

# Hurricane Charley Behavioral Analysis

September 2005  
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# HURRICANE CHARLEY HURRICANE EVACUATION BEHAVIORAL ANALYSIS

## Introduction

### Scope of the Survey

This survey of Florida residents following hurricane Charley is part of a post-storm assessment funded by the Federal Emergency Management Agency and the U.S. Army Corps of Engineers, with support from the Florida Division of Emergency Management. It deals mainly with issues related to evacuation, but also addresses information needs, mitigation, and economic impacts.

### The Threat Posed by Charley

On August 13, 2004 hurricane Charley made landfall just north of Captiva Island on the coast of southwest Florida with winds near 150 MPH. Fortunately the peak winds extended only 7 miles from the center. The eye of the storm passed over Punta Gorda on the mainland and continued inland with winds of 85 MPH near Orlando and 75 MPH near Daytona Beach, where Charley entered the Atlantic.

Hurricane Warnings were issued by the National Hurricane Center along the west coast of Florida from the Florida Keys in the south to the Steinhatchee River in the north. Watches were issued for most of the Florida west coast study area on Wednesday, August 11<sup>th</sup>: 11 AM for the lower Keys, 5 PM for southwest Florida to Bonita Beach, and 11 PM for the Tampa Bay area to Tarpon Springs. On Thursday watches were eventually extended northward to the Suwanee River. When the Wednesday watches were issued, winds in Charley were 70 to 75 MPH.

On Thursday, the first hurricane warning for the west coast of Florida was posted at 5 AM, covering the lower Keys northward to Bonita Beach in southwest Florida. Charley's winds were 85 MPH. At 5 PM the warning was extended northward to Bayport in Hernando County, north of the Tampa Bay area. By that time Charley's winds were 105 MPH, but more importantly they were forecast to reach 120 MPH in fewer than 24 hours. At this point southwest Florida and the Tampa Bay area were being warned for a category 3 hurricane in 24 hours or less. By the next morning, Friday and the day of landfall, the warning extended all the way to the mouth of the Steinhatchee River at the Levy-Dixie County border. Winds were 110 MPH.

As late as Wednesday night at 11 PM the forecast landfall point was in southwest Florida near Charlotte Harbor. Throughout Thursday and until 11 AM on Friday, the forecast track passed over the Tampa Bay area. However, National Hurricane Center forecasters repeatedly cautioned that forecasts are subject to error. Landfall probabilities for southwest Florida and the Tampa Bay areas were essentially the same from place to place during all of Wednesday and Thursday, and southwest Florida was never out of the average error cone depicted along with forecast tracks issued by the National Hurricane Center. After noon on Friday it became apparent that Charley had intensified more than forecast and the track had shifted more to the east than earlier predicted. Landfall occurred at 3:45 PM on Friday.

For another portion of the FEMA-Corps post-storm assessment of Charley, interviews were conducted with state and county emergency management officials to document their actions concerning evacuation notices to the public: what and when they advised or ordered, how they disseminated the notices, and how they arrived at their decisions. There was substantial variation among counties with respect to evacuation actions. Some coastal counties issued notices for areas expected to flood in a category 3 hurricane, whereas other notices applied only to category 1 surge areas. Some counties made their evacuation mandatory, and others made theirs

voluntary. Non-coastal counties typically told mobile home residents and people living in low-lying areas to move to safer housing or to higher ground.

### Survey Methods

Representatives from FEMA, the Corps of Engineers, and the state of Florida specified 27 counties where interviews were to be conducted to document public response in Charley and certain additional subjects. The list included all counties known at the time to have at least recommended evacuation for portions of their residents. The counties in which interviews were conducted are shown in Figure 1. The counties were aggregated into groups for sample allocation and reporting of results. There were three aggregations of coastal counties (northern, Tampa Bay, and southwest Florida) and three aggregations of inland or non-coastal counties (northern, central, and southern). Coastal area aggregations corresponded to regional planning council boundaries, which are the aggregations used for hurricane evacuation planning in Florida. The agency representatives composed a list of questions to be asked in the interviews, resulting in the questionnaire.

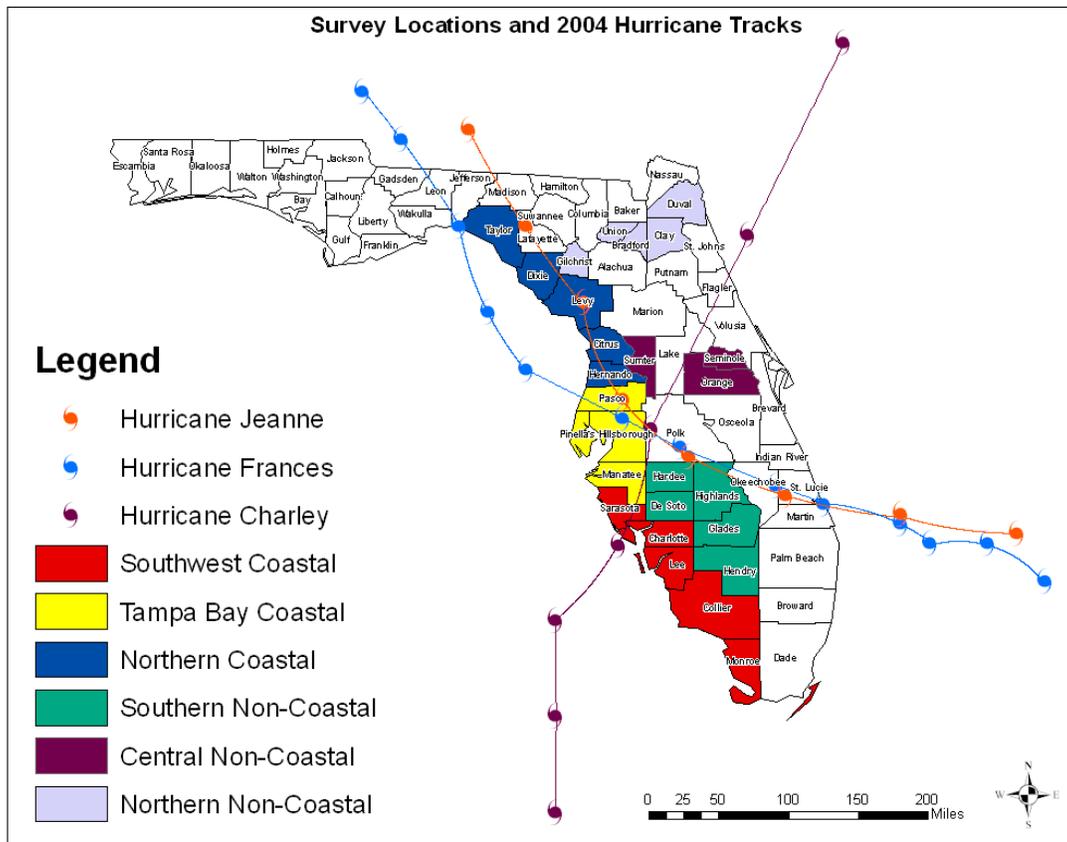


Fig. 1

A total of at least 2800 interviews were to be conducted. The interviews were allocated among the six aggregations of counties in consultation with the agency representatives. In coastal counties the sample was stratified to ensure a targeted number of responses in three specific risk zones: 1) areas that would normally be evacuated in a category 1 hurricane; areas that would normally be evacuated in a category 3 hurricane; and areas inland of the category 3 evacuation zone. In non-coastal counties there was no stratification based on risk. Evacuation in those areas was mainly based on wind and localized flooding. However, some of the southern inland counties

could experience wind-driven flooding from Lake Okeechobee, as could parts of Duval from the St. Johns River, the intracoastal waterway, or the Atlantic Ocean.

Table 1 indicates the number of completed interviews in each location. In coastal counties streets in each evacuation zone were identified using GIS software, and phone numbers at corresponding addresses were looked up in a commercial cross-reference directory. Within aggregations of counties interviews were allocated among counties proportional to their respective risk-zone populations.

Table 1. Sample sizes by area and risk zone

	Northern Coastal	Tampa Bay	Southwest Coastal	Northern Inland	Central Inland	Southern Inland
Cat 1	213	404	455			
Cat 3	106	209	213			
Inland of 3	116	219	216	200	300	300

Samples are subject to statistical error due to the fact that not everyone in the population is included. Appendix A contains a discussion about sample reliabilities in a fair amount of detail and includes a table for confidence intervals for samples of various sizes. The most important thing to remember is that smaller samples are generally less reliable than larger ones. Differences of a few percentage points among survey locations don't necessarily mean differences in the entire populations from which the samples were drawn. The sample sizes shown in Table 1 are reduced in many cases because not everyone in the sample was asked all questions. Only people who evacuated were asked where they went, for example. When samples are large enough results are presented for each group shown in Table 1, particularly if there is reason to expect that results might vary by risk zone as well as county aggregation. In some cases, however, results are shown just for the county grouping, and in a few instances just for the sample as a whole. In tables where formatting is suitable, sample sizes are reported. In many tables, however, sample sizes vary with each cell or figure in the table. In those instances sample sizes are not reported in the tables.

All interviews were conducted by telephone. The survey began in December 2004, but funding was interrupted and was not resumed and completed until April 2005. Most of the interviews were done in December 2004, including almost all of those in coastal counties.

## Evacuation Participation Rates

Respondents were asked whether they left their homes to go someplace safer in response to the threat presented by Charley. Only in the category 1 risk zone of the Tampa Bay area did a majority say they left (Figure 2). Among coastal areas evacuation was highest in the Tampa Bay area, followed by southwest Florida. It was lowest in the northern coastal area, farthest from where landfall occurred and where evacuation clearance times are lower. Among non-coastal locations, evacuation was greatest in the southern area, nearest where Charley crossed the coast. (Note: Absence of bars in the graph and data in certain cells of the table indicate that no interviews were conducted in that location or there were too few respondents to provide reliable data. Data values in the cells of the table correspond to heights of bars in the graphic.)

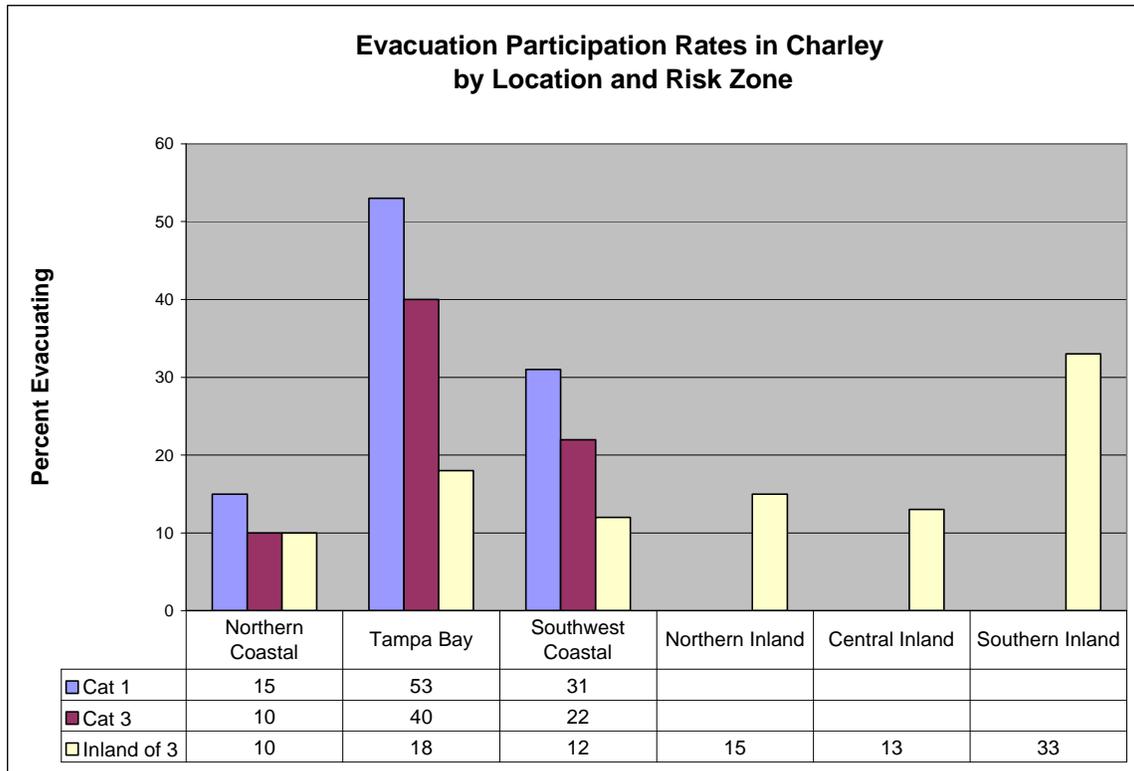


Fig. 2

## Reasons Given for Leaving or Staying

### Leaving

Evacuees were asked what made them decide to go someplace safer, and the most frequent responses are shown in Figure 3. In coastal areas severity of the storm, evacuation notices from officials, and track of the storm were cited most often. In non-coastal areas a larger variety of responses were given (e.g., “wife wanted to leave,” “live in a mobile home,” “felt safer with

others.”). Living in a mobile home was a frequent motivation in the non-coastal areas but not in coastal areas.

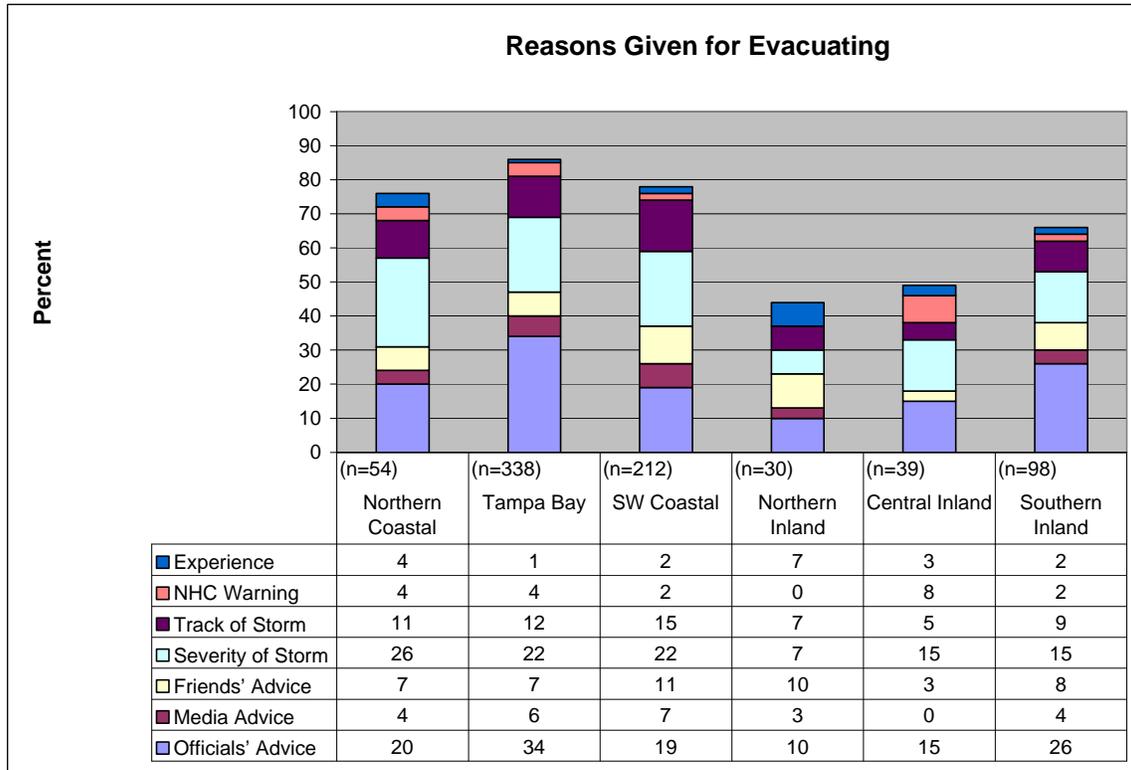


Fig. 3

### Staying

Those who did not evacuate were asked why they didn't leave, and their most frequent reasons are shown in Figure 4. The great majority of responses concerned factors dealing with risk assessment. That is, people felt safe staying where they were. In addition to the dominant factors contributing to risk assessment there were a variety of other reasons such as having to work, concern about looters, protecting property from the storm, having evacuated unnecessarily in the past, and lack of time, transportation, shelter, and a place to take pets. Although none of them individually constituted a large number of responses, collectively they played a role in many, though a minority, of households.

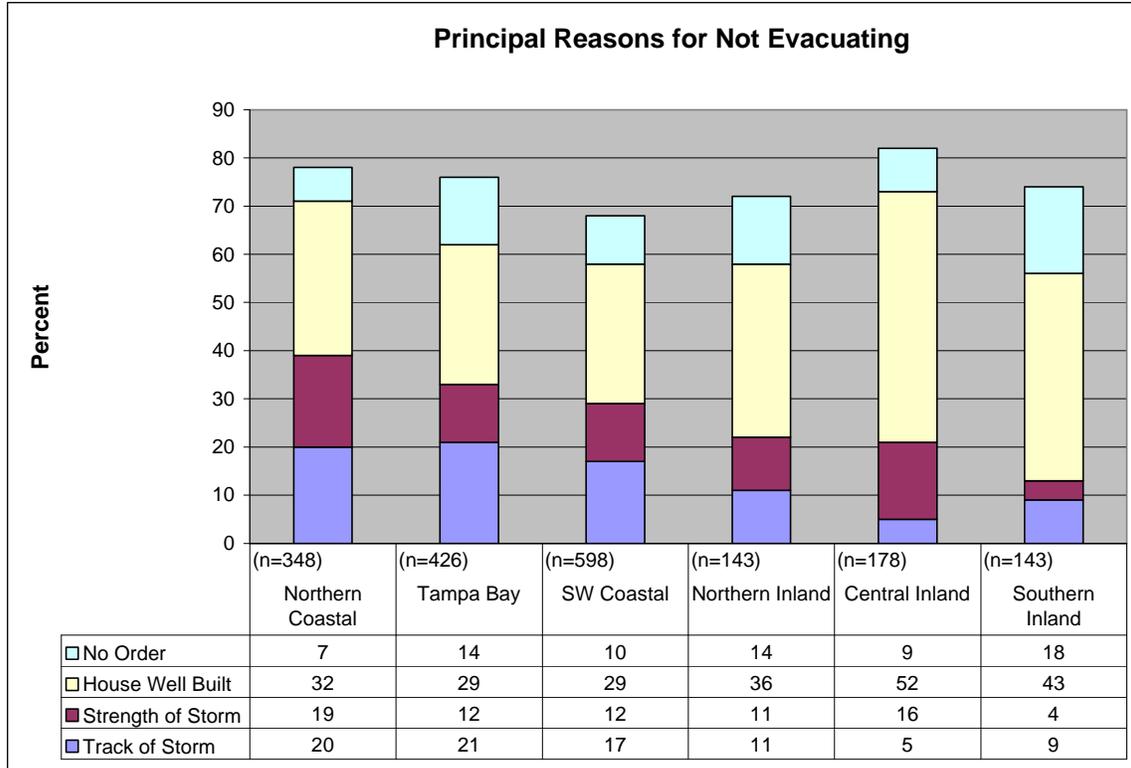


Fig. 4

Threat Information

The two previous questions were open-ended: interviewers recorded whatever reasons for evacuating or staying that respondents mentioned. In another series of questions people were given a list of factors and asked how important each was in their decision whether to evacuate or not. All were threat-related variables, and respondents could indicate that the factor was not important, somewhat important, or very important. Results are shown for the Northern, Tampa Bay, and Southwest coastal areas in Figures 5 – 7, and for the non-coastal areas in Figure 8. In every location media information and NHC watches and warnings were said to be very important to the largest number of people. Hurricane winds were the third most important factor, followed in the surge areas by storm surge and waves. Tornadoes were cited more often than fresh water flooding.

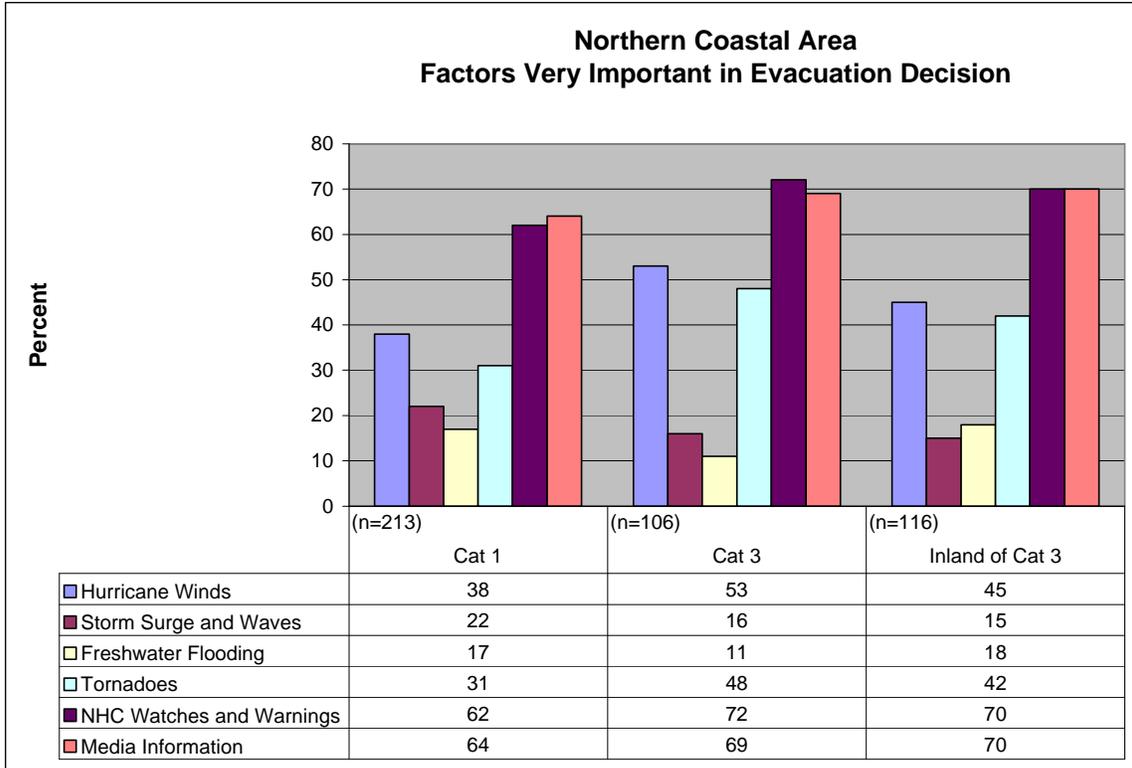


Fig. 5

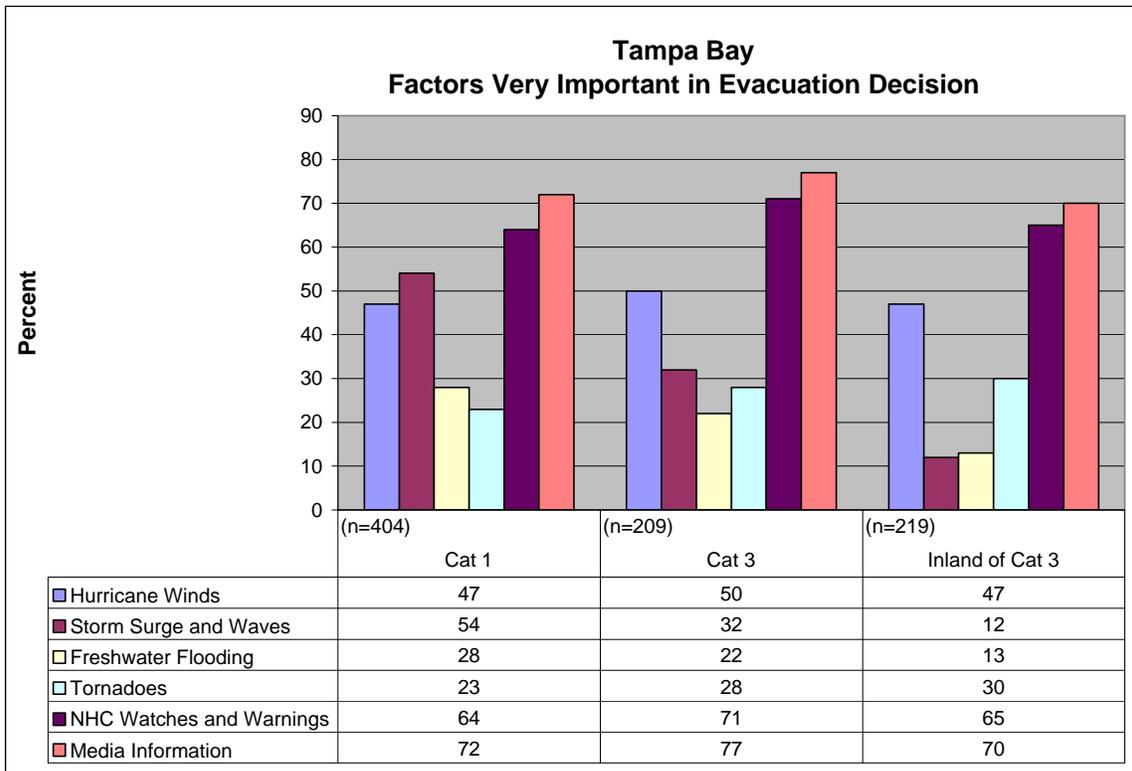


Fig. 6

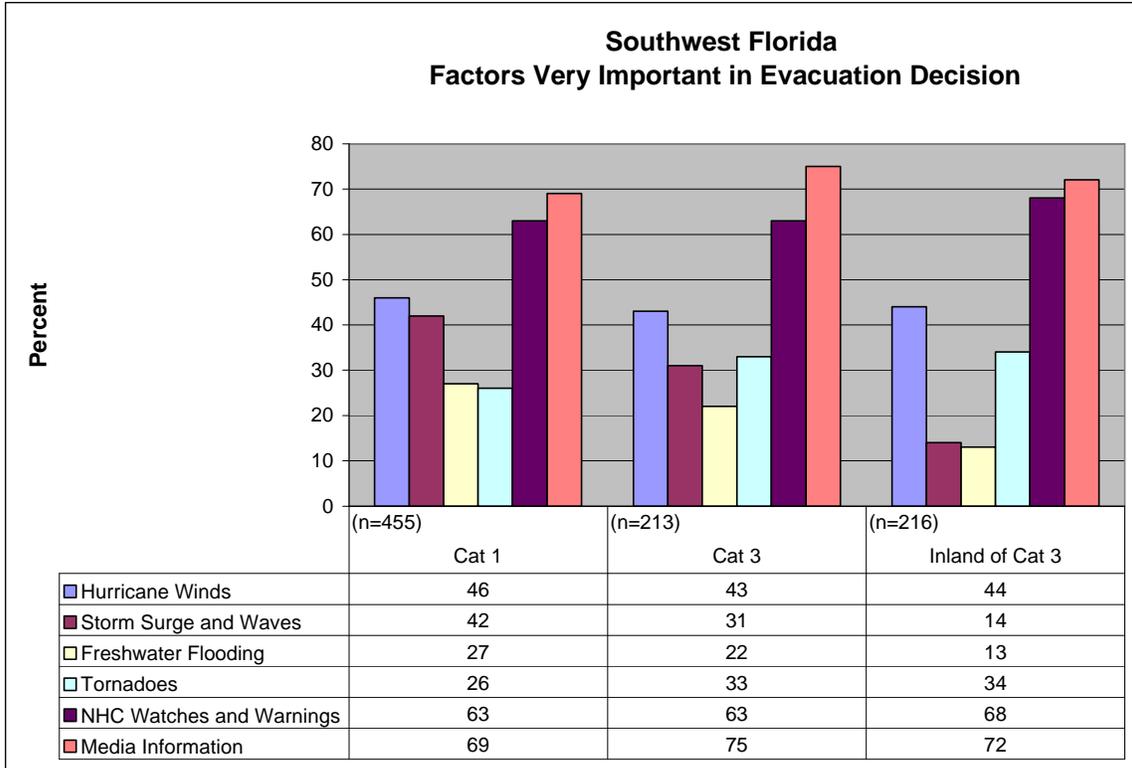


Fig. 7

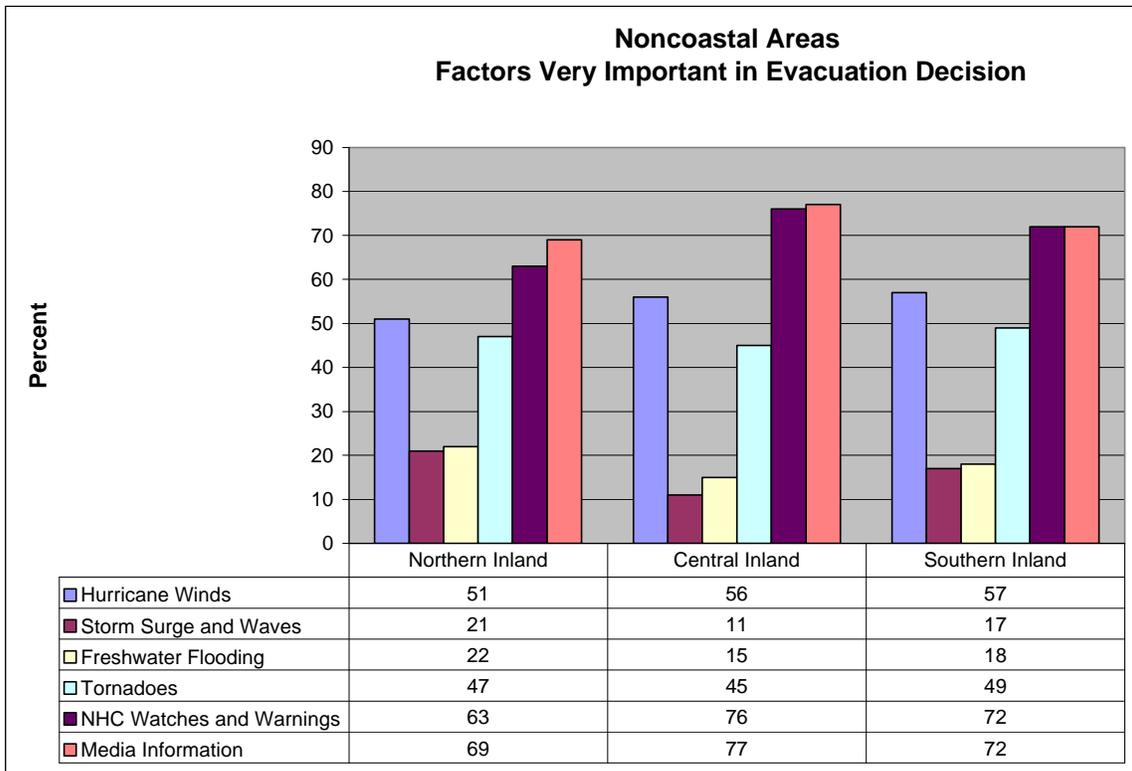


Fig. 8

## Preparations by Those Who Didn't Evacuate

### Would Have Left

Respondents who didn't evacuate were asked whether they would have left had it appeared that Charley was going to hit their location directly. Most people in surge-prone areas of coastal counties said they would have left, as did 40% to 60% outside of surge areas (Figure 9).

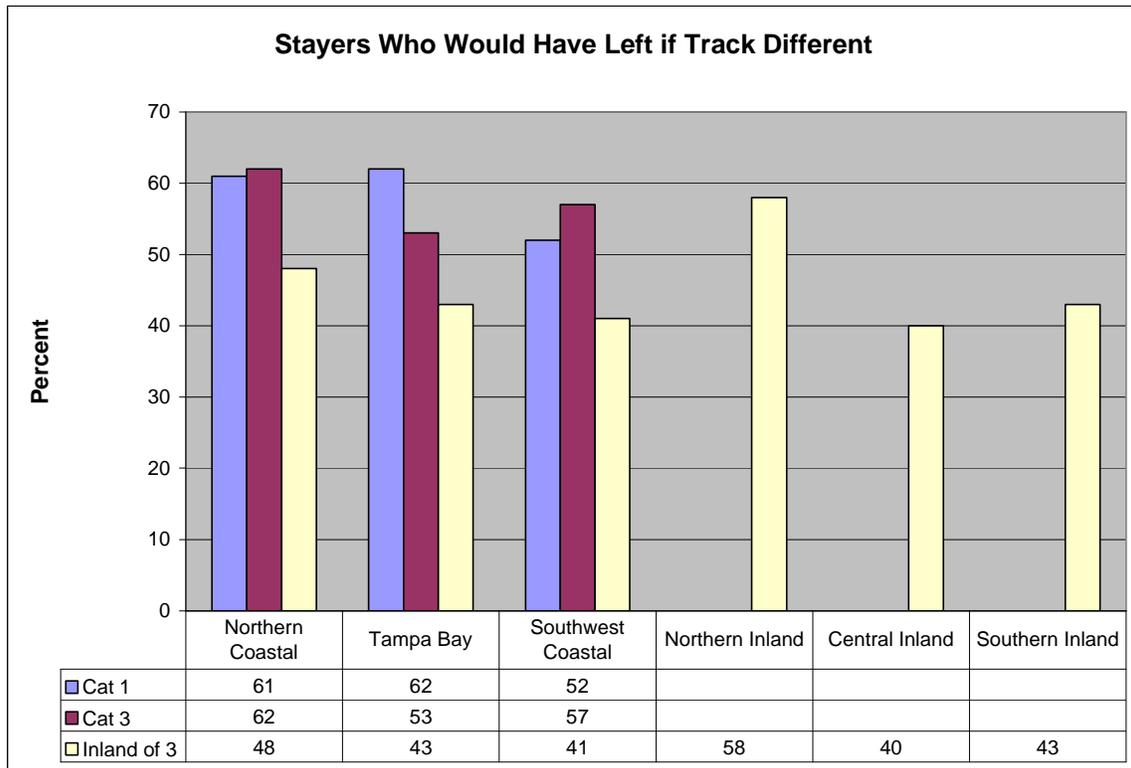


Fig. 9

### Made Preparations to Leave

A majority of those who stayed said they had made preparations to leave in case the threat had worsened (Figure 10). There was little difference among locations or between surge and non-surge areas.

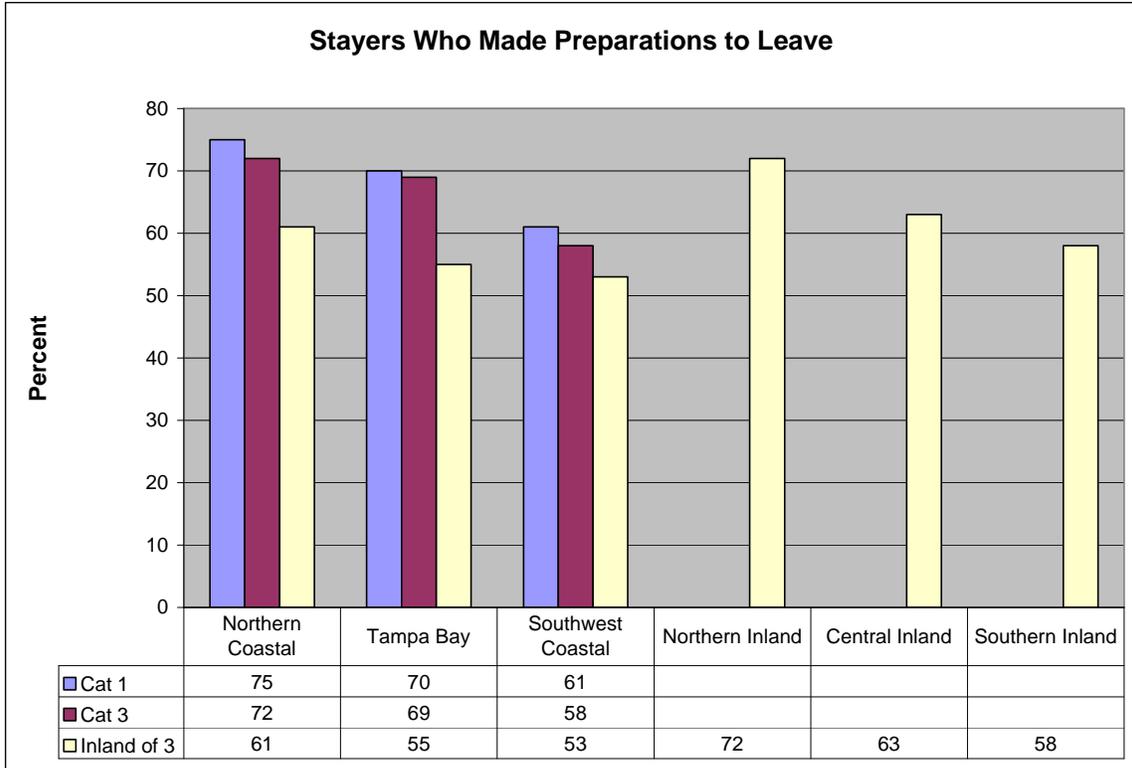


Fig. 10

Ready to Survive for Three Days

In all locations, the overwhelming majority (87% to 96%) of those who didn't evacuate said they were prepared to survive on their own for three days after the storm hit, without electricity, telephones, etc. (Figure 11).

Felt Safe During the Storm

The great majority (86% to 95%) also said they felt safe staying in their homes during Charley (Figure 12). This was true even in the category 1 and 3 surge areas of southwest Florida. Although the sample was fairly small (n=40) 58% of the respondents in the category 1 evacuation zone of Charlotte County said they felt safe staying at home during the storm.

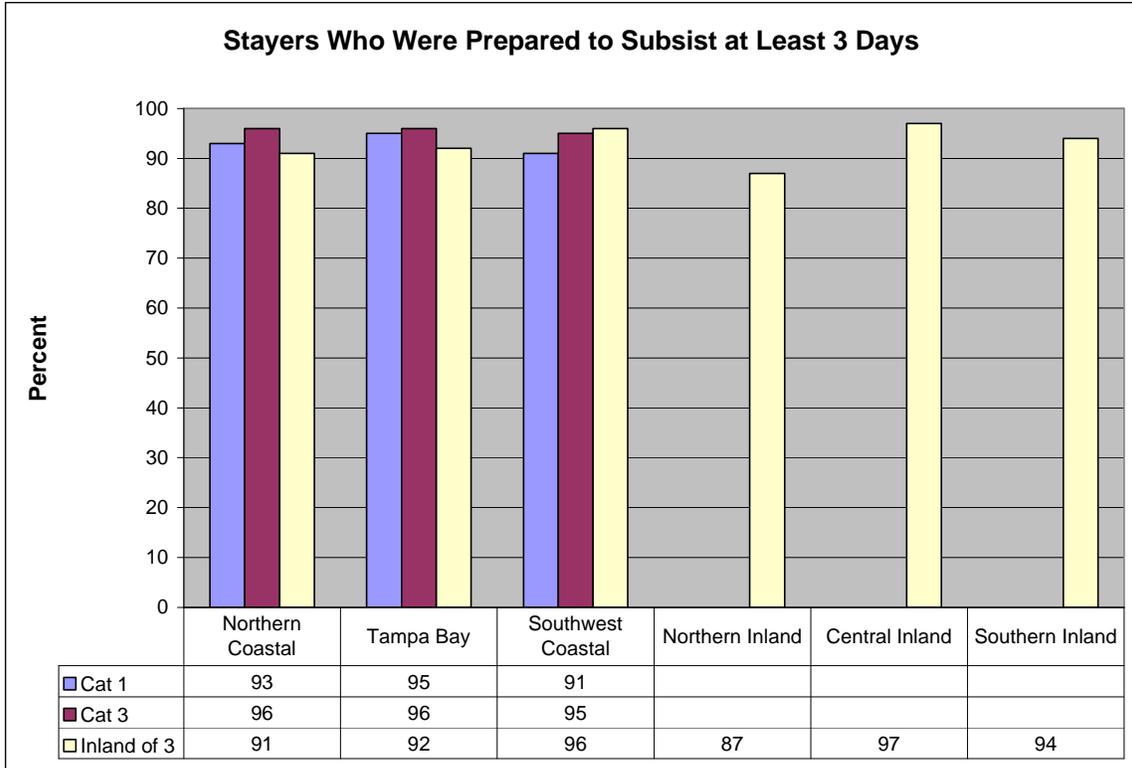


Fig. 11

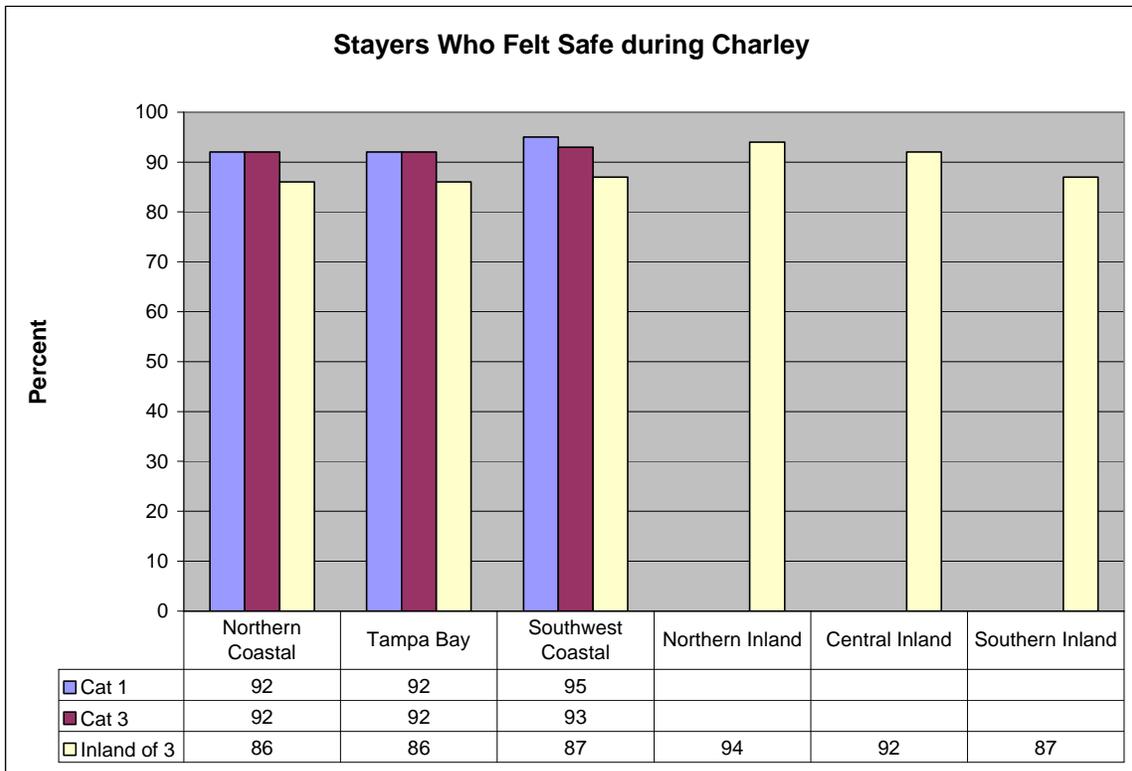


Fig. 12

## Evacuation Notices

All of the counties in the survey issued evacuation notices of one kind or another, but they varied with respect to the areas to which they applied and whether they were mandatory or not. In general, coastal counties issued mandatory evacuation orders at least for category 1 areas and recommendations for category 3 areas. In non-surge areas, including non-coastal counties, evacuation notices were issued for mobile homes and low-lying flood-prone areas. Most inland notices were recommendations but some were mandatory.

