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Do you see what I mean?: Measuring consensus of agreement and understanding of a National Weather Service informational graphic

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Do You See What I Mean?

Measuring Consensus of Agreement and Understanding of a

National Weather Service Informational Graphic

by

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Dedication

This is dedicated to my father who taught me that the sign of an educated person was the ability to talk to anyone and to Kathy for her infectious enthusiasm for the joy of learning.

Special thank you to my mother for her unending support and practical advice and an enormous amount of gratitude to my classmates and *all* the doctors it took to get me through.

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ABSTRACT

Media use of hurricane graphics to apprise populations vulnerable to severe weather provides a persuasive demonstration of the importance and complexity of visual communication. Surprisingly little research, however, has explored how audiences interpret weather graphics. This study examined whether the general public and the National Weather Service share a common understanding of selected weather related terms and meaning of a NWS informational graphic. Using a coorientation model, general public responses to a questionnaire were compared to definitions prescribed by the NWS. Additionally, the public were asked questions to measure trust of the NWS as a credible and reliable source of severe weather information. Selected broadcast meteorologists were surveyed to measure their opinions of the NWS as well as to measure their perceptions of how the general public would respond to questions relating to knowledge of weather terms and graphics.

Results revealed discrepancies between the intent of such graphics and audience interpretations. While the vast majority of respondents recognized the Tropical Cyclone Track Watch/Warning Graphic and understood much of the information it conveyed,

study respondents did not seem to remember or understand the meaning of the terms *Watch* and *Warning*. While these terms or conditions are only one aspect of the graphic they represent critical information for populations at risk. Additionally, the results of this study indicate that weather forecasting professionals' perceptions of the public's understanding of the graphic are inaccurate. Results also show respondents generally rate the NWS as a reliable and competent agency but they do not consistently rate their local weather providers as well.

Weather scientists' foremost concern may be the accuracy of their forecasts, but they also must consider the *accuracy* of the *perceptions* of those forecasts if they are to be effective in warning populations at risk of severe weather. These results have sobering implications for both governmental and private sources of emergency communication.

CHAPTER ONE: INTRODUCTION

Four hurricanes made landfall in Florida in 2004 and ultimately left 167 dead and caused more than $35 billion of damage in the U.S. (Infoplease, 2006). That season marked the beginning of what some scientists are calling a new weather pattern that will continue to produce devastating storms.

Since that remarkable year, warnings of impending disaster and reports of devastation seem to dominate our morning television. However, many of us pay scant attention unless the prediction or aftermath affects us personally (J. Grunig, 1997) or the magnitude of the event reaches new levels of devastation. Exploring how we view these phenomena and their inherent risks is important especially in the face of predicted increases in both natural and manmade disasters (Sellnow & Seeger, 2001). Understanding the science of weather will help us make better decisions to protect both our lives and property.

Our perception of these events, whether they are real or not, is often shaped by our social experiences and institutions (Berger & Luckmann, 1966). One institution that has a considerable effect on our perceptions of reality is the media, especially in times of crisis. When other avenues of information are not available or sufficient to help us during times of crisis, we often look to the media to keep us informed of issues and occurrences such as natural disasters that are beyond our immediate environment (Ball-Rokeach & DeFluer, 1976).

Mass media have dual roles as mass communicators during disasters: “first, as reporters of events and second, as major organizational actors in preparing for, and responding to, disaster” (Quarantelli, 1989, p. 5). They must report the news as well as warn and inform their audiences. These two roles of news reporters are juxtaposed and intermingled during the dramatic crescendo of tension prior to a storm’s landfall. It is during this time that the broadcast stations and newspapers switch from the narrative of past storms to the rhetoric of preparedness (Quarantelli, 1989).

Preparing populations at risk from both man-made and natural disasters is the major challenge for public safety experts. These specialists must identify tools and management techniques that mitigate risk; however, their quest is challenged by the complexity of changing communication technology, population demographics, and psychographics. While radio, television, and now the World Wide Web offer vast avenues for the dissemination of information, they also can be liabilities unless their use and effectiveness is understood. One area of inquiry that sheds light on the effects of media concerns the processes involved in how the media create news and how these social constructions contribute to our perceptions of our world (Tuchman, 1978).

