florida scrub hickory Cornus florida, dogwood Ilex cassine, dahoon holly Ilex glabra, inkberry Ilex opaca, American holly Ilex vomitoria, yaupon holly Lagerstroemia indica, crape myrtle Magnolia grandiflora, southern magnolia Quercus geminata, sand live oak Quercus laevis, turkey oak Quercus myrtiflora, myrtle oak Quercus virginiana, live oak Podocarpus spp, podocarpus Vaccinium arboreum, sparkleberry	Acer saccharum, Florida sugar maple Acer palmatum, Japanese maple Betula nigra, river birch Carpinus caroliniana, ironwood Carya glabra, pignut hickory Carya tomentosa, mockemut hickory Cercis canadensis, red bud Chionanthus virginicus, fringe tree Diospyros virginiana, common persimmon Fraxinus americana, white ash Liquidambar styraciflua, sweetgum Magnolia virginiana, sweetbay magnolia Magnolia x soulangiana, saucer magnolia Nyssa aquatica, water tupelo Nyssa sylvatica, black tupelo Ostrya virginiana, American hophombeam Prunus angustifolia, chickasaw plum Quercus michauxii, swamp chestnut Quercus shumardii, Shumard oak Quercus stellata, post oak Ulmus alata, winged elm	Acer negundo, boxelder Acer rubrum, red maple Acer saccharinum, silver mapple Celtis laevigata, sugarberry Celtis occidentalis, hackberry Cinnamomum camphora, camphor ^b Eriobotrya japonica, loquat ^c Eucalyptus cinerea, silverdollar eucalyptus Fraxinus pennsylvanica, green ash Morus rubra, red mulberry Myrica cerifera, wax myrtle Persea borbonia, redbay Platanus occidentalis, sycamore Prunus serotina, black cherry Quercus alba, white oak Quercus phellos, willow oak Salix x sepulcralis, weeping willow Ulmus americana, American elm	Carya illinoensis, pecan Liriodendron tulipifera, tulip poplar Prunus caroliniana, Carolina laurelcherry Pyrus calleryana, Bradford pear Quercus falcata, southern red oak Quercus laurifolia, laurel oak Quercus nigra, water oak Sapium sebiferum, Chinese tallow ^a Ulmus parvifolia, Chinese elm
Conifers			
Taxodium distichum, baldcypress Taxodium ascendens, pondcypress		Pinus elliotii, slash pine Pinus palustris, longleaf pine Pinus taeda, loblolly pine	Juniperus silicicola, southern red cedar x Cupressocyparis leylandii, Leyland cypress Pinus clausa, sand pine Pinus glabra, spruce pine
Palms			
Butia capitata, pindo or jelly Phoenix canariensis, Canary Island date Phoenix dactylifera, date Sabal palmetto, cabbage, sabal			Washingtonia robusta, Washington fan
^a Prohibited in Florida ^b Invasive, not recommended in Florida ^c Caution: manage to prevent escape in Florida (Fox et al. 2005)			
We present these lists with the caveat that no tree is perfectly wind-proof and that many other factors contribute to wind resistance including soil conditions, wind intensity, previous cultural practices, tree health and age. These lists do not include all trees that could be wind resistant. They list those species encountered during our studies in large enough numbers to run statistical comparisons.			

Table 4.

Tropical/Subtropical Tree Species			
Highest Wind Resistance	Medium-High Resistance	Medium-Low Resistance	Lowest Wind Resistance
Dicots			
Bursera simaruba, gumbo limbo Carya floridana, Florida scrub hickory Conocarpus erectus, buttonwood Chrysobalanus icaco, cocoplum Cordia sebestena, geiger tree Eugenia axillaris, white stopper Eugenia confusa, redberry Eugenia foetida, boxleaf stopper Guaiacum sanctum, lignum vitae Ilex cassine, dahoon holly Krugiodendrum ferreum, ironwood Lagerstroemia indica, crape myrtle Magnolia grandiflora, southern magnolia Podocarpus spp, podocarpus Quercus virginiana, live oak Quercus geminata, sand live oak	Annona glabra, pond apple Calophyllum calaba, Brazilian beautyleaf ^c Chrysophyllum oliviforme, satinleaf Coccoloba uvifera, sea grape Coccoloba diversifolia, pigeon plum Liquidambar styraciflua, sweetgum Lysiloma latsiliqua, wild tamarind Magnolia virginiana, sweetbay magnolia Nyssa sylvatica, black tupelo Sideroxylon foetidissimum, mastic Simarouba glauca, paradise tree Swietenia mahagoni, mahogany	Acer rubrum, red maple Bauhinia blakeana, Hong-Kong orchid Bucidas buceras, black olive Callistemon spp, bottlebrush Cinnamomum camphora, camphor ^b Delonix regia, royal poinciana ^c Enterolobium cyclocarpum, ear tree Eriobotrya japonica, loquat ^c Eucalyptus cinerea, silverdollar eucalyptus Ficus aurea, strangler fig Kigelia pinnata, sausage tree Myrica cerifera, wax myrtle Persea borbonia, redbay Platanus occidentalis, sycamore Quercus laurifolia, laurel oak Tabebuia heterophylla, pink trumpet tree Terminalia catappa, tropical almond ^c	Casuarina equisetifolia, Australian pine ^a Cassia fistula, golden shower Chorisia speciosa, floss-silk tree Ficus benjamina, weeping banyan Grevillea robusta, silk oak Jacaranda mimosifolia, jacaranda Melaleuca quinquenervia, melaleuca ^a Quercus nigra, water oak Peltophorum pterocarpa, yellow poinciana Prunus caroliniana, Carolina laurelcherry Sapium sebiferum, Chinese tallow ^a Spathodea campanulata, African tuliptree Tabebuia caraiba, silver trumpet tree Ulmus parvifolia, Chinese elm
Conifers			
Taxodium ascendens, pondcypress Taxodium distichum, baldcypress		Pinus elliottii, slash pine Pinus palustris, longleaf pine	Araucaria heterophylla, Norfolk Island pine x Cupressocyparis leylandii, Leyland cypress Juniperus silicicola, southern red cedar Pinus clausa, sand pine
Palms			
Butia capitata, pindo or jelly Dypsis lutescens, areca Coccoloba argentea, Florida silver Hyophorbe lagenicaulis, bottle Hyophorbe verschaffeltii, spindle Latania loddigesii, blue latan Livistona chinensis, Chinese fan ^b Phoenix canariensis, Canary Island date Phoenix dactylifera, date Phoenix reclinata, Senegal date ^b Phoenix roebelenii, pygmy date Ptychoesperma elegans, Alexander Sabal palmetto, cabbage, sabal Thrinax morrisii, key thatch Thrinax radiata, Florida thatch Veitchia merrillii, Manila	Caryota mitis, fishtail Cocos nucifera, coconut Dypsis decaryi, triangle Roystonea elata, royal		Syagnus romanzoffiana, queen ^c Washingtonia robusta, Washington fan

Tropical/Subtropical Tree Species			
Fruit Trees			
	Litchi chinensis, lychee	Averrhoa carambola, star-fruit, carambola Citrus spp, oranges, limes, grapefruits Mangifera indica, mango	Persea americana, avocado
^a Prohibited in Florida ^b Invasive, not recommended in Florida ^c Caution: manage to prevent escape in Florida (Fox et al. 2005)			
We present these lists with the caveat that no tree is perfectly wind-proof and that many other factors contribute to wind resistance including soil conditions, wind intensity, previous cultural practices, tree health and age. These lists do not include all trees that could be wind resistant. They list those species encountered during our studies in large enough numbers to run statistical comparisons.			

Wind and Trees: Surveys of Tree Damage in the Florida Panhandle after Hurricanes Erin and Opal ¹

Mary L. Duryea²

Hurricanes Erin and Opal swept across the Florida Panhandle in 1995 bringing with them sustained winds of 85 and 125 mph. In two surveys immediately following the hurricanes, 25 neighborhoods were inventoried for tree damage. This circular summarizes the results of our surveys and ranks the wind resistance of the North Florida tree species in these communities. Hurricane-susceptible communities should consider wind resistance as one of their criteria in tree species selection.

Introduction

When hurricanes strike land, along with damage to property such as houses, power lines, and commercial buildings, they may cause damage to trees in the urban forest. Yet, sometimes a fallen tree may be side-by-side with one which is standing and appears unaffected by the winds. This varied wind resistance by different trees may be due to many factors such as tree age, size, health, and species.

In 1995 two hurricanes impacted the Florida Panhandle. The first, on August 3, was Erin, a slow-moving hurricane which struck the Pensacola area with sustained winds of 85 mph. Two months later, on October 4, Opal moved through the Ft. Walton Beach area more quickly and had sustained winds of 125 mph. Three days after each hurricane we surveyed the damage to trees in neighborhoods where the eye of the hurricane had passed.

Methods

After Hurricane Erin, 12 neighborhoods in the Pensacola area—and after Hurricane Opal—10 neighborhoods near Ft. Walton Beach were inventoried for tree damage Figure 1.

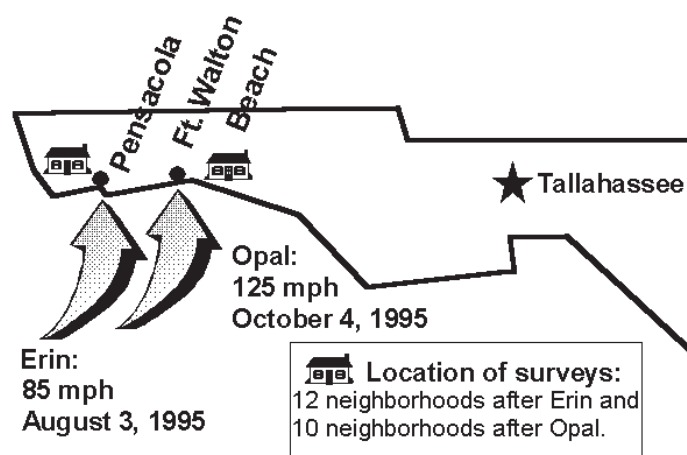


Figure 1.

All trees along the neighborhood transects were observed and the following information was recorded:

- 1) Has the tree fallen? 2) If the tree fell, was it uprooted—or broken at the main stem? 3) If the tree fell, did the tree cause damage to property and if so, what kind of damage? 4) If the tree was still standing, did it have crown damage?

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Results

What tree species fell?

Erin and Opal. Observations were obtained for 2,443 trees after Hurricane Erin and 2,468 trees after Hurricane Opal. Of the 4,911 surveyed trees, 11% fell in Erin and 13% as a result of Opal. Results are presented for 17 species which had a sample size greater than 14 trees in each hurricane. All except one species—Chinese tallow or popcorn tree *Sapium sebiferum*—were native to Florida.

Of the conifer species affected by both hurricanes, sand pine *Pinus clausa* exhibited poor wind resistance with only 61% and 58% standing after these two hurricanes, see Figures 2a, 2b, 2c, and 3.

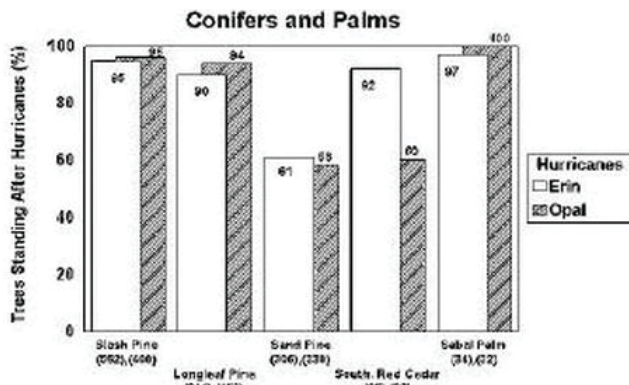


Figure 2a. The percentage of conifers and palms still standing after Hurricanes Erin and Opal.

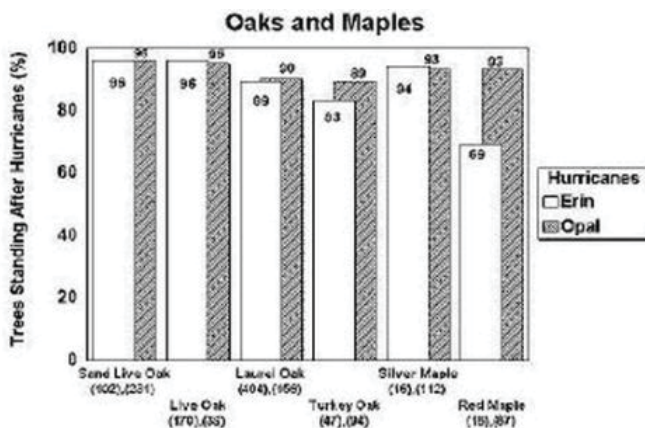


Figure 2b. The percentage of oaks and Maples still standing after Hurricanes Erin and Opal.

Note: in Figures 2a-2c, numbers in parentheses denote the number of trees observed in Erin and Opal, respectively.

Of the conifer species affected by both hurricanes, slash (*Pinus elliotii* var. *elliotii*) and longleaf (*Pinus palustris*) pines survived the winds best Figure 2a.

Southern red cedar *Juniperus silicicola* was one of two species damaged inconsistently during the two hurricanes:

92% were still standing after Erin compared to 60% after Opal Figure 2a.

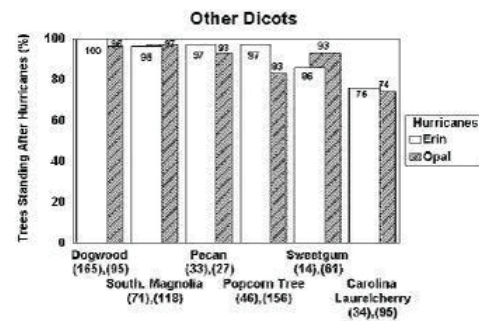


Figure 2c. The percentage of other dicots (broadleaved trees) still standing after Hurricanes Erin and Opal.



Figure 3. Sand pine exhibited poor wind resistance.

Sabal palm *Sabal palmetto* was one of the most wind resistant species with 97% and 100% standing after the hurricanes; actually, the one sabal palm that was recorded as fallen was knocked over by another falling tree Figure 2a.

Of the oaks and maples, sand live oak *Quercus geminata*, live oak *Quercus virginiana* and silver maple *Quercus saccharinum* did the best with laurel oak *Quercus laurifolia*, turkey oak *Quercus laevis*, and red maple *Acer rubrum* comprising a less wind resistant group Figure 2b. Of the other dicot (broadleaf) trees, dogwood *Cornus florida*, magnolia *Magnolia grandiflora*, and pecan *Carya illinoensis* survived the hurricane best while Chinese tallow and sweetgum *Liquidambar styraciflua* comprised a second group and Carolina laurelcherry *Prunus caroliniana* held up poorly to the winds Figure 2c.

Five species were sampled in only one of the two hurricanes and so the results are preliminary for:

- pignut hickory (*Carya glabra*), 100%;
- pindo palm (*Butia capitata*), 97%;
- sweet bay (*Magnolia virginiana*), 97%;
- sycamore (*Platanus occidentalis*), 92%; and

- loblolly pine (*Pinus taeda*)—82% still standing after one of the hurricanes.

Results from Other Hurricanes. After Hurricane Camille (1969) forestland trees were ranked for their wind resistance and live oak was at the top of the list 6, 7. Live oak also did well in our study and after Hurricane Andrew 2. Sabal palm was the second most wind-resistant tree in Hurricane Camille and the only tree that was “immune to hurricane-force winds” of Hugo in 1989 3, 6, 7. Both live oak and sabal palm survived the 145 mph winds of Andrew and then did well in this study after Erin and Opal 2. Pecan was reported as the least wind-resistant tree species during Hurricane Camille 6,7, yet in this study it survived the winds well. Three possible explanations for this different ranking could be:

1) Pecan is more exposed in orchards compared to neighborhoods; 2) Pecan does not tolerate winds greater than Erin and Opal; or 3) Our sample was too small (60 trees). Homeowners should be aware that pecan in urban settings may not be tolerant to stronger winds.

In forests during Camille 6,7, dogwood was reported to be more easily uprooted, yet in our study in neighborhoods 100% and 96% of the dogwoods were still standing.

Southern Pines

Over the years, hurricanes such as Camille, Frederick, Hugo and Andrew have helped people observe effects of hurricane-force winds on southern pines in forests and urban areas. Pines have most often been placed relatively low on hurricane-resistance lists due to their propensity for stem breakage 1, 2, 6, 7.

Hurricane damage to pine trees can also initiate outbreaks of pests such as bark beetles, ambrosia beetles, sawyers, and blue stain fungi that preferentially attack stem-damaged pines.

Example: After Hurricane Andrew in 1992, many individual pines did not show immediate damage but died during the following year.

Therefore, even though high percentages of slash and longleaf pines were standing after Hurricanes Erin and Opal, their ability to survive hurricane level stresses may be less than other species with the same percentage of trees still standing.

How did trees fall?

When trees fell, they were either uprooted or broken at the trunk Table 1. Uprooting was the most common type of failure for slash and sand pines—while longleaf pine exhibited both kinds of damage—and southern red cedar most often broke off at the main stem. Laurel oak was uprooted as compared to Chinese tallow which has a weak stem that snapped in two in the strong winds.

Crown Damage

Some species, still standing after the hurricanes, exhibited crown damage. Crown damage was defined as greater than 50% of the branches in the crown broken. Southern pines, oaks, palms, and dogwood all had little crown damage (less than 2% of the trees). Magnolia, pecan, red maple and Chinese tallow were in the next group with some damage (less than 10%) in one of the hurricanes Table 2.

The most crown damage appeared on Southern red cedar, sycamore, silver maple, and sweetgum. Southern red cedar, sycamore, red maple and pecan were also considered susceptible to breakage in forests after Hurricane Camille. Although sweetgum was considered resistant in Hurricane Camille 6,7, in our study sweetgum suffered the highest crown damage of all species in hurricanes Erin and Opal 20% of the trees.

PROPERTY DAMAGE

Twenty-one percent and 8% of the fallen trees damaged property in Erin and Opal. (Of all the trees surveyed, just 2% and 1% damaged property.) Homes accounted for 67% and 29% of the damage in each of the hurricanes; the rest was damage to minor structures such as signs, fences and sidewalks.

In the study made after Hurricane Andrew, only 18% of the fallen trees damaged property and of the total trees in the survey only 7% damaged property 2.

As would be expected, species that grow into large trees were more likely to cause property damage than small trees. Sand, slash, and longleaf pines and laurel oaks were more likely to cause damage *if they fell* than the smaller Southern red cedar, Carolina laurelcherry, and Chinese tallow Table 3.

Conclusions

Wind-Resistant Species

Using survey data we ranked tree species according to their wind resistance Table 4.

As expected, some species appear to be better-suited for use in hurricane-prone areas than others. Dogwood, sand live oak, live oak, sabal palm, and Southern magnolia are native trees that appear to tolerate hurricane-force winds extremely well.

Less wind-resistant are laurel oak, turkey oak, Chinese tallow, and red maple. Southern red cedar, sweetgum, and silver maple all appear to have crowns which are easily damaged by the winds.

Longleaf and slash pines, although standing up to the winds, receive their lesser wind-resistant rating because of their predisposition to insects and disease after experiencing hurricane-force winds.

Carolina laurelcherry and sand pine are the least wind-resistant species. Because of Carolina laurelcherry's smaller stature, it is less of a threat to property than sand pine. Sand pine should *not* be planted or allowed to grow to a large size near any dwelling; its shallow root system appears to make it extremely vulnerable to wind.

Need for More Information

For several reasons our wind-resistant lists are preliminary and need more observation and study.

First, several commonly planted species—such as loblolly pine, sycamore, and sweet bay—have been under-studied and cannot be placed on the appropriate list until we have more data on them.

For other species—such as water oak *Quercus nigra* we had too small a sample to report, yet observations after Hugo reported that they were “all too aware of this tree's failure to survive the storm in an urban environment” 4. We also have very little information on bald cypress *Taxodium distichum* and pond cypress *Taxodium distichum* var. *nutans* although they are reported to be extremely wind-resistant 5, 6, 7. We need more information on these species to continue to upgrade the lists.

Second, the winds of Hurricanes Erin and Opal (with 85 and 125 mph sustained winds) were not as strong as Hurricanes Camille, Frederick, Hugo, and Andrew (all greater than 135 mph). In Andrew, for example, 38% of the trees died as compared to Erin and Opal with losses of 11 and 13%. Also, in Andrew almost every tree had crown damage compared to relatively little crown damage from Erin and Opal. In Charleston, Hugo destroyed up to 45% of all landscape trees 3. It is because of the preliminary nature

of these results, we urge you to use these lists as a starting point for forming a list based on your observations.

Cultural Practices

Site conditions in urban areas may often hinder good tree growth and tree health. All too often trees are planted where they have little rooting space or the soil is compacted. In contrast, adequate soil depth, lack of soil compaction, a deep water table, and adequate rooting space improve root system development and anchorage which contribute to wind firmness.

Also, maintaining healthy trees is critical to reducing damage in hurricanes. Our Hurricane Andrew study data showed that pruning can improve wind resistance and reduce tree failure 2. However, pruning does not include the practice of topping which misshapes and destroys branching structure, nor does it include excessive crown thinning.

To create and maintain healthy urban forests, sound cultural practices should be observed in tree selection, location and maintenance—while property owners and communities should seek advice from certified arborists and remove hazard trees immediately.

Education

It is common after a hurricane for urban citizens to decide that trees are a problem and are undesirable in urban areas due to their damage potential. In this study we found only 1 to 2 % of the trees studied caused damage to property. While damage is undesirable at any level, impact on property can be balanced against the many other benefits of urban trees including energy conservation, reduction of stormwater runoff, wildlife habitat, and beauty.

In addition to proper species selection, programs to teach urban citizens more about proper tree care, selection, and maintenance can contribute to an urban forest with greater tolerance to hurricanes and storms.

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Table 1. Failure type associated with fallen trees. (Numbers in parentheses denote the number of fallen trees in Erin and Opal combined.)

Tree Species	% Broken	% Uprooted
Carolina Cherry (33)	51	49
Chinese tallow (27)	81	19
Laurel oak (59)	36	64
Longleaf pine (32)	50	50
Sand pine (263)	22	78
Slash pine (44)	34	66
Southern red cedar (32)	63	37

Table 2. Tree species with Crown Damage > 5% after either 1995 panhandle Hurricane.

Tree Species	% after Erin	% after Opal
Chinese tallow	0	7
Magnolia	6	0
Pecan	6	0
Red maple	0	9
Southern red cedar	8	10
Sycamore		15
Silver maple	7	19
Sweetgum	20	19

Table 3. Percentage of fallen trees (large-size species v. small-size species) causing property damage. (Numbers in parentheses denote combined felled trees in Erin and Opal combined.)

Large Species	% damaging property
Laurel oak (59)	17
Longleaf pine (32)	18
Sand pine (263)	11
Slash pine (44)	17
Small Species	% damaging property
Carolina Laurelcherry (33)	2
Chinese tallow (27)	4
Southern Red Cedar (32)	4

Table 4. Wind resistance of tree species growing in the Florida Panhandle as determined by frequency of failure in Hurricanes Erin and Opal and other rankings from Hurricanes Camille and Andrew (2, 6, 7).

Most Wind-Resistant	Dogwood
	Live oak
	Sabal palm
	Sand live oak
	Southern magnolia
Less Wind-Resistant	Chinese tallow (popcorn tree) ¹
	Laurel oak
	Longleaf pine ²
	Pecan ³
	Red maple
	Silver maple ⁴
	Slash pine ²
	Southern red cedar ⁴
	Sweetgum ⁵
	Turkey oak
The worst	Carolina laurelcherry
	Sand pine
Still a Question? ⁶	Loblolly pine (82%)
	Pignut hickory (100%)
	Pindo palm (97%) ¹
	Sweet bay (97%)
	Sycamore (92%) ⁴
	¹ An exotic species
	² Pest problems after storms lower these rankings
	³ Low ranking due to previous hurricanes low ranking
	⁴ Weak crown
	⁵ Very weak crown
	⁶ Not enough urban data

Selecting Coastal Plain Species for Wind Resistance¹

Mary L. Duryea and Eliana Kampf²



Wind damage to urban trees increases with storm intensity, but not all tree species withstand high winds to the same degree, making some trees better choices than others for including in coastal landscapes. A team of scientists at the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) studied 10 hurricanes to determine their effect on the urban forest. One of the major goals of this study was to assemble lists of relative wind resistance for different urban tree species to help communities better prepare for future hurricane seasons by selecting proper species. (Chapter 9 reports on tropical and subtropical tree species). This fact sheet presents the research and methodology that lead to these lists of relative wind resistance. It also discusses in detail the results and additional recommendations for selecting and establishing trees for a healthier and more wind-resistant urban forest.

The Study

In 2004, four hurricanes struck Florida with maximum sustained winds ranging from 169 to 233 km/h (105 to 145 mph). In 2005, Hurricane Dennis struck the Florida panhandle at 193 km/h (120 mph). The impacts of these five hurricanes were widespread. They affected urban areas, agricultural croplands, and Florida's natural ecosystems (Duryea et al. 2007). Since 1992 when Hurricane Andrew struck south Florida, we have been studying the impacts of hurricanes on the urban forest (Duryea et al. 1996). We continued with measurements of hurricane wind damage to urban neighborhoods again in 1995 when two hurricanes struck the Pensacola area (Duryea 1997) and then again in 1998 when Hurricane Georges crossed over the entire island of Puerto Rico. These nine hurricanes with their varied wind speeds gave us the opportunity to study over eighty tree species and their comparable responses to hurricanes. This study reports on the relative wind resistance of southeastern coastal plain species in urban forests (including plant hardiness zones 8 and 9).

Methods

Urban Tree Damage Measurements

Urban tree damage was measured within three to six days following each hurricane that struck the Florida panhandle: Erin, Opal, Ivan, and Dennis (Figure 1). We also report the hurricane response of coastal plain species such as live oak (*Quercus virginiana*) and sabal palm (*Sabal palmetto*) that occur throughout Florida and were impacted by Hurricanes

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Andrew, Charley, Frances, and Jeanne. Hurricane Andrew results were collected in a survey of 128 homeowners in Dade County, Florida who reported the impacts of the hurricane on trees in their yards (Duryea et al. 1996). The methodology for the other eight hurricanes was the same and was as follows. Neighborhoods at the point of landfall of the hurricane were randomly chosen on the strong side of the storm. For each neighborhood, all trees in front yards were observed along street transects. (If invited, we also measured trees in backyards.) Overall we sampled 100 neighborhoods and 18,200 trees. Each tree's diameter at breast height (for dicots and conifers) or height (for palms) was measured (estimated for height), and then it was determined if the tree was standing, leaning or had fallen. Leaning trees were those that were leaning as a result of the storm at less than a 45 degree angle. Fallen trees were either broken at the main stem or lying on the ground. All fallen trees were assessed as either broken or uprooted. Percent survival was calculated for each species using trees that were standing after the hurricane (Trees were considered not surviving if they had fallen or if they were leaning at less than a 45 degree angle.)

Crowns of all standing trees were first assessed for percent branch loss and then for leaf loss from the hurricane. For palms, only percent leaf loss was assessed. Then for dicots and conifers, if a tree had 50% or greater branch loss from the hurricane, it was declared dead and a new second survival percentage was calculated. This is called the “recalculated survival” throughout this document.

The Survey

After four hurricanes struck Florida in 2004, we concluded that urban forest professionals in the state were a resource of knowledge about wind resistance. In June 2005, we sent out 240 surveys to arborists, urban foresters, and forest scientists who were members of the International Society of Arboriculture (Florida chapter) or the Florida Urban Forestry Council or who were faculty at the University of Florida. We asked them to rank the wind resistance (high, medium, or low) of those urban tree species they observed after hurricanes. Eighty-five (85) surveys (35%) were returned. We report these numbers and percentages in this publication and then use these ratings along with our measurements and analyses and the scientific literature to formulate wind resistance lists for tree species in urban areas.



Figure 1. Urban trees were measured following hurricanes striking Florida, the Gulf Coast, and Puerto Rico. For each hurricane, the arrow points to the location of landfall. The maximum sustained wind speed (mph) and year are included.



Figure 1b.

Results

Tree Survival and Branch Loss

Tree species in the Southeastern Coastal Plain respond differently to hurricanes. Response of species to Hurricane Ivan in 2004 illustrates differences at 209 km/h (130 mph) wind speeds (Figure 2). Tree species demonstrating the highest survival in these winds were sand live oak (*Quercus geminata*), American holly (*Ilex opaca*), southern magnolia (*Magnolia grandiflora*), live oak, wax myrtle (*Myrica cerifera*), sweetgum (*Liquidambar styraciflua*), crape myrtle (*Lagerstroemia indica*), dogwood (*Cornus florida*), and sabal palm. Dogwood, live oak, sabal palm, sand live oak, and southern magnolia were also the best survivors in Hurricanes Erin and Opal in 1995 (Duryea 1997).

A more detailed look at live oak and sabal palm demonstrates their repeated resilience to hurricane-force winds (Table 1). However, it can also be seen that in south Florida when the winds reached 233 and 265 km/h (145 and 165 mph) in Hurricanes Charley and Andrew, survival of live oak decreased to 78%.

In a statistical comparison of sand live oak, live oak, and laurel oak, laurel oak had poorer overall survival than both live oak and sand live oak in four panhandle Florida hurricanes ($p < 0.001$) (Figure 3). In several publications, live oak, sabal palm, baldcypress (*Taxodium distichum*) and pondcypress (*Taxodium ascendens*) have been ranked at the

top of lists for hurricane-related wind resistance (Touliatos and Roth 1971; Swain 1979; Barry et al. 1993).



Figure 2. Survival (percentage of trees still standing) of species in Hurricane Ivan, which struck at 209 km/h (130 mph). The LSD (Least Significant Difference) is at the 0.05 level.

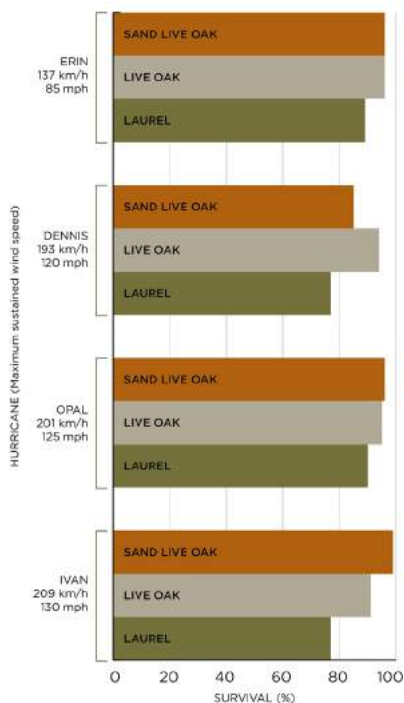


Figure 3. In a statistical comparison of sand live oak, live oak, and laurel oak survival in four Florida panhandle hurricanes, laurel oak survival was significantly less than the other two oaks ($p < 0.001$). There was no difference between sand live oak and live oak survival.

Branch loss in hurricanes may also be an important measure of trees' resilience (Figure 4). In Hurricane Ivan, southern red cedar (*Juniperus virginiana* var. *silicicola*), sycamore (*Platanus occidentalis*), southern red oak (*Quercus falcata*), and laurel oak lost on average over 25% of their branches. Sweetgum, silver maple (*Acer saccharinum*), sycamore, and southern red cedar were species losing the most branches in Hurricanes Erin and Opal (Duryea 1997). Species with 10% or less branch loss were crape myrtle, loblolly pine (*Pinus taeda*), American holly, and tulip poplar (*Liriodendron tulipifera*).

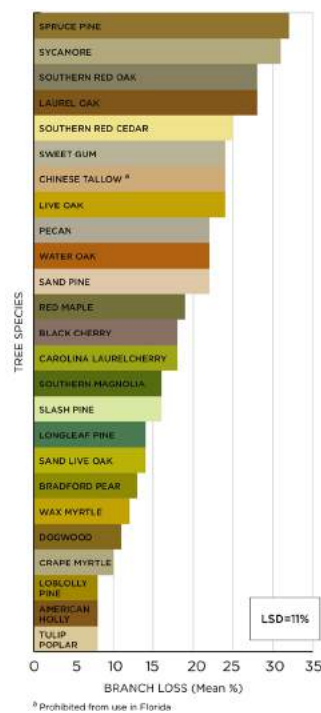


Figure 4. Average branch loss (%) for each tree species in Hurricane Ivan, which struck land at 209 km/h (130 mph). The LSD (Least Significant Difference) is at the 0.05 level.

When we looked at tree diameter and branch loss, we found that large trees (100-200 cm, 39-79 in diameter) lost the most branches (30%), followed by medium sized trees (50-99 cm, 20-39 in) with 25% loss, smaller trees (20-49 cm, 8-19 in) with 20% loss, and finally the smallest trees (< 20 cm, 8 in), which lost 12% of their branches ($p < 0.0001$). Glizenstein and Harcombe (1988) also found that damage was positively correlated with average stem size in a forest stand. In their review, Everham and Brokaw (1996) summarize that most researchers have found a positive correlation between stem size and wind damage. Webb (1989) found that larger trees were more likely to be damaged directly by the wind compared to smaller trees, which were more likely to be indirectly damaged by other falling trees.

Since trees with large amounts of branch loss from a hurricane may not be considered as healthy urban trees, we re-analyzed survival, taking into account branches lost. As mentioned before, standing trees that had 50% or greater branch loss were called dead and a “new” survival was calculated (named “recalculated survival” henceforth) (Figure 5).



Figure 5. A recalculation of survival (%) after declaring trees with ³ 50% branch loss dead after Hurricane Ivan. The LSD (Least Significant Difference) is at the 0.05 level.

Some species with heavy branch loss had significantly lower recalculated survival. Southern red cedar survival was decreased from 61% to 46% due to heavy branch loss. Sycamore survival was reduced from 73% to 52%. Even live oak trees had significant branch loss, and their survival was decreased from 91% to 81%. When we statistically compared the recalculated survival of oak species after Hurricane Ivan, the ranking from greatest to lowest survival was sand live oak (98% survival), live oak (81%), laurel oak (66%), water oak (*Quercus nigra*) (65%), and Southern red oak (50%) ($p=0.0001$). A study in South Carolina coastal plain forests after Hurricane Hugo also found that live oak was less damaged than laurel and water oaks (Gresham et al. 1991).

Survival of pine species showed significant differences with greatest survival for slash pine (*Pinus elliottii* var. *elliottii*) (71%), then loblolly (64%), longleaf (*Pinus palustris*) (57%), sand pine (*Pinus clausa*) (43%), and spruce pine (*Pinus glabra*) (38%) ($p=0.0014$). Three months after Hurricane

Ivan, we re-measured pines and found that 2% to 3% of the slash and longleaf standing trees had died and 56% of the standing sand pine had died. In the southeastern coastal plain forest, longleaf pine was less damaged than loblolly during Hurricane Hugo (12% versus 73% damaged) (Gresham et al. 1991), but a tornado in Texas resulted in equal and intense damage to loblolly, longleaf, and shortleaf (*Pinus echinata*) pines (Glitzenstein and Harcombe 1988). Two conifer species that have shown repeatedly poor performance in our studies during hurricanes are sand pine and southern red cedar (Duryea 1997) (Table 1).

Defoliation

There were distinct species differences in defoliation during Hurricane Ivan. Species like sand live oak, crape myrtle, and dogwood lost an average of 94%, 88%, and 86% of their leaves compared to southern red cedar, wax myrtle, slash pine, longleaf pine, and loblolly pine, which lost 32%, 31%, 29%, 19%, and 11% of their leaves, respectively ($l_{sd}=17\%$) (Figure 6).



Figure 6. By readily losing its leaves right after a hurricane, sand live oak is one of the species that survives hurricanes well.

Leaf loss had a positive relationship ($p<0.0001$) with both survival and recalculated survival (trees with $\geq 50\%$ branch loss excluded), which is to say that losing leaves during the hurricane meant higher survival. Francis and Gillespie (1993), reporting on urban trees in Puerto Rico after Hurricane Hugo in 1989, also found that crown damage appeared to be avoided if the crown surface area was reduced quickly with leaf and twig loss during the hurricane. There are some exceptions to defoliation being a strategy for survival; southern magnolia, American holly, and sabal palm are all excellent survivors, but they only lost 43%, 34%, and 27% of their leaves.

Native and Exotic Species

In the coastal plain area, exotic tree species made up 8% of the trees in the urban forest. The major exotic species were crape myrtle, Chinese tallow (*Sapium sebiferum*)—a prohibited invasive species, camphor tree (*Cinnamomum camphora*)—an invasive species, Bradford pear (*Pyrus calleryana*), and palms such as pindo palm (*Butia capitata*) and Washington fan palm (*Washingtonia robusta*). As a group, native trees survived the same as exotic trees (73% versus 77%, not significantly different [n.s.]) and lost the same amount of branches (20% versus 15%, n.s.) and leaves (58% versus 60%, n.s.). In contrast, after Hurricane Andrew struck south Florida, native trees survived winds better than non-native trees (Duryea et al. 1996). Other studies have shown trends toward increased wind damage of exotic species in rural plantation forests (King 1945; Everham and Brokaw 1996)

The Survey

Arborists' and urban foresters' ratings of wind resistance for coastal plain species show a strong agreement with our measurements over several hurricanes. Small trees that were awarded high wind-resistance ratings were fringe tree (*Chionanthus virginicus*), dogwood, persimmon (*Diospyros virginiana*), myrtle oak (*Quercus myrtifolia*), sparkleberry (*Vaccinium arboreum*), and the hollies (*Ilex* spp.) (Table 2).

While live oak and sand live oak were rated as high, other oaks such as southern red oak and swamp chestnut oak (*Quercus michauxii*) were rated as medium, and in agreement with our results, laurel and water oaks were rated as having low wind resistance. Although we have consistently seen low survival or heavy branch damage in southern red cedar, the ratings were even for each of the wind-resistance categories in the survey results. However, 91% of the respondents rated baldcypress and pondcypress with high wind resistance (Figure 7). Both cypresses were stated to have the best wind resistance along with live oak and sabal palm after Hurricanes Camille and Frederick struck the Gulf Coast in 1969 and 1979 (Swain 1979).

In the survey, sand pine received a low rating, which is consistent with our results (Figure 8), while the other pines were mostly rated as medium, again consistent with our results. In their summarizing list of wind resistance for forest species, Everham and Brokaw (1996) cite ten studies where loblolly, slash, and longleaf pines are ranked with low to intermediate wind resistance.

Sabal palm received a high wind resistance rating from 99% of the survey respondents, in agreement with our ratings

and those of Swain (1979). Canary Island date palm (*Phoenix canariensis*), which is being planted more frequently in north Florida, received a high rating from 89% of the respondents (Figure 9).



Figure 7. Baldcypress, a species increasingly planted in urban areas, was ranked as a highly wind resistant tree.



Figure 8. Sand pine had a low survival rate of 43% and was also ranked as a low wind resistance species by respondents during the survey.



Figure 9. Canary Island date palm, rated as having high wind resistance, is being planted more frequently in north Florida.

Respondents rated sweetgum's wind resistance as medium to high; in a summary table of wind resistance by Everham and Brokaw (1996), seven studies rated sweetgum as having medium to high wind resistance. Our studies have shown that it survives well but is prone to some branch breakage. In a Texas study after a tornado, sweetgum was listed as one of the best survivors, but also the tree with the most branch damage (Glitzenstein and Harcombe 1988). In a study after Hurricane Kate in 1985, sweetgum had low mortality (2%) in a southern mixed hardwood forest compared to spruce pine with 34% mortality (Batista and Platt 2003). They note that wind-firmness of sweetgum is likely due to its underground connections, short and stout branches, and leaves with slender, long petioles that readily detach from branches in wind. On gravelly ridges, hillsides, and upland piedmont sites, sweetgum has been noted to develop a particularly strong taproot and is very resistant to wind (Kormanik 1990).

Tulip poplar had very poor survival in Hurricane Ivan (24%). Survey respondents rated it as having medium to low wind resistance. Everham and Brokaw (1996) summarize two studies in their table with high levels of wind damage for tulip poplar in high intensity storms.

