

HURRICANE IVAN BEHAVIORAL ANALYSIS

September 2005

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EXECUTIVE SUMMARY

Hurricane Ivan Behavioral Study

As part of the Hurricane Ivan post-storm assessment, interviews were conducted with 3200 households in the Florida Keys, Florida Panhandle, Alabama, Mississippi and Louisiana using Computer-Assisted Telephone Interviewing between May 23 – June 24, 2005. The data were analyzed using GIS techniques and multivariate regression analysis in addition to standard procedures.

The overall evacuation rate for Hurricane Ivan in these regions was 45%, but higher for the Florida Panhandle (69%) and Florida Keys (62%). The highest rates were in the highest risk zones in each region. About one quarter (28%) of evacuees did not report living in an evacuation zone, and the rate of over-evacuation was highest in regions with the least hurricane experience. Most said they would make the same decision next time, confirming the notion of a rather persistent group of evacuators and non-evacuators. However, in the Florida Panhandle where the impact was greatest, 18% of those who did not leave said they would the next time.

Beliefs about the safety of their homes was a primary factor in evacuation decisions, followed by traffic concerns. Multivariate analysis of other factors revealed the following significant positive factors on evacuation: hearing an official notice, living in an evacuation zone, and having a good income. These factors had a negative effect: being male, being African American or black, having a household member who had to work, and having window protection.

Other findings include: Many do not know whether they live in an evacuation zone; a growing use of the internet, both before and during a storm; considerable confusion about the meaning of watches and warnings; and very little mitigation. An important finding was that 80% said they had been through a major hurricane. Given their location, this is highly unlikely; therefore, there is a lot of “false” experience that could influence future storm decisions.

Most evacuees did not encounter serious traffic delays and reached their destination, usually the home of a friend or relative, close to the normal time. The longest delays occurred in Louisiana. Those who left in a timely manner (24-36 hours before the storm) encountered the longest traffic delays.

The bottom line is that most people pay attention to hurricanes and base their evacuation decisions on their evaluation of the safety of their home as a shelter, the storm conditions, and their household circumstances. Under the best conditions, evacuation takes a long time – in this case it was about 68 hours between the time the first and the last household left home.

A number of recommendations are made, both in terms of emergency management policies and procedures, and regarding future behavioral studies.

HURRICANE IVAN BEHAVIORAL ANALYSIS

I. INTRODUCTION

As part of the post-storm assessment of the effects of the very active 2004 Hurricane Season in the Atlantic and Gulf of Mexico regions, the Federal Emergency Management Agency (FEMA) and the U.S. Army Corps of Engineers (USACE) tasked Dewberry to conduct a behavioral analysis related to the impact of Hurricane Ivan on households in Florida, Alabama, Mississippi and Louisiana. This behavioral portion of the Ivan post-assessment examines mitigation, preparation and evacuation activities, as well as storm impact, as reported by respondents representing a random sample of 3200 households.

The purpose of these post-storm assessments is to allow FEMA and the USACE to calibrate, correct, and improve the models and products that serve as primary preparedness, assistance and mitigation tools for emergency managers.