One aspect of news construction is the visual graphic, which is often used to explain or highlight scientific information. A common element of tropical storm coverage is the graphical depiction of a storm and its projected path. These graphics, used by both electronic and print media, are new technology products that use sophisticated hardware, software, and historical information to identify the formation of storms, track their development, and predict storm path (National Weather Service, 2005, Tropical Prediction Service). Like much scientific information, these graphical depictions of storms are end products of professional routines and only come to the public as a result of the interaction of two social institutions, science and the press (Nelkin, 1987).

For many news outlets, primary sources of scientific data relevant to tropical storm information are the National Weather Service (NWS) and the National Hurricane Center (NHC). The NWS not only supplies the data on weather systems, but it also provides text forecasting and graphics. Viewed from this perspective, the National Weather Service could be seen as performing a significant communication function for its parent organization, the National Oceanic and Atmospheric Administration (NOAA). It is through the development and dissemination of weather related "products," that the National Weather Service (NWS) functions "to issue forecast and warnings to minimize loss of life property and enhance the Nation's economy" (NWS, 2005, p.ii). However, for that information to be useful, it must be accessible and understandable by their wide and varied audiences. To that end the NWS also has moved to increase the public's environmental literacy. "Our outreach and education activities are aimed at making sure the public understands the information we provide and can use it effectively in the decisions they make" (p. ii).

Deciding if and when to evacuate in advance of a storm depends on a multitude of factors. While the NWS and NHC concentrate their efforts on the collection and analysis of scientific information of severe weather, they must also ensure that their messages are understood by populations at risk. It is relatively easy to measure the accuracy of the NWS and NHC predictions against their own models, but measuring the level of their audience's understanding of those predictions is another matter. Continually working to develop new tools and "products" the NWS and NHC have historically relied upon attitudinal responses from their audiences as well as anecdotal information to measure understanding (Holleman,2004; NWS, Customer Survey, 2005). NOAA, NWS, and NHC, like many governmental organizations, also operate within an environment that has political, monetary, and legal constraints. While organizations within the U.S. government are prohibited from formally performing the function of public relations (Lee, 2002), they can and must follow some basic public relations and communication tenets to be successful.

One prime example of successfully communicating with the public is the interaction that the NWS and NHC had with its public audiences during the 2004 and 2005 hurricane seasons. Additionally, these organizations were two of only a few governmental agencies to be lauded for their performance during Hurricane Katrina. Both agencies ably performed their missions of collecting information about what began as a tropical disturbance and informed the public of its development and potential danger. The NWS and NHC, unlike FEMA, demonstrated behaviors in line with tenets of “Excellent Public Relations” as described by Grunig, Grunig, and Dozier, (2002); and Mayfield, (2005). Of particular note, however, were the organization’s efforts the previous year to redesign one graphic in response to concerns and complaints raised in the aftermath of Hurricane Charley in 2004.

In an unpublished report to the International Hurricane Research Center, the results of fieldwork and interviews of Punta Gorda, Port Charlotte and Arcadia, Florida residents were detailed and analyzed (Morrow, 2004). The research was initiated the week following the Florida landfall of Hurricane Charley and its intent “was to capture a snapshot of experiences and attitudes in the immediate aftermath” of the storm (p. 8).

Data were drawn from a convenience sample and included 100 interviews and 92 completed surveys by area residents as well as interviews from others including emergency managers and area meteorologists. While the data are not generalizable, it provided insight into the actions and thoughts of “some of the storm’s most affected citizens” (p. 3). Although many themes emerged from analysis of the data, one primary conclusion cited in the report was a lack of attention paid by residents to hurricane watches and warnings which may have contributed to the seemingly reduced sense or perception of danger. “They did not believe Hurricane Charley posed much danger as it approached the coast of Florida” (p. 9). The researchers suggest that the reduced sense of danger could be partially explained by Hurricane Charley’s development and slight track change prior to landfall, however, many of the respondents expressed opinions that the storm was headed north of them. “Nearly everyone interviewed said they thought the storm was going to hit the Tampa area” (p. 10). The perception that the storm was headed elsewhere was in contrast, according the author, to the accurate forecasts by the NHC. The author reported NOAA data which concluded that the forecast at 24 hours, 48 hours and 72 hours prior to landfall of Hurricane Charley was from 9% - 43% better than the average 10 year forecasting error rate (Morrow, 2004). To further emphasize the difference between perceptions of danger and the actual forecast, the authors note that at the time of landfall Punta Gorda, and neighboring areas, “had been:

- In the cone of uncertainty for almost 4 days
- Under a Hurricane Watch for almost 35 hours
- Under a Hurricane Warning for almost 23 hours and
- In the 50% probability of the striking area about 11 hours.” (p. 10)

The report concluded that two factors played a role in residents' perceptions of threat. One was "a long history of warnings with no serious impact, and too much attention to the center of the forecast track" (Morrow, 2004, p. 10) also referred to as the center forecast line. Another conclusion was that "people still do not understand hurricane track probabilities and pay too little attention to the entire cone of uncertainty" (p. 5).

