Freeze Survival Survey of 21 Palm Species in New Orleans and Vicinity

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Summary. Landscape palms were surveyed for cold damage 8 to 10 months after the coldest weather episode recorded this century in the New Orleans, La., area. Fourteen genera and 21 species of palms totaling 9039 individuals were surveyed and assigned to one of three condition categories within six geographic areas. Area 1, north of Lake Pontchartrain, was not a reliable area for the majority of the 21 species found. South of Lake Pontchartrain, areas 2-6 were considered statistically better for overall palm survival, with area 3 best followed by areas 4, 2, 5, and 6. Although species survival depended somewhat on area, 10 species were found to be statistically reliable south of Lake Pontchartrain: *Brahea armata, Chamaedorea microspadix, Phoenix canariensis, Rhapidophyllum hystrix,* Sabal *mexicana, S. minor, S. palmetto, Sabal* spp., Sabal spp. seedlings, and *Trachycarpus fortune;. Two* species, Phoenix *reclinata* and *Phoenix* spp., were found to be marginal and seven species were found to be unreliable: *Butia capitata, Chamaerops humilis, Livistona chinensis, Rhapis excelsa, Syagrus romanzoffiana, Washingtonia filifera,* and *W. robusta.* Due to low individual numbers, survival for three species could not be reliably estimated: *Arenga engleri, Phoenix dactyfifera,* and *Serenoa repens.*

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Palms are monocotyledonous plants in the order *Arecales,* which are recognized as a natural and isolated family, the *Palmae* or *Arecaceae* (Tomlinson, 1990; Uhl and Dransfield, 1987). There exist some 200 genera and 2700 species, most of which occupy areas of mixed tropical and subtropical forests (Uhl and Dransfield, 1987).

Palms are used extensively in landscapes in warmer regions of the contiguous United States, principally Florida, the northern Gulf of Mexico coast, southern Texas, Arizona, and California. According to Tomlinson (1990), they are emblematic of tropical regions and their distinctive form commonly is associated with tropical plants. They long have been sought after by horticulturists, even as early as the 18th century. Today they still are highly prized by landscape designers, horticulturists, and collectors.

According to Uhl and Dransfield (1987), palms do have climatic limitations. They are found more in humid tropics and subtropics and are generally absent from semideserts and deserts unless a water source is present. Very few of the 2700 species occupy temperate regions. According to Larcher and Winter (1981), a restriction in distribution for palms is the ground frost limit. Roots are the most vulnerable organ of palms, and they are very susceptible to freeze injury (Larcher and Winter, 1981). Consequently, palms are unable to survive in regions where sufficient negative Celsius temperature durations develop in soil (Larcher and Winter, 1981).

In the New Orleans, La., area, USDA Cold Hardiness Zones 8B and 9A, 14 genera comprising 21 species have been identified in landscapes. Occasional advective freeze episodes (such as occurred in 1989) occur that cause various levels of damage and death to certain species. According to the National Weather Service (1989), the severe advective freeze of Dec. 1989 was by far the most significant of this century in New Orleans. Eighty-one of 82 h, beginning on 22 Dec. and ending on 25. Dec., were below 32F (0C). Temperatures were at or below freezing for a consecutive 64 h from 22 through 24 Dec. This was the worst of three coldest outbreaks ever recorded in New Orleans, with 15 h of 15F (-9.4C) or less occurring and a record low of 11F (-11.67C) on 23 Dec.