Recommendations

Taking our survival and branch loss results from hurricanes and incorporating results from the survey and from the scientific literature, we have developed lists of relative wind resistance for tree species in the southeastern coastal plain (Table 3). These lists should be used with caution, with the knowledge that no species and no tree is completely wind proof. In addition, local considerations such as soil, cultural practices, tree age and health, and other urban forest health conditions need to be taken into account. In addition to hurricane wind speed, other conditions accompanying hurricanes such as precipitation and the speed with which the storms move through an area appear to influence tree response.

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Table 1. Survival for Southeastern Coastal Plain tree species after six hurricanes.

Tree Species		Survival (%) After Each Hurricane (Wind Speed in km/h)					
		Erin (137)	Jeanne (193)	Opal (201)	Ivan (209)	Charley (233)	Andrew (265)
Dicots							
<i>Acer rubrum</i>	Red maple	—	—	93	76	—	—
<i>Acer saccharinum</i>	Silver maple	—	—	93	—	—	—
<i>Carya floridana</i>	Florida scrub hickory	—	83	—	—	—	—
<i>Carya illinoensis</i>	Pecan	97	—	93	76	—	—
<i>Carya glabra</i>	Pignut hickory	100	—	—	—	—	—
<i>Cinnamomum camphora</i> ^a	Camphor	—	—	—	—	90	—
<i>Cornus florida</i>	Flowering dogwood	100	—	96	81	—	—
<i>Ilex opaca</i>	American holly	—	—	—	95	—	—
<i>Lagerstroemia indica</i>	Crape myrtle	—	—	—	84	—	—
<i>Liquidambar styraciflua</i>	Sweet gum	—	—	93	86	—	—
<i>Liriodendron tulipifera</i>	Tulip poplar	—	—	—	24	—	—
<i>Magnolia grandifolia</i>	Southern magnolia	96	—	97	92	—	—
<i>Magnolia virginiana</i>	Sweet bay magnolia	97	—	—	—	—	—
<i>Myrica cerifera</i>	Wax myrtle	—	—	—	90	—	—
<i>Platanus occidentalis</i>	Sycamore	—	—	92	73	—	—
<i>Prunus caroliniana</i>	Carolina laurelcherry	76	—	74	53	—	—
<i>Prunus serotina</i>	Black cherry	—	—	—	64	—	—
<i>Pyrus calleryana</i>	Bradford pear	—	—	—	68	—	—
<i>Quercus falcata</i>	Southern red oak	—	—	—	60	—	—
<i>Quercus virginiana</i>	Live oak	96	97	95	91	78	78
<i>Quercus geminata</i>	Sand live oak	96	94	96	99	—	—
<i>Quercus laurifolia</i>	Laurel oak	89	94	90	77	85	—
<i>Quercus laevis</i>	Turkey oak	83	—	89	—	—	—
<i>Quercus nigra</i>	Water oak	—	—	—	72	—	—
<i>Sapium sebiferum</i> ^a	Chinese tallow	97	—	83	73	—	—
Monocots—Palms							
<i>Butia capitata</i>	Jelly palm	97	—	—	—	—	—
<i>Sabal palmetto</i>	Sabal palm	97	92	100	80	92	93
<i>Washingtonia robusta</i>	Washington palm	—	80	—	—	92	—
Conifers							
<i>Juniperus virginiana</i> var. <i>silicicola</i>	Southern red cedar	92	—	60	61	—	—
<i>Pinus clausa</i>	Sand pine	61	4	58	48	—	—

Tree Species		Survival (%) After Each Hurricane (Wind Speed in km/h)					
		Erin (137)	Jeanne (193)	Opal (201)	Ivan (209)	Charley (233)	Andrew (265)
<i>Pinus elliottii</i> var. <i>elliottii</i> and var. <i>densa</i>	Slash pine (and south Florida slash pine)	95	90 (<i>densa</i>)	96	72	79 (<i>densa</i>)	73 (<i>densa</i>)
<i>Pinus glabra</i>	Spruce pine	—	—	—	46	—	—
<i>Pinus palustris</i>	Longleaf pine	90	—	94	59	57	—
<i>Pinus taeda</i>	Loblolly pine	—	—	82	66	—	—
<i>Taxodium distichum</i>	Baldcypress	—	—	—	—	95	—

^a Prohibited from use in Florida.

* Survival is defined as the percentage of trees still standing after the hurricane. Numbers are only presented for tree species having a sample greater or equal to n=20 trees for each hurricane. Least Significant Differences at p=0.05 are 35% for Jeanne, 35% for Ivan, and 30% for Charley. Erin and Opal survival percentages are from Duryea 1997; Andrew survival percentages are from Duryea et al. 1996

Table 2. Results of survey of arborists, scientists, and urban foresters in Florida.*

Scientific Name	Common Name	Wind Resistance						p-value	Total N
		High		Medium		Low			
		N	%	N	%	N	%		
Dicots and Pines									
<i>Acer negundo</i>	boxelder	1	8	6	50	5	42	n.s.	12
<i>Acer palmatum</i>	Japanese maple	6	50	6	50	0	0	n.s.	12
<i>Acer rubrum</i>	red maple	12	20	32	52	17	28	0.0049	61
<i>Acer saccharinum</i>	silver maple	0	0	10	45	12	55	n.s.	22
<i>Acer saccharum</i> subsp <i>floridanum</i>	Florida sugar maple	2	11	11	61	5	28	0.0302	18
<i>Betula nigra</i>	river birch	11	39	16	57	1	4	0.0019	28
<i>Carpinus caroliniana</i>	ironwood	7	50	6	43	1	7	n.s.	14
<i>Carya glabra</i>	pignut hickory	11	41	14	52	2	7	0.0131	27
<i>Carya illinoinesis</i>	pecan	6	21	9	32	13	47	n.s.	28
<i>Carya tomentosa</i>	mockernut hickory	6	50	6	50	0	0	n.s.	12
<i>Celtis laevigata</i>	sugarberry	4	15	18	70	4	15	0.0005	26
<i>Celtis occidentalis</i>	common hackberry	2	18	5	46	4	36	n.s.	11
<i>Cercis canadensis</i>	red bud	14	48	8	28	7	24	n.s.	29
<i>Chionanthus virginicus</i>	fringe tree	7	50	5	36	2	14	n.s.	14
<i>Cornus florida</i>	flowering dogwood	9	60	6	40	0	0	n.s.	15
x <i>Cupressocyparis leylandii</i>	leyland cypress	7	22	13	41	12	37	n.s.	32
<i>Diospyros virginiana</i>	common persimmon	14	56	9	36	2	8	0.0128	25
<i>Eucalyptus cinerea</i>	silver dollar eucalyptus	2	13	9	56	5	31	n.s.	16
<i>Eriobotrya japonica</i> ^c	loquat	9	24	24	63	5	13	0.0004	38
<i>Fraxinus americana</i>	white ash	3	30	6	60	1	10	n.s.	10
<i>Fraxinus pennsylvanica</i>	green ash	3	24	5	38	5	38	n.s.	13
<i>Ilex cassine</i>	dahoon holly	34	76	10	22	1	2	0.0001	46
<i>Ilex opaca</i>	American holly	21	75	6	21	1	4	0.0001	28
<i>Ilex vomitoria</i>	yaupon holly	28	81	7	19	0	0	0.0004	37
<i>Juniperus virginiana</i> var. <i>silicicola</i>	southern red cedar	14	28	18	35	19	37	n.s.	51
<i>Lagerstroemia indica</i>	crape myrtle	55	83	11	17	0	0	0.0001	66
<i>Liriodendron tulipifera</i>	tulip poplar	2	8	14	58	8	33	0.0111	24
<i>Liquidambar styraciflua</i>	sweetgum	18	43	21	50	3	7	0.0013	42
<i>Magnolia grandiflora</i>	southern magnolia	45	82	9	16	1	2	0.0001	55
<i>Magnolia virginiana</i>	sweetbay magnolia	15	42	17	47	4	11	0.0169	36
<i>Magnolia</i> x <i>soulangiana</i>	saucer magnolia	8	44	9	50	1	6	0.0421	18
<i>Morus rubra</i>	red mulberry	6	23	14	54	6	23	n.s.	26
<i>Myrica cerifera</i>	wax myrtle	18	33	15	28	21	39	n.s.	54
<i>Nyssa aquatica</i>	water tupelo	7	58	5	42	0	0	n.s.	12
<i>Nyssa sylvatica</i>	black tupelo	14	58	9	38	1	4	0.0469	24
<i>Ostrya virginiana</i>	American hophornbeam	8	67	4	33	0	0	n.s.	12
<i>Pinus glabra</i>	spruce pine	7	54	1	8	5	38	n.s.	13
<i>Pinus elliotii</i> var. <i>elliotii</i>	slash pine	16	25	36	57	11	18	0.0002	63
<i>Pinus palustris</i>	longleaf pine	23	56	13	32	5	12	0.0017	41

<i>Pinus taeda</i>	loblolly pine	7	20	19	54	9	26	0.0289	35
<i>Platanus occidentalis</i>	sycamore	17	38	21	48	6	14	n.s.	44
<i>Prunus angustifolia</i>	chickasaw plum	12	50	8	33	4	17	n.s.	24
<i>Prunus caroliniana</i>	Carolina laurelcherry	5	16	15	48	11	36	n.s.	31
<i>Prunus serotina</i>	black cherry	4	18	10	46	8	36	n.s.	22
<i>Pyrus calleryana</i>	Bradford pear	5	21	5	21	14	58	0.0342	24
<i>Quercus alba</i>	white oak	6	55	5	45	0	0	0.0539	11
<i>Quercus falcata</i>	southern red oak	4	20	15	75	1	5	0.0003	20
<i>Quercus geminata</i>	sand live oak	36	92	2	5	1	3	0.0001	39
<i>Quercus laevis</i>	turkey oak	17	47	16	45	3	8	0.0062	36
<i>Quercus laurifolia</i>	laurel oak	3	4	27	39	39	57	0.0001	69
<i>Quercus michauxii</i>	swamp chestnut oak	8	50	8	50	0	0	n.s.	16
<i>Quercus myrtifolia</i>	myrtle oak	13	76	4	24	0	0	0.0290	17
<i>Quercus nigra</i>	water oak	3	8	14	36	22	56	0.0009	39
<i>Quercus phellos</i>	willow oak	1	8	8	67	3	25	0.0388	12
<i>Quercus shumardii</i>	shumard oak	13	52	10	40	2	8	0.0207	25
<i>Quercus stellata</i>	post oak	5	33	10	67	0	0	n.s.	15
<i>Quercus virginiana</i>	live oak	64	89	8	11	0	0	0.0001	72
<i>Salix x sepulcralis</i>	weeping willow	2	12	8	50	6	38	n.s.	16
<i>Taxodium distichum</i>	baldcypress	59	91	6	9	0	0	0.0001	65
<i>Taxodium ascendens</i>	pondcypress	41	91	4	9	0	0	0.0001	45
<i>Tilia americana</i>	basswood	5	38	4	31	4	31	n.s.	13
<i>Ulmus alata</i>	winged elm	15	53	12	43	1	4	0.0030	28
<i>Ulmus americana</i>	American elm	6	30	12	60	2	10	0.0224	20
<i>Ulmus parvifolia</i>	Chinese elm	7	23	11	35	13	42	n.s.	31
<i>Vaccinium arboreum</i>	sparkleberry	11	85	2	15	0	0	0.0126	13
Palms									
<i>Butia capitata</i>	pindo, jelly	34	79	7	16	2	5	0.0001	43
<i>Phoenix canariensis</i>	Canary Island date palm	49	89	4	7	2	4	0.0001	55
<i>Phoenix dactylifera</i>	date palm	33	94	2	6	0	0	0.0001	35
<i>Sabal palmetto</i>	cabbage, sabal palm	71	99	1	1	0	0	0.0001	72
<i>Washingtonia robusta</i>	Washington fan palm	29	54	16	29	9	17	0.0033	54

^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005)

* Rankings for wind resistance of southeastern US coastal plain tree species. N is the number of respondents for each species, out of a total of eighty-five experts. P-values from the chi-square test for equal proportions indicate the significance level for one or more of the categories being different from the others; n.s. means that there is no significant difference between the categories of high, medium and low (p>0.05).

Table 3. Wind resistance of southeastern US coastal plain tree species.*

Highest Wind Resistance	<p>DICOTS</p> <p><i>Carya floridana</i>, Florida scrub hickory <i>Cornus florida</i>, dogwood <i>Ilex cassine</i>, dahoon holly <i>Ilex glabra</i>, inkberry <i>Ilex opaca</i>, American holly <i>Ilex vomitoria</i>, yaupon holly <i>Lagerstroemia indica</i>, crape myrtle <i>Magnolia grandiflora</i>, southern magnolia <i>Podocarpus</i> spp, podocarpus <i>Quercus geminata</i>, sand live oak <i>Quercus laevis</i>, turkey oak <i>Quercus myrtiflora</i>, myrtle oak <i>Quercus virginiana</i>, live oak <i>Vaccinium arboreum</i>, sparkleberry</p> <p>CONIFERS</p> <p><i>Taxodium ascendens</i>, pondcypress <i>Taxodium distichum</i>, baldcypress</p>
Medium-High Wind Resistance	<p>DICOTS</p> <p><i>Acer saccharum</i>, Florida sugar maple <i>Acer palmatum</i>, Japanese maple <i>Betula nigra</i>, river birch <i>Carpinus caroliniana</i>, ironwood <i>Carya glabra</i>, pignut hickory <i>Carya tomentosa</i>, mockernut hickory <i>Cercis canadensis</i>, red bud <i>Chionanthus virginicus</i>, fringe tree <i>Diospyros virginiana</i>, common persimmon <i>Fraxinus americana</i>, white ash <i>Liquidambar styraciflua</i>, sweetgum <i>Magnolia virginiana</i>, sweetbay magnolia <i>Magnolia x soulangiana</i>, saucer magnolia <i>Nyssa aquatica</i>, water tupelo <i>Nyssa sylvatica</i>, black tupelo <i>Ostrya virginiana</i>, American hophonbeam <i>Prunus angustifolia</i>, chickasaw plum <i>Quercus michauxii</i>, swamp chestnut oak <i>Quercus shumardii</i>, Shumard oak <i>Quercus stellata</i>, post oak <i>Ulmus alata</i>, winged elm</p>

Medium-low Wind Resistance	<p>DICOTS</p> <p><i>Acer negundo</i>, boxelder <i>Acer rubrum</i>, red maple <i>Acer saccharinum</i>, silver maple <i>Celtis laevigata</i>, sugarberry <i>Celtis occidentalis</i>, hackberry <i>Cinnamomum camphora</i>, camphor^b <i>Eriobotrya japonica</i>, loquat^c <i>Eucalyptus cinerea</i>, silverdollar eucalyptus <i>Fraxinus pennsylvanica</i>, green ash <i>Morus rubra</i>, red mulberry <i>Myrica cerifera</i>, wax myrtle <i>Persea borbonia</i>, redbay <i>Platanus occidentalis</i>, sycamore <i>Prunus serotina</i>, black cherry <i>Quercus alba</i>, white oak <i>Quercus phellos</i>, willow oak <i>Salix x sepulcralis</i>, weeping willow <i>Ulmus americana</i>, American elm</p> <p>CONIFERS</p> <p><i>Pinus elliottii</i>, slash pine <i>Pinus palustris</i>, longleaf pine <i>Pinus taeda</i>, loblolly pine</p>
Lowest Wind Resistance	<p>DICOTS</p> <p><i>Carya illinoensis</i>, pecan <i>Liriodendron tulipifera</i>, tulip poplar <i>Prunus caroliniana</i>, Carolina laurelcherry <i>Pyrus calleryana</i>, Bradford pear <i>Quercus falcata</i>, southern red oak <i>Quercus laurifolia</i>, laurel oak <i>Quercus nigra</i>, water oak <i>Sapium sebiferum</i>, Chinese tallow^a <i>Ulmus parvifolia</i>, Chinese elm</p> <p>CONIFERS</p> <p><i>Juniperus virginiana</i> var. <i>silicicola</i>, southern red cedar x <i>Cupressocyparis leylandii</i>, Leyland cypress <i>Pinus clausa</i>, sand pine <i>Pinus glabra</i>, spruce pine</p> <p>PALMS</p> <p><i>Washingtonia robusta</i>, Washington fan palm</p>
<p>^a Prohibited from use in Florida ^b Invasive and not recommended for use in Florida ^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005) * Wind resistance of southeastern coastal plain species as estimated utilizing the hurricane measurements and the survey results in this study, and the scientific literature cited throughout this publication.</p>	

Table 4. New Trees

To promote a healthy and more wind- resistant urban forest, additional recommendations for establishing new trees include:
Plant a mixture of species, ages, and layers (shrubs and trees) to maintain diversity in your community.
Plant trees from the “Highest” and “Medium-High” Wind Resistance lists and match these to local site conditions.
Give trees adequate rooting space with no obstructions (e.g., sidewalks, buildings, and streets): for small trees, provide at least 3 meters by 3 meters; for large trees, provide at least 10 meters by 10 meters.
Consider planting trees in groups as opposed to individually.
Consider soil properties when deciding what to plant (e.g. soil depth, water table depth, and compaction).
Give trees adequate aerial space considering their crown size when mature.
Plant high quality trees with good structure.
Establish a structural pruning program early on.

Table 5. Established Trees

Likewise, recommendations for managing established trees include:
Have tree health evaluated and remove hazard trees.
Consider removing trees that are on the “Lowest Wind Resistance” list, especially if they are over-mature and endangering life or property.
Establish a regular structural pruning program (especially for dicots).
Consult with a certified arborist.
Do not over-prune palms especially before a hurricane; palms only need to have dead or dying leaves removed.
Be aware of possible root damage and lack of anchoring when construction has resulted in sidewalks or trenches near the roots of trees.
Avoid damage to the trunk of the tree (e.g., mechanical weed control damage).

How to Minimize Wind Damage in the South Florida Landscape¹

Timothy K. Broschat and Derek Burch²

When an area has been free of hurricane-strength winds for a number of years, there is a possibility of severe damage to trees and to the structures near them when a storm finally hits. Trees and shrubs, even those native to an area, can grow too massive or unbalanced to be able to stand wind-storms, and it is worth learning how to prune and shape trees in order to minimize the risks of damage.

The ideal approach to avoiding storm damage begins with the initial selection of the plants. Such selection takes into consideration the branch and trunk strength of the trees being considered for planting, how strong their root system is, and their placement relative to structures and utilities. A regular system of pruning must then be established; pruning should develop a sturdy, well-spaced framework of healthy branches carrying an open, leafy canopy that allows air to move freely.

Trees Resistant to Wind

There are some tree species that stand up to strong winds much better than others. (No tree can be guaranteed to stand up to hurricane-force winds or even strong gusts of wind. This is particularly true if it has been growing unpruned for a number of years.) These trees are more likely to withstand strong winds.

- *Cordia sebestena*—geiger tree
- *Mangifera indica*—mango

- *Manilkara roxburghiana*—mimusops
- *Quercus virginiana*—live oak
- *Tamarindus indica*—tamarind

Most palm species.

Brittle Trees

At the other end of the scale are the trees noted for dropping branches or splitting apart under stress. Losing leaves or twigs in a high wind will make a garden untidy, but may give the trees an advantage by reducing the stress on the main branches. The trees on this list are likely to lose major limbs.

- *Acacia auriculiformis*—earleaf acacia
- *Bischofia javanica*—bischofia
- *Enterolobium cyclocarpum*—ear tree
- *Eucalyptus* spp.—eucalyptus
- *Grevillea robusta*—silk oak
- *Hibiscus tiliaceus*—sea hibiscus
- *Persea americana*—avocado
- *Spathodea campanulata*—African tulip tree

Most species fall between the extremes and have a good chance of surviving a moderate to strong storm intact, provided they have had proper pruning.

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Shallow-Rooted Trees

Another class of damage occurs when the whole tree blows over rather than breaking up. The soil in which the trees are growing may have a major influence on how shallow-rooted a tree is, but there are certain species that almost never make deep roots, and these are always likely to blow over. On poorly drained soils, such as marl, where the water table periodically comes close to the soil surface, most trees that would otherwise form deep roots will be shallow-rooted and much more easily blown over than they would be on well drained soils. It is interesting to consider that in nature, blowing over rather than breaking up may help the tree to survive. The roots left in the ground supply the fallen tree with nutrients and new upright shoots form from the base and along the trunk. In a controlled landscape this is not a desirable characteristic, but it may be an advantage in semi-wild situations, particularly along the coast.

Species with shallow root systems include:

- *Albizia lebbek*—woman's tongue
- *Bulnesia arborea*—vera wood
- *Casuarina* spp.—Australian pine
- *Ficus microcarpa*—Indian laurel
- *Peltophorum* spp.—yellow poinciana, copperpod
- *Thespesia populnea*—seaside mahoe

Planting Considerations

When a tree falls or breaks up it is more likely to damage a structure close to it than one farther away. If the landscape planning includes the use of trees to shade the house, some compromise will be necessary to avoid the shade trees turning into wreckers during a storm. It is more important to shade the east and west walls than the roof. Small trees could be planted fairly close to the house to accomplish this, and they would be much less hazardous than larger trees, even if the larger trees were farther away. Observations of native tree hammocks in Dade County suggest that a large number of trees close together may be an effective storm protection for structures, but no definitive testing of this theory has been carried out. Overhead utility lines are even more vulnerable to damage than the roof or windows of a house, and there should be no tree branches close enough to drop across them or even brush against them.

Once the tree has been selected and planted in such a place as to reduce hazards, there still remain cultural practices throughout the life of the tree that will affect its survival during a storm.

When planting, the usual advice has been to dig a large hole, put the tree in the hole, and fill around the ball of roots with enriched soil. Under certain circumstances, this may be exactly the wrong thing to do! In really bad soil or rock, the hole full of rich soil may allow the tree roots to get off to a good start, but the roots may take a long time to grow from the good soil into the poor soil surrounding it. Roots may coil around in the hole just as they would in a pot, and with the same disadvantages: a danger of encircling and constricting the lower part of the trunk, a limited volume from which to draw water and nutrients, and very little resistance to being blown over.

If the soil is enriched or amended before planting, use no more than 1/3 organic matter (by volume) mixed well with the original soil from the site, making this addition to an area large enough to support an extensive root system. If this is not feasible, plant the tree in unamended soil and pay close attention to watering and fertilizing until the tree roots have grown out strongly. Use of organic mulches 3 to 4 inches deep around the tree (but not touching the trunk) will help with the establishment of the tree by keeping the ground cooler, moister, and with fewer weeds than if the ground were bare. The mulch will gradually improve the soil, too.

In Dade County, where limestone can be a problem, dynamiting before planting is very helpful in opening cracks through which the roots can travel. Once established, trees planted in this way are extremely resistant to blowing over. Unfortunately, dynamiting is not allowed in many areas.

Pruning for Wind Resistance

The most wind-resistant form for a tree is one with a central leader and a well-spaced framework of branches around and up and down the trunk (Figure 1). Most trees can be grown in this form when they are young, but the growth habit of some species will change to a multi-trunked spreading form as they mature.

There should be no narrow forks or branches leaving the trunk at an acute angle (Figure 2), since these branches are likely to split under stress. Crotches from 45 to 90 degrees are less likely to split than narrow V-crotches of less than 40 degrees.

A wind-resistant tree is the result of regular care since its early life. Young trees should not be cut back to make them bushy, but should rather be encouraged to form a strong leader with well-spaced laterals (branches that go out to the

side) that are held back enough to stop them from forming multiple, competing leaders (Figure 3).

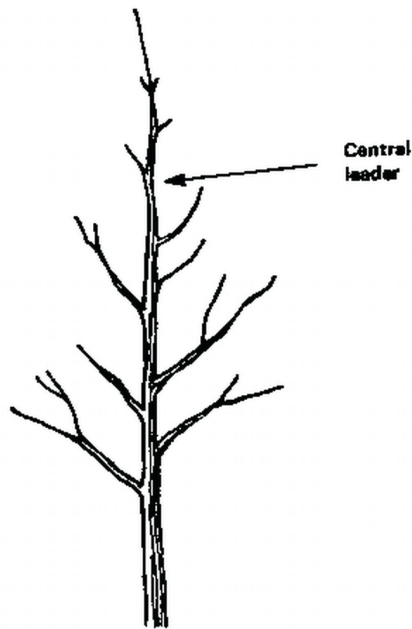


Figure 1. Encourage wind-resistant form.

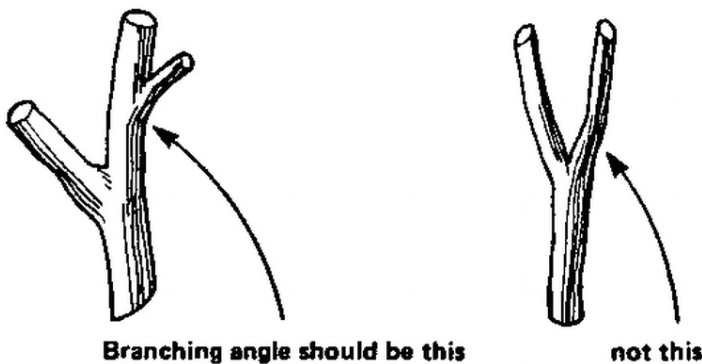


Figure 2. Encourage wide branching angles.

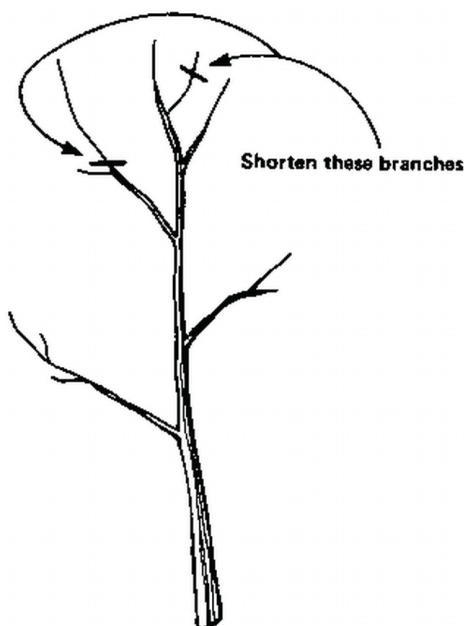


Figure 3. Encourage a strong leader.

A young tree in the form shown in Figure 3 can have the lower branches removed over a period of time to give a clear trunk to whatever height is necessary. It should not, however, be cleaned of laterals in the lower part of the trunk too soon, since the branches there (provided they are not allowed to form competing leaders) will help to give a larger trunk diameter and a much sturdier tree (Figure 4).

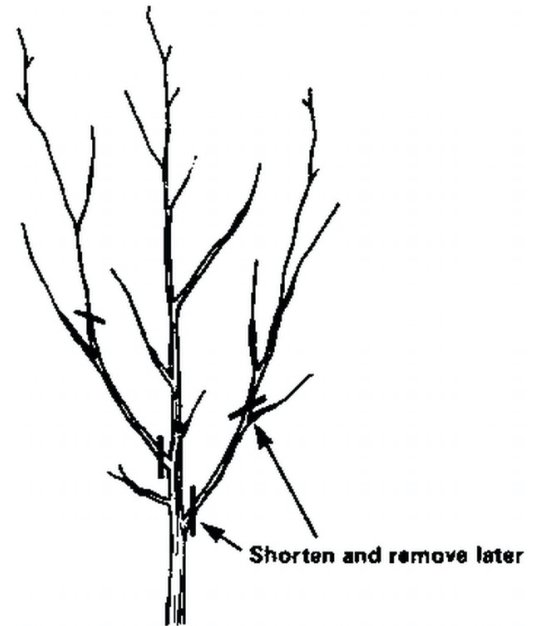


Figure 4. Trim lower lateral branches gradually over time to encourage a larger trunk diameter.

Later pruning should consist of forming a well-spaced framework of strong branches, and a pleasing outline to the tree.

Preparing for a Storm

Faced with the threat of a storm, gardeners who have kept their trees thinned and with a canopy in proportion to the trunk and branches have little extra to do. The overgrown, neglected tree, however, is another matter. It may be necessary to reduce the size of the tree, which will be a minor operation and hardly noticeable for a tree which has been well maintained. For a neglected tree it will mean severe surgery and a tree that will be ugly for a few months whether or not the storm hits.

The order of pruning is always the same (Figure 5).

1. Cut out dead, diseased, and damaged wood.
2. Take out watersprouts.
3. Cut out crossing branches and those growing into the center of the tree.

4. Clean off small branches that clutter the center of the tree.
5. Select a well spaced framework of branches and cut all others out completely.
6. Shorten branches to give a balanced head.

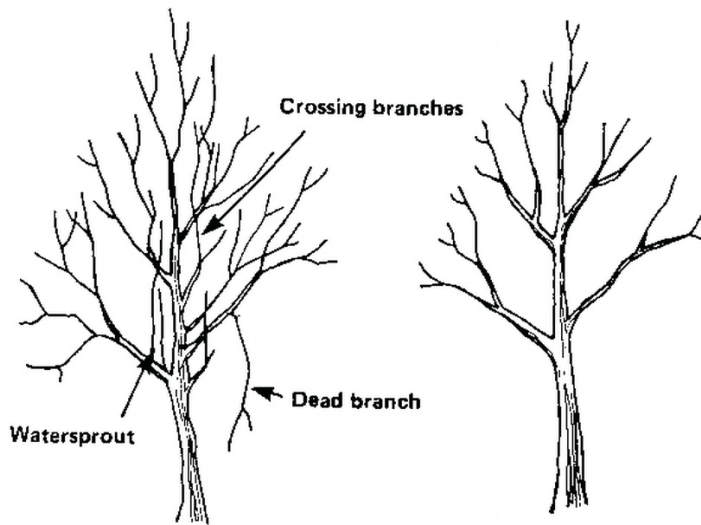


Figure 5. Pruning order is always the same.

Whenever possible, this shortening should be done to a bud that has already started to grow out as a sidebranch. (Figure 6). Cutting to an upward pointing branch or one leading to one side or the other will determine the direction in which new growth occurs for a time. If the tree has been well managed, pruning in this way (drop crotch pruning) will mean that the cuts scarcely show since a lot of foliage will remain to disguise them. In cutting back a neglected tree, many of the cuts will have to be made to a part of the branch with no leaves or side branches. Even when the cut can be made to a fork, the remaining branch may also need to be shortened so that the cuts have very little foliage to hide them.

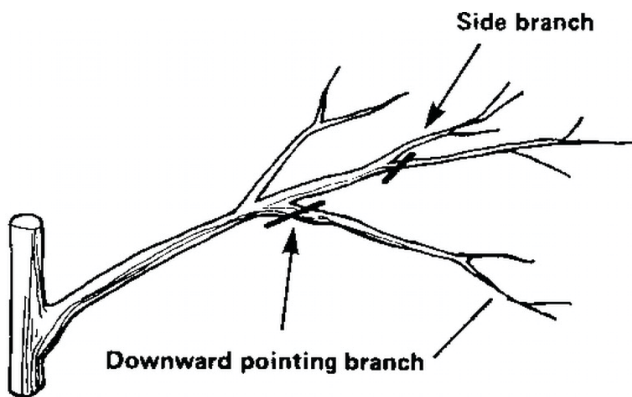


Figure 6. Shorten buds that have begun to grow as side branches.

Heading back (cutting branches severely to a bare stump) should be avoided unless absolutely necessary. Not only does this risk sunburn for all the trunk suddenly exposed

to the light, but it also means that a tuft of twigs will grow from each stump which will have to be thinned later. All cutting should be done so as to avoid damage to the parts of the tree that are to remain. Cuts should be finished close to the trunk or remaining branch and at the angle shown in Figure 7 so that they will heal well. Painting the cuts is not recommended. It is of no value in promoting healing, although it may help to disguise the cut.

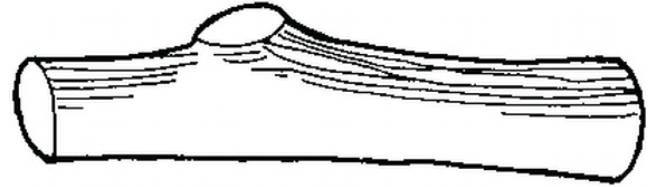


Figure 7. Finished cut.

If you have coconut palms, preparing for storms includes harvesting all nuts that are of any size. Coconuts and most other large palms should have dead leaves removed. The nuts and the leaves can act as missiles if the wind catches them right. Do not, however, cut off all leaves except the central upright tuft, since this removes the protection for the bud (Figures 8 and 9). Last minute prunings can also blow around dangerously and should thus be disposed of for safety.



Figure 8. Coconut palms that were overtrimmed prior to a hurricane (left) showed high mortality rates (right). Note that the untrimmed palms of the other species in this picture showed no damage from this storm.

Credits: D. Caldwell



Figure 9. Coconut palms one block away that were untrimmed prior to this hurricane showed little storm damage.

Credits: D. Caldwell

Windstorms are always a matter of concern, but trees that have been selected properly, sited with care, and maintained so as to have a sturdy form and an open canopy stand the best chance of surviving intact and not adding to the damage in the area.

Selecting Tropical and Subtropical Tree Species for Wind Resistance¹

Mary L. Duryea and Eliana Kampf²



Introduction

A team of scientists at the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) has been tracking and studying major hurricanes since Hurricane Andrew in 1992 to determine their effect on the urban forest. One of the major goals of this study is to assemble lists of relative wind resistance for different urban tree species. These lists can assist communities to better prepare for the next hurricane season and to rebuild a healthy urban forest by selecting proper species.

This fact sheet presents the research and methodology that lead to lists of relative wind resistance for tropical and subtropical tree species (Chapter 8 reports on coastal

plain tree species). It also discusses in detail its results and additional recommendations for selecting and establishing tropical and subtropical species for a healthier and more wind-resistant urban forest.

Study

Since 1992 when Hurricane Andrew struck south Florida, we have been studying the impacts of hurricanes on urban forests (Duryea et al. 1996; Duryea et al. 2007a; Duryea et al. 2007b). In 1998 when Hurricane Georges (177 km/h) crossed over the entire island of Puerto Rico, and in 2004 when Hurricanes Jeanne (193 km/h) and Charley (233 km/h) struck south Florida, we continued with these measurements. Hurricanes striking the subtropical and tropical regions of Florida and Puerto Rico, with their varied wind speeds, gave us the opportunity to study over 60 species and their comparable responses to wind. This study utilizes our results from hurricanes and incorporates results from a survey and the scientific literature to present lists of relative wind resistance for tropical and subtropical tree species.

Methods

Urban tree damage was measured within 3 to 10 days of the two hurricanes that struck Florida (Charley and Jeanne 2004) and the one that struck Puerto Rico (Georges 1998). In this study, we also included the hurricane response of some tropical/subtropical species, such as live oak (*Quercus*

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virginiana) and sabal palm (*Sabal palmetto*), that occur throughout Florida and were impacted by Hurricanes Erin (1995), Opal (1995), and Ivan (2004) in the Florida panhandle (Figure 2).

Hurricane Andrew measurements involved a survey of 128 homeowners in Dade County, Florida who measured and reported to us about each tree in their yards (Duryea et al. 1996). The methodology for the other hurricanes was the same and is as follows: neighborhoods at the point of landfall of the hurricane were randomly chosen. For each neighborhood, all trees were observed along street transects. For each of the three hurricanes, we sampled 26 neighborhoods and 3,678 trees (Georges), 17 neighborhoods and 2,272 trees (Charley), and 7 neighborhoods and 1,642 trees (Jeanne). (Branch loss measurements for Hurricanes Frances [2005] and Jeanne were combined and made immediately following Hurricane Jeanne).

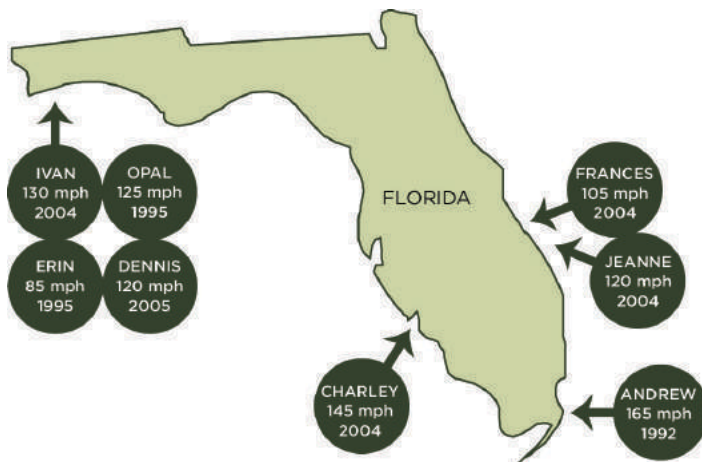


Figure 2. Urban trees were measured following hurricanes striking Florida and Puerto Rico. For each hurricane, the arrow points to the location of landfall. The maximum sustained wind speed (mph) and year are included.

Results

Overall Urban Forest Loss

The percent of urban forest loss (mortality) ranged from 13% for Hurricane Georges to 16% for Hurricane Jeanne to 18% for Hurricane Charley. The urban forest loss for these hurricanes combined with hurricanes striking the southeastern coastal plain is reported in EDIS publication FOR118 [Lessons Learned from Hurricanes](#). To evaluate tree survival and responses, we divided the species into four categories: palms, dicots, conifers, and Puerto Rico species. We then talk about native versus exotic species.

Tree Survival and Branch Loss

Palms

Sabal palms along with the smaller palms such as areca (*Chrysalidocarpus lutescens*), Manila (*Veitchia merrillii*) and pigmy date (*Phoenix roebelenii*), had 89% or greater survival (Table 1). In Hurricane Charley, palm survival was 88% compared to 77% for all other tree species ($p=0.0001$). In Hurricane Jeanne, palm survival was 86% versus 76% for all other tree species ($p<0.0001$). When compared to dicots, palms have often been observed to be more resistant to winds (Francis and Gillespie 1993; Frangi and Lugo 1991). Zimmerman *et al.* (1994) conclude that palms are wind resistant because they are able to lose all their leaves without losing their terminal meristem. Coconut palm (*Cocos nucifera*), which survived poorly in Hurricane Andrew (Duryea *et al.* 1996), exhibited intermediate survival in both Charley's and Georges' winds (77% survival) (Table 1). Royal palm (*Roystonea elata*) which had only 63% survival in Andrew, had improved survival (87%) in Hurricane Charley in the deeper soils of the Gulf Coast. Washington palm (*Washingtonia robusta*) survived well in Charley's 233 km/h (145 mph) winds (92%) but less well in Jeanne's winds of 193 km/h (120 mph) (80%). This was perplexing to us until we looked at the height comparisons of the two populations. Washington palms in the Ft. Pierce area that experienced Hurricane Jeanne averaged 11 m in height, with 42% of the palms above 10 m, compared to an average of 4 m and only 7% over 10 m for Charley; perhaps as Washington palms acquire heights of 20 meters and above, their wind resistance starts to decline.

Dicots

Of the dicot tree species, the poorest surviving were melaleuca (*Melaleuca quinquenervia*), Australian pine (*Casuarina equisetifolia*), and black olive (*Bucida buceras*) in Hurricane Charley. Dicots with highest survival were camphor (*Cinnamomum camphora*), gumbo limbo (*Bursera simarouba*), sea grape (*Coccoloba uvifera*), strangler fig (*Ficus aurea*), live oak, and laurel oak (*Quercus laurifolia*) (Figure 3).

Trees with large amounts of branch loss in a hurricane (Figure 4) may not be considered as healthy urban trees, so we re-analyzed survival taking into account branches lost. Standing trees with 50% or greater branch loss were called dead and a "new" survival was calculated (named "recalculated survival").

Some species such as camphor, strangler fig, laurel oak, and live oak may continue to stand in hurricane- force winds

but at the same time lose large branches, especially at the 233 km/h (145 mph) winds of Charley (Figure 5).