### Type of Notice Heard

Figures 13-16 indicate what respondents said they heard. In no place did a majority of people say they heard from officials that it was mandatory that they evacuate, and the category 1 risk zone of the Tampa Bay area was the only place where a majority said they heard evacuation notices of any kind, either mandatory or recommendations. In the category 1 area of southwest Florida just 37% said they heard evacuation notices from officials. Although a county-by-county, zone-by-zone comparison isn't possible at this time, a great many people who were told to evacuate apparently were unaware of that fact. In non-surge areas 15% to 35% of the respondents said they were told to evacuate. Although many of those responses came from mobile home residents, many also came from people in other types of housing, especially inland of the category 3 surge zone in coastal counties.

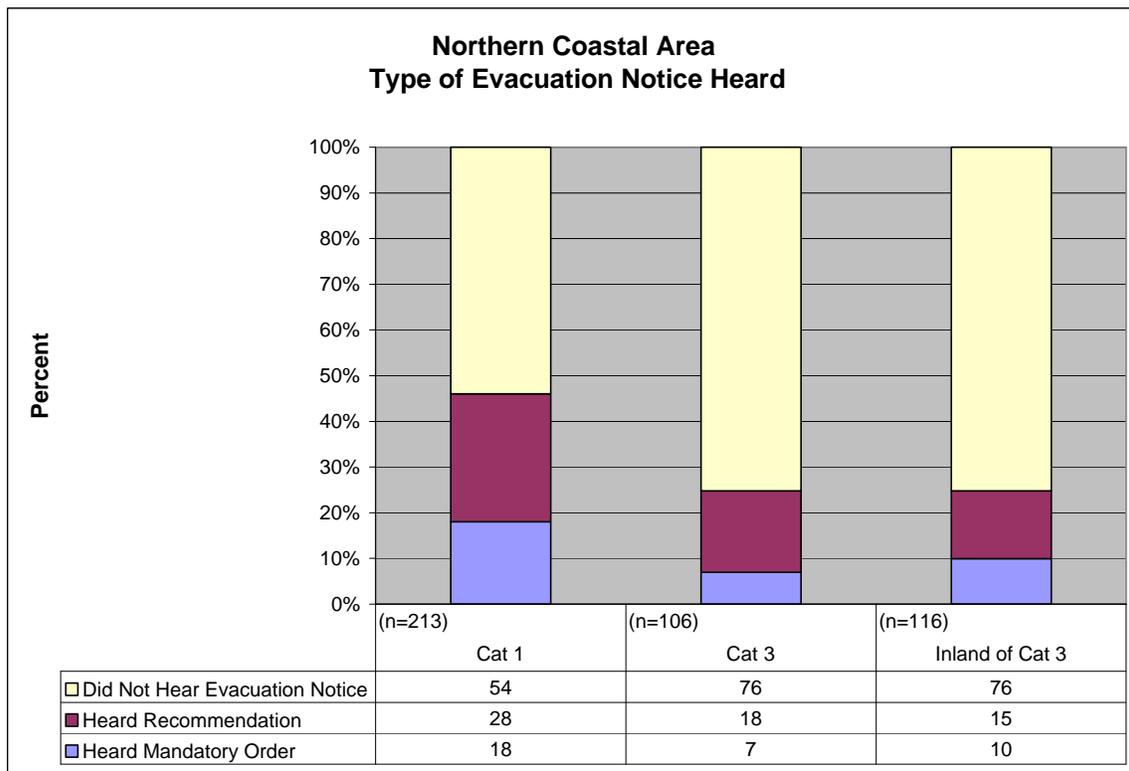


Fig. 13

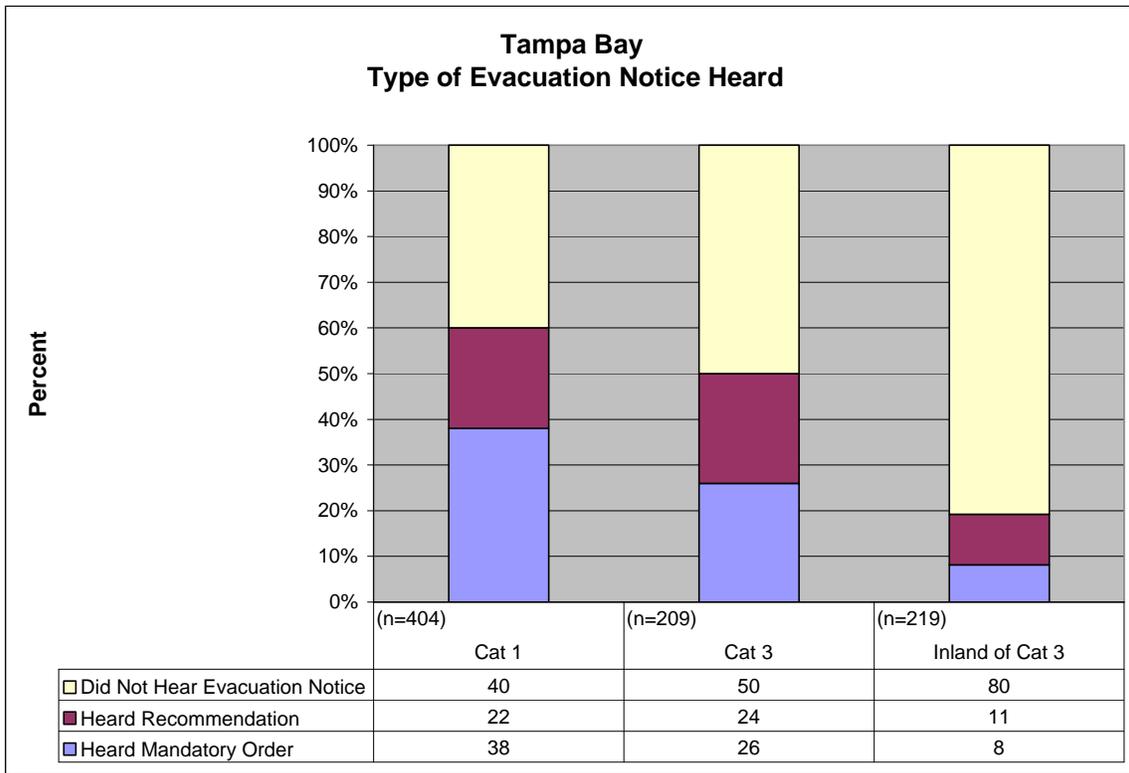


Fig. 14

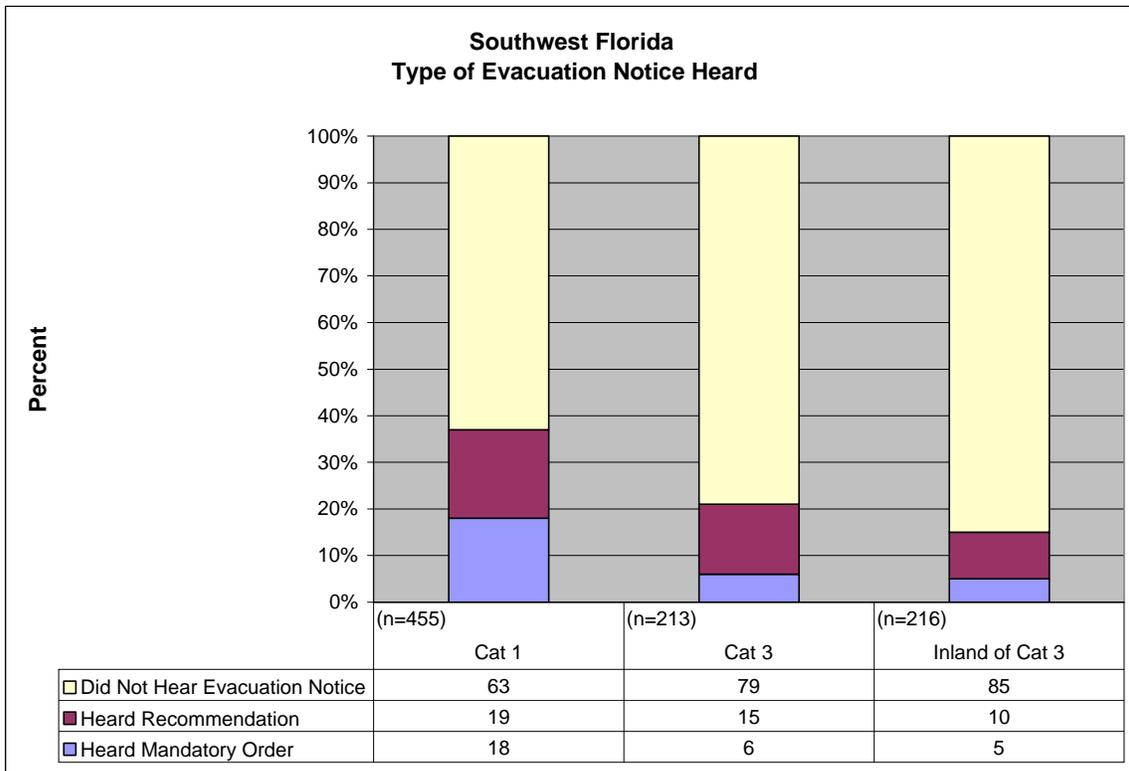


Fig. 15

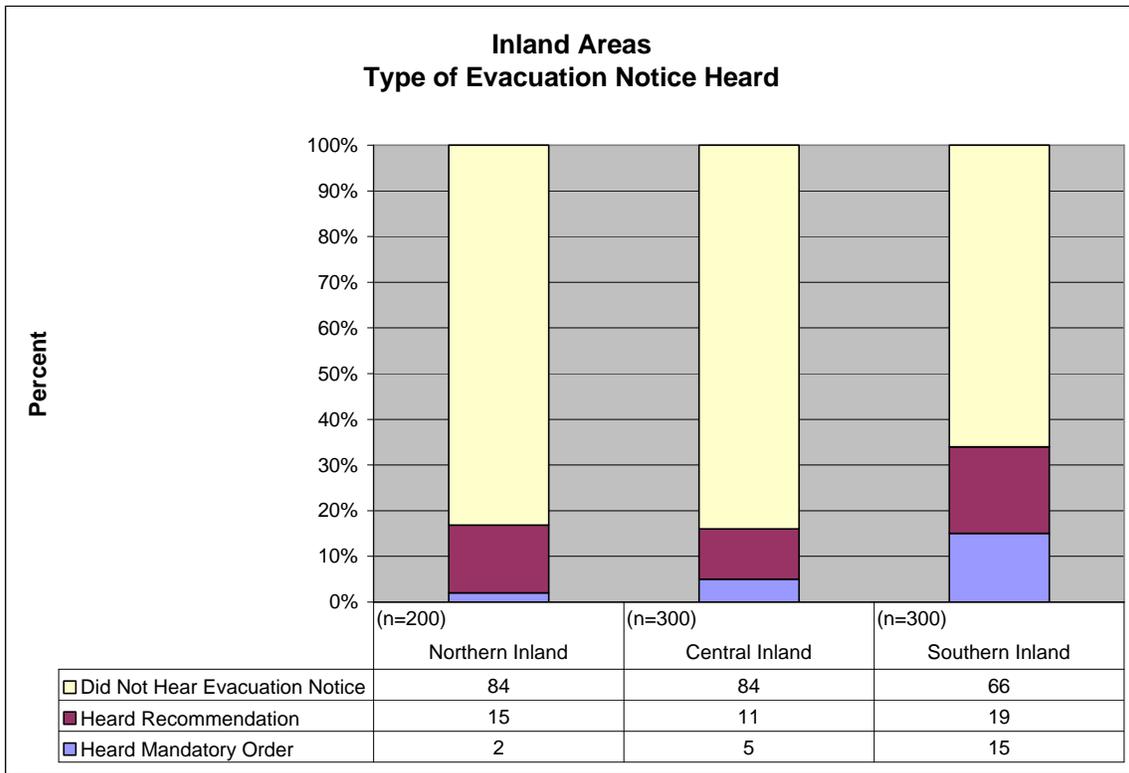


Fig. 16

#### Neighborhood Dissemination of Notices

People who said they did hear evacuation notices were asked whether police or other authorities came into their neighborhoods going door-to-door or with loudspeakers, telling people to evacuate. Few respondents in any location said that authorities came into their neighborhoods making evacuation announcements (Figure 17). The highest responses came from the category 1 surge area in the northern coastal sample (28%), the category 1 and 3 evacuation zones in Tampa Bay (27% and 26%), and in the southern inland area (21%). In southwest Florida fewer than 10% said announcements were made in neighborhoods.

#### Effect of Notices on Evacuation

In Figure 18 evacuation participation rates are shown for category 1 risk zone respondents who heard mandatory evacuation orders, those who heard recommendations to evacuate, and those who said they heard neither. The effect of hearing orders is strong. The northern coastal area is the only area where fewer than 50% of those who heard orders failed to evacuate, and there would have been time most of them to have left if the storm had not struck southwest Florida before reaching their location. In the Tampa Bay area 85% of the respondents in category 1 areas who said they were ordered to leave did so, compared to just 28% of those who said they heard no evacuation notices.

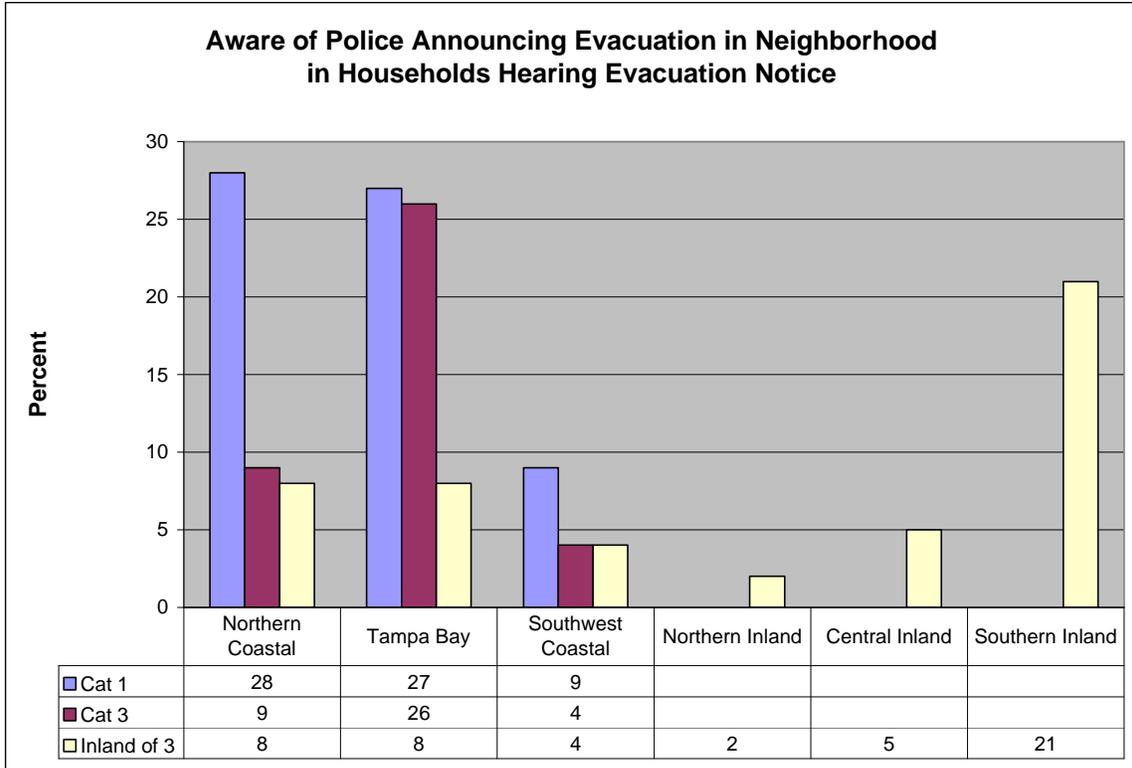


Fig. 17

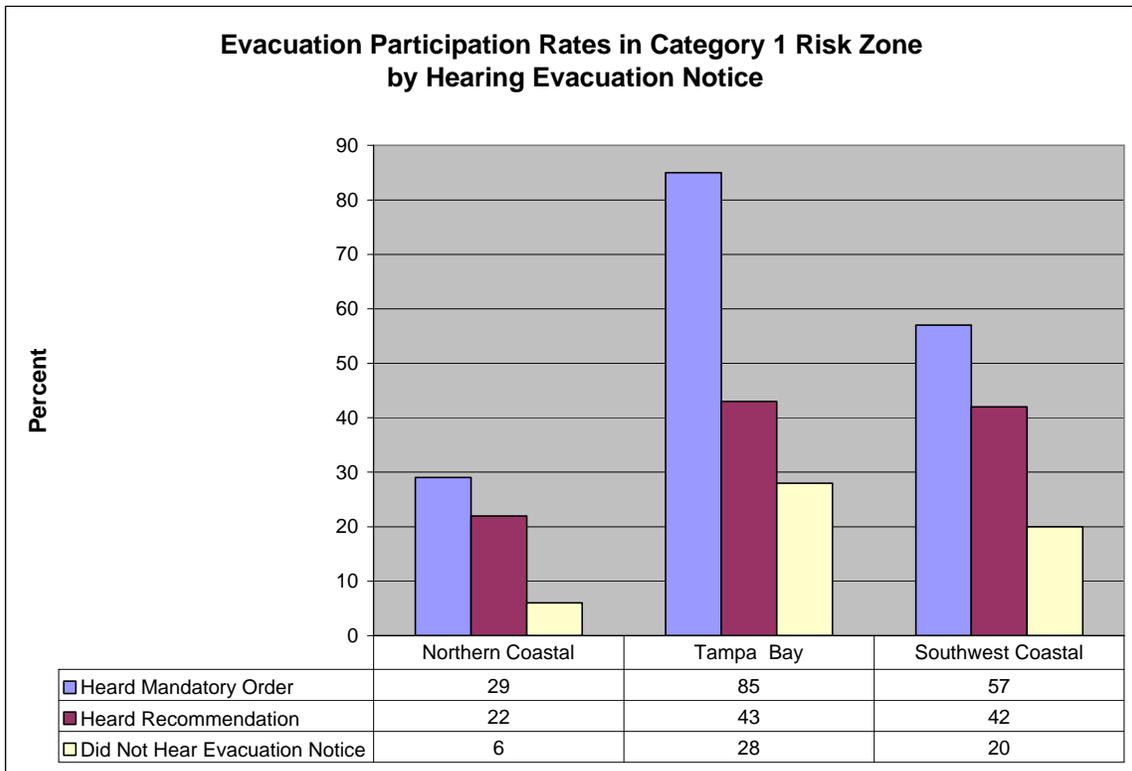


Fig. 18

How Evacuation Notices Were First Heard

The reliance on the media in communicating evacuation notices is shown in Figure 19. Respondents who said they heard evacuation notices were asked how they first heard the notice. Between 63% and 96% said they first heard about it over radio or television. Loudspeakers were mentioned frequently in certain locations.

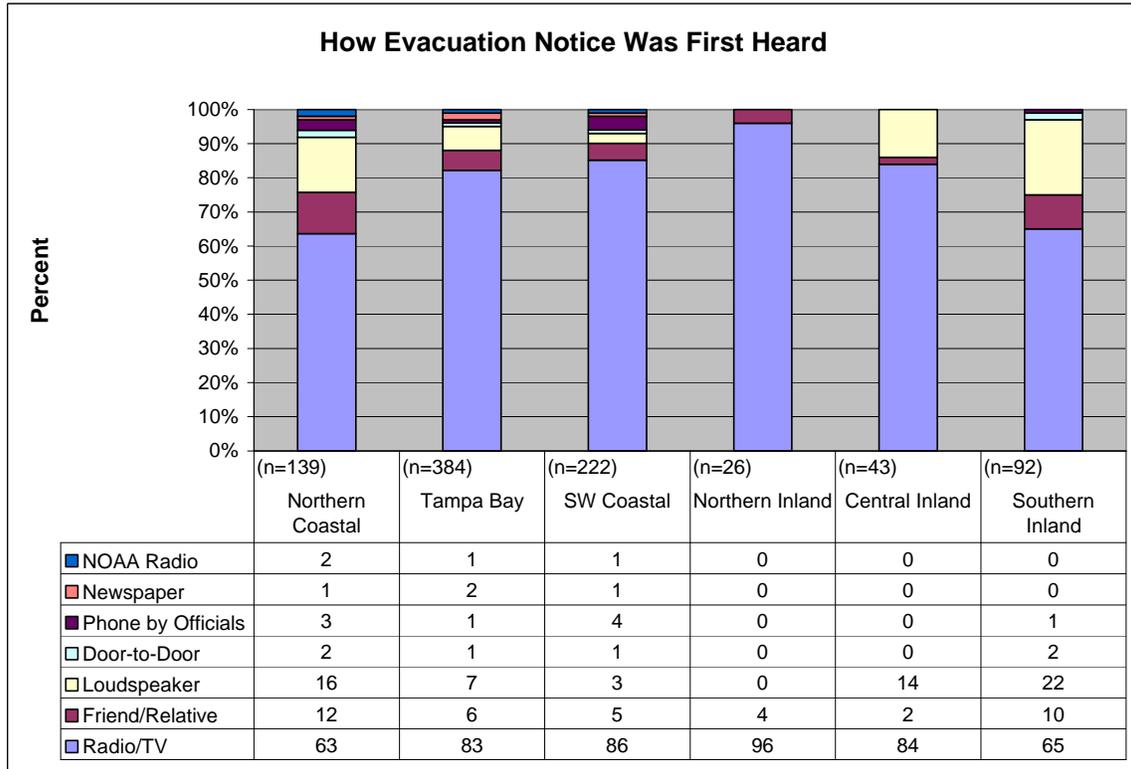


Fig. 19

Satisfaction with Timing of Evacuation Notices

People who heard evacuation notices were asked whether the notices were announced sufficiently early. A large majority in almost all locations said that notices were issued early enough (Figure 20). The lowest figure was 62%, in the non-surge portion of Tampa Bay. In southwest Florida 86% to 93% of the surge zone respondents said notices were issued early enough.

Satisfaction with Content of Evacuation Notices

Respondents who heard evacuation notices were also asked if the information in the notice was useful to them (e.g., which specific locations needed to evacuate, what people in those areas needed to do). In all areas except southwest Florida over 80% of the interviewees said the information was useful. In southwest Florida a majority also found the information useful, but the level was only 60% in the category 3 risk area.

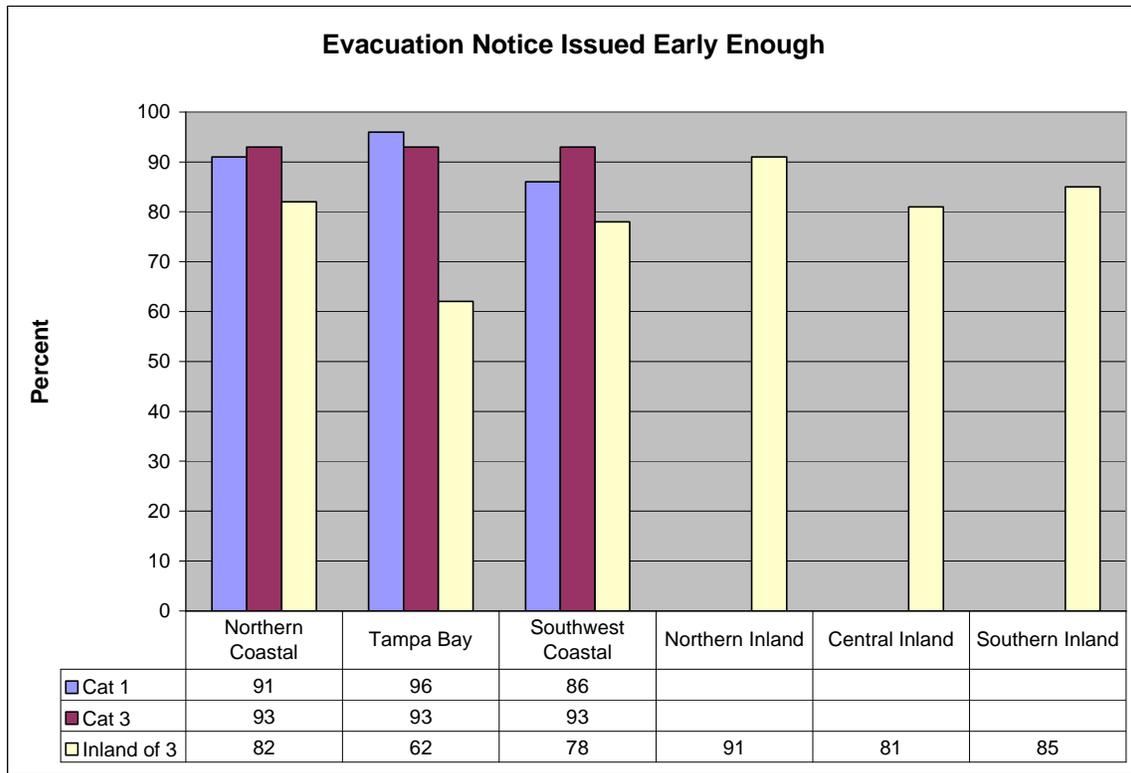


Fig. 20

### Beliefs Regarding Who Issues Evacuation Notices

All respondents were asked who in their community is responsible for issuing evacuation notices. Between 25% and 43% said they didn't know (Figure 21). Of those who did give an opinion, the most frequent responses were law enforcement (15% to 29%), the local emergency management director (12% to 27%), and the county administrator (6% to 15%). Respondents could make multiple responses to the question, and data in the graphic displays percentage of all responses, not percentage of respondents.

### **Potential Constraints to Evacuation**

#### Special Needs

Interviewees were asked whether anyone in their household requires assistance from an agency in order to evacuate or whether anyone requires special care in a shelter. Positive responses ranged from 3% to 11% (Figure 22). In households requiring such assistance respondents were asked whether the person needed just transportation, special care in a shelter or both. Tampa Bay reported the highest incidence of need for transportation (42%), the southern inland had the greatest need for special shelter care (38%), and the southwest coastal and northern inland areas had the largest percentage saying they needed both (42%) (Figure 23). Sample sizes were small in all locations, so the sample differences are not generally indicative of comparable differences in the populations. Approximately half of the households said that having a person with special needs affected their decision whether to evacuate (Figure 24). However, the actual evacuation rate in households with special needs was lower than the evacuation rate in other households

only in the category 3 risk zone (aggregating all three coastal study areas). In category 1 and non-surge areas households with and without special needs evacuated at the same rate.

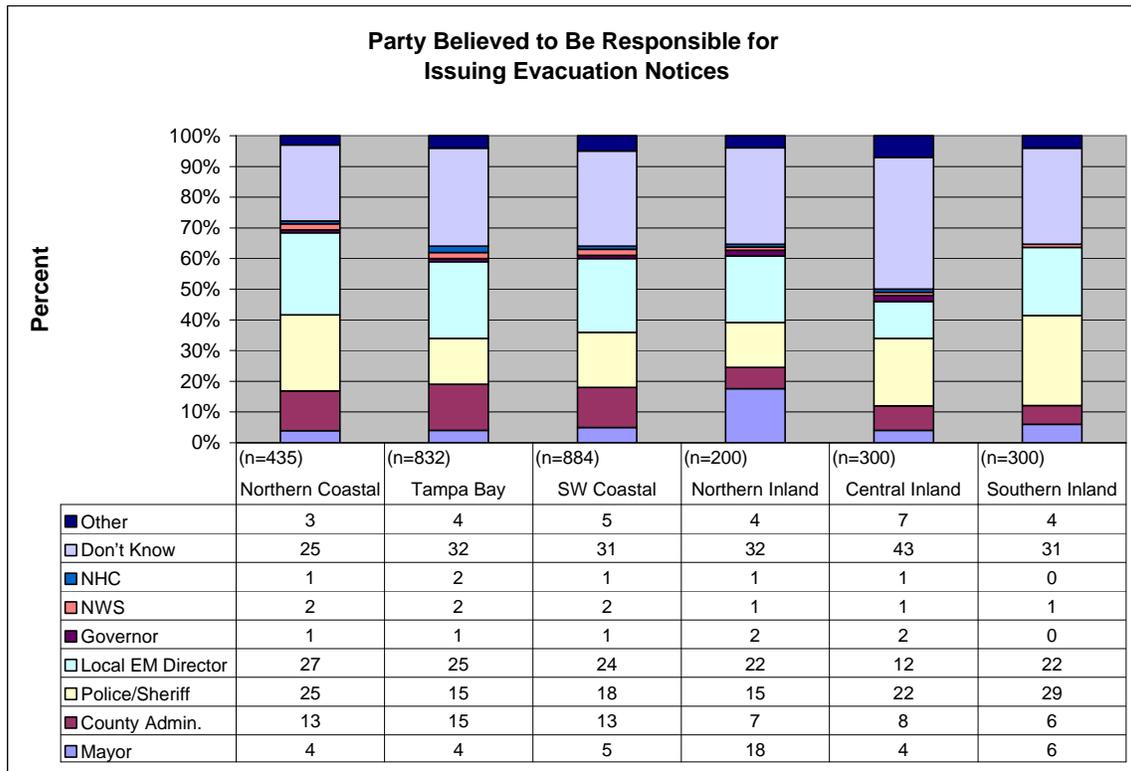


Fig. 21

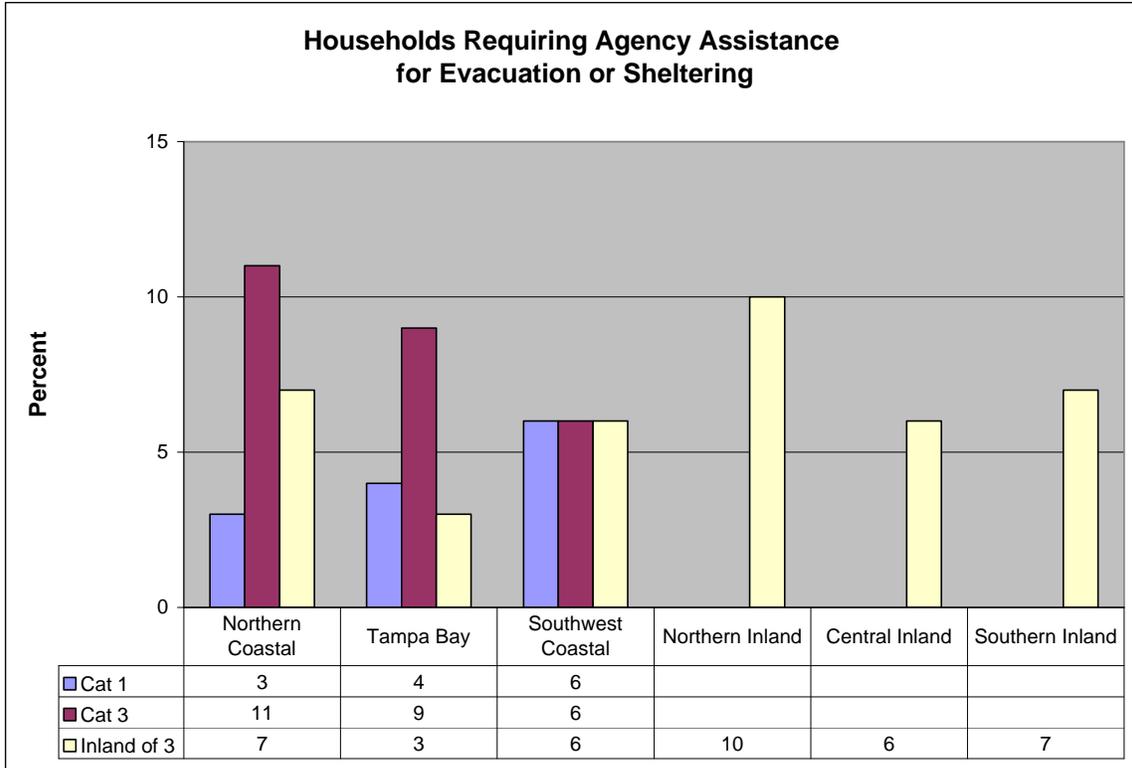


Fig. 22

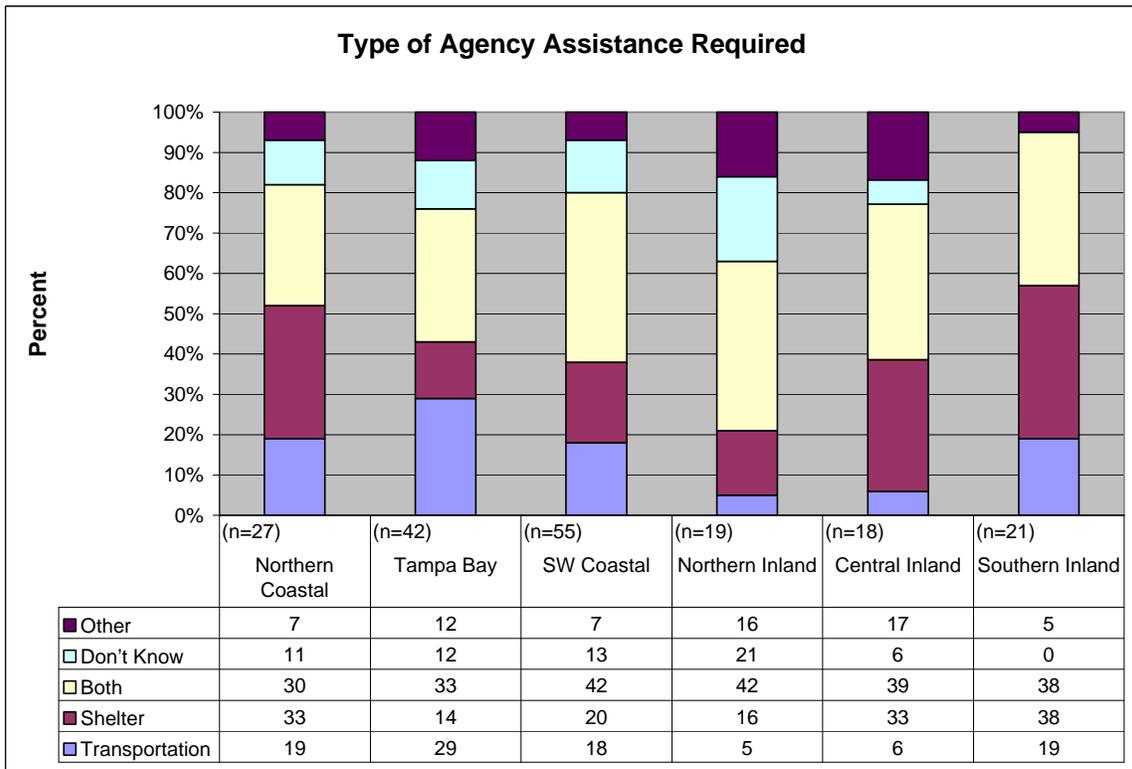


Fig. 23

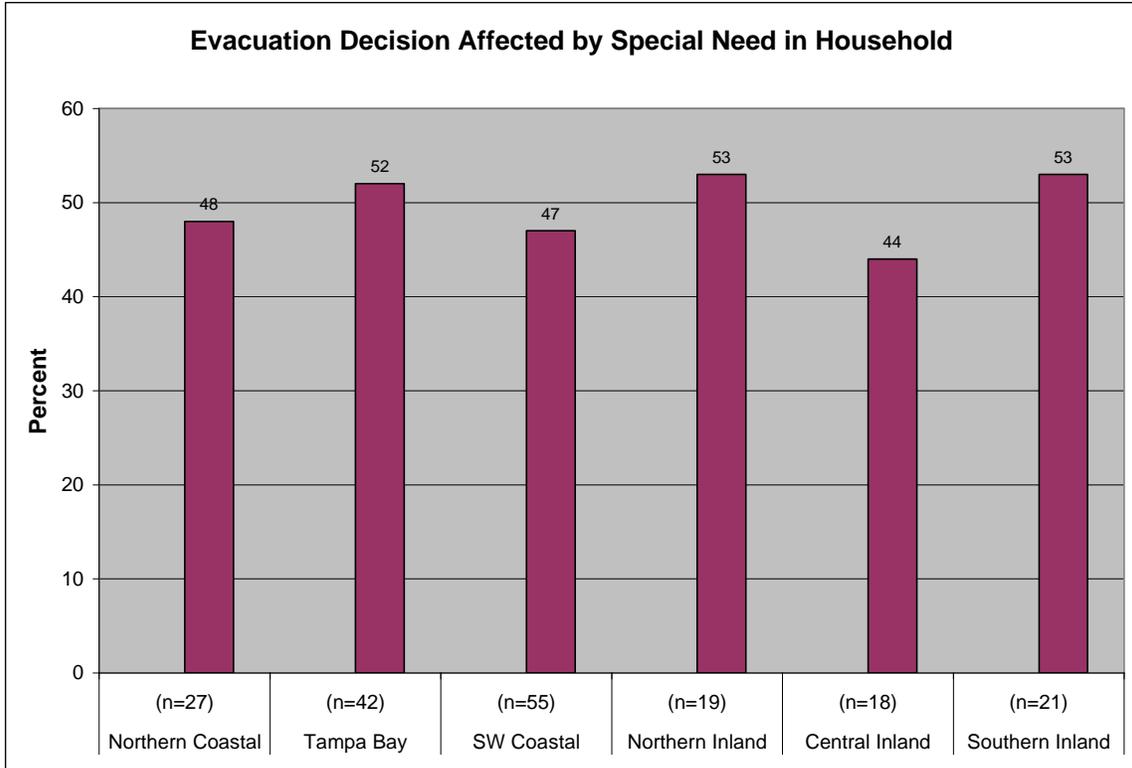


Fig. 24

Having to Work

Between 18% and 36% of the respondents said someone in their household had to work during the threat being posed by Charley (Figure 25). Response was lowest in category 1 evacuation zones. In all locations most people (60% to 75%) said their household’s evacuation decision was not affected by someone having to work (Figure 26). Only 6% to 12% said their household did not evacuate because of the work constraint. In households in which someone had to work, actual evacuation rates were slightly lower compared to other households in category 1 evacuation zones (30% vs. 38%) and in non-surge areas of coastal counties (9% vs. 17%). There was no difference in category 3 risk zones or in con-coastal counties.

School Closings

Most respondents (64% to 80%) in all locations said that schools were closed early enough to permit their household to evacuate (Figure 27). Positive responses in the surge-prone areas of southwest Florida coastal counties were slightly lower than in other locations.

