

## COMMUNICATING HURRICANE IMPACTS ON LANDSCAPE PLANTS TO FLORIDA'S CITIZENS

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**Abstract.** Four major hurricanes and a tropical storm ravaged Florida yards in 2005. The public requested immediate information on which species fared well, which suffered the most and how to mitigate windstorm damage. Case studies from Hurricane Andrew and the 2004 storms are used to illustrate the different information sources and communication methods that were used to relay information to property owners. Results are reported on a survey of how effective these methods were from the property owners' and managers' viewpoints. A discussion is also offered on how more rigorous analyses of landscape failure information collected by Florida landscape professional can be used to predict hurricane impacts.

One of the results of the devastating 2004 hurricane season was the opportunity for horticulturalists to examine the effects of these horrific events on the way we practice our art and science. While a rigorous examination of the recent storm events on landscapes is now underway, it will take several years to fully assess the impacts of these storms on Florida yards. However, there exists an immediate need to quickly communicate what is known about landscape recovery methods to property owners and managers to aid in recovery and help current preparations for future storms.

This paper examines how information was collected and distributed on hurricane impacts to Florida landscapes. With predictions that the region is entering an era of more intense storm activity, being able to advise consumers what to expect and how to prepare for severe storms is an important task facing the horticultural industry. The authors will offer a series of case studies on how communicating storm recovery has been accomplished. Examining what others have done may help to illustrate what works and what does not work.

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### Hurricane Andrew and Lessons Learned

Hurricane Andrew struck Miami-Dade County on 24 Aug. 1992. Its effects on the landscape in the central and southern portions of Dade County were devastating. Andrew was a severe category 5 storm, a rare event, with wind and storm surges damaging almost all landscape plants.

Miami-Dade County's Extension office in Homestead received severe damage from Andrew. There was no phone service for many months and electricity was also absent for a month before a generator was installed. Not only was the building unable to function for one full year, there were very few alternative facilities for classroom type programming. Some Extension agents were unable to work for six months or longer. Without power, telephones, computer systems or office equipment, almost no Extension work could be done for many months.

Few people in the hurricane path had access to newspapers, mail, or electricity for weeks to months. One-quarter of a million people were left homeless. Many of those people had to leave the area for months, and some relocated permanently.

There was no way to advertise that informational assistance was available to the stricken areas. Hurricane recovery information needed to be timely to be effective. It is suggested that unless steps are taken to mitigate storm damage to landscapes in one to three days, permanent plant injury will result. Little capacity existed after Andrew for local Extension staff to provide this timely information.

In the aftermath of Hurricane Andrew, several Extension staff from nearby counties mobilized themselves with critical tools and supplies, and traveled to effected areas armed with quantities of appropriate Extension publications in both English and Spanish. The efforts of one agent in particular were recognized by state and federal authorities as nothing short of heroic (M. J. Holsinger, Sarasota County Cooperative Extension, pers. comm.).

An analysis of vegetation losses and the demands for landscape material and equipment was offered in the aftermath of Hurricane Andrew (Ritter, 1993). In areas hardest hit by the storm, relandscaping took a back seat to rebuilding, and attention to vegetation began several months later. Landscape recovery efforts began almost immediately in areas that were not as severely impacted by the storms. Overall there was a greater demand for replacement fruit trees, large affordable shade plants, and flowering plants that could provide color for visual relief. Sod was needed to replace lawns damaged not by the storms but during the rebuilding process. There was also an opportunity to replace damaged irrigation systems by considering hydrozones as new designs were installed.

As judged by Extension staff, the most efficient method to "get the word out" was to use local radio stations or television news. However, due to the state of emergency and the need for other news, messages on how to help the landscape recover were a low priority.

The take home lesson learned by the Dade County Extension staff from Andrew was the need to do hurricane teaching before storms arrive and to effectively reach a large audience through mass media. Being proactive with information before a storm hits is viewed as the key to successfully delivering landscape recovery information.

### 2004 Storm Recovery and Communications

During 2004, Extension agents in areas unaffected by storms began to immediately mobilize the materials and tools needed to assist impacted areas. Staff rendering this assistance often traveled with their cameras and documented the devastation as they distributed food, feed, equipment supplies and encouragement. One agent, Daniel Culbert, took over 1,700 photos of hurricane impacts and recovery efforts in 2004.

