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The Groundhog Day Florida Tornadoes: A Case Study of High-Vulnerability Tornadoes

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Abstract

On February 2, 2007, a severe thunderstorm moving across central Florida spawned three tornadoes, which resulted in 21 deaths in the second-worst tornado outbreak in state history. The outbreak exhibited three vulnerabilities for tornado casualties revealed by prior research: The tornado hit at night, during a fall or winter month, and in an area with a large proportion of manufactured homes. We combine property and damage characteristics to examine risk factors for fatalities in this high-vulnerability event. All the fatalities occurred in mobile homes, and 16 of 17 fatalities for which we have property characteristics occurred in homes that were leveled. Newer manufactured homes were 60% less likely to be leveled than older homes, which is evidence that the stricter construction and tie-down codes enacted by the Department of Housing and Urban Development and the state of Florida after Hurricane Andrew and the 1998 tornado outbreak are saving lives.

Introduction

During the overnight hours of February 2, 2007, a line of thunderstorms moving across central Florida spawned three tornadoes. The tornadoes struck Sumter, Lake, and Volusia counties between 3 a.m. and 4:30 a.m., and killed 21 people in the second-deadliest tornado outbreak in Florida history. The first tornado struck The Villages in Sumter County and Lady Lake in Lake County, was rated EF-3 on the Enhanced Fujita Scale, and killed eight people. The second tornado, also rated EF-3, struck the Lake Mack area of Lake County and near Deland in Volusia County. The third tornado, rated EF-1, struck New Smyrna Beach in Volusia County. These tornadoes contributed to a nationwide tornado fatality total in 2007 that by the end of May exceeded the total for all of 2006.

The Groundhog Day Florida tornadoes are of interest to researchers because they exhibit three societal vulnerabilities. Statistical analysis demonstrates that tornado casualties are higher when tornadoes strike mobile homes, at night, and during "off peak" months like February, instead of the late spring or summer. Bringing casualties of tornadoes with these vulnerabilities into line with those occurring at other times or hitting permanent homes could substantially reduce the annual tornado death toll. Statistical analysis, however, only reveals patterns and provides little insight as to why tornadoes with these vulnerabilities produce more casualties. We examine the February 2, 2007, Florida tornadoes as a case study of a high-vulnerability tornado event. The Groundhog Day tornadoes raised other research questions, including the value of tornado sirens and the vulnerability of the elderly and hearing-impaired persons.

Lake County, Florida: A Tale of Two Tornadoes

All 21 fatalities on February 2 occurred in Lake County, a sprawling county of 1,163 square miles and population of nearly 300,000, northwest of Orlando. But the areas in Lake County struck by the

two tornadoes were very dissimilar. The Villages and Lady Lake in northwestern Lake County are home to many affluent retirees, while the Lake Mack area in northeastern Lake County is a rural, poor area near the Ocala National Forest. Table 1 displays demographic characteristics from the 2000 census for the state of Florida, Lake County, Sumter County, and Volusia County, and the tornado paths within Lake County. The demographic variables for the tornado paths are constructed using the census blocks in Lake County struck by the tornadoes.

Data of Lake and Sumter Counties differ from Florida averages in several notable ways. Lake and Sumter are fast-growing counties, even relative to a fast-growing state, with 38% and 29% population increases between 2000 and 2006, respectively. The counties are less urban, with older, more Caucasian populations than the state as a whole. Both counties are home to a large number of new Floridians, many of whom are presumably retirees; nearly a quarter of Sumter County residents in 2000 lived in another state in 1995. The residents of the counties have lower educational attainment and are more likely to live in mobile homes than other Floridians. Median household income is slightly below the state, which might be a result of the high proportion of retirees.

Table 1 also reveals the differences between the Lady Lake and Lake Mack tornado paths. The Lady Lake area resembles Lake and Sumter Counties overall, with 26% of residents over age 65 and an urban population of around 65%. The Lake Mack area is entirely rural, relatively poor (median income is 74% that of Lake County), overwhelmingly Caucasian (nonwhite and Hispanic populations are both less than 5%), and has low educational attainment (6% college graduates). Mobile homes comprise 43% of housing units in Lady Lake and 72% in Lake Mack. The housing stock in Lake Mack is also notably older, with a median year built of 1979, which implies many older mobile homes in the area. The populations of each area are thus vulnerable to nighttime tornadoes. Lady Lake is vulnerable due to many elderly persons living in manufactured homes, and Lake Mack is vulnerable due to a preponderance of older manufactured homes.