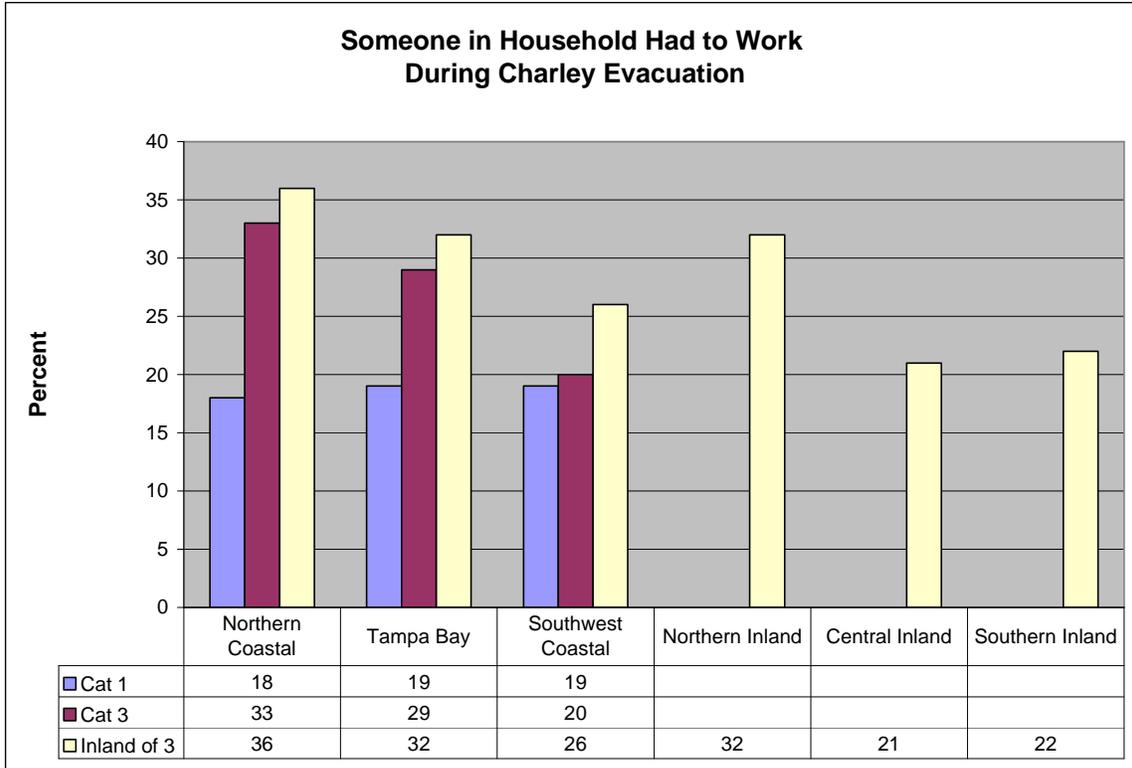


Fig. 25

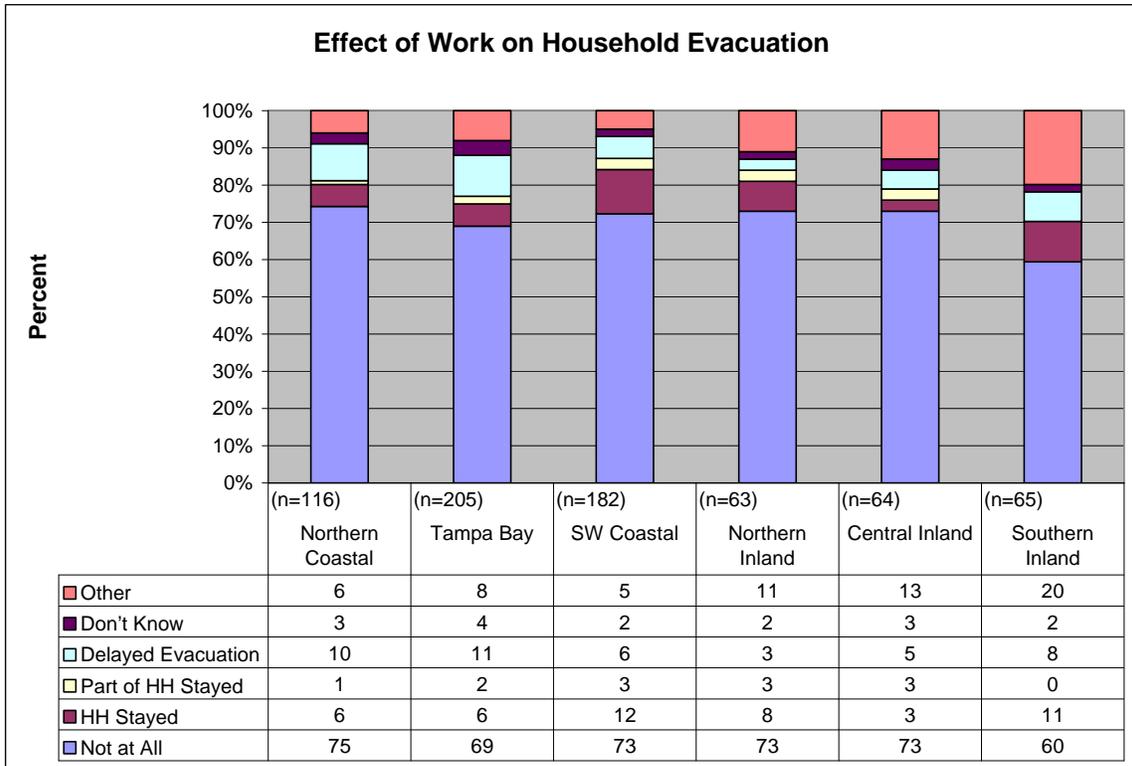


Fig. 26

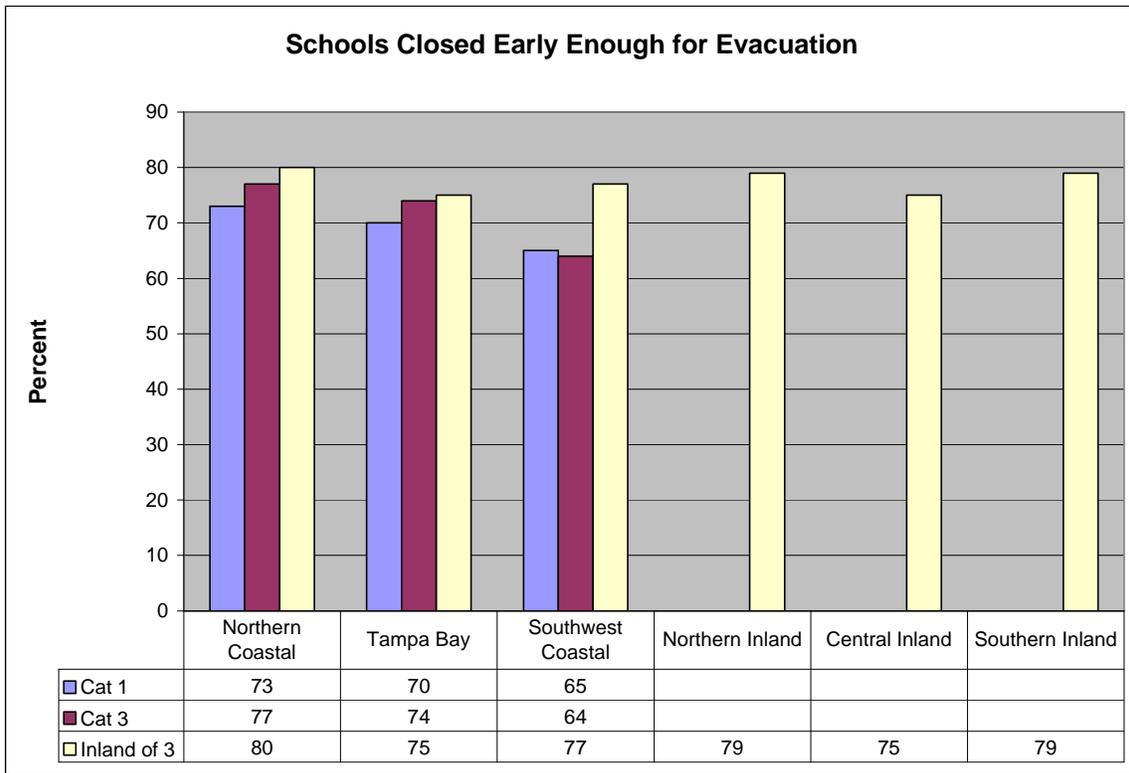


Fig. 27

Pets

Pets are sometimes viewed as a constraint to evacuating because pets aren't accepted in most public shelters, many hotels and motels, and probably the homes of certain friends and relatives. Between 45% and 62% of respondents said they had pets in their households (Figure 28). As few as 28% and as many as 55% of those interviewees said the presence of a pet affected their decision whether to evacuate (Figure 29). In coastal areas the reported pet influence increased from north to south, with the highest incidence in the category 3 risk area of southwest Florida. The actual evacuation participation rate in homes with pets was 24% compared to 29% in homes without pets. However, when the sample is broken down into risk zones, the only location where evacuation was lower in homes with pets was the non-coastal area.

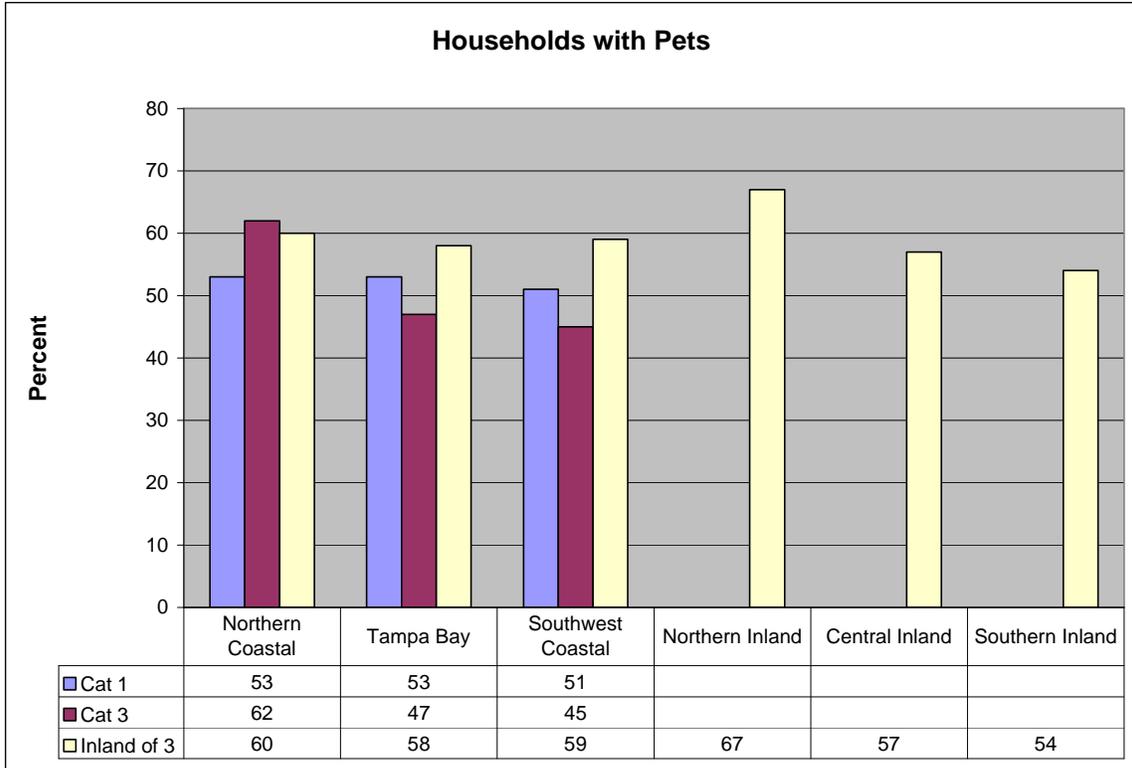


Fig. 28

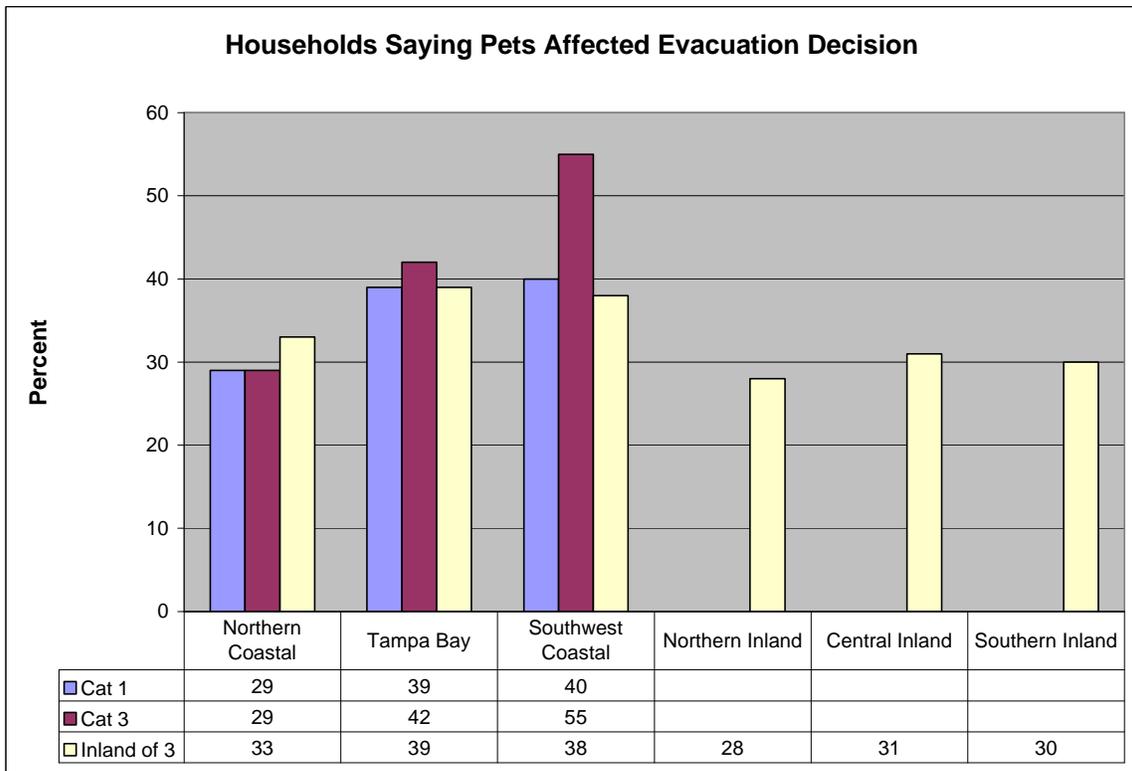


Fig. 29

## Preparations by Evacuees

### Evacuation Supply Kit

Between 51% and 91% of the evacuees said they took kits with them containing items such as food, medicine, personal objects, and extra clothes (Figure 30). The frequency of positive responses decreased slightly in coastal counties from north to south but increased in non-coastal counties from north to south. In locations with large enough samples from which to generalize, between 50% and 60% of the interviewees said they had their evacuation supply kits ready in advance rather than putting them together at the last minute (Figure 31). In all locations a large majority of people (80% to 88%) said their kits proved to contain everything they needed (Figure 32).

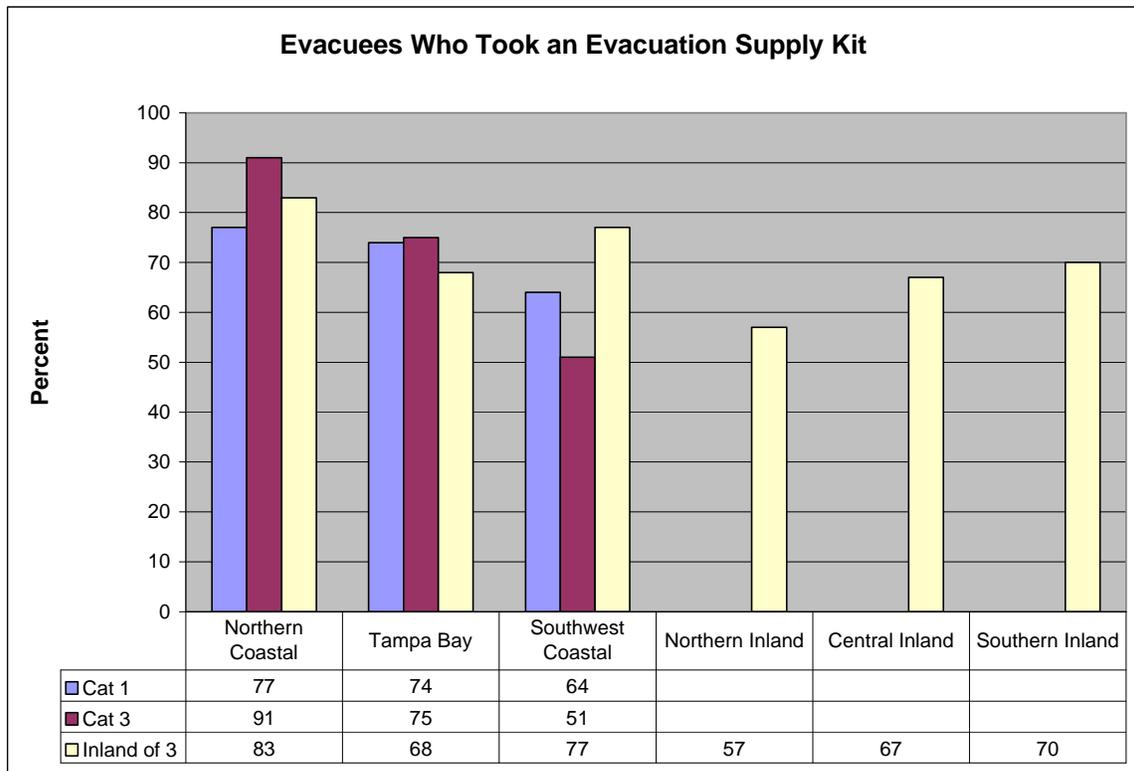


Fig. 30

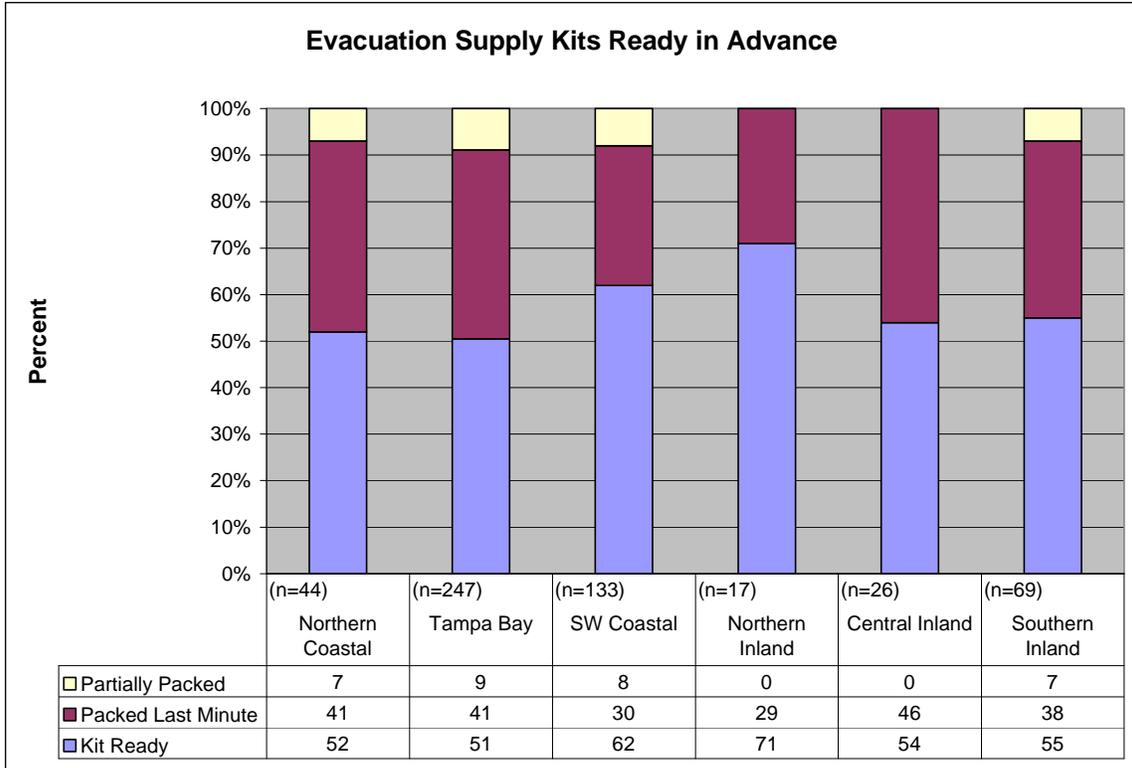


Fig. 31

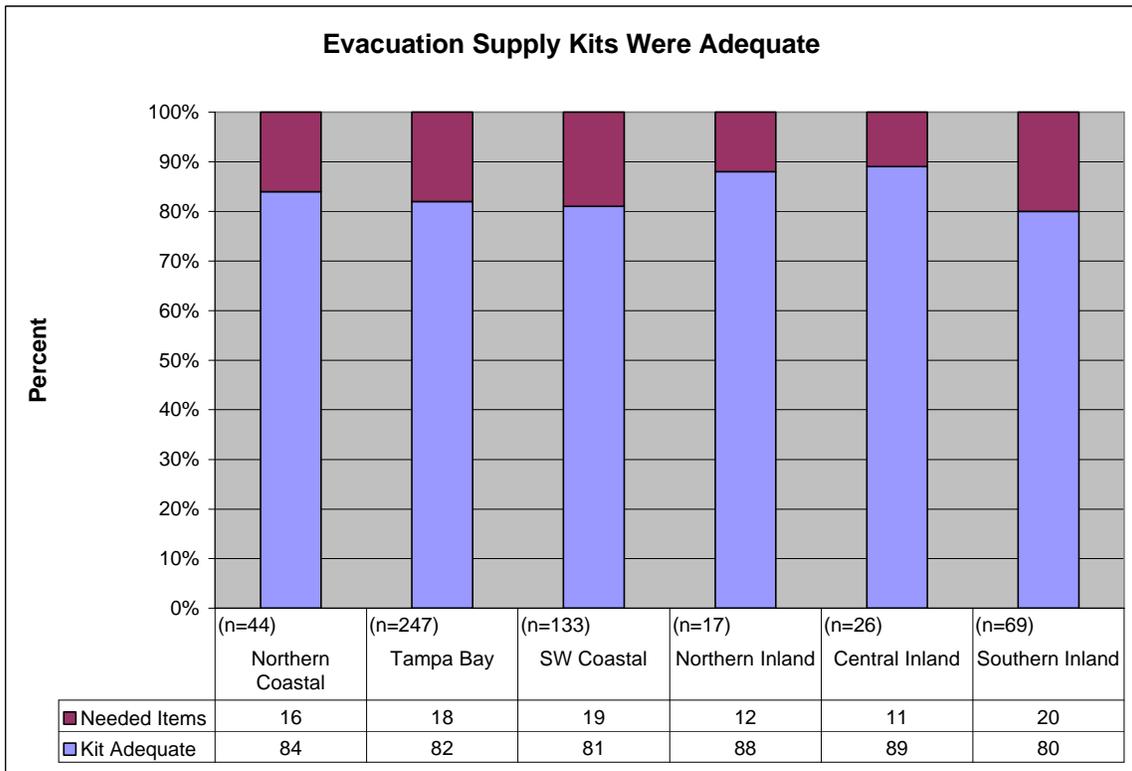


Fig. 32

Property Protection

Between 40% and 55% of respondents said they took actions to protect their homes and property from Charley (Figure 33). Positive responses were only slightly higher in coastal counties than in non-coastal counties. As few as 17% and as many as 40% of the interviewees in households taking protective actions said the actions they took affected their evacuation decisions (Figure 34). In coastal counties that response was highest in southwest Florida and lowest in Tampa Bay. In households saying their property protection affected their evacuation decision, 15% evacuated. In households saying property protection did not affect their evacuation decision, 30% evacuated. However, the actual evacuation participation rates were the same in household that did and did not take actions to protect their property except in the non-surge areas of coastal counties. In that risk area 23% evacuated from households taking protective actions, compared to 29% in other households.

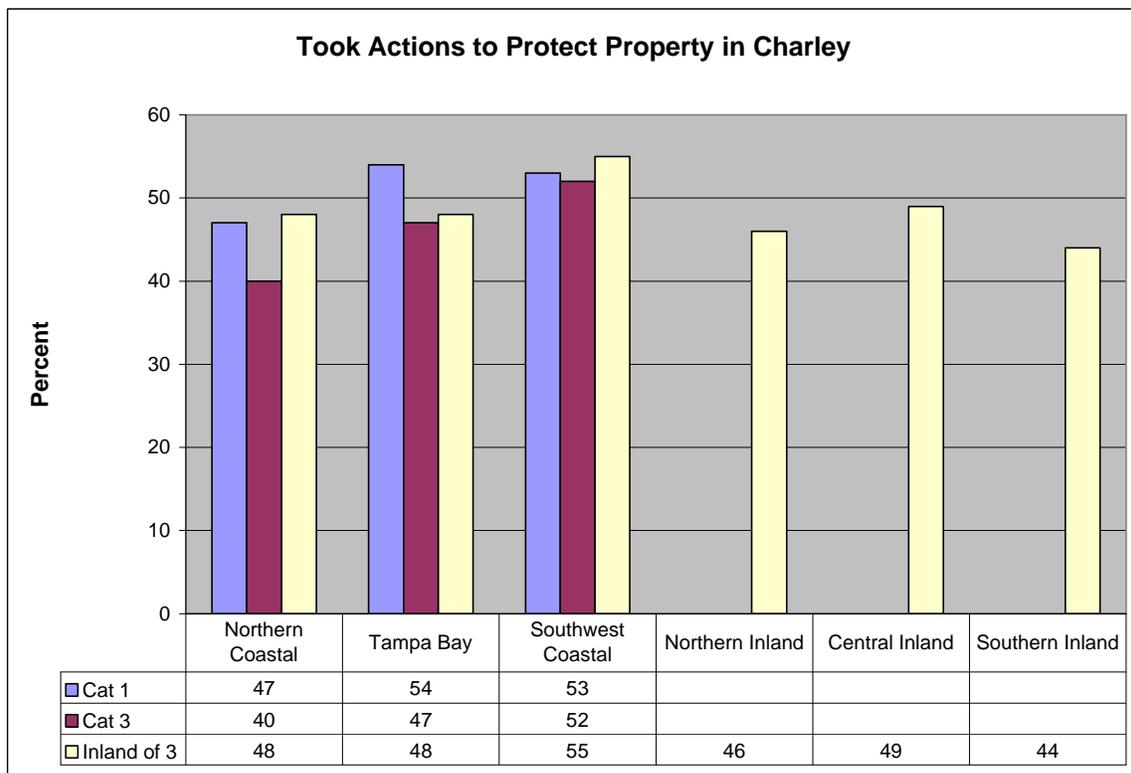


Fig. 33

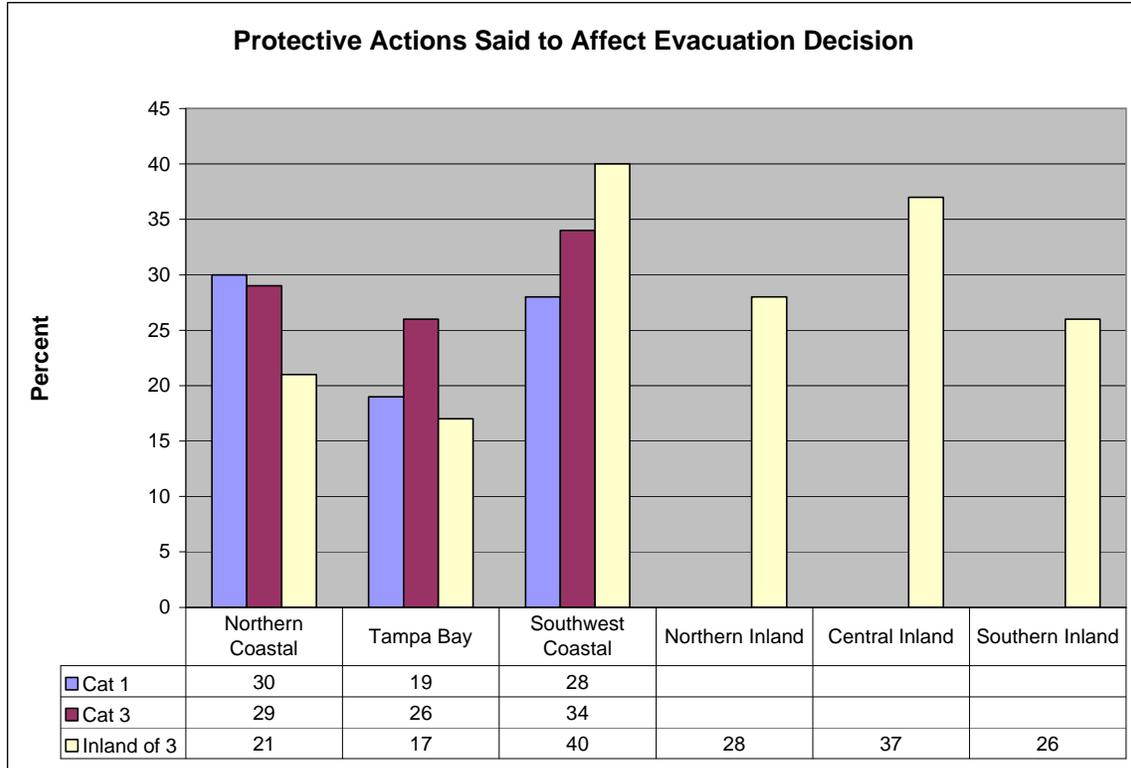


Fig. 34

### Perceived Vulnerability

Respondents were asked two questions about three different hurricanes to measure their beliefs about the safety of their homes. The first question asked whether the hurricanes would cause their homes to flood dangerously from storm surge, waves, or rivers if the storms passed directly over their homes. The second asked whether it would be safe for them to stay in their homes in the storms, considering both wind and water. The storms were described in terms of wind velocity and the Saffir-Simpson scale: 155 MPH, Cat 4; 125 MPH Cat 3; and 100 MPH Cat 2.

#### 155 MPH Category 4

The highest percentage of people saying their homes would flood dangerously in a 155 MPH hurricane was 61%, in the category 1 risk zone of the Tampa Bay area (Figure 35). In the category 1 zones of the northern coastal counties and southwest Florida the figures were 46% and 52% respectively. The Tampa Bay area was the only location where a majority of respondents (54%) in category 3 risk areas said their homes would flood dangerously in a 155 MPH hurricane. Except in central Florida, approximately 30% of the respondents living in non-surge areas expect dangerous flooding in a 155 MPH hurricane.

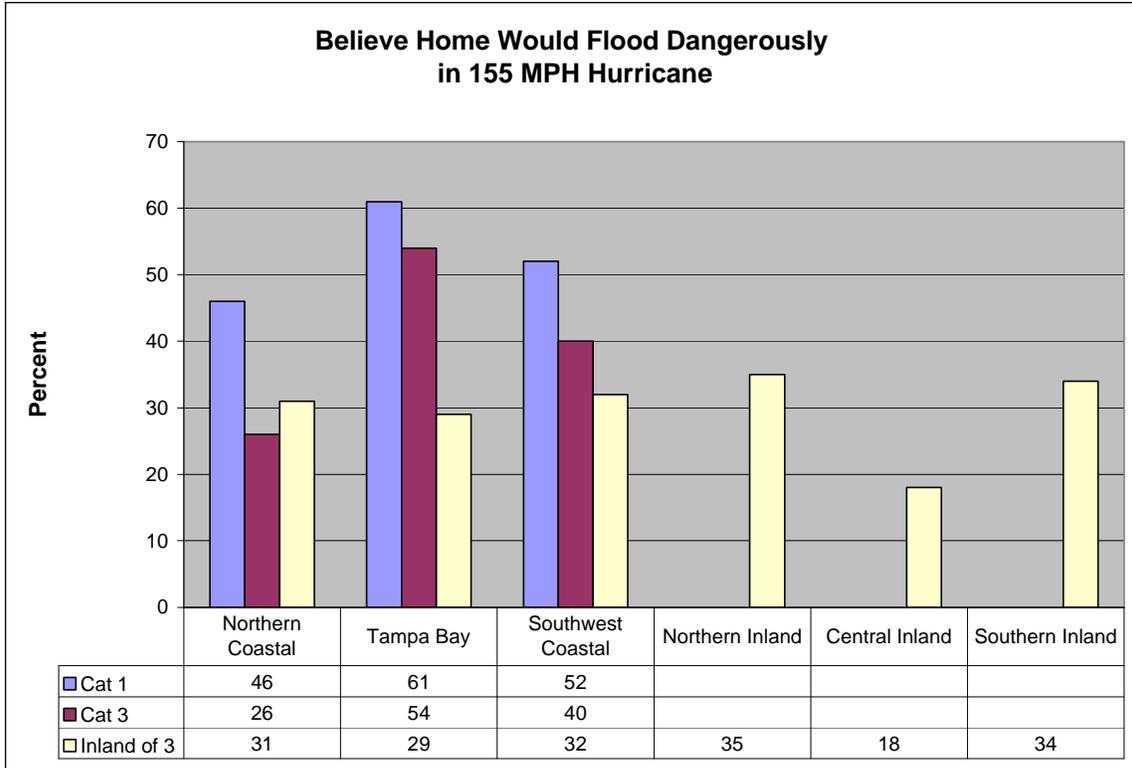


Fig. 35

Significantly more people believe their homes would be unsafe considering both wind and water (Figure 36). The lowest figure was 54% in inland areas of southwest Florida coastal counties and the highest was 74% in the Tampa Bay category 1 risk area.

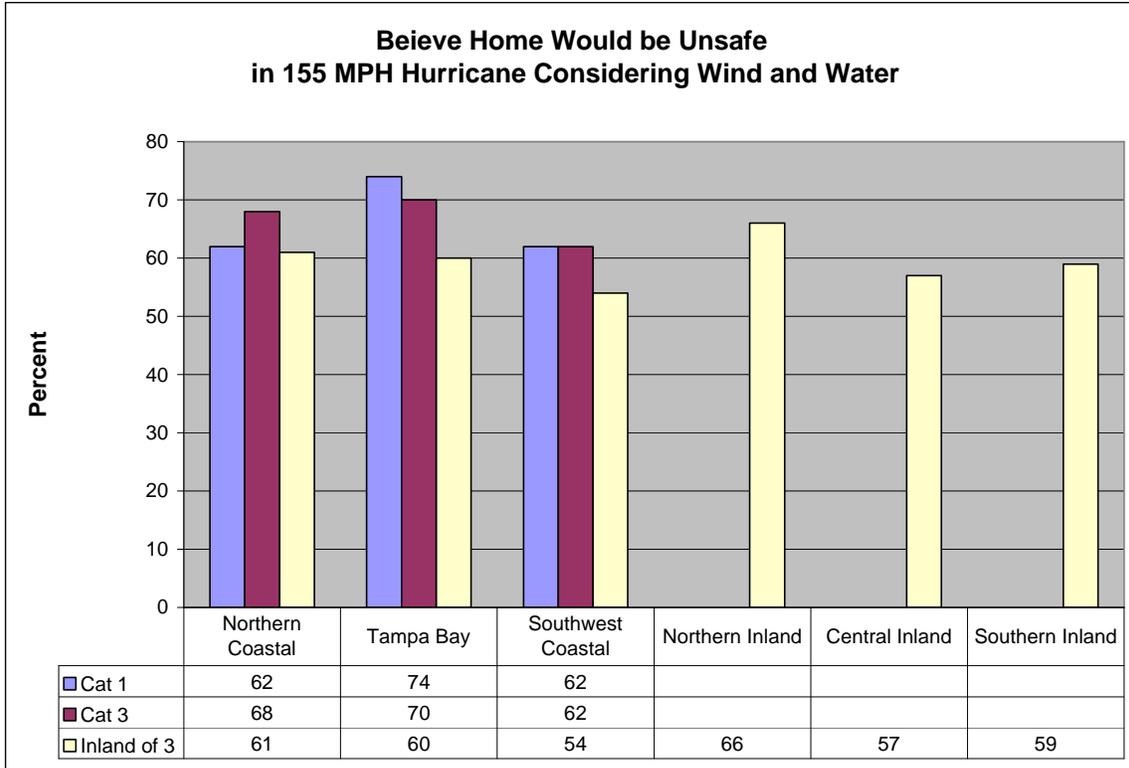


Fig. 36

### 125 MPH Category 3

Tampa Bay surge area respondents were the most likely to say their homes would flood dangerously in a 125 MPH hurricane, but only about half held that belief and they resided in the category 1 risk zone (Figure 37). In the northern coastal area and in southwest Florida only 36% and 37% of the category 1 risk area interviewees expect their homes to flood dangerously in a 125 MPH hurricane. Affirmative responses in category 3 zones ranged from 19% in the northern area to 37% in Tampa Bay.

In category 1 and 3 surge areas 44% to 58% of those interviewed said it would be unsafe to stay in their homes in a 125 MPH hurricane, considering both wind and water (Figure 38). Responses in non-coastal counties were comparable to those in coastal counties.

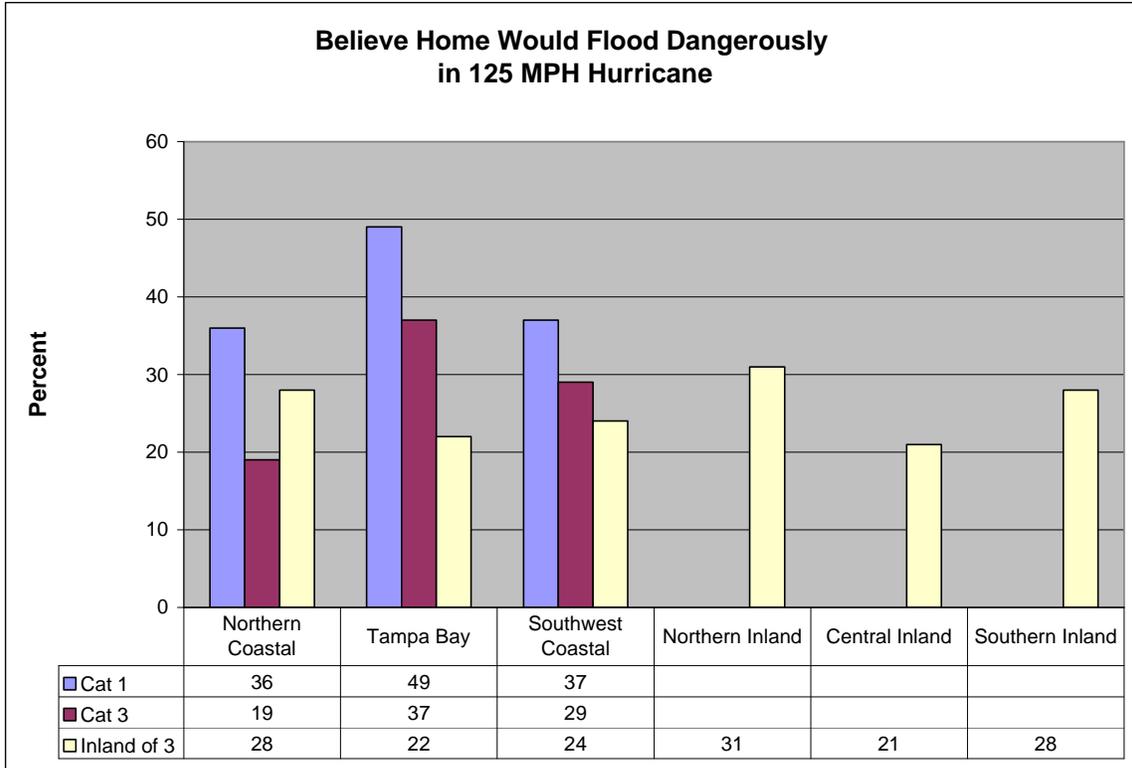


Fig. 37

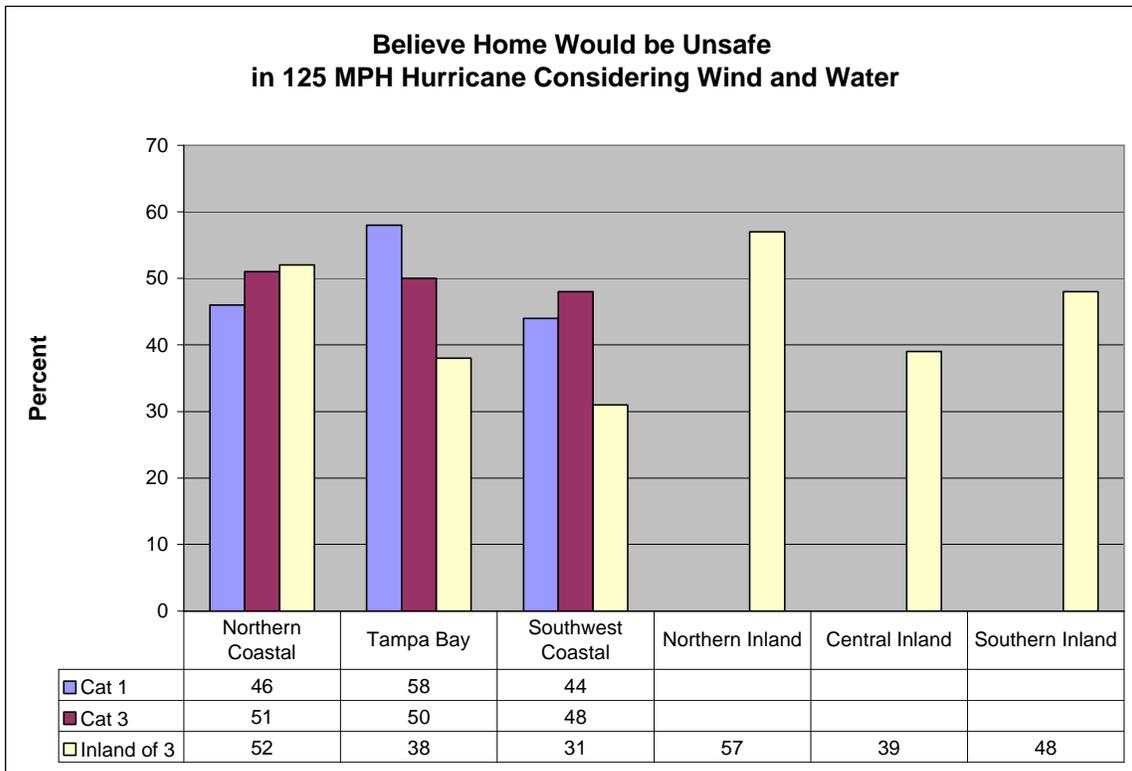


Fig. 38

100 MPH Category 2

For a 100 MPH hurricane expectation of dangerous flooding ranged from 19% to 34% in category 1 and 3 risk areas (Figure 39). Concerns were greatest in the Tampa Bay area, but in non-coastal counties responses were similar to those in coastal counties.

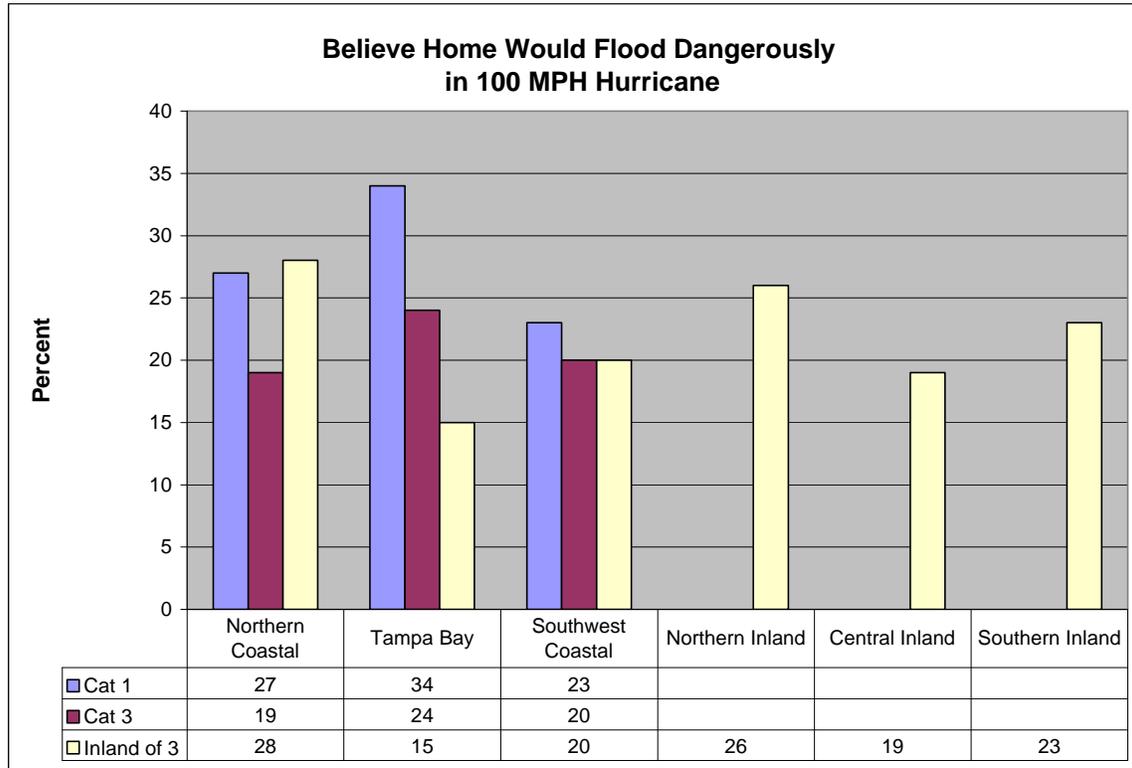


Fig. 39

With exceptions in only a few locations, only about 25% of the respondents said their homes would be unsafe considering both wind and water in 100 MPH hurricane (Figure 40). More than 40% in the Tampa Bay category 1 zone and in the northern coastal non-surge area said their homes would be unsafe.

Comparisons within Risk Zones

Figures 41, 42, and 43 show some of the same data in Figures 35-40, but arranged to facilitate comparisons within risk zones for all three storms at once. The most obvious overall pattern is the decrease in concern among 155 MPH, 125 MPH, and 100 MPH hurricanes. One conclusion in Figure 43 is that concern is generally greater in non-coastal counties than in the areas of coastal counties inland of the category 3 surge zone.