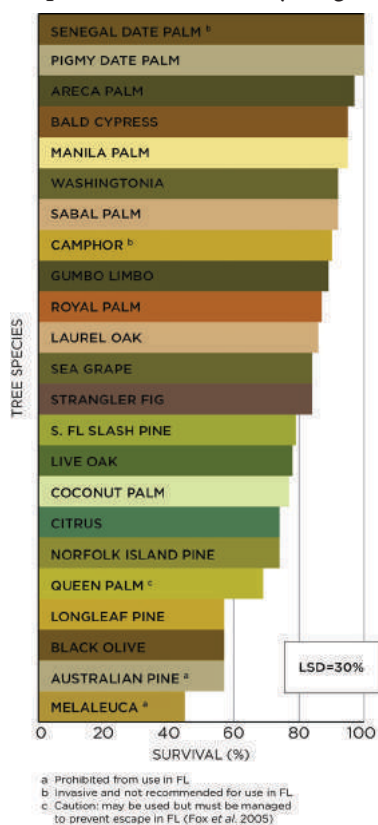


Figure 3. Survival (%) of tree species in Hurricane Charley, which struck at 233 km/h (145 mph)

After intermediate survival in Hurricane Andrew, West Indian mahogany (*Swietenia mahagoni*) and white cedar (*Tabebuia heterophylla*) exhibited higher survival in Hurricane Georges at 177 km/h (110 mph). After relatively poor survival in Andrew, 94% of the royal poinciana (*Delonix regia*) survived the relatively lighter winds of Hurricane Georges. In a study of 24 species of urban trees in San Juan, Puerto Rico after Hurricane Georges, species with the highest survival (lowest failed stems) were West Indian mahogany (100%), mango (*Mangifera indica*) (98%), queen's crape myrtle (*Lagerstroemia speciosa*) (98%), and royal poinciana (98%) (Francis 2000). Species with the poorest survival were African tuliptree (*Spathodea campanulata*) (66%) and weeping banyan (*Ficus benjamina*) (70%) (Francis 2000). Studies summarized in Everham and Brokaw's table of species resistance to catastrophic wind (1996) rank gumbo limbo, mahogany, sea grape, baldcypress (*Taxodium distichum*), live oak, and white cedar with high wind resistance in at least two or more studies. Species that received the lowest wind resistance ratings in two or more studies were Australian pine (*Casuarina equisetifolia*), Honduras mahogany (*Swietenia macrophylla*), swamp mahogany (*Eucalyptus robusta*), and Caribbean pine (*Pinus caribaea*).

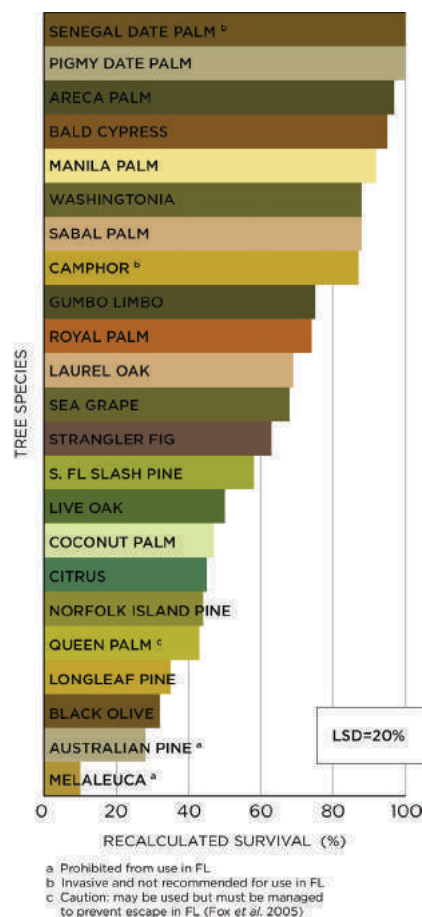


Figure 4. A recalculation of survival (%) after considering trees with greater than or equal to 50% branch loss as dead after Hurricane Charley.

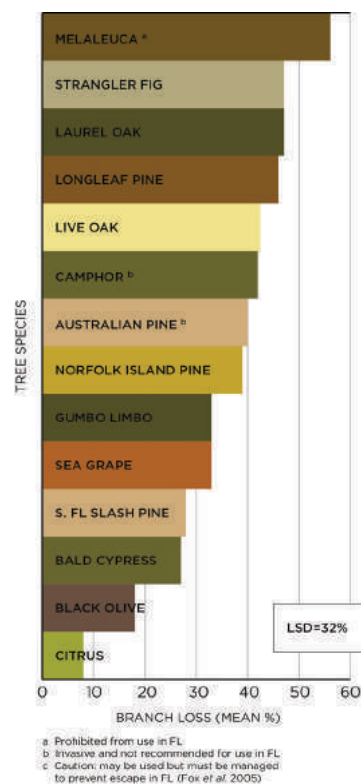


Figure 5. Branch loss (%) for each tree species in Hurricane Charley, which struck land at 233 km/h (130 mph).

In the urban areas of the southeastern coastal plain, laurel oak trees did not survive as well as live oak and sand live oak (*Quercus geminata*) in four hurricanes (Duryea *et al.* 2007b). However, in the two south Florida hurricanes, both survival and branch loss for live and laurel oaks were similar (Figures 4 and 5). We also compared large trees of these species (greater than 50 cm diameter) and found that their survival, branch loss, and re-calculated survival were not significantly different in Jeanne and Charley (Figure 6).

Speculations about the reasons for lack of difference between live oak and laurel oak in south Florida include:

(1) Laurel oak in south Florida may be a different cultivar or variety than those in north Florida and (2) sandier soils in south Florida and their accompanying lower site quality may result in laurel oaks with shorter heights or lower height-to-diameter ratio (as occurs between the north Florida and south Florida varieties of slash pine (*Pinus elliotii* var. *elliotii* and var. *densa*). Still, many authors point to live oak as a tree with strong wood and little failure in hurricanes (Touliatos and Roth 1971; Swain 1979; Hook *et al.* 1991; Barry *et al.* 1993).



Figure 6. When compared to live oaks, laurel oaks in south Florida (above) showed no statistical difference for either survival, branch loss, or re-calculated survival in Hurricanes Charley and Jeanne.

Conifers

Of the conifer species, baldcypress survived Hurricane Charley the best with 95% survival (Figure 3). Baldcypress also suffered little damage after Hurricane Hugo (Putz and Sharitz 1991; Gresham *et al.* 1991). After Hurricane Andrew, cypress trees in the Everglades National Park were still standing on the edges of the hammocks while many hardwoods had failed (Orr and Ogden 1992). Only 4% of the sand pine (*Pinus clausa*) survived Hurricane Jeanne; sand pine's poor survival has been measured in several

other hurricanes (Duryea 1997; Duryea *et al.* 2007a). South Florida slash pine is next best in wind resistance for the conifers across the south Florida hurricanes (Figure 6); however, longleaf pine (*Pinus palustris*), which is usually similar to slash pine in wind resistance in the coastal plain hurricanes (Duryea *et al.* 2007a), had 57% survival in Hurricane Charley. Survival of south Florida slash pine in pine rockland ecosystems ranged from 78% to 88% in Hurricane Andrew. Mortality of the standing pine trees continued for one year with 17% to 25% dying (Platt *et al.* 2000). We returned three months after Hurricane Charley and found that 27% of the standing south Florida slash pines and 48% of the standing longleaf pines had died.



Figure 7. South Florida slash pine had 79% survival rate after Hurricane Charley.

Puerto Rico Species

Of the species measured in Puerto Rico, the species with the highest survival and least branch damage were Santa Maria (*Calophyllum calaba*), Caribbean pine, schefflera, West Indian mahogany, and Oriental arbovitae (*Thuja orientalis*) (Table 2).

Many trees had extensive branch loss that reduced survival further with the most notable species being Norfolk Island pine (*Araucaria heterophylla*), Napoleon's plume (*Bauhinia monandra*), apple blossom (*Cassia javanica*), yellow cassia (*Cassia siamea*), swamp mahogany, mahoe (*Hibiscus elatus*), and African tuliptree. The 24 tree species measured in Francis' study (2000) following Hurricane Georges also showed extensive branch damage ranging from 23% to 81%.

Similar to our study, Francis also found that West Indian mahogany was the best survivor (100% survival) and had the least branch loss, while African tuliptree suffered the most crown loss and was one of the poorest survivors (66% survival) (Francis 2000). Results for black olive and royal poinciana were also similar to those in our study, with trees surviving well (98%) but losing nearly half of their branches.

Native and Exotic Species

Native tree species survived better in Hurricanes Jeanne, Charley, and Andrew but not in Hurricane Georges (Figure 8).

Native species also lost fewer branches than exotic species in Jeanne (21% versus 36%, $p=0.0001$) and Charley (36% versus 39%, $p=0.0001$). Some of the exotic species with low survival were melaleuca, Australian pine, and queen palm, and these can be compared to native species with high survival—live oak, gumbo limbo, and sabal palm. In their extensive review of hurricanes and forest damage, Everham and Brokaw (1996) summarize that there is a trend towards more damage in exotic forest plantations, although they also point out that these exotic forests are often monocultures. Out of the 35 tree species measured after Hurricane Georges in Puerto Rico ($n \geq 20$), only four were native trees to Puerto Rico—Santa Maria, black olive, white cedar, and common calabash tree (*Crescentia cujete*). Santa Maria survived very well (93%), but the other three had 84%, 83%, and 67% respectively, not surviving better than many of the exotic species (Table 2). Branch loss of exotics and natives in Puerto Rico, too, appeared to be equal (31% for exotics versus 27%, not statistically significant). With few exotic species in the urban forest population, natives also did not survive better in the southeastern US coastal plain during Hurricane Ivan.

The Survey

Arborists, urban foresters, and scientists confirmed many of our results about wind resistance but also provided new information about some species not frequently seen and measured in the urban forest. Consistent with our results, queen palm was ranked by the experts as the palm with the lowest wind resistance (Table 3). Royal palm and coconut palm were intermediate, again consistent with our results. Sabal palm was ranked high, which is consistent with our results from the tropical and northern areas of Florida (Duryea 1996; Duryea 1997; Duryea *et al.* 2007a). Some of the species with little information from our studies that were ranked high by the experts include pond apple (*Annona glabra*), cocoplum (*Chrysobalanus icaco*), and lignum

vitae (*Guaiacum sanctum*). Species with little research information that were ranked with low wind resistance include weeping banyan, jacaranda (*Jacaranda mimosifolia*), and golden trumpet (*Tabebuia chrysotricha*). Species ranked with high wind resistance in agreement with our results were crape myrtle (*Lagerstroemia indica*), dahoon holly (*Ilex cassine*), southern magnolia (*Magnolia grandiflora*), sand live oak, live oak, and both species of cypress (*Taxodium distichum* and *T. ascendens*). One perplexing species is West Indian mahogany, which fared reasonably well in Georges and Andrew (Table 1); however, the survey respondents ranked it with medium to low wind resistance. In agreement with our results but in contrast to the survey results, another study of 24 species experiencing Hurricane Georges found West Indian mahogany had the best survival and the least branch loss (Francis 2000).

Recommendations

Taking the results from our studies and incorporating the survey results and the scientific literature, we have developed lists of relative wind resistance for tropical and subtropical tree species (Table 4). These lists should be used with caution, with the knowledge that no species and no tree is completely wind proof, and with the consideration of local soil conditions, tree age, structure and health, and other urban forest conditions. In addition, hurricane characteristics other than wind, such as rain amount and storm duration, can also influence the ability of trees to survive hurricanes. In their thorough review of forest damage from wind, Everham and Brokaw (1996) concluded that species differences do exist and can be explained by differences in wood density, canopy architecture, rooting patterns, susceptibility to diseases, and bole shape. Yet these differences, they say, can also be masked by varied soil conditions, exposure, wind intensity, and cultural practices.

Important Recommendations

- One of the most important findings reported is the rooting space results: the more rooting space that a tree has, the healthier it is, meaning better anchorage and resistance to wind.
- Another important cultural practice for broadleaved trees is pruning. Pruning conferred more wind resistance to trees and should be considered an important practice for tree health and wind resistance.
- Trees growing in groups or clusters were also more wind resistant compared to individual trees. This might be an especially good strategy for tree establishment in parks or larger yards.

- Especially in south Florida, native trees appear to survive winds better than exotics. When considering species to plant, know which exotic species do not fare well in wind—some of these include melaleuca, Australian pine, queen palm, African tulip tree, and weeping banyan.

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Table 1. Survival of tropical and subtropical tree species after four hurricanes*

Tree Species	Survival (%) After Each Hurricane (Wind Speed in km/h; mph)			
	Georges (177 km/h; 110 mph)	Jeanne (193 km/h; 120 mph)	Charley (233 km/h; 145 mph)	Andrew (265 km/h; 165 mph)
Dicots				
<i>Araucaria heterophylla</i>	88	—	74	—
<i>Bucida buceras</i>	84	—	57	68
<i>Bursera simarouba</i>	—	—	89	84
<i>Callistemon viminalis</i>	—	—	—	52
<i>Carya floridana</i>	—	83	—	—
<i>Casuarina equisetifolia</i> ^a	—	—	57	4
<i>Cinnamomum camphora</i> ^b	—	—	90	—
<i>Citrus</i> spp.	—	67	74	25 to 66
<i>Coccoloba uvifera</i>	—	—	84	64
<i>Delonix regia</i> ^c (in S. FL)	94	—	—	57
<i>Eugenia foetida</i>	—	—	—	96
<i>Ficus aurea</i>	—	—	84	—
<i>Mangifera indica</i>	76	—	—	60
<i>Melaleuca quinquenervia</i> ^a	65	75	45	79
<i>Persea americana</i>	—	—	—	46
<i>Quercus geminata</i>	—	94	—	—
<i>Quercus laurifolia</i>	—	94	86	—
<i>Quercus virginiana</i>	—	97	78	78
<i>Schefflera actinophylla</i> ^b (in C. and S. FL)	87	—	—	85
<i>Swietenia mahagoni</i>	92	—	—	75
<i>Tabebuia heterophylla</i>	83	—	—	72
Monocots – Palms				
<i>Chrysalidocarpus lutescens</i>	94	—	97	93
<i>Cocos nucifera</i>	77	—	77	41
<i>Phoenix reclinata</i> ^b (in S. FL)	—	—	100	—
<i>Phoenix roebelenii</i>	—	100	100	—
<i>Roystonea elata</i> (<i>R. borinquena</i> in PR)	93	—	87	63
<i>Sabal palmetto</i>	—	92	92	93
<i>Syagrus romanzoffiana</i> ^c (in S. FL)	—	74	69	42
<i>Veitchia merrillii</i>	89	—	95	—
<i>Washingtonia robusta</i>	—	80	92	—
Conifers				
<i>Pinus clausa</i>	—	4	—	—
<i>Pinus elliotii</i> var. <i>densa</i> (<i>P. caribaea</i> in PR)	89	90	79	73
<i>Pinus palustris</i>	—	—	57	—
<i>Taxodium distichum</i>	—	—	95	—
^a Prohibited from use in Florida ^b Invasive and not recommended for use in Florida ^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005) *Survival is defined as the percentage of trees still standing after the hurricane. Numbers are only presented for tree species having a sample size greater than 20 trees for each hurricane. Least Significant Differences at p=0.05 are 16% for Georges, 35% for Jeanne, and 30% for Charley; Andrew survival percentages are from Duryea et al. 1996.				

Table 2. Survival and branch loss of tree species in Puerto Rico after Hurricane Georges (110 mph)*

Tree Species	Sample Size	Survival (%)	Branch Loss (%)	Re-calculated Survival (%)
<i>Araucaria heterophylla</i>	25	88	41	52
<i>Bauhinia monandra</i>	31	71	41	39
<i>Bucida buceras</i>	286	84	33	59
<i>Callistemon citrinus</i>	42	81	12	69
<i>Calophyllum calaba</i> ^c (in S. FL)	295	93	20	81
<i>Cassia javanica</i>	28	86	42	57
<i>Cassia siamea</i>	94	85	53	30
<i>Crescentia cujete</i>	21	67	12	62
<i>Cupressus sempervirens</i>	31	29	7	29
<i>Delonix regia</i> ^c (in S. FL)	194	94	33	68
<i>Enterolobium cyclocarpum</i>	20	100	23	85
<i>Eucalyptus robusta</i>	69	86	59	28
<i>Ficus benjamina</i>	65	83	25	63
<i>Ficus macrocarpa</i>	33	76	18	67
<i>Ficus microcarpa</i> ^c (in C. & S. FL)	22	100	25	73
<i>Hibiscus elatus</i>	25	100	63	20
<i>Lagerstroemia speciosa</i>	138	88	28	70
<i>Mangifera indica</i>	76	76	36	51
<i>Melaleuca quinquenervia</i> ^a	37	65	21	57
<i>Melicoccus bijugatus</i>	22	82	25	64
<i>Pinus caribaea</i>	53	89	16	85
<i>Pterocarpus indicus</i>	32	97	29	75
<i>Pterocarpus macrocarpus</i>	43	95	33	77
<i>Schefflera actinophylla</i> ^b (in C. & S. FL)	24	88	17	79
<i>Spathodea campanulata</i>	24	67	52	37
<i>Swietenia mahagoni</i>	146	92	21	80
<i>Swietenia macrophylla</i>	69	74	28	64
<i>Swietenia macrophylla</i> x <i>mahagoni</i>	36	89	43	58
<i>Tabebuia heterophylla</i>	334	83	26	65
<i>Terminalia cattapa</i> ^c (in S. FL)	44	89	35	52
<i>Thuja orientalis</i>	36	92	16	86
Least Significant Difference, p=0.05	—	16	21	23

^a Prohibited from use in Florida
^b Invasive and not recommended for use in Florida
^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005)
*Reported rates exclude Palms (see Table 1). Re-calculated survival was calculated by subtracting trees with ≥ 50% branch loss. Numbers are only presented for tree species having a sample size greater than 20 trees for each hurricane.

Table 3. Survey results for wind resistance of tropical and subtropical tree species*

Scientific Name	Common Name	Wind Resistance						p-value	Total N
		High		Medium		Low			
		N	%	N	%	N	%		
<i>Acer rubrum</i>	red maple	12	20	32	52	17	28	0.0049	61
<i>Annona glabra</i>	pond apple	10	71	4	29	0	0	n.s.	14
<i>Araucaria heterophylla</i>	Norfolk Island pine	8	18	14	31	23	51	0.0224	45
<i>Averrhoa carambola</i>	star-fruit or carambola	3	18	6	35	8	47	n.s.	17
<i>Bauhinia blakeana</i>	Hong Kong orchid	1	5	9	41	12	54	0.0122	22
<i>Bucida buceras</i>	black olive	8	30	14	52	5	18	0.0538	27
<i>Bursera simarouba</i>	gumbo limbo	21	64	10	30	2	6	0.0007	33
<i>Callistemon</i> spp	bottlebrush	8	21	23	61	7	18	0.0018	38
<i>Calophyllum calaba</i> ^c (in S. FL)	Brazilian beautyleaf	6	38	8	50	2	12	n.s.	16
<i>Cassia fistula</i>	golden shower	4	18	7	32	11	50	n.s.	22
<i>Ceiba</i> (or <i>Chorisia</i>) <i>speciosa</i>	floss-silk	4	18	12	55	6	27	0.0498	22
<i>Chrysobalanus icaco</i>	cocoplum	18	78	5	22	0	0	0.0067	23
<i>Chrysophyllum oliviforme</i>	satinleaf	11	61	7	39	0	0	n.s.	18
<i>Citrus</i> spp.	citrus (lime, orange, etc.)	18	44	18	44	5	12	0.0162	41
<i>Coccoloba diversifolia</i>	pigeon plum	11	58	8	42	0	0	n.s.	19
<i>Coccoloba uvifera</i>	sea grape	18	50	12	33	6	17	0.0498	36
<i>Conocarpus erectus</i>	buttonwood	11	35	17	55	3	10	0.0084	31
<i>Cordia sebestena</i>	geiger tree	8	33	13	54	3	12	0.0439	24
x <i>Cupressocyparis leylandii</i>	leyland cypress	7	22	13	41	12	37	n.s.	32
<i>Delonix regia</i> ^c (in S. FL)	royal poinciana	2	6	20	63	10	31	0.0005	32
<i>Enterolobium cyclocarpum</i>	ear tree	1	5	7	33	13	62	0.0058	21
<i>Eriobotrya japonica</i> ^c (in S. & C. FL)	loquat	9	24	24	63	5	13	0.0004	38
<i>Eucalyptus cinerea</i>	silver dollar eucalyptus	2	13	9	56	5	31	n.s.	16
<i>Eugenia axillaris</i>	white stopper	7	64	3	27	1	9	n.s.	11
<i>Eugenia foetida</i>	boxleaf, Spanish stopper	7	64	2	18	2	18	n.s.	11
<i>Ficus aurea</i>	strangler fig	4	36	5	46	2	18	n.s.	11
<i>Ficus benjamina</i>	weeping banyan	0	0	2	18	9	82	0.0348	11
<i>Grevillea robusta</i>	silk oak	1	4	8	32	16	64	0.0012	25
<i>Guaiacum sanctum</i>	lignumvitae	10	83	2	17	0	0	0.0209	12
<i>Ilex cassine</i>	dahoon holly	35	76	10	22	1	2	0.0001	46
<i>Jacaranda mimosifolia</i>	jacaranda, black poui	1	7	2	13	12	80	0.0006	15
<i>Juniperus silicicola</i>	SE red cedar	14	28	18	35	19	37	n.s.	51
<i>Kigelia pinnata</i>	sausage tree	7	41	6	35	4	24	n.s.	17
<i>Koelreuteria paniculata</i>	golden raintree	11	37	11	37	8	26	n.s.	30
<i>Krugiodendron ferreum</i>	ironwood	10	77	3	23	0	0	n.s.	13
<i>Lagerstroemia indica</i>	crape myrtle	55	83	11	17	0	0	0.0001	66
<i>Ligustrum japonicum</i>	privet	30	75	9	23	1	2	0.0001	40
<i>Liquidambar styraciflua</i>	sweetgum	19	43	22	50	3	7	0.0013	44
<i>Litchi chinensis</i>	lichee	8	57	5	36	1	7	n.s.	14

Scientific Name	Common Name	Wind Resistance						p-value	Total N
		High		Medium		Low			
		N	%	N	%	N	%		
<i>Lysiloma latisiliqua</i>	wild tamarind	9	50	6	33	3	17	n.s.	18
<i>Magnolia grandiflora</i>	SE magnolia	45	82	9	16	1	2	0.0001	55
<i>Mangifera indica</i>	mango tree	6	20	16	53	8	27	n.s.	30
<i>Peltophorum pterocarpa</i>	yellow poinciana	1	5	15	68	6	27	0.0010	22
<i>Persea americana</i>	avocado tree	1	3	20	63	11	34	0.0002.	32
<i>Pinus clausa</i>	sand pine	3	7	7	16	34	77	0.0001	44
<i>Pinus elliottii</i> var. <i>densa</i>	FL slash pine	18	38	25	52	5	10	0.0016	48
<i>Pinus palustris</i>	longleaf pine	23	56	13	32	5	12	0.0017	41
<i>Podocarpus</i> spp.	podocarpus	24	75	7	22	1	3	0.0001	32
<i>Prunus caroliniana</i>	carolina laurel cherry	5	16	15	48	11	36	n.s.	31
<i>Quercus geminata</i>	sand live oak	36	92	2	5	1	3	0.0001	39
<i>Quercus laurifolia</i>	laurel oak	3	4	27	39	39	57	0.0001	69
<i>Quercus nigra</i>	water oak	3	8	14	36	22	56	0.0009	39
<i>Quercus stellata</i>	post oak	5	33	10	67	0	0	n.s.	15
<i>Quercus virginiana</i>	live oak	64	89	8	11	0	0	0.0001	72
<i>Sideroxylon foetidissimum</i>	mastic tree	3	30	6	60	1	10	n.s.	10
<i>Simarouba glauca</i>	paradise tree	5	42	5	42	2	16	n.s.	12
<i>Spathodea campanulata</i>	African tuliptree	0	0	6	38	10	62	n.s.	16
<i>Swietenia mahagoni</i>	West Indian mahagony	2	9	13	56	8	35	n.s.	23
<i>Tabebuia aurea</i>	silver trumpet	0	0	4	33	8	67	n.s.	12
<i>Tabebuia chrysotricha</i>	golden trumpet	2	7	5	18	21	75	0.0001	28
<i>Tabebuia heterophylla</i>	white cedar	0	0	6	55	5	45	n.s.	11
<i>Tabebuia impetiginosa</i>	purple tabebuia, ipe	3	12	12	50	9	38	n.s.	24
<i>Tecoma stans</i>	yellow elder	0	0	8	73	3	27	n.s.	11
<i>Terminalia catappa</i> ^c (in S. FL)	tropical almond	3	20	8	53	4	27	n.s.	15
<i>Taxodium distichum</i>	baldcypress	59	91	6	9	0	0	0.0001	65
<i>Taxodium ascendens</i>	pondcypress	41	91	4	9	0	0	0.0001	45
Palms									
<i>Butia capitata</i>	pindo	34	79	7	16	2	5	0.0001	43
<i>Caryota mitis</i>	fishtail	8	38	6	29	7	33	n.s.	21
<i>Chrysalidocarpus lutescens</i>	areca	19	63	11	37	0	0	n.s.	30
<i>Coccothrinax argentata</i>	FL silver, silver thatch	21	95	1	5	0	0	0.0001	22
<i>Cocos nucifera</i>	coconut	22	63	13	37	0	0	n.s.	35
<i>Hyophorbe lagenicaulis</i>	bottle	13	81	3	19	0	0	0.0124	16
<i>Hyophorbe verschaffeltii</i>	spindle	11	79	2	14	1	7	0.0015	14
<i>Latania loddigesii</i>	blue latan	8	67	3	25	1	8	0.0388	12
<i>Livistona chinensis</i> ^c (in S. & C. FL)	chinese fan	29	71	9	22	3	7	0.0001	41
<i>Neodypsis decaryi</i>	triangle	14	58	6	25	4	17	0.0302	24
<i>Phoenix canariensis</i>	Canary Island date	49	89	4	7	2	4	0.0001	55
<i>Phoenix dactylifera</i>	date	33	94	2	6	0	0	0.0001	35
<i>Phoenix reclinata</i> ^b (in S. FL)	Senegal date	29	85	5	15	0	0	0.0001	34

Scientific Name	Common Name	Wind Resistance						p-value	Total N
		High		Medium		Low			
		N	%	N	%	N	%		
<i>Phoenix roebelenii</i>	pygmy date	40	98	1	2	0	0	0.0001	41
<i>Ptychosperma elegans</i>	Alexander, solitary	16	73	6	27	0	0	0.0330	22
<i>Roystonea elata</i>	Florida royal	19	56	10	29	5	15	0.0118	34
<i>Roystonea regia</i>	Cuban royal	17	61	10	36	1	4	0.0010	28
<i>Sabal palmetto</i>	cabbage	71	99	1	1	0	0	0.0001	72
<i>Syagrus romanzoffiana</i> ^c (in S. FL)	queen	5	10	17	33	29	57	0.0002	51
<i>Thrinax morrisii</i>	Key thatch	13	87	2	13	0	0	0.0045	15
<i>Thrinax radiata</i>	Florida thatch	17	89	2	11	0	0	0.0006	19
<i>Veitchia merrillii</i>	Manila, Christmas	13	81	3	19	0	0	0.0124	16
<i>Washingtonia robusta</i>	Washington fan	29	54	16	30	9	17	0.0033	54

^b Invasive and not recommended for use in Florida

^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005)

*Results of the survey of arborists, scientists, and urban foresters in Florida with their rankings for wind resistance of tropical and subtropical tree species. N is the number of respondents for each species, out of a total of 85 experts. P-values from the chi-square test for equal proportions indicate the significance level for one or more of the categories being different from the others; n.s. means that there is no significant difference between the categories of high, medium, and low (p>0.05).

Table 4. Wind resistance of tropical and subtropical tree species*

Highest Wind Resistance	Medium–High Wind Resistance
Dicots	Dicots
<i>Bursera simaruba</i> , gumbo limbo <i>Carya Floridana</i> , Florida scrub hickory <i>Conocarpus erectus</i> , buttonwood <i>Chrysobalanus icaco</i> , cocoplum <i>Cordia sebestena</i> , geiger tree <i>Eugenia axillaris</i> , white stopper <i>Eugenia confusa</i> , redberry <i>Eugenia foetida</i> , boxleaf stopper <i>Guaiaacum sanctum</i> , lignum vitae <i>Ilex cassine</i> , dahoon holly <i>Krugiodendrum ferreum</i> , ironwood <i>Lagerstroemia indica</i> , crape myrtle <i>Magnolia grandiflora</i> , southern magnolia <i>Podocarpus</i> spp, <i>podocarpus</i> <i>Quercus virginiana</i> , live oak <i>Quercus geminata</i> , sand live oak	<i>Annona glabra</i> , pond apple <i>Calophyllum calaba</i> , Brazilian beautyleaf ^c <i>Chrysophyllum oliviforme</i> , satinleaf <i>Coccoloba uvifera</i> , sea grape <i>Coccoloba diversifolia</i> , pigeon plum <i>Liquidambar styraciflua</i> , sweetgum <i>Lysiloma latsiliqua</i> , wild tamarind <i>Magnolia virginiana</i> , sweetbay magnolia <i>Nyssa sylvatica</i> , black tupelo <i>Sideroxylon foetidissimum</i> , mastic <i>Simarouba glauca</i> , paradise tree <i>Swietenia mahagoni</i> , mahogany
Conifers	Conifers
<i>Taxodium ascendens</i> , pondcypress <i>Taxodium distichum</i> , baldcypress	N/A
Palms	Palms
<i>Butia capitata</i> , pindo or jelly <i>Dypsis lutescens</i> , areca <i>Coccothrinax argentata</i> , Florida silver <i>Hyophorbe lagenicaulis</i> , bottle <i>Hyophorbe versaffeltii</i> , spindle <i>Latania loddigesii</i> , blue latan <i>Livistona chinensis</i> , Chinese fan ^b <i>Phoenix canariensis</i> , Canary Island date <i>Phoenix dactylifera</i> , date <i>Phoenix reclinata</i> , Senegal date ^b <i>Phoenix roebelenii</i> , pygmy date <i>Ptychoesperma elegans</i> , Alexander <i>Sabal palmetto</i> , cabbage, <i>sabal</i> <i>Thrinax morrisii</i> , key thatch <i>Thrinax radiata</i> , Florida thatch <i>Veitchia merrillii</i> , Manila	<i>Caryota mitis</i> , fishtail <i>Cocos nucifera</i> , coconut <i>Dypsis decaryi</i> , triangle <i>Roystonea elata</i> , royal
Fruit Trees	Fruit Trees
N/A	<i>Litchi chinensis</i> , lychee
Medium–Low Wind Resistance	Lowest Wind Resistance
Dicots	Dicots
<i>Acer rubrum</i> , red maple <i>Bauhinia blakeana</i> , Hong-Kong orchid <i>Bucidas buceras</i> , black olive <i>Callistemon</i> spp, bottlebrush <i>Cinnamomum camphora</i> , camphor ^b <i>Delonix regia</i> , royal poinciana ^c <i>Enterolobium cyclocarpum</i> , ear tree <i>Eriobotrya japonica</i> , loquat ^c <i>Eucalyptus cinerea</i> , silverdollar eucalyptus <i>Ficus aurea</i> , strangler fig <i>Kigelia pinnata</i> , sausage tree <i>Myrica cerifera</i> , wax myrtle <i>Persea borbonia</i> , redbay <i>Platanus occidentalis</i> , sycamore <i>Quercus laurifolia</i> , laurel oak <i>Tabebuia heterophylla</i> , pink trumpet tree <i>Terminalia catappa</i> , tropical almond ^c	<i>Casuarina equisetifolia</i> , Australian pine ^a <i>Cassia fistula</i> , golden shower <i>Chorisia speciosa</i> , floss-silk tree <i>Ficus benjamina</i> , weeping banyan <i>Grevillea robusta</i> , silk oak <i>Jacaranda mimosifolia</i> , jacaranda <i>Melaleuca quinquenervia</i> , melaleuca ^a <i>Quercus nigra</i> , water oak <i>Peltophorum pterocarpa</i> , yellow poinciana <i>Prunus caroliniana</i> , Carolina laurelcherry <i>Sapium sebiferum</i> , Chinese tallow ^a <i>Spathodea campanulata</i> , African tuliptree <i>Tabebuia caraiba</i> , silver trumpet tree <i>Ulmus parvifolia</i> , Chinese elm

Conifers	Conifers
<i>Pinus elliottii</i> , slash pine <i>Pinus palustris</i> , longleaf pine	<i>Araucaria heterophylla</i> , Norfolk Island pine <i>x Cupressocyparis leylandii</i> , Leyland cypress <i>Juniperus silicicola</i> , southern red cedar <i>Pinus clausa</i> , sand pine
Palms	Palms
N/A	<i>Syagrus romanzoffiana</i> , queen ^c <i>Washingtonia robusta</i> , Washington fan
Fruit trees	Fruit trees
<i>Averrhoa carambola</i> , star-fruit, carambola <i>Citrus spp</i> , oranges, limes, grapefruits <i>Mangifera indica</i> , mango	<i>Persea americana</i> , avocado
^a Prohibited from use in Florida ^b Invasive and not recommended for use in Florida ^c Caution: may be used but must be managed to prevent escape in Florida (Fox et al. 2005) *Wind resistance of tropical and subtropical tree species as estimated utilizing the hurricane measurements and the survey results in this study, and the scientific literature cited throughout this publication.	

Six Steps in Making an Insurance Claim¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Step One: Contact Your Agent Immediately

- Give your name, address, policy number, and the date and time of your loss.
- Make sure to tell your insurance agent where you can be reached, especially if you are unable to stay in your home.
- Follow up the call with a letter detailing the problem. Keep a copy of the letter.
- Your insurance agent will arrange for an adjustor to visit your property and assess the damage. Be sure the adjustor is properly licensed. In Florida, call the Department of Financial Services Consumer Help Line, toll-free, at 1-877-693-5236. If you are not in Florida, check online or in a phone book for your state's insurance consumer help line.

Step Two: Carefully Document Your Losses

Safety first! Before entering a building, always check for structural damage. Do not go inside the building if there is any chance of the building collapsing. Be careful walking around inside and outside the building. Upon entering the building, do not use open flames since gas may be trapped inside the building. Instead, use your flashlight to light your way. Keep power off until an electrician has inspected your system for safety.

- Make a detailed list of lost or damaged property.
- Videotape and/or photograph damaged property before beginning any repairs.
- Do not throw away damaged property without your adjustor's approval.
- Try to document the value of each object lost. To help value lost objects use bills of sale, canceled checks, charge account records, and insurance evaluations. If you have no such records, estimate the value, and give

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purchase place and date of purchase. Include this information with your list.

- List cleaning and repair bills, including materials, cost of rental equipment, and depreciation of purchased equipment.
- List any additional living expenses you incur if your home is so severely damaged that you have to find other accommodations while repairs are being made (this includes motel bills, restaurant bills, home rental, and/or car rental).

Step Three: Protect Your Property from Further Damage or Theft

- If there is roof damage or broken windows, make sure to make temporary repairs. Cover damaged roof areas with tarps and cover broken windows with boards or plastic.
- If household furnishings are exposed to weather, move them to a safe location for storage.
- Remember the documentation from Step Two! Save receipts for what you spend and submit them to your insurance company for reimbursement.
- If your home has been flooded, protect your family's health by cleaning your home right away. Floodwaters pick up sewage and chemicals from roads, farms, and factories. Throw out food and medicine that may have come into contact with floodwater. Dry out water-damaged furnishings and clothing as soon as possible to prevent fading and deterioration.

Step Four: Working with Adjustor

- Your insurance agent will arrange for an adjustor to visit your property and assess the damage. Be sure the adjustor is properly licensed. In Florida, call the Department of Financial Services Consumer Help Line, toll-free, at 1-877-693-5236. Check online or in a phone book for your state's insurance consumer help line.
- Be sure that you or a trusted advisor is present when the adjustor visits the site.
- Work with the adjustor. It is the adjustor's job to assist you and review your claim. The adjustor will inspect your list of lost or damaged property. The adjustor will work with you to calculate the value of the items on the list and prepare a repair estimate of damage to the property.
- You and your adjustor need to come to an agreement as to the scope of damage, which is an agreement as to *what* needs to be repaired or replaced without a dollar amount.

- Make sure you know what needs to be done to follow up on this agreement and why. If you do not understand what needs to be done, ask the adjustor for instructions in writing.

Step Five: Settling Your Claim

- You may settle personal property and structural claims at separate times, although your adjustor may suggest that you file the claims together. Filing the two types of claims separately allows you to take the time needed to determine the full extent of your losses.
- Do not be in a hurry to settle your claim. Wait until you have discovered all the damage before filing a claim.
- If you are dissatisfied with the settlement offer, talk things over with your agent and adjustor.
- If you and your adjustor cannot reach a settlement, you may obtain mediation through your state's department of insurance. Mediation is an informal process where a neutral third party helps the parties resolve the dispute. If you are in Florida, call the Department of Financial Services Consumer Help Line, toll-free, at 1-877-693-5236 for information on mediation or other methods of dispute resolution. Check online or in a phone book for your state's insurance consumer help line.

Step Six: Repairing Your Home

- You or your insurance company may contract for the repair of your home. Make sure the contractor is a reputable firm that is both licensed and insured. You can find out whether the contractor holds a proper license by contacting your state's department of business regulations. In Florida, contact the Department of Business and Professional Regulation online, or call 1-850-487-1395 (this is not a toll-free number).
- Beware of door-to-door sellers when choosing a contractor to make repairs. Sometimes undependable workers enter a damaged area, make cheap repairs, and leave before the residents discover that the repairs are inadequate. If your local contractor cannot do the work, ask the contractor to recommend someone.
- Get a written estimate that includes any oral promises the contractor made. Always ask if there is a charge for an estimate before allowing anyone into your home.
- Your insurance company may initially pay you a sum equal to the actual cash value, unless you request minimal repairs. The company will withhold the balance of the full replacement cost until after you complete the repairs.

Sources for This Publication

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Individual Assistance Programs from FEMA¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Introduction

Individuals, families, and businesses may be eligible for federal assistance from the Federal Emergency Management Agency (FEMA). You are eligible if you live, own a business, or work in a county declared a Major Disaster Area; incur sufficient property damage or loss; and do not have the insurance or other resources to meet your needs.

FEMA and other federal, state, local, and volunteer agencies offer disaster assistance in several forms:

- Low-interest loans
- Individual and Family Grant (IFG) program
- Veterans benefits
- Temporary housing assistance
- Tax refunds
- Excise tax relief
- Free legal counseling
- Crisis counseling

- Getting in touch with family members
- Your rights
- Florida emergency information line

You can learn more about FEMA's programs online at <https://www.fema.gov/individual-disaster-assistance>.

Low-Interest Loans

Most, but not all, federal assistance is in the form of low-interest loans to cover expenses not covered by state programs, local programs, or private insurance. People who do not qualify for loans may be able to apply for cash grants.

These agencies offer low-interest loans to eligible farmers, business owners, and other individuals to repair or replace damaged property and personal belongings not covered by insurance.

- Farm Service Agency (FSA). Access online at <https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/>

1. This document is DH200 (formerly DH0432), one of a series of the Food and Resource Economics Department, UF/IFAS Extension. Original publication date June 1998. Revised January 2016 and October 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. The funding for the revision of this publication was provided by the James S. and Dorothy F. Wershow Endowment. This publication is part of the Disaster Handbook, a component of the Comprehensive Disaster Preparedness and Recovery Education Module. There are ten Disaster Handbook documents by Olexa, Caracciolo, and Grant: DH138, DH199, DH200, DH201, DH202, DH203, DH204, DH206, DH215, and DH219.

2. Michael T. Olexa, professor, Food and Resource Economics Department, and director, Center for Agricultural and Natural Resource Law; Jana Caracciolo, student, UF Levin College of Law; and Lauren Grant, student, UF Levin College of Law; UF/IFAS Extension, Gainesville, FL 32611.

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- Small Business Administration (SBA). Access online at <https://disasterloan.sba.gov/ela/Information/Index>

Individuals and Households (IHP) Program

IHP provides cash grants up to a limit, which is adjusted annually for inflation. More information is available at the FEMA website. Access online at <https://www.fema.gov/media-library/assets/documents/24945>.