Florida Extension agents provided initial help in the aftermath of Charley to support offices in other counties, especially Charlotte, Hardee and DeSoto counties. Phone contact lists were invaluable to aid in reaching staff. It was difficult to share needs lists identified by impacted personnel to the outside world because overloaded cellular telephone service was erratic at best, and often absent where signal towers blew down. Daily requests were assembled and provided to agents who traveled daily into and out of storm ravaged areas. Once cell phone service was reached on leaving the impacted areas, the needs were quickly relayed to those that could supply the materials. The staging of materials for the next day's recovery run was often completed before traveling agents returned home. DeSoto county Extension Director Jim Selph estimates that relief efforts for Desoto County alone resulted in thousands of bags of feed, bales of hay and fencing materials being rushed into this county (McGovney, 2004.)

Plans were made in late August to begin comprehensive field surveys of hurricane impacts to landscape plants. One researcher contacted several Extension horticulture agents to conduct assessments of areas impacted by Hurricane Charley (M. Dureya, personal communication). The subsequent arrival of Hurricanes Frances, Ivan and Jeanne caused some of this assessment work to be delayed.

A take home lesson here is that training in the research methodologies to be used needed to be provided prior to the storm season. A standard document such as one similar to the one used by International Tree Failure Database (Smiley et al., 2005) may provide a model for how additional horticulturalists can collect information that can be added to hazard analysis data bases.

Colleagues from across the country wanted to gain an understanding of the impacts and render assistance as well, so a web page was created and published. Photos of damaged areas, descriptive emails from impacted Extension staff and clientele, and lists of needed supplies were included at first. As information from recovery agencies became available, this was added to the webpage (Culbert, 2004). As additional areas of Florida suffered the wrath of Hurricanes Ivan, Frances, and Jeanne, additional photos, agency links, and updates on disaster assistance guidelines for various agricultural industries was added to the web page.

At present, this webpage is still available and has registered over 900 hits since mid-Sept. 2004. Among those visiting this site were a television production company charged with creating a retrospective account of the devastating effects of

Hurricane Hazel in Canada during 1954. Photos from the 2004 hurricane recovery website were provided to and broadcast as part of a documentary film over much of eastern Canada (Harvest Television International, 2004).

The webpage is viewed as a way to provide impact and assistance information to those able to render assistance immediately after a storm. It would not be widely available to storm-affected areas until electrical and telephone service is restored and computers are unpacked and set up. It requires a minimal level of training and expertise to create such a communication channel, but is useful only if information seekers are computer literate and aware of the site. Another relevant website in the arena of landscape recovery has been posted with photos and information about the 2004 storm impacts on trees (Gilman, 2004).

### Stormscaping

Another approach used to provide landscape recovery information involved the rapid creation of a book that summarized anecdotal information on recent hurricanes effects on landscapes. Landscape architect Pamela Crawford suggests plants for various applications based on the characteristics which make them suitable for a particular application. Her experiences as a nursery grower and a design consultant has allowed for a broad evaluation of a variety of plant materials.

After Andrew, she summarized observational data and included wind tolerances on plant profiles in her publications. After Frances and Jeanne destroyed much of her nursery, she observed dramatic differences between different plants and among different environments. She began to record these observations as a historical record, but the volume of reports that came to her warranted their assembly into a book form that could be rapidly disseminated.

In order to improve the evaluation of the landscape's ability to withstand windstorms, a wider body of data was required. Subsequently, extensive interviews, observations and anecdotal reports were obtained from a wide variety of property owners, landscape managers, Extension volunteers and agents, botanical garden staff and emergency managers. There were 54 specific individuals or organizations that were identified as contributors to this body of knowledge.

The author developed a four-tiered subjective rating for wind tolerance based on the amount of physical damage demonstrated by a species of plant in a given wind exposure. Thus, plants with minimal damage in category 4 hurricanes (winds to 155 mph) could be described as having very high wind tolerance, while those that routinely suffered structural damage from category 1 hurricane winds (74-95 mph) were termed low wind tolerant plants.

The anecdotal data from these reports from 2004 and other information from previous storms was used to assign particular plants a wind tolerance rating (Table 1). In some cases, survey data could be used to provide definitive ratings, such as with slash pines (*Pinus elliottii*). For other species, tentative ratings were assigned based on limited anecdotal data, such as with Simpson Stopper (*Myrcianthes fragrens*). Where data were conflicting or lacking, no rating was offered, such as with Blolly (*Guapira discolor*). Ratings will be refined as more data is received.

Note that these ratings were based on storm effects after a short period of time. Continued monitoring of landscapes, es-

Table 1. Wind tolerance ratings of Florida landscape trees<sup>a</sup>.