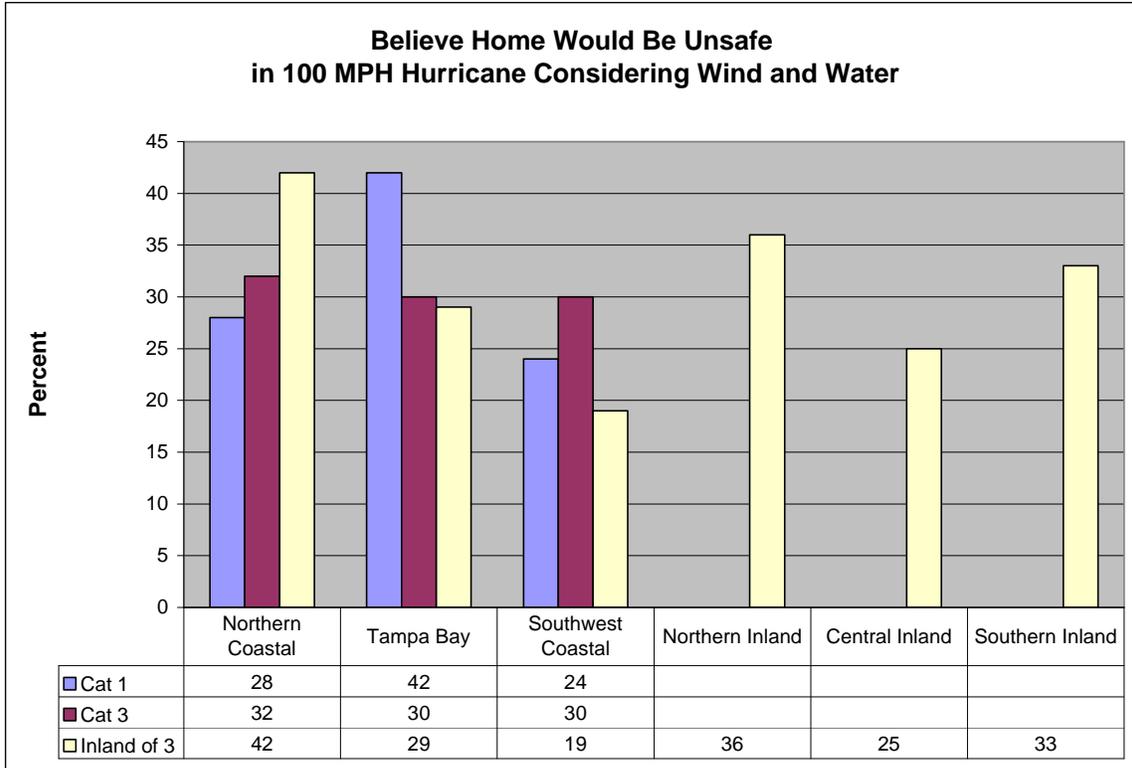


Fig. 40

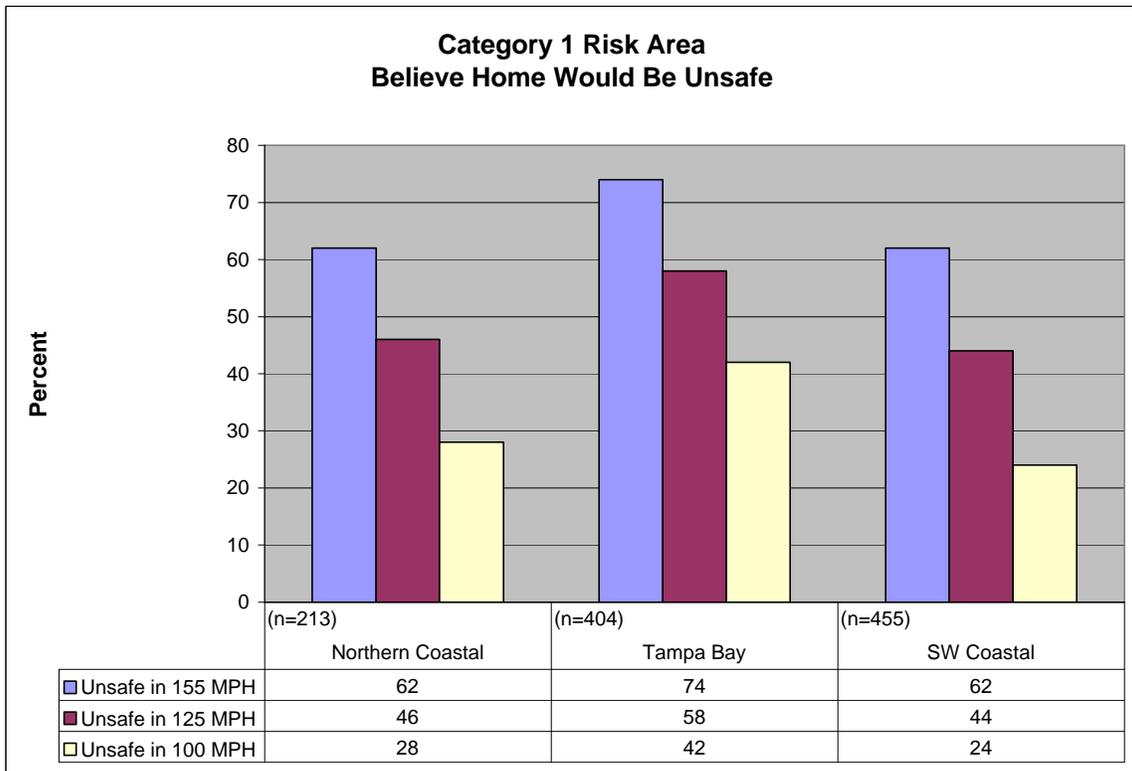


Fig. 41

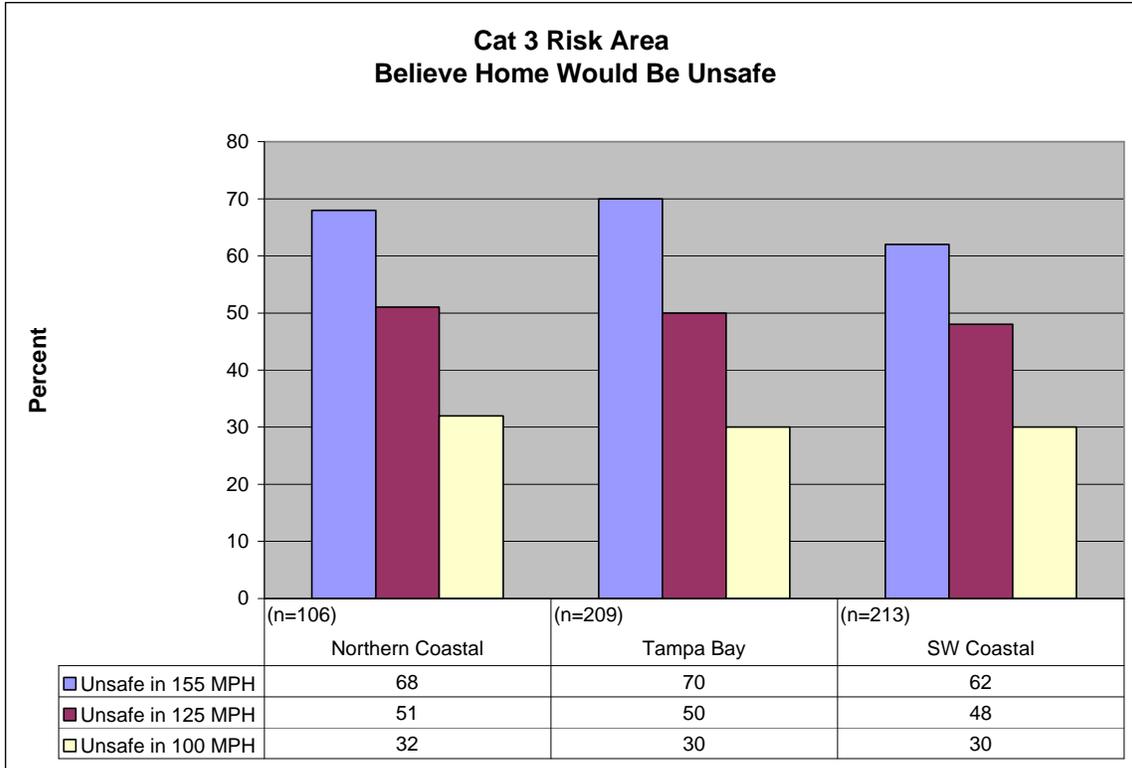


Fig. 42

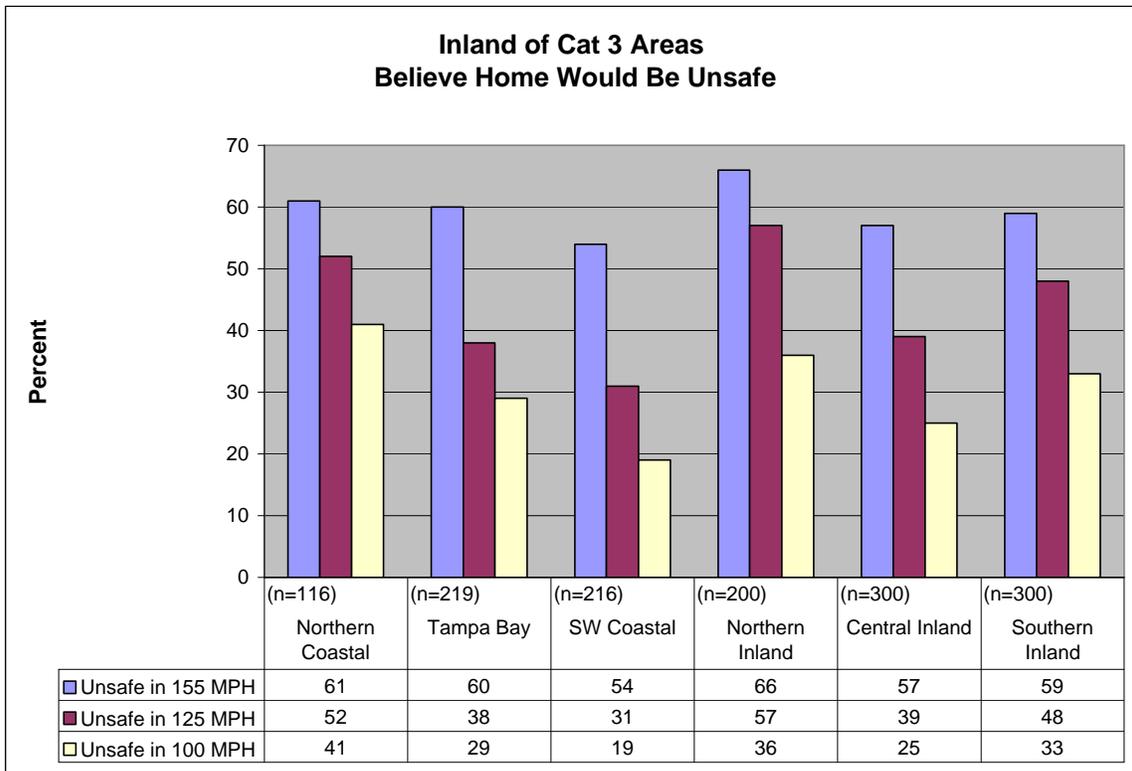


Fig. 43

Perceived Vulnerability and Housing Type

Figure 44 shows the percentage of people saying their homes would be unsafe in a 125 MPH hurricane for three categories of housing: single family detached, multi-family, and mobile homes. Mobile home residents consider their housing substantially less safe than others, regardless of risk zone. Inland residents in mobile homes were as likely as mobile home residents in surge-prone areas to say they were unsafe. People living in post-1993 mobile homes were less likely than other mobile home residents to believe their homes would be unsafe. People living in homes elevated on pilings or on fill to prevent flood damage did not differ from people in other housing in their concerns about flood vulnerability except in non-surge areas. People with window protection were slightly less likely than others to say their homes would be unsafe considering wind and water.

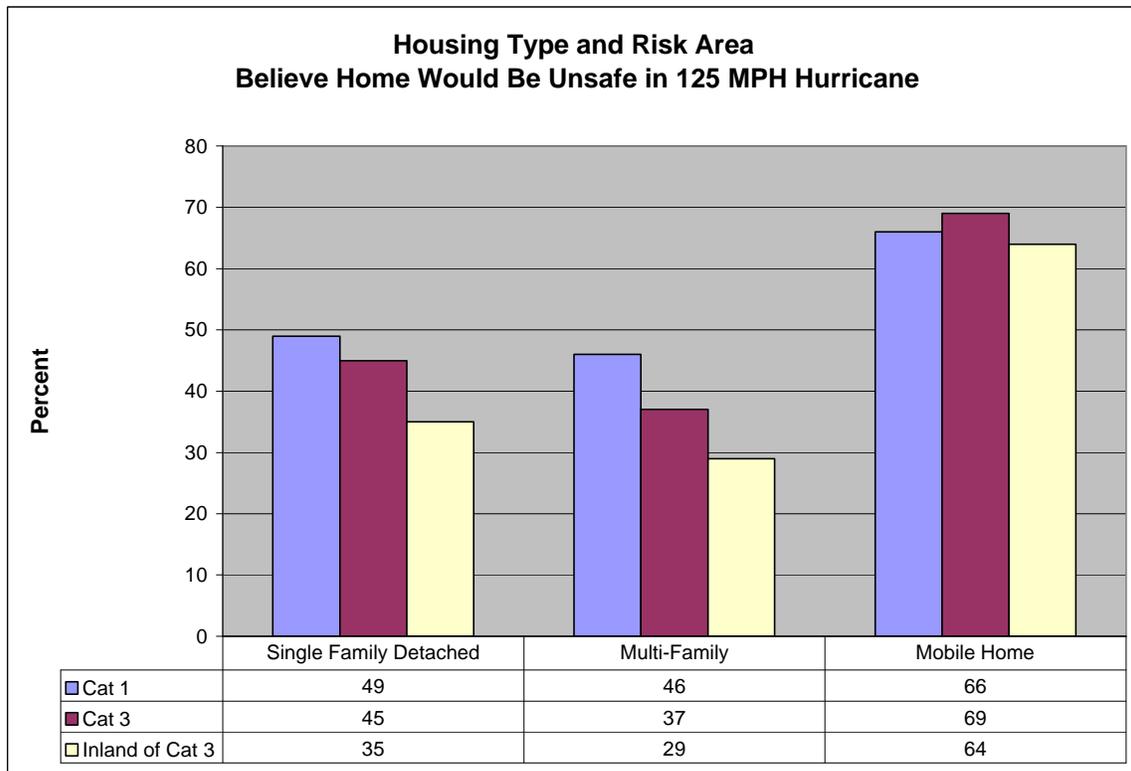


Fig. 44

Effect of Perceived Vulnerability on Evacuation

Figures 45 - 48 indicate the evacuation participation rate for each survey area, comparing people who said their home would be safe in a 125 MPH hurricane to those who said their home would be unsafe. Figures 45 – 47 show results for the three coastal areas and Figure 48 depicts data for the three non-coastal areas. For each risk area and every location, people who believe their homes would be unsafe in a 125 MPH were two to three times more likely than others to evacuate in Charley.

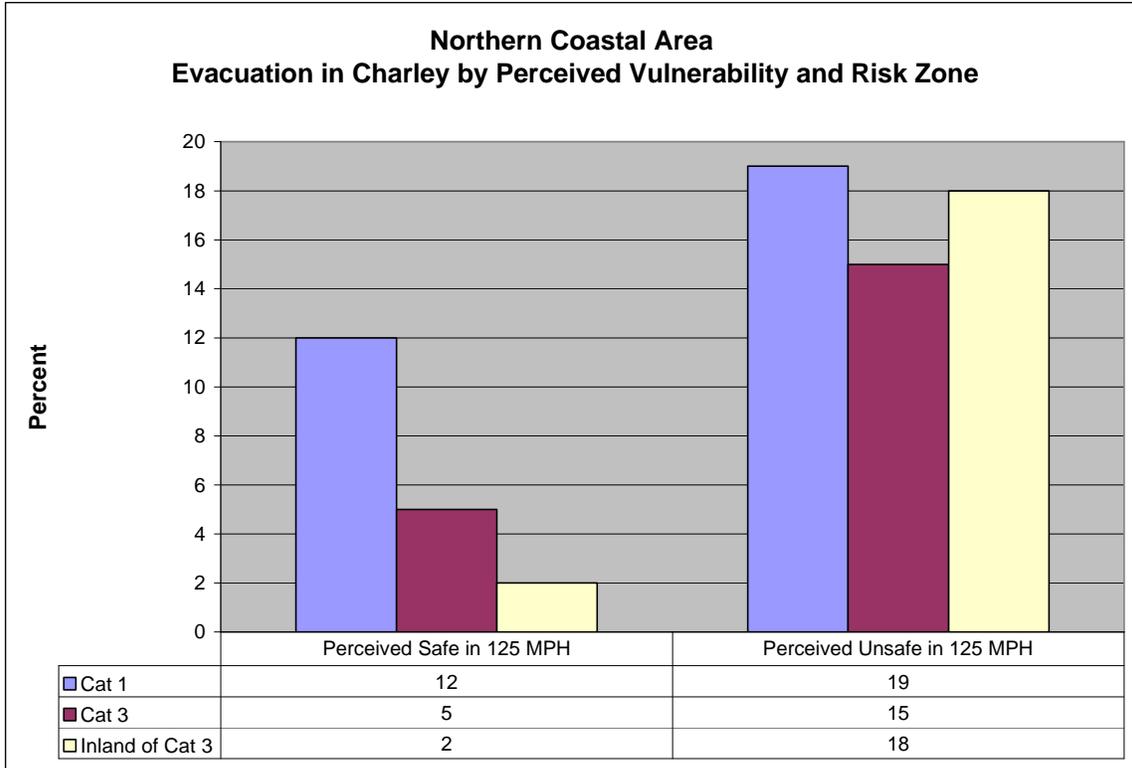


Fig. 45

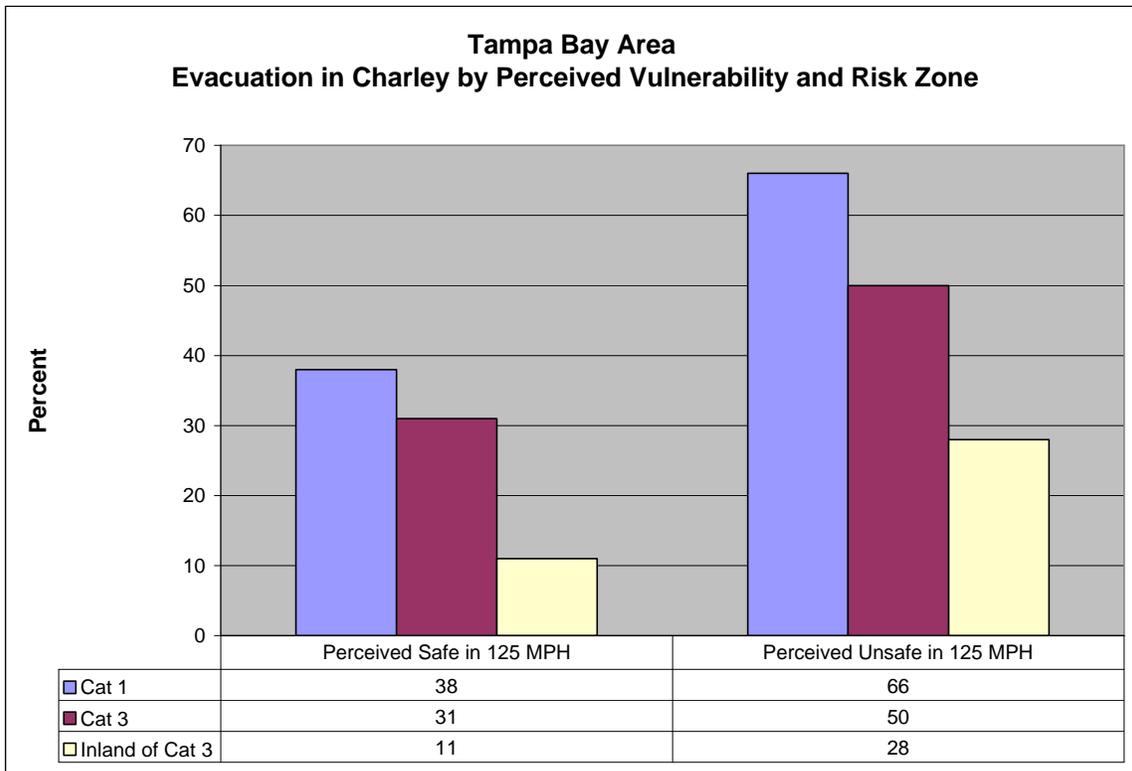


Fig. 46

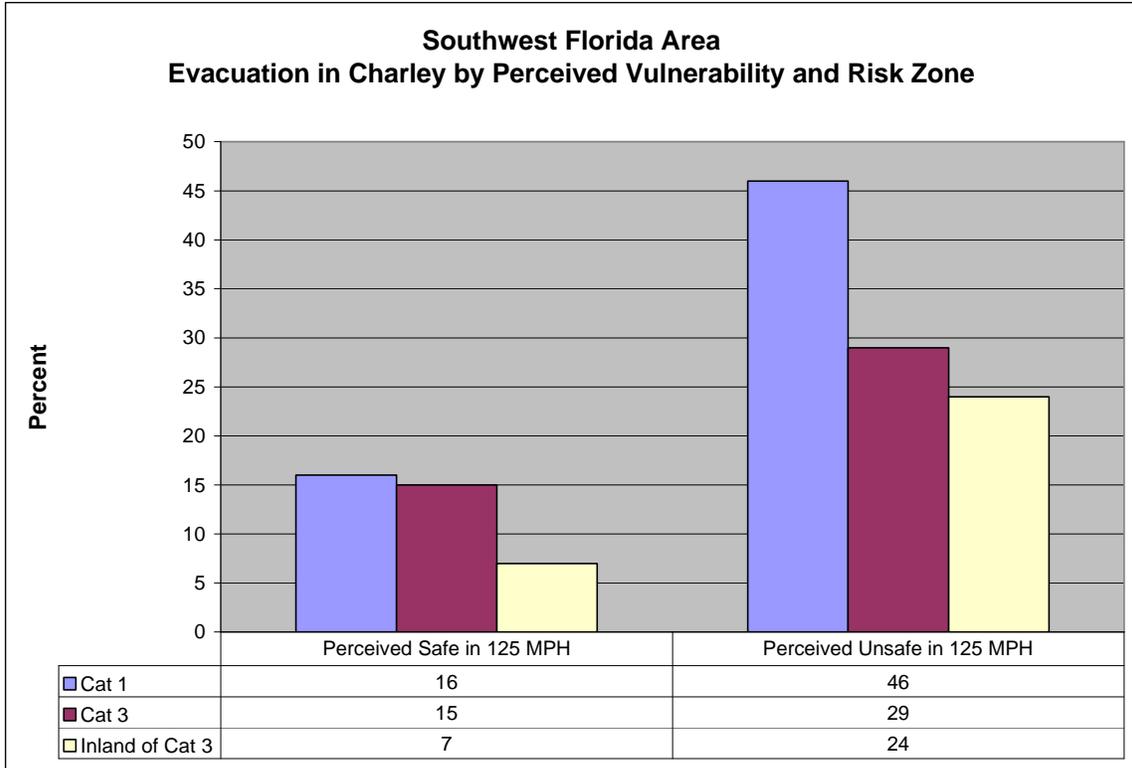


Fig. 47

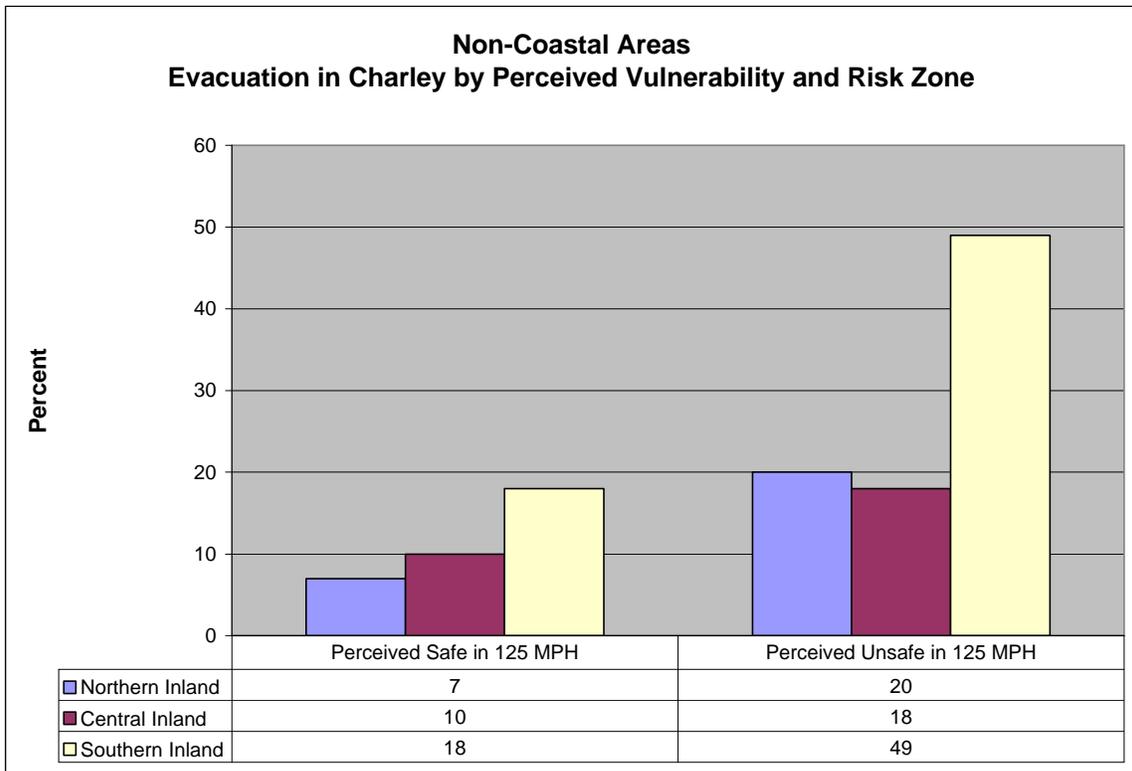


Fig. 48

## Forecast Graphic

There were anecdotal accounts of the low evacuation rate in southwest Florida being attributed to the fact that during the 24 hours prior to landfall Charley was forecast to strike the Tampa Bay area and many southwest Florida residents placed undue confidence in that forecast. Some graphical depictions of the forecast path of Charley showed just a line, some showed a cone indicating the possible tracks it could follow, and others showed both.

The great majority of respondents (88% to 97%) in all locations said they saw some sort of graphic depicting the likely track Charley would take (Figure 49). Most of those people said they saw either the cone or both the cone and line (Figure 50).

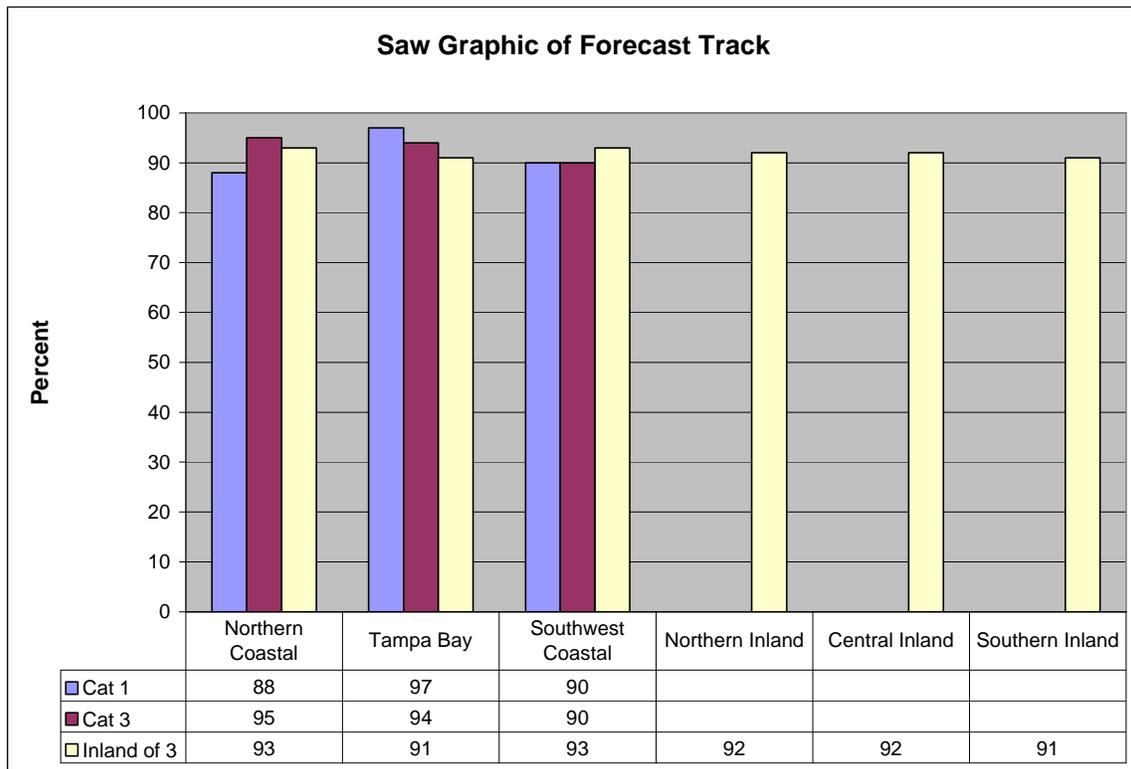


Fig. 49

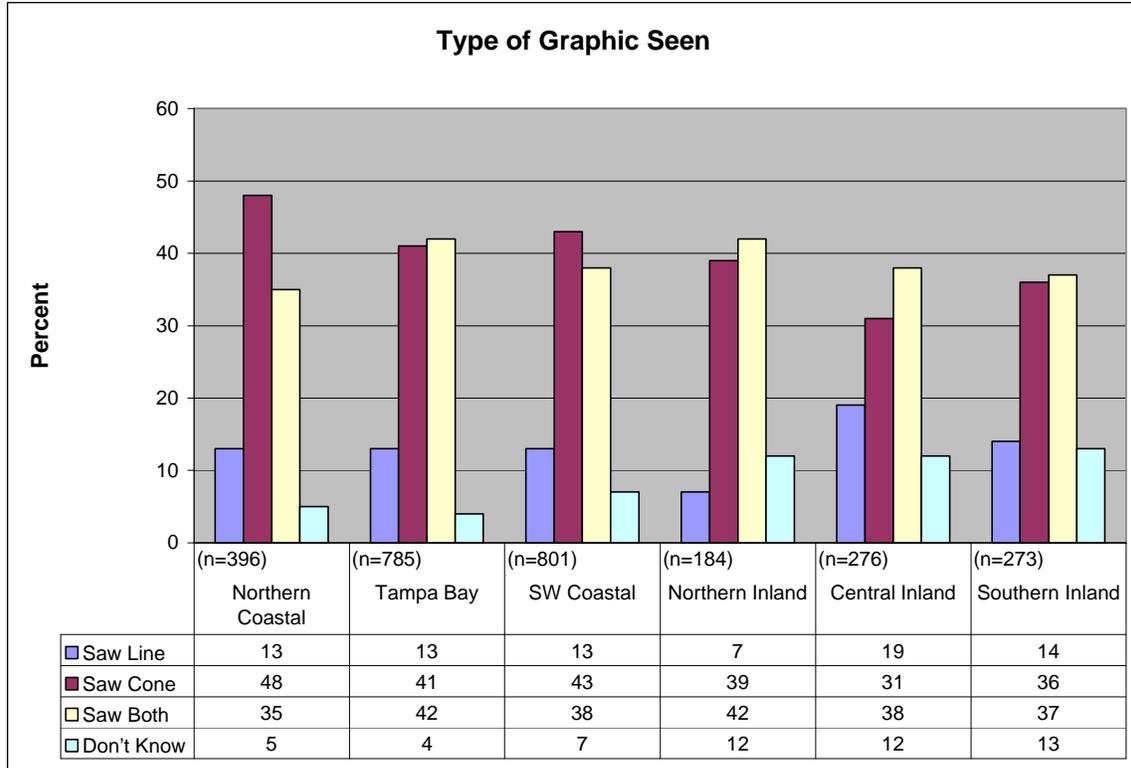


Fig. 50

When asked how important the forecast graphic was to their decision to evacuate or not, most people (56% to 68%) said it was very important (Figure 51). However, actual evacuation participation rates do not reflect that statement (Figure 52). The percentage of people evacuating in Charley was statistically the same for those who saw each type of graphic (line, cone, both). The one possible exception is in the northern non-coastal area, but even there, because of the smaller sample size in that location, it would be tenuous to conclude that the sample difference was proof of a difference in the entire population.

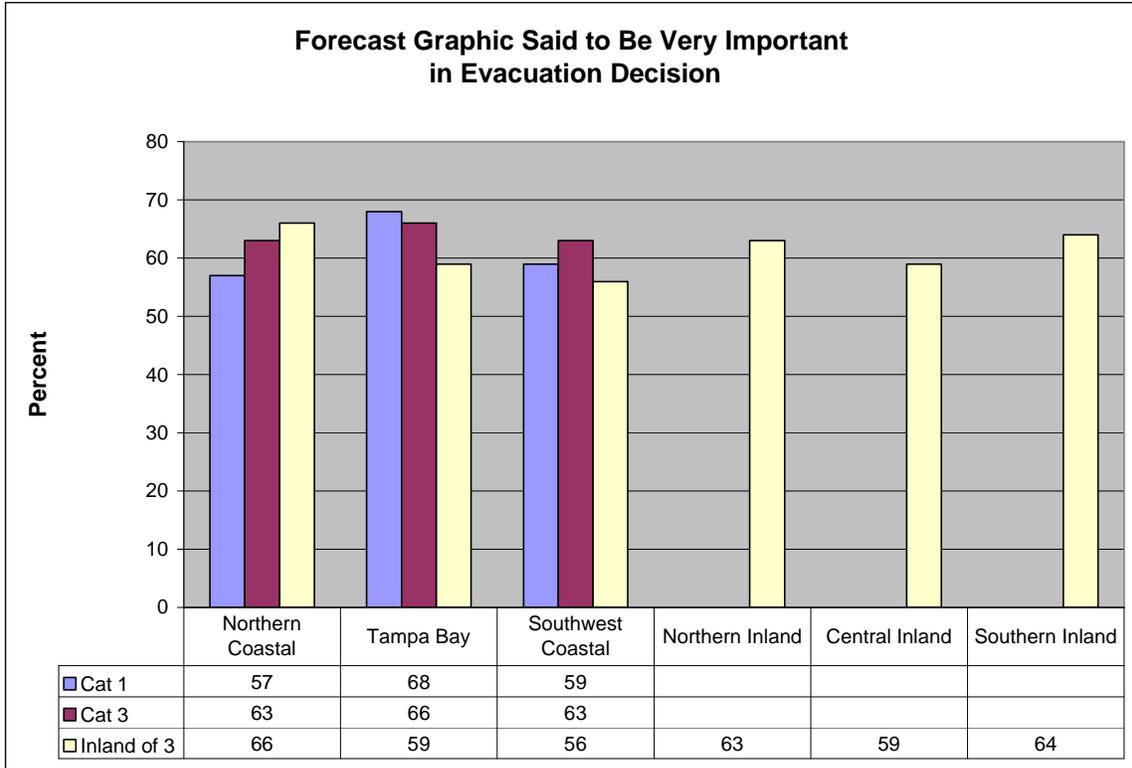


Fig. 51

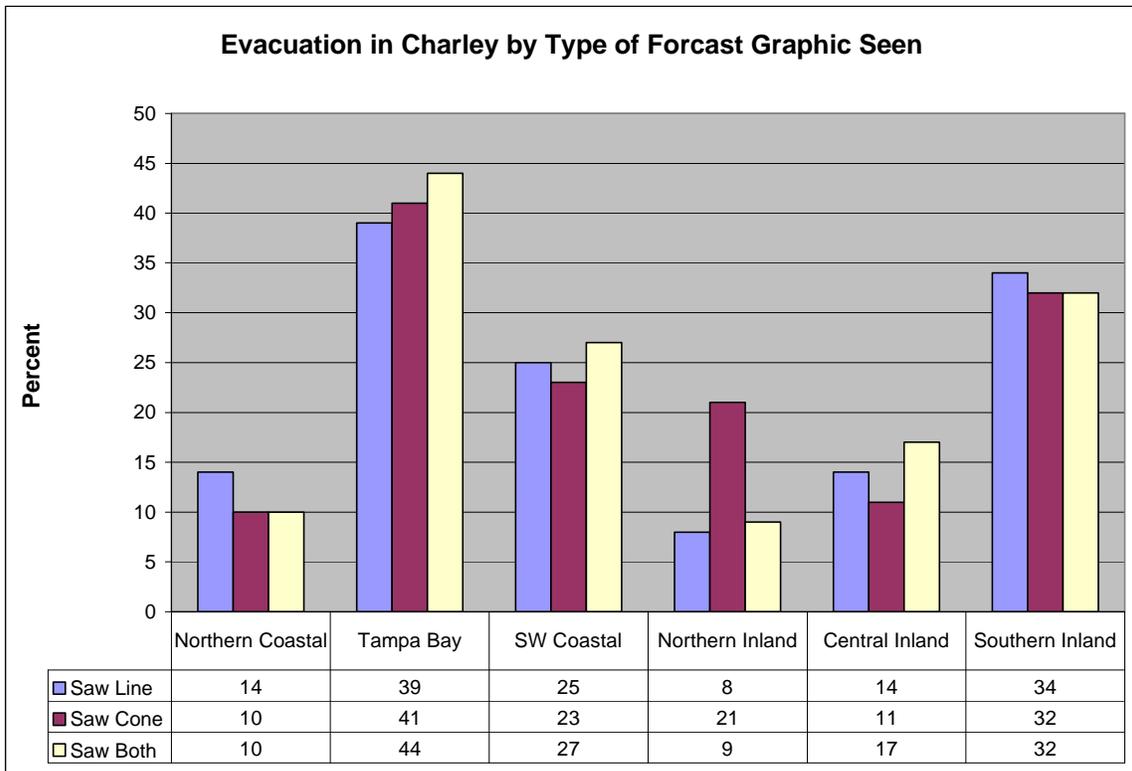


Fig. 52

## Housing and Demographics

Several housing and demographic variables were recorded about respondents, and their relationship to evacuation can be analyzed in a large number of combinations. Some of the more straightforward associations are described here.

- Housing type. People in mobile homes were more likely than people in other types of housing to evacuate. People in single family detached structures were the least likely.
- Age of mobile home. People in post-1993 constructed mobile homes were less likely than people in other mobile homes to evacuate.
- Window protection. There was no difference in evacuation rates between people in homes with and without window protection.
- Building materials. People living in brick homes were slightly less likely than people in wood and concrete block homes to evacuate.
- Children. Households with children were slightly less likely than others to evacuate.
- Living alone. People living alone were more likely than others to evacuate.
- Years in home. There was no difference in evacuation based on the number of years people had lived in their home.
- Years in region. People who had lived in their region of Florida for less than 10 years or between 21 and 40 years were slightly more likely than others to evacuate.
- Age. People under 30 and people over 50 were more likely than others to evacuate.
- Income. In category 1 areas wealthier people were more likely than others to evacuate. In non-surge areas wealthier people were less likely to evacuate. In category 3 areas there was no difference in evacuation based on income.
- Education. In category 1 areas people with more years of education were more likely than others to evacuate. In non-coastal counties people who were college graduates were less likely than others to evacuate. In other risk zones there was no difference in evacuation based on education.
- Race. Whites were more likely than others to evacuate, except in non-coastal counties, where there was no difference.

## Evacuation Timing

### Time Between Decision and Departure

Evacuees were asked how much time elapsed from when they made their decision to evacuate and when they left their homes. The overall impression is that for most people there was little delay between decision time and departure time (Figure 53). In southwest Florida 43% of the evacuees said they left within an hour of making their decision, and in other areas the figure ranged from 28% to 52%. In every location more than half the departures took place within 3 hours of the decision to leave. Decision making time might have taken much longer. The responses in Figure 53 show just the time between final decision and departure.

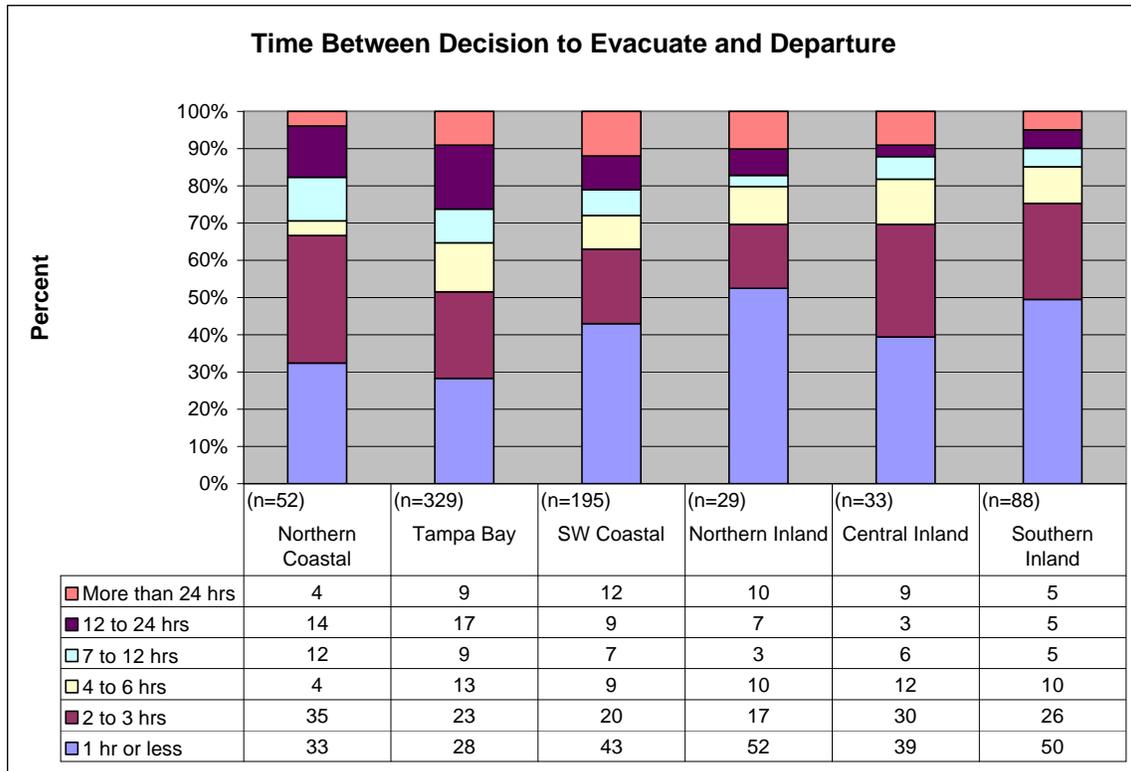


Fig. 53

### Response Curves

After being reminded of when certain events such as warnings and landfall occurred, evacuees were asked when they actually left their homes (time and date). Figure 54 shows cumulative evacuation during the 12<sup>th</sup> and 13<sup>th</sup> of August. That is, it depicts the cumulative percentage of eventual evacuees from each location who had left by various times. The northern and central non-coastal samples were aggregated to provide a more reliable sample size. By the beginning of the day on the 12<sup>th</sup> 5% to 15% of the eventual evacuees had already departed, depending on location. Departures increase on the afternoon of the 12<sup>th</sup>, then slowed on the evening of the 12<sup>th</sup>,

then resumed on the morning of the 13<sup>th</sup>. The latest evacuation was in the southern inland area, followed by the other non-coastal areas. Despite the late shift in storm track, evacuation curves in Tampa Bay and southwest Florida were very similar.