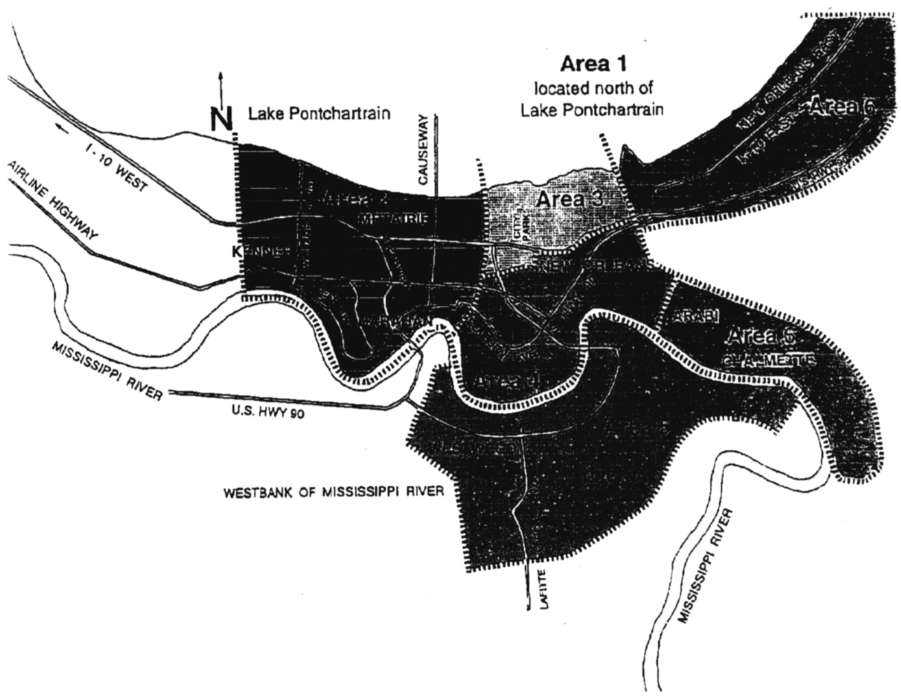

Fig. 1. ***Five geographical regions of metropolitan New Orleans where 9039 palms comprising 14 genera and 21 species were surveyed from 16 Aug through 30 Oct. 1990, for freeze damage. Area 1 is located north of Lake Pontchartrain and comprises St. Tammany and Washington parishes, La.***

Not only were low temperatures a factor, but also high winds contributed markedly to palm damage by desiccating plant tissues. In some cases, wind protection meant survival to certain species, such as *Washingtonia filifera* and *Livistona chinensis.*

Determination of freeze damage is often very hard to discern soon after the event, but becomes more apparent with time. Freezing temperatures can damage or destroy leaves, the apical bud, the trunk, or a combination of tissues. Depending on the palm spe-

Table 1. ***Percentages of overall palm species and conditions by areas.***

		Condition		
Area	**n**	**Good (r = 1)**	**Fair (r = 2)**	**Poor (r = 3)**
North of Lake Pontchartrain (Area 1)	254	47[NS]	31	22
Metro west (Area 2)	1826	65***	20	15
Central (Area 3)	2666	77***	14	9
Central south (Area 4)	1881	70***	12	18
Westbank (Area 5)	830	58***	22	20
East & southeast (Area 6)	1582	54**	19	27

,*,[NS] *Significant at* P = 0.01, ≤ 0.001, *or nonsignificant when comparing* r = 1 *to* r = 2 *and* r = 3.

Table 2. ***Percentages of palm species and conditions in Area 1 by species.***

		Condition		
Species	**n**	**Good (r = 1)**	**Fair (r = 2)**	**Poor (r = 3)**
Butia capitata	23	26**	30	43
Phoenix canariensis	2	50[z]	0	50
Phapidophyllum hystrix	7	57[NS]	29	14
Sabal minor	10	100***	0	0
Sabal palmetto	108	39**	36	25
Sabal spp. "quadrilogy"	3	100	0	0
Trachycarpus fortunei	101	52[NS]	31	17

[z] *Percentages statistically invalid due to low n.*
,*,[NS] *Significant at* P = 0.01, ≤ 0.001, *or nonsignificant when comparing* r = 1 *to* r = 2 *and* r = 3.

ties, various plant parts are affected differently. Trunk damage on *Phoenix canariensis* has been observed result-ing from prior freezes, especiallywithin 3 ft (0.9 m) from the ground. This reduces water conduction to the leaves permanently. This damage may not become apparent for years after the event. Larcher and Winter (1981) indicated that there was a positive correlation between growth activity and frost susceptibility, which led them to expect seasonal variations in the cold-sensitivity level. According to their work, simulated frost injury to juvenile *Trachycarpus fortunei* leaf bases, unfold-ing leaves, and shoot apices were found to be seasonal. These tissues were able to withstand colder temperatures in January than in May or July. However, there were few differences found in mature leaves (Larcher and Winter, 1982).