A. The Storm

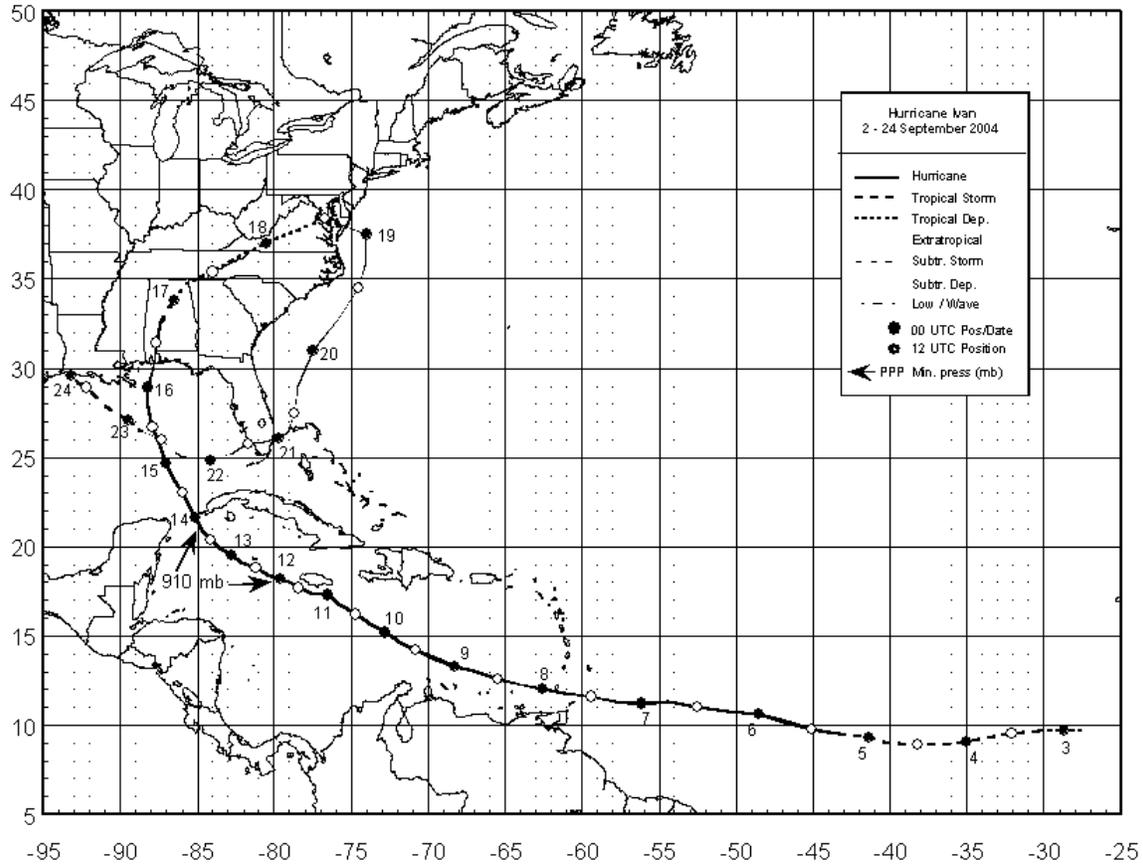
In order to interpret the behavioral data collected on Hurricane Ivan, it is important to understand the context in which the respondents experienced this storm. Hurricane Ivan was the third and most dangerous storm to hit Florida in the summer of 2004. It was a long-lived storm that reached Category 5 strength three different times, causing considerable damage in the Caribbean before making its first U.S. landfall as a Category 3 storm just west of Gulf Shores, Alabama at 2 AM CDT on September 16th.¹

This storm system then turned northeastward across eastern Mobile bay, weakened to a tropical storm as it crossed Alabama, continued across the U.S. as a tropical depression, and exited as a tropical low over the Delaware – Maryland - Virginia peninsula on September 18th. It then moved southward in the Atlantic, crossed Florida on September 21st and emerged into the Gulf of Mexico where it again became a tropical depression, making its second landfall in southwestern Louisiana on September 24th before finally dissipating over Texas.

¹ Stewart, Stacy. 2004. Tropical Cyclone Report: Hurricane Ivan. National Hurricane Center. www.nhc.noaa.gov/2004ivan.shtml.

Figure 1 depicts the unusual track of this storm system.