Individuals may be eligible for grants to help recover necessary expenses and serious needs that cannot be met through insurance or other forms of disaster assistance. Examples are housing, personal property, medical, dental, funeral, transportation, and required flood insurance premiums incurred as a result of the disaster.

Veterans Benefits

The Department of Veterans Affairs (VA) provides veterans with death benefits, pensions, insurance settlements, and adjustments to home mortgages. More information is available at the VA website. Access online at <http://www.va.gov>.

Temporary Housing Assistance

This program ensures that people whose homes are damaged by disaster have a safe place to live until repairs can be completed. The program is designed to provide funds for expenses that are not covered by insurance. Displaced homeowners and renters must be legal residents of the United States to be eligible. Program services include:

- Home repair assistance
- Rental assistance
- Mortgage and rental assistance (MRA)
- If necessary, referral to other government housing programs

More information is available at the FEMA website. Access online at <http://www.fema.gov/disaster-assistance-available-fema>.

Tax Refunds

The Internal Revenue Service (IRS) allows certain casualty losses to be deducted on federal income tax returns for the year of the loss or through an immediate amendment to the previous year's return.

- Internal Revenue Service (IRS) Publication 584. Casualty, Disaster, and Theft Loss Workbook (Personal-Use Property). <http://www.irs.gov/pub/irs-pdf/p584.pdf>
- Internal Revenue Service (IRS) Publication 2194B. Disaster Losses Kit for Businesses: Help from the IRS. <https://www.irs.gov/pub/irs-pdf/p2194.pdf>.

Excise Tax Relief

Under various circumstances, businesses may file claims with the Bureau of Alcohol, Tobacco, and Firearms (ATF) for federal excise taxes paid on alcoholic beverages and tobacco products lost, rendered unmarketable, or condemned by a duly authorized official. One such circumstance is when the President has declared a major disaster. More information is available at the FEMA website. Access online at <http://www.fema.gov/pdf/emergency/nrf/nrf-esf-06.pdf>.

Unemployment Benefits

Disaster unemployment assistance and unemployment insurance benefits may be available through the state unemployment office and supported by the United States Department of Labor (DOL). More information about Disaster Unemployment Assistance (DUA) is available at the DOL website. Access online at <http://workforcesecurity.doleta.gov/unemploy/disaster.asp>.

Residents of Florida: If you work or reside in an officially declared disaster county and are now unemployed as a result of the disaster, you may be eligible for Unemployment Compensation Benefits or Disaster Unemployment Assistance. More information is available at the Florida Jobs website. Access online at <http://www.floridajobs.org/office-directory/division-of-workforce-services/reemployment-assistance-programs/disaster-unemployment-assistance>.

Free Legal Counseling

The Young Lawyers Division of the American Bar Association, through an agreement with FEMA, provides free legal advice for low-income individuals regarding cases that will not produce a fee (i.e., those cases where attorneys are only paid part of the settlement, which is awarded by the court). Cases that may generate a fee are turned over to the local lawyer referral service.

Crisis Counseling

The purpose of the crisis counseling program is to help disaster survivors cope with grieving, stress, or other mental health problems caused or aggravated by a disaster

or its aftermath. These short-term services, provided by FEMA as supplemental funds granted to state and local mental health agencies, are available only to eligible survivors of presidentially-declared major disasters. Those who may require this confidential service should inquire about it while registering for disaster assistance.

Crisis counseling services are also offered by the American Red Cross (<https://www.redcross.org/get-help/disaster-relief-and-recovery-services/recovering-emotionally.html>), churches, synagogues, and other service agencies. Mental health information may be found at the website for the United States Department of Health and Human Services, Substance Abuse and Mental Health Services Administration. Access online at <http://www.samhsa.gov/find-help/disaster-distress-helpline>.

Contacting Family Members

The American Red Cross maintains a database to help you find family. Contact your local American Red Cross chapter. Do not contact the chapter in the disaster area. More information is available at the Red Cross website. Access online at <https://www.redcross.org/get-help/disaster-relief-and-recovery-services/contact-and-locate-loved-ones.html>.

Florida Emergency Information Line

The Florida Emergency Information Line (FEIL) is a toll-free hotline providing accurate and up-to-date information regarding an emergency or disaster situation impacting Florida. The FEIL hotline is 1-800-342-3557 (toll-free). More information is available at the Florida Division of Emergency Management website. Access online at <https://www.floridadisaster.org/>.

Your Rights

Each federal agency that provides federal financial assistance is responsible for investigating complaints of discrimination in the use of its funds. If you believe your civil rights have been violated in receiving disaster assistance, you may contact one of FEMA's Equal Rights Officers (ERO), who has the job of ensuring equal access to all FEMA disaster programs. The ERO will attempt to resolve your issues.

In addition to these services, FEMA and other federal, state, and local agencies provide assistance with the following:

- Aging Services
- Agricultural Aid
- Business Loan Program
- Consumer Services
- Disaster Unemployment Assistance
- Emergency Assistance
- Federal Tax Assistance
- Financial Counseling
- Hazard Mitigation
- Home and Personal Property Loan Program
- Insurance Information
- Social Security

More information on these services is available at the FEMA website. Access online at <https://www.fema.gov/office-equal-rights>.

Sources for This Publication

A Guide to the Disaster Declaration Process and Federal Disaster Assistance. Federal Emergency Management Agency (FEMA). Access online at <https://www.fema.gov/media-library/assets/documents/6094>

Help after a Disaster: Applicant's Guide to the Individuals and Households Program, Federal Emergency Management Agency (FEMA). Access online at <https://www.fema.gov/media-library/assets/documents/24945>

Florida Department of Community Affairs/Division of Emergency Management. Access online at <https://www.floridadisaster.org/>

American Red Cross Disaster Services. Access online at <http://www.redcross.org/>

USDA Farm Service Agency Disaster Assistance¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Introduction

1. Where to Apply for Assistance
2. USDA Assistance Available in Areas Designated as Natural Disaster Areas
3. USDA Assistance Available in Areas without a Determination of Major Disaster

Where to Apply for Assistance

Every county in the United States has a USDA agency office that can help citizens find the right place to apply for the assistance they need. Applications and information about emergency food assistance can be obtained at any state or local government food assistance office (e.g., SNAP—Supplemental Nutrition Assistance Program, formerly known as Food Stamps Program). Find the location of your county office online at the United States Department of Agriculture (USDA) website. Access online at <https://www.fns.usda.gov/>.

For assistance for Indian tribes, first contact the nearest tribal office or the Bureau of Indian Affairs (BIA), United States Department of the Interior.

USDA Assistance Available in Areas Designated as Natural Disaster Areas—Emergency Loans

The Farm Service Agency (FSA) provides emergency loans to help cover production and physical losses in counties declared as disaster areas by the President or designated by the Secretary of Agriculture as a disaster area or quarantine area. Additionally, emergency farm loans for physical losses may be authorized by the FSA Administrator.

The loan limit is up to 100 percent of actual production or physical losses, with a cap of \$500,000.

Depending upon the loan purpose, repayment ability, and the collateral available as loan security, you will normally have from one to seven years to repay loans for crop, livestock, and non-real estate losses. Loans for physical

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losses to real estate are normally repaid within thirty years. In unusual circumstances, repayment may be extended.

Eligibility for USDA Loans

- You must be an established family farm operator
- You must be a citizen or permanent resident of the United States
- You must have the ability, training, or experience to repay the loan
- You must have suffered a qualifying physical loss, or a production loss of at least 30 percent in any essential farm or ranch enterprise
- You must not be able to obtain commercial credit
- You must provide collateral to secure the loan
- The agency must receive your application within eight months of the disaster designation date
- You must have acceptable farm records
- You must operate in accordance with a farm plan that you develop and that the FSA and you agree upon
- You may be required to participate in a financial management training program
- You may be required to obtain crop insurance

USDA Loan Uses

- Restore or replace essential property
- Pay all or part of production costs associated with the disaster
- Pay essential family living expenses
- Reorganize the farming operation
- Refinance debts

USDA Assistance Available in Areas without a Major Determination of Disaster

USDA Crop Insurance

With the passage of the Federal Agriculture Improvement and Reform Act of 1996, producers are responsible for more of their agricultural risks than ever before. Crop insurance is one way producers can address their own risk management needs. The USDA created the Risk Management Agency (RMA) in 1996 to administer the federal crop insurance program and to provide producers with risk education and access to other risk management tools.

Producers must sign up for crop insurance in advance of the growing season. If you have crop insurance provided through the RMA, you can be reimbursed for unavoidable crop losses. When a disaster occurs, immediately contact your insurance provider to provide a “notice of loss.” Your insurance provider will make the necessary arrangements to have a loss adjustor visit your farm to determine the extent of the damage and to fill out the necessary paperwork.

Non-Insured Crop Disaster Assistance Program (NAP)

The Non-insured Crop Disaster Assistance Program (NAP) provides assistance to reduce financial losses that occur when natural disasters cause a catastrophic loss of production or prevent planting of an eligible crop.

Eligible crops include commercial crops or other agricultural commodities (except livestock) for which catastrophic risk protection under Section 508(b) of the Federal Crop Insurance Act is not available. In addition to the requirement that the crops be uninsurable, the crops must also be grown for food, livestock consumption, or fiber, or must be grown in a controlled environment as a specialty crop, a value loss crop (such as aquaculture and Christmas trees), sea oats, or sea grass, or seed crops where the seeds will be sold for other NAP-eligible crops.

- **Beneficiaries:** Landowners, tenants, and sharecroppers who share in the risk of crop production and have an adjusted gross income of less than \$900,000.
- **Limitations:** Producers must report acreage and production by specified deadlines and furnish a timely notice of loss within 15 days of the date when a loss becomes obvious. Additionally, applications for NAP payments must be filed with the local office no later than the first acreage reporting date for the crop in the crop year immediately following the crop year in which the loss occurred.
- **Eligibility:** Payments for a crop year are capped at \$125,000. If a producer is eligible to receive assistance and benefits for the same crop loss under any other program administered by the USDA, the producer must choose whether to receive the other program benefits or NAP assistance. The producer is not eligible for both.

For more information about the NAP program visit https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdfiles/FactSheets/noninsured_crop_disaster_assistance_program-nap-fact_sheet.pdf.

Rural Development Program

Information about the Rural Development Program is available online at the USDA website. Access online at <https://www.rd.usda.gov/>

- **Rural Business-Cooperative Services:** This service provides direct and guaranteed rural economic loans and rural business enterprise grants. Programs are offered to businesses and cooperatives affected by natural disasters.
- **Rural Housing Service:** This service provides subsidized direct and guaranteed loans to low-income rural residents and communities in need of housing or community facilities. When needed, existing borrowers are offered loan forbearance to recover from the effects of a natural disaster.
- **Rural Utilities Service:** This service provides electric and telecommunications cooperatives and companies financed by the Rural Utilities Service with technical and/or loan assistance for restoration of service after a natural disaster.

USDA Food Assistance

- Foods donated for school food services and other Food and Nutrition Service programs may be released to relief organizations that prepare meal services in situations of distress.
- Additionally, the Secretary of Agriculture may authorize state and local agencies to make supplemental nutrition assistance available during any disaster that disrupts commercial channels of food distribution. Such assistance may be determined to be necessary if, as a result of the disaster, income or resources are reduced or inaccessible, and households need food assistance that cannot be met by the regular Food and Nutrition Service Program procedures.

USDA Technical Assistance

- **Animal Diseases and Plant Pest Control:** The Animal and Plant Health Inspection Service's regional emergency response organizations have a network with animal health officials in every state and also have their own personnel who can advise and assist in disaster responses involving control, movement, euthanasia, and disposal of livestock and poultry. The main APHIS customer service call center phone number is 1-844-820-2234. Local phone numbers would be established in the event of an emergency response.

- **Food Safety:** When food safety questions arise due to reasons such as power failure, natural disaster, or product recalls, the Food Safety and Inspection Service helps consumers through its toll-free meat and poultry hotline. Consumers may call 1-888-674-6854, Monday through Friday, from 10 a.m. to 4 p.m. Eastern Standard Time.

USDA Non-Discrimination Statement

The USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. Not all prohibited bases apply to all programs. Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center in Washington, D.C. at 1-202-720-2600 (voice and TDD) (this is not a toll-free number). Alternatively, persons may dial 1-844-433-2774 (toll-free nationwide).

Source for This Publication

United States Department of Agriculture, Farm Service Agency. Disaster Assistance Programs. Access online at <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=diap&topic=landing>

What You Need to Apply for Disaster Rehabilitation Assistance ¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Introduction

After a disaster, you may need to seek financial assistance to restore your home or farm. There are many sources of assistance, but you will be required to provide certain information. The lists below can help you assemble the necessary information before you meet with any agents.

Applying for Assistance

What You Will Need for Grants or Loans

- Itemized list of losses
- Estimates of the repair or replacement cost of each item
- Estimates of new flood insurance premiums
- Federal income tax returns from last three years (copies)
- Deed, mortgage, or renter's lease (copy)
- Previous insurance policy or insurance settlement (copy)

What You Will Need for Personal Loss

- Proof of monthly income (stubs, statements)
- Driver's license and/or Social Security Number

What You Will Need for Business/Farm Loss

- A brief history of the business or farm
- Personal and business financial statements
- Loan repayment schedule
- List of bills owed
- Farm Service Agency information on farm crop base and assigned yields

Source for This Publication

FEMA Disaster Assistance Application: <https://www.disasterassistance.gov/get-assistance/application-checklist>

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Replacing Lost or Damaged Documents¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Introduction

This article deals with information on how to replace lost or damaged papers.

Birth Certificates

Florida Birth Certificates

1. The process for applying for a birth certificate can be found at the Florida Department of Health (DOH) website. Access online at <http://www.floridahealth.gov/certificates/certificates/birth/index.html>
2. Florida birth certificates can only be issued to the registrant (if at least 18 years of age), the registrant's parents listed on the birth record, the registrant's legal guardian (must provide guardianship papers), the legal representative of the registrant or the registrant's parents/legal guardian, or other persons by court order (must provide recorded or certified copy of court order).
3. All applications must be accompanied by a copy of a valid photo identification and a non-refundable processing fee.

Checks and money orders should be made payable to the "Vital Statistics." For current fees, telephone the Florida Bureau of Vital Statistics in Jacksonville at 1-904-359-6900 (this is not a toll-free number), or visit the DOH website. Access online at <http://www.floridahealth.gov/certificates/certificates/birth/index.html>.

4. Send the information and non-refundable processing fee to the following address: Bureau of Vital Statistics, ATTN: Vital Records Section, PO Box 210, Jacksonville, FL 32231-0042.

Out-of-State Birth Certificates

1. If the birth did not occur in Florida, contact the vital statistics office in the state where the birth occurred. A list of state offices is at the National Center for Health Statistics website. Access online at <http://www.cdc.gov/nchs/howto/w2w/w2welcom.htm>.
2. For United States citizens born abroad who need to obtain birth records, you must request a Replacement Form FS-240 from the Department of State in Washington,

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D.C. This information can be found at the CRBA website. Access online at <http://travel.state.gov/content/passports/en/abroad/events-and-records/birth.html>.

3. All requests must be accompanied by the requester's valid identification and a non-refundable processing fee. Checks or money orders must be made payable to "Department of State." For the current fee, visit the CRBA website. Access online at <http://travel.state.gov/content/passports/en/abroad/events-and-records/birth/replace-or-amend-consular-report-of-birth-abroad.html>.
4. Send the information and non-refundable processing fee to the following address: U.S. Department of State, Passport Vital Records Section, 44132 Mercure Cir., PO Box 1213, Sterling, VA 20166-1213.

Citizenship/Naturalization Papers

You can obtain information about Form N-565, the form necessary to request citizenship and naturalization papers, by contacting your regional United States Citizenship and Immigration Services (USCIS) office, or by visiting the USCIS website. Access online at https://my.uscis.gov/exploremyoptions/lost_stolen_certificate.

Form N-565 must be accompanied by a non-refundable fee and filed in person at a USCIS office in the United States or at a USCIS office abroad. If Form N-565 is filed abroad, it must be signed in front of a USCIS or consular official.

General information about citizenship and naturalization papers can be found at the USCIS website. Access online at <https://www.uscis.gov/>.

Death Certificates

Florida Death Certificates

1. The process for applying for a death certificate can be found at the Florida Department of Health (DOH) website. Access online at <http://www.floridahealth.gov/certificates/certificates/death/index.html>.
2. All signed letters of request and applications must meet the eligibility requirement. There are two eligibility rules in Florida. The first rule is that anyone may order a Florida Death Certificate "without cause of death" of the decedent. The second rule is that a Florida Death Certificate "with cause of death" is confidential by Florida law and may only be issued to the decedent's spouse, parent, child, grandchild, or sibling (if 18 years of age or older); or to any person who provides a "Will" that has

been executed pursuant to Florida Statute 732.502, or an insurance policy, or other document that demonstrates the applicant's interest in the estate of the decedent; or to any person who provides documentation that he or she is acting on behalf of an eligible person; or to any person fifty years following the date of death that "cause of death" becomes public information.

3. All letters of request and applications must be accompanied by a copy of a valid photo identification of the applicant and a non-refundable processing fee. Checks and money orders should be made payable to "Vital Statistics." For current fees, telephone the Bureau of Vital Statistics in Jacksonville at 1-904-359-6900 (this is not a toll-free number), or visit the DOH website. Access online at <http://www.floridahealth.gov/certificates/certificates/death/index.html>.
4. Send the information and non-refundable processing fee to the following address: Bureau of Vital Statistics, ATTN: Vital Records Section, PO Box 210, Jacksonville, FL 32231-0042.

Out-of-State Death Certificates

1. If the death did not occur in Florida, contact the vital statistics office in the state where the death occurred. A list of state offices is at the National Center for Health Statistics website. Access online at <http://www.cdc.gov/nchs/howto/w2w/w2welcom.htm>.
2. For consular death records of US citizens who died abroad, you must submit a notarized request to the Department of State in Washington, D.C. The information required in the letter and additional information about requesting a Certified Copy of a Report of Death of an American Citizen Abroad can be found at the CRBA website. Access online at <https://travel.state.gov/content/travel/en/international-travel/while-abroad/death-abroad1/consular-report-of-death-of-a-u-s-citizen-abroad.html>.
3. All requests must be notarized, accompanied by the requester's valid identification, and a non-refundable processing fee. Checks or money orders must be made payable to "Department of State." For the current fee, visit the CRBA website. Access online at <https://travel.state.gov/content/travel/en/international-travel/while-abroad/death-abroad1/consular-report-of-death-of-a-u-s-citizen-abroad.html>.

4. Send the information and non-refundable processing fee to the following address: Department of State, Passport Vital Records Section, 44132 Mercure Circle, PO Box 1213, Sterling, VA, 20166-1213.

Driver's Licenses

In Florida, you must go to your local driver license office and apply for a duplicate driver's license. For a list of offices, telephone 1-850-617-2000 (this is not a toll-free number), or visit the Florida Department of Highway Safety and Motor Vehicles website. Access online at <http://www.flhsmv.gov/locations/>.

You must present original documents that indicate your identity, Social Security number, residential address, and proof of citizenship or legal presence. There is a fee for duplicate licenses.

Income Tax Returns

To request a copy of your federal tax return, contact the IRS and ask for IRS Form 4506. Request one for each year's return you are requesting. You can find this form at the IRS website. Access Form 4506 online at <http://www.irs.gov/pub/irs-pdf/f4506.pdf>.

To request federal tax forms for delivery via United States Postal Service, telephone, toll-free, 1-800-TAX-FORM (1-800-829-3676).

Insurance Policies

To replace lost or destroyed insurance policies, contact the agent or company providing the coverage. You may be required to complete a form, pay a fee for duplicate copies, or both. Providing the policy number will expedite this request.

Marriage Certificates

Florida Marriage Certificates

1. The process for applying for marriage certificates can be found at the Florida Department of Health (DOH) website. Access online at <http://www.floridahealth.gov/certificates/certificates/marriage/index.html>.
2. All applications must be accompanied by a non-refundable processing fee. Checks and money orders should be made payable to the "Bureau of Vital Statistics." For current fees, telephone the Florida Bureau of Vital Statistics in Jacksonville at 1-904-359-6900 (this is not a toll-free number), or visit the DOH website. Access

online at <http://www.floridahealth.gov/certificates/certificates/marriage/index.html>.

3. Send the application and non-refundable processing fee to the following address: Bureau of Vital Statistics, ATTN: Vital Records Section, PO Box 210, Jacksonville, FL 32231-0042.

Out-of-State Marriage Certificates

Contact the vital statistics office in the state where the marriage occurred. For a list of offices, visit the National Center for Health Statistics website. Access online at <http://www.cdc.gov/nchs/howto/w2w/w2welcom.htm>.

Military Discharge Papers

To obtain copies of military discharge papers, request Form 180 from any Veterans Administration Office, the American Legion, Veterans of Foreign Wars, Red Cross, Veterans Association, or military recruiter office. Form 180 is also available at the NARA website. Access Form 180 online at <http://www.archives.gov/research/order/standard-form-180.pdf>.

Send the completed form to the following address: National Personnel Records Center, 1 Archives Drive, St. Louis, MO 63138.

If a veteran has filed for education or disability benefits, the Veterans Administration can furnish a copy of military discharge papers or a statement of service.

If discharge papers were recorded in the county clerk's office at the time of discharge, they can be replaced by contacting that office (Registrar of Deed) in the county where they were recorded.

Passports

Passports Lost in the United States

If your passport is lost or stolen in the United States, report the loss or theft immediately to the Department of State or to the nearest Passport Agency. The loss or theft should also be reported to local police.

Passports Lost Abroad

If your passport is lost or stolen while you are abroad, it should be reported immediately to the nearest United States embassy or consular office.

A passport is a traveler's principal means of identification abroad, and its loss is very serious. Whether lost or stolen in

the United States or abroad, you must submit Form DS-11 in person. Where to turn the form in depends on where you are at and when you are traveling. For more information visit <https://travel.state.gov/content/travel/en/passports/have-passport/lost-stolen.html>.

Property Deeds

You may be concerned if the deed to your home or other property is destroyed or lost in a disaster. The deed you receive is really just a certification to you that your transaction has been established as public record; the true declaration of your ownership is held at the county courthouse. You can obtain a certified copy of your deed at your county courthouse (there is a fee). Because you are requesting a public record, you will not need any identification, but you will need to know the property holder's name. For more information, visit the Florida website. Access online at https://www.myfloridacounty.com/official_records/index.html.

If the deed is held by a bank or mortgage company, check to be sure that it is being held safely. If damage has occurred, work with the lending/mortgage organization to find out how the deed can be replaced.

Savings Bonds/Notes

To get your bond replaced, complete FS Form 1048 from the United States Treasury Department, Bureau of Public Debt. To receive this form, either telephone, toll-free, 1-844-284-2676, or visit the US Treasury website. Access FS Form 1048 online at <http://www.treasurydirect.gov/forms/sav1048.pdf>.

On FS Form 1048, provide the approximate issue date, along with the complete names, addresses, and Social Security numbers that appeared on the bond, and the bond serial number. If you do not know the serial number or denomination, just write "unknown" in the space provided. If the bond owner is a minor, the form should be signed by both parents and should include the minor's age and Social Security number (the duplicate bond will show the original issue date). Mail the completed form to the following addresses depending on type of bond: (HH or H savings bonds) Treasury Retail Securities Site, PO Box 2186, Minneapolis, MN 55480-2186 or (E, EE, or I savings bonds) Treasury Retail Securities Site, PO Box 214, Minneapolis, MN 55480-0214.

Social Security Cards

For information about Social Security, visit your nearest Social Security Administration (SSA) office or go online (<https://www.ssa.gov/>). To find your nearest office, telephone, toll-free, 1-800-772-1213, or visit the SSA website. Access online at <https://secure.ssa.gov/apps6z/FOLO/fo001.jsp>.

To file an application for a duplicate card, you will need documents demonstrating your identity and US citizenship. You will also need a valid photo identification.

Vehicle Titles

In Florida, to replace a lost vehicle title, contact the Florida Department of Highway Safety and Motor Vehicles (FLHSMV) and request an Application for Duplicate or Lost in Transit/Reassignment for Motor Vehicle, Mobile Home, or Vessel Title Certificate. To request this form, telephone 1-850-617-2000 (this is not a toll-free number), or visit the FLHSMV website. Access online at <http://www.flhsmv.gov/forms/duptitle.html>.

Wills

If your will is misplaced or destroyed, contact the attorney who prepared it. If your circumstances have changed, a new Will may be appropriate.

Source for This Publication

Replace your Vital Records, USAGov. Access online at <https://www.usa.gov/replace-vital-documents>

Avoiding Fraud and Deception¹

Michael T. Olexa, Jana Caracciolo, and Lauren Grant²

Introduction

Disaster victims must be cautious about employing strangers to remove trees and do repair work on their property. Every agreement and credit contract should be read carefully and evaluated before it is signed. Shoddy workmanship and price gouging are common in crises.

Make sure the contractor holds a proper license by contacting the Florida Department of Business and Professional Regulation (FDBPR) in Tallahassee at 1-850-487-1395 (this is not a toll-free number), or visit the FDBPR website. Access online at <http://www.myfloridalicense.com/dbpr/>

If you do not live in Florida, check online or in the phonebook for your state's department of business and professional regulation. Beware of door-to-door salesmen and sound-alike names. Sometimes undependable workers enter a damaged area, make cheap repairs, and then leave before the residents discover that the repairs are inadequate. If your local contractor cannot do the work, ask him or her to recommend someone.

Make sure the contractor is insured and bonded. Uninsured workers may have the right to sue you if they are injured on your property.

Never let anyone begin working on your home or business without first establishing a written contract. Do not let anyone rush you into a deal.

Only donate or request disaster assistance through a reputable accountant, financial counselor/planner, bank, credit union, or non-profit organization. Do not give information out over the telephone.

Tree Removal

When the storm is over, workers may appear with chain saws eager to make a "fast buck" removing trees and other damaged property.

Tree removal requires great skill; the best bet is to contact local tree services. Improperly felled trees can damage your home or neighbors' homes. Also, the tree cutter may be injured. Professional tree services are licensed, insured, and experienced; they carry liability insurance protecting

1. This document is DH219 (formerly DH0207), one of a series of the Food and Resource Economics Department, UF/IFAS Extension. Original publication date June 1998. Revised January 2016 and October 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. It is part of The Disaster Handbook, a component of the Comprehensive Disaster Preparedness and Recovery Education Module. There are ten Disaster Handbook documents by Olexa and Walker: DH138, DH199, DH200, DH201, DH202, DH203, DH204, DH206, DH215, and DH219.
2. Michael T. Olexa, professor, Food and Resource Economics Department, and director, Center for Agricultural and Natural Resource Law; Jana Caracciolo, student, UF Levin College of Law; and Lauren Grant, student, UF Levin College of Law; UF/IFAS Extension, Gainesville, FL 32611.

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the homeowner from a lawsuit in case of an accident. Make sure that any company you employ meets these criteria. Ask to see the company's license and evidence of liability insurance.

Ask for a cost estimate and schedule for completion of the work. Be sure the trees will be removed from your property after they are cut. Try to get estimates from more than one tree service provider. All details of the agreement should be in a contract and signed by both a representative of the tree service and the homeowner. If there is considerable local damage, tree service providers from throughout the region may come to help clear.

If you decide to employ an independent tree cutter in spite of the risks involved, draw up a written contract that clearly spells out the work to be done (e.g., number of trees to be cut, stump height or treatment, what is to be done with the cut trees and by whom, beginning and completion date of work, and amount to be paid and when). NEVER pay for work before it is done. Include a statement about who is responsible for expenses in case of an accident. This should include what happens if the worker accidentally damages your property and who pays if the worker is accidentally injured. This statement is no assurance of protection, but it may help.

Home Repairs

If your home is damaged during a disaster, you should immediately contact your insurance company. The insurance company may require that specific procedures be followed to collect for repairs.

There are certain precautions to follow if you are responsible for arranging for the repairs. Take time to investigate the work quality and reliability of the home repair contractor or the worker you are considering hiring. Shoddy work will only increase your loss and frustration. Ask to see any applicable licenses. Before work begins, always get any agreement in writing and signed by both parties. Verbal agreements can be misunderstood and usually are unenforceable.

Contracts for home improvement projects should include the following information:

- Approximate date for beginning and completing the work (sometimes a specific disclosure states that no completion date is provided; however, it is advisable that you always require a completion date be given)

- A description of the work to be done (always require this to be detailed, describing the repairs to be made and the materials and grades to be used)
- All financing information required by state and federal laws
- Any warranty agreements
- Name and address of contractor and person for whom work is to be done

Never sign a completion certificate until all work is satisfactorily done. Also, never pay a home repair contractor or a worker for work before it is done. If considerable work is to be done, you may divide the cost for the work into two payments (i.e., you pay half of the payment up front and the other half when the job is completed).

Landlords and Tenants

You have special rights and responsibilities if you are renting a residence that is damaged. Repairs are the responsibility of the landlord. You should immediately notify the landlord of any damage to the property and make reasonable efforts to help protect the property from any additional damage. The landlord is responsible for having the residence repaired and returned to livable condition. If repairs are not made within a reasonable time, the tenant has the right to reduced rent, or perhaps to terminate the lease and move.

Source for This Publication

Beware of Fraud After Disasters. University of Illinois Extension. Access online at <http://web.extension.illinois.edu/disaster/PDF/fraud2.pdf>

Tax Relief in Disaster Situations¹

Donna Davis²

Transcribed from the Family Album Radio Program, a co-production of University of Florida IFAS Extension, the Department of Family, Youth and Community Sciences and of WUFT-FM. If you'd like to learn more, please visit our website at familyalbumradio.org

Listening, learning, and living together: it's the science of life.



Credits: Hemera

As a Florida resident, my family had first-hand experience with hurricane recovery. But while joining the world in watching the plight of the people of Mississippi, Louisiana, and Alabama after Hurricane Katrina, I realized how fortunate we had been. When disaster strikes, regardless of the magnitude, trying to pick up the pieces and getting your family's life back in order can be overwhelming.

The IRS offers disaster victims a Disaster Losses Kit to help claim unreimbursed losses on property destroyed by a natural disaster. Forms provided in the kit can help you sort through what was lost or destroyed and help prepare you for insurance claims as well as federal funding that is made available to victims of federally declared disaster areas. The IRS understands that tax records may have been lost or destroyed and can provide copies or transcripts of previously filed tax returns free of charge. The required form, in addition to many other helpful guides and forms, is included in the Disaster Kit.

Special tax law provisions were also granted for additional relief to disaster victims, including additional time to file returns and pay taxes. Both individuals and businesses in a declared disaster area can also get a faster refund by claiming losses related to the disaster on the tax return for the previous year, usually by filing an amended return. For more information, go to <http://www.irs.gov>.

Listening, learning, and living together: it's the science of life. "Family Album" is a co-production of University of Florida IFAS Extension, the Department of Family, Youth and

1. This document is FAR9043, one of a series of the Family Youth and Community Sciences Department, UF/IFAS Extension. Broadcast as program 271 and published March 2009. Reviewed January 2015. In the interest of time and/or clarity, the broadcast version of this script may have been modified. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Donna Davis, senior producer, Family Album Radio, Department of Family, Youth and Community Sciences, UF/IFAS Extension, Gainesville, FL 32611.

Community Sciences, and of WUFT-FM. If you'd like to learn more, please visit our website at <http://www.familyalbumradio.org>.

To listen to the radio broadcast:

http://www.radiosource.net/radio_stories/271.mp3

http://www.radiosource.net/radio_stories/271.wav

Reference

Internal Revenue Service. (2007). *Tax relief in disaster situations*. Retrieved July 28, 2007, from <http://www.irs.gov/newsroom/article/0,,id=108362,00.html>

Preparing for and Recovering from Hurricane and Tropical Storm Damage to Tropical Fruit Groves in Florida¹

Jonathan H. Crane, Jeff Wasielewski, and Carlos F. Balerdi²

Background

Southern Florida has experienced numerous hurricanes and tropical storms. The most recent hurricanes, Irma (10 September 2018) and Katrina (25–26 August 2005), to make landfall in south Florida were rated as category 1 and 2 hurricanes by the National Weather Service. Other hurricanes in 2004 (Charley, Frances, Jeanne, and Ivan) also affected commercial tropical fruit operations along the southeast and southwestern areas of Florida. In 1992, southeast Florida was devastated by Hurricane Andrew, a category 5 hurricane.

The Saffir-Simpson Hurricane Scale is a 1 to 5 rating based on the wind intensity of the hurricane and is useful in estimating the potential damage expected from a hurricane landfall. The scale is as follows: Category 1 hurricane, winds 74–95 mph (119–153 km/hr); Category 2 hurricane, winds 96–110 mph (154–177 km/hr); Category 3 hurricane, winds 111–130 mph (178–209 km/hr); Category 4 hurricane, winds 131–155 mph (210–249 km/hr); and Category 5 hurricane, winds greater than 155 mph (249 km/hr).

The estimated destruction to tropical fruit crops caused by recent hurricanes and tropical storms (1992, 1994, 2004, 2005, and 2018) was in the hundreds of millions of dollars.

As with the aftermath of previous hurricanes, growers are currently assessing their options, such as replanting, rehabilitating damaged trees, and repairing equipment and irrigation systems. They are also assessing their economic situation.

Winds from hurricanes may cause almost complete defoliation of all fruit crops, moderate to severe limb damage, severe trunk twisting and breakage, tree toppling, uprooting of entire trees, and the loss of almost all fruit (Campbell et al. 1993; Crane et al. 1993). Flooding during and after hurricanes may lead to root rot caused by low soil oxygen conditions and/or fungal diseases, and increased insect infestations (especially stem- and trunk-boring beetles). In addition to the direct effects of strong winds, wind-blown debris, such as loose sand and rock from adjacent open fields, may strip bark off of trees (sandblasting).

Grove infrastructure such as irrigation systems, tractors, roads, and farm buildings that house equipment and supplies may also be heavily damaged by hurricanes and tropical storms.

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U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

Pre-Hurricane Practices

There are a number of planning practices that will help to minimize damage and speed recovery after a tropical storm or hurricane. These include planning for post-storm equipment needs; ranking groves as to their importance and repair potential; assessing the grove site and adjacent areas; and taking into account the previous preplant soil preparation practices and plant propagation methods used, the presence of windbreaks, and the current or needed tree size control practices.

Planning

Proper planning prior to a hurricane enables growers to make sound decisions before and after a storm and increases the chances of rapid recovery after the storm. Florida's hurricane season is from June to November each year. However, preparations for a hurricane should be made well before a tropical storm or hurricane watch or warning is announced. This is because cultural practices, such as pruning, topping, and hedging prior to a hurricane take time, labor, and equipment—all in short supply just before a hurricane.

Components of a hurricane plan should include insurance coverage for equipment, buildings, and orchards (including crop and tree loss); accumulation and safe storage of equipment needed for the recovery, such as saws, slings, shovels, fuel, paint, and equipment parts; and the knowledge of the location and cost of backhoes, front-end loaders, and wood chippers. Prioritizing groves as to their economic importance along with the resources needed for their repair is important. Identifying which groves will be worth resetting, clearing, and replanting with the same or a different crop or topworking is equally important.

Site Selection

Choice of a planting site is an important consideration that can affect the amount of hurricane damage. Natural woodlands can significantly reduce the velocity of winds during storms. They also reduce bark damage to fruit trees caused by wind-blown sand and gravel from open fields. Sites with planted windbreaks also afford some wind protection as long as the windbreak trees are well-rooted and have been topped, thus reducing the chances of their toppling into the adjacent fruit trees.

Preplant Soil Preparation

In Miami-Dade County, most tropical fruit crops are grown on a hard but porous oolitic limestone solid, commonly called Rockland or Krome soil (Calhoun et al. 1974; South

Dade Soil and Water Conservation District 1989; Noble et al. 1997). Typically heavy tractors with 42-inch (107 cm) wide front-end plows ("rock plows") are used to scarify the limestone rock to a 4 to 8 inch (10 to 20 cm) depth. After rock-plowing, front-end trenching plows are used to make trenches (16 to 18 inches wide and 18 to 24 inches deep [41 cm to 46 cm wide and 46 to 61 cm deep]) in rows corresponding to tree rows and tree spacing distances (Colburn and Goldweber 1961). Trees then are planted at the intersections of the crossed trenches, which greatly increases the depth and volume of soil available for rooting and anchoring trees.

Past hurricanes in southern Florida showed that preplant practices that increased the soil depth available for rooting increased tree stability during high winds. "Flat-planted" trees in rockland soil generally toppled during tropical storms and hurricanes, revealing a shallow but extensive lateral root system (Colburn and Goldweber 1961). Observations after Hurricane Andrew suggested that some trees grown in cross-trenched groves broke off along the trunk, leaving only a jagged stump. Thus, while the tree was well anchored, the trunk could not withstand the wind stress. Hence, there may be some argument for flat-planted trees that can be reset after toppling. However, in many cases, flat-planted trees were uprooted completely or blown away.

Tropical fruit trees planted in the shallow sands along the southeast and southwest coasts of Florida also have a restricted root zone due to high water tables (ground water levels). This also limits root anchoring and increases the likelihood of tree toppling. Construction of large, high beds may increase the extensiveness of the root system and improve tree anchorage during high winds.

Grafted vs. Air-Layered Trees

A number of fruit crops, such as lychee, longan, guava, and 'Tahiti' lime (no longer commercially produced in Florida to any extent) are commonly propagated by air layering (marcottage) for commercial planting in southern Florida. However, hurricanes during the 1940s and 1960s and Hurricane Andrew in 1992 revealed that grafted lime trees withstood the high winds, while air-layered trees were toppled or blown out of the ground. A survey of mature lime groves after Hurricane Andrew indicated that only 17% of the trees in groves established with air-layered trees survived while 93% to 96% of the trees survived in groves established with grafted trees (Crane et al. 1994). Guava groves established with air-layered trees and allowed to grow to approximately 12 to 15 ft tall toppled, whereas those pruned to 7 to 8 ft remained in place. Thus, there is

an effect of tree species, propagation method, and tree size on high wind tolerance.

Tree Size Control Practices

The canopies of trees, especially mature trees, resist wind movement, although there is much difference among species. If the wind is of sufficient speed and duration, trees may have leaves blown off, limbs broken, trunks snapped and/or twisted off (at or near the soil surface), or be toppled or blown out of the ground.

The most beneficial pre-hurricane cultural practice to reduce tree damage and toppling is a regular pruning program to control tree size. Tree size may be reduced by topping and hedging with heavy equipment (Newman 1971; Phillips 1972) and/or with hand-operated saws and pneumatic shears for selective limb removal. Other benefits of tree size control include ease of harvest, increased penetration and efficiency of foliar sprays, increased light and air penetration, retention of a lower bearing canopy, and improved equipment movement through the orchard.

A post-Hurricane-Andrew survey indicated that the percentage of trees toppling over and surviving varied with fruit species, the age of the trees, and the height prior to the storm (Crane et al. 1994). In general, in groves where tree height was limited to 12 to 22 ft (3.7 to 6.7 m), more trees remained upright than in groves where no tree height control was practiced. In an avocado orchard rejuvenation study (Crane et al. 1992), the fewest toppled trees after Hurricane Andrew were in treatments where trees were topped to 12 ft (3.7 m). In contrast, more non-topped trees (30 to 60 ft; 9 to 18 m) and trees topped to 16 to 22 ft (4.9 to 6.7 m), had fallen.

Windbreaks

The benefit of windbreaks depends on whether they withstand high winds, remain upright and mostly intact during a storm, or topple, uproot, and destroy the trees they were intended to protect.

In southern Florida, traditional flat-planted windbreaks of Australian pines resulted in heavy damage to fruit trees after a hurricane when they fell into the orchards (Brooks 1946; Loomis 1946). In addition, they increased the grove restoration cost because windbreak trees had to be removed. Observations from previous hurricanes showed that no common windbreak species withstood hurricane winds in excess of 100 mph (161 kph) without serious damage or uprooting (Ruehle 1963). Similar problems with planted windbreaks were observed after Hurricane Andrew.

However, an exception was mature, well established sapodilla trees, which appeared to be quite stable even against strong winds. It is recommended they be topped to 22 ft (6.7m) or less to reduce their chances of toppling.