The assessment that area residents paid too much attention to the center line of the hurricane track graphic was echoed by meteorologist interviewed for the 2004 study. While the author argues that "most television visualizations of the storm had the cone marked with the center line and *mentioned* Tampa as the *probable* [emphasis added] landfall point over and over in the days preceding the storm" (Morrow, 2004, p. 11) meteorologists seemed to put the onus of errant focus on the viewers. Despite broadcasters' self-reported efforts to shift viewer focus away from the line to the wider area of the cone graphic, the authors quote study participants as having "heard" the storm was headed north, or forecasters "said" the storm was supposed to hit Tampa. This apparent emphasis on "hearing" versus "seeing" the forecasted area of landfall suggest the narrative was more influential than the visual. However, this highlighting of the audio cues could be the result of the author's choice of quotes or just linguistic preference by respondents.

In a later report, Hurricane Ivan Behavioral Analysis (2005) which examined another of the 2004 storms, researchers analyzed evacuation behavior. Respondents represented a random sampling of 3200 households from Louisiana, Alabama, Mississippi, and the Florida panhandle and Florida Keys. The assessment examined storm impact as well as behaviors such as mitigation and preparation. Of special interest was an analysis of evacuation activities. “It is crucial for emergency managers and other officials to understand, not only who will or will not evacuate, but the factors involved in household evacuation decisions (FEMA, 2005, p. 12). The post-storm assessment reported findings were consistent with earlier research and concluded that “household evacuation decision-making tends to be a complex process in which more than one factor is considered” (p. 62).

The study supported previous research citing television as a primary information source. “The vast majority of households first heard about the evacuation on television. What is different is that , while still small, a growing number are turning to the internet for additional information, and this is particularly true in the Florida Keys” (p. 63). However, regardless of region or medium, respondents valued information issued from the National Weather Service (NWS). The majority, from “78-85% of respondents reported that the NHC watches and warnings were an important factor in their evacuation decision” (p. 27). That the NWS and the NHC are viewed as trusted sources of information is a positive for emergency planners, but it is a concern “there is still considerable confusion about the meaning of hurricane watches and warnings” (p. 63).

Respondents from all five study areas were asked to define both terms by choosing from multiple choice questions that asked how many hours before expected landfall does the National Hurricane Center issue a Hurricane Warning and the choices were 12 hours, 24 hours, 36 hours, and Don’t Know. The question was then repeated for Hurricane Watch. Of the total sample, 62% chose the correct definition for hurricane watch, and only 40% knew the definition for hurricane warning (p. 27).

The study also examined respondents' recollection of the hurricane track graphics. A remarkable "95-97% said they saw the hurricane's track on television and about 90% said it was an important factor in their evacuation decisions: (p. 27). When asked to identify separate elements of the graphic, "64% reported seeing a cone, 12% a line and 24% both" (p. 28). The question probed respondents by asking if the graphic showed a line with "exactly where the storm was predicted to go, or did it show a wider area, like a cone, saying the storm would go someplace in the large area, but you couldn't tell exactly where?'" (p. 28) These results indicate a positive emphasis, supported by NHC (Mayfield, 2005) on the track as an area of potential landfall rather than a single point of landfall. The report concluded the results "may be explained in part by the attention given to this issue after Hurricane Charley. It is interesting to note that those who reported seeing only the forecast track line were less likely to evacuate" (p. 64).

In slide show entitled "2004 Post Storm Assessments" posted to the Army Corps of Engineer's web site, (FEMA & USACE, 2005) recommendations for assisting residents in making evacuation decisions were listed. These recommendations resulted from the 9000 surveys conducted after the 4 large hurricanes in 2004. The first two of seven recommendations were "Evaluate and improve evacuation order communication techniques to optimize public response" and the second was "Work with NOAA to increase watch and warning public awareness" (slide 6).