Figure 1. Hurricane Ivan Track

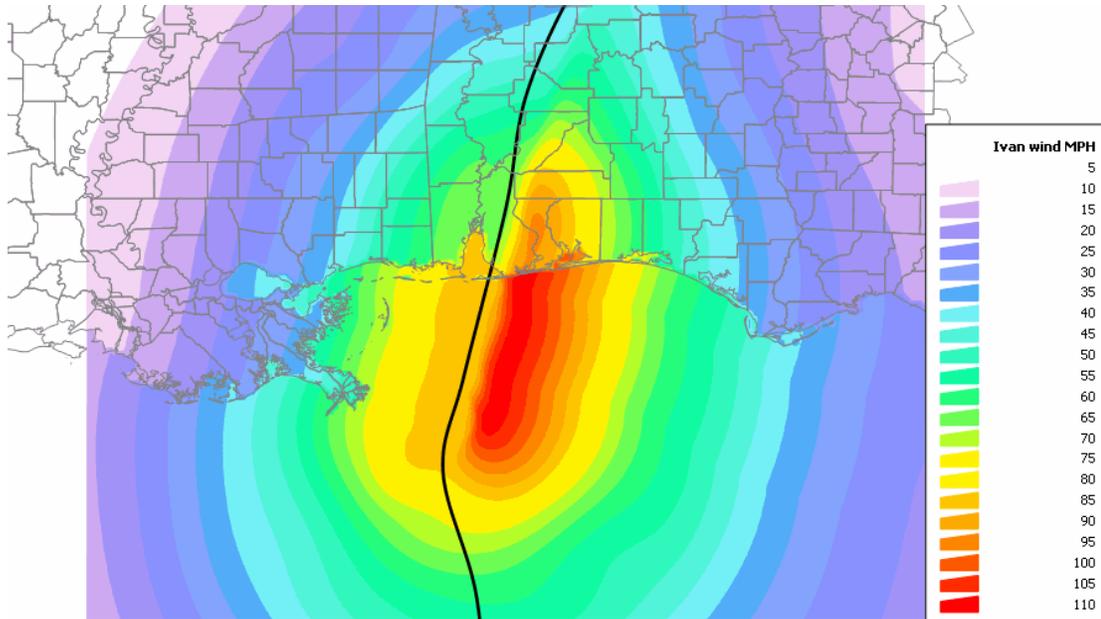


This cyclone system existed for 22 days and produced a track more than 5600 nautical miles. Of importance to this report, this storm was in the news for several weeks, menaced the Gulf coastal areas for days, and impacted various regions of the U.S. over an eight-day period. Residents of the states included in this report – Florida, Alabama, Mississippi and Louisiana – were threatened at two different times.

Hurricane Ivan had sustained winds of 120 mph at the time of first landfall over Perdido Key in the Florida Panhandle area. It was a wide storm with an eye diameter between 40-50 miles across and hurricane force winds extending up to 105 miles from the center.

Figure 2 depicts the windfields at the time the highest winds reached the area on September 16th.

Figure 2. Hurricane Ivan Windfields



In addition to hurricane winds, Ivan spawned at least 34 tornados. The highest storm surge varied from 10-15 feet and the storm produced heavy rainfall across the U.S. A total of 66 deaths were attributed directly or indirectly to this storm system. It was the most destructive hurricane to impact the Florida Panhandle-Alabama area in more than 100 years, causing widespread power outages, flooding, and structural and environmental damage. Total losses are estimated at more than \$14 billion.

B. Impacts by Region

Each state included in the survey presents a unique context in terms of its geography, history (including hurricane experience), government (including emergency management practices), and, of course, Hurricane Ivan impact. In the case of Florida, two distinctly different areas were threatened and/or experienced the storm – the Florida Keys and the Florida Panhandle, and, for this reason, their results are analyzed separately. For purposes of data interpretation these two Florida regions, together with Alabama, Mississippi and Louisiana, will be presented as five regions or study zones. It is important to understand the circumstances under which the respondents from each of these regions experienced Hurricane Ivan.

1. Monroe County (Florida Keys)²

Hurricane Ivan was a dangerous storm as it moved through the Caribbean, leaving a trail of death and destruction. It followed two other hurricanes, Charley and Jeanne, which had slammed into Florida within the past month. When Hurricane Ivan threatened the Florida Keys (Monroe County), a mandatory evacuation was ordered on September 10th. This was the third mandatory evacuation of the year for tourists, but the first in three years for residents. The closest approved shelter for Monroe County residents is 150 miles north in Miami-Dade County. Fortunately for the Keys and Florida's southern coastline, Ivan shifted westward on September 11th.

Thus, Monroe County residents responded to a major hurricane that did not impact their households and communities. It is in the context of a serious "false alarm" that Keys respondents participated in this study.

2. Florida Panhandle

The northwestern panhandle of Florida was included in the hurricane watch area on September 14th that soon became a hurricane warning. When the storm made landfall, Escambia and Santa Rosa counties were in its most severe northeast quadrant, experiencing 120 mph winds, a 10-15 surge, 16 inches of rainfall, and several tornados.³ Ivan was the most destructive hurricane to impact this region

² Throughout this report the names Monroe County, Florida and the Florida Keys are used synonymously.

³ National Weather Service. National Hurricane Center. *Tropical Cyclone Report: Hurricane Ivan*. 2-24 September. www.nws.noaa.gov.

in more than 100 years. There was widespread destruction, beach erosion, flooding and 14 deaths. Approximately 75,000 homes were damaged and 50,000 people displaced. More than half of the damaged homes were households with annual incomes of less than \$30,000. A quarter-mile section of the I-10 bridge was destroyed. Nearly 150,000 Panhandle homeowners, renters and businesses applied for FEMA assistance and more than \$100 million in low-interest loans were approved.