Human-constructed windbreaks have become common for carambola production in southern Florida. These windbreaks may be up to 22 ft (6.7 m) high and may surround an entire planting or just the portion of the grove perimeter not protected by natural windbreaks. Typically, they consist of aluminum or wooden poles with horizontal support cables from which shade cloth is attached vertically or on an incline to the cables. In most instances, groves are also sectioned-off inside the orchard with vertical shade cloth suspended 12 to 20 ft (3.6 to 6.1 m) above the orchard. These windbreaks work well to reduce wind speeds (5 to 36 mph; 2 to 16 ms⁻¹ or more) commonly experienced from November to March (Crane and Schaffer 1992), thus allowing trees to grow vigorously and produce fruit (Crane 1992). However, constructed artificial windbreaks were damaged during recent category 1 storms and did not survive the category 3 winds of Hurricane Wilma and the category 5 winds of Hurricane Andrew. On the other hand, groves adjacent to woodlands and planted windbreaks that had been topped had fewer toppled fruit trees and much less damage from windborne loose rock and sand than trees in unprotected groves.

Irrigation Infrastructure

Removing risers from the overhead and under-tree irrigation systems before a tropical storm or hurricane will dramatically reduce the amount of damage to risers and the underground piping of the system. During riser removal, plugging the riser bottom and open ground pipe with tape will greatly reduce debris entry and subsequent plugging of the irrigation system. Placing pumps and engines in an enclosed building also will reduce the chances of damaging them. However, moving such heavy equipment may not be practical.

Post-Hurricane Practices

The first step after a tropical storm or hurricane is to visually assess the damage and to estimate the cost and materials needed for resetting the grove. Once the equipment and labor have been assembled, debris removal, pruning of damaged trees, and resetting of toppled trees can begin.

Repairing or arranging for some type of functioning irrigation system should be one of the top priorities after the storm. This is because downed trees as well as trees

uprighted after the storm will need access to water immediately to promote new root growth.

Trees should be reset as soon as possible after a hurricane. The timing, however, may depend on many factors, including the cost and availability of equipment and labor and which groves or trees are deemed most valuable and/or saveable. The amount of root damage, the percentage of the root system remaining in the ground, and the amount of soil left around the exposed roots should be used to determine which trees to reset first. If possible, mounding soil on exposed roots or providing some type of shade will help keep the roots alive until resetting is possible.

Equipment

The equipment needed for resetting trees after a hurricane includes hand-pruning saws, chain saws, combination front-end loaders and backhoes, picks, shredders or chippers, shovels, hand hoes, loppers, and slings or large-diameter ropes for resetting fallen trees. Slings should not be made of cable or chain because they may damage the bark and cambial layer and may girdle already damaged and stressed trees. Cables also can be extremely dangerous to workers if they snap.

Protecting Sun-Exposed Trunks and Limbs

Cambial damage (“sunburn”) may occur to defoliated and/or toppled trees exposed to direct sunlight for prolonged periods (Boyce 1961; Levitt 1980; Tattar 1978). This injury is thought to be caused by overheating of the cambium layer, and symptoms include drying and peeling of the bark, defoliation, branch dieback, wood injury, and growth of saprophytic fungi on dead bark and wood.

Spraying or painting tree trunks and branches with white, water-based latex paint immediately after a hurricane will help prevent cambial overheating due to sun exposure. The latex can be diluted with water in a 1:1 ration (whitewash). If latex is not available, a whitewash can be made by mixing 1 part water, 1 part fine-grade hydrated lime, and $\frac{1}{10}$ part zinc sulfate (1:1:01 ratio). For example, 1 gallon of water, 1 lb of hydrated lime and $\frac{1}{10}$ lb of zinc sulfate (3.785 liters of water, 454 g of hydrated lime and 45 g of zinc sulfate). The zinc sulfate should be dissolved in water first. For application purposes, the mixture can be diluted to the desired consistency with water. If the material is to be applied with a mechanical sprayer, it will have to be strained first and diluted further.

If white-wash or paint is not readily available then piling brush (e.g., from limbs cut from fallen trees) on the

exposed surfaces of major limbs and the trunk area will also aid in preventing sunburn damage.

Pruning

Pruning may be a part of the debris removal and preparation for resetting toppled trees. Pruning cuts should be made back to sound wood, as in normal selective pruning practices. This includes pruning back to lateral buds, to the nearest crotch, or to the trunk. Additional pruning will be essential for proper tree management as new growth continues to develop and trees recover. In some cases, this may be a good time to cut trees back for topworking to more desirable cultivars.

Toppled trees also should be pruned back to sound wood. However, because of the extensive root damage of partially uprooted trees, a moderate to large amount of the tree canopy may have to be removed. Removing part or most of the canopy reduces the weight of the tree, making resetting and stabilizing the tree easier. It will also reduce the transpirational surface area. Depending on the size of the tree and the amount of damage, it may have to be cut back to main scaffold limbs or to the trunk (stump). Some trees may shift back to their original positions as the tops are removed. This can be dangerous for anyone pruning the tree or working near the root mass or trunk.

During the pruning process, braces for propping up trees may be made by cutting 4 to 10 ft (1.2 to 3.1 m) long limbs of 4 to 6 inches (10 to 15 cm) diameter with forked branches. These braces can be used to help stabilize trees after the resetting process.

Pruned-off branches can be stacked in the row for natural decomposition, removed from the orchard, chipped or shredded at the grove, or burned. Burning is not recommended because of air pollution, whereas chipped wood can be used immediately as mulch or composted for later use. Non-plant debris, such as metals, plastics, and rubber, should be removed and stacked outside the grove for later removal.

In some instances, when it is impossible to reset the trees immediately, pruning to remove most of the canopy of toppled trees will reduce transpiration and prevent desiccation. In addition, the pruned-off branches can be draped over the remaining trunk and scaffold branches for protection against sunburning. However, keep in mind that this practice may provide protection for wood-boring insects from their natural enemies (S. Goldweber, personal

communication), and the pruned branches may act as a bridge for weedy vines.

Once plant and non-plant debris have been removed and the orchard or some part of the orchard has been cleared, re-digging planting holes and resetting fallen trees can begin.

The Resetting Operation

Before resetting a tree, lateral and vertical roots completely out of the ground and damaged roots should be removed with a lopper and/or a saw. This will enable the tree to stand level when reset. A backhoe or similar machine should be used to remove enough soil from the tree hole so that the tree will stand at or near the same level as before. Soil underneath the root mass of the fallen trees also may be removed by hoes and shovels.

Heavy-duty slings or ropes attached to tractors or backhoes can be used to assist in raising the trees to an upright position. Pre-cut braces can be used to stabilize or prop the trees after they are raised. The hole should be filled with excavated soil and the soil “flooded-in.” The use of wood chips or other mulch on top of the soil is helpful in conserving moisture and controlling weeds.

Irrigation Practices

Invariably, irrigation systems are damaged to some extent during tropical storms or hurricanes. Irrigation systems should be repaired as soon as possible because drought stress may cause dieback of new shoots and leaves and may result in tree death. In addition, high-volume sprinkler irrigation systems need to be working for cold protection of cold-sensitive trees. We recommend irrigating at least twice per week at a 0.5 to 1.0 inch (1.3 to 2.5 cm) rate per irrigation until trees become reestablished.

Salt damage to trees depends on plant tolerance, the salt concentration of the water and the duration of exposure in addition to whether the roots are immersed (salt water intrusion or tidal surge) and whether salt is deposited by wind (foliar). If irrigation is available after a storm, irrigation to wash salt off remaining foliage and to leach salts in the soil beyond the root zone will help reduce salt damage to sensitive trees.

Fertilizer Practices

Obtaining fertilizers and distributing them to reset or reconditioned trees may not be possible and/or may be of secondary importance immediately after a hurricane. However, major fertilizer elements should be applied when

new growth begins to prevent nutrient deficiencies after stored reserves in the trees are depleted. Fertilizer rates for trees with limb loss should be reduced in proportion to the amount of tree damage, keeping in mind that previously fallen trees will have a damaged and much-reduced fibrous root system. More frequent light applications of low-analysis fertilizers may ensure a steady supply of nutrients and aid in a rapid recovery of canopy, limbs, and roots. In contrast, trees that lost mainly only leaves and remained upright should receive slightly higher-than-normal rates of fertilizer per tree as they reestablish their canopy. If possible, the fertilizer should be placed within a 3 to 6 foot (0.9 to 1.8 m) area of the trunk. This is because the fibrous root systems of fallen trees probably have been reduced and damaged.

Micronutrients such as Mn and Zn commonly are applied to foliage in south Florida, especially in Miami-Dade County because the limestone-based soil has a pH of 7.5 to 8.5. As trees refoliate, micronutrients such as Mn and Zn should be applied to the leaves. Chelated iron soil drenches should be applied as the trees begin to refoliate.

Weed Control Practices

Weed control may be difficult after a storm because of a lack of equipment, materials, or labor. However, because more of the land surface area is exposed to direct sunlight, weeds and weed vines will proliferate. Weeds and vines will compete with the trees for sunlight, water, and nutrients and become more difficult to control as they mature. When row middles become accessible, mowing and herbicide applications should be resumed.

Mulching Practices

The use of mulch (wood chips) around the trees will be helpful in conserving soil moisture and reducing weed growth. Mulch should not be mounded against the trunks because continuous moisture along the trunk may facilitate attack by fungi and borers. The mulch should be kept at least 8 to 12 inches (20 to 30 cm) from the trunk.

Some fruit tree species (e.g., lychee, mango, avocado) may be injured by thick layers of mulch and/or certain mulch materials. If in doubt, only weathered materials that are coarsely textured should be used and applied in thin layers of no more than 2 to 4 inches (5 to 10 cm). Slightly increased fertilizer rates, especially of N, may be necessary because some of the fertilizer will be used by microorganisms decomposing the mulch into compost (Brady 1974).

Insect and Disease Control Practices

Depending on location, various primary and secondary pathogens may attack defoliated and weakened trees. In addition, insect pests may attack what are usually considered non-host species. This may be due to a lack of normal host plant material or to decreased resistance of stressed plants. Local extension personnel should be contacted for identification and control recommendations.

Post-Hurricane Andrew Observations

The following observations on tree recovery after Hurricane Andrew (1992) may be useful examples of post hurricane care for specific species.

Tree Size Management

A post-storm investigation found pruning to control tree size was the most important cultural practice to limit tree toppling, windthrow, limb damage and tree destruction. Overly tall trees should be reduced in height either gradually or through a rejuvenation process. Annual to biannual tree size management should be implemented to reduce and maintain trees at a height where fruiting canopy is maintained from about 3 feet from the ground to the top of the trees. In addition, foliar sprays and harvesting are more efficient when tree size is limited (Table 1).

Atemoya and Sugar Apple

Most atemoya and sugar apple trees began to grow vigorously post storm; however, subsequent regrowth had chlorotic leaves, and trees began to decline (Crane et al., 2001). One or more cycles of new flush and shoot growth occurred followed by dieback over the next 18 to 24 months. This was especially common for trees that had toppled during the storm and had been reset. The root system of atemoya and sugar apple trees appeared to be damaged by the resetting process; however, even those left leaning (not reset) showed marked iron deficiency and declined slowly.

Subsequently, most atemoya and sugar apple trees were removed within 2 years of the storm.

Avocado

Trees reset or left standing after Hurricane Andrew recovered canopy and production rapidly during the next 7 years (Crane et al. 2001). Furthermore, overall industry production was only 20% below that of the season preceding the storm when commercial acreage was 25% higher.

Carambola

The vast majority of mature carambola trees refoliated quickly after the storm and bloomed twice: first, 3 to 4 weeks post-storm with little fruit set; second, 3 to 4 weeks later, setting a good crop. Post-hurricane observations 14 to 15 months later of 4-year-old (young) 'Arkin' carambola trees indicated those trees that were declining had detached bark and or major roots at or below the soil line (Crane et al. 1994). Trees that were not heavily damaged appeared to recover well from the storm and little evidence of damage was noted 7 years later (Crane et al., 2001).

Guava

Guava trees began regrowth immediately after the storm, flowered on the new growth, and set a crop within 2 months; fruit was harvested 6 to 7 months later (Crane et al. 2001). Root sprouting from damaged roots was common resulting in multi-trunked trees.

'Tahiti' Lime

Six to 12 months after Hurricane Andrew, surviving lime trees had refoliated and some production was re-established (Crane et al. 2001). Seven years after the storm an estimated 80% of the surviving lime trees had recovered well. Root-stock sprouting and sunburn damage was somewhat of a problem.

Lychee and Longan

Lychee production was greatly reduced for 1 to 2 years after Hurricane Andrew but trees generally recovered well and re-established a normal growth cycle. Six months after the storm, longan trees made a slow to moderate recovery; 10% to 20% were dying back. As with lychee, yields were low for 1 to 2 years and then re-established a normal pattern.

Mamey Sapote

Two months and six months after the storm many mamey sapote trees were vigorously flushing (Crane et al. 2001). Some trees grew vegetatively for the next 4 to 5 years before resuming fruit production. Many previously damaged branches and weak new limbs have been observed to break since the hurricane.

Mango

Recovery of many mango trees after Hurricane Andrew was poor. In a post-storm survey four years later, about 20% of the mango trees that had previously toppled and been reset remained stunted and continued to slowly decline (Crane and Balerdi 1997). Seven years after the storm 25% of the

remaining mango trees were still declining (Crane et al. 2001).

Conclusions

Planning for a hurricane will help reduce damage to fruit trees and enhance recovery of the farming operation. The three most important pre-hurricane practices are the use of grafted plant material (for those fruits where this is a viable option), preparation of planting sites to increase rooting depth available for anchoring trees in place, and maintenance of a regular pruning program to limit tree size. After a hurricane, being prepared for clearing debris, repairing the irrigation system, resetting toppled trees, protecting trees from sunburn, and irrigating and fertilizing trees frequently will increase chances that the trees will recover and the farming operation will survive.

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Table 1. Recommended plant height for tropical fruit trees.

Common Name	Scientific Name	Recommended maintenance tree height (ft)
Atemoya	<i>Annona cherimola</i> x <i>A. squamosa</i>	8-12
Avocado	<i>Persea americana</i>	12-20
Caimito (star apple)	<i>Chrysophyllum cainito</i>	8-15
Canistel (egg fruit)	<i>Pouteria campechiana</i>	10-15
Carambola	<i>Averrhoa carambola</i>	6-12
Guava	<i>Psidium guajava</i>	3-12
Jackfruit	<i>Artocarpus heterophyllus</i>	8-14
Lime	<i>Citrus latifolia</i>	7-9
Longan	<i>Dimocarpus longan</i>	10-18
Lychee	<i>Litchi chinensis</i>	10-18
Mamey sapote	<i>Pouteria sapota</i>	12-15
Mango	<i>Mangifera indica</i>	6-18
Sapodilla	<i>Manilkara zapota</i>	12-18
Soursop	<i>Annona muricata</i>	8-12
Spondias	<i>Spondias</i> species	8-12
Sugar apple	<i>Annona squamosa</i>	8-12
White sapote	<i>Casimiroa edulis</i> and <i>C. tetrameria</i>	10-15

Assessment and Management of Hurricane Damaged Timberland¹

Alan Long, Rick Williams, Chris Demers, Jarek Nowak, Nicole Strong, Jib Davidson, and John Holzaepfel²

Tropical storms and hurricanes have damaged timberland across Florida and other southern states. When hurricane- or tropical storm-force winds rip through forestland, the remaining twisted, broken and damaged timber is no longer the same merchantable product as it was before the storm (see Figure 1). In addition to timber value and infrastructure losses, many forest landowners are also concerned about potential problems, such as bark beetles and wildfire, which may add to their woes in coming months. Every year, southern timberland is damaged by hurricanes, ice storms, or tornadoes somewhere in the region. In response, a variety of information sources have been developed to address the many issues associated with such damage. This fact sheet summarizes information and guidelines from these sources, with a focus on Florida. It provides guidance to forestland owners for assessing severe storm damage, handling salvage operations and timber sales, minimizing potential impacts of other disasters after the storm, dealing with financial issues such as income tax casualty losses, and altering management plans. The references listed at the end may provide landowners with additional information relevant to their particular situation. (see Figure 1).



Figure 1. Catastrophic damage from category 4 hurricane winds in Bay County, Florida.

Credits: James R. Karels, October 2018

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Sources for Assistance

You do not have to deal with your losses alone. However, recognize that most of the sources described below are limited in the number of people they can help, and working with your neighbors or doing your own research may provide a good first step until other help is available.

Financial Assistance for Disaster-Damaged Forest Stands

The USDA Farm Service Agency (FSA) administers many safety-net programs to help producers recover from eligible losses. The Emergency Forest Restoration Program (EFRP) helps the owners of non-industrial private forests restore forests damaged by natural disasters. The EFRP does this by authorizing payments to owners of private forests to restore disaster-damaged forests. For more information, see <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/emergency-forest-restoration/index>

The FSA [Emergency Conservation Program](#) provides funding and technical assistance for farmers and ranchers to rehabilitate farmland damaged by natural disasters. For more information, see <https://www.fsa.usda.gov/programs-and-services/conservation-programs/emergency-conservation/index>

Producers located in counties that receive a primary or contiguous disaster designation are eligible for low-interest [emergency loans](#) to help them recover from production and physical losses. Compensation also is available to producers who purchased coverage through the [Noninsured Crop Disaster Assistance Program](#), which protects non-insurable crops against natural disasters that result in lower yields, crop losses, or prevented planting. USDA encourages farmers and ranchers to contact their local FSA office to learn what documents can help the local office expedite assistance, such as farm records, receipts, and pictures of damages or losses.

Find your USDA Service Center contacts at: <https://offices.sc.egov.usda.gov/locator/app>

Technical Assistance

Forestry consultants, county foresters, timber dealers and brokers, wood processing mills, landowner assistance programs, and UF/IFAS Extension agents may be able to assist you with assessing your damages and determining your next steps. Find your Extension agent at: <https://sfyl.ifas.ufl.edu/find-your-local-office/>.

County foresters are employees of the Florida Forest Service (FFS) and are listed in the government pages of your telephone book and on the FFS website, <http://www.fresh-fromflorida.com/Divisions-Offices/Florida-Forest-Service/For-Landowners/County-Foresters>. County foresters also maintain lists of forestry consultants and logging companies that operate in your area. If you have access to the Internet, use your favorite search engine, such as Google™, to find help. Key words such as “Florida forestry,” “Florida timber buyers,” “Florida foresters,” and other similar terms will help narrow your search.

Another source of timber buyers is the Florida Forestry Associations website, <http://www.floridaforest.org/>. Click on the Master Logger Search Tool. Input your county at the bottom of the page as well as adjacent counties for a complete list of Master Loggers in your area. A private consultant can also help you evaluate your stand conditions and plan sales of the damaged timber. Other private consultants can be found through the Association of Consulting Foresters of America, Inc. website, <http://www.acf-foresters.org>.

Telephone numbers for loggers, timber dealers, brokers, and wood processing mills can be found in the Yellow Pages of your telephone book under “Timber.” Check our Directory of loggers and timber buyers at http://sfrc.ufl.edu/extension/florida_forestry_information/directory/loggers.html.

Given the high demand for assistance following major disasters, property size, and, more importantly, timber volume will influence how much help you will be able to receive. It will be very difficult, if not impossible, to have a small volume of timber harvested. If a number of adjacent landowners are willing to work together to arrange for a salvage timber sale, then the combined timber volume may enhance the chances for hiring logging crews and receiving reasonable stumpage prices.

Assessing Damage Timber

The first critical step for planning salvage harvests or handling tax losses is to determine the extent and type of damage across your property. Using an aerial photo or map of your property, walk all the boundaries and throughout the stands (if you can do so safely) and note on the photo or map the locations of the major pockets and types of damage. Take pictures to show the actual property damage **before** any cleanup or salvage operations begin. The extent of tree damage and location, and average tree diameter,

might influence your salvage decisions. At several locations throughout the damaged parts of your stands it will be important to count and record the numbers (or percentages) of trees that are undamaged or in one of the following categories:

1. Uprooted hardwoods or pines.
2. Broken tops or major stems with less than four main live limbs left on the tree.
3. Broken tops or major stems with four or more main live limbs left on the tree.
4. Severely bent pines.
5. Major wounds, more than 2 inches deep and/or over 1 square foot in size.

For both hardwoods and pines, if trees are reasonably vertical and have at least four main live limbs remaining on the tree (category 3) they will probably survive, although growth will likely be reduced until the crown redevelops. They can be retained for removal in a future thinning or final harvest, but continue to carefully monitor the trees through the next year for infestations of bark beetles, since the trees have been stressed and wounds are likely present.

Trees that are bent, broken (with three or fewer live limbs), or splintered (categories 2 and 4) probably have internal wood damage such as ring shake and pulled fibers and all or part of the tree may not be suitable for lumber or plywood but could be used for pulpwood, mulch, woody biomass for energy, or particleboard. Ring shake may be less of an issue if the trees have only been subject to winds in one direction; severe winds from alternating directions can lead to twisting and torque stresses. Broken stems, however, inevitably lead to some ring shake and pulled fibers. When merchandizing a section of the tree as solid wood product such as chip-n-saw, sawlog, or plylog, the logger often must start the log several feet past the break to avoid these defects.

Uprooted (category 1) and leaning trees are more likely to have undamaged wood, may dry out more slowly than broken trees, and could still be suitable for lumber if harvested within 1 to 2 months, before blue stain or decay fungi discolor the wood or wood-boring insects create holes in the trees. If major wounds (category 5) are extensive, pine bark beetles could threaten residual pine trees. Also, wood borers and decay may be a problem soon, and the trees should be harvested as soon as possible.

Roads and Infrastructure

Part of the damage assessment should focus on roads, fences, gates, stream crossings and any other structures on the property. If they are damaged you should note what needs to be done to maintain or repair them. You must have enough access to support 80,000 pound log trucks and the accompanying logging equipment. Again, pictures will prove very helpful for documenting expenditures and repairs.

High Priority Problems

Value of storm-damaged timber decreases with time for a number of reasons: blue stain or decay fungi, wood borers, further losses from bark beetles, large volumes of wood on the market, and higher harvesting costs in damaged stands. Prompt action to assess timber and conduct salvage harvests should focus on the highest value timber (large diameters), which may only be useful for pulpwood, mulch, energy wood or particleboard once stain and decay fungi or wood borers set in. Several factors influence the amount of time that it takes for wood to degrade from a solid wood product to a less valuable product such as pulpwood. Some factors include weather conditions, type of damage, and whether the timber is immediately dead or perhaps still initially alive after the storm event. As a general rule, damaged timber that could be sold for lumber or plywood should be harvested within one or two months.

Potential for Insects, Disease, or Wildfire

The more severely the timber is damaged, the more likely is an attack by insects. Trees with less than three remaining limbs are most likely to be attacked as well as those that are bent, leaning, or scarred. The southern pine beetle (SPB) is the most serious threat to storm-weakened pine timber. This insect is capable of killing even healthy trees under favorable outbreak conditions. If such conditions occur, they will most likely be in late spring or summer the year after the storm. Cool winter temperatures and sufficient rainfall should reduce tree stress until the following spring. Weakened pines emit a scent that is attractive to SPB, and once the beetles settle in, an infestation may engulf large areas of pine timber. An uncontrolled SPB infestation can kill hundreds of acres of pine timber in a relatively short time span. The other pine bark beetles (species of engraver or *Ips* beetles and the black turpentine beetle) also attack weakened, injured and stressed pines; and under more normal conditions, individual infestations seldom encompass more than 10–15 trees. These beetles usually attack scattered single trees, or two to three trees in a group. However, when stands of pine are suffering high stress,

larger, more extensive infestations can occur. Salvaging damaged trees as soon after the storm as possible is the best way to prevent pine bark beetle infestations.

Whether the standing timber is heavily damaged or not, branches, leaves, and broken tops litter the forest floor after a storm and become potential fuel for a wildfire the following spring. Bush-hogging, crushing, roller chopping or prescribed burning will help reduce those fuels.

Decisions to Make

Once you have assessed the damage, you are in a much better position to determine whether you need to consider a salvage harvest or whether the stand has a sufficient number of healthy trees to recover on its own. The North Carolina Forest Service offered these guidelines in 2002, modified for Florida in this publication:

1. If there is only minor bending or leaning of merchantable-size trees with intact root systems, the trees will naturally recover, and it is probably best to wait and see before exploring salvage options.
2. If trees have only minor damage and the timber is still green and standing, don't rush to salvage; wait and see if they will naturally recover.
3. If less than 20 percent of the trees in your forest appear to be damaged, don't harvest the entire tract. If most of the damage is in one area or small pockets, consider small clearcuts of those areas. If, instead, the damaged trees are scattered throughout the stand, leave it for a thinning operation when timber markets improve.
4. If the majority of the timber stand is broken down and salvage is needed, get professional guidance in finding a timber buyer.
5. Have patience during this time and use good business sense. Disreputable timber buyers may seek to take advantage of less knowledgeable or inexperienced sellers of timber when they are not represented by a professional forester. Use the resources available to you to make sure you are getting all that your timber may be worth.

Salvage the Stand

If you determine that a salvage harvest is necessary, you should plan that harvest as soon as possible to best utilize the timber and redeem its value rather than let it go to waste and attract insects. The available salvage period varies according to the expected product, but would not usually

exceed 60–90 days. Sometimes, under certain conditions, the salvage period can exceed 90 days. The North Carolina Forest Service's Evaluation and Management Of Storm Damage to Southern Yellow Pines (https://ncforestservice.gov/Managing_your_forest/pdf/EvaluationMngt-Storm-DamageSYellowPines.pdf) suggests that trees in damage categories 1, 2, 4, and 5 (see "Assessing Timber Damage," above) should be harvested as soon as possible. Harvesting trees with category 3 damage (broken tops, but major stems standing with four or more main live limbs) can be delayed to the next thinning or when timber markets improve.

Timber salvage operations are more time consuming than regular harvesting; therefore, the prices paid for the damaged timber will be lower than prices for standing timber. From a logging point of view, it takes two to three times as long to salvage one load of downed timber as it does to harvest a regular load of logs. As production times increase, so do logging costs, and these increases are especially noticeable if salvage operations are conducted separately for lumber versus pulpwood or woody biomass products. Thus, salvage harvests will be least costly if all products are merchandized at one time. Several other factors also influence salvage results. A broken tree may not be able to be converted to lumber or plywood and may have to be sold as pulpwood regardless of its size; with that in mind, salvage harvests for pulpwood can be delayed for up to six months. However, dead timber often dries out rapidly and has less dollar value when weight scaled. In fact, most mills will not accept timber when the bark is falling off the tree.

What about hardwoods?

Hardwood trees that are standing and have even a small portion of the crown remaining will probably recover in time. Large hardwood trees that are uprooted should be removed, especially those near structures. Hardwood trees with large damaged areas on the trunk or large broken limbs may be infected with decay fungi, which, after several years, will weaken a tree structurally and make the tree more susceptible to future wind damage. Damaged hardwood trees in residential areas that are not removed should be properly pruned to eliminate broken branches and branch stubs and promote rapid healing. Homeowners are reminded to contact their insurance agent concerning the loss of shade trees, pines, or hardwoods, or property damage caused by falling trees.

Tax Considerations

Timber Casualty Loss Deductions

If you have trees that have blown over, had tops severed, trunks split or other damage that stopped growth or resulted in tree death, you may be eligible to file for casualty loss deductions for income tax purposes (Greene 2004, Wang 2008). To be allowed as a casualty deduction, a loss to one's timber must be caused by natural or other external factors acting in a sudden, unexpected, and unusual manner. A sudden event is one that is swift, not gradual or progressive. An unexpected event is one that is ordinarily unanticipated and one that you do not intend. Hurricanes should fit those IRS definitions.

Unfortunately, most timber casualty losses are limited to the adjusted basis of the timber. The general rule is that the amount of deductible loss is the lesser of the decrease in the fair market value of the timber or the adjusted basis (minus any income received from a salvage operation and/or any insurance proceeds). Part of the casualty loss deduction depends on how the timber is held, the type of property and how it is used, the timber's age and merchantability, and other nontimber asset income and expenses that will influence this deduction. It is extremely important to work this out with your tax advisor and/or a knowledgeable consulting forester. Be sure to ask your forester if he or she has the necessary expertise to advise you in this area.

To claim a loss deduction, you must make an authentic attempt to sell and salvage the damaged timber and keep records of your attempt to do so. You must also identify the damaged or destroyed object or property. For timber, this identification is expressed in terms of the specific units of volume destroyed such as board feet, cords, cubic feet, etc. However, several recent court cases led the IRS to issue Revenue Ruling 99-56, which allows loss deductions to be calculated on a "block" method (Greene 2004; Wang 2018).

When you salvage your timber, be sure to get a written contract to protect the residual trees and your forest land. Identify what type of trees are to be salvaged such as those that are broken, downed or bent at certain angles, and what trees are to be left on the site, if any. Finally, determine how you will be paid for the salvaged timber and include this information in the contract. For more information on marketing timber and timber sale contracts, see this UF/IFAS Extension publication: <http://edis.ifas.ufl.edu/fr130>.

If your receipts from a salvage sale are greater than your adjusted basis in the timber, you will have a taxable gain, which is a separate transaction from the casualty loss

deduction and must be reported as a gain. However, the gain and tax on it can be postponed by using it to purchase qualifying replacement property within an allowable replacement period.

Casualty losses should be reported to the IRS with Federal Form 4684 and as a deduction on your tax return for the year the loss takes place. If the casualty loss resulted from a presidentially declared disaster (as was the case after many recent hurricanes), you can choose to deduct the loss on an original or amended tax return for the year immediately before the year the disaster took place (Greene 2004). It is also recommended that you make sure you get documentation of the date of the casualty, the location of the damage, property appraisals, and, if possible, photographs of the property before and after the disaster occurred.

Young Plantations

If you have maintained your records of costs incurred in young plantations, you may also be able to receive casualty loss deductions for those stands. The amount that you may claim is calculated by dividing the costs for establishing the stand to date by the total number of acres in plantation. The value per acre multiplied by the number of acres destroyed is the amount you can claim.

Non-business Casualty Losses

You may also deduct damage sustained to personal property, such as downed trees in your yard. To do so you need all the documentation required for business casualty losses. The amount that you may claim is based on the fair market value (FMV) of your property. Once you have calculated the decrease in FMV caused by the loss, you need to subtract \$100.00 from the total loss for each event as well as subtract 10% of your adjusted gross income from your combined losses from all events during the year. Also, if you receive insurance or other reimbursements (such as loan forgiveness), these need to be subtracted from the amount of loss that you calculate for deduction.

A certified public accountant, a tax attorney, or a knowledgeable consulting forester with a good tax background are the best options for high quality tax information and assistance.

Timber Tax and Financial Assistance

Information Sources

Haney, H.L., W.L. Hoover, W.C. Siegel, and J.L. Greene. 2001. Forest Landowners' Guide to the Federal Income Tax. Agriculture Handbook 718. U.S. Department of Agriculture, Forest Service, Washington, D.C. 157 p.

National Timber Tax website. <http://www.timbertax.org>. This site has information you will need in order to file casualty loss deductions.

<https://www.irs.gov/credits-deductions-for-individuals> [18 October 2018]. This website includes information for filing for tax deductions as well as the appropriate forms. See <https://www.irs.gov/help/contact-your-local-irs-office> to find contact information for your local office.

<http://www.fs.fed.us/spf/coop/programs/loa/tax.shtml> This website provides links to a number of tax-related documents and articles, including Agriculture Handbook 718; it also includes a sample timber sale contract.

<http://www.disasterassistance.gov/>. This website includes information on all federal assistance programs.

Management Plan Revisions

Once you have dealt with damage assessment, salvage operations, and financial issues, one more important post-storm step will be to revise your management plan to reflect the changes. Regeneration plans, harvest schedules, and activities to minimize future potential problems will undoubtedly need to be reviewed and updated, especially for those activities that will be necessary in the next few years and for which technical and financial assistance might become available. The county or consulting forester who helped you prepare your last plan will be your best first contact for this process. If you do not have a current management plan, now may be a good time to develop one as you deal with the changes before you.

Additional Sources of Assistance

USDA offers a variety of programs and services to help communities, farmers, ranchers, and businesses that have been hard hit by Hurricanes and other natural disaster events. To find out how USDA can further assist you, visit USDA's Storm Disaster Page at <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/index>. This Florida Forest Service page has information on available resources and services for forest landowners in recover after a hurricane: <https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Our-Forests/Forest-Health/Forest-Recovery-After-a-Hurricane>.

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Barry, P.J., C. Doggett, R.L. Anderson, and K.M. Swain, Sr. 1998. How to evaluate and manage storm-damaged forest areas. USDA Forest Service Southern Region Management Bulletin R8 MB 63.

The North Carolina Forest Service website http://www.ncforestservice.gov/Managing_your_forest/damage_recovery.htm contains many pages and fact sheets related to storm damage and response.

Greene, John. 2004. Loss deductions for timber damaged or destroyed by a natural disaster. <http://www.fs.fed.us/spf/coop/library/LossDeduct.pdf>

Wang, Linda. 2018. Income tax deduction for timber casualty loss. USDA Forest Service. 2 pg <https://timbertax.org/Income%20Tax%20Deduction%20on%20Tree%20Losses%20from%20Casualty.pdf>

Storm-Damaged Agrichemical Facilities ¹

Thomas W. Dean, O. Norman Nesheim, and Fred Fishel²

This fact sheet provides guidelines useful for people or organizations needing to secure pesticides and other agricultural chemicals that have been subjected to severe storm conditions.

Background

Hurricanes and other severe storms can seriously damage agricultural chemical storage facilities and the chemicals they contain. Storm-damaged facilities may adversely affect the environment and people.

Area Security

Following a severe storm, keep unauthorized people away from the chemical storage facility and adjacent areas. Post the area to indicate that potentially hazardous chemicals are present; erect fencing or rope cordons, and inform people entering the property of the presence of an agricultural chemical storage facility. The idea is to keep people and animals out of the surrounding area.

Personal Safety

Make personal safety a priority. When dealing with a storm-damaged facility, wear the personal protective equipment (PPE) needed to protect a person handling the most dangerous material present. This usually means respirator, eye protection, unlined nitrile gloves, rubber boots, long-sleeved shirt, work trousers, and a chemical-resistant apron. Before using ANY personal protective equipment, check

to see that it is in serviceable condition. Be alert for SIGNS or SYMPTOMS of pesticide poisoning: nausea, headache, difficult breathing, pinpoint pupils, or convulsions. If these appear and pesticide poisoning is suspected, seek medical attention immediately.

Site Inspection

As soon as possible, inspect the site for storm damage. Focus on 1) the presence of damaged containers; 2) if and where the storm has moved pesticide containers off site; 3) structural damage to the storage facility; and 4) ways to avoid further weather damage.

Spill Management

Finding broken packages or ruptured containers indicates the need for spill management efforts. To manage spills, use a stepwise procedure and focus on:

- CONTROLLING actively spilling materials by standing containers upright, plugging holes, etc.;
- CONTAINING spilled chemicals by installing absorbent barriers;
- COLLECTING spilled product and absorbents and placing these in sturdy containers; and
- STORING all containers of spilled agrichemicals in an area where disturbance is likely to be minimal.

1. This document is PI9 (originally published as AS054), one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date April 1993. Revised September 2004 and October 2015. Reviewed October 2018. Visit the EDIS website at <http://edis.ifas.ufl.edu>. For additional information, contact the UF/IFAS Pesticide Information Office, PO Box 110710, Gainesville, FL 32611-0720, (352) 392-4721.

2. Thomas W. Dean, Ph.D., former assistant extension specialist; O. Norman Nesheim, Ph.D., professor emeritus and former pesticide information coordinator, Food Science and Human Nutrition Department; and Fred Fishel, professor, Agronomy Department; UF/IFAS Extension, Gainesville, FL 32611.

Spill Prevention

Consolidate agrichemicals having intact packaging. Sort these according to package type (glass, paper, plastic, metal), substance type (insecticides, herbicides, etc.) and reactivity group (flammables, corrosives, etc.); then, put them in areas protected from weather, flooding, and building collapse. Consider alternatives such as pallets placed on blocks and covered with tarpaulins or plastic sheeting. The idea is that consolidating intact containers and providing sheltered storage will help prevent container deterioration and subsequent spills.

Product Identity and Labels

Knowing the contents of an agrochemical container is extremely important. Make every effort to preserve and protect container labeling. Containers lacking labeling will likely end up being considered unknowns—and disposal of unknowns is often very costly. Exposure to severe storms, heavy rain, or flood waters, will often cause labels to loosen. Refasten all loose labeling. Use non-water-soluble glue or sturdy transparent packaging tape to refasten loose labels. NEVER refasten labels with rubber bands (they quickly rot and easily break) or non-transparent tapes such as duct or masking tape (they can obscure important product caution statements or label directions for product usage).

As a supplement to marred or badly damaged labels, fasten a baggage tag to the container handle. On the tag write the product name, formulation, concentration of active ingredient(s), and date of product purchase. If there is any question about the contents of a container, set it aside for disposal.



Figure 1. Dry product containers damaged following storm event.
Credits: UF/IFAS Pesticide Information Office

Salvage

If the labeling is legible and secure, agrichemicals in intact waterproof containers, and formulated as liquids, emulsifiable concentrates, flowables, or oil solutions are often salvageable. Check each container for hidden damage. In particular, determine whether or not the pour spout seal has been broken. Upon finding a broken seal, examine the contents for evidence of contamination-- especially water-induced damage. In general, liquid formulations that have a

milky appearance have been corrupted by water encroachment. In most cases, these should be set aside for disposal.

Oil solutions, such as livestock sprays, can often be salvaged. Water is easily detected in oil solutions. Since oil floats on water, carefully pour off the oil and leave the water behind. Handle the water as a container rinsate (e.g., use it as make-up water); thereafter, return the oil solution to its original container. Triple rinse the temporary container and handle the rinsate as dilute pesticide (e.g., include in a batch of spray mix.)

The salvageability of dry formulations (baits, dusts, wettable powders, granules, dry flowables, etc.) is more difficult to assess. In general, products held in paper packaging are more vulnerable to severe-storm- induced damage. But, paper is not the sole problem. Plastic and foil-lined bags are also difficult to assess for pinholes and unsound seams. As a rule, avoid opening large quantities of dry formulation packaging and examining contents in detail. Again, when in doubt, set the container aside for later disposal.

Temporary Storage

Temporary storage is another key concern for agrochemical facilities damaged by severe storms. In addition to the aspects of storage discussed earlier (see Spill Prevention), four other points merit mention:

- Designate three separate storage areas, one for salvaged materials, a second for materials intended for disposal, and a third one for materials in the process of being re-collected and evaluated.
- Make sure each storage area is secure and not readily accessible to persons or animals.
- Provide each area with protection from further weather and debris-induced damage
- Keep each of the three stockpiles away from supplies of water, foods, fuels, machinery, and personal protective equipment.

Handling and Transport

All post-storm movement of agrichemicals and their containers (including re-collection of off-site containers) requires care and greater-than-normal safeguards. Labeling must be preserved (even for those that will ultimately require disposal). Storm-damaged packaging is more spill-prone. Also, for certain agrichemicals, moisture increases the reactivity and fire hazard. Handling and transport efforts must take these considerations into account BEFORE movement of the product is attempted.

Consult SDS sheets. Finally, before moving agrichemicals whose packaging is suspected to be weakened and likely to spill, have temporary containment vessels (such as garbage cans lined with plastic bags) on hand.

Disposal

Disposal of natural-disaster-induced agrochemical waste should proceed only after proper authorities have been contacted. In certain cases, part of the disposal costs might be paid by disaster-relief funds. Persons having severe-storm-damaged agrichemicals should contact the Florida Department of Environmental Protection (850-245-8705) for information on their disposal.

MONSTER MIXTURES

DANGEROUS HOUSEHOLD CLEANING COMBINATIONS!



The CDC* recommends that we clean and disinfect frequently touched surfaces to kill viruses and bacteria that can make us sick. You might be tempted to use two or more cleaning products together to make them more effective. **BUT STOP!** Common cleaners that are safe to use by themselves can be very dangerous if they are used together.