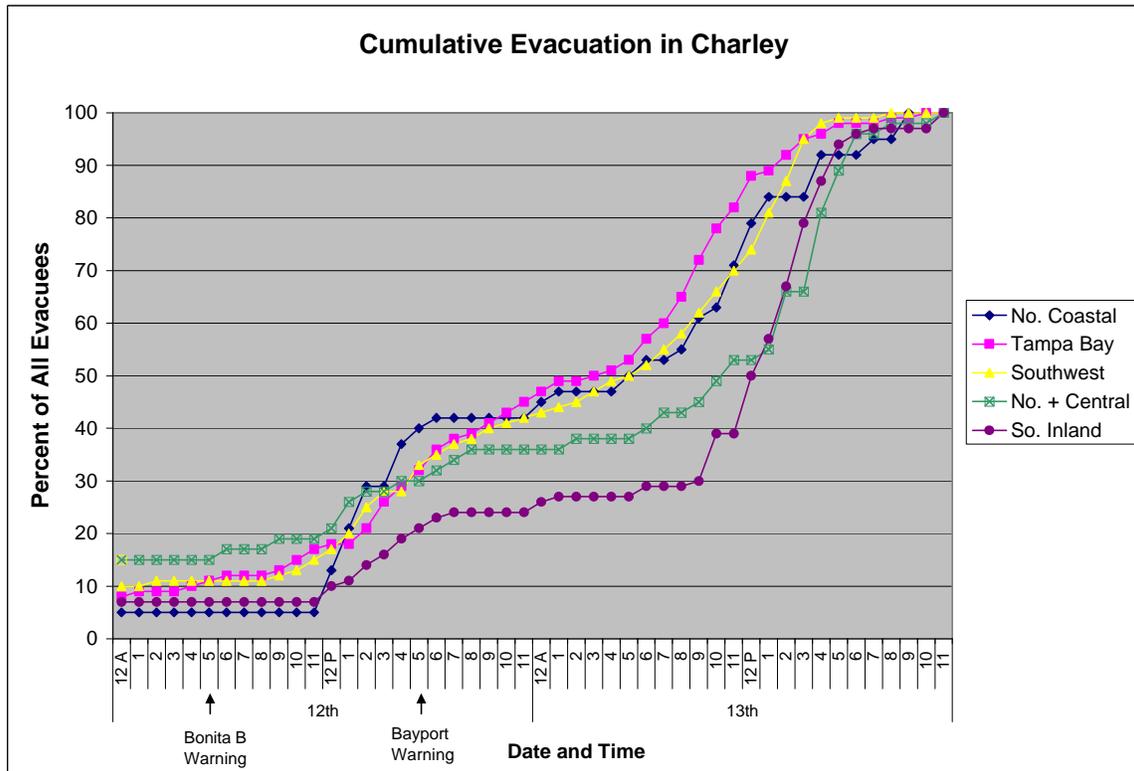


Fig. 54

## Evacuation Destinations and Travel

### Type of Refuge

Evacuees were asked whether they went to a public shelter, a hotel or motel, the home of a friend or relative, or someplace else when they evacuated. Figure 55 shows the distribution of refuge types for the six survey locations. As in most hurricane evacuations, the majority of evacuees (49% to 70%) went to the homes for friends and relatives. The percentage going to public shelters ranged from 6% in the Tampa Bay area to 20% in the southern non-coastal area. The category labeled “other” includes second homes, workplaces, churches, mobile home park clubhouses, and boats. The following groups were more likely than others to rely on public shelters:

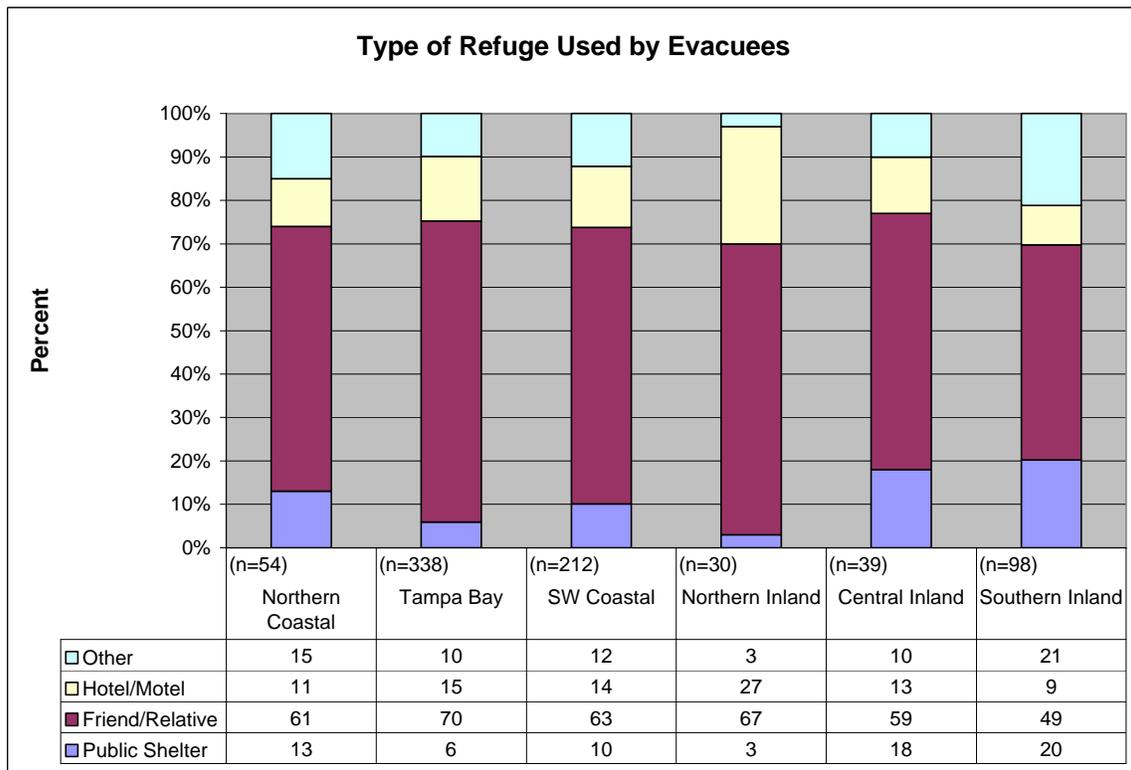


Fig. 55

### Factors Associated with Type of Refuge Used

It is typical for evacuees from more vulnerable locations to rely less than others on public shelters, and that was the case in Charley (Figure 56). This can be related to income, but evacuees from non-surge areas often wait longer to decide whether to evacuate and don't have

time to go far from their homes. The effect was even more pronounced in the Tampa Bay and southwest Florida areas (Figures 57, 58). There weren't enough evacuees from each risk zone in the northern coastal area to provide a comparable breakdown.

Demographics and Use of Public Shelters

The following demographic variables were related to use of public shelters in Charley:

- Mobile home residents used public shelters more than other residents.
- Younger and older residents used public shelters more than middle-age residents.
- People in homes in which at least two residents were 80 or more years of age used public shelters more than other people.
- People in homes in which there were people with special needs used public shelters more than other people.
- Non-whites used public shelters more than whites.
- People in households with higher incomes used public shelters less than other people.

There was no relationship between public shelter use and number of years in ones home, number of years in region of Florida, number of people in household, and education.

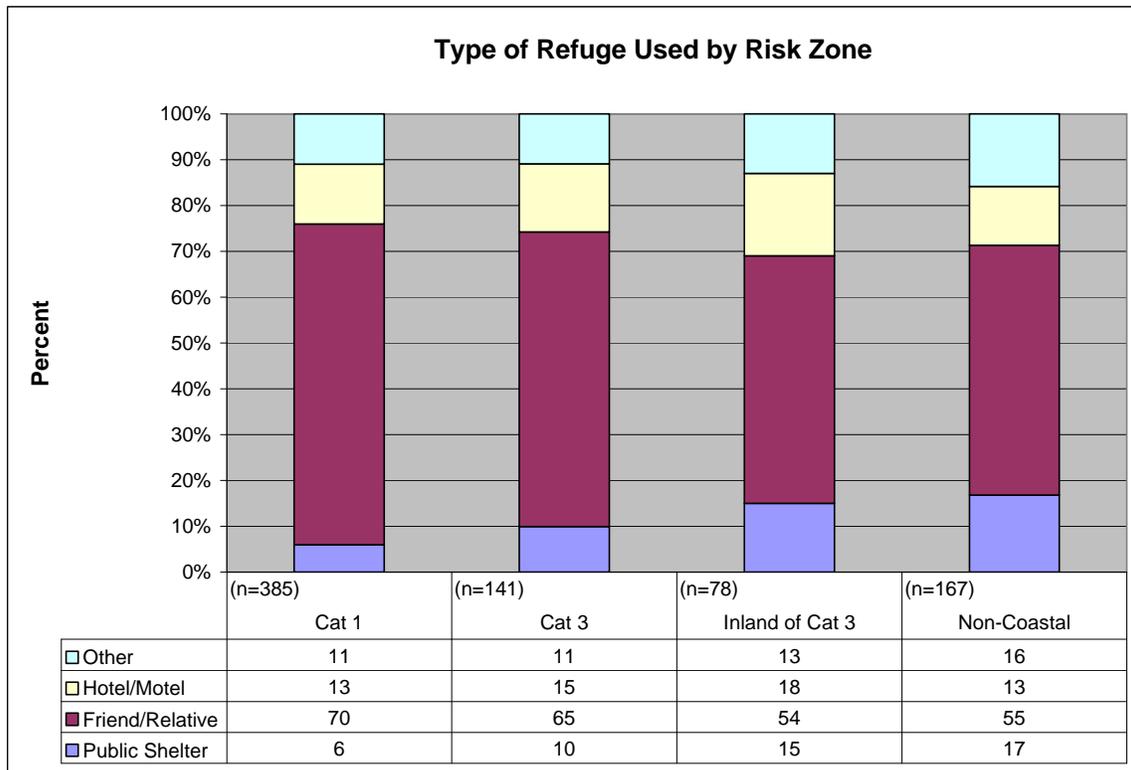


Fig. 56

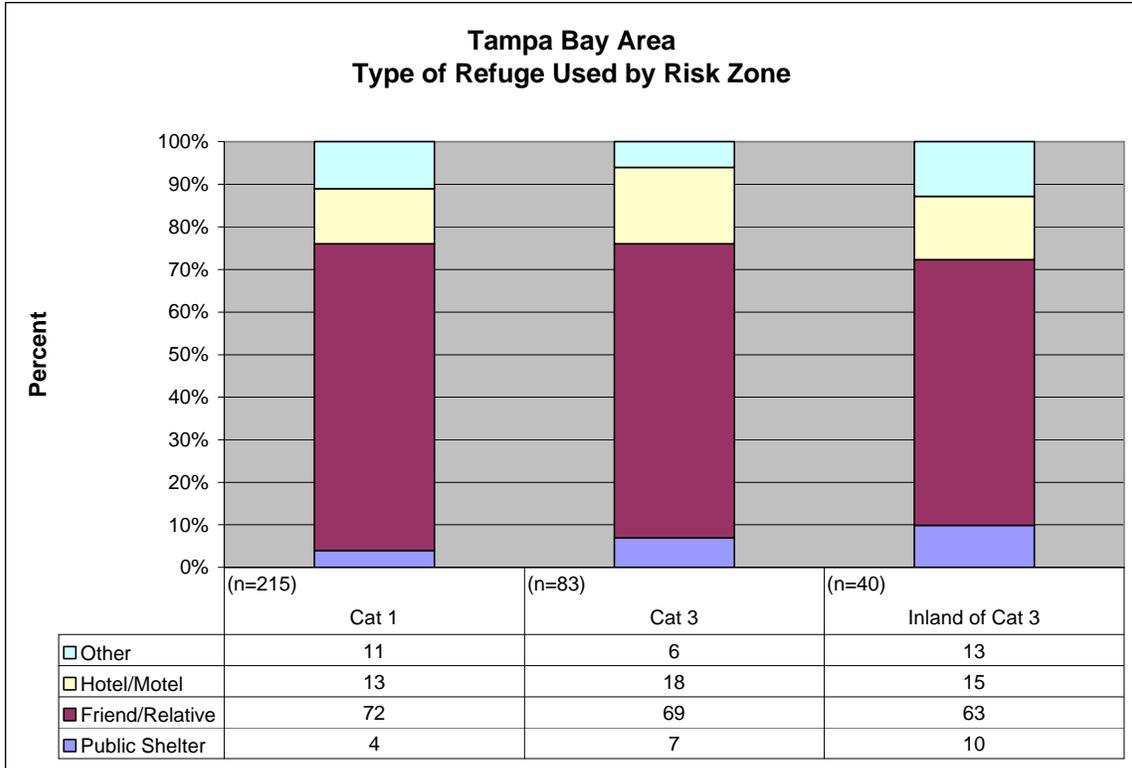


Fig. 57

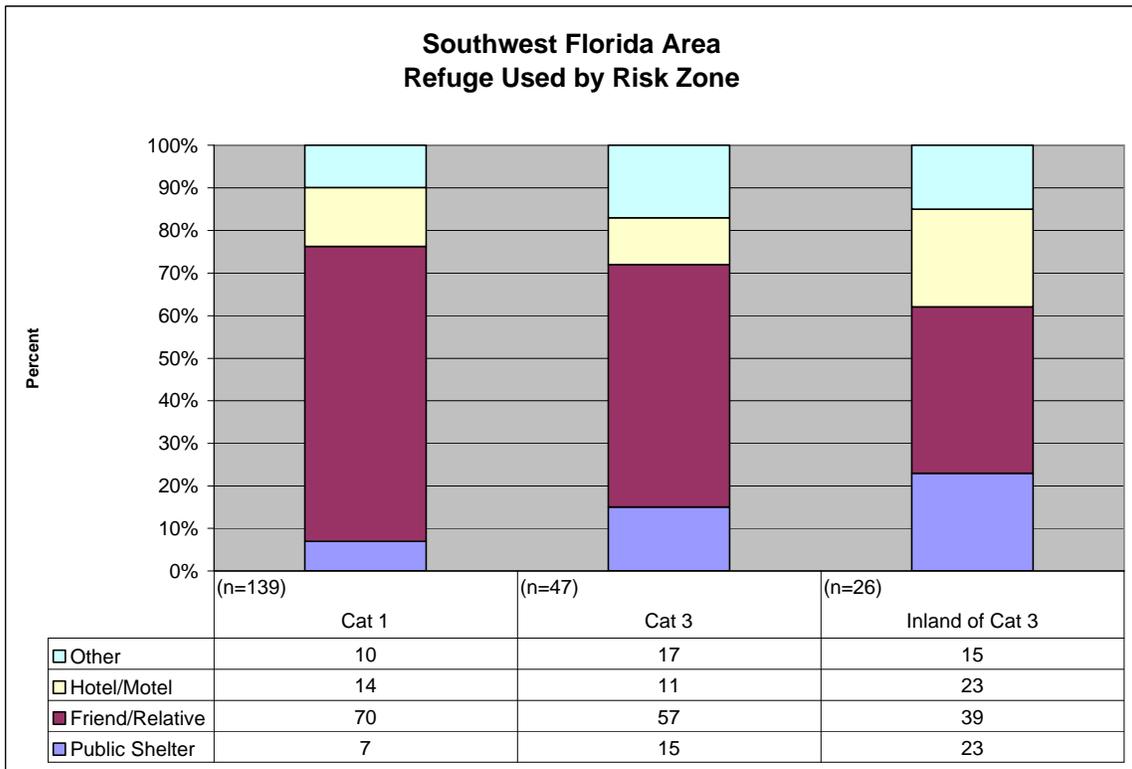


Fig. 58

## Location of Refuge

Most evacuees in Charley went to locations near their own homes. Other than in the Tampa Bay area, 34% to 66% said they went to places in their own neighborhoods (Figure 59). In the Tampa Bay area only 17% stayed in their own neighborhood. A low of 15% in the central non-coastal area and a high of 40% in the northern non-coastal area went out of county when they evacuated (however, both figures are based on small numbers of respondents). A more reliable and representative range is 33% to 40% going out of county, meaning that the remainder went to places within their own counties. Evacuees from surge areas were less likely than others to go to places in their own neighborhoods and more likely than others to go out of county (Figure 60, 61, 62).

Among evacuees going to public shelters, 68% did so in their own neighborhood and 30% did so elsewhere in their own county. Only one percent of those going to public shelters went outside their own county. Of all the evacuees going out of their own county, less than one percent went to public shelters.

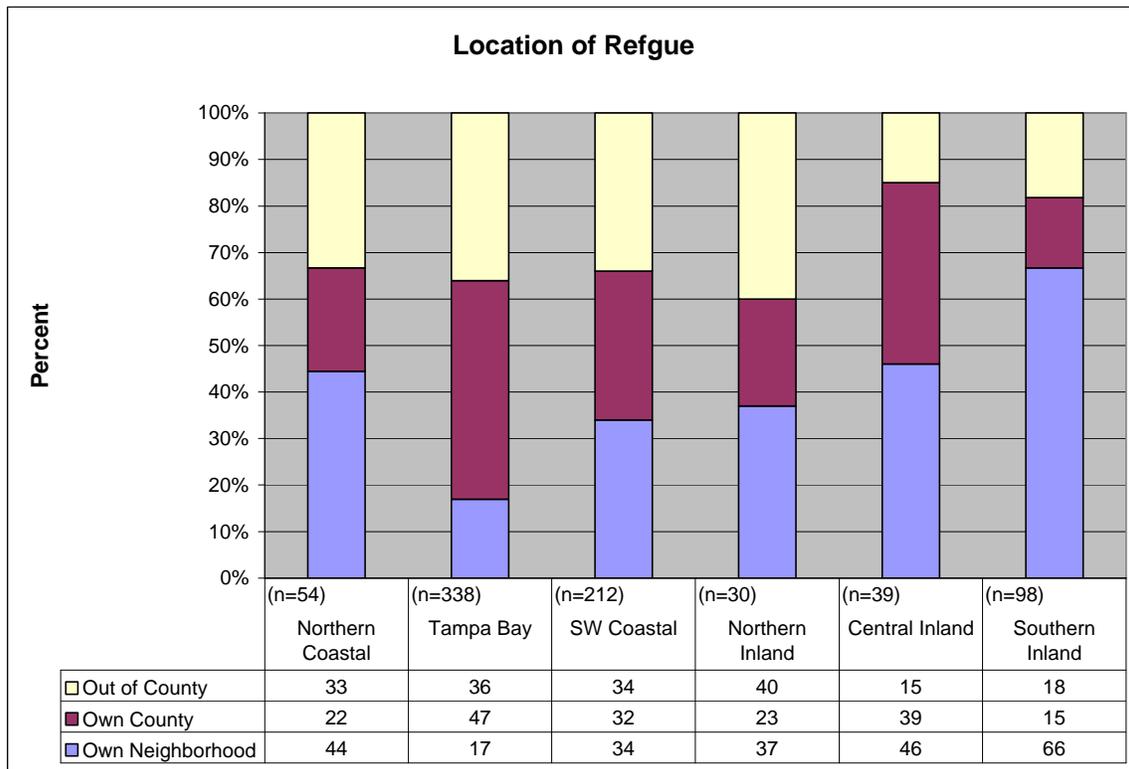


Fig. 59

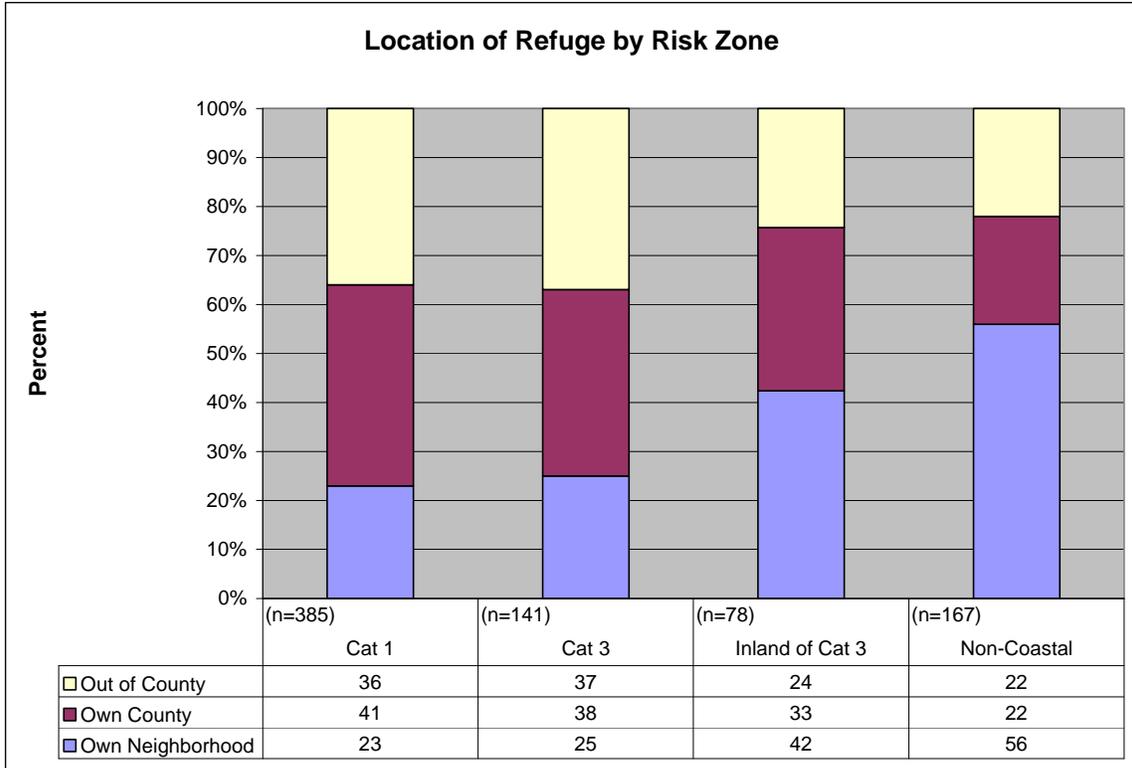


Fig. 60

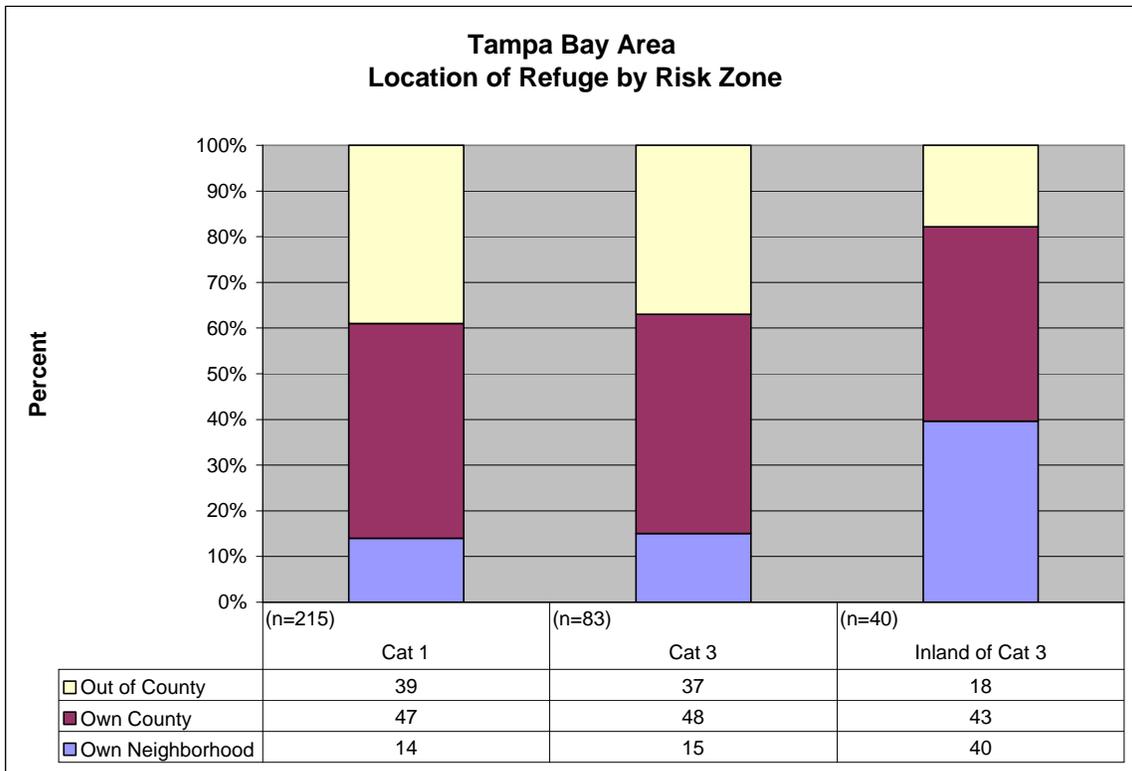


Fig. 61

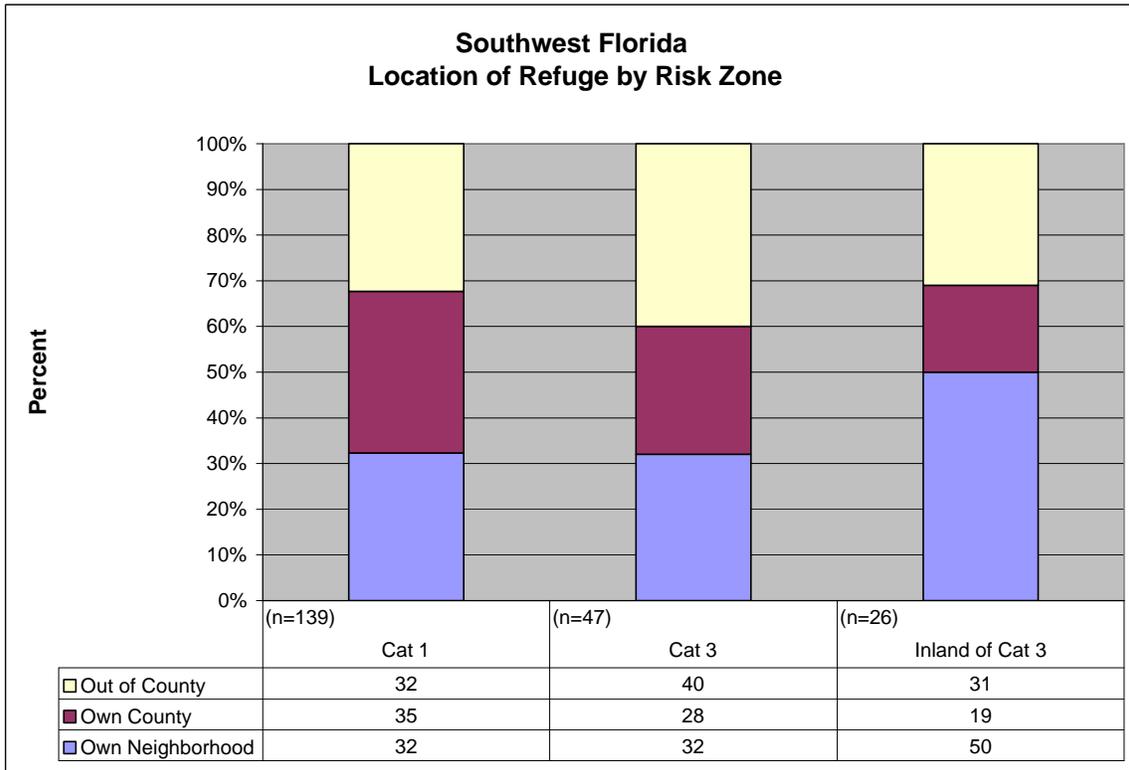


Fig. 62

## Travel

### Original Destination

Almost all evacuees (87% to 97%) said they reached their original destination when evacuating (Figure 63). There was little variation among interview locations.

### Time to Reach Destination

The number of hours traveled en route to destinations was consistent with the distribution of trips to nearby locations. Between 24% and 39% of the trips required less than an hour, and 36% to 48% took 1 to 2 hours (Figure 64). Travel times in Charley were essentially the same as the times normally required to reach the same destinations, reflecting little roadway congestion in Charley (Figure 65).

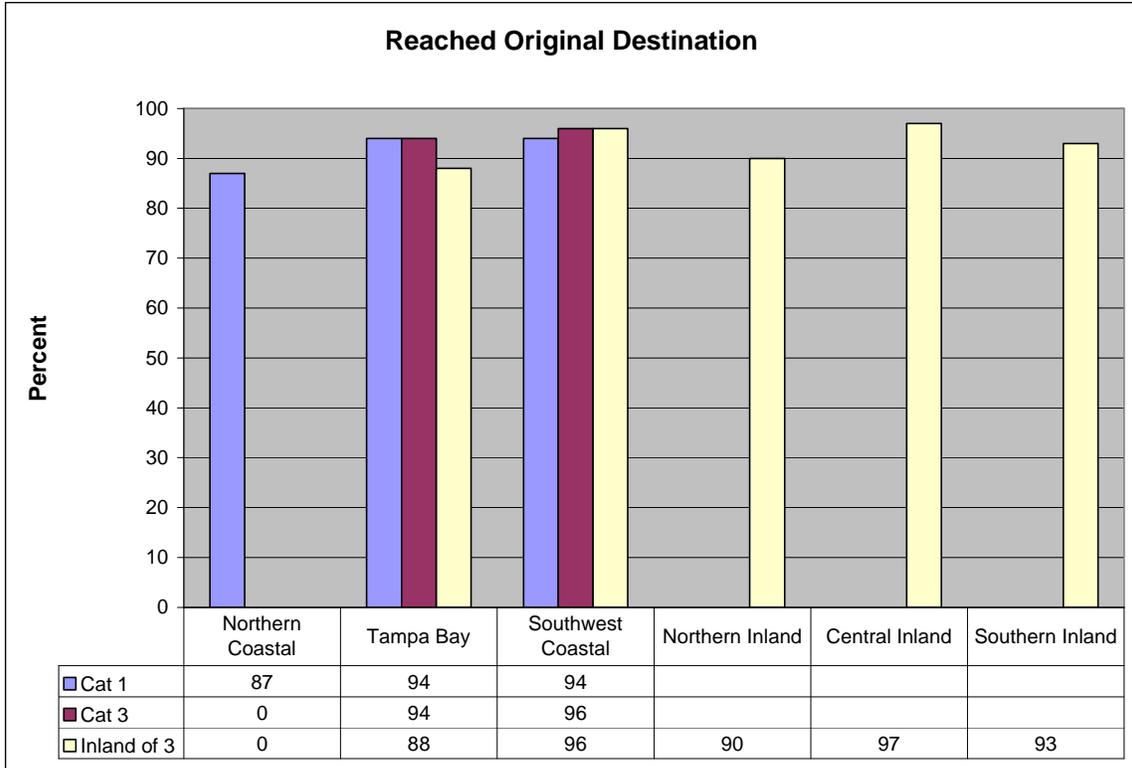


Fig. 63

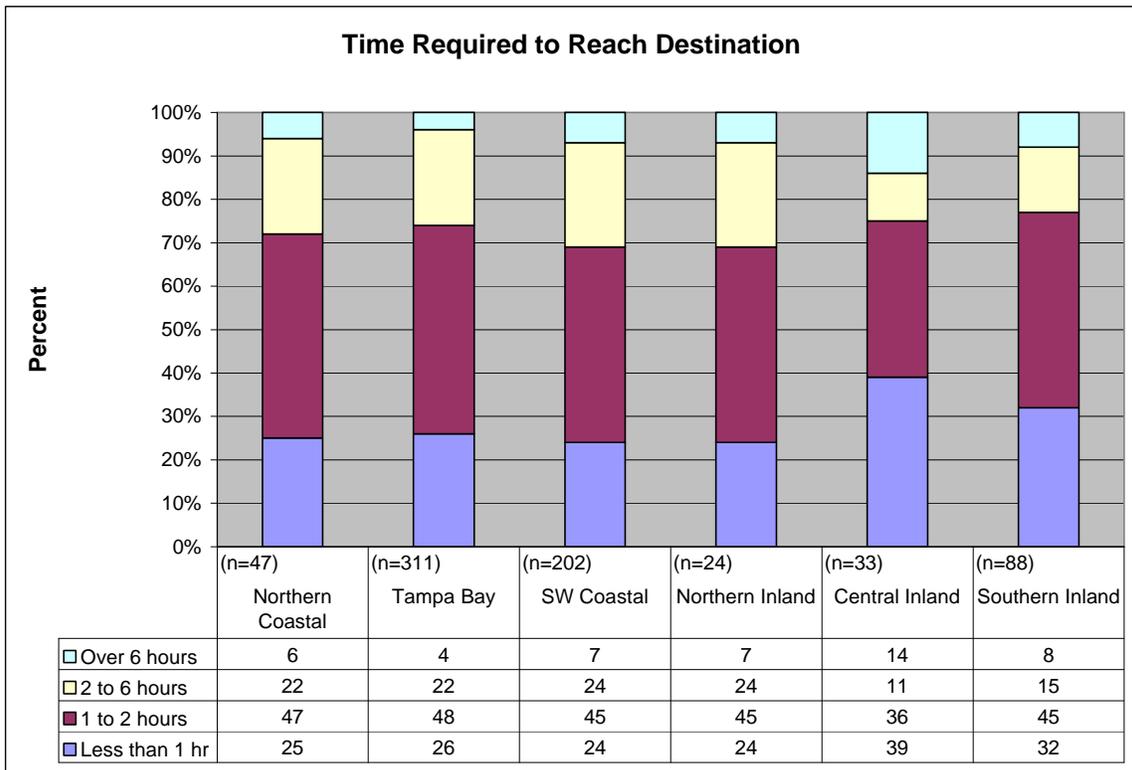


Fig. 64

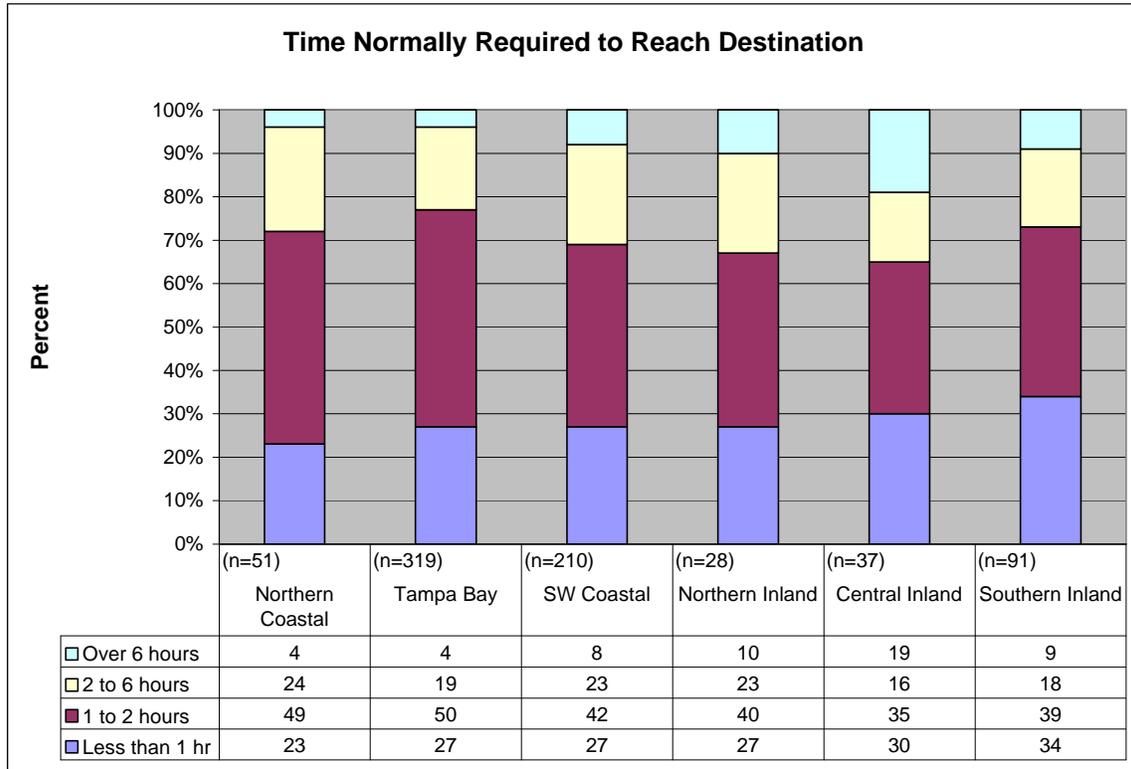


Fig. 65

Distance to Destination

Southern and central non-coastal evacuees traveled the shortest distances to reach their destinations (Figure 66). More than half the trips in those locations were five miles or fewer. The northern non-coastal evacuees had the fewest trips of 5 miles or less (18%). In all but one location at least 40% of the trips were of 10 or fewer miles. Less than a third of the evacuees in all locations went 50 or more miles.

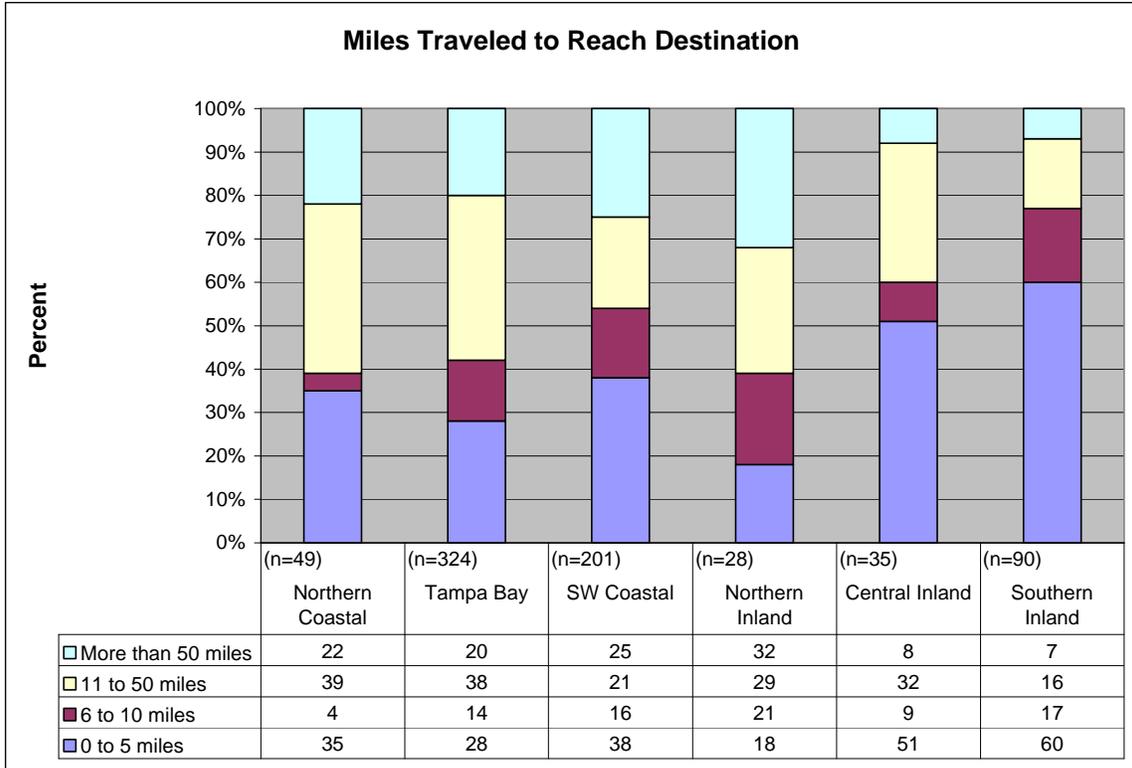


Fig. 66

Choice of Route

Most people said they selected the route they used in evacuating because it was the route they routinely use when going to that place or because they were otherwise familiar with it (Figure 67). Very few respondents said they took the route because of recommendations or instructions from officials. Respondents could make multiple responses to the question, and data in the graphic displays percentage of all responses, not percentage of respondents.

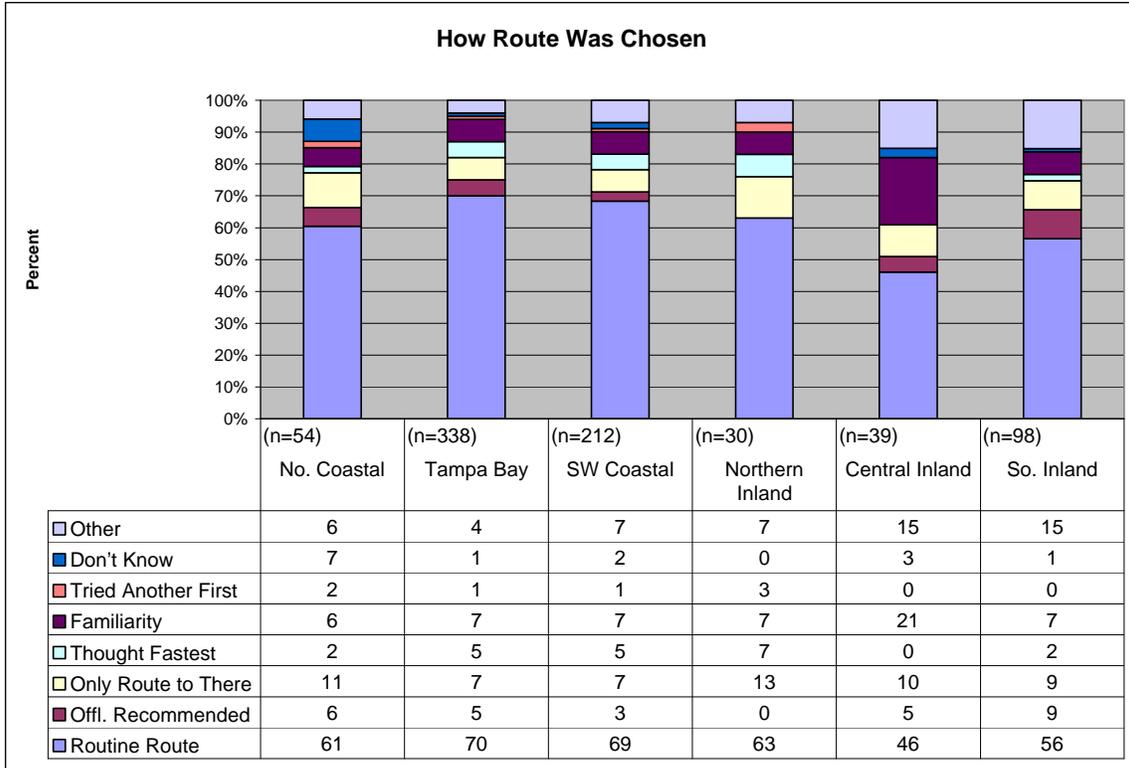


Fig. 67

Availability of Traffic and Road Information

Between 13% and 24% of the evacuees said they were not able to find the information they sought about traffic and roads, after leaving home (Figure 68). Responses were similar in all interview locations.

Daily Expenditures

Thirty-seven percent to 52% of all evacuees indicated that they spent less than \$25 per day on their evacuation (Table 69). In all locations fewer than half said they spent more than \$50 a day, reflecting the large number of people staying with nearby friends and relatives.