Survey respondents from the Florida Panhandle were likely to have been impacted severely by Hurricane Ivan. At the time of the survey thousands of households were still living in temporary or damaged homes.

3. Alabama

The Alabama coastline was included in the September 14th warning area. A mandatory evacuation was ordered for Gulf Shores, Orange Beach and Fort Morgan. The eye of Hurricane Ivan made landfall at Gulf Shores, Alabama. Baldwin County sustained 75 mph winds with one peak gust measured at 145 mph, a 5-9 foot surge, and 7-8 inches of rainfall. The Mobile National Weather Service office issued an Inland Hurricane Wind Warning for southwest Alabama. Major destruction occurred in Escambia, Conecuh, Monroe and Wilson counties.

Since the eye went through Gulf Shores, no doubt many of the survey respondents from Alabama believe they experienced the full force of a Category 3 hurricane. In reality, the storm's worst effects occurred to the east in the Pensacola area. Nevertheless, many homes and communities were impacted.

4. Mississippi

The Governor ordered a mandatory evacuation of the 78 miles of coastline in Harrison, Jackson and Hancock counties and the Mississippi Emergency Management Agency reported that most of the evacuation

was completed 10 hours before landfall. Extra shelters were opened inland for evacuees who could not find a safe refuge. It was estimated that 75,000 evacuated Harrison County alone. Mississippi coastal communities were spared the worse effects, but did experience a 4-5 foot storm surge, peak winds of over 90 mph, and up to 6 inches of rainfall. The effects included significant beach erosion, some environmental and structural wind damage, lowland flooding, and power outages. Two deaths were attributed directly to the storm. More than \$4 million in disaster aid was distributed in the 23 counties included in the disaster declaration.

Mississippi coastal residents were menaced by this storm for several days prior to landfall and were told to evacuate. The counties included in this study were under hurricane watch and warning. While they missed the brunt of the storm, residents of the counties included in this study experienced heavy winds and rainfall.

5. Louisiana

Due to its extremely hazardous geography, Louisiana officials take every hurricane threat seriously. The New Orleans area was included in the warning on September 14th and 1.4 million residents were urged to leave. Officials hesitate to issue a mandatory evacuation due to the large number of low-income residents without cars. The Superdome served as a special needs shelter. It is estimated that about 600,000 citizens tried to evacuate. Contra-flow procedures were put into effect for the interstate routes out of the city. Serious gridlock was reported in some areas. Once again the area escaped catastrophe as the center of the storm passed to the east. However, it did experience 70 mph winds and about 7 inches of rain, causing some damage and power outage. Southwest Louisiana was affected by the storm system's second landfall as a tropical storm on September 23rd, causing minor flooding.

Respondents from Louisiana have been hearing about the grave danger posed by hurricanes for years, but have not had a direct hit since 1965.

The responses to this survey should reflect the extent to which Louisiana residents took the threat seriously. During the evacuation officials implemented contra-flow procedures on a portion of the evacuation route, and questions about contra-flow were included in the survey for Louisiana respondents only.

C. Survey Methodology

1. Sampling Technique

In consultation with representatives from the contracting agencies, counties and parishes in and adjacent to the path of Hurricane Ivan in the four states were selected to be included in the study. A random sample was then selected from these regions and used to complete a total of 3200 telephone interviews. The sample was drawn from a database of listed phone numbers to enable latitude/longitude geocoding of each sample point.

Table 1. Counties and Parishes Included in Study

County	No. of Interviews
Alabama	
Baldwin	200
Mobile	200
Louisiana	
Jefferson Parish	200
Orleans Parish	200
Plaquemines Parish	100
St. Bernard Parish	100
St. Charles Parish	100
St. John Parish	100
St. Tammany Parish	100
Mississippi	
Hancock	200
Harrison	200
Jackson	200
Florida	
Bay	150
Escambia	200
Franklin	100
Gulf	100
Inland Counties*	150
Monroe	200
Okaloosa	150
Santa Rosa	150
Walton	100
TOTAL INTERVIEWS	3200

* Includes Liberty, Calhoun, Holmes, Washington, and Jackson counties.