In some instances, these mixtures can cause breathing problems within minutes of inhaling the vapors!

Follow label instructions, store cleaners in their original containers, do not use more cleaner than is recommended on the label, and never mix cleaners or use them one right after another without rinsing first with water.

- **Mixing bleach and vinegar** can irritate your eyes, make you cough, and cause breathing problems.
- **Mixing bleach and ammonia** produces a toxic gas that causes shortness of breath and chest pain.
- **Mixing bleach and alcohol** (both rubbing alcohol and ethyl alcohol) can damage your eyes, lungs, and liver.
- **Mixing hydrogen peroxide and vinegar** produces a corrosive acid that will irritate your eyes, skin, and respiratory tract.



Beware of the potential health risk from breathing these household chemicals. Use cleaners as the label instructs, in the amounts advised, and separately from other cleaners to avoid creating a monster mixture—and a serious risk to your health!

MEZCLAS MONSTRUOSAS

¡COMBINACIONES PELIGROSAS DE LIMPIEZA DOMÉSTICA!



El Centro de Control y Prevención de Enfermedades (CDC por sus siglas en inglés) recomienda que limpiemos y desinfectemos con frecuencia las superficies que tocamos para matar los virus y las bacterias que pueden enfermarnos. Es posible que sienta la tentación de mezclar o usar dos o más productos de limpieza para que sean más efectivos. **¡Deténgase!** Los detergentes comunes que son seguros de usar por sí solos pueden ser muy peligrosos si se mezclan con otros limpiadores.

¡En algunos casos, estas mezclas pueden causar problemas respiratorios a pocos minutos de inhalar los vapores!

Siga las instrucciones de la etiqueta, guarde los limpiadores en sus envases originales, no use más limpiadores de los recomendados en la etiqueta, y nunca mezcle los limpiadores ni los use uno tras otro sin antes enjuagarlos primero con agua.

- **Mezclar blanqueador cloro y vinagre** puede irritar los ojos, causar tos y problemas respiratorios.
- **Mezclar blanqueador cloro y amoníaco** produce un gas tóxico que causa dificultad para respirar y dolor en el pecho.
- **Mezclar blanqueador cloro y alcohol** (alcohol isopropílico o alcohol etílico) puede dañar los ojos, los pulmones y el hígado.
- **Mezclar peróxido de hidrógeno y vinagre** (agua oxigenada) produce un ácido corrosivo que irritará los ojos, la piel y las vías respiratorias.



Use limpiadores como se indica en la etiqueta, en cantidades recomendadas, y por separado de otros limpiadores. De esta manera, evitara crear una mezcla monstruosa y un riesgo grave a su salud.

Help Prevent Virus
and Bacteria Spread with

NIGHTLY CLEANING



Make your own disinfecting solution at home.

Prepare a bleach solution by mixing:

- 5 tablespoons (1/3rd cup) bleach per gallon of water or
- 4 teaspoons bleach per quart of water

Prepare alcohol
solutions with at
least 70% alcohol

KITCHEN



- Refrigerator handles and doors
- Drawer and cabinet pulls
- All countertops
- Stove including knobs
- Sink including the taps

GENERAL HOUSEHOLD



- High traffic common surfaces
- Light switches
- Doorknobs
- TV remote controls
- AC returns

BATHROOM



- Toilet including handle
- Sink including the taps
- Light switch
- Doorknobs
- Replace hand towels daily

ELECTRONICS



- Computers and mice
- Keyboards
- Tablets
- Phones

Review specific manufacturers
recommendations for cleaning.

Ayude a prevenir la
propagación de
virus y bacterias con

LIMPIEZA NOCTURNA



Haga su propia solución desinfectante en casa.

Prepare una solución de blanqueador con cloro al mezclar:

- 5 cucharadas (1/4 de taza) de blanqueador con cloro por galón de agua o
- 4 cucharaditas de blanqueador con cloro por litro de agua

Prepare soluciones de alcohol con al menos 70% de alcohol

COCINA



- Manijas y puertas del refrigerador
- Tiradores de cajones o gavetas y gabinetes
- Todas las encimeras
- Estufa, incluyendo las perillas
- Fregadero, incluyendo el grifo

HOGAR GENERAL



- Superficies de contacto frecuente en áreas de uso común
- Interruptores de luz
- Manijas de puertas
- Controles remotos
- Rejillas de entrada y salida del aire acondicionado

BAÑO



- Inodoro, incluyendo la manija
- Lavamanos, incluyendo el grifo
- Interruptor de luz
- Manijas de puertas
- Reemplace las toallas de mano diariamente

ELECTRÓNICA



- Computadoras y ratón de la computadora
- Teclados
- Tabletas
- Teléfonos

Revise las recomendaciones específicas del fabricante para la limpieza.

Food Safety within the Household: Risk Reduction¹

Lucianna Grasso, Rachael Silverberg, George L. Baker, Renée M. Goodrich-Schneider, and Keith R. Schneider²

The Centers for Disease Control and Prevention (CDC) estimates that 48 million Americans acquire foodborne illness every year, 128,000 are hospitalized, and 3,000 die (CDC 2011). In 2013, 12% of all foodborne illnesses with a single reported setting (86 outbreaks and 1,078 reported instances of illness) were attributed to food preparation occurring in private homes (CDC 2015). Many cases of foodborne illness are not reported, and of those that are, the causative agent is not investigated or identified. In 2013, the top five identified bacterial and viral foodborne illness agents attributed to home food preparation were *Salmonella*, norovirus, shiga-toxin-producing *Escherichia coli* (e.g., serovars O104, O111, O157:H7 and others), *Clostridium perfringens*, and *Campylobacter* (CDC 2015).

Household Risks and How They Occur

Salmonella

Food poisoning from *Salmonella* infections can cause serious illness and even death; symptoms include acute diarrhea, vomiting, dehydration, septicemia, or bacteremia (i.e., bacteria in bloodstream) (Bell and Kyriakides 2009a). Possible secondary illnesses associated with this infection are reactive arthritis, meningitis, and urinary-tract infections, etc. In home-kitchen settings, *Salmonella* is often linked to egg and egg-based products like homemade mayonnaise in which the choice of acidulant (acetic acid

vs. citric acid) and other factors influence the survival of *Salmonella* introduced through contamination of raw eggs (Radford et al. 1993). Chicken and other poultry, produce, fruits, chocolate, and nuts have also been implicated as vehicles of *Salmonella* transmission. These food sources may become contaminated with *Salmonella* by contact with fecal matter (either directly or through cross-contamination), inadequate cooking techniques, and cross-contamination due to poor personal hygiene or improperly cleaned equipment.

Norovirus

Noroviruses are responsible for 20 million reported cases of acute gastroenteritis, or stomach flu, each year (CDC 2014). Symptoms typically begin within 12 hours of ingestion of contaminated food and may include nausea, vomiting, diarrhea, abdominal cramps, headaches, fever/chills, and muscle aches. Norovirus is highly contagious and contact with as few as 100 virus particles is sufficient to cause illness. Foodborne norovirus transmission can occur anywhere people consume food prepared by others. In home-kitchen settings, food can be easily contaminated through handling by infected persons, contact with infectious stool or vomit on kitchen surfaces, or contact with aerosolized vomitus droplets from an infected person (CDC 2014).

1. This document is FSHN12-10, one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date October 2012. Revised November 2015. Reviewed September 2018. Visit the EDIS website at <http://edis.ifas.ufl.edu/>.

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Shiga-Toxin-Producing *Escherichia coli* (STEC)

Shiga-toxin-producing *Escherichia coli* (STEC) bacteria, such as *E. coli* O157:H7, can cause severe abdominal cramping, bloody diarrhea, and vomiting (Bell and Kyriakides 2009b). STEC infections can lead to hemolytic uremic syndrome (HUS), which is potentially fatal, especially in young children. *E. coli* O157:H7 infections occur when people consume contaminated food or water products, including undercooked meat, unpasteurized milk products, and leafy green vegetables. Between 2003 and 2012, ground beef and leafy greens were implicated as the source of more than 25% of all reported *E. coli* outbreaks in the United States (Heiman et al. 2015). In home-kitchen settings, washing contaminated ready-to-eat leafy greens in tap water may have the unintended effect of cross-contaminating previously uncontaminated portions, thus increasing the potential for STEC infection (Jensen et al. 2015).

Clostridium perfringens

As the second-most common bacterial agent of foodborne illness in the United States, *Clostridium perfringens* affects nearly one million individuals each year (Grass et al. 2013). Only a fraction of these cases are actually reported due to the mild, self-limiting nature of resultant symptoms. Generally, individuals experience abdominal pain, stomach cramps, and diarrhea within 6–24 hours after consuming contaminated food. High-protein foods of animal origin, including meat and meat products, stews, broth, soups, gravies, milk, etc., are commonly implicated as sources of *C. perfringens* infection. Because the bacteria is naturally present in the normal intestinal flora of animals, proper cooking of food to an internal temperature of 165°F or higher for at least 15 seconds is necessary to inactivate the bacteria. Additionally, cooked food should be kept hot at 140°F before serving or rapidly cooled to 41°F for storage (FDA 2013).

Campylobacter

Campylobacter is the primary cause of a type of foodborne gastroenteritis known as campylobacteriosis. Resulting symptoms appear between 2–5 days after ingestion of contaminated material, last between 7–10 days, and are usually flu-like in nature: acute diarrhea, fever, nausea, and vomiting. Because the bacteria occurs as a natural part of the normal flora of domestic animals like cattle and poultry, raw or undercooked meat (especially chicken) is a frequent source of foodborne *Campylobacter* illness in home kitchen settings (Blackburn and McClure 2009). Other vehicles of infection include contaminated water, raw or unpasteurized

milk, and salad vegetables. Cross-contamination due to inadequate hygiene practices within the kitchen is a high risk factor for contracting *Campylobacter*

Risk Reduction Requires Knowledge and Behavior Change

Even though the number of foodborne illness cases occurring in domestic settings appears to be decreasing, educating consumers about home food safety is of the utmost importance (Scott 2003). Having insufficient knowledge of the risks associated at each level of food preparation can increase the number of incidents of foodborne illnesses at home (Collins 1997). Yet, the correlation between knowledge of proper hygiene practices and actual hygienic behavior in the home kitchen is still low among consumers (Worsfold and Griffith 1997).

The most common food-safety handling mistakes that occur within the household are improper food storage, inadequate cooking or reheating temperatures, cross-contamination, and infected food handlers (Scott 2003). However, research has shown that maintaining good hygiene practices can greatly help reduce many of the occurrences of foodborne illnesses (Scott 1996).

Food Storage

Food must be stored in a manner that minimizes microbial growth. Cooked food should be stored in the refrigerator below 41°F or in the freezer below 0°F (FDA 2013). Because refrigeration does not completely eliminate the potential growth of pathogenic bacteria, leftover food stored in the refrigerator should be consumed or discarded within 3 to 5 days. Expiration dates for foods should also be checked regularly (NNC 1999). Frozen food should be thawed either in the refrigerator until ready, under cold running water (below 70°F), or in a microwave oven (FDA 2013). Raw foods and cooked foods should be stored separately in the refrigerator in order to prevent cross-contamination between the two. Furthermore, each item should be covered or wrapped (NNC 1999).

Cooking and Reheating

In the prevention of microbial growth, proper cooking of food is equally important. All cooking equipment (e.g., ovens and microwaves) should be used as instructed in the manufacturer's guide and should be maintained and cleaned (NNC 1999). Internal cooking temperatures should reach and sustain the safe minimum as recommended in Table 1 and should be checked with the appropriate

food thermometer in accordance with these latest USDA guidelines.

Keeping It Clean

High-risk sources of cross-contamination in the kitchen include hands and food-contact surfaces such as cutting boards and counter tops (NNC 1999). It is very important to adequately wash hands with warm, soapy water and a sanitizing solution before handling food, before eating, after using the restroom, after handling a pet or child, and after contact with raw meat or other high-risk food items. The use of a dishwasher has been found to be more effective in reducing contamination of cutting boards and flatware than by washing by hand (NNC 1999).

Resources for Educators

Healthy People 2020, an initiative set forth by the US Department of Health and Human Services (HHS), has already begun to outline objectives that will improve these food safety practices among consumers (DOH 2011). These objectives (Figure 1) aim to increase the number of people who wash hands and food contact surfaces (CLEAN), do not cross contaminate (SEPARATE), cook to adequate temperatures (COOK), and refrigerate promptly (CHILL). Thus, adequate hygiene factors are the basis of many educational and assistance programs aimed at improving food safety in home kitchen settings. Each of these food-safety goals can be traced back to the general conclusion that prevention of foodborne illness occurs through proper food preparation and sanitation techniques (Collins 1997).



Figure 1. CLEAN-SEPARATE-COOK-CHILL / LIMPIAR-SEPARAR-COCINAR-ENFRIAR

Credits: <http://www.healthypeople.gov/>

The Partnership for Food Safety Education is a non-profit organization that works to eliminate illness and death from foodborne disease through various educational campaigns. It was established in 1997 in response to a need for increased awareness of food safety among consumers (especially among at-risk populations including pregnant

women, young children, the elderly, and the immuno-compromised). Food-safety education campaigns such as “Fight BAC!” and “Be Food Safe” provide information on potential causes and associated costs of foodborne illness and promote lifestyle changes in accordance with preventative guidelines (The Partnership for Food Safety 2011).

Another newly established campaign that began in 2011 is *Food Safe Families*. It is a collaboration between the USDA’s Food Safety Inspection Service (FSIS), the US Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC). Its aim is to raise awareness about foodborne illness and encourage consumers to make lifestyle changes that lower their risk of contracting foodborne illness and practice safe food-handling techniques. The target audiences are English- and Spanish-speaking families who cook at least four times a week (USDA-FSIS 2011).

Closing Remarks

Although food-safety education is well established, people continue to be affected by foodborne illnesses associated with unsafe food handling at home. Many individuals just might not be aware of the potential risks associated with certain food-handling practices. Additionally, individuals with adequate knowledge of food-safety practices might not always apply these standards in home-kitchen settings. Because of these risks, *Healthy People 2020* seeks to educate consumers about foodborne illness in a manner that promotes harm-reducing lifestyle changes (DOH 2011).

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Table 1. Safe Minimum Cooking Temperatures Chart

Category	Food	Temperature (°F)/Cooking Instructions	Rest Time
Ground meat & meat mixtures	Beef, pork, veal, lamb	160	None
	Turkey, chicken	165	None
Whole cuts of beef/veal/lamb	Steaks, roasts, chops	145	3 minutes
Whole cuts of poultry	Chicken & turkey, whole	165	None
	Poultry breasts, roasts	165	None
	Poultry thighs, legs, wings	165	None
	Duck & goose	165	None
	Stuffing (cooked alone or in bird)	165	None
Whole cuts of pork	Fresh pork chops, loin	145	3 minutes
	Fresh ham (raw)	145	3 minutes
	Precooked ham (to reheat)	140	None
Eggs & egg dishes	Eggs	Cook until yolk and white are firm.	None
	Egg dishes	160	None
Leftovers & casseroles	Leftovers	165	None
	Casseroles	165	None
Seafood	Fin fish	145 or cook until flesh is opaque and separates easily with a fork.	None
	Shrimp, lobster, and crabs	Cook until flesh is pearly and opaque.	None
	Clams, oysters, and mussels	Cook until shells open during cooking.	None
	Scallops	Cook until flesh is milky white or opaque and firm.	None

Source: Keep Food Safe (<http://www.foodsafety.gov/keep/charts/mintemp.html>)

Safe Handling of Food and Water in a Hurricane or Related Disaster¹

Ronald H. Schmidt, Keith L. Schneider, Renée Goodrich, Amarat Simonne, and Douglas L. Archer²

The following is a summary of general recommendations to protect the safety of food and water in the event of a hurricane, flooding, or related natural disaster. These recommendations have been adapted from those developed under *National Recommendations for Disaster Food Handling*, a multi-state grant involving Cooperative Extension collaborators from Tennessee, Florida, and Missouri as well as the American Red Cross and Tennessee Department of Agriculture. Recommendations have also been included from additional up-to-date sources such as the: Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA), Food and Drug Administration (FDA), Florida Department of Agriculture and Consumer Services (DOACS), Florida Department of Health (DOH), Federal Emergency Management Agency (FEMA), and American Red Cross.

Emergency Preparation (Before the Storm)

Have a Plan

As hurricane season approaches, a written plan should be developed for your household. The plan should be reviewed frequently with all members of the household.

What to Include in the Plan

At a minimum, the plan should include the following:

1. ESSENTIAL ITEM CHECK LIST

Make a list of items considered essential in the event of evacuation (e.g., special medications, foods for those on special diet), and collect these items in one location.

2. ADEQUATE CONTAINERS, UTENSILS, AND PAPER GOODS

Collect several food grade containers for storing water and food. To make potential evacuation more efficient, these containers should be light weight and easy to carry. Collapsible water containers are available through camping supply stores. Maintain a supply of disposable utensils (e.g., forks, knives, spoons, cups), as well as a manual can opener. Finally, maintain an adequate supply of paper goods (e.g., paper towels, toilet paper). As the supply of clean water may be limited following an evacuation, it is recommended that a supply of sanitary hand wipes be purchased. While these hand wipes do not replace hand washing, they can be used in addition to hand washing.

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3. DISASTER SUPPLY KIT

Assemble a “kit” (to fit in the trunk of your vehicle) which includes nonperishable food and water (for a minimum of 24 hours) and other disaster supplies. This disaster supply kit should be updated annually.

4. REFRIGERATOR AND FREEZER

Organize and prepare the refrigerator and freezer (where time allows) as follows:

- A thermometer should be maintained in the refrigerator at all times and the temperature should be held at 41°F (5°C) or less. However, in preparation for a possible power outage, it is recommended that the temperature controls be set colder than normal;
- Clean the refrigerator and freezer, and examine the gaskets, replacing those that are worn
- Discard old or unnecessary items;
- Take an inventory of food items and post the inventory list in an accessible location;
- Organize the freezer compartment by grouping meat and poultry on one side or on separate trays so that, in the event of thawing, their juices will not contaminate each other or other foods; and
- If the freezer is not full, fill and freeze containers of water to fill the space. This will slow down the temperature increase in the event of a power failure.

5. WATER SUPPLIES

Evaluate the water needs of your family. It is recommended that you maintain at least a two-day supply of water. Allow a sufficient quantity per day for drinking (1 gallon/person), food preparation (one half gallon/person), and hygiene (one half gallon/person). In hot weather, allow more water for drinking (2 gallons/day). Commercially bottled water is best if available. If you do not have commercially bottled water, other sources of emergency water may be used.

Assess and make a list of potential emergency water supplies available to your household. Some recommendations suggest filling bathtubs with water as a source of water (for non-drinking purposes). Be sure the tub is cleaned thoroughly prior to filling. The toilet tank may also be used as a source of water. These water sources may be used for bathing or shaving without purification provided that care is taken not to swallow the water. However, if water stored in either of these places is to be used for drinking, hand washing, washing fruits and vegetables, dish washing, or cooking, it should be purified (or sanitized) using a recommended procedure as described later (see the section

“Water Handling”). In preparation, the following should be purchased and maintained on hand:

- Commercially bottled water (several bottles); and
- Non-scented liquid chlorine bleach (several bottles).

6. FOOD SUPPLIES

A sufficient quantity of shelf-stable, non-perishable foods should be maintained on hand. Recommendations include:

- Canned foods such as: vegetables, soups, condensed milk, canned meat, canned fruit and fruit juices, and nuts;
- Dry foods such as: powdered milk, dried fruit, pasta, rice, instant coffee and tea, cocoa, and crackers;
- Potatoes and other shelf-stable vegetables;
- Ready-to-eat cereals;
- Soft drinks; and
- Other easy-to-prepare or ready-to-eat foods.

A variety of freeze dried food items are also available at camping supply stores. These stores may also stock “self-cooking” food items and other innovations.

It is important that family members maintain their strength during and after the storm. Therefore, be sure to consider nutrition as well as likes and dislikes of family members (especially children) when stocking up on food.

7. DRY ICE

It is recommended that you locate the supplier of dry ice in your area. Dry ice is not available in all locations.

Evacuation

If evacuation is required, follow instructions from local agencies and evacuate to the designated evacuation site. Take essential items with you.

Assessing In-Home Damage and Needs (After the Storm)

The following is a list of recommended areas to consider when assessing damage and emergency needs, either following the storm or when returning home from an evacuation:

Structural and Related Damage

1. ELECTRICAL AND STRUCTURAL SYSTEMS

Use care in examining these services and systems for damage. Consult a professional as needed.

2. FLOODING OR RAIN INTRUSION

If flooding has occurred, inspect the area for hazardous chemical containers that may have been buried, been moved, or have leaked. Flooding may also carry silt, raw sewage, oil, and other chemicals into your house. Leaking from structural damage to the roof may also cause contamination of food and food contact surfaces.

3. WATER SUPPLY AND PLUMBING

Examine (or have a professional examine) your plumbing for damage. Consult local authorities regarding the potential safety of the water supply or have the water supply tested (especially wells, cisterns, or springs) for safe use. If the municipal water supply is considered contaminated or at risk, the local Health Department will usually issue a *Boil Water Advisory* via the news media.

Emergency Provisions

1. EMERGENCY WATER

Examine your emergency water supplies to be sure that they have not become contaminated. Any water from these emergency sources should be decontaminated or purified using one of the procedures described in the “Water Handling” section.

2. FOOD

Assess whether any food items have become contaminated or whether perishable foods have been held at an unsafe temperature due to a power outage. See the “Food Handling” section below for further procedures.

3. FOOD UTENSILS AND OTHER NON-FOOD ITEMS

Assess whether there has been contamination of food utensils, paper or plastic items, medicines, or any other items which will come in contact with food or the mouth.

Emergency Procedures

Water Handling

If the water supply is contaminated, or if you are under a *Boil Water Advisory*, all water to be used for drinking, hand washing, washing fruits and vegetables, dish washing, or cooking, must be purified (e.g., disinfected or sanitized). Certain precautions must be taken when handling water. They are outlined below.

PURIFYING WATER

The most common methods for purifying water include: boiling, using commercially available purification kits, or

using common household chemicals. If performed according to recommended procedures and conditions, these water purification methods adequately remove unwanted infectious bacteria or other biological contaminants from most water. It should be noted, however, that none of these methods will purify water that is contaminated with hazardous chemicals. In addition, presence of suspended soils and other contaminants in water decrease the effectiveness of water purification or disinfection. Prior to purification, water with suspended soils should be allowed to sit for sufficient time to allow settling of the impurities. It should then be decanted, and filtered through several layers of cloth or paper towels. If the water is cloudy after these treatments, longer boiling times or high chemical concentrations are usually recommended.

The recommended water purification procedures are as follows:

1. Boiling

This is a relatively easy water purification technique to perform. However, this option may not be available when the power is out. If boiling is used, the water should be brought to a rolling boil for at least one (1) minute and allowed to cool before dispensing into a clean, sanitized, tightly capped container. Water that is cloudy should be boiled longer (3-5 minutes). If your area is under a *Boil Water Advisory*, follow the health department’s recommendations, which may involve longer boiling times if more heat resistant parasites and certain protozoa (e.g., *Giardia*, *Cryptosporidium*) are suspected as contaminants. In general, boiling is more effective at killing these pathogens than most chemical methods.

2. Water purification kits

Commercial water purification kits are available from pharmacies, and camping and outdoor supply stores. These range from chemical disinfectants (liquid or pellets) to water filtration devices. These kits are generally designed for small quantities of water and, thus, may not be practical for large quantities. If a purification kit is used, closely follow the recommended procedures on the label.

3. Water purification using common household chemicals

The most common chemical water purification in the home is done with either chlorine bleach or iodine. If used properly, the water will not be toxic after the use of these chemicals, but may have an odor or taste.

A. Household chemicals used

1. **Chlorine Bleach.** There are many different types of bleach on the market. Read the label to be sure that sodium hypochlorite is the only active ingredient. Do not use bleach solutions that contain detergents or other chemical components (e.g., scented bleach). If the container has a label warning “not for personal use” it should not be used. Fresh, unopened, liquid laundry bleach contains 5.25% sodium hypochlorite. However, a bottle of bleach which has been open for an extended period of time may lose some of its strength, especially if the container is only partially full.
2. **Iodine.** Iodine tablets and liquid iodine (*Tincture of Iodine*) can also be used to purify water. Again, read the label for recommended procedures. *Tincture of Iodine* usually contains 2.0% U.S.P. iodine. However, there is some variation in this product. In general, iodine has the disadvantage (compared to chlorine) in that it is not as effective over a wide range of pathogens and it imparts taste and a brown tint to the water. Thus, it should be used only when chlorine is not available.

B. Purification Procedure

1. Add the recommended level of the chemical (Table 1) using a clean, uncontaminated medicine dropper or suitable utensil. The following conversions may be helpful in determining the correct amount:
 - 8 drops = 1/8 teaspoon
 - 16 drops = 1/4 teaspoon
 - 32 drops = 1/2 teaspoon
 - 64 drops = 1 teaspoon
 - 192 drops = 1 tablespoon
 - 384 drops = 2 tablespoons (1/8 cup)
2. Stir the chemical thoroughly into the water. If the water does not have a faint chemical smell after the 30 minute waiting period, add another dose and let it sit for an additional 15 minutes.
3. Allow the water to stand for 30 minutes. If the water is cloudy, repeat the procedure.
4. Dispense into a clean, sanitized, and tightly capped container, which has been appropriately labeled to indicate its contents.

STORING WATER

Conserve water as much as possible and handle purified water with care. It defeats the purpose of purification to allow the water to be re-contaminated. If stored in a tight container in a cool, dry, dark place, both commercially bottled and purified water are safe for an indefinite time period. However, once opened, it should be used within 2-3 days (or re-purified). Do not store water in direct sunlight, and do not store it next to gasoline, kerosene, pesticides, or similar substances. To improve the taste of stored water, pour it back and forth between two clean containers several times to aerate it prior to use.

Ice Handling

Freezing does not purify water and just because it is cold does not mean that ice is safe. Therefore, unless there is absolute certainty that ice is free of contamination, it should not be used for drinks, or be in direct contact with food. Any potentially contaminated ice that is melted and used, should be purified as described above.

Dry Ice Handling

If available, dry ice can be used to maintain frozen foods in the event of a power outage. Use approximately twenty five (25) pounds of dry ice per ten (10) cubic foot of freezer or chest space. The following precautions should be observed when using dry ice:

- Dry ice is much colder than any freezer; it will instantaneously freeze skin. Avoid contact with skin. Use gloves or cloths to prevent skin contact;
- Only use dry ice in rooms with adequate ventilation, as dry ice emits carbon dioxide gas when thawing. If used in a confined freezer compartment, do not cover vent openings; and
- Do not eat dry ice. It is not for consumption.

Food Handling

WHAT TO DISCARD

Carefully evaluate which food to discard. Remember to follow these two adages: *it is better to be safe than sorry* and *when in doubt, throw it out*. Discard all food products that may have come in direct contact with flood-waters, may have otherwise become contaminated, or may have been stored at an unsafe temperature.

FOLLOW GOOD SANITATION PROCEDURES

When handling food, use appropriate precautions so as not to contaminate the food. This includes washing your hands

(using clean, purified water) before handling food, and preventing cross contamination of food by avoiding contaminated surfaces or objects. In extreme conditions where the purified or potable water supply is strictly limited, the hands may be washed in non-potable water followed by the use of a hand sanitizer or hand sanitizer wipe in accordance with label recommendations.

RECOMMENDED ORDER OF FOOD USAGE

In general, if there has been a power outage, it is recommended that perishable foods from the refrigerator or pantry be used first. Then use the foods from the freezer, followed by non-perishable food supplies. The following guideline can be used to estimate the approximate time that food may be held at appropriate cold temperatures in:

- **Refrigerator:** if kept closed, approximately 4 hours;
- **Full freezer:** if kept closed, approximately 48 hours;
- **Half full freezer:** if kept closed, approximately 24 hours; and
- **Dry ice:** 2 to 3 days.

HOW TO HANDLE SPECIFIC FOOD CATEGORIES

1. Fresh fruits and vegetables

If exposed to flood waters, all fresh fruits and vegetables, garden produce, and related fresh foods should be discarded. If contaminated, these foods cannot be adequately cleaned and sanitized.

2. Refrigerated food

In general, if there is a power outage, a well insulated freezer or refrigerator will maintain refrigeration or freezing temperatures for several hours, provided that the door is kept closed and only opened as often as necessary. However, it is recommended that you monitor the temperature of the refrigerator periodically. Remember that you cannot rely on appearance or odor to determine whether a food will make you sick. Your only indication of safety is temperature control. If the refrigerator temperature has risen above 41°F (5°C) for two (2) hours or more, discard all perishable foods. If you are returning to the house after an evacuation of several days and the refrigerator is above 41°F (5°C) upon your return, discard perishable foods, as you have no indication of the length of time the food has been at an unsafe temperature. A partial list of foods, normally found in a home refrigerator, have been categorized as perishable vs. more stable, less perishable in Table 2.

3. Frozen food

Examine frozen food for evidence of thawing. This should be done with care. As above, the rule of thumb of food safety is that food not be above 41°F (5°C) for 2 hours or more. This also applies to frozen foods. Thus, just because the food has thawed does not mean it is unsafe. It is the total time and temperature that it is held at in the unfrozen state. If upon returning from an evacuation, the temperature of the freezer is at 41°F (5°C) or above, and all food has thoroughly thawed, simply discard the food unless you have an accurate indication of how long the food had been under these conditions. However, food that has been thawed and refrozen, due to the power cycling off and on over an extended time period, is more difficult to assess for damage given its time and temperature history. Thus, if you have reason to suspect that the food has been thawed and refrozen over an extended time period, the safest plan is to discard it. If you have reasonable certainty that the temperature in the freezer had not been above 41°F (5°C) for 2 hours or more, the following recommendations can be followed:

- A. **Partially frozen food** (with ice crystals in the center) should be safe. In addition, such food that contains ice crystals may be refrozen (when the power comes back on) without concern.
- B. **Fully thawed food** (no ice crystals) can be consumed, provided that it has not been held for 2 hours or more at 41°F (5°C). Such thawed food may be cooked, then refrozen, provided that it has been held at 41°F (5°C) or less for no more than two (2) days.

4. Commercially canned and bottled foods

- A. **Risk of food contamination.** In the event of a flood, canned foods and beverages in metal (including pull top cans) or glass containers run the risk of becoming contaminated if exposed to flood waters. Use extreme care and discard any screw capped bottles, snap-lid cans, and similar containers which have been exposed to flood waters. To sanitize the outside of metal cans prior to opening, remove the labels and follow one of the following procedures:
- B. **Sanitizing the outside of food containers.** Tightly sealed metal cans with no evidence of bulging, swelling, seeping, or other damage may be safe for use, provided that the outside of the containers are carefully and thoroughly cleaned with a detergent, and sanitized prior to opening.

C. Handling and storage of sanitized containers. Following sanitizing, relabel (using a permanent marker) and store the cans where they will not be recontaminated. As metal cans that have been sanitized may rust, it is imperative that they be used as soon as possible. As an additional precaution, thoroughly cook the food products from these cans.

D. Exposure of containers to hazardous materials. In an urban or industrial environment with extensive flooding, there is increased risk that the outside of the cans have been exposed to hazardous chemicals. In this case, it is recommended that the cans be discarded.

5. Home canned foods

The seals of home canned foods may not be as tight or complete as those on commercially canned food products. Thus, it is generally recommended that if home canned foods have been exposed to flood-waters or otherwise contaminated, they should be discarded.

6. Dehydrated foods (e.g., dry or powdered)

Dry foods which have become wet by contact with flood or rain water should be discarded. Other dry foods, if properly stored to avoid contamination, are generally considered safe.

FOOD DISPOSAL

Food disposal may be done with normal garbage pickup. However, if garbage pickup is delayed for an extended time period, spoiled and deteriorated food will create a nuisance and pest problem. In this situation, the discarded food may be buried in the ground at a depth of at least one foot.

FOOD PREPARATION

The following tips can be used in cooking and preparing foods:

1. Cooking Foods

If the electricity is off, alternative cooking methods may be used (with appropriate caution). Use extreme care when using open flames. Charcoal grills and camp stoves should not be used to cook indoors, but can be used outdoors. Many ready to eat foods (including commercially canned foods) can be eaten without heating or cooking.

2. Water Use in Food Preparation

Use purified water or water from a safe source for washing fruits and vegetables, and for diluting concentrated or powdered food products.

3. Infant Foods

If possible, use canned or prepared baby formula that requires no added water. Use only purified or safe water for diluting concentrated or powdered formula.

Non-food Items Intended for Food or Mouth Contact

Paper and plastic items, and items packaged in plastic cannot be adequately cleaned and sanitized. Therefore, all medicines, cosmetics, baby pacifiers, and baby bottle nipples, which may have become contaminated, should be discarded.

Food Utensils and Food Preparation Areas

1. WHAT TO USE AND WHAT TO DISCARD

Evaluate all food utensils and food preparation areas that may have become contaminated with flood waters. Discard any potentially contaminated paper or plastic utensils (e.g., picnic type), wooden or plastic cutting boards. All other potentially contaminated food utensils (e.g., pots, pans, glasses, dishes) may be used if properly cleaned and sanitized.

2. CLEANING AND SANITIZING FOOD UTENSILS, EQUIPMENT, AND PREPARATION AREAS

Food utensils and equipment that will fit in the sink should be washed thoroughly in detergent solution, rinsed in purified or safe water, and sanitized as follows:

- A. Completely immerse in clean water and bring it to a rolling boil for 1 minute, allow to cool, remove, and air dry prior to use; or
- B. Completely immerse in clean water (room temperature) containing two (2) teaspoons chlorine bleach per quart or three (3) tablespoons chlorine bleach per gallon for 15 minutes, remove, and air dry prior to use.

Food preparation areas, large food preparation equipment, the inside of refrigerators, and all other food contact surfaces should also be cleaned thoroughly and sanitized using a bleach sanitizing solution (as described above).

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Table 1. Recommended concentrations of chlorine bleach or iodine products for water purification.

Volume of Water to Be Purified	Recommended Amount of Chemical		
	Chlorine (bleach) ¹	Iodine Tablets ²	Tincture of Iodine ³
1 quart (1 liter)	4 drops	2 tablets	½ drop
½ gallon (2 liter)	8 drops (1/8 teaspoon)	4 tablets	1 drop
1 gallon (4 liter)	16 drops (¼ teaspoon)	8 tablets	2 drops

¹Fresh, unscented laundry bleach containing 5.25% hypochlorite. If the bleach has been opened for a period of time or is less concentrated, increase the amount added. If the water is cloudy in appearance repeat the procedure.

²Dry iodine tablets.

³Liquid iodine solution. Label concentration of 2.0% iodine. If a tincture of iodine is used with a different stated iodine concentration, the usage level may be calculated as follows: Drops/gal = 80 divided by the % iodine in the concentrated solution.

Table 2. Partial list categorizing refrigerated food stability.

Perishable Foods	More Stable, Less Perishables Food
Baby formula, opened Chicken Cold cuts Custard pies Deli Meats Fresh cut fruits and vegetables Hamburger Leftovers Low fat margarine or spreads Meat Milk Milk Products Poultry Seafood Shredded cheeses Soft cheeses	Beef Jerky Butter/margarine, higher fat Canned fruits Fruit juices Hard cheeses Jam, jellies or preserves made with sugar Ketchup Mayonnaise, commercial Mustard Peanut butter Pickles Steak sauces and related items Sterile shelf milk (Brik Pak) and beverages, unopened Syrups

Preparing and Storing an Emergency Safe Drinking Water Supply¹

Shuchi Shuklaa, Thomas Obreza, and Andrea Albertin²

Introduction

The purpose of this fact sheet is to emphasize the importance of having a personal safe drinking water supply during an emergency and to describe the steps that Florida's citizens should take to prepare and store drinking water.

Why store water?

- Occasionally, Florida is affected by severe weather systems like hurricanes, floods, or other natural disasters. In their wake, people can be left without electric power and/or running water for days or weeks at a time.
- Humans can survive a scarcity of food for weeks but cannot go without water for more than a few days.
- During a natural disaster, normal drinking water supplies can quickly become contaminated without notice.
- The best strategy for an impending emergency is to collect and store a personal safe water supply, which includes water for drinking, food preparation, and personal hygiene.

How much water should be stored?

- If your normal water source becomes unavailable or if you are unsure about its fitness to drink, you will need an alternative clean water supply for drinking, preparing food, and personal hygiene.

- You should store enough clean water to allow each person in the household to use 1 to 1.5 gallons per day. Increase the amount stored if there are children, sick people, and/or nursing mothers in the home. If you have pets, store a quart to a gallon per pet per day, depending on its size.
- You should store a minimum 3-day supply of water. If you have the space for it, consider storing a two-week supply.
- Example: A four-person household requiring 1.5 gallons per person per day for 3 days would need to store $4 \times 1.5 \times 3 = 18$ gallons.

What containers can be used to store water?

- Water should be stored before a disaster occurs, in thoroughly sanitized food-grade plastic or glass containers with tight-fitting lids. Food-grade plastic containers will not transfer harmful chemicals into the water or food they contain. Examples include containers previously used to store beverages, like 2-liter soft drink bottles, juice bottles or containers made specifically to hold drinking water. If you are going to purchase a container to store water, make sure it is labeled food-grade or food-safe.
- To sanitize containers:
 - First, wash the inside and outside of each container with soap and hot water.
 - Next, sanitize containers with a solution of 1 teaspoon of non-scented household bleach per quart of water.

1. This document is SL220, one of a series of the Department of Soil and Water Sciences, UF/IFAS Extension. Original publication date October 2004. Revised February 2010, June 2016, and December 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. Shuchi Shukla, engineer; Thomas Obreza, professor, Department of Soil and Water Sciences; and Andrea Albertin, specialized agent in water resources, Northwest Extension District, UF/IFAS North Florida Research and Education Center; UF/IFAS Extension, Gainesville, FL 32611.

Close the container tightly and shake well, making sure that the bleach solution touches all of the internal surfaces of the container. Let the container sit for 30 seconds and pour the solution out.

- Finally, rinse thoroughly with plain clean water.
- Avoid using milk containers because they can be hard to clean. Bacteria can grow quickly in a milk container, contaminating the water stored in it. However, if there is no alternative, special care should be taken when sanitizing these containers.
- Avoid using bleach containers for drinking water storage because they are not made of food-grade plastic. Water stored in them to use for washing could mistakenly be used for drinking, with serious consequences.

Do I need to disinfect (add chemicals to) the water?

- If your drinking water comes from a public supply, no chemical disinfectant is needed. An exception is if an emergency “boil water” notice has been given, in which case you would need to disinfect the water before storing it (see below).
- Although properly stored public-supply water should have an indefinite shelf life, replace it every 6 to 12 months for best taste.
- If the water you are storing comes from a private well, spring, or other untested source, purify it before storage to kill pathogens (see below).

How should water be stored?

- After containers have been filled with clean water, mark them with the words “Drinking Water” and indicate the date of storage.
- Direct heat and light can slowly damage plastic containers, resulting in eventual leakage, so they should be stored in a dark, cool, and dry place.
- Container caps should be tightly secured.
- Store water away from gasoline, kerosene, pesticides, or similar substances because vapors from these materials can penetrate plastic.
- Water can also be stored in a freezer. Frozen water provides the added benefit of helping to keep frozen food cold for a longer time if power is out for an extended period. Use only plastic containers to store water in a freezer, as glass may not be able to withstand the pressure of expanding ice.

How is water kept safe once a container is opened?

- To minimize exposure to bacteria, open a container just before use and then refrigerate it if power is available. If no refrigeration is available, keep the container up high, away from children and pets.
- Use water from opened containers within 1 to 2 days if possible.

When is disinfection of water necessary?

- If your drinking water comes from a public supply and a “boil water order” has not been issued, you can assume that it is safe to drink.
- If there is any possibility that your water source has been contaminated, do not use it for drinking, preparing food, making ice (if you have electricity), or brushing teeth. If you have any open cuts or wounds, do not use it for bathing.
- Sometimes the appearance of water can be a reason for concern. If water appears murky or has a foul taste or smell, it is likely that it is contaminated. Do not consume this water; use an alternative clean source instead.