The Problem

Graphical depictions of impending storms are used to warn populations at risk. While the graphics are products of significant scientific measurements and prediction models, the graphics themselves have not been extensively examined for how they are interpreted or what they mean to the general public. The search for meaning implies a "…recognition that there is an intention on the part of the producing agent" (Barbatsis, 2005, p. 273). The first part of the equation is how the creator wishes his or her verbal or visual text to be read or understood. The second part is what the viewer constructs from the text. For example, both the intention and reception of the meaning of certain graphics are tacitly accepted in the world of science. In what Kostelnick and Hassett (2003) refer to as discourse communities, both creators and viewers of scientific information are familiar with the rules or conventions used to visually present concepts or ideas. Understanding of conventions is often gained through professional education and helps to build agreement between creators and viewers of how concepts are visually displayed.

Public relations practitioners and organizational communicators often use standardized conventions of layout and design in their communication products. Additionally, they use graphics to highlight points or to explain concepts. It is assumed that the graphics add clarity to an issue, but can we be sure without examining what the author/designer intends to convey and what the audience interprets? Agencies must go beyond merely tracking how their informational products are used and even how they are perceived. If communication is to be truly effective for organizations such as the NWS in fulfilling their mission, they must find a way to measure whether their publics understand the particular storm information they receive. Specifically, the NWS must be cognizant of whether there is a consensus between the agency and the public on the intended meaning and public understanding of NWS graphical products.

During the 2004 hurricane season, there were indications that one NWS forecast product was misunderstood by the public. In response to customer requests to "modify its

Tropical Storm Track and Watch/Warning Graphic," the NWS queried nearly 1,000 product users on their preference for two alternative graphical designs (Appendix A). The new graphics were rejected because the "majority of respondents prefer to maintain the current format" (NOAA Press Release, April 9, 2005, Appendix B). This survey, and others, seems to indicate that NWS' focus has been on the customer perceived effectiveness, ease of use, and feature preference of the new graphics. In an effort to measure customer acceptance of proposed watch/warning graphics, it appears the NWS outreach efforts have centered on customer satisfaction rather than the basic measurement of understanding – specifically relating to the center or forecast track line.

Purpose of the Study

During the 2004 hurricane season the news coverage of the storms was intense, and three Florida papers were nominated for their staff work and coverage of *Hurricane Charley* (Pulitzer Prize Board, 2005). Some Florida television stations received good marks for their coverage as well. However, many of the same stations were also criticized for later use of overwrought graphic images. It was one commonly used graphic, the NWS Tropical Cyclone Track and Watch/Warning Graphic, though that raised particular concern.

The graphic in question had been used for a number of years and is a "cone" that depicts the area where the storm is located and where it may go. This graphic has been referred to as the "cone of uncertainty" (Stone, 2004). In 2004, the design and use of this graphic (see Figure 1) was reexamined by the National Weather Service (NWS) and its parent organization the National Oceanographic and Atmospheric Administration. It came under scrutiny because, according to some, it has been misinterpreted by the public and failed to “warn” residents of Punta Gorda of the probability of *Hurricane Charley’s* landfall (Holleman, 2004). Although the graphic clearly showed Punta Gorda within the “cone of uncertainty,” many residents relied and focused on only one aspect of the graphic, the center black line that indicated a more westerly and northerly landfall – “they just hadn’t understood” (Holleman, p. 1). However, the media were blamed as well (Holleman, 2004). Newscasters had predicted a landfall in the Tampa, Florida, area, but “the hurricane suddenly changed course and headed inland just north of Ft. Myers, devastating the barrier islands of Sanibel and Captiva (and splitting North Captiva into two islands) and churning up Charlotte harbor to wreak havoc in Punta Gorda” (Radio Business Report, 2004, p.1). It seems broadcasters were focused on the center black line, as well.

The thin black line in the center of the cone (Figure 1) represents the most probable path of a particular storm based upon a combination of computer projections and the activity of past storms (NWS, 2004, National Hurricane Center Forecast Verification). However, the NWS considered removing the black center line in 2004 because, as Stone (2004) reported, they were “concerned that too many people focus on that narrow corridor and don’t adequately consider the more wide-ranging impacts of tropical storms and hurricanes” (Stone, 2004, p. 1) That “line of deception” (Stone, 2004) however, remains in use even after receiving public comment on two alternative NWS graphics without the center line.