The survey sample of 3200 was stratified into units by county with at least 100 interviews per county to enable valid inferences to be made about each county. The only exception is four inland counties in the Florida Panhandle with small populations (Holmes, Jackson, Washington, and Calhoun). These counties were combined into a group called "Inland Counties" with 150 sample cases drawn proportionally to their respective populations. Within each county sample phone numbers were drawn proportional to the population, thus the more populated areas of the county contributed more interviews. In the Florida Panhandle

counties, zip code areas near the coast were over-sampled to allow greater precision in estimates across areas of different risk levels.

For Mississippi, Alabama, and the Florida Panhandle GIS files were obtained delineating evacuation risk zones. There are four of these zones: “Cat 1+” evacuates for any hurricane, “Cat 3+” evacuates for a category 3 and higher hurricane, “Cat 4+” evacuees only for a category 4 or 5 hurricane, and “No Evac Zone” means no evacuation is required (except mobile home parks and other localized risk areas subject to flooding). Data on evacuation zones were not available for the coastal Louisiana parishes or for Monroe County, Florida. Given their geography, it was assumed that these entire regions were told to evacuate.

The following tables depict the sample distribution and demographics. (See Appendix for weighted numbers by county/parish).

Table 2. Total Sample by Regions and Risk Zones*

Evacuation Zone	Louisiana		Alabama		Mississippi		FI Panhandle		FL Keys	
	No.	%	No.	%	No.	%	No.	%	No.	%
Cat 1+	0	0	73	14	152	45	71	7	0	0
**No Evac. Zone Data Assume 1+	1232	100	0	0	0	0	0	0	102	100
Cat 3+	0	0	101	20	65	19	100	10	0	0
Cat 4+	0	0	65	13	60	18	144	14	0	0
No Evac Zone	0	0	267	53	65	19	703	69	0	0
Total	1232	100	506	100	342	100	1018	100	102	100

* Weighted to make proportional to population

2. Sample Demographics

Based on sample specifications, interviews were completed with 3200 residents of Florida, Alabama, Mississippi, and Louisiana. The demographics of these respondents are summarized in Table 3 and reflect the diversity of the target populations with one exception. Educational and income levels are higher than expected for these populations, but this may be explained, at least in part, by the over-sampling of coastal residents who tend to be more affluent.

Table 3. Sample Demographics*

	Percent of Total Sample
Gender	
Female	51
Education	
Some High School or Graduate	30
Some College	26
College Graduate	26
Post-Graduate	15
Race/Ethnicity	
Caucasian or White	84
African American or Black	9
Hispanic	15
Own Home	89
Size of Household	
Live Alone	15
2 Persons	42
3-4 Persons	32
5+	10
Children under 18	
None	53
1 – 2	25
3 or more	6
Elderly 80 Years or Over	6
Special Needs Household Member	5
Pets	60
Income	
Less than \$15,000	8
\$15,000-\$24,999	9
\$25,000 - \$39,999	15
\$40,000 - \$79,999	26
\$80,000 or More	20

* Percentages do not add up to 100% due to missing values or omission of some categories from the table, and/or rounding to nearest percent.

3. Housing Characteristics

a. Type of Home

It is important to know the type of housing in which the respondents reside. The vast majority live in single family homes, but there is some variation by regions, with more Louisiana and Monroe County residents living in multiple family units. Between 7-9% of respondents from the Florida Keys, Alabama, Mississippi and the Florida Panhandle live in mobile or manufactured homes.

Table 4. Type of Home by Region (Percent)

Type of Home	Louisiana	Alabama	Mississippi	FL Panhandle	FL Keys
Single Family Home	81	88	87	85	76
Multiple	17	4	4	5	17
Mobile or Manufactured	2	8	9	9	7

b. Construction Material of Home

There was considerable regional variation in the materials used to construct these homes.