According to Donselman and Atilano (1981), when warm weather returns after a freeze, primary and/or secondary plant pathogens frequently attack damaged tissues. The extent of decay to severely damaged apical buds can cause death 3 months to several years after the freeze. Damaged trunk tissues also may be attacked, but the extent of damage is poorly understood. Significant cavities can occur, especially in *Butia capitata* and *Phoenix canariensis,* years after a severe freeze.

With so much palm damage apparent, a systematic survey was conducted to determine the extent of damage to palms in the metropolitan New Orleans area. There are accounts of various species of palms surveyed after cold episodes in Georgia (Manley, 1967); Dallas, Texas (Hintz, 1978); Daytona Beach, Fla. (Smith, 1964), and, more recently, at Fairchild Tropical Gardens in Miami, Fla. (Hubbuch, 1990). Another account of various palms surviving low temperatures was given by Popenoe (1973). However, no report of a systematic approach using thousands of palms and statistical analyses was found.

The main purpose of this study was to provide a systematic survey of cold-damaged plants. Several other purposes included the determination of the probability of success of the 2 1 species reported in various areas surrounding New Orleans.

Table 3. **Percentages of *palm species and conditions in Area 2 by species.***

Species	n	Condition		
		Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Arenga engleri	3	0[z]	100	0
Brahea armata	3	100[z]	0	0
Butia capitata	164	52[NS]	18	30
Chamaerops humilis	36	19***	75	6
Livistona chinensis	11	91***	9	0
Phoenix canariensis	84	81***	15	4
Phoenix dactylifera	1	0[z]	100	0
Phoenix reclinata	1	0[z]	100	0
Rhapidophyllum hystrix	9	100***	0	0
Sabal mexicana	8	100***	0	0
Sabal minor	39	97***	3	0
Sabal palmetto	791	57***	21	22
Sabal spp. "quadrilogy"	4	100[z]	0	0
Sabal spp. seedlings	33	100***	0	0
Trachycarpus fortunei	594	77***	20	3
Washingtonia filifera	40	13***	10	77
Washingtonia robusta	5	0[z]	0	100

[z]*Percentages statistically invalid due to low n.*
***,[NS]*Significant at P £ 0.001 or nonsignificant when comparing* r = 1 *to* r = 2 *and* r = 3.

Table 4. ***Percentages of palm species and conditions in Area 3 by species.***

Species	n	Condition		
		Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Brahea armata	2	100[z]	0	0
Butia capitata	101	67***	15	18
Chamaedorea microspadix	34	82***	18	0
Chamaerops humilis	42	36*	64	0
Livistona chinensis	35	23**	29	48
Phoenix canariensis	476	69***	21	9
Phoenix reclinata	3	67[z]	33	0
Rhapidophyllum hystrix	2	100[z]	0	0
Rhapis excelsa	8	0**	100	0
Sabal mexicana	545	75***	15	10
Sabal minor	7	100***	0	0
Sabal palmetto	388	67***	18	15
Sabal spp. "quadrilogy"	177	80***	11	9
Sabal spp. seedlings	577	97***	1	2
Trachycarpus fortunei	251	83***	14	3
Washingtonia filifera	15	27*	13	60
Washingtonia robusta	3	0[z]	0	100

[z]*Percentages statistically invalid due to low n.*
*,**,****Significant at P* = 0.05, 0.01, *or £ 0.001,* or nonsignifcant when *comparing r = 1 to r =2 and r = 3.*

Materials and methods

The survey began 16 Aug. 1990, -8 months after the freeze, and ended 30 Oct. 1990. Initially, metropolitan New Orleans was divided into 20 geographical regions. Randomly selected streets, both with and without a known high population ofexisting palms, were surveyed. All or part of 20 days totaling 57.25 h were spent traveling-l 125 miles by automobile.