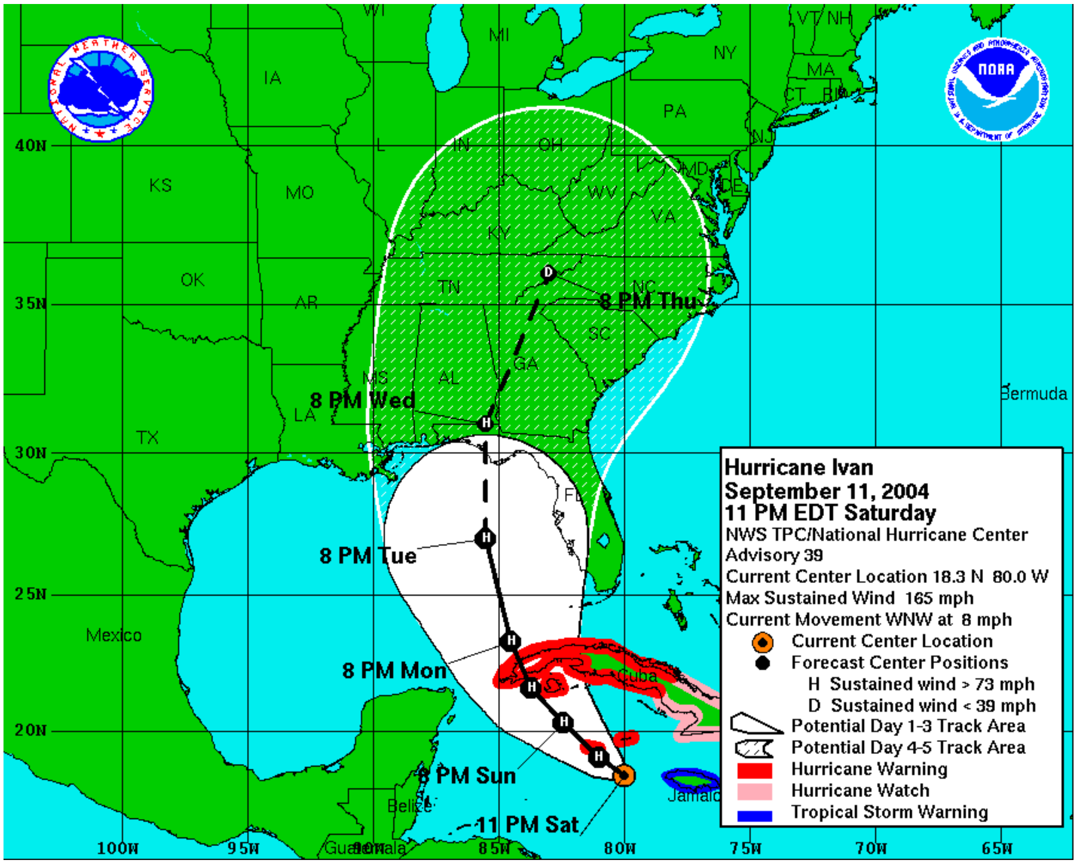

Figure 1. Tropical Cyclone Track and Watch/Warning Graphic

From Alternative Tropical Cyclone Graphics: Solicitation for Comments (2004). NOAA National Weather Service. Retrieved March 1, 2005. http://www.nhc.noaa.gov/graphicsprototypes.shtml.

If the NWS had conducted research oriented on understand and meaning, would it have spent the time and money designing the alternative graphics that were eventually rejected by the majority of their users? This study is an examination of whether the NWS designers and their publics are in fact in agreement about the meaning of the tropical cyclone graphic. Using two graphics and two questionnaires, this study used instruments that attempted to measure several variables including whether the general public trusts the NWS. It also sought to measure if the public has the general knowledge of weather-related terms and the ability to discern graphic conventions that are implicitly assumed by the NWS graphic designers. This research also sought to determine if the NWS and the general public agree in their interpretation of the graphics, if they think they share an understanding, and if they know it.