Botanical name	Common name	Rating
Eleven worst trees		
<i>Acacia auriculiformis</i>	Ear Leaf Acacia	Low
<i>Casurina</i> spp.	Australian Pine	Low
<i>Cercis canadensis</i>	Redbud	Low
<i>Ficus benjamina</i>	Weeping Fig	Low
<i>Pinus clausa</i>	Sand Pine	Low
<i>Prunus caroliniana</i>	Cherry Laurel	Low
<i>Quercus laurifolia</i>	Laurel Oak	Low
<i>Quercus nigra</i>	Water Oak	Low
<i>Syagrus romanzoffiana</i>	Queen Palm	Low
<i>Tabebuia</i> spp.	Golden shower tree	Low
<i>Ulmus parvifolia</i>	Drake Elm	Low-medium
Great trees for our windy times		
<i>Acer palmatum</i>	Japanese Maple	High
<i>Bursera simaruba</i>	Gumbo limbo	High
<i>Butia capitata</i>	Pindo Palm	High
<i>Cocoloba uvifera</i>	Sea grape	High
<i>Cornus florida</i>	Dogwood	High
<i>Eugenia axillaris</i>	White Stopper	High
<i>Eugenia confuse</i>	Redberry Stopper	High/very high
<i>Eugenia foetida</i>	Spanish Stopper	High
<i>Guaiacum sanctum</i>	Lignum Vitae	High/Very high
<i>Krugiodendron ferreum</i>	Ironwood	High
<i>Lagerstromia indica</i>	Crape Myrtle	High
<i>Magnolia grandiflora</i>	Southern Magnolia	High/Very high
<i>Persea borbonia</i>	Red Bay	High
<i>Phoenix canariensis</i>	Canary Island Date Palm	High/very high
<i>Phoenix dactylifera</i>	Date Palm	High
<i>Phoenix roebelenii</i>	Pygmy Date Palm	Very high
<i>Quercus geminata</i>	Sand Live Oak	High/very high
<i>Quercus virginiana</i>	Live Oak	High/Very high
<i>Roystonea elata</i>	Royal Palm	Very high
<i>Serenoa repens</i>	Saw Toothed Palmetto	Very high
<i>Thrinax radiata</i>	Thatch Palm	High
<i>Taxodium distichum</i>	Bald Cypress	High
<i>Wodyetia bifucata</i>	Foxtail Palm	High

<sup>a</sup>Ratings based on data collected for *Stormscaping* (Crawford, 2005).

pecially trees, will address long term survival of hurricanes impacted landscapes.

An additional component of the book is a discussion of the environmental and management factors that relate to wind tolerance. Among the factors influencing tree failure suggested by the 2004 storm events were the following: professional pruning, soil drainage, size of the planting space, soil compaction, proximity to buildings, multiple vs. solitary planting, length of establishment, age of the tree, height of the tree, and freedom from structural defects. It is recognized that some of these factors interact and may have multiplicative effects on wind tolerance.

As a method of communicating hurricane impacts, books may take several years to research, compile, edit, and produce. While the groundwork for this book was in mind for some time, the storm events of 2004 brought the concept to the forefront and events established a need. The rapid production and release of this book in a period of approximately six months is unusual. In six months, over 7,000 copies were distributed.

The public has relied on University of Florida Extension Master Gardeners as a reliable source of information for 26 years (Stephens, 2002). Not only are these Extension volunteers essential in communication information to the public, they are homeowners and horticultural consumers in their own right. It was felt that a survey of their experiences with communication methods in the aftermath of the 2004 storm season would elicit a collective summary of what methods were accessible to the public at large.

To understand how persons received information about post-hurricane landscape care, an informal survey of UF Master Gardeners was conducted. In May, 2005, 193 participants from 13 central and south central Florida counties participated in a one-day Master Gardener Training conference in Kissimmee. The audience was invited to complete a 6 question survey instrument and return it before the end of the day. Results are summarized in Tables 2-5.

The ability of homeowners to participate in landscape recovery operations involves, at a minimum, the utilities necessary to help do the work and the mental state to participate in the process. Electrical power was interrupted for many Floridians; Florida Power & Light (2004) reported that their customers were without power for between eight days (for Hurricane Jeanne) and 13 days (for Hurricane Charley). Nearly three-quarters of the survey respondents reported they were without power for periods of hours to weeks (Table 2).

Without electricity, modes of communication are hampered. Valuable battery or generator power is focused on other uses than the operation of televisions, radios, or computers—all instruments of mass communications which can get appropriate messages to the consumer. And, without power, some landscape tools used by homeowners become inoperative during recovery. Daily life often becomes too miserable to participate in landscaping activities.