Table 1. Demographic characteristics

	Florida	Sumter	Lake	Volusia	Lady Lake	Lake Mack
Population Change	+13.2%	+28.9%	+38.0%	+12.0%	N.A.	N.A.
% Urban	89.3	49.4	69.6	90.7	64.4	0.0
% Nonwhite	22.0	18.0	12.5	13.8	8.2	4.8
% Hispanic	16.8	6.1	5.6	6.6	3.8	4.0
% Under 18	22.7	16.2	20.3	20.2	21.0	25.6
% Over 65	17.6	27.6	26.4	22.1	26.2	14.3
% Diff State	12.4	24.0	14.7	13.9	16.2	6.7
% College	22.5	12.2	16.6	17.6	11.4	6.3
% Poverty	12.5	13.7	9.6	11.6	10.6	18.1
Mobile Homes	11.6	37.7	29.7	11.5	42.9	71.8
Year Built	1980	1987	1984	1979	1987	1979
Median Income	$38,819	$32,073	$36,903	$35,219	$35,116	$27,350

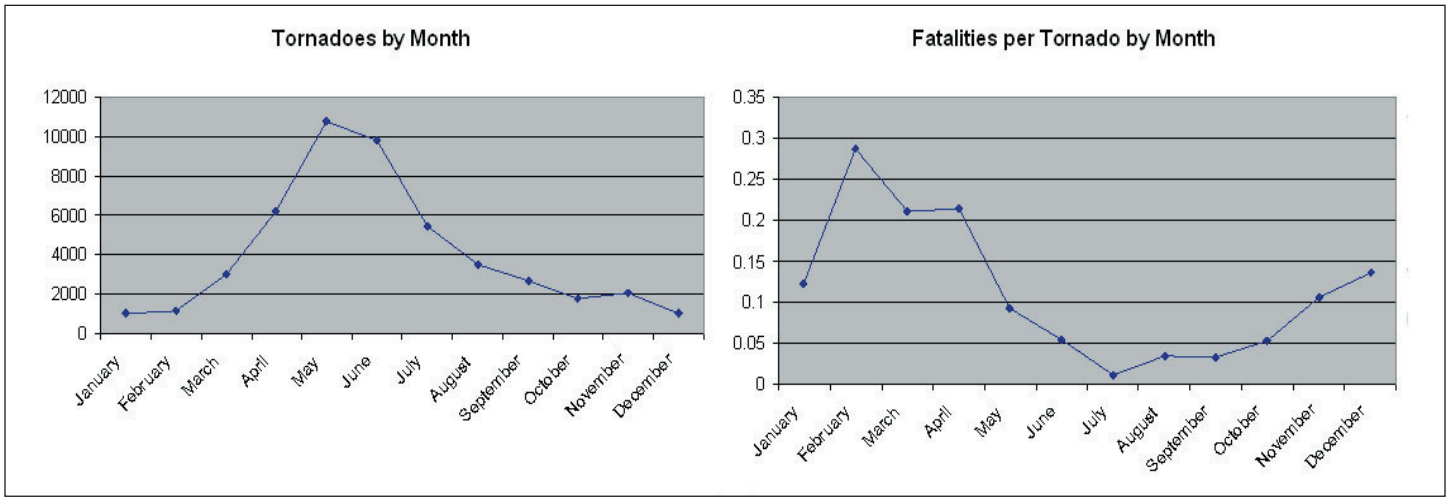
Risk Factors for Tornado Casualties

Regression analysis reveals several factors (some obvious, others less so) that strongly affect tornado fatalities and injuries (Simmons and Sutter 2005, 2007a). Mobile homes are a widely recognized risk factor for death in tornado fatalities. Between 1985 and 2006, 42% of tornado fatalities occurred in mobile homes, even though they comprised less than 8% of U.S. housing units in 2000. The fatality rate for residents of mobile homes is 10 to 15 times higher than the rate for residents of permanent homes (Brooks and Doswell 2002, Simmons and Sutter 2006). Regression analysis shows that if mobile homes comprise an additional one percent of county housing units, expected fatalities increase by six percent (Simmons and Sutter 2007a).