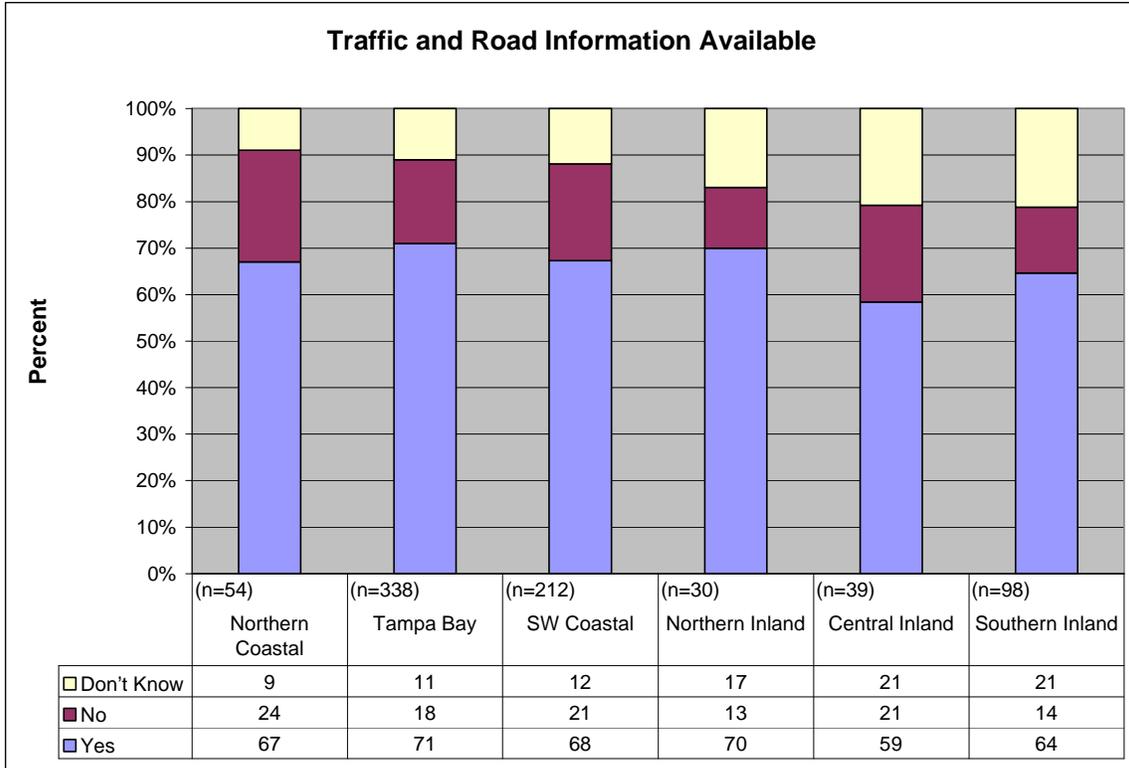


Fig. 68

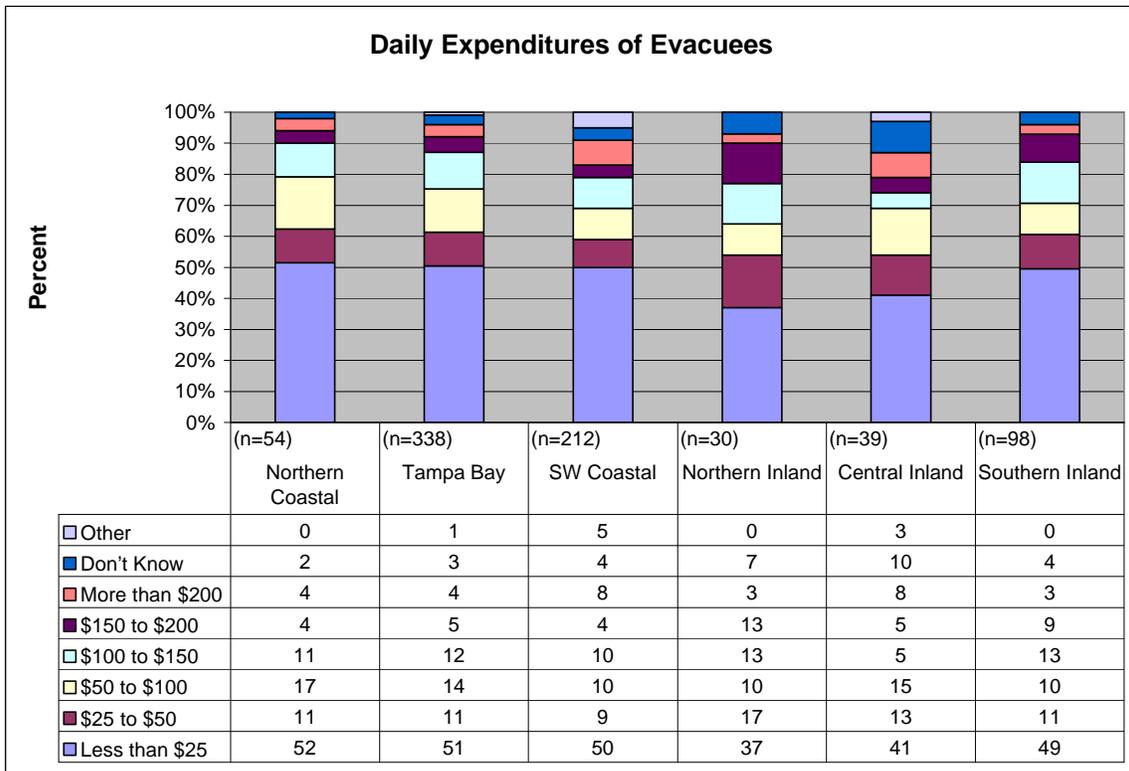


Fig. 69

### Time Away from Home

A low of 23% in the northern non-coastal area and a high of 52% in the Tampa Bay area said they were gone from home a day or less (Figure 70). In the coastal areas 63% to 82% were gone 2 or fewer days. Evacuees from non-coastal areas were generally gone longer than those from coastal areas (but estimates of their stays relied on smaller samples).

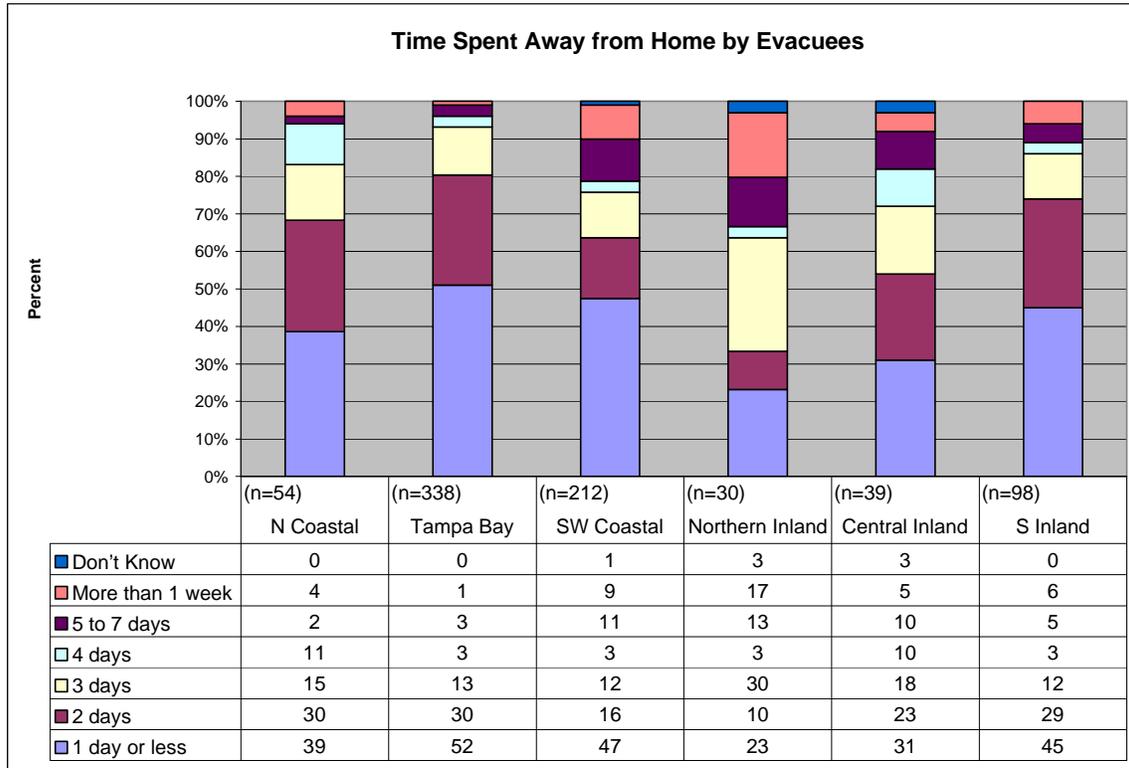


Fig. 70

### Availability of Information about Reentry

Twelve percent to 24% of evacuees said they were not able to find the information they sought about returning home (routes to use, local flooding, whether neighborhoods were accessible) (Figure 71). Respondents in southwest Florida and in the southern non-coastal area were more likely than others to say they were unable to find reentry information.

### Source of Information about Reentry

At least a plurality of evacuees in all locations said they received their information about reentry from television or radio (Figure 72). Radio was the predominant source in some areas and television was more common in others. Reliance on television was particularly high in the Tampa Bay area. Friends and relatives constituted the third most common source of information. Relatively few telephoned agencies. Respondents could make multiple responses to the question, and data in the graphic displays percentage of all responses, not percentage of respondents.

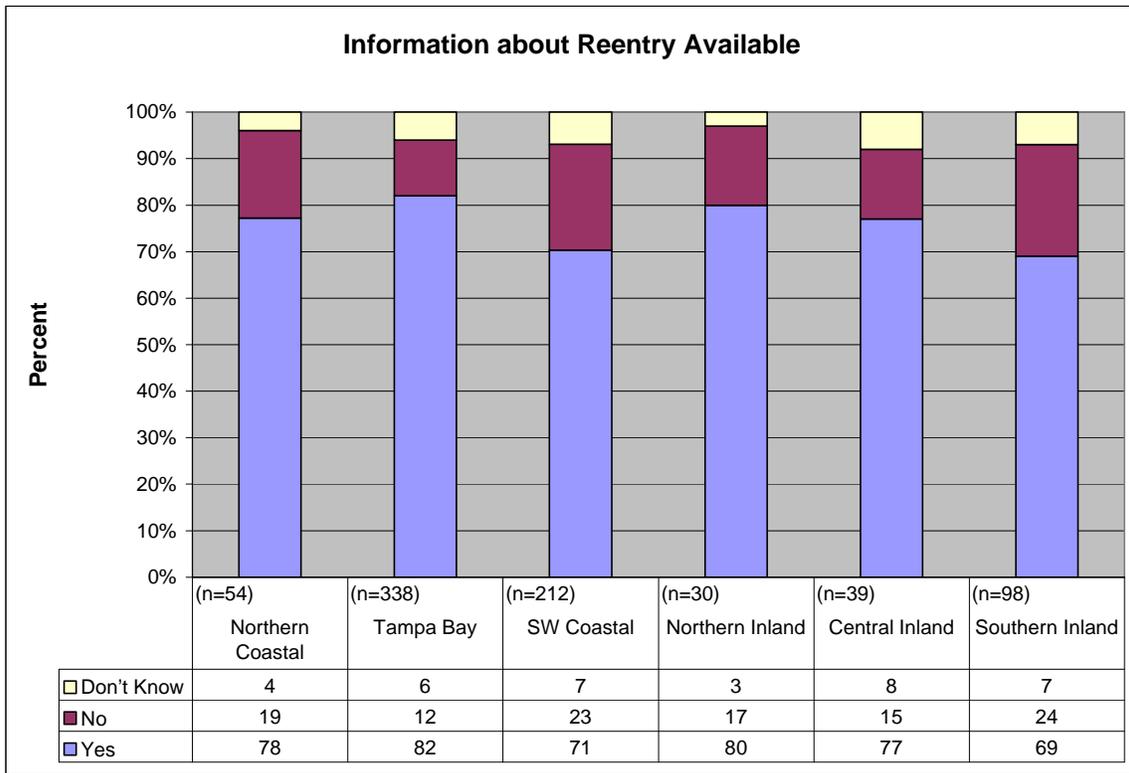


Fig. 71

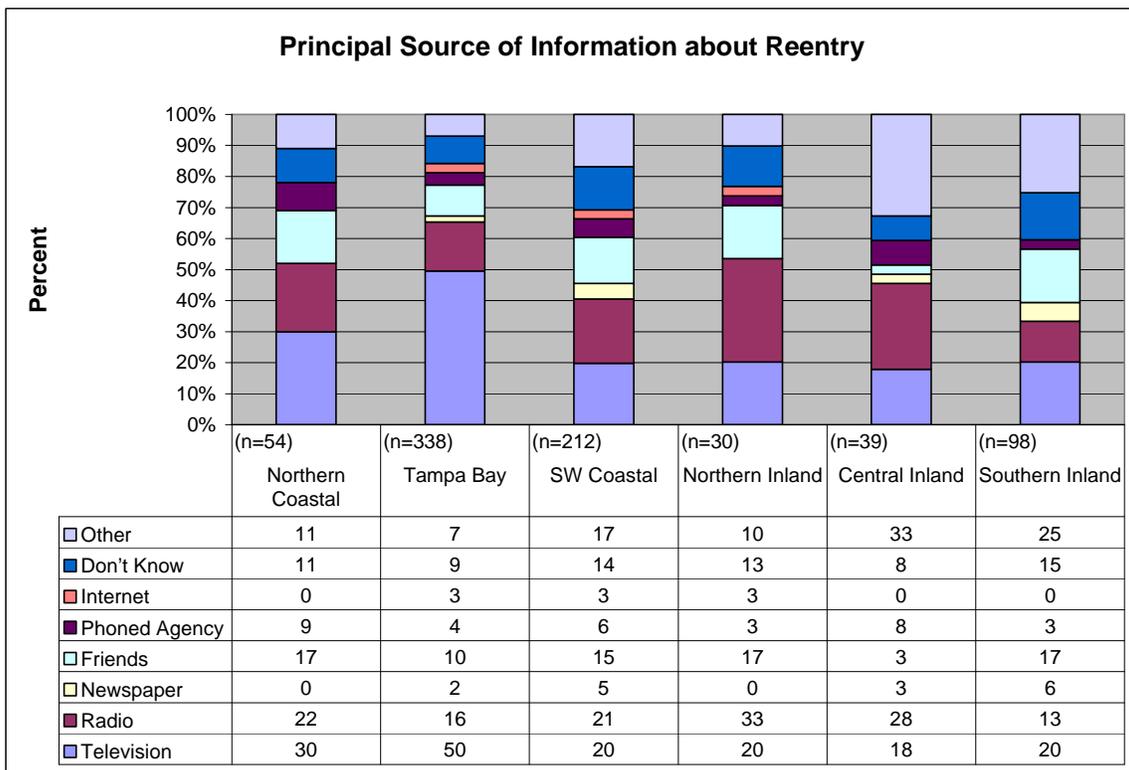


Fig. 72

Vehicle Use

Evacuees were asked how many vehicles were available for use for the household to evacuate and then asked how many of those vehicles were actually used in Charley. Sixty-nine to 75% of the available vehicles were used in the evacuation (Figure 73). That range is within the 65% to 75% range routinely documented in hurricane evacuations. The number of vehicles used per evacuating household varied from 1.06 in the central non-coastal area to 1.33 in the Tampa Bay area (Figure 74). Seven percent of the evacuating households in the northern coastal area said they pulled trailers or boats or took motorhomes, but in most locations the number was 3% or 4% (Figure 75).

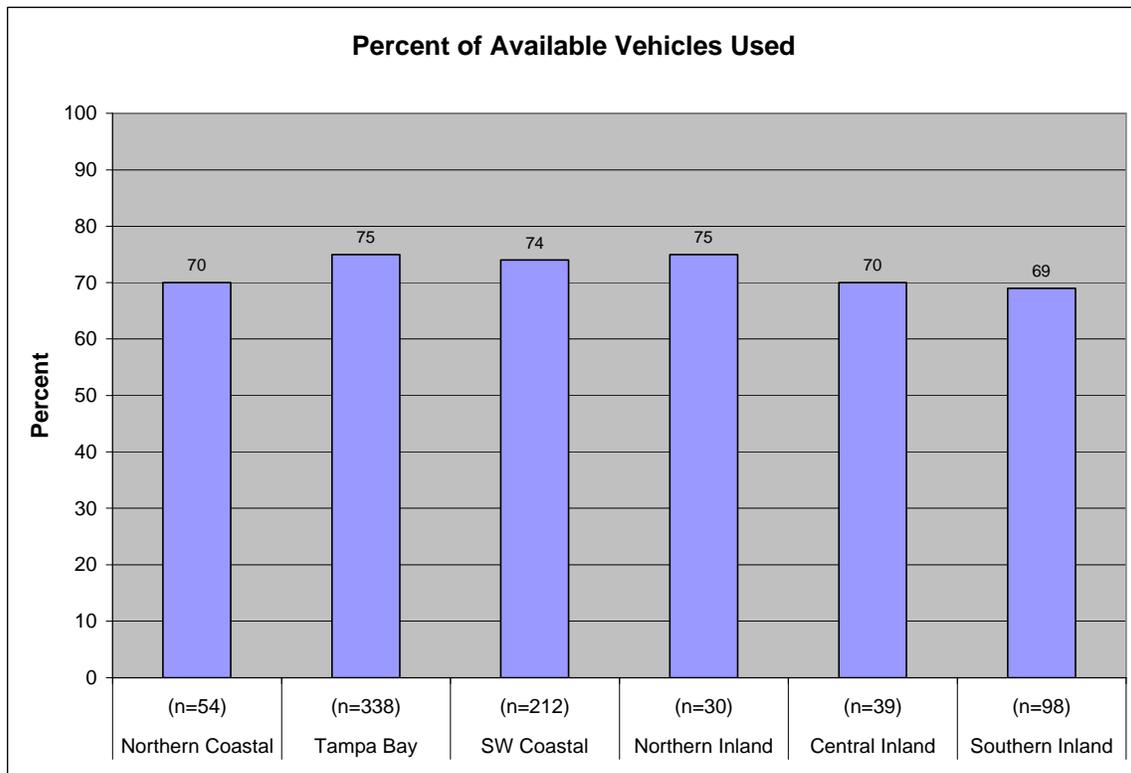


Fig. 73

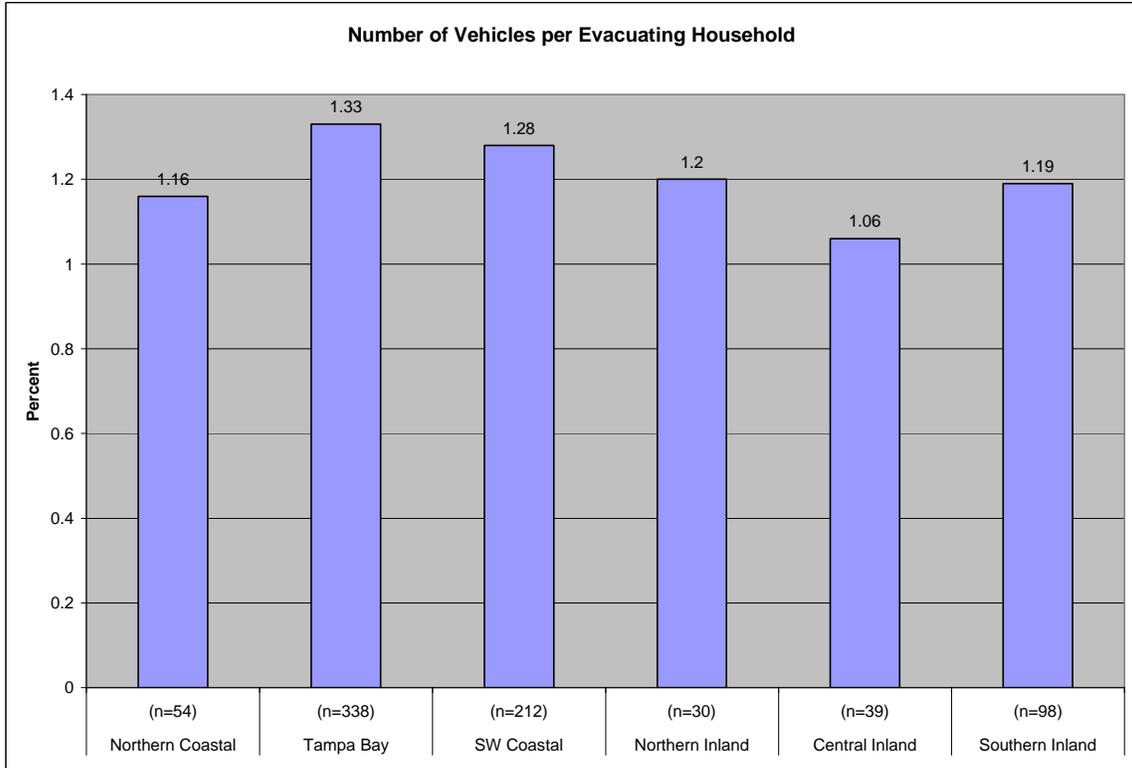


Fig. 74

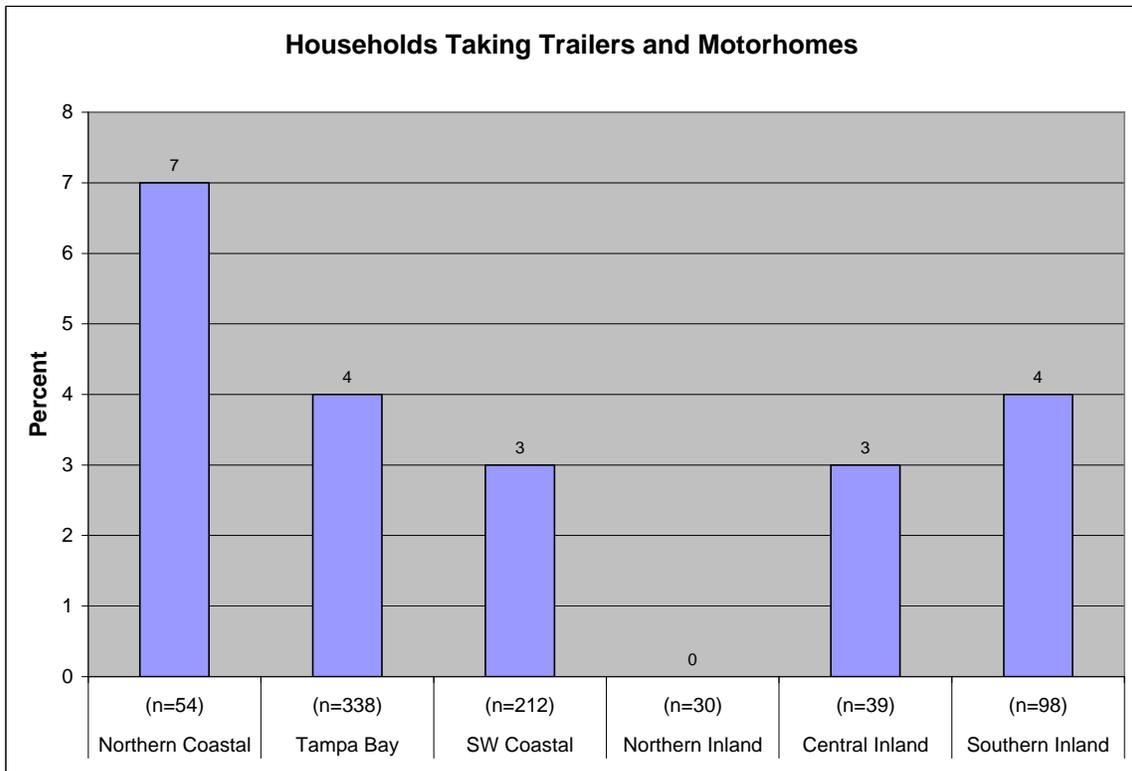


Fig. 75

### Different Response Next Time

Respondents were asked whether they would respond differently in the future if faced with another hurricane threat like Charley. The vast majority, 78% of those who evacuated and 82% of those who did not, said they would do nothing different (Table 2). Of those who didn't leave in Charley, 9% said they would next time. Of those who did leave in Charley 5% said they would not next time. Small numbers of respondents said they would go to different destinations or leave at a different time.

Table 2. What respondents would do different next time, given the same circumstances (percent of respondents)

Nothing different	78 (if evacuated) 82 (if stayed)
Evacuate (if didn't leave in Charley)	9
Stay (if evacuated in Charley)	5
Leave earlier	4
Wait later to leave	1
Go farther	3
Don't go as far	1
Go to public shelter	1
Go someplace other than public shelter	1
Use different route	<1

## Information

### Needed Improvements to Evacuation Information

Evacuees were asked whether they had any suggestions for improving evacuation information, and most said they did not (Figure 76). Among those who said they did have suggestions for improvement, the most common suggestions had to do with better identification of locations needing to evacuate (21%), directions to, locations of, and rules about use of public shelters (18%), and better dissemination of evacuation notices (18%) (Figure 77). There were too few evacuees answering this question in the Northern Coastal cat 3 and non-surge areas to provide responses in the table.

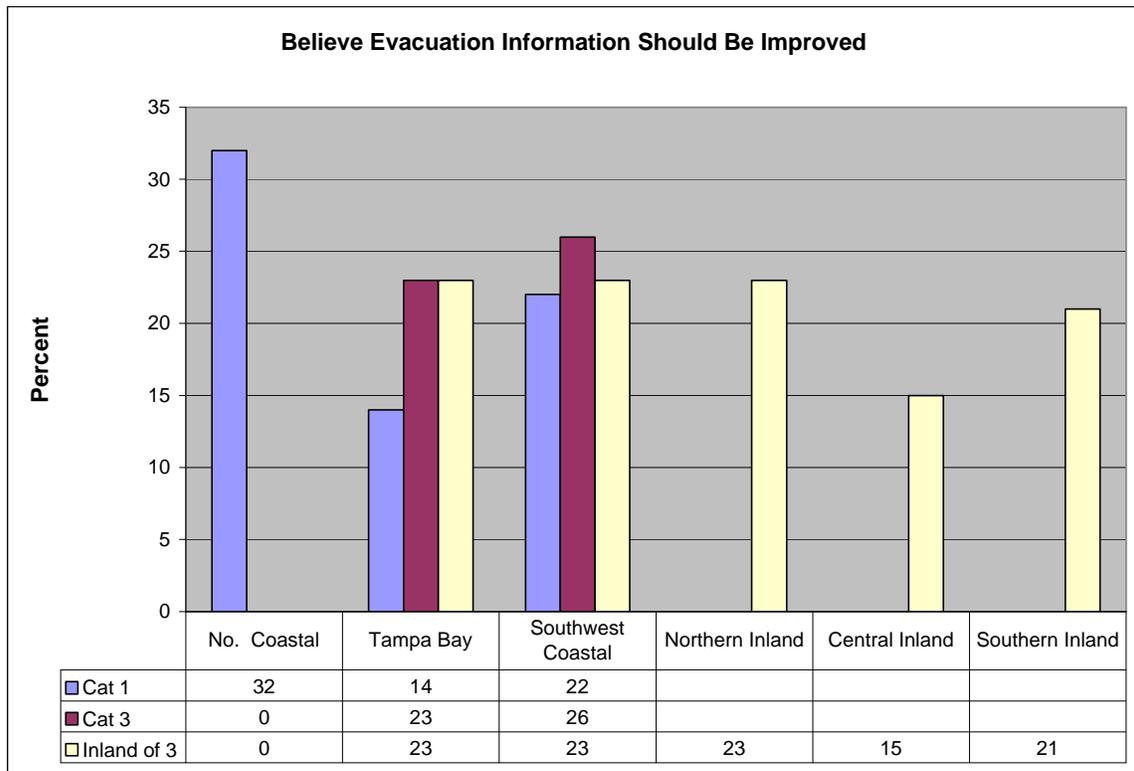


Fig. 76

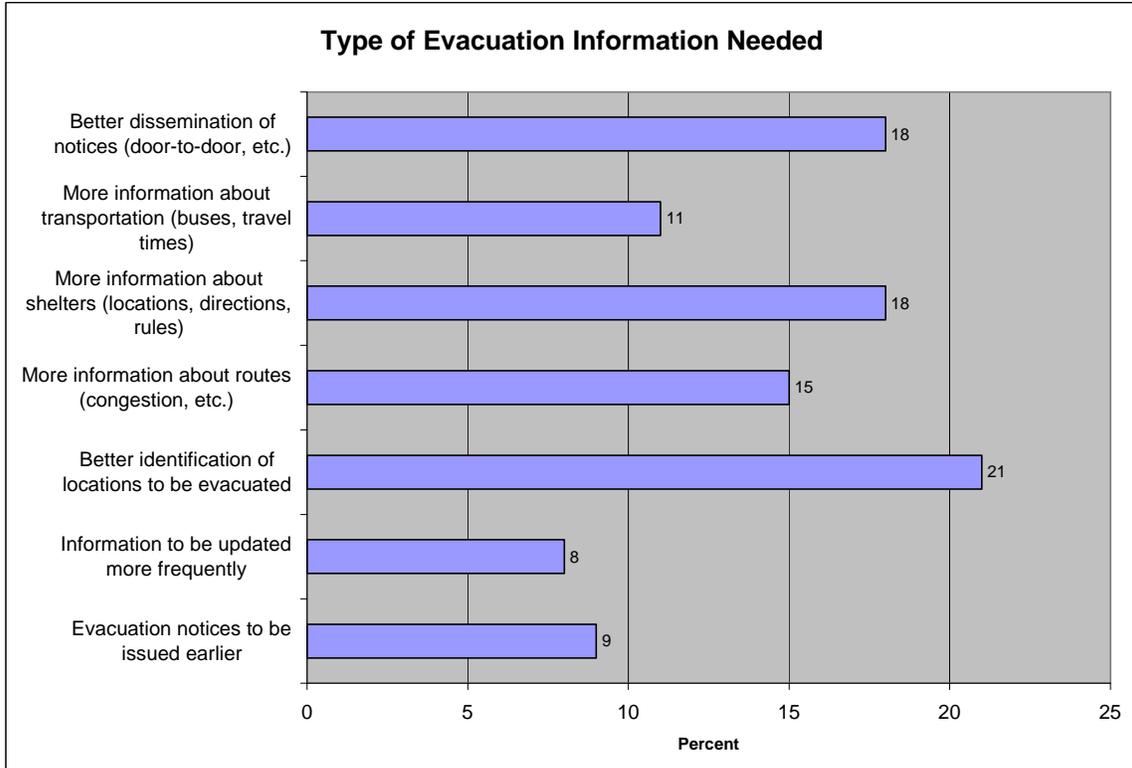


Fig. 77

### Reliance on Various Information Sources

All interviewees were read a list of sources of information about hurricanes and asked how much they relied on each for information about Charley. Response options were “not at all,” “a little,” “a fair amount,” and “a great deal.” Figure 78 shows the percentage of respondents who said they relied a great deal of each source of information. Local television was the most frequently cited source in all locations, followed by the Weather Channel, and local radio. Only 11% to 17% said they relied a great deal on the Internet for information about Charley, but those figures are higher than documented in past hurricane response surveys. Approximately 30% said they relied on the Internet at least some.

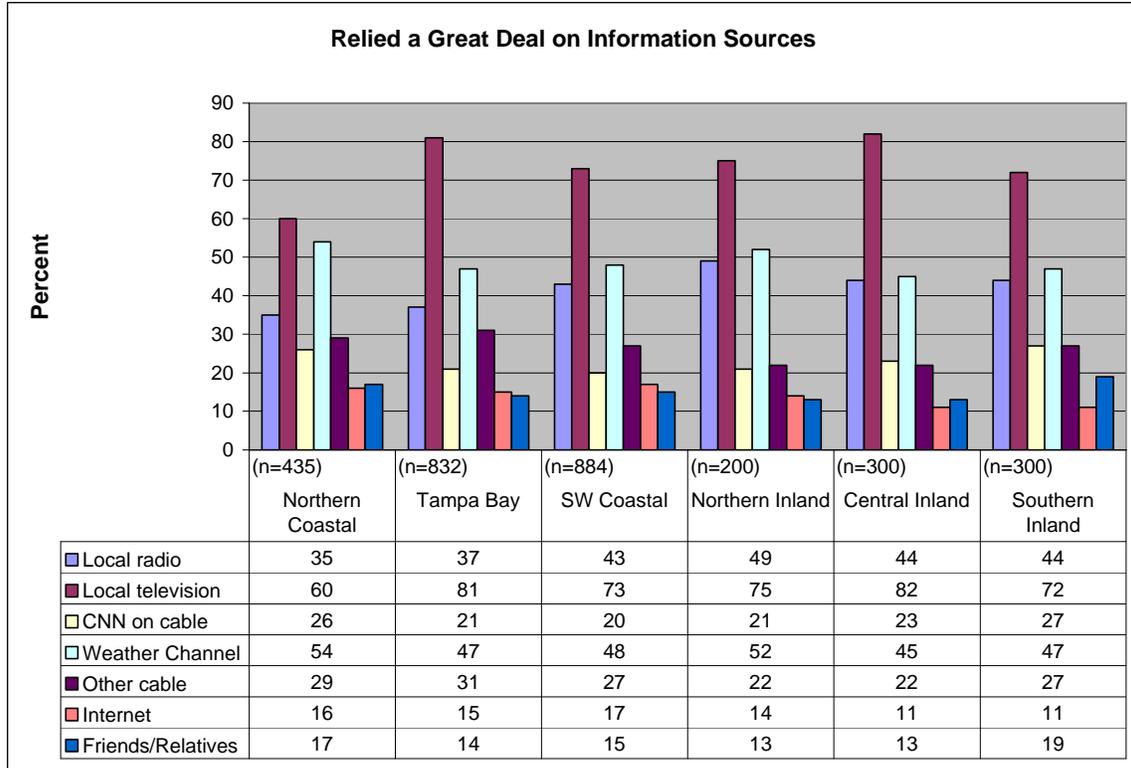


Fig. 78

### Trust Media for Weather Information

Respondents were asked if they generally trusted their local television or radio stations for weather information. Replies were extremely affirmative, ranging from 87% to 94% (Figure 79).

### Sought Information about Charley from Local National Weather Service

Only 25% to 37% of the interviewees said they sought weather information from their local National Weather Service office as Charley was approaching (Figure 80). Overall there was little difference among locations.

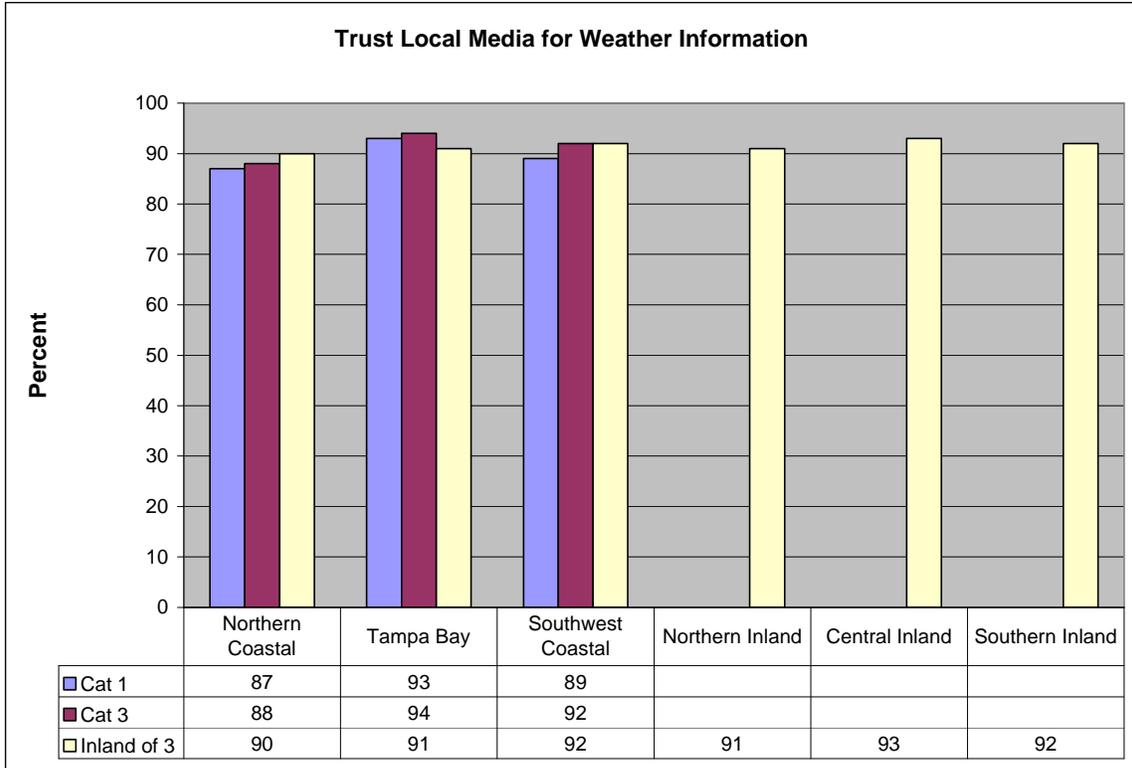


Fig. 79

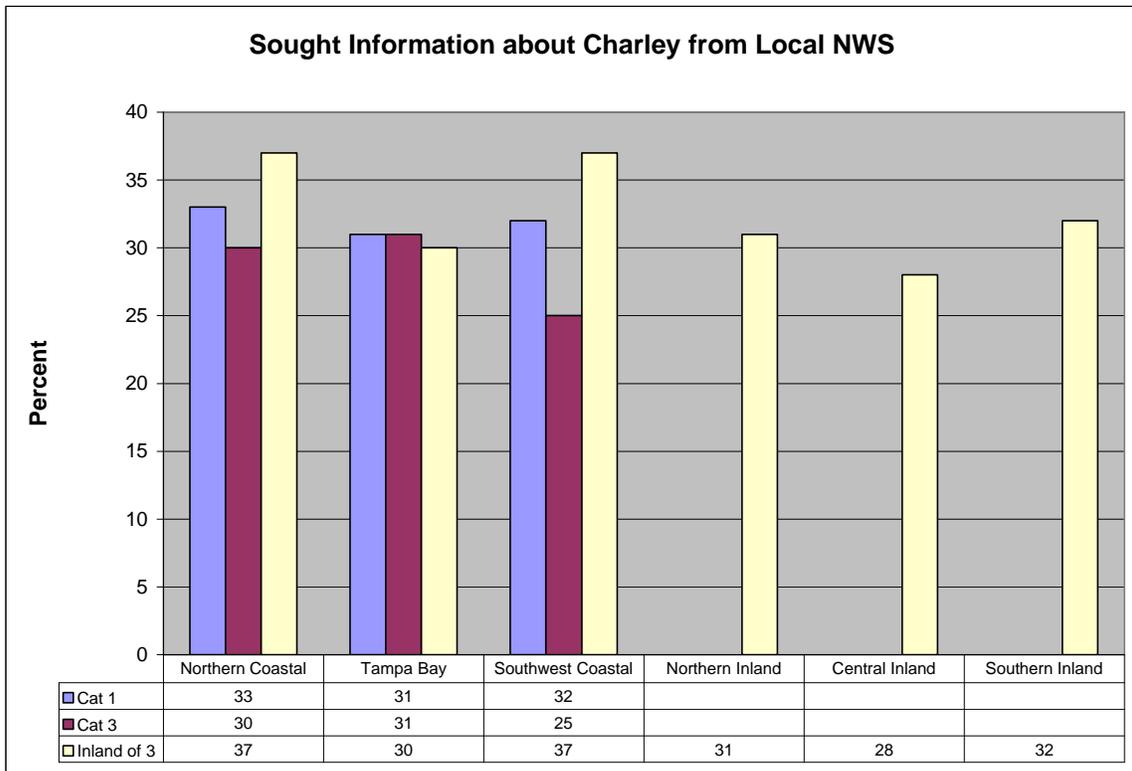


Fig. 80

## Subjects People Would Like to Know More About

Respondents were presented with a list of subjects pertaining to hurricanes and asked if they would like to know more about any of them. Thirty-four percent to 45% of the responses indicated no desire to know more about any of the subjects (Figure 81). Among responses indicating a desire for more information, interest was fairly evenly divided among the subjects listed (shelters, mitigation, vulnerability, evacuation routes, roadways, sheltering in place, safe rooms, and insurance). Insurance was mentioned slightly more often than other subjects. Respondents could make multiple responses to the question, and data in the graphic displays percentage of all responses, not percentage of respondents.

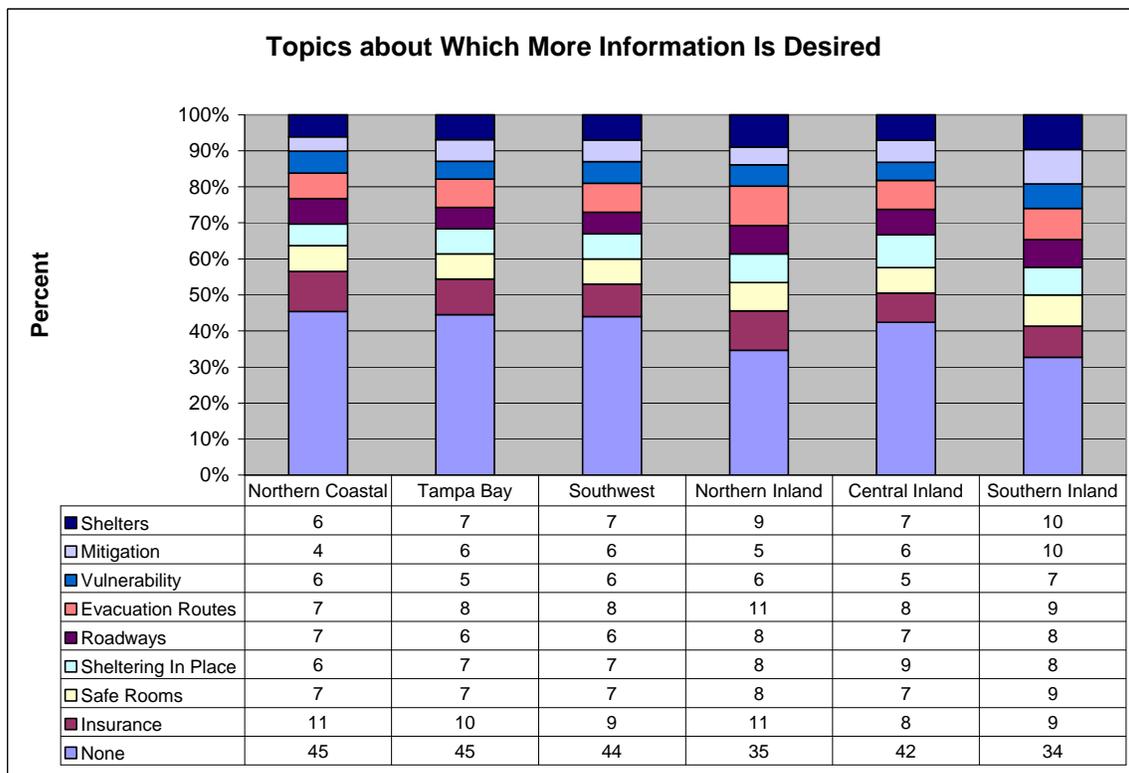


Fig. 81

## Property Protection and Mitigation

### Window Protection

#### Window Protection at the Start of the 2004 Season

Most people said they did not have window protection for their homes at the beginning of the 2004 hurricane season (Figure 82). Southwest Florida had the highest incidence of window protection (50% in the category 1 zone), followed by Tampa Bay (38% in the category 1 risk zone). In non-coastal areas 26% to 38% said they had window protection.