Table 5. Construction Material of Home by Region (Percent)

Construction Material	Louisiana	Alabama	Mississippi	FL Panhandle	FL Keys
Brick	60	60	55	50	3
Cement Block	2	4	4	15	63
Other	4	4	4	4	6

c. Elevation of Home

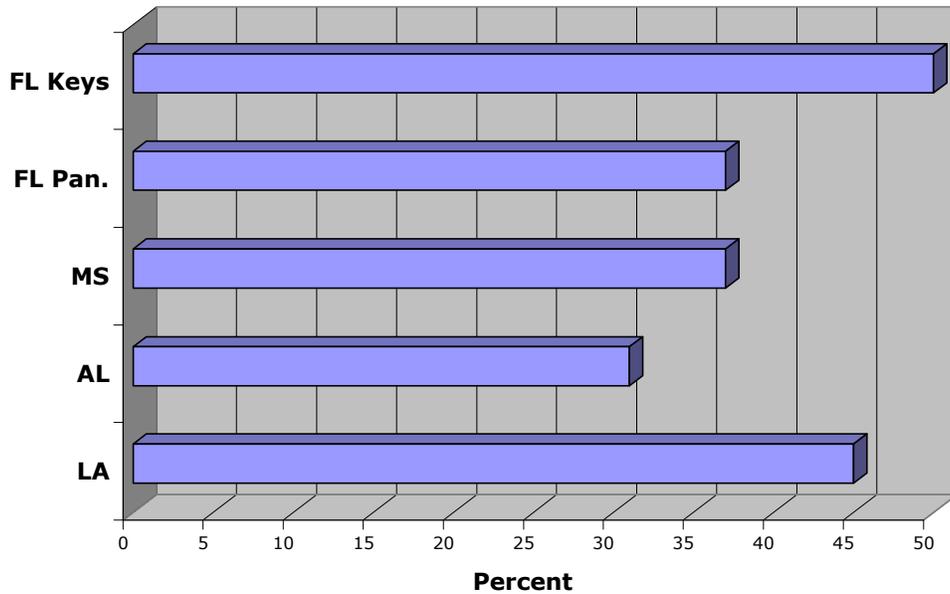
When asked if their home or building was elevated on pilings or fill material to raise it above flood water, about 30% of the total sample answered in the affirmative.

d. Age of Mobile or Manufactured Home

About 54% of owners of mobile or manufactured homes said their homes were built to the stronger wind standards required after 1993. The next figure reveals some regional differences in older homes with the Florida Keys and Louisiana coastal parishes having the largest stock of older mobile homes.

Figure 3.

Mobile Homes Built Before 1993



	LA	AL	MS	FL Pan.	FL Keys
■ Before 1993	45	31	37	37	50

In the regions included in this study, the highest percent of households living in mobile homes was found in Mississippi (9%) and the Florida Panhandle (9%), the oldest stock is located in the highly vulnerable areas of the Florida Keys and coastal Louisiana.

4. Questionnaire

The survey instrument used to conduct the behavioral analyses of the other 2004 hurricanes – Charley, Frances and Jeanne – was modified slightly for this assessment to include suggestions from representatives of FEMA and the Corps of Engineers. The final questionnaire included questions on evacuation decisions and behavior, home mitigation and/or preparation, household circumstances, and economic impacts, as well as household information needs. Questions on contra-flow lanes were added for the Louisiana sample.

5. Data Collection

The interviews were conducted using a Computer Assisted Telephone Interviewing (CATI) system. Each interview lasted approximately 20 minutes. The interviews took place between May 23 and June 24, 2005.

6. Analysis and Interpretation

One problem with simple tabulations based on a stratified sample is that an area with a smaller population will have a disproportionately larger effect on survey results than an area with a larger population and the same sample size. In order to correct for this, results are weighted by geographic area so that estimates over the entire study area are more accurate. When the entire sample was used in the analysis, the data were weighted to keep county and parish sample effects proportional to their population. For example, 200 interviews each were done in Hancock and Harrison Counties in Mississippi. Hancock has a population of 32,163 and Harrison 140,213. Without weighting, Hancock interviews would each affect the results more than four times as much as Harrison interviews.

As true of all surveys based on a proportion of the total population, data estimates will vary from the true numbers. When the entire sample of 3200 interviews are analyzed as a group, this variation or *margin of error* is approximately $\pm 2\%$. Or, stated in terms of *confidence levels*, in 95 out of 100 cases the margin of error will be $\pm 2\%$. When results from areas with smaller sample sizes are analyzed independently, the margin of error will increase. For example, the margin of error will be approximately $\pm 7\%$ for the states with a sample size of 200 (i.e. Alabama, Louisiana and Mississippi). What this means is that a 5% difference would not be statistically significant within a state, though it would be for the entire sample.

In all tables and graphs percents are rounded to whole numbers. Therefore, they will not always add up to 100%. In some cases the graphs depict combined questions that were not mutually exclusive, and thus will add up to more than 100%.