Tornadoes after dark are substantially more dangerous. The warning process proceeds more slowly at night (Sorensen 2000); Paul et al. (2003) found that the percentage of residents who received a warning in the May 4, 2003, tornado outbreak was significantly lower for tornadoes at night. After controlling for tornado and path characteristics, Simmons and Sutter (2007a) find that expected fatalities and injuries are 64% and 43% lower when a tornado occurs during the day (between 6 a.m. and 6 p.m. local time), rather than overnight (midnight to 6 a.m.). While lower daytime casualties demonstrate that tornado warnings and warning responses save lives, casualties would be lower if nighttime tornadoes were no more lethal than daytime tornadoes.

Time of the year also matters for casualties. While tornadoes occur most frequently in the late spring and summer, tornadoes during the fall or winter, the "off season,"

Figure 1. Tornadoes and fatalities by month, 1950-2005



actually are more dangerous, everything else equal. Figure 1 displays the number of tornadoes nationally and fatalities per tornado by month, based on tornadoes from 1950 to 2005. March through August are the most active months nationally for tornadoes, but fatalities per tornado are lower in the most active months. Regression analysis, controlling for storm strength and path characteristics, confirms the relationship apparent in Figure 1. Expected fatalities and injuries are 15% and 22% lower for tornadoes during the "season" than during off-peak months (Simmons and Sutter 2007a). One possible explanation is greater awareness on the part of residents that ominous thunderstorms might produce tornadoes during the spring and summer, with that awareness translating into better response to a warning.

Table 2. State tornado casualties in February, 1950-2006

Fatalities		Injuries	
State	Percentage	State	Percentage
1. Mississippi	37.6	1. Mississippi	39.5
2. FLORIDA	31.7	2. Missouri	40.1
3. Georgia	13.4	3. FLORIDA	16.8
4. Missouri	11.1	4. Tennessee	14.2
5. Tennessee	4.9	5. California	12.6

Table 3. State tornado casualties at night, 1950-2006

Fatalities		Injuries	
State	Percentage	State	Percentage
1. FLORIDA	46.8	1. West Virginia	50.5
2. Kansas	40.7	2. Louisiana	40.1
3. Georgia	37.0	3. Missouri	39.3
4. Louisiana	28.7	4. Georgia	29.9
5. Tennessee	27.1	5. FLORIDA	29.5

Characteristics of Florida Tornadoes and Tornado Fatalities

Florida tornadoes and casualties reflect these vulnerability factors. Over the past 125 years, including the Groundhog Day tornadoes, over 30% of Florida tornado deaths have occurred in February, more than double the total in the next deadliest month (NWS Melbourne). But Florida tornado outbreaks are close to uniformly distributed across the year (Hagemayer 1997), so tornadoes in February seem especially dangerous. Table 2 shows that between 1950 and 2006, Florida ranked second and third nationally in the percentage of state tornado deaths and injuries occurring during February. Florida tornado fatalities are also particularly likely to occur at night. Since 1882, 40% of Florida tornado fatalities have occurred between midnight and 6 a.m., more than in any other six-hour segment of the day (NWS Melbourne). Table 3 shows that since 1950, Florida ranks first and fifth nationally in the percentage of deaths and injuries between 10 p.m. and 6 a.m. And a disproportionately large percentage of Florida tornado fatalities occur in manufactured homes. Table 4 shows that between 1995 to 2006, Florida ranks fourth nationally with 33 mobile home fatalities. Fifty-eight percent of Florida tornado fatalities during the period were in mobile

Table 4. State tornado fatalities in mobile homes, 1995-2006

State	Mobile Home Fatalities	% of State Tornado Fatalities
T1. Alabama	44	53.0
T1. Georgia	44	86.3
3. Tennessee	41	46.1
4. FLORIDA	33	57.9
5. Arkansas	26	44.8

homes, well above the national figure of 43% in the same years. This cannot be explained entirely by a preponderance of mobile homes, because mobile homes comprise only about 12% of Florida housing units (see Table 1).