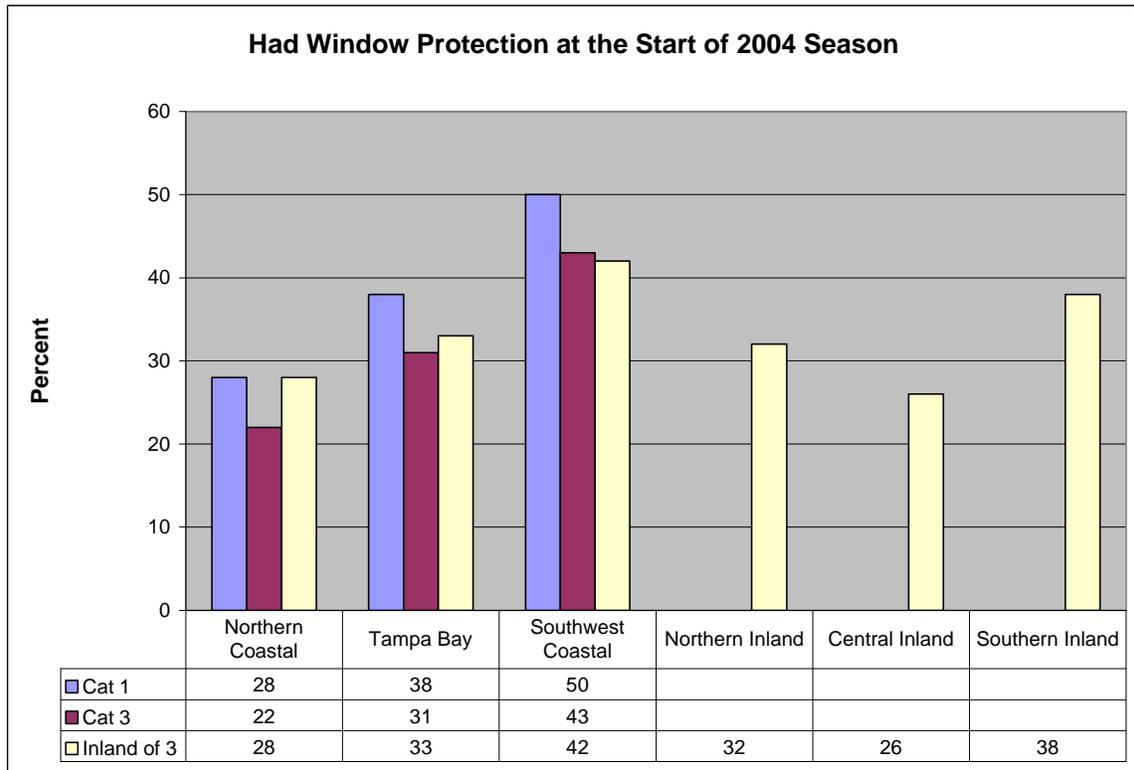


Fig. 82

In households with window protection at the start of the 2004 season, plywood sheets were the most prevalent type of protection (Figure 83). This was especially true in non-coastal areas and in the northern coastal location. Southwest Florida homes were more likely than others to have metal panels or roll-down metal barriers.

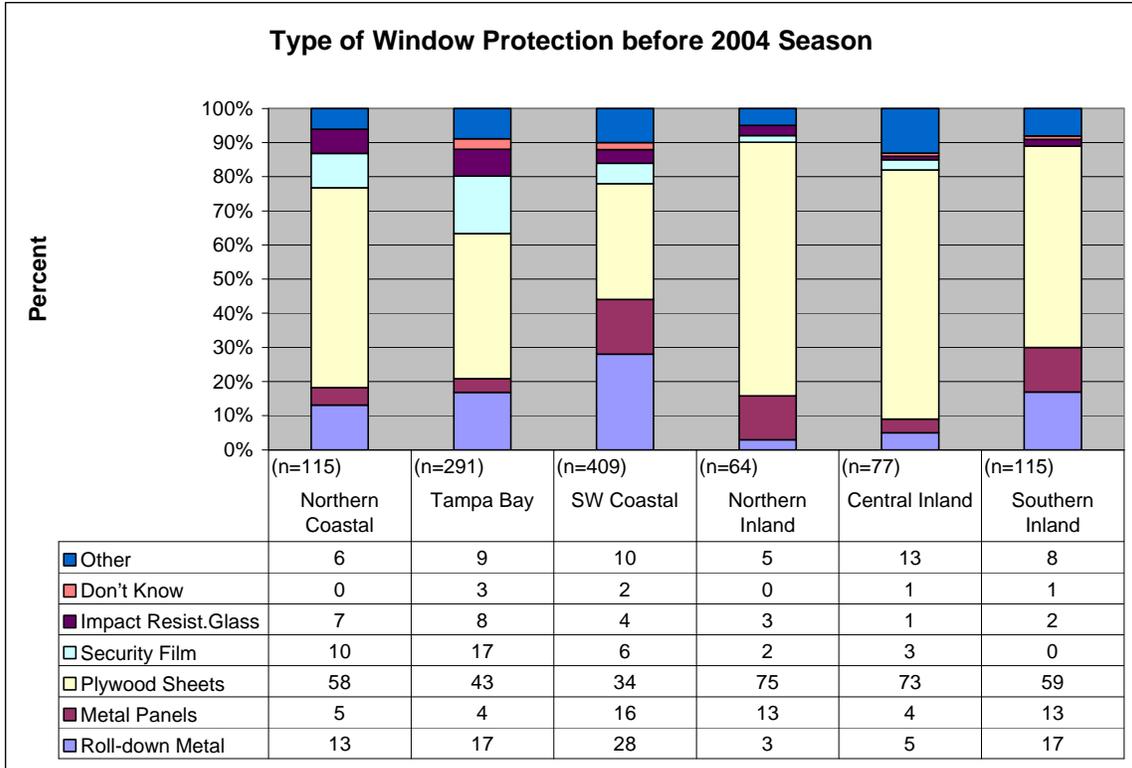


Fig. 83

Window Protection Now

More people said they had window protection at the time of the interview than at the start of the 2004 season (Figure 84). In some locations there was an increase of ten percentage points (e.g., 26% to 36% in the central non-coastal area). Southwest Florida still has the highest incidence of window protection. Plywood sheets still predominate as the most common form of protection, with little change since the beginning of the 2004 season (Figure 85).

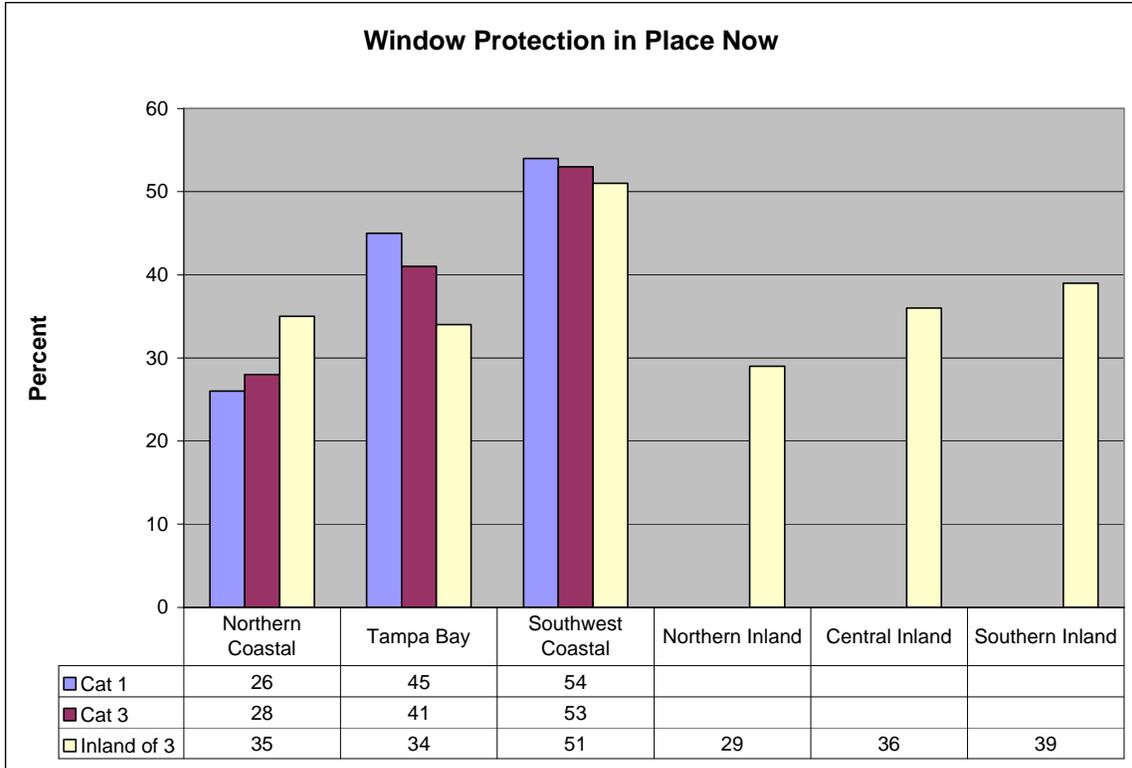


Fig. 84

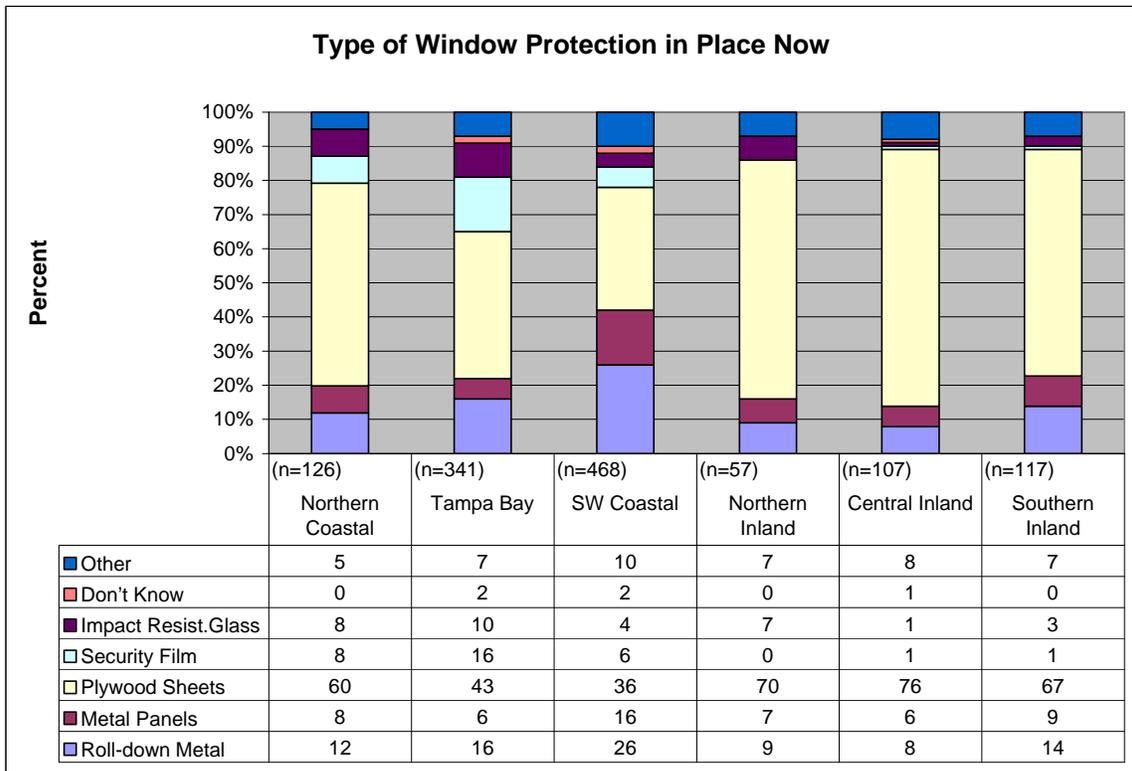


Fig. 85

## Property Protection in Charley

As noted earlier 40% to 55% of the interviewees said they took actions to prevent damage to their houses and property in Charley (Figure 86). Affirmative responses were slightly higher in the Tampa Bay and southwest Florida areas than in other locations.

### Permanence of Protective Improvements

The great majority of those protective actions were just for Charley, not resulting in permanent mitigation improvements to the property (Figure 87). However, up to a third of the improvements were permanent (counting “permanent” and “both” responses), which might include the purchase of items such as plywood that could be used again. Southwest Florida and the southern non-coastal area were more likely than other areas to say their protective actions were permanent.

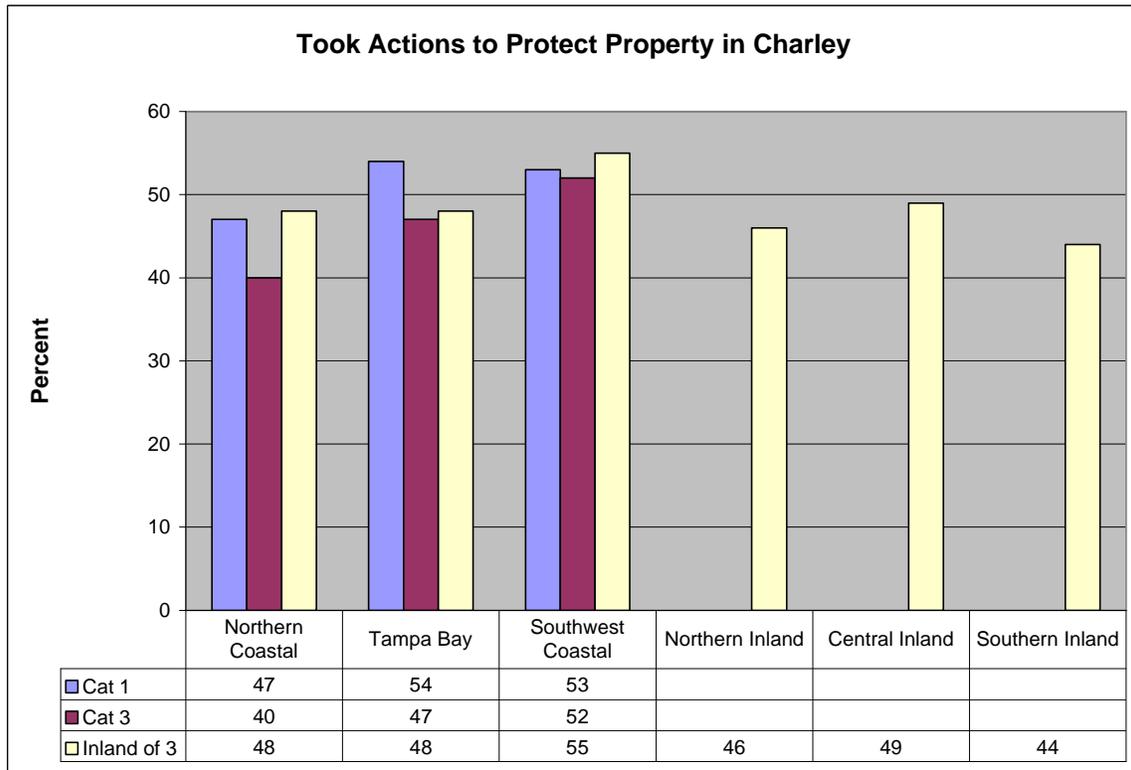


Fig. 86

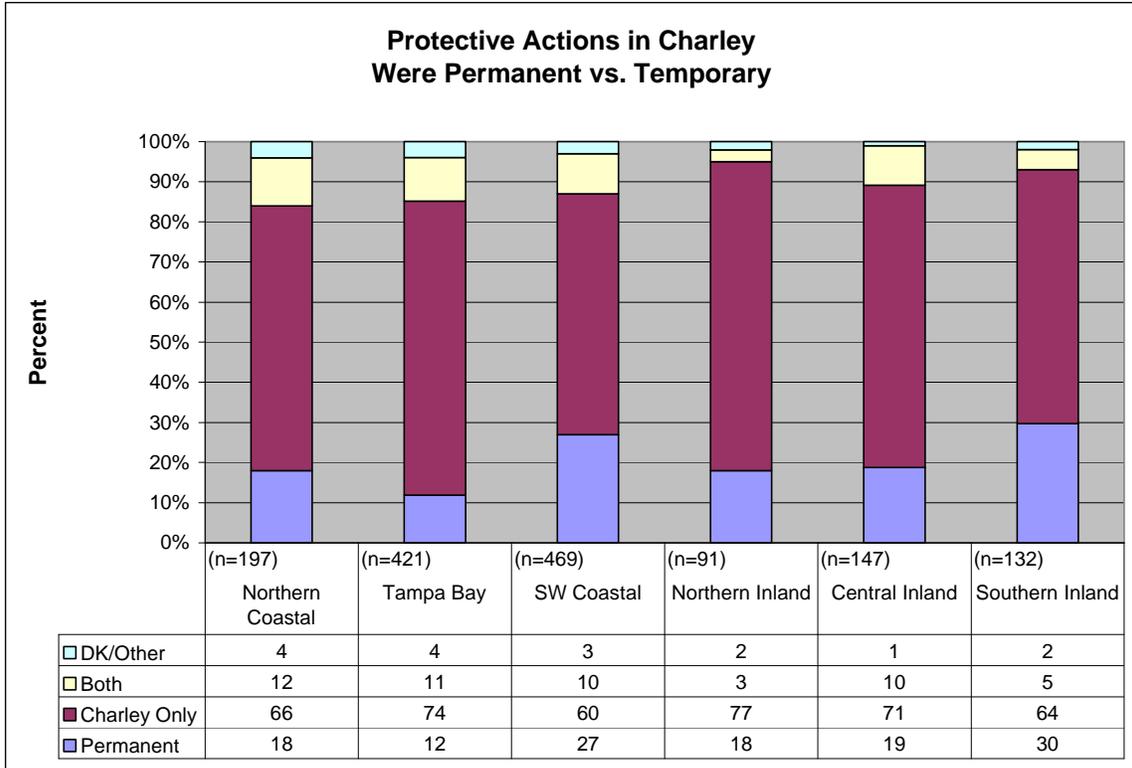


Fig. 87

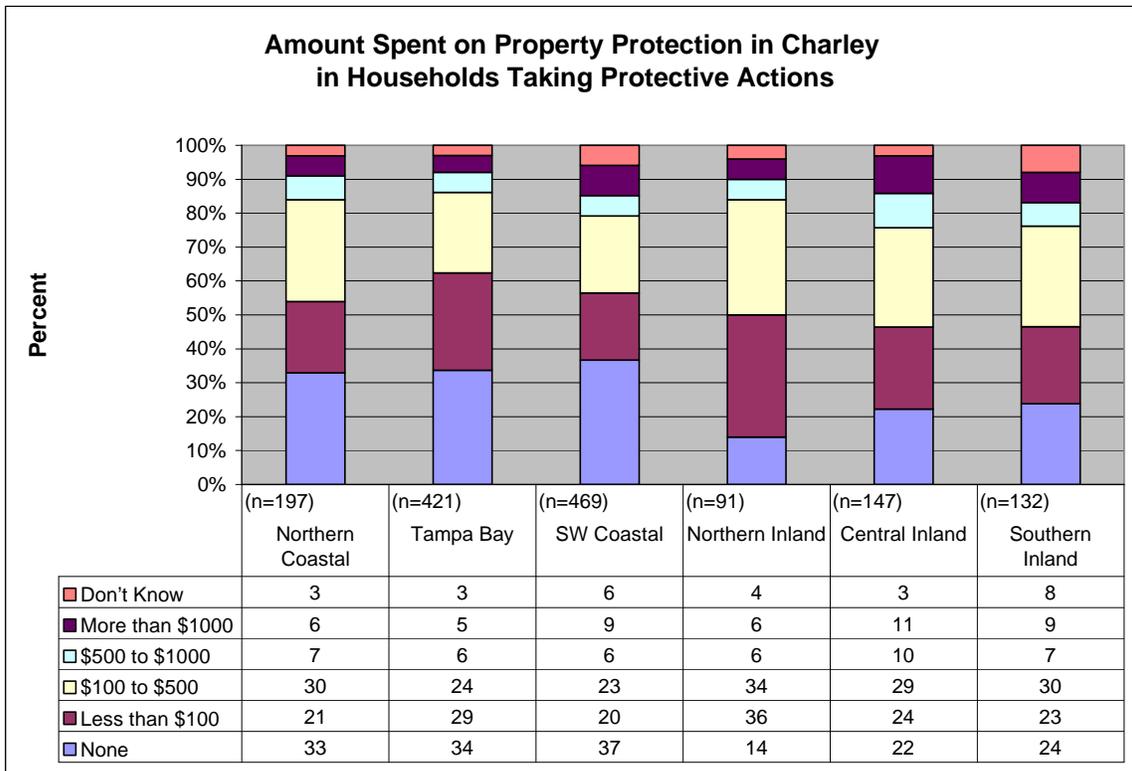


Fig. 88

Expenditures on Property Protection in Charley

Respondents saying they took actions to protect their property in Charley were asked how much they spent. In up to 37% of the homes, people said they didn't spend anything (Figure 88). That could include actions such as installing and applying materials already on hand or securing loose objects. People in coastal areas were more likely than others to say they didn't have to spend anything. More than half the sample said they spent less than \$100 (Figure 89).

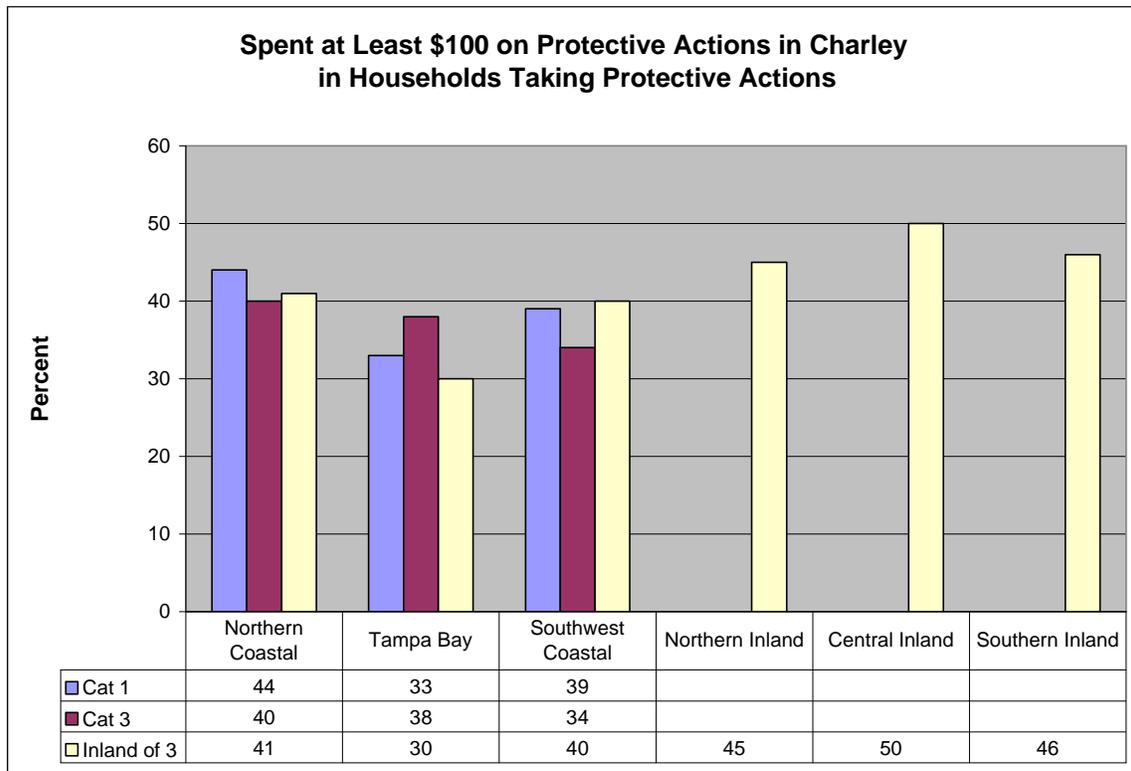


Fig. 89

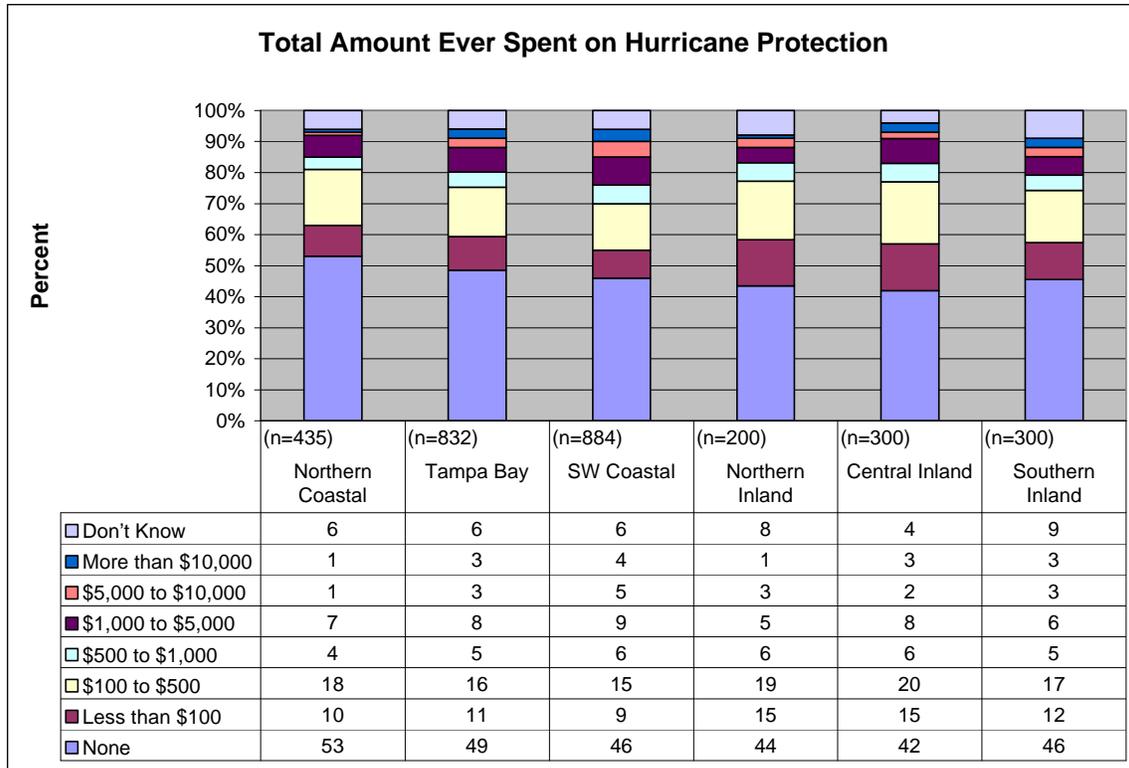


Fig. 90

### Total Expenditures on Hurricane Protection

Almost half the people in the sample said they had never spent anything on hurricane protection, either during 2004 or before (Figure 90). Only 13% (northern coastal area) to 24% (southwest Florida) said they have spent \$500 or more.

### Awareness of Mitigation Assistance Grants

Between 14% and 29% of the respondents said they were aware of programs in their community that would provide funds to make homes more hurricane resistant (Figure 91). Affirmative responses were more common in non-coastal counties.

### Elevation of Homes

In 21% to 38% of the households interviewed, respondents said their home or building was elevated on pilings or fill material to raise it above flood water (Figure 92). Two of the highest response rates were in non-coastal counties.

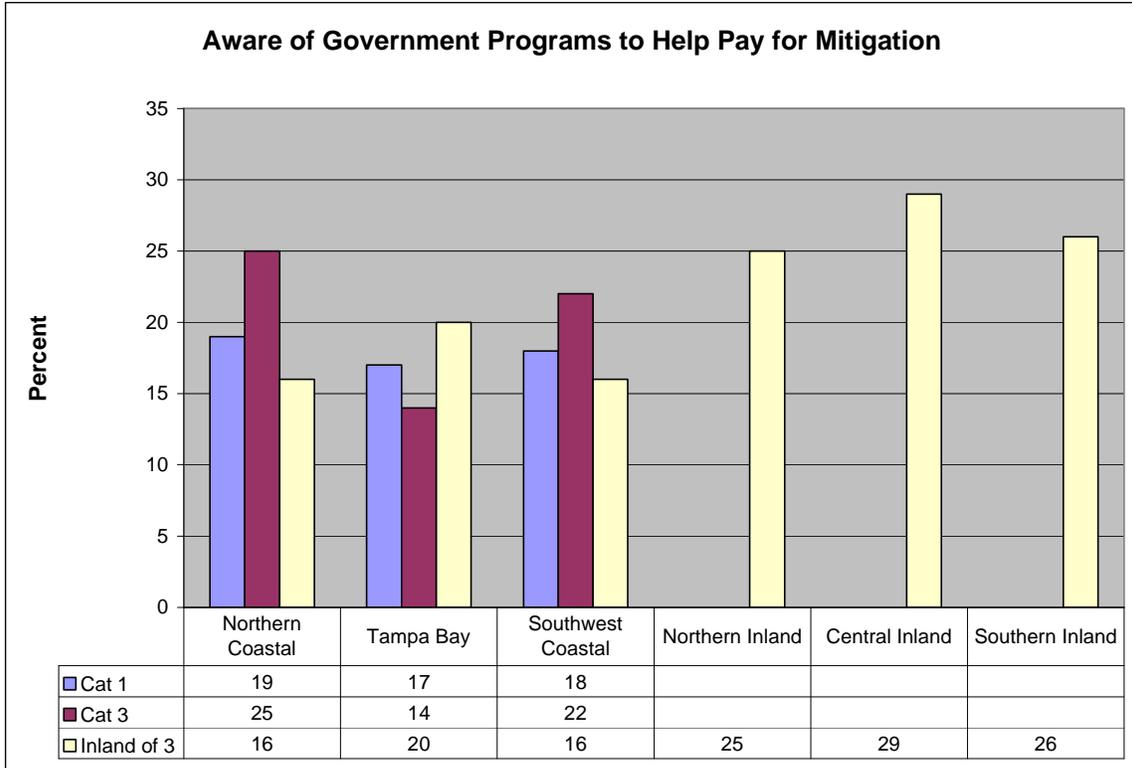


Fig. 91

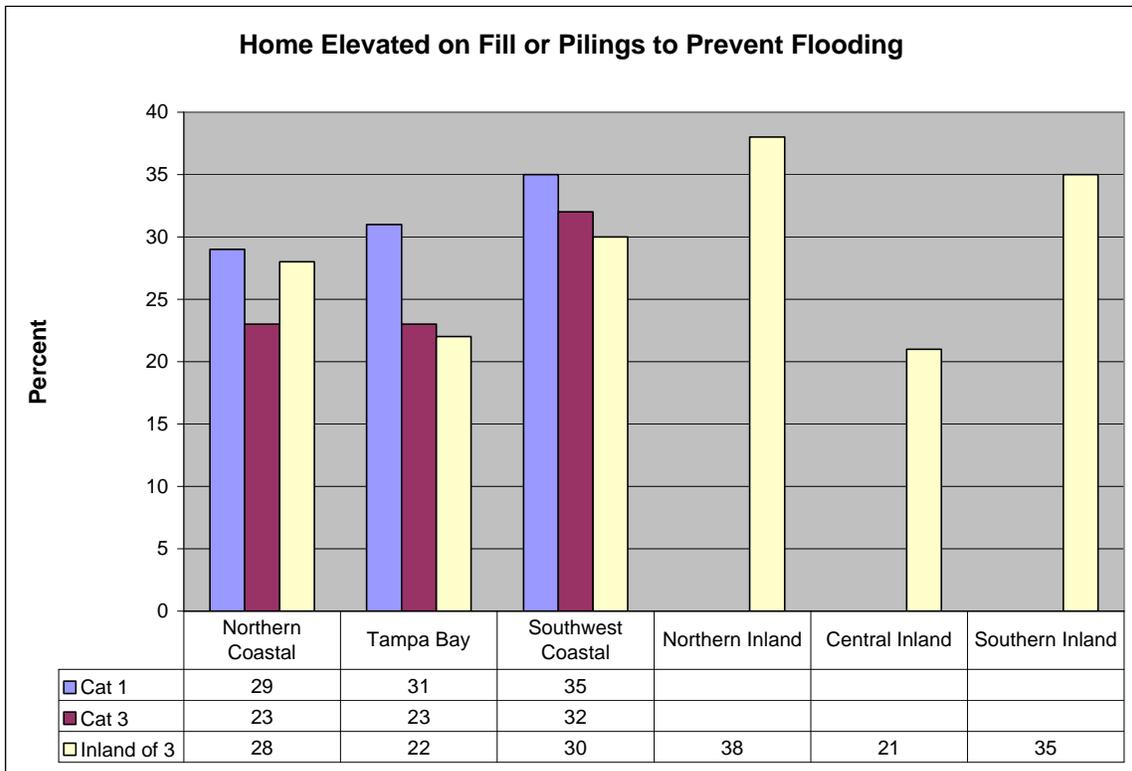


Fig. 92

## Effects of Charley

### Lost Work

A relatively small percentage of interviewees said they lost work due to Charley (Figure 93). Up to 6% in southwest Florida said they lost work, as did 5% in the northern coastal and southern non-coastal areas.

Of those who lost work, 27% said they were out of work less than a week and 47% said they were out less than two weeks (Figure 94). Almost 10% said they were still out of work at the time of the survey.

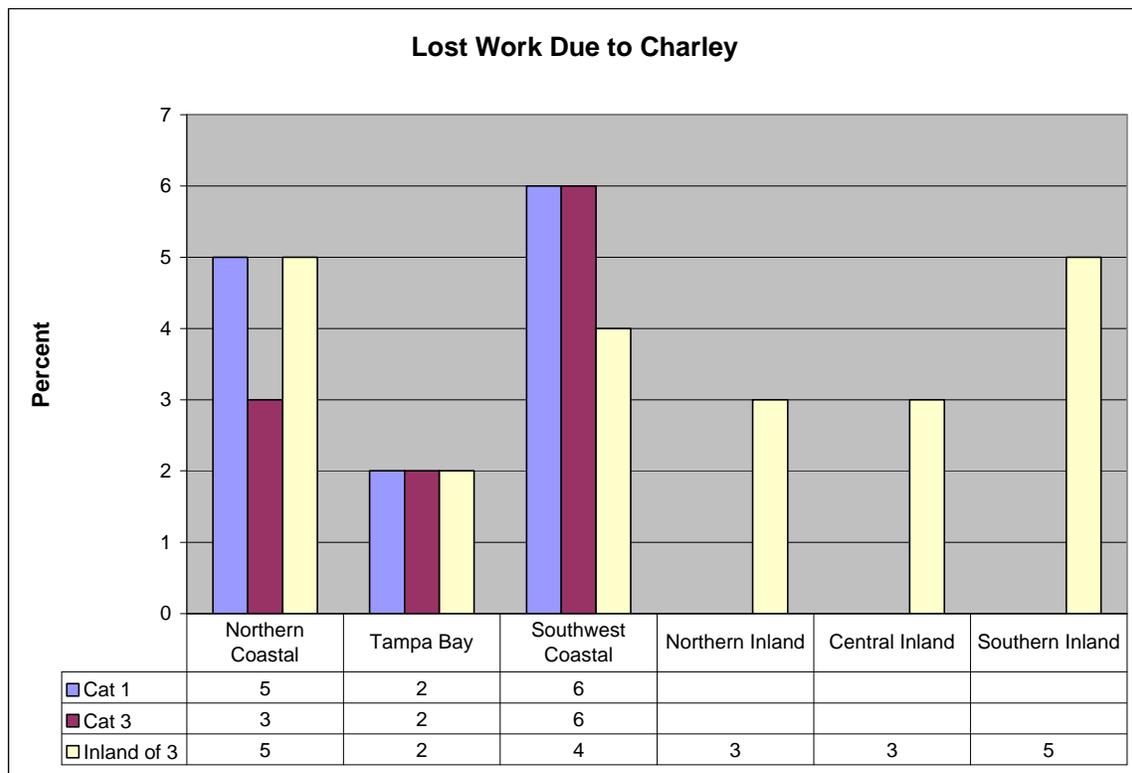


Fig. 93

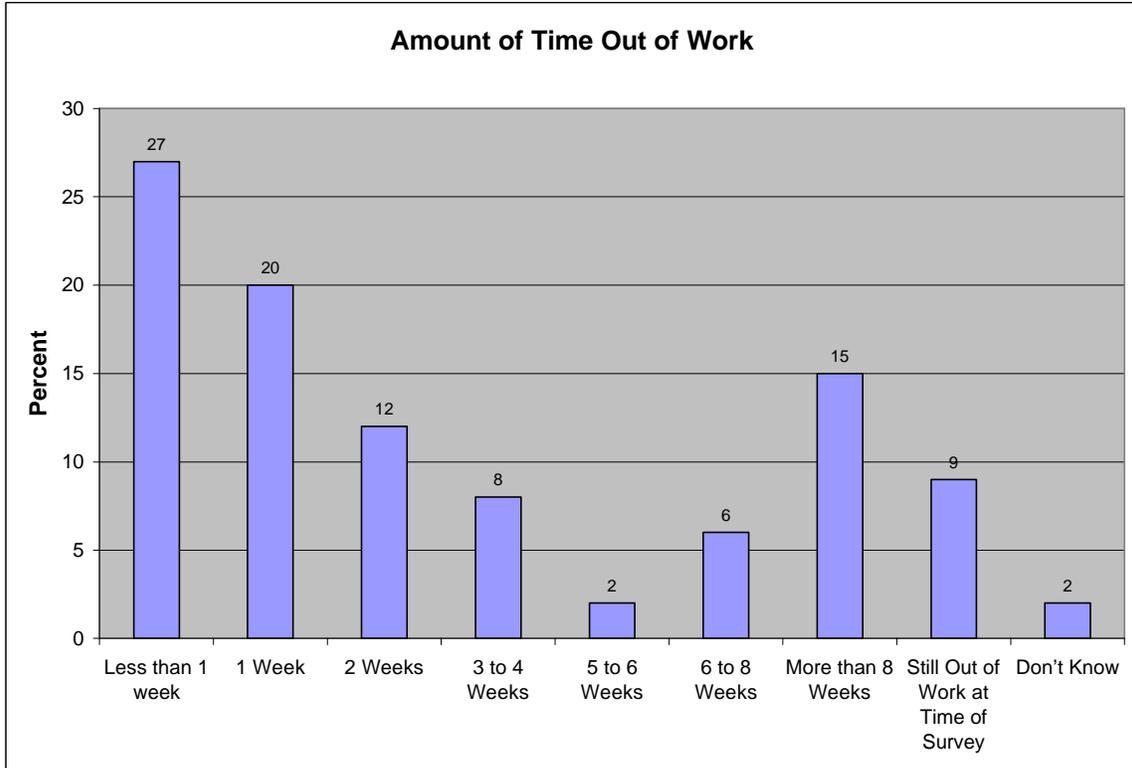


Fig. 94

### Plan to Move to Someplace with Fewer Hurricanes

As many as 7% of the respondents (in the category 1 risk zone of southwest Florida) said they planned to move someplace with fewer hurricanes (Figure 95). In other locations 2% to 5% said they planned to move.

Between 12% and 21% of those interviewed said they owned their own business (Figure 96), and up to 9% of those who own businesses said they plan to move their business to a place with fewer hurricanes (Figure 97).