Twenty-one species of palms comprising 14 genera were found on both private and public properties and were assigned initially to one of seven condition categories:

1) no visible freeze-related injury to either leaves or trunk;

2) lost most or all foliage but replaced them with vigorous new growth in early to mid-spring;

3) lost foliage but replaced them slowly with half-size and narrower new leaves;

4) lost foliage and barely resprouted new growth with leaf size and shape severely malformed, small, and spindly;

5) lost all foliage, resprouted, but new growth died soon after emergence;

Table 5. ***Percentages of palm species and conditions in Area 4 by species.***

Species	n	Condition Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Brahea armata	1	100[z]	0	0
Butia capitata	67	46[NS]	28	26
Chamaerops humilis	24	63[NS]	25	12
Livistona chinensis	119	8***	30	62
Phoenix canariensis	507	82***	8	10
Phoenix dactylifera	2	100[z]	0	0
Phoenix reclinata	2	0[z]	100	0
Phoenix spp. (hybrid?)	7	43[NS]	28	29
Rhapidophyllum hystrix	4	100[z]	0	0
Sabal mexicana	165	82***	9	9
Sabal minor	79	100***	0	0
Sabal palmetto	423	75***	13	12
Sabal spp. "quadrilogy"	44	98***	0	2
Sabal spp. seedlings	83	100***	0	0
Syagrus romanzoffiana	6	0**	0	100
Trachycarpus fortunei	218	76***	19	5
Washingtonia filifera	50	12***	4	84
Washingtonia robusta	80	1***	0	99

[z]Percentages statistically invalid due to low n.
,*,[NS]Significant at P = 0.01, ≤ 0.001, or nonsignificant when comparing r = 1 to r = 2 and r = 3.

Table 6. ***Percentages of palm species and conditions in Area 5 by species.***

Species	n	Condition Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Butia capitata	62	45[NS]	36	19
Chamaerops humilis	16	38[NS]	62	0
Livistona chinensis	2	100[z]	0	0
Phoenix canariensis	37	86***	14	0
Phoenix reclinata	2	100[z]	0	0
Sabal mexicana	1	100[z]	0	0
Sabal minor	6	100***	0	0
Sabal palmetto	461	50[NS]	22	28
Sabal spp. "quadrilogy"	2	100[z]	0	0
Sabal spp. seedlings	6	100***	0	0
Trachycarpus fortunei	218	77***	20	3
Washingtonia filifera	11	27[NS]	18	5
Washingtonia robusta	6	0**	0	100

[z]Percentages statistically invalid due to low n.
,,[NS]Significant at P = 0.01, £ 0.001, or nonsignificant when comparing r = 1 to r = 2 and r = 3.*

6) lost their foliage but did not resprout; and

7) lost their foliage, did not resprout, and trunks were either broken in two or had fallen over, indicating death of the apical meristem.

For purposes of statistical analyses and to provide more-reliable estimates of survival, the initial 20 geographical regions were reduced to six. They are area 1, north of Lake Pontchartrain; area 2, metro west; area 3, central; area 4, central south; area 5, west bank (geographically south); and area 6, east and southeast (Fig. 1). The initial seven condition categories were reduced to three. Categories one and two were combined (good condition, r = 1), categories three and four were combined (fair condition, r = 2) and categories five, six, and seven were combined (poor condition, r = 3). In all statistical analyses, the percentage of palms doing well (condition category 1) was compared to the combined percentage doing fairly or poorly (condition categories 2 and 3) using the binomial test.

Results and discussion

The total number of palms in the six geographic regions and the percent in each category condition are given in Table 1. North of Lake Pontchartrain is unacceptable forplanting most palms (Table 1). There was no statistical difference between the percent doing well (47%) and the percent doing fairly or poorly (5 3%). Overall palm survival was best south of Lake Pontchartrain, with the central (area 3) and central south (area 4) areas of the city showing the greatest percent survival rates.

Only seven palm species, comprising a total of 254 individuals, were found growing in area 1 (north of Lake Pontchartrain) (Table 2), and among those only *Subal* minor can be recommended highly for survival. *Rhapidophyllum hystrix* and *Trachycarpus fortunei* were determined to be marginally suitable. *Butia capitata* and *Sabal palmetto* should not be considered for planting on the north shore because there was statistically more damage to these palms.

Phoenix canariensis and Sabalspp. quadrilogy representation was too low to analyze statistically. There was difficulty in identifying a *Sabal* palm intermediate between of *S. mexicana* and *S. palmetto.* The coined term, *Sabal* spp. quadrilogy, is used because four species could be involved *(S. umbraculifera, S. blackburniana, S. domingensis,* or *S. bermudana)* until positive identification can be made.