As a final observation on Florida tornado casualties, Table 5 presents the states with the largest proportion of casualties occurring in tornadoes rated F3 or weaker on the Fujita scale between 1950 and 2005 (among states with at least 50 tornado fatalities). Nationally, the 1.2% of tornadoes rated F4 or F5 account for 64% of fatalities and 50% of injuries. In Florida, however, 92% of fatalities and 83% of injuries occurred in F3 or weaker tornadoes, percentages that respectively ranked Florida first and second nationally among states with at least 50 fatalities over the period. Nationally, tornadoes rated F3 or weaker are collectively not extremely deadly, and rarely produce large fatality events. But in Florida and the Southeast, F2 and F3 tornadoes account for the bulk of casualties.

The Groundhog Day tornadoes exhibit three risk factors for tornado casualties. Statistical analysis reveals that casualties would be lower if tornadoes struck during the day instead of at night, during the late spring or summer rather than in the fall or winter, and if residents were in permanent homes instead of mobile homes. The lower casualty rates in daytime and summer tornadoes and for those in permanent homes indicate that society can better protect against tornadoes. Statistical analysis, however, provides little insight into why casualties are higher or if reductions in casualties in high-vulnerability tornadoes would be practical or affordable. For example, building 2,000-square-foot permanent homes at taxpayer expense for all residents of mobile homes would reduce tornado fatalities, but would be excessively costly. Our case study provides evidence on the potential for reducing casualties in high-vulnerability conditions.

Table 5. Percentage of state casualties occurring in tornadoes rated F3 or weaker on Fujita scale, out of all states with at least 50 fatalities, from 1950 to 2006

Fatalities		Injuries	
State	Percent	State	Percent
1. FLORIDA	92.1	1. Georgia	84.5
2. Georgia	74.5	2. FLORIDA	83.2
3. North Carolina	60.1	3. Louisiana	71.4
4. South Carolina	52.8	4. South Carolina	67.8
5. Tennessee	52.2	5. Tennessee	63.2

Groundhog Day Tornado Victims and Warnings

Ten males and eleven females died in the Groundhog Day tornadoes, and the victims ranged in age from 6 to 92, with an average age of 49.6 years. The average and distribution by age of the victims in Lake County overall are in line with nationwide totals from 1995 to 2006. But the ages of the victims in the Lady Lake and Lake Mack tornadoes differed noticeably. Six of the eight victims in Lady Lake were 66 or older, with an average age of 66, while the average age in Lake Mack was 39.5 years. The age difference of the victims reflects the difference in the proportions of young and old persons the tornado path demographics shown in Table 1.

The Storm Prediction Center issued a tornado watch that included Sumter, Lake, and Volusia Counties at 12:50 a.m., a little over two hours before the event. The Melbourne National Weather Service (NWS) office issued a warning for Lake County at 3:06 a.m. The first tornado began in Sumter County at 3:08 a.m. and moved into Lake County shortly afterward, lifting at 3:25 a.m. Therefore, the official lead time is around 10 minutes for the Lady Lake tornado. The Lake Mack tornado began at 3:37 a.m., with a warning lead time of 31 minutes—well above the national average tornado warning lead time. Thus the Groundhog Day tornadoes were well warned. While the lead time in Lake County for the Lady Lake tornado is below the national average, it is still in the 6 to 10 minute lead time range, identified by Simmons and Sutter (2007) as the range in which the largest reduction of fatalities is seen. False alarms should not have been too great of a problem in deterring response, as 26 tornado warnings were issued for Lake County between 1986 and 2004, and the false alarm rate was .654 (below the national average over these years of .77). The false alarm rate for Volusia County was .720. Over the period, Lake County spent 1,324 minutes under tornado warnings, or 22 hours in 19 years. False alarms and excessive warnings should not have been a particular problem for Lake County. One point worth noting about watches and warnings is that the watch was issued after midnight, after primetime television and the late local news, so many residents could have gone to sleep unaware of the potential for tornadoes during the night. This might have slowed response if residents were awakened during the night by the thunderstorm.