Irrigation is critical to the survival of landscape plants that have suffered root damage. Irrigation water availability is often a function of electrical supply, as many personal wells are used to provide water to the landscape. In other cases, municipal water may be unsafe for human consumption after a storm and unavailable due to a reduction in pressure. More than one-quarter of the survey respondents reported relatively brief periods without water supplies, while another 27% lacked water for periods of several weeks (Table 2). The absence of irrigation water for many hurricane victims means that landscape recovery information must take into account that certain practices become unavailable after a storm event. Messages that give ideas on how to reduce plant water loss (e.g., mulching or foliage reduction) should be priority in the immediate messages after severe storms.

It is obvious that the basic human needs of food and shelter must be attended to before quality of life issues are addressed in recovery tasks. Educational messages and services targeted to property owners must be delivered when the teachable moment is at hand—if delivered too early, they will not be useful. Survey respondents were also asked how long it took them to begin tasks needed to get their landscapes back in order: 85% of these persons were ready to begin landscape recovery within weeks of the storm.

Because some persons with minimal storm impacts are ready to tackle the landscape soon after storms, a limited capacity to respond to individual questions would be valuable.

Table 2. Interruption of electrical power service.<sup>z</sup>

	Minutes to hours	Hours to days	Days to weeks	Weeks to months
How long were you without power?	18%	36%	38%	6%
How long were you without irrigation water?	27%	13%	27%	10%
How long after the storms did it take for you to begin thinking about landscape recovery?	22%	32%	29%	15%

<sup>z</sup>Percentages based on 78 respondents attending the May 2005 Master Gardener conference in Kissimmee, FL.

It is suggested that proactive educational programs for landscape recovery information begin first with updating available staff, and that more formal programs be delayed for a few weeks until a larger audience is ready to participate in landscape recovery.

Knowing what kind of informational resources were used to gain recovery messages may help direct future educational programs towards more effective communication. Data on landscape recovery information resources used are summarized in Table 3. The audience where this survey was conducted was composed of volunteer Master Gardeners, and the communication channels these volunteers use are often tied to Extension resources.

More than half used Extension as a source of information, and more than a third used Master Gardeners as a resource. One-seventh of these respondents were self-reliant on informational needs. It would be instructive to ask similar questions of a general audience to see if their responses matched the other responses of the survey participants.

Nearly a quarter of these person used electronic mass media as a way to get information about landscape recovery, while very few used computer websites as a delivery mode. Consider that many lacked electricity for several weeks. One-sixth of the respondents used print media or books as a source of information. Few among this group reported using emergency support agencies or horticultural business as a source of this kind of information. If this trend holds true among the general population, an opportunity exists among nurseries and garden centers to improve customer relations by offering landscape recovery advice during this critical time period.

Survey respondents were also asked *how they received* landscape recovery information. Their responses are summarized in Table 4. Responses were then collapsed into four categories that summarized the way contact was made with the respondents. More than two thirds of these persons received

Table 3. Sources of landscape recovery information.

Source	Respondents getting information from this source (%)
Cooperative Extension Service (organization)	54 <sup>z</sup>
Master Gardener (organization)	38
TV/ Radio (media)	23
Newspaper/ book (media)	17
Self (personal)	13
Website (media)	6
Emergency worker (organization)	3
Nursery or garden center (organization)	1
Other	1

<sup>z</sup>Percentages based on 78 respondents attending the May 2005 Master Gardener conference in Kissimmee, Fla.

their information through personal contacts with the person or organization that supplied the recovery information. More than half learned of recovery ideas from print media, with newspapers being the most commonly read source. One quarter of these persons learned about landscape recovery from electronic mass media, most popularly from television. Group meetings appeared to be the least likely way to reach this kind of audience.

Survey participants were asked to assess the timeliness and quality of the information resources they used. Data from these respondents is summarized in Table 5. Nearly three-quarters of the respondents felt the quality of information was sufficient for their needs and nearly two-thirds of these persons felt that the information was available at the right time. It is felt that the response may have been different if a non-Extension audience would have been surveyed.