In area 2, suburbs west of the city, 10 genera and 16 species were represented among palms surveyed (Table 3). Eight species were found to be reliable forplanting: *Livistona chinensis, Phoenix canariensis, Rhapidophyllum hystrix, Sabal mexicana, S. minor, S. palmetto, Sabal* spp. seedlings, and *Trachycarpus fortunei.* Although *Livistona chinensis* was determined to be reliable for planting, too few were represented to make a recommendation. *Butia capitata* was marginally reliable in this area, whereas *Chamaerops humilis* and *Washingtonia filifera* were not reliable.

In area 3, close to Lake Pontchartrain but in the center of the city (west to east) (Table 4), eight species were found to be statistically reliable for planting: *Butia capitata, Chamaedorea microspadix, Phoenix canariensis, Sabal minor, S. palmetto, Sabal* spp. quadrilogy, *Sabal* spp. seedlings, and *Trachycarpus fortunei.* It should be noted that *Sabal* spp. seedlings and *Sabal* spp. quadrilogy are grouped as one species because they are thought to be so interrelated. *Butia capitata* was more reliable in this area. This

Table 7. *Percentages of palm species and conditions in Area 6 by species.*

Species	n	Condition		
		Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Brahea armata	1	0^{z}	0	100
Butia capitata	183	31^{***}	22	47
Chamaerops humilis	13	38^{NS}	54	8
Livistona chinensis	3	67^{z}	0	33
Phoenix canariensis	134	52^{NS}	27	21
Phoenix reclinata	8	38^{NS}	50	12
Rhapidophyllum hystrix	2	100^{z}	0	0
Rhapis excelsa	1	0^{z}	100	9
Sabal mexicana	21	100^{***}	0	0
Sabal minor	96	97^{***}	3	0
Sabal palmetto	738	50^{NS}	16	34
Sabal spp. "quadrilogy"	9	100^{***}	0	0
Sabal spp. seedlings	52	94^{***}	6	0
Serenoa repens	1	100^{z}	0	0
Trachycarpus fortunei	269	61^{***}	32	7
Washingtonia filifera	24	21^{**}	17	62
Washingtonia robusta	27	0^{***}	4	96

[z]*Percentages statistically invalid due to low n.*
,*,[NS]*Significant at P = 0.01, ≤ 0.001, or nonsignificant when comparing* r = *1 to* r = *2 and* r = *3.*

Table 8. *Percentages of palm species and conditions in* **all areas** *combined by species.*

Species	n	Condition		
		Good (r = 1)	Fair (r = 2)	Poor (r = 3)
Arenga engleri	3	0^{z}	100	0
Brahea armata	7	86^{**}	0	14
Butia capitata	600	46^{*}	22	32
Chamaedorea microspadix	34	82^{***}	18	0
Chamaerops humilis	131	37^{***}	58	5
Livistona chinensis	170	19^{***}	28	53
Phoenix canariensis	1240	74^{***}	16	10
Phoenix dactylifera	3	67^{z}	33	0
Phoenix reclinata	16	44^{NS}	50	6
Phoenix spp. (hybrid?)	7	42^{NS}	29	29
Rhapidophyllum hystrix	24	88^{***}	8	4
Rhapis excelsa	9	0^{***}	100	0
Sabal mexicana	740	77^{***}	13	10
Sabal minor	237	98^{***}	2	0
Sabal palmetto	2909	57^{***}	19	24
Sabal spp. "quadrilogy"	239	85^{***}	8	7
Sabal spp. seedlings	751	97^{***}	2	1
Serenoa repens	1	100^{z}	0	0
Syagrus romanzoffiana	6	0^{**}	0	100
Trachycarpus fortunei	1651	73^{***}	22	5
Washingtonia filifera	140	16^{***}	10	74
Washingtonia robusta	121	1^{***}	1	98
Total n =	**9039**			

[z]*Percentages statistically invalid due to low n.*
*,**,***,[NS]*Significant at P =0.05, 0.01, ≤ 0.001, or nonsignificant when comparing* r = *1 to* r = *2 and* r = *3.*