How can water be purified (disinfected)?

Boiling Water

Boiling water is the most effective way to destroy potential pathogens, including viruses, bacteria and parasites.

- Water boiled continuously for 3 to 4 minutes can be stored in a suitable container at room temperature.
- Aeration can improve the flat taste of boiled water. Aerate water by transferring water back and forth from one container to another. You can also add a pinch of salt for each quart of boiled water to improve its taste.

Chemical Treatments

Chemical treatments like chlorination and iodine tablets are also popular ways to purify water.

- **Chlorinate** water using basic household bleach (5%–6% sodium hypochlorite) that is unscented and free of any other cleaner or color-safe component. The table below represents the recommended amount of bleach to be used to disinfect water. After mixing in the bleach, let the water stand for 30 minutes. If the water is cloudy after 30 minutes, repeat the chlorination procedure once.

- **Iodine** tablets will eradicate heat-resistant pathogens. Iodine purification is more convenient and faster than chlorination, but it has limitations.

Amount of water	Amount of bleach	
	Clear water	Cloudy water
1 quart	2 drops	4 drops
1 gallon	8 drops	16 drops
5 gallons	½ teaspoon	1 teaspoon

Distillation and Filtration

Distillation and filtration are newer procedures compared with boiling. In these cases, water is treated physically rather than chemically.

- Distillation involves collection of vapor from boiling water followed by condensation back to a liquid. The condensed water does not contain any impurities that may have been in the raw water. The “flat” taste of distilled water can be improved by aerating it.
- Filtration is a simple process where water is passed through a filter to remove impurities. Mechanical filters like strainers and sediment filters are effective in removing debris and some suspended solids.

Reverse Osmosis

- Activated carbon filtration systems combined with reverse osmosis (RO) are effective in removing total dissolved solids (TDS), turbidity, asbestos, lead, and other heavy metals.
- RO filters can remove pathogens of all sizes but are not specifically designed to do so. Do not rely on an RO water treatment system to remove pathogens from contaminated water.

Summary

- Preparing for an emergency requires only a little awareness and effort.
- Storing water prior to an impending disaster is one of the most important things you can do.
- If an emergency situation is imminent, every household should have at least a 3-day supply of drinking water stored.
- Water from public supplies and bottled water are safe to store without purification.
- Water from a well or spring should be purified before storing.
- Containers used to store water must be clean and food-grade.

- The easiest ways to purify water are to boil it or add basic household bleach.

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Protect with Plywood¹

Hal S. Knowles III, Kathleen C. Ruppert, Karla A. Lenfesty, Barbara Haldeman, and Craig Miller²

This publication is part 3 of 6 in the Education + Action = Wind Damage Mitigation series. For the rest of the series, visit http://edis.ifas.ufl.edu/topic_series_wind_damage_mitigation.

Proper storm protection requires time and money. But if you don't have the time to hire a commercial contractor or you need to keep costs low, properly installed plywood shutters can provide reasonable protection for your house.

Because of the temporary nature of plywood shutters, the panel weight, and the installation labor required, we recommend using them as a last resort. See the second publication in this series, *Install Window Shutters* (<http://edis.ifas.ufl.edu/ae411>), to review other options.

Are All Plywood Shutters the Same?

No. There are many ways to install plywood shutters. However, we suggest you use one of two main methods. We recommend using barrel bolt plywood shutters for concrete block homes with windows inset two or more inches from the exterior wall. Overlapping plywood shutters are best for windows inset less than two inches.



Figure 1. Plywood is strongest in the direction of its wood grain.
Credits: Institute for Business & Home Safety

Barrel Bolt Plywood Shutters Needed Materials

- Minimum 7/16-inch-thick plywood (3/4-inch is recommended.)
- 3- or 4-inch barrel bolts
- Drill
- Circular saw

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2. Hal S. Knowles III, associate in, Program for Resource Efficient Communities; Kathleen C. Ruppert, professor emeritus, Program for Resource Efficient Communities; Karla A. Lenfesty, family and consumer sciences agent (retired), UF/IFAS Extension St. Lucie County; Barbara Haldeman, editorial assistant, Program for Resource Efficient Communities; and Craig Miller, associate in, Program for Resource Efficient Communities; UF/IFAS Extension, Gainesville, FL 32611.

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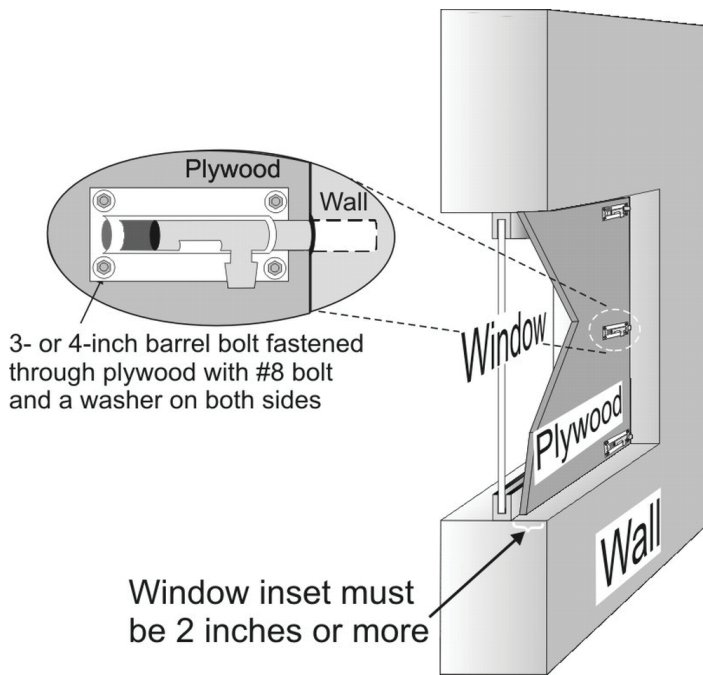


Figure 2. Barrel bolt plywood shutter.
Credits: Barbara Haldeman, UF/IFAS PREC

Basic Installation Directions

Cut the plywood to fit snugly in each window indentation. Connect multiple sheets with 2×4 s or sturdy hinges for large openings. Screw barrel bolts to each plywood shutter, using one bolt for every 12 inches of vertical plywood. Mark the locations for bolt holes in the wall. Label each panel with “Top” and “Bottom” and the window it fits. Drill the holes. Plug the holes when not in use.

Overlapping Plywood Shutters

Needed Materials

- Minimum 7/16-inch-thick plywood (3/4-inch is recommended)
- Nails (less secure) or screws/bolts (more secure) at least 2 inches long
- Lead or stainless-steel sleeve wall anchors (do not use plastic)
- Hammer (for nails) and/or drill (for screws)
- Wood shims (if necessary)
- Circular saw

Basic Installation Directions

Cut the plywood to overlap each window opening by 4 inches or more. Connect multiple sheets with 2×4 s or sturdy hinges for large openings. Drill matching holes through the plywood and the wall. Label each panel with “Top” and “Bottom” and the window it fits. Hammer sleeve

anchors into wall holes. Screw (or bolt) the plywood into the anchors. Plug the holes when not in use.

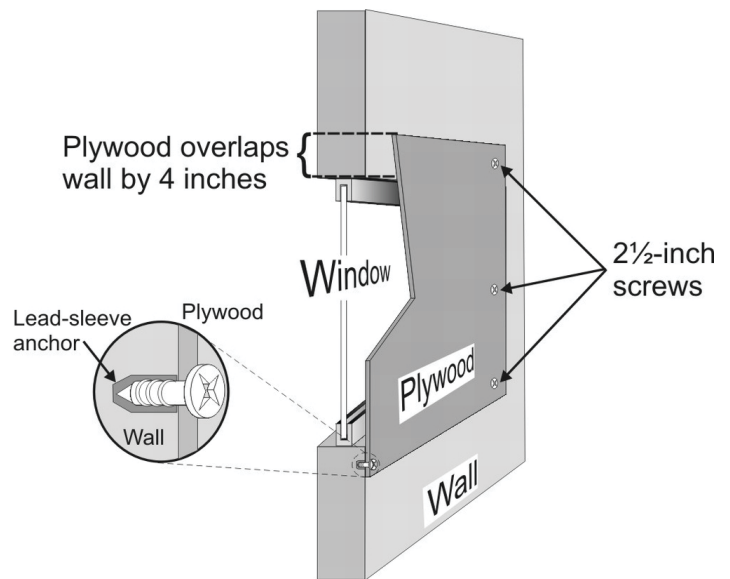


Figure 3. Overlapping plywood shutter.
Credits: Barbara Haldeman, UF/IFAS PREC

Issues to Consider

Avoid Oriented Strand Board

It takes 30% thicker oriented strand board (OSB) to equal the impact strength of plywood. We recommend using plywood.

Plan Ahead

Plywood is cheap, convenient, and available at most hardware stores. However, buy your plywood before a storm approaches. Your local hardware store may run out if you wait until the last minute.

Store Properly

Plywood requires proper storage to prevent wood damage. Florida's hot, humid climate can warp or degrade plywood, making the shutter unusable. It is best to waterproof your plywood shutters with a sealant or paint, and store them in a cool, dry place. Keep the shutter hardware (the bolts and screws) in a labeled container with the shutters. Storing plywood flat may also help prevent warping. Never store wet plywood.

Watch Out for Termites

Choose a storage location that keeps the plywood shutters off the ground. This helps reduce the potential for termite damage.

Label the Shutters

Most homes have a variety of window types and sizes. Clearly mark each of your plywood shutters so you know which window it fits and which side is up. You may consider making a drawing of your house and marking each window on it with a special number to match your shutter labels.

For more detailed, Florida-specific guidelines on a variety of plywood shutter designs, visit the APA (Engineered Wood Association) website.

Other Resources

APA – The Engineered Wood Association: Publications.

Use “hurricane shutters” as a search term, or type “T460” into the search box on the page to download a free copy of the association’s 2013 publication *Hurricane Shutter Design Considerations for Florida*. (Registration may be required; there is no cost to register.) http://www.apawood.org/level_b.cfm?content=pub_main

National Oceanographic and Atmospheric Administration (NOAA), Atlantic Oceanographic and Meteorological Laboratory (AOML): Plywood Hurricane Shutter

Instructions: <http://www.aoml.noaa.gov/hrd/shutters/index2.html>

How Wind Affects Homes¹

Kathleen C. Ruppert, Hal S. Knowles III, Karla A. Lenfesty, and Craig Miller²

This publication is part 6 of 6 of the Education + Action = Wind Damage Mitigation series. For the rest of the series, visit http://edis.ifas.ufl.edu/topic_series_wind_damage_mitigation.

Wind forces are complex. The effect of wind on a building depends on the interaction of many variables. Natural variables include wind speed, wind height, ground surface features, and the properties of the air. Building variables include the shape, location, and physical properties of structures. Together, these variables create differences in pressure that push and pull on the exterior surfaces of buildings.

How Wind Forces Affect Homes

Uplift occurs as wind flows over a roof. Similar to the effect on airplane wings, wind flow under a roof pushes upward while wind flow over a roof pulls upward (Figure 1).

Tilting or sliding occurs when horizontal wind pressures create a shearing action along the foundation (Figure 2).

Overturning, or rotating off the foundation, can also result from shearing action when a structure is unable to tilt or slide off the foundation (Figure 3).

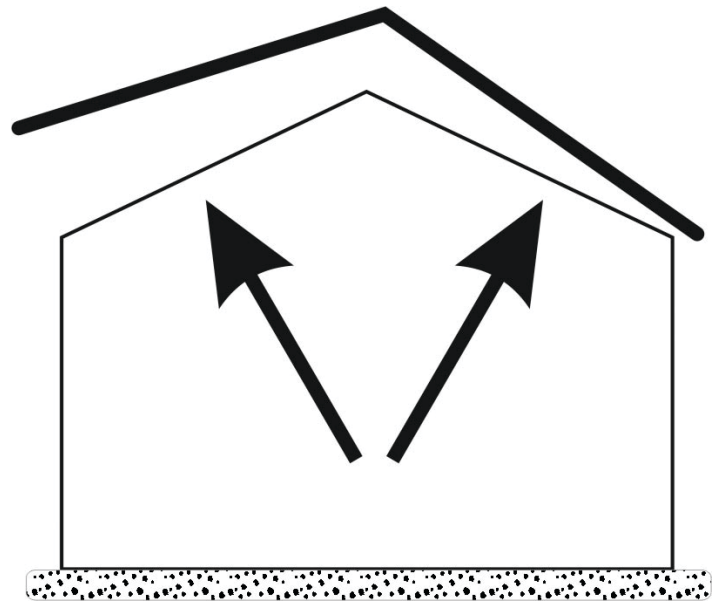


Figure 1. Uplift.

Credits: Barbara Haldeman, UF/IFAS PREC

Only as Strong as the Weakest Link

A safe home is designed to resist these three effects of wind. The exterior surfaces of a home interact to function as the building envelope. Think of this envelope as a protective shield from the outdoor elements such as heat, humidity, and stormy weather. A stronger shield makes for a safer home and more comfortable occupants.

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2. Kathleen C. Ruppert, professor emeritus, Program for Resource Efficient Communities; Hal S. Knowles, III, associate in, Program for Resource Efficient Communities; Karla A. Lenfesty, windstorm damage mitigation program specialist (retired), UF/IFAS Extension St. Lucie County; and Craig Miller, associate in, Program for Resource Efficient Communities; UF/IFAS Extension, Gainesville, FL 32611.

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the *Education + Action = Wind Damage Mitigation* series: http://edis.ifas.ufl.edu/topic_series_wind_damage_mitigation.

How Wind Forces Cause Damage

Wind forces can break the building's load path or punch a hole in the building envelope. Sometimes the actual force of high winds can cause a door or window to break open.

Other times nearby debris can be picked up in the wind and projected against the building envelope. Roof shingles from a neighbor's home, branches from fallen trees, or unsecured yard furniture are examples of potentially dangerous wind-borne debris.

Once wind forces create an opening in the building envelope, the dangers of structural failure greatly increase. Water intrusion is another damaging effect of wind-driven rain.

If your house is in an unobstructed location or within 1,500 feet of open water, you are more susceptible to damages caused by high winds. Proper landscaping may help to shield your home and divert winds around the building.

Hurricane and Tornado Resistance

Check with your local building official to determine the wind speed and wind-borne debris region of your location. Use the protections that will help your home resist the wind speed of your region. It is a good investment to build or renovate beyond minimum code requirements. This may provide additional damage resistance, peace of mind, increased market value, and help you qualify for current or future incentives such as property wind insurance discounts.

- **Fortified... for safer living** is a home certification program of the Institute for Business and Home Safety (IBHS), a research and educational organization of property insurance companies. The "Fortified...for safer living" designation means that a qualified inspector has confirmed the house is designed and built to withstand the perils commonly experienced in the area. Some insurance companies offer premium discounts on wind coverage for certified homes. For more information, visit <https://disastersafety.org/fortified/>
- **Blueprint for Safety** is an educational program of the Federal Alliance for Safe Homes (FLASH), a non-profit, charitable education organization dedicated to promoting home safety. The program offers guidelines and builder

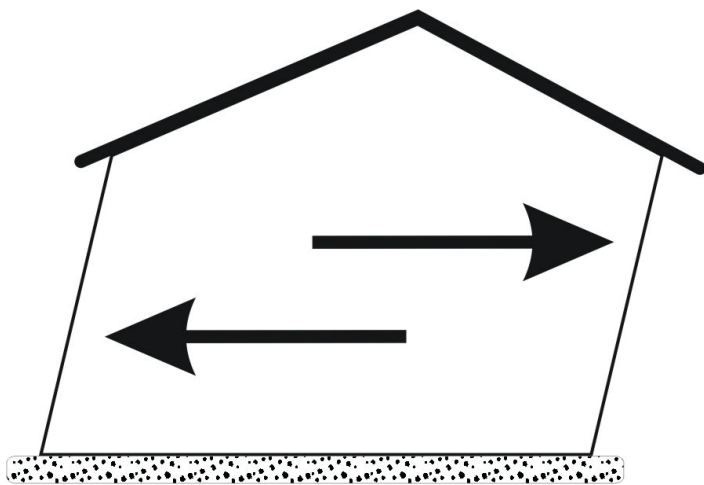


Figure 2. Tilting.

Credits: Barbara Haldeman, UF/IFAS PREC

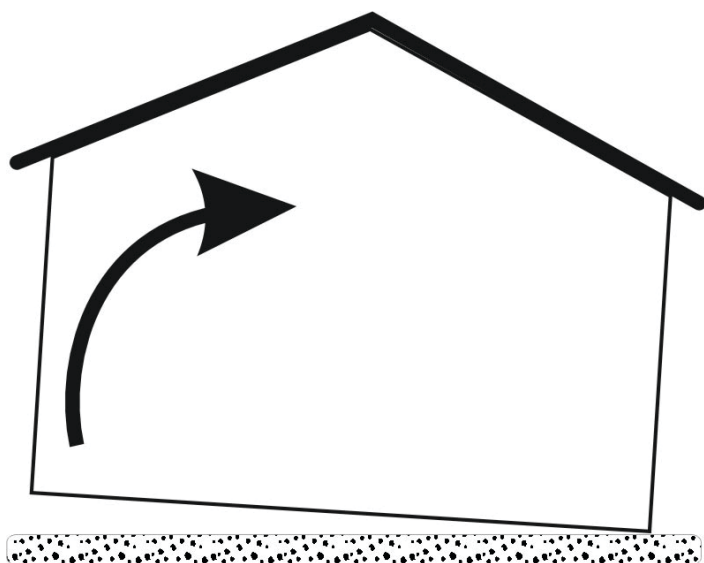


Figure 3. Overturning.

Credits: Barbara Haldeman, UF/IFAS PREC

The structural components of a building envelope are the foundation, walls, and roof. A safe envelope has a continuous load path. This path connects all the structural parts of a building envelope similar to the way the skeleton supports and connects parts of the body.

The non-structural components of a building envelope include windows, doors, garage doors, and other openings in the structural components. These parts protect the inside of a building similar to the way the skin protects internal organs.

The weakest link in the building envelope is the point most likely to fail in a windstorm. When a hurricane or tornado strikes, a home is only as strong as the weakest link.

For more detailed information about wind-resistant building envelopes, please read the other fact sheets in

training designed to provide reliable information about disaster-safety building techniques and features for floods, wildfires, and windstorms. For more information, visit <http://www.blueprintforsafety.org/mission.php> and www.flash.org

Other Resources

Federal Emergency Management Agency Library:
<https://www.fema.gov/resource-document-library>

FloridaDisaster.org: Florida Division of Emergency Management: <http://www.floridadisaster.org/>

Texas Tech University National Wind Institute:
<http://www.depts.ttu.edu/nwi/>

University of Florida: The Disaster Handbook – Master Guide: <http://disaster.ifas.ufl.edu/masterfr.htm>

Hurricane Preparation: Evacuating Your Home¹

Elizabeth Bolton, Muthusami Kumaran, and Angela Lindsey²

Every year Floridians are faced with the possibility of hurricanes. Most years these dreaded storms do not land on our shores and mainland. However, recent hurricanes have had devastating effects on many communities in Florida, and every year the possibility exists that communities will be hit by hurricanes during the summer and fall months.

During the months of potential hurricanes, it is important to plan for the worst and hope that it never happens. For example, you and your family may be asked to leave your home due to some emergency conditions in your community. Your local emergency officials will not ask you to leave your home or location unless there is a valid reason. Do not try and second-guess the validity of their request. Do as they say immediately. Most of the time these requests and related information will come through radio broadcasts, websites, social media, and/or the local TV station. Different warning methods may be used, such as a siren or telephone calls.

Stay tuned and follow the directions and the evacuation routes recommended by the emergency officials. The most important thing to keep in mind is to have a plan for a possible evacuation. Be prepared to evacuate and keep the following suggestions in mind.

1. Know the Route and Follow Directions

Keep a paper map on hand that will enable you to take a route that may be unfamiliar to you. Use caution when using GPS or phone apps as they may not be up-to-date with

emergency information. Be prepared to use routes specified by the emergency officials. Do not use any road or shortcut that they do not recommend. Some areas familiar to you may no longer be accessible, or they may be dangerous for reasons unknown to you.

2. Local Authorities Will Tell You What to Do

Stay up to date with information from local authorities. They have contact with the state or federal authorities and will know which route to take and what local conditions might be. If you follow their instructions, you are more likely to arrive in a safe location and to be able to communicate with your family members or friends.

3. Keep Your Vehicle's Tank Filled

Gas stations may be closed during a hurricane and prior to its arrival. In addition, long lines may develop and stations may run out of gas quickly. During power outages, fuel pumps at gas stations may not work. Prepare for the hurricane by filling your tank well in advance of the storm.

4. One Vehicle per Household

If it is necessary to evacuate, plan to take one vehicle per household. This will keep family members together and reduce the number of cars on your particular evacuation route.

1. This document is FCS3254, one of a series of the Department of Family, Youth and Community Sciences, UF/IFAS Extension. Original publication date June 2005. Revised May 2015 and June 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. Elizabeth Bolton, professor emerita; Muthusami Kumaran, associate professor; Angela Lindsey, assistant professor, Department of Family, Youth, and Community Sciences; UF/IFAS Extension, Gainesville, FL 32611.

5. Power Lines

Do not go near power lines, especially if they are broken or down.

6. Clothing

Wear clothing that protects you as much as possible. Even though it is not cold during hurricane season, wear long sleeves and long pants. Wear sturdy shoes that will be suitable for walking, which you may or may not have to do. Take along a hat that can be used to shelter you from the sun.

7. Disaster Kit

Take your disaster kit with the supplies you will need. The kit should include items such as a battery-powered radio, extra batteries, food, water, medications, and clothing. Make plans to have enough supplies for at least three days and more if possible.

8. Phone

Bring your cellular phone and necessary chargers. Be sure to bring battery powered chargers in case there is no electricity. .

9. Prepare Your Home before Leaving

- Lock all doors and windows
- Turn off the water. You should know how to use the tools needed to do this, typically an adjustable pipe wrench and a crescent wrench.
- If you have food in a home freezer, your local officials will advise you as to whether or not to turn off electricity. You may lose power in which case the food will not keep for very long.
- Leave your natural gas on unless you are instructed to turn it off. You may need gas for heating or cooking and only a professional can turn it on once it has been turned off. In times of emergency, it may take days or weeks to get a professional to your home to turn on your gas once it has been turned off.

10. Family Communications

If you have time, call your family and friends. In any event, leave a note as to the route you are taking and your destination. Put your emergency communications plan into effect as follows.

- Choose an out of town contact your family or household members will call or email to check on each other should a disaster occur. Your selected contact should live far enough away that they would be unlikely to be directly affected by the same event, and they should know they are the chosen contact.
- Make sure household members have each other's contact information, including e-mail addresses and telephone numbers (home, work, and cell). Leave these contact numbers at your workplace, and if you have children, at your children's school.
- Your family should know that if telephones are not working, they need to be patient and try again later or try e-mail or social media messaging. Families should pre-determine 2–3 social media platforms they will use to try and communicate. Many social media platforms have messaging tools that work when other forms of communication do not work.

11. Emergency Shelters

Know in advance where the emergency shelters are located in your vicinity. If there is more than one in your vicinity, know all the locations. The steps you should take in preparing for shelter depends on the type of emergency situation that results from a weather-related disaster. For example, during a tornado you should go to an underground room if it is available. During a hurricane, go to the most well fortified building in your location. These emergency shelters are usually announced well ahead of a hurricane warning.

12. Shelter in Place

If your emergency officials tell you to “shelter in place,” this means that you should remain inside your home or office and protect yourself there.

- Close and lock all windows and exterior doors.
- Turn off all fans, heating, and air conditioning systems.
- Close the fireplace damper.
- Get your disaster kit and make sure your radio is working.
- Go to an interior room without windows that is above ground level.
- Keep listening to your radio or television until you are told all is safe or that you are to evacuate. The length of your stay can range from a few hours to two weeks. During this time you should maintain a 24-hour communications and safety watch. Take turns with family in listening for radio broadcasts.

- Assemble an emergency toilet, if necessary. Use a garbage container, pail, or bucket with a snug-fitting cover. If the container is small, use a larger container with a cover for waste disposal. Line both containers with plastic bags. After each use, pour or sprinkle a small amount of a regular household disinfectant, such as chlorine bleach, into the container to reduce odor or germs.

13. Predetermined Meeting Place

Have a predetermined destination for meeting your family in the event you are separated from them. This will save time and anxiety as well as minimize the confusion if you are told to evacuate. Have some prior arrangements with friends or family who may provide temporary shelter in case of emergency.

14. Children at School

Have a plan for who is to pick up the children from school or how they will be taken care of and by whom.

15. Animals and Pets

Have a plan for caring for animals in the event of an emergency evacuation. Make plans for where they will be sheltered.

Many shelters are pet friendly, but have strict guidelines regarding vaccination records and supplies needed for pets. Be sure to know guidelines when preparing your pet to go to a shelter.

These preparations can help ensure safety and peace of mind if a weather emergency occurs. Be aware that location-specific information will vary greatly even with the

state or county. Become aware of conditions or situations in your area that would be important during a weather emergency.

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<https://floridadisaster.org/family-plan/>

Handbook of Florida Fence and Property Law: Trees and Landowner Responsibility¹

Michael T. Olexa and Jeffery W. Van Treese II²

Preface

With approximately 19,000 livestock farms in the state, along with horse farms; orange groves; croplands of soybeans, sugarcane, cotton, and peanuts; and many other agricultural and livestock facilities, livestock and farming have a significant impact on Florida's economy. Florida's agricultural economy has been required to co-exist with rapid population and commercial growth in the state over the last twenty-five years. Conflicts between these interests bring to prominence issues such as the rights and responsibilities of adjoining landowners, farmers, and property owners in general. Due to the added importance placed on these areas of real property, the legal aspects of fences in the state of Florida have taken on significant importance.

This handbook is designed to inform property owners of their rights and responsibilities in terms of their duty to fence. Discussed areas include a property owner's responsibility to fence when livestock is kept on the property, the rights of adjoining landowners to fence, the placement of fences, encroachments, boundary lines, easements, contracts, nuisances, and a landowner's responsibilities towards persons who enter his or her property.

This handbook is intended to provide a basic overview of the many rights and responsibilities that farmers

and farmland owners have under Florida's fencing and property law. Readers may value this handbook because it informs them about these rights and responsibilities. However, the reader should be aware that because the laws, administrative rulings, and court decisions on which this handbook is based are subject to constant revision, portions of this handbook could become outdated at any time. This handbook should not be viewed as a comprehensive guide to fencing and property laws. Additionally, many details of cited laws are left out due to space limitations. This handbook should not be seen as a statement of legal opinion or advice by the authors on any of the legal issues discussed within. This handbook is not a replacement for personal legal advice, but is only a guide to inform the public on issues relating to fencing and property laws in Florida. For these reasons, the use of these materials by any person constitutes an agreement to hold the authors, the Institute of Food and Agricultural Sciences, the Center for Agricultural and Natural Resource Law, and the University of Florida harmless for any liability claims, damages, or expenses that may be incurred by any person as a result of reference to or reliance on the information contained in this book.

1. This is EDIS document FE962, a publication of the Food and Resource Economics Department, UF/IFAS Extension. This information is included in the Handbook of Florida Fence and Property Law, Circular 1242. Published November 1999; revised December 2006, August 2010, November 2014, and July 2018. Eugene E. Shuey, certified real estate attorney; and Patrick H. Todd, law student, Levin College of Law, University of Florida, contributed to previous versions of this publication. Please visit the EDIS website at <http://edis.ifas.ufl.edu>.
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Readers wishing to find further information from the Florida Statutes may access those statutes online at <http://www.leg.state.fl.us/STATUTES/>.

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Landowner Responsibilities for Trees

What is the rule for the removal of a healthy tree on boundary line?

The removal of a tree on the boundary by one landowner without the consent or authorization of the adjoining landowner may result in liability for “reduction in value of the land resulting from removal of the tree” as well as for the “loss of the ornamental value and creature comforts provided by the tree” (*Elowsky v. Gulf Power Company*, 172 So. 2d 643, 645 [Fla. 1st DCA 1965]).

In *Elowsky v. Gulf Power Company*, a tree was located on the boundary line between the properties of the plaintiff and the defendant (*Id.* 644). The plaintiff was a police officer who worked night shifts and regularly had to sleep during the day (*Id.*). The tree shaded and cooled the bedroom during the afternoon (*Id.*). The defendant removed the tree, and the plaintiff had trouble sleeping after its removal (*Id.*). The jury awarded the plaintiff \$500 in damages (*Id.*). The First District upheld the verdict and stated:

An owner of real estate has a right to enjoy it according to his own taste and wishes, and the arrangement of buildings, shade trees, fruit trees, and the like may be very important to him, may be the result of large expense, and the modification thereof may be an injury to his convenience and comfort in the use of his premises which fairly ought to be substantially compensated, and yet the arrangement so selected by him might be no considerable enhancement of the sale value of the premises, it might not meet the taste of others, and the disturbance of that arrangement, therefore, might not impair the general market value (*Id.* 645).

What is the liability for over-hanging branches and encroaching roots?

Branches and roots frequently extend across property lines. Whether a branch or root from a tree on an adjacent landowner's property is the responsibility of the landowner with the tree located on his or her property or the

landowner of the property to which the branches overhang or roots encroach depends upon the branches or roots themselves. If the branches or roots are healthy, then the landowner with the tree located on his or her property is not liable for damage caused by the branches or roots. The adjoining landowner may, at his or her own expense, trim back the branches or roots as he or she desires up to the property line. If the branches are dead, however, then the landowner with the tree located on his or her property may be responsible and could be liable for damages caused by the branches (1 Fla. Jur 2d Adjoining Landowners section 8 [2014]).

In *Scott v. McCarty*, a property owner brought action against a neighbor alleging that overhanging branches and roots from the neighbor's tree caused damage to his property (41 So.3d 989, 989 [Fla. 4th DCA 2010]). The Court affirmed the trial court's dismissal with prejudice of appellant's complaint for damages based upon *Gallo v. Heller*, 512 So. 2d 215, 216 (Fla. 3d DCA 1987), which explained the common law rule:

[A] possessor of land is not liable to persons outside the land for a nuisance resulting from trees and natural vegetation growing on the land. The adjoining property owner to such a nuisance, however, is privileged to trim back, at the adjoining owner's own expense, any encroaching tree roots or branches and other vegetation which has grown onto his property.

Scott, 41 So. 3d at 989 (quoting *Gallo*, 512 So. 2d at 216) (alterations in original).

The *Scott* court prescribes the adjoining property owner engage in self-help to combat encroaching vegetation by suggesting the landowner resort to trimming. By doing so, this leaves an open question as to what other methods of self-help are available. It is not clear whether the adjoining property owner may spray encroaching vegetation with herbicide such as glyphosate, which could translocate and kill the entire plant. Alternatively, the adjoining property owner may wish to use a stump grinder to destroy roots that have encroached onto his/her property. It is not clear whether these or other self-help methods are permitted and whether employing them would create a cause of action against by the encroaching landowner against the encroached landowner.

Which landowner is responsible for dead or live trees falling on adjoining property?

The health of the tree may determine which landowner is responsible for damages to property. A secondary source called “Florida Jurisprudence” provides that where a dead tree falls on an adjoining property and damages that property owner’s home, the landowner who owns the property where the tree originally was located is responsible for damages (1 Fla. Jur 2d Adjoining Landowners section 8 [2014]). Alternatively, Florida Jurisprudence provides that where a live tree falls on an adjoining property and damages that property owner’s home, the adjoining property landowner is responsible for damages. Put another way, consider Landowner A (property owner of tree) and Landowner B (adjoining landowner). If Landowner A’s dead tree falls on Landowner B’s property, Landowner A is responsible for damages. Conversely, if Landowner A’s living/live tree falls on Landowner B’s property, Landowner B is responsible for damages.

However, there is no case law discussing the live/dead tree distinction discussed in Florida Jurisprudence. Florida Jurisprudence is not binding authority and a court may disregard it when adjudicating a case. Under a negligence theory, one could argue that a dead tree is a hazard that could cause foreseeable damage to a neighboring property. In other words, it is foreseeable that a dead tree will fail (especially during a storm), which creates a common law duty of care to remove the dead tree in order to prevent damage to neighboring property. Under this theory, the duty to remove trees may not be limited to dead trees, but may also include live trees with a high risk of failure such as trees with co-dominant leaders and girdling roots. As of this writing, there is no case law on point discussing the duty owed by landowners to remove dead/hazardous trees to prevent damage to neighboring landowners. It will be up to future courts to decide this point.

Summary

A landowner is not liable to the adjoining property owner for an alleged nuisance caused by overhanging branches and roots from a tree on his or her property; however, the adjoining property owner is legally entitled to trim back, at the adjoining owner’s own expense and only up to the property line, any encroaching tree roots or branches and other vegetation that had grown onto his or her property. If the branches or roots are dead, or a dead tree falls onto the adjoining landowner’s property, then the landowner of the property where the tree was originally located may be responsible. If a live tree falls onto the adjoining

landowner’s property, then the adjoining landowner is responsible for any damages.

Further Information

Circular 1242, Handbook of Florida Fence and Property Law http://edis.ifas.ufl.edu/TOPIC_BOOK_Florida_Fence_and_Property_Law

Hurricane Impacts on Florida's Agriculture and Natural Resources¹

Young Gu Her, Ashley Smyth, Pamela Fletcher, Elias Bassil, Ulrich Stingl, Zachary Brym, and Jiangxiao Qiu²

Introduction

Hurricanes are capable of affecting almost everything in their paths. Their strong winds and heavy rains can directly impact both inland and coastal areas in short periods that usually last about a day. Understanding the effects of hurricanes is the first step to preparing for these weather events. Hurricanes can have extensive and potentially permanent effects on whole ecosystems. Many efforts have been made to develop ways to accurately predict, effectively prepare for, and quickly recover from hurricanes; however, the storms' sizes and complexity make this difficult. Multidisciplinary collaborations are required to improve our understanding of hurricanes. This document reviews basic facts about hurricanes and their effects in Florida and discusses ways they might affect Florida's agriculture and natural resources. Examples in this document demonstrate how weather, agriculture, environment, and ecosystem are connected to each other across spatial scales ranging from microorganisms to an entire landscape.

What are hurricanes?

Hurricanes are large, swirling tropical storms that develop over warm ocean water. Hurricanes affecting Florida usually form in the Atlantic Ocean from June to November when the trade winds are able to carry them west or

northwest at a speed of 10 to 15 miles per hour (NOAA 2017a). Once hurricanes reach the latitudes of 25° to 30°N (the subtropical ridge), the westerlies usually drive them northeast (NOAA 2017d). The scientific name for a hurricane is a tropical cyclone, also known as a typhoon when it develops in the North Pacific Ocean.

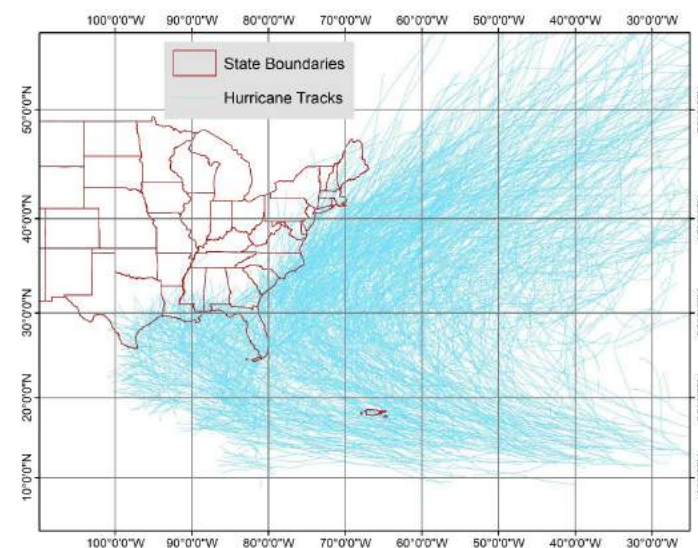


Figure 1. Paths of historical hurricanes.

Credits: NOAA

Ocean water holds heat, which is released when water vapor evaporates from the ocean surface. This is called latent heat, and it fuels the formation and travel of tropical cyclones.

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Hurricanes are categorized by the sustained speed of their winds based on the Saffir-Simpson Hurricane Wind Scale (NOAA 2017c). Hurricanes in Category 3, Category 4, and Category 5 are major hurricanes. Although hurricanes are commonly associated with rainfall, the rainfall characteristics are not considered in the classification of hurricanes, presumably due to the difficulty of making accurate remote estimations of rainfall.

Hurricanes consist of the eye, eyewall, and rainbands (Figure 2). The eye is the hurricane center where skies are clear with light winds. The location of the eye is used as a reference point to track hurricanes (Figure 1). The eyewall consists of the strongest winds and thunderstorm clouds and is the most destructive part. Rainbands are long, curved groups of clouds and thunderstorms that stretch for hundreds of miles (NOAA 1999) from the eye, and they sometimes contain very strong wind and tornadoes, especially on the east side of the eye. The winds and rainfall weaken between bands compared to within a band.

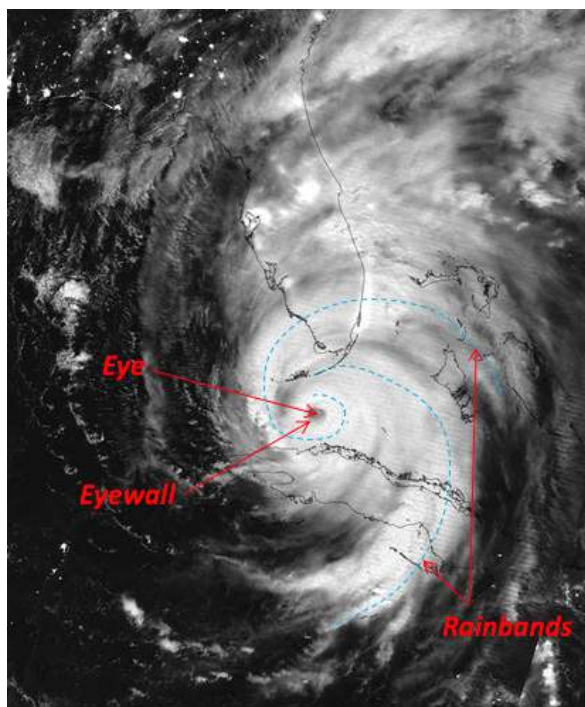


Figure 2. Hurricane parts (September 10, 2017 at 3:38 a.m. EDT; NASA's Suomi NPP satellite infrared nighttime image of Hurricane Irma. Credits: NASA

NOAA National Hurricane Center names hurricanes and tropical storms using established lists that follow the procedures maintained and updated by the World Meteorological Organization (WMO) (NOAA 2017e). Names are reused every six years, but the names of extremely destructive storms such as Andrew are retired. The main purpose of naming hurricanes is to facilitate clear and quick communications among people, institutes, stations, and

bases, which is why the names are usually short, distinctive, and easy to pronounce (NOAA 2017f).

Hurricane Impacts on Florida

Hurricane landfalls are frequent in Florida, making it one of the most hurricane-affected states. Since 1851, 898 hurricanes have formed in the Atlantic Ocean, with 322 classified as major hurricanes (NOAA 2017b). The number of hurricanes has increased slightly, but with fluctuations (Figure 3). Of the 898 hurricanes, 289 made landfall on the coast of the US, and 120 of them (36 major hurricanes) affected parts of Florida (Figure 4). The data indicate that Florida has been affected by a hurricane every 1.38 years (every year to two years) on average.