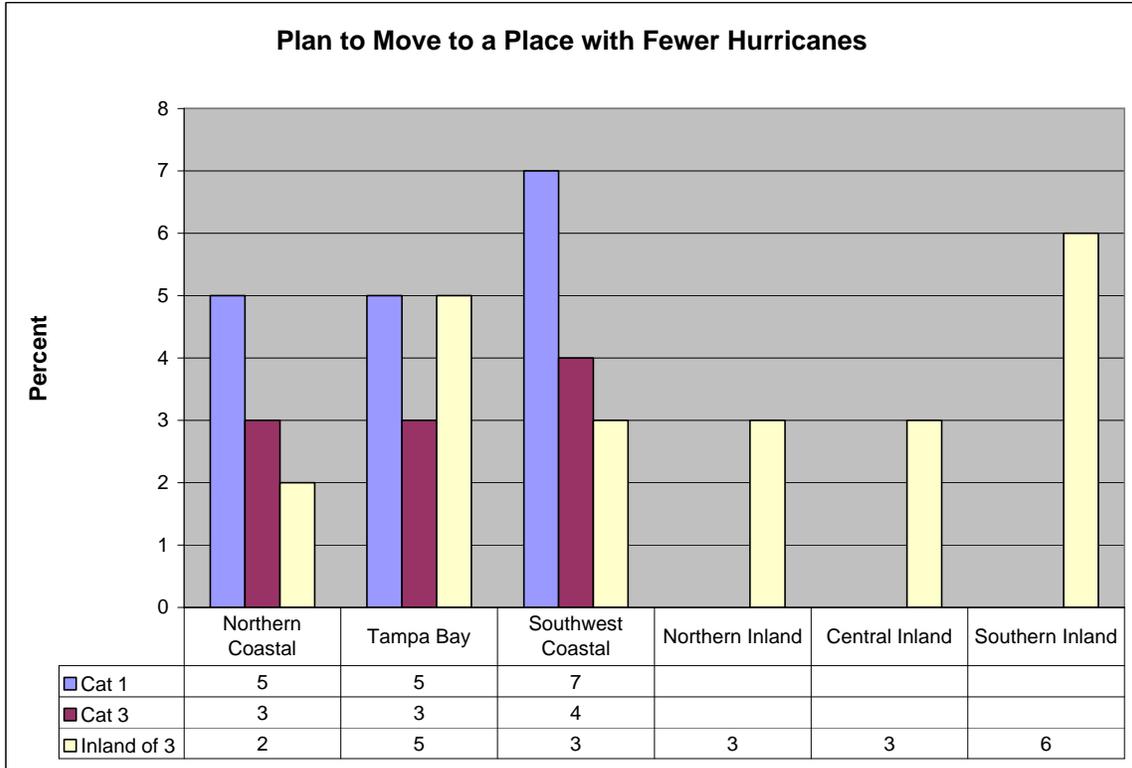


Fig. 95

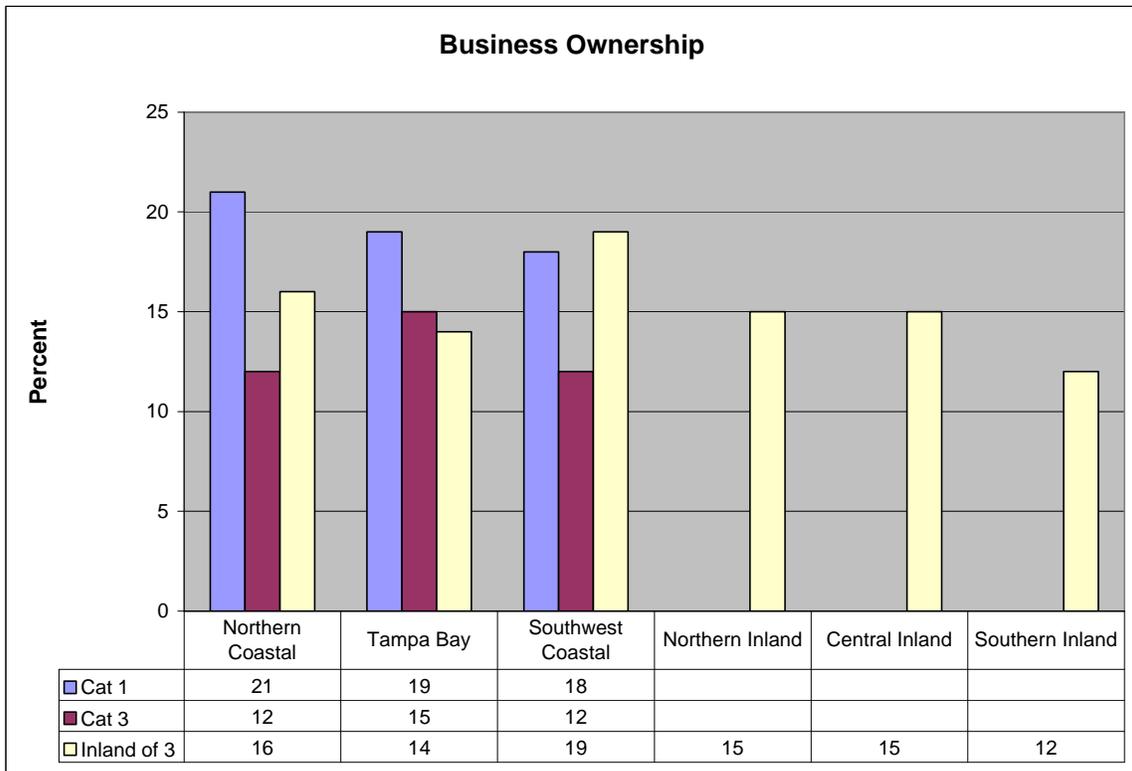


Fig. 96

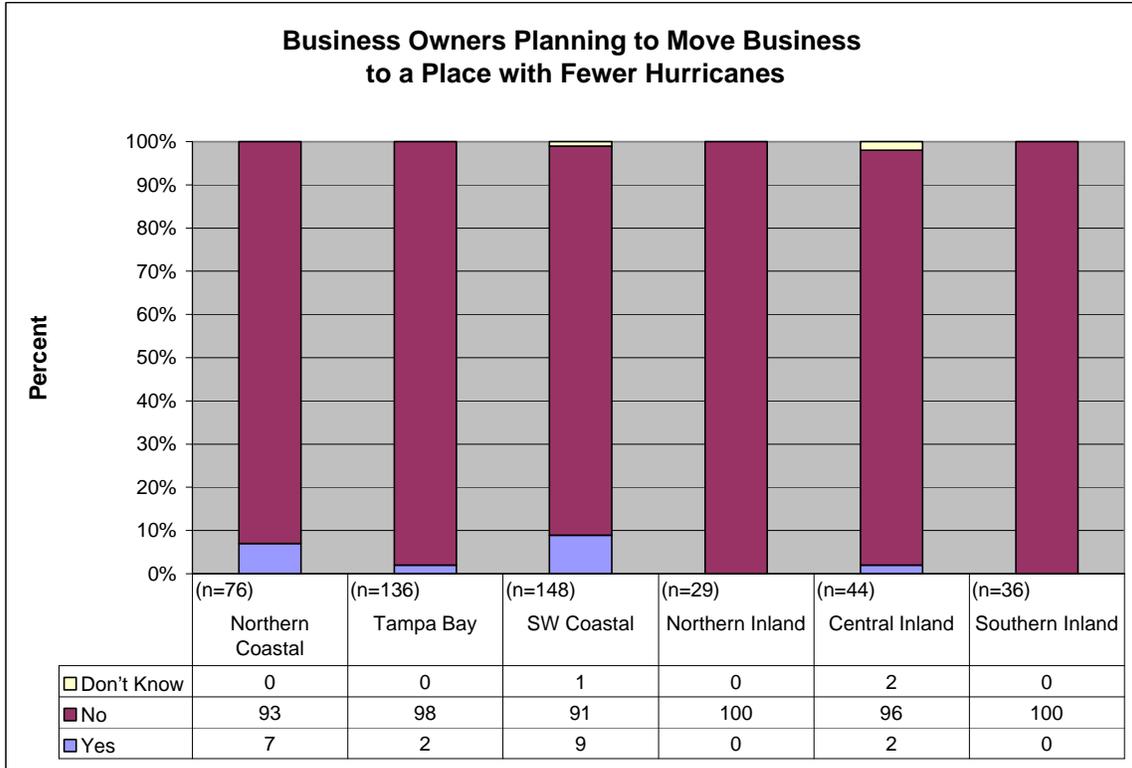


Fig. 97

### Damage in Charley

The highest incidence of people saying their homes were damaged in Charley was in the central and southern non-coastal areas (Figure 98). Forty-seven percent of the respondents in the southern non-coastal area said they experienced damage. In coastal areas southwest Florida had the greatest occurrence of homes with damage in Charley (34% in the category 3 risk zone and 31% in the category 1 zone).

The largest dollar value of damages occurred in southwest Florida (Figure 99). In households experiencing damage in Charley, 46% of the category 1 respondents in southwest Florida said they experienced at least \$10,000 in damage, followed by 40% in the areas of those counties inland of the category 3 evacuation zone (Figure 100).

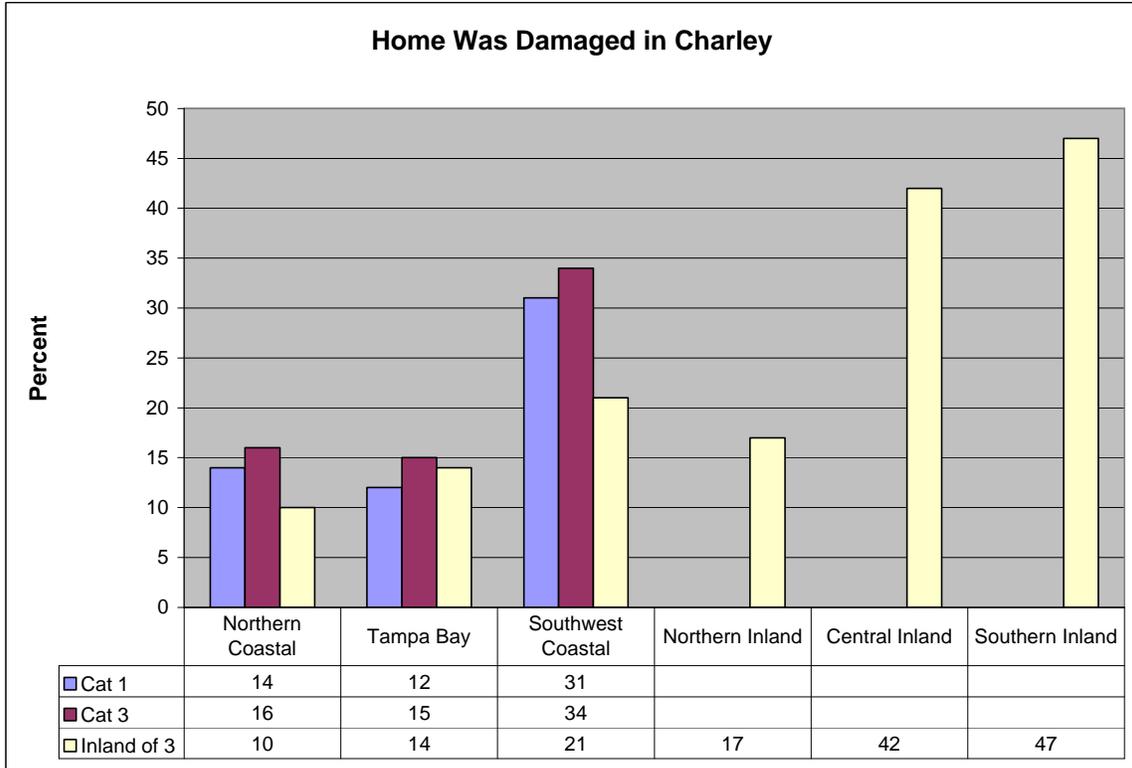


Fig. 98

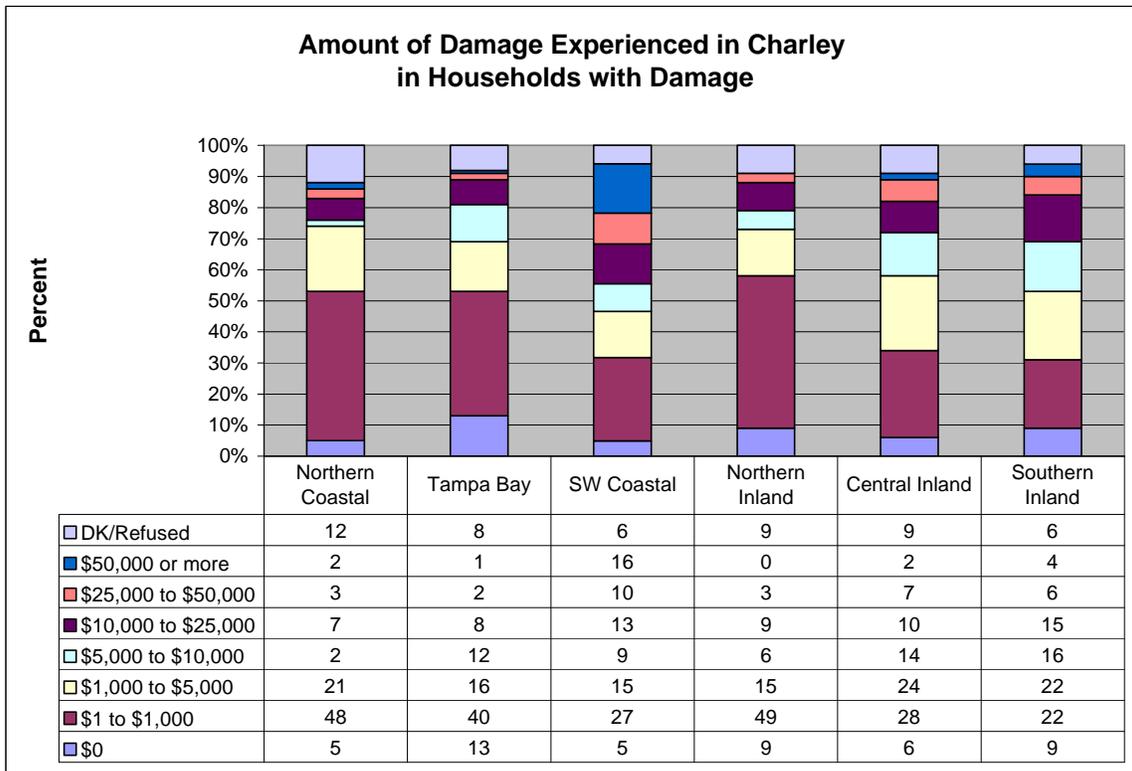


Fig. 99

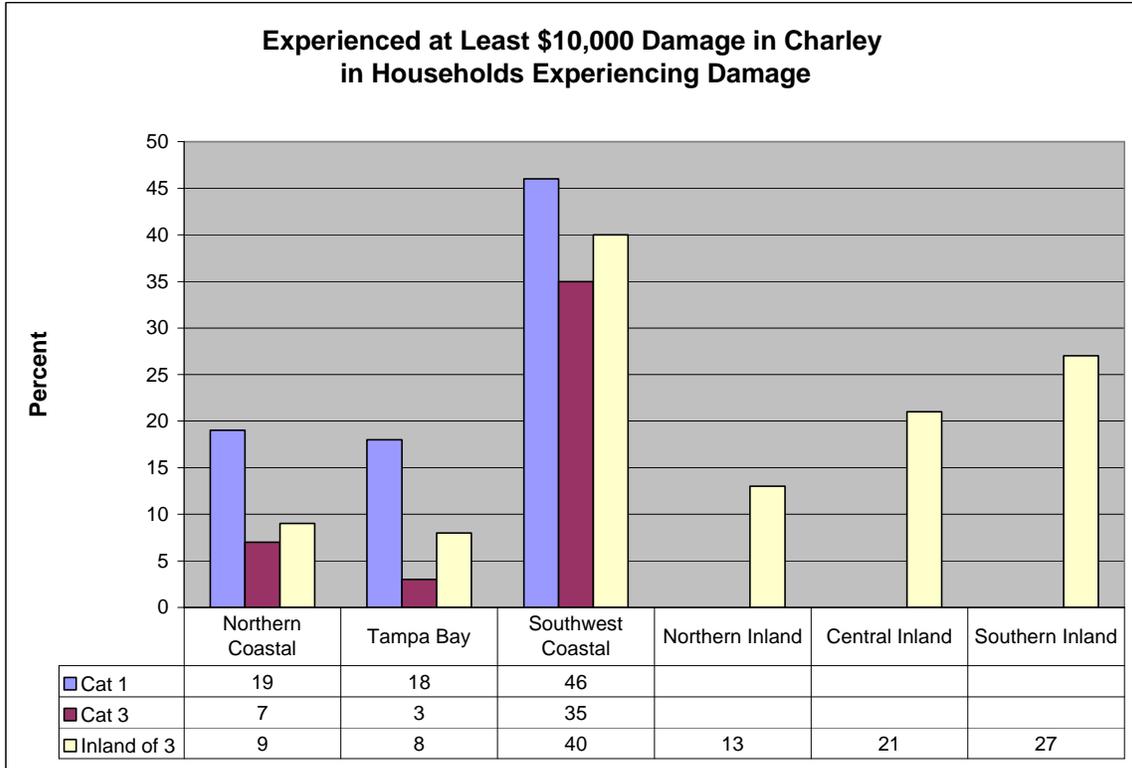


Fig. 100

### Worst Damage Ever

Interviewees were asked for the worst damage they had ever experienced in any hurricane, including Charley. Results are shown in Figure 101. In the southern inland area 19% of the respondents said they had experienced at least \$10,000 in damage, and the category 1 residents of southwest Florida reported essentially the same incidence (18%).

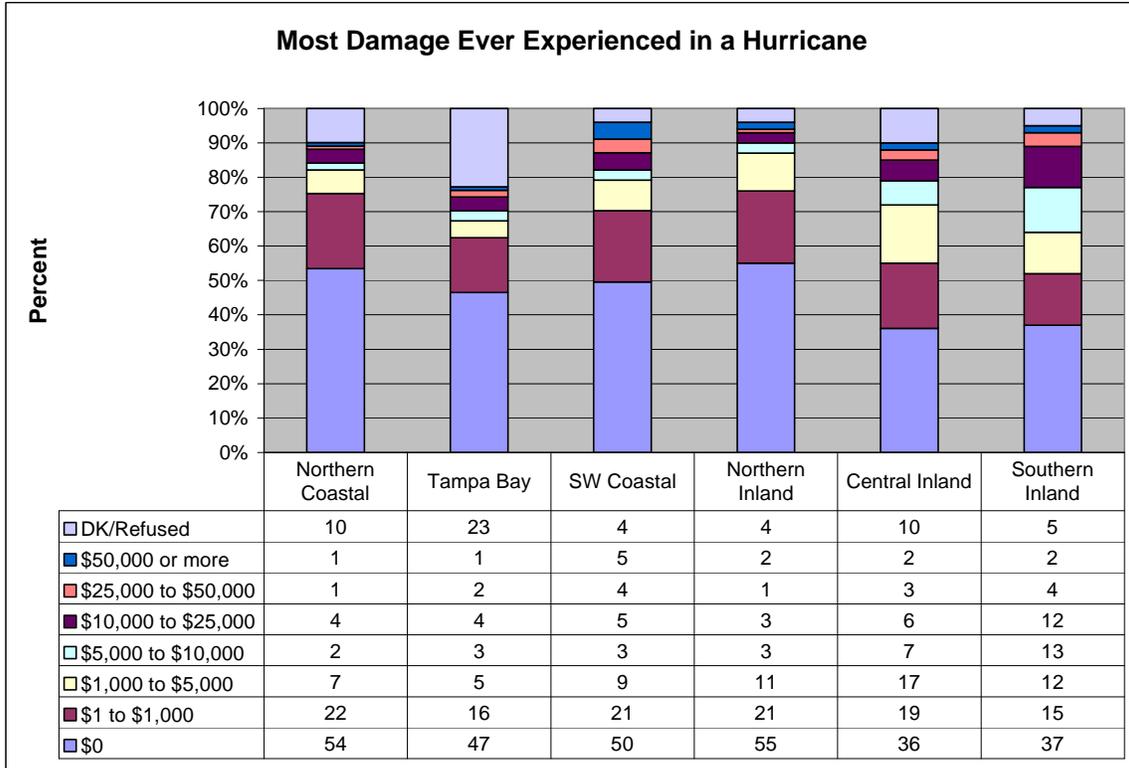


Fig. 101

## Major Hurricane Experience

### Before 2004

Between 42% and 62% of those interviewed said they had experienced a major hurricane prior to 2004 (Figure 102). Among coastal counties reported experience decreased from north to south. As many people in non-coastal counties as coastal counties said they had experienced a major hurricane before 2004.

### 2004

Between 54% and 84% of the respondents said they experienced a major hurricane in 2004 (Figure 103). The lowest levels were in the category 1 and 3 risk zones of the northern coastal area and Tampa Bay. The highest levels were in the category 3 risk zone of southwest Florida and in the central and southern non-coastal areas.

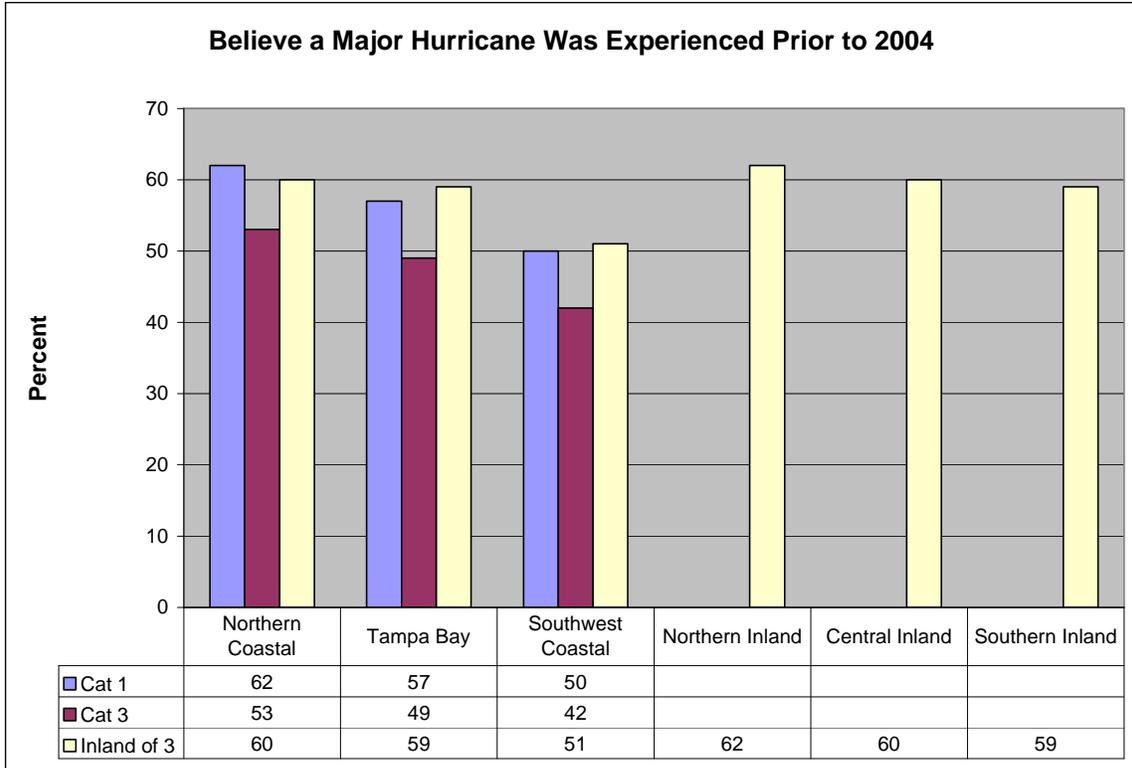


Fig. 102

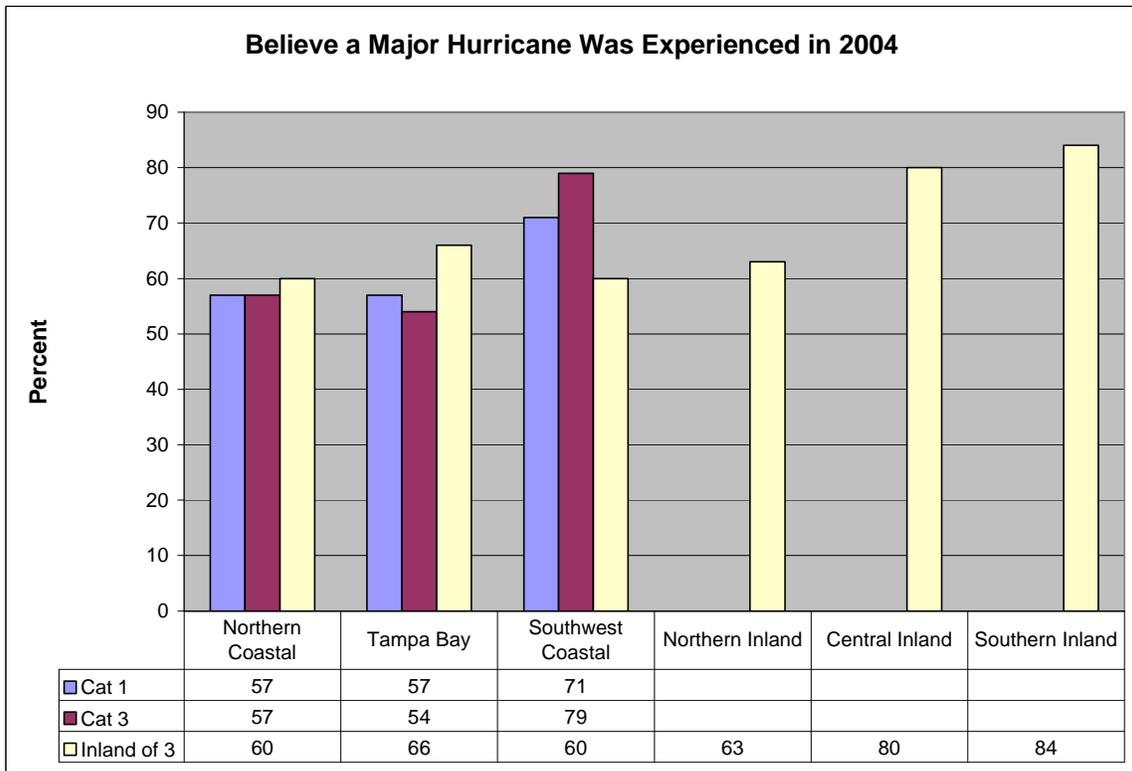


Fig. 103

## Evacuation in Frances and Jeanne

Hurricanes Frances and Jeanne posed less threat than Charley to the locations surveyed about Charley, but the threats were serious enough to prompt some counties to call for evacuation of low-lying areas and mobile homes. Both storms made landfall in Martin County, then crossed the peninsula north of Tampa. Frances moved into the Gulf of Mexico and turned north. Jeanne turned north just before reaching the Gulf.

### Evacuation in Frances

In the northern coastal area evacuation rates in Frances were higher than in Charley (Frances exited into the Gulf of Mexico near that area) (Figure 104). Except in the southern non-coastal area evacuation was lower in Frances than in Charley elsewhere in the study area.

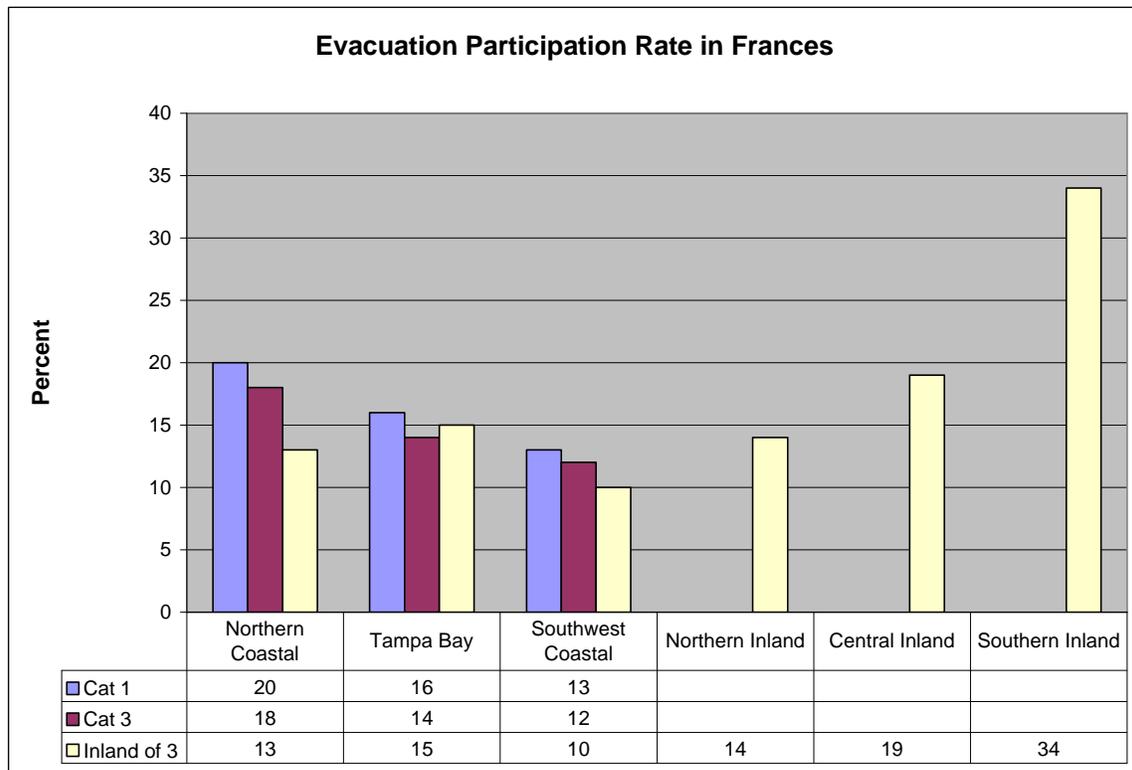


Fig. 104

### Evacuation in Jeanne

Throughout the Charley study area evacuation was either the same or slightly lower in Jeanne than in Frances (F105). The highest rate was in the southern non-coastal location.

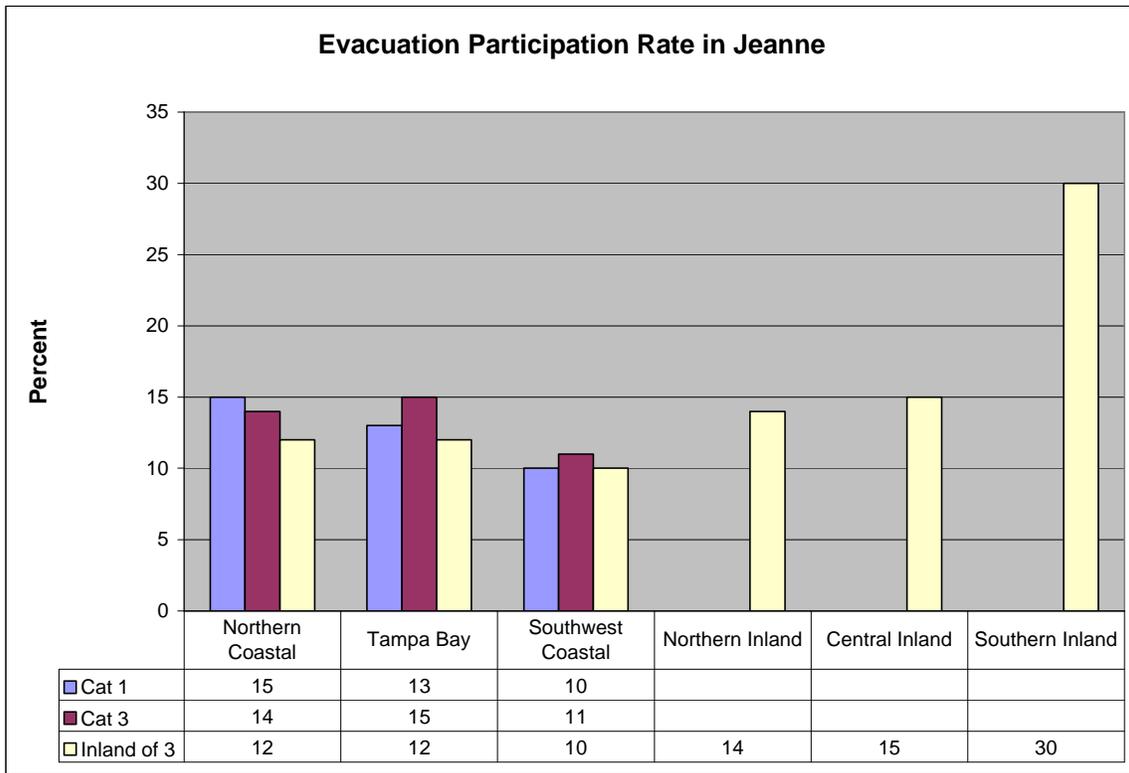


Fig. 105

**Comparison with Charley**

Figure 106 shows what people did in Frances and Jeanne, depending on what they did in Charley. Respondents who evacuated in Charley were four to five times more likely to evacuate in Frances and Jeanne than people who did not evacuate in Charley.

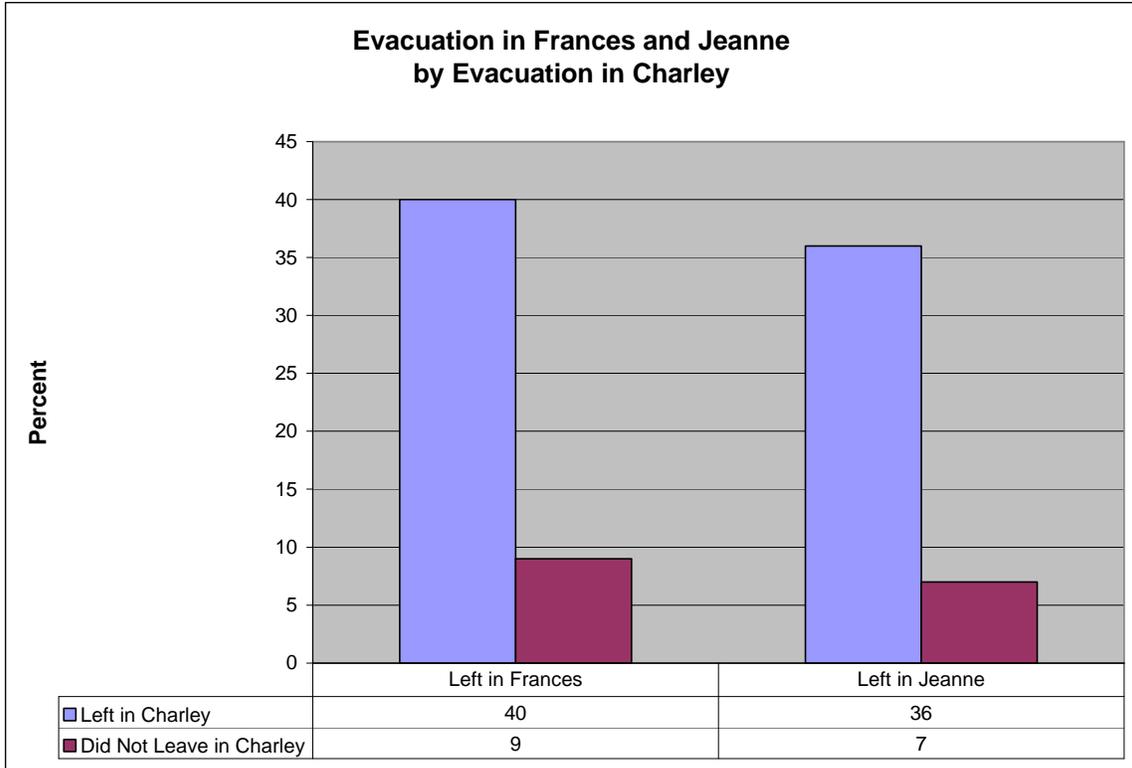


Fig. 106

**Reasons Given for Not Evacuating in Frances and Jeanne**

Respondents who didn't evacuate in Frances and Jeanne were asked why not. Responses are shown in Figure 107 for Frances and 108 for Jeanne. In both storms the large majority of responses dealt with risk assessment (storm track, storm strength, home construction, location). Relatively few people cited previous experience with other 2004 storms as being the reason for not leaving. Most notably few if any respondents indicated what might be interpreted as "hurricane fatigue" as the reason for not leaving in later season storms. Respondents could make multiple responses to the question, and data in the graphic displays percentage of all responses, not percentage of respondents.

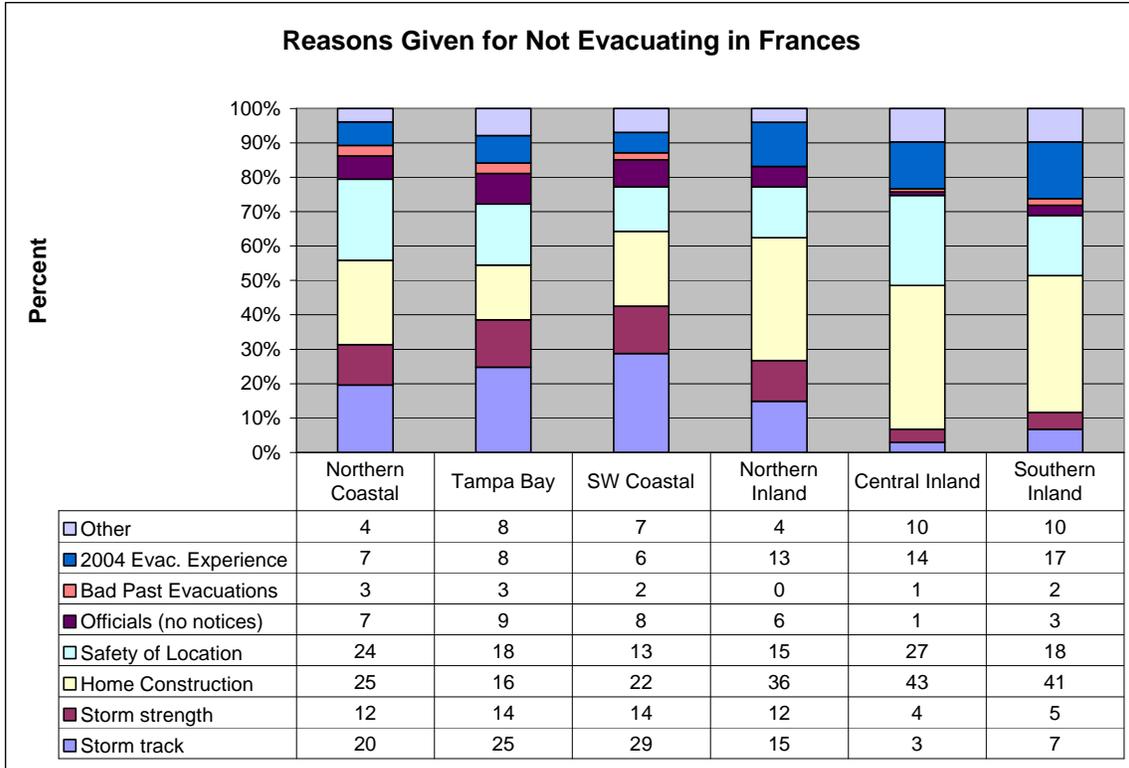


Fig. 107

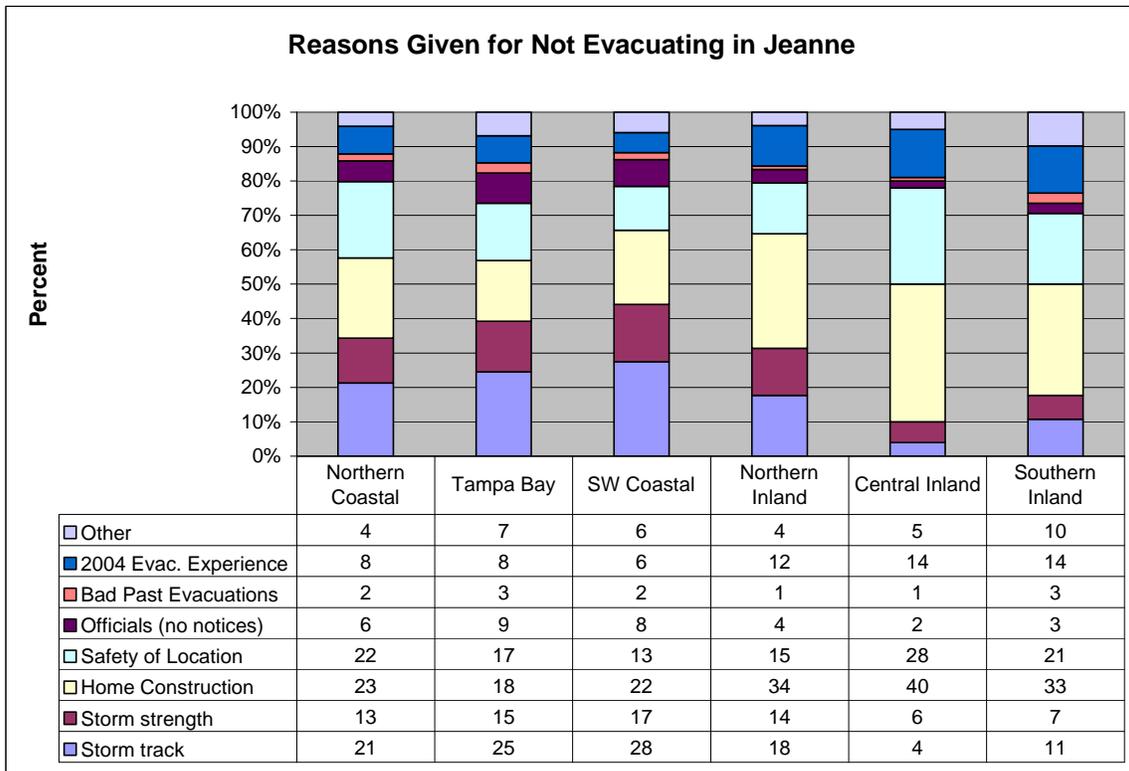


Fig. 108

Appendix A  
Statistical Reliability and Sample Sizes

Statistical Reliability of Survey Results

Data reported in the survey cited in this report are based upon samples taken from larger populations. The sample values provide estimates of the values of the larger populations from which they were selected, but are usually not precisely the same as the true population values. In general, the larger the number of people in the sample, the closer the sample value will be to the true population value. A sample of 100 will provide estimates which you can be 90% "confident" are within 5 to 8 percentage points of the true population values.\* With a sample of 50, you can be 90% "confident" of being within 7 to 11 percentage points of the actual population value. A sample of 25 is 90% "accurate" only within 10 to 17 percentage points. To be 95% or 99% "confident" you have to use an even wider range

The ranges (e.g., "10 to 17") stem from the fact that the reliability of an estimate depends not only on the size of the sample but also upon how much agreement there is among the responses. Having 90% of the respondents give a particular answer means almost everyone agreed. By the same reasoning, if only 10% gave a particular response, almost everyone agreed (i.e., 90% disagreed with the 10% but agreed with one another). The maximum disagreement is for the responses to be split 50-50. Thus, if 90% (or 10%) of a sample of 100 give a particular response, that estimate will be within 5 percentage points of the true population value 90% of the time. If 75% (or 25%) of a sample of 100 give a particular response, that estimate will be within 7 percentage points 90% of the time. If 50% of a sample of 100 give a particular response, that estimate will be within 8 percentage points 90% of the time.

Table B-1 summarizes the reliability values for samples of various sizes and response distributions. For example, suppose you interviewed 200 people in the category 1 surge zone of a group of counties and 50% of those 200 people said they believed their home would flood in a hurricane. You can be 90% "confident" that between 44% (50% - 6%) and 56% (50% + 6%) of *all* the people who live in the category 1 surge zone of those counties believe their homes would flood. If you wanted to be 95% or 99% "confident" of your estimate, you would need to add and subtract even larger values in order to a intervals of values in which you could have the desired confidence.

Table B-1. Approximate sample reliabilities for 90% confidence intervals, as a function of sample size and distribution of responses (i.e., variance)

Sample Size	Percent Giving Response		
	50%	25% or 75%	10% or 90%
25	± 17%	± 15%	± 10%
50	± 12%	± 10%	± 7%
75	± 10%	± 8%	± 6%
100	± 8%	± 7%	± 5%
200	± 6%	± 5%	± 4%
400	± 4%	± 4%	± 2%
800	± 3%	± 3%	± 2%
1500	± 2%	± 2%	± 1%

## Assessing Differences

Differences of a few percentage points in sample results do not necessarily mean the populations from which the samples were drawn are different. A “quick and dirty” way of comparing results is to add and subtract values in Table B-1 to and from of the two values being compared and seeing whether the ranges overlap. If there is overlap in the ranges created by adding and subtracting from the sample estimates, you should be reluctant to conclude that the population values differ. For example, suppose two samples of 100 yielded values of 50% and 40%. From Table B-1 you see that the 50% value for the population might actually be as low as 42%, and the 40% value might actually be as high as 48%. The 42% to 50% and 40% to 48% ranges overlap.

A more accurate method of assessing whether sample differences are large enough to imply population differences involves “tests of statistical significance.” In some instances the results of such tests are reported in this analysis. In general the following guidelines can be used. For samples in 50 in each group, the sample differences must be at least 20% (20 percentage points); samples of 100 must differ by at least 15%; samples of 200 must differ by at least 10%; and samples of 350 must differ by at least 7%. Those rules-of-thumb apply in cases in which both sample estimates are near 50% (55% vs. 45%, for example). In cases where the estimates are much higher or lower (90% vs. 80% or 10% vs. 20%) slightly smaller sample differences are required to conclude that population differences also exist. In those circumstances samples of 100 require only differences of 15% to imply population differences, for example.

Tests of statistical significance were performed for a number of sets of variables in the survey. The detailed results of the tests are not presented in the report, but the conclusions from the tests often are. For certain types of response, the report states that there was no difference between two groups in the sample. This means that given the sample size, differences in the sample did justify the conclusion that differences existed in the population from which the sample was drawn.

\*More correctly this means that if you took a “large” number of additional samples of the same size, 90% of those samples would yield estimates of the population value that were within 5 to 8 percentage points of the value you found with the original sample.