Butia palm was almost as reliable as *Phoenix canariensis,* which appeared very reliable in all but areas 1 and 6. Also, *P. canariensis* was found to be highly statistically reliable when compared to all species over all areas (74%, $P < 0.001$). Four species, *Chamaerops humilis, Livistona chinensis, Rhapis excelsa,* and *Washingtonia filifera* are not recommended for planting in area 3 because they were damaged more often. In area 4, in the center of the city and south of area 3 (Table 5), six species were found to be reliable: *Phoenix canariensis, Sabal mexicana, S. minor, S. palmetto, Sabal* spp. seedlings, and *Trachycarpus fortunei.* Four species, *Livistona chinensis, Syagrus romanzoffiana, Washington filifera,* and *Washington robusta,* are not recommended for planting in area 4.

Area 5 is on the west bank of the Mississippi River (actually south of area 4) (Table 6), and four species can be recommended for planting: Phoenix *canariensis, Sabal minor, Sabal* spp. seedlings, and *Trachycarpus fortunei. Sabal* spp. seedlings, which have apical buds relatively close to the ground, were protected more from cold, desiccating winds than were their taller-growing counterparts-this is thought to be the reason for higher survival. *Sabal palmetto* was found to be marginal, as were *Butia capitata, Chamaerops humilis,* and *Washingtonia filifera. Washingtonia robusta* was the only palm found to be unreliable.

In area 6, located to the east and southeast of the central city (Table 7), four species were found to be reliable for planting: *Sabal mexicana, S. minor, Sabal* spp. quadrilogy, *Sabal* spp. seedlings, and *Trachycarpus fortunei.* Four species were found to be marginal, including *Chamaerops humilis, Phoenix canariensis, P. reclinata,* and *Sabal palmetto.* Three species, *Butia capitata, Washingtonia filifera,* and *W. robusta,* were found unreliable for planting. *Sabal palmetto,* found to be marginal in this area, may have been placed in this category because of statistical combination of data. At one new landscape site, 114 S. palmetto palms were planted in Spring 1988. Of that population, four were assigned good condition (r = 1), six fair condition (r = 2), and 104 poor condition (r = 3). By combining the data of this site, which was originally a separate site, with the rest of the data in area 6, it is thus possible that *S. palmetto* may be more reliable than is indicated by these results.

In examining all species over all areas (Table 8), nine species appeared to be statistically reliable for planting: *Brahea armata, Chamaedorea microspadix, Phoenix canariensis, Rhapidophyllum hystrix, Sabal mexicana, S. minor, S. palmetto, Sabal* spp. quadrilogy, *Sabal* spp. seedlings, and *Trachycarpus fortunei.*

The reliability of two species, *Phoenix reclinata* (44%) and *Phoenix* spp. hybrid (42%), were found to be marginal. *Phoenix reclinata* will not be a reliable tall-growing landscape accent plant but it may live through most cold episodes.

Palms found to be statistically unreliable included *Butia capitata, Chamaerops humilis, Livistona chinensis, Rhapis excelsa, Syagrus romanzoffiana, Washingtonia filifera,* and *W. robusta. Rhapis excelsa* plant rhizomes and roots were not killed, but all that were surveyed had leaves and trunks that were killed to ground level. The species grows so slowly and with such sparse growth resulting after the freeze that it would not be acceptable as a reliable landscape plant in any area.

Three palms had low representation and could not be evaluated statistically. However, *Arenga engleri* behaved the same way as *Rhapis excelsa.* Over the past 30 years, *Phoenix dactylifera* has experienced a steady decline in cultivated populations in the study area due to cold temperatures, while *Serenoa repens,* a endangered species native to Louisiana, has declined not from cold episodes but from habitat decimation.

Conclusion

This study outlines a procedure by which cold-damaged plants can be surveyed to serve as a future potential planting guide. It also provides a good inference as to the survivability of landscape palms in the New Orleans area. The results also may be used in other sites within USDA Hardiness Zones 8B and 9A. Consumers and growers alike can benefit from this survey because growers can determine the probability of success of 21 palm species and grow those with greatest potential. Consumers, including professional landscape industry personnel, also will know which species are likely to survive in a landscape planting and can select those that are most cold-hardy.

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