Home Quality and Tornado Fatalities

To explore risk factors for the fatalities, we obtained a damage assessment on and building characteristics of properties in the tornado paths from the Lake County Tax Assessor's Office. Our goal was to examine the relationship between home characteristics, damage, and casualties.

All 21 fatalities in the Groundhog Day tornadoes occurred in mobile homes, so the short version of a risk assessment for fatalities would be residence in a mobile home. Analysis though reveals two notable patterns. The first involves the damage level of properties. The Lake County Tax Assessor used a six-point, 0 to 5, scale of damage, with 0 indicating no damage, 4 a destroyed property, and 5 a leveled property. Ratings of 4 or 5 represent equivalent values of damage, since the structure is a total loss in both cases. The leveled structures were flattened or blown away, with little of the structure remaining in place.

Almost all of the fatalities in the Groundhog Day tornadoes occurred in leveled structures. The 21 fatalities occurred in 13 different mobile homes. We were able to match the fatality locations with individual property characteristics from the tax appraiser for 9 of these 13 homes. Eight of these mobile homes had a damage level of 5, while the other home had a damage level of 2. Sixteen of the 17 fatalities in these homes occurred in the eight leveled homes. The remaining fatalities were in the Lady Lake and Sunshine Mobile Home Parks, and for these properties we have only totals for the number of units damaged and destroyed, not a damage assessment or characteristics for the individual units. Preventing a manufactured home from being leveled was an important factor in avoiding fatalities in Lake County.

Table 6 presents the distribution of properties in the tornado paths by damage level for mobile homes and other homes. A difference in the distribution of damage levels is readily apparent. The average damage level for mobile homes is 2.2, with 19% damaged at level 5 and 38% with damage level 0. For other homes, the average damage level is 1.3, with 2.4% damaged at level 5 and almost half of homes, 48%, with damage level 0.

The second result from the analysis concerns home age. The Department of Housing and Urban Development (HUD) issued the Federal Manufactured Home Construction and Safety Standards, or the HUD Code, effective June 15, 1976, and HUD and the state of Florida implemented new requirements for mobile homes after Hurricane Andrew, effective in 1995 and 1999. The third through fifth rows of Table 6 display the distribution of damage levels for mobile homes by year built, comparing homes built in 1975 or earlier to those built from 1976 to 1994 and from 1995 to the present. Newer mobile homes were less likely to be destroyed or leveled than older homes: 24% of mobile homes built in 1975 or earlier were leveled, as compared to 20% of homes built between 1976 and 1994 and 9% of homes built since 1995. The reduction in the proportion of leveled homes for those built post-Andrew is statistically significant.[1] Since deaths occurred almost exclusively in leveled mobile homes, this reduction in damage level is quite significant in potentially reducing fatalities.[2] The fraction of leveled damage among homes built since 1995 was reduced by 60%, compared to the fraction leveled for homes built before 1995. The post-Andrew manufactured homes wind resistance and tie-down provisions were shown by Grosskopf (2005) to substantially reduce damage to manufactured homes in the 2004 hurricanes. Our results here suggest, given the preponderance of fatalities in leveled mobile homes, that the post-Andrew requirements might in time reduce mobile home tornado fatalities by 60%. At the other end of the scale, 52% of the newest mobile homes received damage of 0, compared with 40% of homes built between 1976 and 1994, and 30% of the oldest homes.[3] A direct analysis of the age of the homes where fatalities occurred confirms the importance of age. None of the nine homes with fatalities for which we have tax appraiser data was built after 1994.