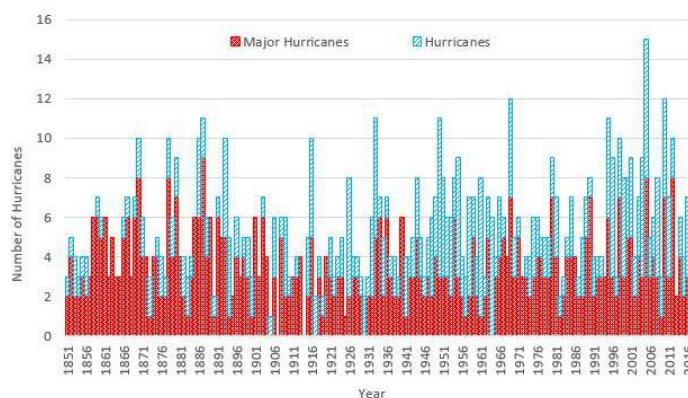


Figure 3. The number of hurricanes formed in the Atlantic Ocean in the past. Credits: NOAA

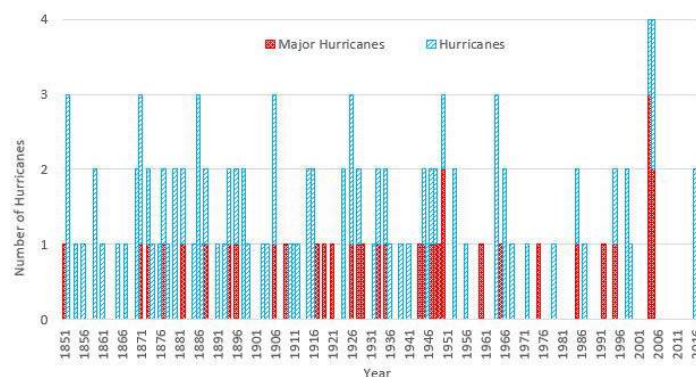


Figure 4. The number of hurricanes that affected Florida in the past. Credits: NOAA

Since 1900, Florida has had a total of approximately \$526 billion (2005 USD) worth of hurricane damage, which is equal to that of the rest of the US (Pielke, Jr. et al. 2008). Major hurricanes caused 87% of the damage. The Great Miami hurricane of 1926 caused an estimated \$157 billion (2005 USD) worth of damage. It is followed by Katrina in 2005 (\$81 billion), Galveston (\$78 billion in 1900), another Galveston (\$62 billion in 1915), and Andrew (\$58 billion in 1992). Florida is also the state that has been the most frequently damaged (25 times) by the top 50 devastating

hurricanes, followed by Texas (11 times) and North Carolina (eight times). Hurricanes cause loss of life as well as property damages. Large amounts of rainfall brought by the 1928 Lake Okeechobee hurricane, one of the most devastating Atlantic hurricanes on record, damaged the earthen dam of Lake Okeechobee and caused extensive flooding in its downstream areas, resulting in 2,400 deaths (Blake 1980).

Impacts on Ecosystems

Hurricanes can affect a wide range of terrestrial and aquatic ecosystems as well as the associated ecosystem services, or benefits people obtain from nature to improve their livelihood. In terrestrial ecosystems, the strong wind generated by the hurricane can substantially affect the structure and functioning of coastal forest and wetland ecosystems, including upland forests, mangrove swamps, hardwood hammocks, sawgrass, and forested wetlands. Because of the proximity of these ecosystems to coastlines, these ecosystems often sustain dramatic damages from hurricane winds. Impacts often include uprooting of trees and complete removal of leaves and branches. Besides direct wind impacts, storm surges can also transport large amounts of saline water and sediment inland, which can lead to additional physiological stresses (salinity or oxygen) to plants. In 1992, for example, Hurricane Andrew in south Florida caused significant damage to the mangrove forests of the Everglades (Roman et al. 1994), with almost 100% visual structural damage observed and about 60% of the trees uprooted or broken due to combined effects of high wind speed and tidal surges.

The loss of mangrove forests leads to loss of carbon that is released to the atmosphere, destabilization of shorelines, and reduction of critical habitats for many endangered species (e.g., Key deer, American crocodiles, hawksbill sea turtles, etc.). Moreover, changes in abiotic conditions (such as light, temperature, and humidity) due to losses of forest canopy can also have profound implications for other species such as birds and lizards in terms of food sources, habitat suitability, and increased predation risks. Destruction of vegetation can cause a large influx of litterfall in the form of fallen leaves, branches, and other natural debris into aquatic systems. For Hurricane Andrew, it was estimated that 41% of the normal seasonal litterfall occurred during the one day of the passage of the hurricane (Roman et al. 1994). Such an enormous flow of organic materials into the coastal water can lead to abnormally high levels of nitrogen, phosphorus, potassium, and other nutrients for these ecosystems. The decomposition of this organic matter can lower the amount of oxygen in the water column and

lead to large kills of aquatic species, such as fish, crabs, and other invertebrates.

Impacts on Agroecosystems

The high winds and flood waters from hurricanes can have catastrophic impacts on agriculture. Total crop losses from Hurricane Irma were estimated at \$2 billion, while total losses to production agriculture were estimated at \$2.5 billion (FDACS 2017). A UF/IFAS survey reported Hurricane Irma damaged more than half of the agricultural and horticulture crops in seven Florida counties. Nineteen counties reported 40% of crops were damaged, and 63 counties reported some form of damage. Damages include losses of harvestable fruit, whole crops, and farm infrastructure. These damages from Hurricane Irma constitute a serious ecological and economic disturbance to Florida's agriculture. However, land planning and management can mitigate losses from future hurricanes. For example, increasing crop and plant diversity in agricultural landscapes can buffer crops from high winds and rainfall.

Disturbance is a periodic event that causes disruption or distress to entities (i.e., plants) and their systems (i.e., farms). All farmers use disturbance purposefully to maintain viable economic outputs through management practices such as tilling and pesticide applications (Vandermeer 2011). These managed disturbances are similar to natural disturbances in that they influence the growth and survival of many plants and animals, including crops and livestock, and the overall structure and dynamics of populations, communities, and ecosystems (Sousa 1984). Managed disturbances are often moderate-intensity events that deliberately provide an advantage to the crop through intentional preparation of the environment and removal of competitors in the agricultural system. These management practices improve production outcomes but also remove complexity from the agroecosystem that is necessary for the overall stability and resilience of the system (Altieri 1999). The lack of stability and resilience may then increase the intensity of ecological disturbance and economic loss from catastrophic natural disasters, such as hurricanes (Buma and Wessman 2011).

Moving forward, land planning and management for agriculture should focus on maintaining diversity and complexity in the agroecosystem through practices such as perennial crops and wind breaks. Surrounding natural areas may also be maintained as a buffer to the impacts of disturbance events, although these natural areas may also be greatly impacted by hurricanes and other major disturbance events. Additional benefits to agroecosystems,

such as water and nutrient retention, pollination services, and pest and disease mitigation, may arise with management for diversity and resilience to mitigate the impacts of hurricanes.

Impacts on Crops

The effects of hurricanes on crops can range from slight and temporary to profound and long-lasting, depending on conditions and crop type. In general, damage to seasonal or annual crops tends to be limited whereas damage to fruit tree orchards will be more persistent. Hurricane conditions affect crops in several ways, primarily through high wind, heavy rainfall, and/or flooding damage.

Winds can have devastating and long-lasting effects on tree orchards because they can break limbs, defoliate leaves and fruit, or even topple trees, leading to long-term crop losses. Perhaps the most evident damage following storms is that of fallen trees. This type of damage occurs when soils become saturated after heavy rain and lose the soil structure needed to support the trees. Mature trees with large canopies require a deep and extensive root system to support themselves. In south Florida, and especially in Miami-Dade County, tree orchards are more susceptible to toppling during hurricanes because soils are shallow and overlay a root-impenetrable bedrock. Pruning trees prior to hurricanes can reduce tree toppling because it reduces high wind resistance and lowers trees' center of gravity. In the case of avocados, pruning can also help trees recover from prolonged flooding (Crane and Balerdi 2015).

Prolonged flooding brought on by hurricanes causes soil pore spaces that normally contain air to fill with water and reduces oxygen availability to soil microorganisms and plant roots, causing varying degrees of anoxia or hypoxia. Plant roots require oxygen for respiration, healthy metabolism, and growth. Some plants, such as avocado, are particularly sensitive to prolonged hypoxic or anoxic conditions in which tree death can occur after only four to seven days (Schaffer, Davies, and Crane 2007). Typical symptoms include yellowing and dropping of leaves followed by limb and whole tree death, even if flooding recedes. Depending on the cultivar, other tropical fruit trees such as mango are less susceptible to prolonged flooding. This reduced susceptibility could be related to the ability of certain mango cultivars to exude toxic metabolites that accumulate during metabolism under low root oxygen conditions. Flooding tolerance mechanisms are complex and include a number of metabolic adjustments to deal with limitations in anatomy and metabolism.

Hurricane-affected areas near the coast often experience seawater flooding caused by high tides and sea surges. Floods with seawater have the added problem of high salinity. Hurricanes can cause saline water intrusion above ground or through subsurface aquifers which can inundate inland areas where high salinity is not common and expose plants to serious additional environmental stress. Perhaps the most lasting effect of hurricanes is the rapid and long-term salinization of coastal areas that are not otherwise saline. Salinity is a significant problem to agriculture and one of the most serious causes of yield loss. It often exists in arid areas where evaporation exceeds rainfall and crop irrigation is practiced for many years. Salinity is deleterious to plants due to high concentrations of sodium and chloride ions that affect plants in two ways. High concentrations of these ions outside roots effectively reduce the available water for root uptake. Sodium and chloride lower the osmotic potential around the root and reduce the ability of roots to draw water into the plant, thereby creating a water deficit similar to a mild drought. Higher concentrations of these ions also cause direct toxicity because they accumulate inside plant tissue and affect normal metabolic processes. Plants have developed several strategies to deal with toxic concentrations of salts in their tissues, and some include either extrusion back into the soil or compartmentalization of salts into specialized organs within cells known as vacuoles. However, if the concentration of salt exceeds the ability of cells and organs to exclude or compartmentalize these ions away from metabolically sensitive cells and tissue, it will result in leaf tip burning, leaf yellowing, early senescence and, if severe enough, plant death.

Impacts on Freshwater Bodies

Hurricanes bring heavy rainfall and strong winds in wide areas while passing. Large amounts of rain falling for a short time can quickly fill the storage of reservoirs and dams. Once the water level reaches a certain height, additional rainfall that comes onto the surface of reservoirs and dams will be released through the spillways so that water will not overflow and break the levees, banks, and/or dikes. In south Florida, the canal system includes pumping stations that can quickly move water and help empty reservoirs and lakes before the onset of hurricanes so these areas can hold the extra water from increased rainfall. Heavy rain falling on the ground may form concentrated flow or drain into storm water sewers and streams.

Rather than running off into streams and canals, some of the rain that reaches the ground moves into soils and then the aquifer. Florida's limestone soils allow rainwater to infiltrate quickly. Thus, standing water is not common on

the soil surface even when rainfall is heavy, especially in south Florida. However, this is not the case in urban areas, as rainwater cannot penetrate pavement and concrete. This is why urban areas with wide, impervious surfaces tend to be more frequently flooded.

The heavy rainfall from hurricanes can wash soil, debris left on roads, and fertilizers applied to yards and farms to downstream areas such as lakes and estuaries. These materials that accumulate downstream can negatively impact water quality. For example, nutrients transported from land can cause algal blooms and eutrophication in the water bodies. Additionally, nutrients can move to the aquifer through soils and contaminate groundwater. Such transport processes happen even with small storm events, but a large amount of water created by hurricanes can accelerate and disturb natural processes.

While hurricanes increase the quantity of water delivered to water bodies, their high and sustained winds from one direction can push water up at one end of lakes and estuaries. The water level raised by the winds on the land around a lake or estuary is called storm surge. An elevated water level can be several feet high, depending on the strength of wind, the depth of water bodies (lakes and estuaries), and the height of sea level. The raised water can overflow banks, levees, and dikes and then flood the downstream areas of the lakes and the low-lying inland areas adjacent to the estuary, especially when hurricanes coincide with a high tide (Genovese and Green 2015; Balaguru, Judi, and Leung 2016; Hung, Wang, and Yarnal 2016). Storm surge can travel inland for miles and contaminate freshwater resources with saltwater (Miami-Dade County Board 2016). Studies show that sea level rise is likely to increase flood and saltwater risks in Florida's coastal areas in the future (Frazier et al. 2010; Wdowinski et al. 2016).

Storm surge hazard maps show areas susceptible to storm surge so that people living in or passing by those areas can be aware of flooding risks (Figures 5 and 6). A storm surge hazard map, which is prepared by national agencies (e.g., NOAA) and city/county governments (e.g., Miami-Dade County), is different from Federal Emergency Management Agency's (FEMA) flood insurance rate map that shows flood zones defined based on mitigation activities and facilities (e.g., construction of dams, levees, or seawalls) as well as topography and (extreme) weather events (Figure 7).

Strong winds and rapid changes in atmospheric pressure can create a tidal wave oscillating back and forth across a lake (Chimney 2005; NOAA 2017g). This wave, known as a seiche, can intensify, causing water to overflow the banks

and break dikes. A standing wave oscillating is common in large lakes such as Lake Okeechobee and the Great Lakes, but hurricanes can set up wind and atmospheric conditions that make large and dangerous seiches.

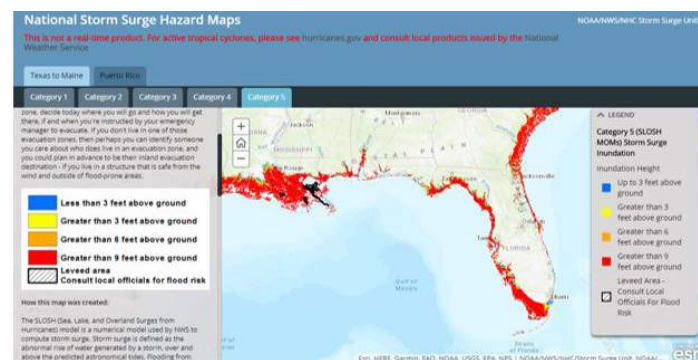


Figure 5. NOAA National Storm Surge Hazard Maps. Credits: NOAA

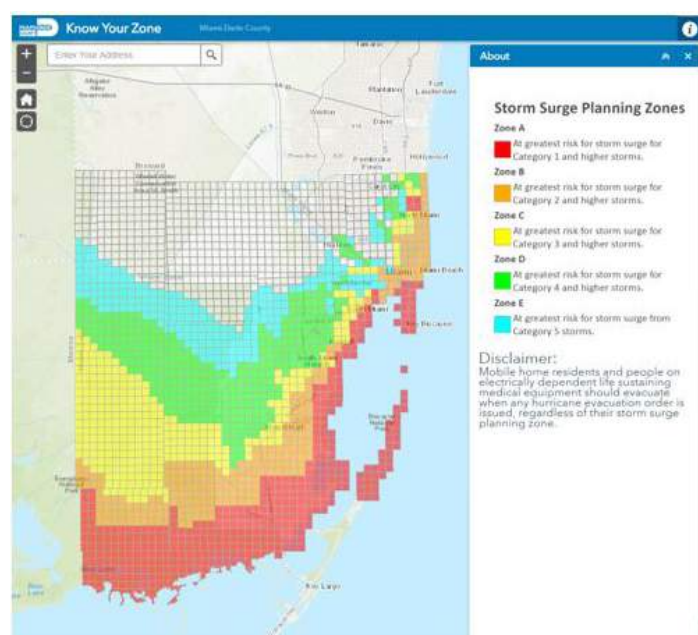


Figure 6. Storm surge planning zones in Miami-Dade County. Credits: Miami-Dade County

Impacts on Coral Reefs, Seagrasses, and Wetlands

South Florida's coastal and marine habitats can suffer direct or indirect impacts from hurricanes. While some of the effects are instant and obvious, others occur well after the eye of the storm has passed. Intense winds, heavy rains, and storm surge, which can pull water from beaches, leave underwater areas exposed, and push water to the shore, are a few ways hurricanes affect coastal and marine resources. Marine fish and mammals, such as sharks and dolphins, can escape to deeper water or move away from the storm. However, not all marine organisms can avoid hurricanes. Powerful storms can erode coastal plants such as seagrass

beds, destroy mangrove wetlands, and break corals. These effects can have long-term consequences for the health of coastal and marine ecosystems.

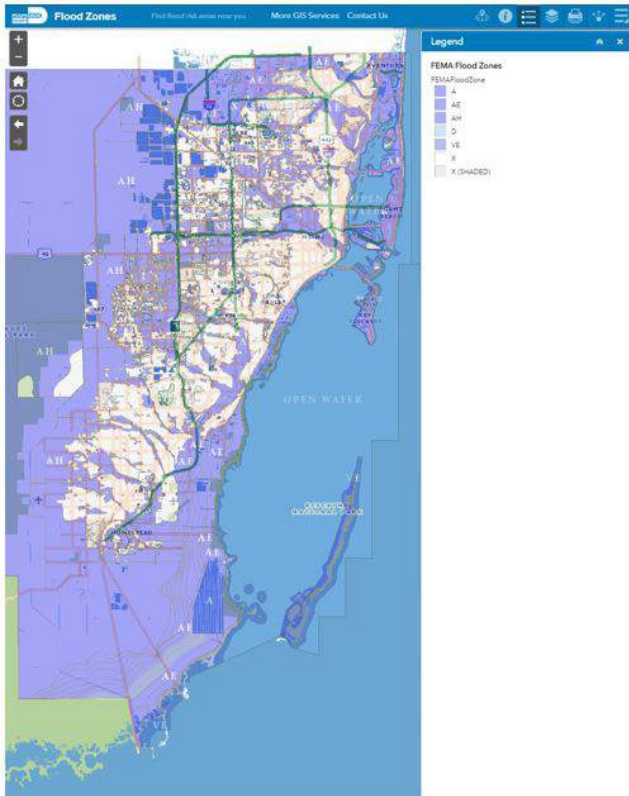


Figure 7. Flood zone (or flood insurance rate) map of Miami-Dade County.

Credits: Miami-Dade County

Seagrass damage is commonly associated with hurricanes. The intense winds and subsequent tidal and wave energy can cause massive loss of leaf material from seagrasses and may uproot the plants completely. Additionally, the wind suspends sand and sediment, moving them into the coastal zone and occasionally covering or eroding the seagrass. The combined effects impact seagrass meadows. The conversion of seagrass meadows to unstructured and bare subtidal flats affects fisheries and water quality. Seagrass beds serve as a nursery habitat for a variety of commercially important fish and increase water clarity by trapping material as it settles from the water column. Thus, the loss of seagrass beds due to hurricanes can harm ecosystem services even after the storm has passed.

Erosion of wetlands also occurs during hurricanes. Wetlands, such as mangroves and marshes, help defend against storms. Mangroves and marshes absorb and filter water and provide habitat. However, hurricane force winds and increased wave action can cause erosion, leaving coasts more vulnerable to storm impacts in the future. Hurricanes also move sediment to wetlands, which can smother the

marsh or help the mangrove or marsh accrete and keep pace with rising seas. While there has been a shift to hardened structures, such as concrete seawalls, to protect property from storms, wetlands offer natural protection by reducing the risk of flooding from storm surge. Restoration and protection of these habitats may provide a natural buffer against the effects of future hurricanes.

Hurricanes also affect coral reefs. Coral reefs can reduce the effect of storm surge. It is common to see broken and overturned corals as well as abrasions on corals after a hurricane. Damage is not restricted to hard corals. Soft corals and sponges also experience detachment, burial, or breakage. Breaking of some branching stony coral during a hurricane can be beneficial because these pieces are able to form new colonies once they settle after the storm. However, the increase in turbidity following a hurricane will limit light availability and can impact zooxanthellae. Zooxanthellae are the photosynthetic algae that live in the tissue of corals and make the corals different colors. Corals protect the zooxanthellae from the environment while the zooxanthellae provide the corals with oxygen and nutrients. Stress to the corals and zooxanthellae lead to bleaching events that can cause detrimental impacts to corals.

Hurricanes can also affect the clarity of water. Coastal waters after hurricanes are often turbid and contain small particles of sediment. The increase in turbidity limits light availability to the sea floor and can inhibit recovery of the marine ecosystem that requires light for growth, reproduction, and survival.

Hurricanes are a natural threat to coastal and marine resources. However, localized man-made stressors influence the ability of these areas to overcome the increase in turbidity and nutrients. A critical question is whether the south Florida ecosystem can still respond naturally to perturbations despite considerable stress from chronic pollution, development, and use.

Impacts on Microbial Communities

Florida has many unusual and diverse aquatic ecosystems, including mangrove forests, swamps, wetlands, different types of natural and man-made lakes and waterways, coral reefs, and open ocean habitats. The environmental, commercial, and recreational importance of these habitats cannot be stressed enough. NOAA estimates that coral reefs in southeast Florida have an asset value of \$8.5 billion, generating \$4.4 billion in local sales, \$2 billion in local income, and 70,400 full- and part-time jobs (NOAA 2018c).

In 2007, its touristic value alone was determined to be \$174 million per year (Brander and van Beukering 2013).

In all of these habitats, single-celled microbes play a key role in the health and functioning of the ecosystem. This is demonstrated by both their enormous biomass (which can account to up to 90% of the total biomass in oceans) and their impact on global biogeochemical cycles, including carbon and nitrogen (Karl 2007). However, many basic questions on the structure and function of microbial communities, especially in wetland and estuary systems, remain unsolved. Changes in the composition of species within microbial communities occur very quickly when nutrient concentrations change in the environment. Previous studies have shown the potential impact of hurricanes, including increased concentrations of human and animal pathogens and/or potentially toxic phytoplankton blooms (Presley et al. 2006; Huang, Mukherjee, and Chen 2011). In 1996, nutrient loading and severe deficits of dissolved oxygen caused by Hurricane Fran resulted in massive fish kills (Burkholder et al. 2004). Hurricanes Fran, Katrina, and Rita as well as tropical cyclones off the coast of China dispersed fecal and pathogenic bacteria, which caused severe disease outbreaks (Burkholder et al. 2004; Amaral-Zettler et al. 2008; Bae and Hou 2013). A woman in Texas died after contracting an infection of flesh-eating *Vibrio* bacteria from floodwaters caused by Hurricane Harvey (Washington Post 2017), and many infection-related deaths were expected in the aftermath of Hurricanes Harvey and Irma (NewScientist 2017). The actual numbers of infection-related deaths have not been published yet. Other potential microbial hazards such as blooms of toxic phototrophic and heterotrophic microorganisms might not be noticeable immediately after the storm. Toxic cyanobacterial species such as *Cylindrospermopsis raciborskii* expanded their ranges throughout Florida, and in the summer of 2016, Florida was in a state of emergency due to toxic cyanobacterial blooms. These blooms had a significant impact on the state economy and resulted in considerable negative international press (Scott 2016).

Our understanding of prokaryotic microbial communities in the Florida Coastal Everglades (FCE) is limited, even in undisturbed conditions. Although microbial cell counts in the waters of the FCE reach concentrations of several million per mL, no study has sufficiently addressed their community structure and function. No systematic survey using modern molecular high-throughput sequencing methods to determine the presence and quantity of potentially pathogenic bacteria and toxic cyanobacteria has been completed. The aftermath of flooding associated with

natural disasters has been fittingly described as a “microbe’s paradise.” All long-term microbial hazards to public health can cause more damage than the physical effects of the storm itself (Linscott 2007). Recent hurricanes might also have initiated changes in microbial processes in ecosystems in Florida that have the potential to be hazardous, both ecologically and economically. However, the symptoms of these changes might not become apparent until severe diseases develop or fish kills occur.

Conclusion

This list of potential effects of hurricanes on Florida’s agriculture and natural resources is by no means complete, but it provides an idea of the scope of the impacts from microbial communities to an entire ecosystem. The strong winds and heavy rain affect both the physical elements of our environment and their biological and chemical components. Long-term impacts may be present but not immediately visible, and they must be considered when developing recovery plans or preparing prevention and mitigation measures for hurricanes.

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Table 1. Progressive levels of organized disturbed weather in the tropics (NOAA 2018a).

Category	Tropical depression	Tropical storm	Category 1 hurricane	Category 2 hurricane	Category 3 hurricane (major)	Category 4 hurricane (major)	Category 5 hurricane (major)
Sustained Wind Speed (mph)	Less than or equal to 38	39 to 73	74 to 95	96 to 110	111 to 129	130 to 156	Greater than or equal to 157

Hurricane Lilies, *Lycoris* Species, in Florida¹

Gary W. Knox²

Hurricane lilies, *Lycoris* species, are bulbs that flower suddenly after heavy summer rains in August and September. Their common name in Florida, hurricane lily, results from their blooming period coinciding with the height of the hurricane season. Other common names for *Lycoris* species are spider lily, surprise lily, magic lily, resurrection lily, naked lady, schoolhouse lily, and Guernsey lily. Hurricane lilies are members of the Amaryllis Family, which includes other well-known bulbs such as amaryllis (*Hippeastrum* spp.), daffodils (*Narcissus* spp.), rain lilies (*Zephyranthes* and *Habranthus* spp.), and snowdrops (*Leucojum* spp.).

Hurricane Lilies in the Garden

Hurricane lilies are easy to grow in north and central Florida. Bulbs should be planted so the “neck” is just below the soil surface. Dormant bulbs are best planted during late summer and fall, whereas actively growing plants can be planted other times of the year. Hurricane lilies thrive in sunny to partially sunny areas such as the edges of woodlands and shrub borders or under deciduous trees. These sites also help protect the fragile flowers from wind and sun. Hurricane lilies do not require fertilizer or irrigation, but grow best in rich, moist soil.

The types of hurricane lily that grow best in Florida have long, narrow leaves that emerge in fall, persist through winter, and die down in spring. The clumps of blue-green foliage resemble *Liriope* spp. but with a pale stripe down the center of each leaf. Leaves turn yellow in spring and should be allowed to die naturally. Cutting back leaves

while they are yellowing will harm the bulb and reduce flowering. No leaves are present during summer months when bulbs are dormant. *Lycoris* species have not yet been assessed by the UF/IFAS Assessment of Non-Native Plants in Florida’s Natural Areas (<https://assessment.ifas.ufl.edu/>) and therefore are not considered a problem species at this time and may be recommended.

Surprise Flowering

In August and September after a heavy rain (it does not have to be a hurricane), flowers appear almost magically since there is no foliage to indicate where the bulb is planted (thus providing the common names, magic lily and surprise lily). Leafless stems emerge and quickly grow 12 to 24 or more inches tall before being topped by 8-inch clusters of 5 to 7 tubular flowers. Most species have flowers with narrow, strap-like petals and extremely long stamens, giving a spidery appearance to the flowers (and hence another common name, spider lily). Each cluster of flowers lasts about 2 weeks, or longer if flowers are protected from wind and sun. Each bulb can produce 1 to 4 flower stems, and all bulbs typically do not flower at once, so subsequent rains often result in a sequence of flowering. Hurricane lilies make excellent cut flowers as well as beautiful garden plants.

Hurricane lilies have a reputation for inconsistent flowering from year to year. This is often caused by bulb crowding or, conversely, recent planting. Large clumps of bulbs should be divided every few years to avoid reduced growth and

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flowering caused by crowding. Bulb clumps are best divided in early summer when bulbs are dormant. Flowering may be delayed a year or more if clumps are divided and planted at other times of the year. Newly planted bulbs may not flower until the second year after planting, especially if roots are missing or have dried before planting.

Some hurricane lilies produce viable seeds. Unfortunately, seeds do not germinate easily, and it may take 6 to 12 years for seedlings to produce bulbs large enough to flower.

Ancient, Beautiful, Poisonous, and Deer-Resistant

Lycoris species have long been used as garden flowers in their native habitats of China and Japan, particularly around temples, graveyards, and cultivated fields. One common name in China can be translated as “stone garlic”, and another mentions the legendary Chinese ghost-catcher, Chung Kwei. The first name refers to the onion-like bulbs, and the second to the poisonous components in *Lycoris* that would allow Chung Kwei to easily capture the ghost of any hapless bulb-eater mistaking it for garlic.

Bulbs of all *Lycoris* species contain the alkaloid poison, lycorine, which causes vomiting, diarrhea, convulsions, and sometimes death in humans and other animals. Although *Lycoris* bulbs are considered to have low toxicity, homeowners should be aware of the poisonous potential of hurricane lilies, particularly if small children and pets are present. On the other hand, this poisonous component has the benefit of making hurricane lilies resistant to damage from deer and rodents. The Japanese exploited this poisonous aspect of *Lycoris* species by planting them along the edges of rice paddies, presumably to discourage mice.

Another alkaloid component is galantamine, which is used in medications to treat Alzheimers-type dementia. *Lycoris* is being grown in plantations in China for mass harvest to extract this compound.

Availability

Common hurricane lilies can be found growing in many older homesteads throughout the southeastern US. Interestingly, they are not widely grown in nurseries, and it may be challenging to find them. Hurricane lily bulbs are more likely to be available in summer and fall from better garden centers as well as some mail-order nurseries. Unusual *Lycoris* species and hybrids may be found at specialty bulb nurseries or from collectors and breeders.

Widely Available Hurricane Lilies

The most common hurricane lily is *Lycoris radiata* var. *radiata* (also known as red spider lily; Figure 1), producing red-orange flowers. This plant is a sterile triploid, preventing it from forming seeds and causing it to be free-flowering. Without the burden of producing seeds, this plant is also very fast growing, resulting in large clumps of bulbs that can be separated and planted. *Lycoris radiata* var. *radiata* is vigorous and produces bulbs so prolifically that it is far more common than its smaller, seed-producing diploid form known as *Lycoris radiata* var. *pumila*. Red spider lily has been cultivated since ancient times in China and Japan and since the early 1800s in the US. This plant has naturalized and is considered an “heirloom plant” in the southern US.



Figure 1. Red spider lily, *Lycoris radiata* var. *radiata*.

Lycoris aurea (golden spider lily) produces clusters of 4 to 7 yellow, trumpet-shaped flowers on stems 18 to 24 or more inches tall. Sturdy, bluish leaves emerge in fall and grow up to 24 inches long, producing a larger plant than red spider lily. Golden spider lily also may be sold as *Lycoris traubii*, an obsolete name for this species or perhaps a subspecies.

Lycoris squamigera (magic lily) may be commonly found in nursery catalogs but is not well adapted to the heat and humidity of Florida. Its gray-green leaves emerge in spring and die down by early summer. Magic lily has lilac-pink, amaryllis-like flowers in July.



Figure 2. Golden spider lily, *Lycoris aurea*.

Less Common Hurricane Lilies

Lycoris albiflora (white spider lily) produces clusters of 6 to 8 white flowers on a stem 12 to 18 inches tall. Each petal may have a narrow creamy-pink stripe down the center, but the stripe (and flower) fades to white with age. Like red spider lily, this plant's leaves emerge in fall and die down in spring. This plant is a sterile hybrid of *L. radiata* and *Lycoris traubii* and is sometimes mislabeled as *Lycoris alba*.

Lycoris haywardii (surprise lily) is one of the few spring-leaving hurricane lilies that grows well in Florida. In fact, this plant was first discovered in Winter Park, Florida, in a 1948 shipment of Chinese plants to Dr. Wyndham Hayward. It develops leaves in early spring that die down in early summer. The trumpet-shaped flowers are magenta-pink with bright blue tips at the ends of petals. The plant flowers in July, often earlier than other hurricane lilies. It is believed to be a hybrid of *L. squamigera* and *L. radiata* var. *pumila*.

Lycoris sanguinea (orange spider lily or surprise lily) is another spider lily said to grow poorly in Florida. As with magic lily (*L. squamigera*), it develops leaves in early spring rather than in fall. It produces clusters of 3 to 5 orange-red flowers.

More than twenty *Lycoris* species are known, and there are countless hybrids, but most are not widely grown.

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Hurricane Preparedness For Citrus Groves¹

Mongi Zekri, Robert E. Rouse, and Jonathan H. Crane²

Introduction

Each year, growers look forward to the rainy season because it helps their young trees grow fast and their mature trees produce good crops. Growers hope for good distribution of rains following the usual dry spring season. However, along with the anticipation of the rainy season, there is also the reality that tropical storms or hurricanes may bring too much rain and wind, causing devastations to citrus groves (Figure 1). The hurricane season is June 1 through November 30. Any hurricane or severe tropical storm poses a threat to all of Florida with additional issues for south Florida shallow-rooted citrus trees. Strong winds blow fruit off trees. Tree damage resulting from wind and 10–20 inches of rain could be the most severe and lasting injury. In addition to rain, high tides caused by wind blowing toward land may cause saltwater flooding several miles inland. Grove flooding may also be caused by the damaging effect of high tides, which raise the level of water in bays, estuaries, and rivers and prevent excess water from running off groves. While a hurricane has the potential to inflict heavy damage on any grove, growers who have developed hurricane plans prior to the event have the best chance of minimizing losses. They will be the ones most likely to save groves by quickly replanting uprooted and blown-over trees and by removing excess water within 72 hours to avoid root damage caused by suffocation from lack of oxygen.



Figure 1. Limb damage, trunk twisting and breakage, tree toppling, and loss of leaves and fruit.

Plan and Prepare

It is best to devise a hurricane plan and use it to make preparations far before June, the start of the hurricane season. Although hurricanes can strike at any time during the June–November period, they are most likely to occur in August and September, at the end of the rainy season when the soil and water retention areas are least able to accommodate more water. The hurricane plan should provide for both protection from a storm and recovery after the storm. Little can be done to protect trees and fruit from wind; but growers can take steps to protect the people, equipment, and supplies that will be needed in the recovery process

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to include adequate insurance for groves, buildings, and equipment. Additional information can be obtained from local county offices of Emergency Management, Sheriff, Chamber of Commerce, and Economic Development. Following are some things to consider in a pre-storm preparation plan and a post-storm recovery plan.

Pre-Storm Preparation

Personnel assignments—A major part of the hurricane plan is ensuring that all managers know their responsibilities prior to, during, and after a hurricane. Make a list of all tasks that will need to be performed so there are no last-minute, unanticipated gaps to plug. Identify and maintain an updated list of the members of a damage inspection team, which will determine where storm damage occurred and how extensive it is. Make sure each team member knows his or her responsibilities. Specific workers should be assigned to fix ditches, prop up trees, fix roadways, and perform other tasks after the storm. Make sure you know how to contact workers at their place of safety, and that they have a way to call in after the storm.

Safety training—Workers should be trained in the safe operation of unfamiliar equipment that they may have to use if a hurricane hits. For instance, drivers may wind up using chain saws to remove a downed tree that is blocking a road.

Liquid tanks—Tanks containing fuel, fertilizer, and other materials should be kept full so they do not move in the wind and rain, and to ensure that sufficient fuel is available for machinery used in recovery efforts after the storm.

Ditches—Ditches should be kept clean and pumped down to help maximize water removal efforts after the storm.

Cultural Practices—Trees should be pruned regularly to reduce broken limbs and minimize toppled or uprooted trees. Windbreaks can also reduce tree damage and the spread of citrus canker bacterium.

Emergency equipment—Make sure that all emergency equipment—including generators, chain saws, torches, and air compressors—is on hand and in good repair. Emergency generators should be available for use in headquarters and equipment maintenance shops. Large diesel powered generators with 25 to 60 kilowatt capacity can be rented or leased by the month during the hurricane season.

Communications equipment—Ensure that radios are in good working order. Have hand-held portable radios with

extra charged battery packs available for workers who will need them in the field after the storm. Direct truck-to-truck radio communication is most reliable when phone lines are down, but cellular phones with radio capabilities and standard cellular phones can help workers save valuable time during the recovery process, as opposed to communication systems that require messages to be relayed through a base unit.

Hazardous materials—Hazardous materials should be secured prior to a storm, and gasoline pumps should be shut down.

Emergency contacts—Have a list of phone numbers you might need in an emergency, including numbers for the phone and electric companies, sheriff, and medical facilities.

Post-Storm Recovery

Activity check list—An activity check list will help ensure that all essential damage assessment and recovery operations are carried out. Additionally, a plan that prioritizes the importance of individual blocks makes grove recovery efficient. With a priority plan, managers can quickly determine where to begin recovery operations.

Employee call-in—Maintain a current list of employee locations and phone numbers. As soon as it is safe to do so, call in those who will be needed for damage inspection and grove recovery work.

Damage inspection—If roads are passable, inspection of tree and equipment damage may be conducted from trucks. Since flooding, downed trees, and electrical poles may have blocked roads, large growers should consider making prior arrangements for a helicopter or flying service to transport the grove manager to survey grove damage. Aerial surveillance can also determine routes of passage through the grove.

Clear road access—Have crews clear all roads leading to parts of the grove where trees must be reset or other recovery activities must be conducted. Having a clear path for workers will speed the recovery effort.

Water removal—Remove excess water from tree root zones as soon as possible. It is essential to accomplish this task within 72 hours to avoid feeder root damage due to insufficient oxygen.

Tree rehabilitation (Figure 2)—Resetting of trees to an upright position should be accomplished as soon as possible after the storm. Ensure that employees know how to properly upright toppled trees and that appropriate equipment is available. Such equipment might include pruning saws, chain saws, front-end loaders, backhoes, and shovels. Toppled trees should be pruned back to sound wood. Painting exposed trunks and branches with white latex paint helps prevent sunburn.



Figure 2. Pruning and resetting a tree to an upright position.

Tropical Depressions, Tropical Storms, and Hurricanes

Florida experiences an average of two tropical cyclones each year. “Tropical cyclone” is a term that includes tropical depressions, tropical storms, and hurricanes. The difference between each of these is determined by the strength of its maximum winds.

Tropical depression—The sustained winds for a tropical depression are less than 39 miles per hour (mph). Wind damage to trees usually begins when the winds exceed 40 mph; only tropical storms and hurricanes will pose a wind damage threat to citrus groves. However, because tropical depressions frequently bring more rainfall than storms and hurricanes, they pose a flooding risk to citrus trees.

Tropical storms—Tropical storm winds are sustained between 39 and 73 mph. At these velocities, light damage to groves will occur in the form of twigs and branches broken off trees, fruit knocked off, and the first and/or second row of trees on the windward side may have an occasional tree pushed over.

Hurricanes—Hurricane winds are sustained at greater than 73 mph velocities and are further categorized from 1

through 5 according to the speed of maximum sustained winds (Table 1). For categories 1 and 2 (sustained wind speeds of 74 to 110 mph), moderate damage to groves will occur. The first five rows of trees to windward may have trees snapped or broken, or blown over. Mobile homes may be overturned and outbuildings demolished. For categories 3 and 4 (sustained wind speeds of 111 to 155 mph), considerable damage to groves will occur. The first 10 rows of trees to windward may be snapped or uprooted. Roofs may be torn off of frame houses, outlying buildings may be lifted and moved, and mobile homes demolished. For category 5 (sustained winds in excess of 155 mph), catastrophic damage to groves will occur. Whole groves may be uprooted and trees carried some distances. Well-constructed houses likely will be destroyed, heavy vehicles lifted and thrown, and pavement pulled from roads.

Wind gusts and tornadoes—Wind gusts are generally 30% stronger than the sustained winds in storms and hurricanes and greatly increase the potential for damage. There is an increased threat of tornadoes during hurricanes.

How much rain?—The amount of rainfall from a tropical depression, tropical storm, or hurricane is dependent on the cyclone’s speed of movement. A rule of thumb to determine how much rainfall is possible is to divide 100 by the forward movement speed of the cyclone (in mph). For example, the maximum amount of rainfall from a 10 mph moving storm would be 10 inches, and for a 5 mph moving storm, 20 inches. Because tropical depressions move relatively slowly, they frequently bring more rainfall than tropical storms and hurricanes.

Conclusion

Planning for a hurricane will help reduce damage to citrus trees and enhance recovery of the grove operation. The most important pre-hurricane practice is the maintenance of a regular pruning program to limit tree size. After a hurricane, being prepared for clearing debris, repairing the irrigation system, resetting toppled trees, protecting trees from sunburn when significant portion of the canopy has been removed, and irrigating and fertilizing trees frequently will increase chances of tree recovery.

Table 1. Saffir-Simpson hurricane storm rating scale.

Category	Wind (mph)	Expected Damage to Citrus Trees and Fruit
1	74–95	Some loss of leaves and fruit, heaviest in exposed areas
2	96–110	Considerable loss of leaves and fruit with some trees blown over
3	111–130	Heavy loss of foliage and fruit, many trees blown over
4	131–155	Trees stripped of all foliage and fruit, many trees blown over and away from property
5	over 155	Damage would be almost indescribable, groves and orchards completely destroyed

**For more information,
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