## Conclusions

Based on these case studies and the responses from a limited survey of storm victims, it is suggested that preparation for landscape recovery messages can be provided to Florida

Table 4. Informational methods for receiving recovery information<sup>z</sup>

Method	Respondents getting information from this method (%)
Cooperative Extension service (personal contact)	35
Newspaper (print media)	35
Television (electronic media)	23
Master Gardener clinic (personal contact)	19
Presentation (group contact)	13
Bulletin (print media)	12
Meeting (group contact)	9
Books (print media)	9
Radio (electronic media)	5
botanical garden (personal contact)	4
Landscape (personal contact)	4
Nursery (personal contact)	3
Emergency worker (personal contact)	3
Newsletter (print media)	3
Magazine (print media)	1
Trade show (group contact)	1
Experienced resident (personal contact)	1
<b>Summary of grouped methods</b>	
Personal contacts	69
Print media	60
Electronic media	28
Group contact	23

Percentages based on 78 respondents attending the May 2005 Master Gardener conference in Kissimmee, Fla.

Table 5. Satisfaction with recovery information<sup>a</sup>

	Yes	No	(No response)
Quality of information	73%	13%	14%
Timeliness of information	62%	21%	18%

<sup>a</sup>Percentages based on 78 respondents attending the May 2005 Master Gardener conference in Kissimmee, FL.

residents before storms arrive. Documentation of storm effects by digital photography can be essential in communicating immediate information to outside interests, and can be used for followup educational efforts such as with web pages, media presentations or even the production of videos and books. There is a need to develop consistent record keeping methods and train personnel on how to document storm damage to landscapes.

While research-rigor surveys are essential to analyzing landscape plant and tree failure, anecdotal data may provide insight to appropriate landscape recovery communication methods and choices. Surveying impacted audiences reveals that most heavily impacted storm victims will not be concerned with landscape recovery until basic housing and utility issues are resolved. Proactive programming designed to educate storm victims about landscape recovery may need to wait for several months until a teachable moment can exist. Final-

ly, a limited survey of storm impacted residents indicates that personal contacts and newspapers may produce the high quality information needed to rapidly transfer landscape recovery information.

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Human Impacts - Altered Landscapes. - The alteration of beaches for development such as resorts, retirement centers, etc. could lead to the removal of protective habitat such as mangrove swamps. - Similarly, draining of swampland for development can increase the risk of hurricane impact. Human Impacts - Changing Hazards.Â Impacts - Storm Surge. - the rapid and large rise in water level as the water is pushed to the shoreline during the hurricane. - the height it reaches will be dependent on the size and speed of the storm. What is fetch?Â - Methods of warning and communicating include watches, media broadcasts and for immediate warning the use of sirens. - Evacuation plans and routes need to be well organized and designed for a large volume of traffic. Florida, Nicaragua and Honduras are still battling flood waters after this year's 28th storm, Hurricane Eta, inundated the regions with rain. The season could even stretch into winter: In 2005, Tropical Storm Zeta, the 28th that year, formed in late December.Â - "When it comes to climate change, I think one of the most straightforward impacts is increased rainfall. A warmer atmosphere holds more moisture," says Phil Klotzbach, an atmospheric scientist at Colorado State University.Â Kossin and Emanuel advise us to think of climate change impacts on hurricanes in terms of probabilities. As an example, Emanuel says, "We can say about Hurricane Harvey in 2017, the probability of that amount of rain was two to three times larger in 2017 than it was in 1970." From the people Hurricane Katrina impacted many families, leaving them homeless and with no access to food, water and other necessities. The people in New Orleans themselves went around the community trying to rescue people with the very little amount of possessions that they had. Elderly and people who were sick were dying.Â ...Hurricane Katrina is one of the worst natural disasters in the history of the United States of America. It took thousands lives of citizens of New Orleans, left them without homes and families, and changed their lives forever. Many of those who survived the hurricane died waiting for help to come. Hurricane Katrina exposed the existence of "two Americas". It took government several days to get help to the victims of Katrina in New Orleans. Such landscapes do not have to be a lost cause. Kremen and Merenlender review how biodiversity-based techniques can be used to manage most human-modified lands as "working landscapes." These can provide for human needs and maintain biodiversity not just for ecosystem services but also for maintenance and persistence of nonhuman species. Science, this issue p. eaa6020. A landscape that people have modified is called a cultural landscape. People and the plants they grow, the animals they care for, and the structures they build make up cultural landscapes. Such landscapes can vary greatly. They can be as different as a vast cattle ranch in Argentina or the urban landscape of Tokyo, Japan.Â The growth of technology has increased our ability to change a natural landscape. An example of human impact on landscape can be seen along the coastline of the Netherlands. Water from the North Sea was pumped out of certain areas, uncovering the fertile soil below. Dike s and dams were built to keep water from these areas, now used for farming and other purposes. Dams can change a natural landscape by flooding it.