Tornado Sirens and Fatalities in the February 2 Tornadoes

Lake County, like most other counties in Florida, does not have tornado sirens. The lack of sirens produced controversy in the aftermath of the Groundhog Day tornadoes, and many residents were upset. One resident of Lake County whose

Table 6. Distribution of damage levels of mobile homes and other buildings

	0	1	2	3	4	5
Permanent Homes	47.4	2.1	30.8	13.0	4.0	2.4
Mobile Homes	38.5	2.5	13.7	12.6	13.3	19.4
1995-present	52.2	4.3	19.6	6.5	8.7	8.7
1976-1994	39.6	1.4	12.5	15.3	11.1	20.1
Pre-1976	29.5	3.4	12.5	11.4	19.3	23.9

home was destroyed remarked, "What we need is a damn siren! Some kind of wake-up call! There's a lot of people who got hurt and killed" (quoted in Damron 2007). Other residents appeared under the impression that the area did have sirens and figured that sirens would alert them if there was a tornado, so a lack of blaring sirens was interpreted as implying no danger. Tiefenbacher et al. (2001) found that residents of Siren, Wisconsin, expected the town's sirens to sound during a June 2001 tornado event, but the town's sirens had been knocked out by a lightning strike the month prior. Table 1 illustrated that a large proportion of Lake and Sumter County residents had recently moved to Florida. If new Floridians were from states where sirens are prevalent, they may assume their new Florida community has sirens. The lack of a siren warning may result in an entirely unwarranted sense of security.

City and county officials in Florida faced pressure to install sirens in the aftermath of the event, and 26 of 28 officials surveyed by *The Orlando Sentinel* indicated an interest in installing sirens. Officials stated several factors to explain their reluctance to date to invest in sirens. New, energy efficient homes are more sound resistant, and many Floridians keep their homes buttoned up with the air conditioning running much of the year, so officials wondered if residents today could actually hear sirens. The high proportion of elderly residents, many with hearing losses, contributes to doubts about whether residents would hear sirens. And sirens in rural areas could be quite costly per resident. Many Florida officials view the purchase of NOAA Weather Radios by residents as a superior alternative to public tornado sirens.

Unfortunately hazards researchers cannot provide citizens and government officials with definitive evidence on whether tornado sirens save lives. The ages of victims in the Lake Mack tornado establish that it was not merely the elderly who failed to hear a tornado warning and take cover; only one of the 13 Lake Mack victims was over 60. The Lake Mack tornado reemphasizes Liu et al.'s (1996) observation that residents must have access to some type of shelter for tornado sirens to save lives. Liu found that many of the Alabama residents they studied failed to respond to sirens because they lacked a safe place to shelter. Occupants of a manufactured home about to be obliterated must get out of the home to survive.

Conclusion: Can Casualties in High-Vulnerability Tornadoes be Reduced?

The Groundhog Day tornadoes in Florida exhibited three elements of high vulnerability for casualties: they occurred during the overnight hours, struck an area with many mobile homes, and hit ground during an "off-peak" winter month when tornadoes nationally are infrequent. We have examined this event in depth to determine if casualties could have readily been reduced. All of the fatalities on February 2 occurred in mobile homes, and predominantly leveled mobile homes. The tornadoes were well warned, with a lead time of 13 minutes for the Lake County portion of the Lady Lake tornado, a 31-minute lead time for the Lake Mack tornado, and a tornado watch issued more than two hours in advance. A lack of sirens in Lake County probably slowed dissemination of the tornado warning, but disseminating the warning would not have saved lives had Lake Mack residents not had a safe location in which to go. Liu et al. (1996) noted the lack of shelter as a limitation to warning response in a 1994 Alabama tornado. Our analysis shows that the bulk of the fatalities occurred in totally destroyed mobile homes. Mobile homes built after new HUD regulations following Hurricane Andrew reduced the proportion of homes leveled by 60%, and thus these new provisions might in time reduce mobile home tornado fatalities by up to 60%.

The danger for residents of older mobile homes highlights the need to find an alternative, safer location that residents would be willing to move to during a stormy night. Residents may be quite reluctant to follow the NWS recommendation to leave their home and lie in a ditch, exposed to rain, wind, and lightning. Community shelters offer an opportunity for protection, particularly for mobile home parks. Florida mobile home parks tend not to have community shelters (Schmidlin et al. 2001), and neither the Sunshine nor the Lady Lake Mobile Home Park struck on February 2 had shelters. But evidence suggests that residents value shelters. Simmons and Sutter (2007b) recently found that lots in mobile home parks with tornado shelters in Oklahoma rent at a 5% premium relative to lots in comparable parks without shelters. Residents of mobile homes are aware of their tornado risk, and at least some are willing to pay extra to protect themselves against the risk. Florida has a higher tornado rate than Oklahoma, and even though a larger proportion of Florida tornadoes are weak, weak tornadoes can be

lethal for residents of mobile homes. In addition to shelters, mobile home parks and retirement communities could also install their own siren or alert systems to warn their residents. The proprietors of these communities do not have to rely on local governments to install sirens, but could rather take the initiative to protect their customers.

Mobile home parks allow sharing of the cost of community shelters or sirens, but a majority of manufactured homes in the United States are not located in parks. None of the manufactured homes struck in the Lake Mack tornado were in parks, and the residents of this area probably lack discretionary income to pay for their own shelter. What are residents of manufactured homes, and particularly older homes, to do when a tornado warning is issued? Research by Thomas Schmidlin and his colleagues (Schmidlin et al. 2002, King et al. 1999, Ono 2002) suggests that automobiles might be safer than mobile homes. More research is required to confirm if cars afford more protection than mobile homes, since there are instances of residents killed while fleeing a mobile home in a car. But residents might be more willing to leave their mobile homes for their cars at night. Cars do not have to be perfectly safe to save lives; they only need to be safer than mobile homes, and particularly older mobile homes. The wind resistance and tie-down regulations enacted by HUD and Florida after Hurricane Andrew appear to have saved lives in the Groundhog Day tornadoes. Applying these regulations to older homes and encouraging further efforts to tie down mobile homes could yield benefits in the future. Fatalities predominantly occurred in leveled mobile homes. Any measures which can prevent the total destruction of mobile homes will save lives.

Finally, warning response should improve once the NWS implements the new storm-based warnings for tornadoes and other types of severe weather nationally in 2007 (Jacks and Ferree 2006). Counties are large relative to the size of tornadoes, particularly a large county like Lake County, which is over 1,100 square miles and over 40 miles from north to south. A tornado on the ground in southern Lake County poses little threat to residents in the northern part of the county, and so county-based warnings currently overwarn, imposing substantial costs on society (Sutter and Erickson 2007). In trials in 2004 and 2005, the area warned with storm-based tornado warnings was reduced by almost 75% compared to county-based warnings. Whatever course of action is recommended for residents of mobile homes, they will be more likely to take this action if they are asked to respond less often. Storm-based warnings will convey a greater danger to the areas actually warned, and the heightened threat should lead to improve response and reduce casualties.

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Notes

[1] The probability of four or fewer leveled mobile homes out of the total of 46 homes built since 1995 given the pre 1995 proportion of leveled homes (.216) is .019.

[2] Other structures were unlikely to be leveled, as Table 6 shows. There were fatalities in 8 of the 54 leveled mobile homes, or .148 of the homes, and 9 permanent homes were leveled. The probability of no fatalities in these 9 leveled permanent homes, applying .148 as the probability of a fatality per leveled structure, is .237. Thus, preventing structures from being leveled is arguably the crucial factor in preventing further fatalities.

[3] One limitation of this analysis is a lack of detailed wind fields for the tornadoes; consequently, we cannot rule out the possibility that the older mobile homes happened to be exposed to more destructive winds. Both of the Lake County tornadoes, however, were rated EF-3 with wind speeds estimated in the 150 to 165 mph range, and NWS personnel in Melbourne who surveyed the paths judged that the damage was consistently at this level across the entire tornado damage area in Lake County. Thus, it is unlikely that wind speed differences explain the observed variation in damage, but we cannot rule this alternative explanation out.

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The tornado statistics presented in this report are from the following sources: the Melbourne, Florida, National Weather Service Forecast Office's Florida Tornadoes research page at http://www.srh.noaa.gov/mlb/Tornado_Stats.html; authors' calculations from the Storm Prediction Center's tornado archive available at http://www.spc.noaa.gov/archive/; and the National Weather Service's Hazards Stats Web page at http://www.weather.gov/os/hazstats.shtml.

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