Organization of the Study

This study begins with a discussion of the panoply of theories that seek to explain how the media help us make sense of our world. Opening with the theory of reality as a social construction, the literature review follows with the premise that the news media act as one social institution that shapes our reality – specifically through its depiction of scientific information. This discussion spotlights a few of the myriad factors that may affect our perceptions of reality and risk. By highlighting these confounding influences, this review will illustrate how difficult it is for organizations such as the NWS to either predict or measure the effects of their warnings. However, before working to determine which of these theories might be used to explain how we understand these warnings, this study seeks to demonstrate that it may be better to first determine whether there is a consensus of understanding. This first practical step could be an alternative for organizations seeking to measure audience cognitions and sense making. Measuring levels of consensus also could provide a better basis for later analysis and also prevent misunderstandings.

The intent of this study is to examine how the use of graphic design conventions impact the public's interpretation and understanding of scientific information, specifically as it relates to the probability of the landfall of a tropical storm or cyclone. It is possible that the visual conventions used in the creation of a hurricane graphic are not interpreted by the general public as they are intended by the designers.

It is only with the “inclusion of data from both sides of the relationship” (Broom, 1977, p. 118) that the effectiveness of communication can be measured. Considering that the NWS is “the sole U.S. official voice for issuing warnings during life-threatening weather situations (NWS Strategic Plan, 2005, p. 1), it is imperative that it understands the information needs of their customers. NWS products must be understood as they are intended by designers if populations at risk are to fully understand critical information relevant to their immediate situation.

By applying a coorientation measurement model (Broom, 1977) to the understanding and intended meaning of storm graphics, this study aims to assess whether there is a consensus in understanding between the makers and viewers of two graphical depictions of a tropical cyclone and its path. By isolating and measuring consensus of understanding of aspects of graphic conventions such as map reading and scale, this study seeks to offer insight into the foundations of the NWS/public consensus or disagreement.

CHAPTER TWO: LITERATURE REVIEW

Introduction

It seems incredible that a graphic drawing consisting of a cone-shaped figure superimposed over an outline of a landmass can provide enough information to convince people of a dangerous future occurrence and motivate them into action. However, the National Weather Service and mass communication media use such a graphic tool every summer to warn citizens of impending hurricanes. What makes believers out of viewers is a complicated and not completely understood process. Myriad communication constructs, including cognitive theory, narrative theory, media aesthetics, and reception theory, may explain how we create, see, interpret, and derive meaning from words, sounds, and pictures such as the cone. This study operates from the premise that the construction of the graphic and the context in which it is presented affect peoples' perceptions.

Reality as a Social Construction

In their seminal work, *The social construction of reality*, Berger and Luckmann (1966) posit that we base our beliefs of how the world works and what is real upon what we are taught as children through a variety of cultural institutions and adult experiences.

One very important aspect of this common reality, according to Berger and Luckmann (1966), is that it is continually shaped by a dialogue that navigates between an individual's perception of the world and that of others. "The reality of everyday life is taken for granted as reality. It does not require additional verification over and beyond its simple presence" (p. 23). This reality may be questioned or challenged, the authors argue, but suspension of belief only occurs with a deliberate effort. In the case of severe weather, convincing a population to evacuate may be more difficult when the same population previously survived or thought they survived a hurricane conditions.

More often however, hurricanes and other potentially devastating phenomenon represent a reality that is beyond our everyday existence. These enclaves of existence are often the realm of the scientists and they use language and symbols to help bring to us regions that are otherwise unavailable to us (Berger & Luckmann, 1966). Satellite images and vector graphics are such symbols and the mass media is often the vehicle that connects our world to the world of science.

The mass media, however, is not a benign medium. According to Tuchman, (1978) news is also a social construction. When the media present information as news it is the result of personal and professional routines and influences. According to McNair (1998) the presentation of facts only becomes journalism "when they are given meaning and context – when they are transformed into a story or narrative – by an author" (p. 5). The presentation of thermometer and barometer readings, according to McNair, "tell us something about weather on a given day, but does not tell us a story (and is not journalism)" (p. 5). It becomes storytelling and journalism when those readings are offered in context around a "set of assumptions, beliefs and values" (p. 5). When weather is presented in a narrative as either 'good' or 'bad' value judgments are introduced. They then become part of a framework that aids us in giving meaning and context to events beyond our immediate sensory experience (McNair, 1998). Extending his argument, McNair (1998) suggests that:

> a hurricane is news not because it exists but because it threatens the social organization of human beings somewhere on the planet. The natural world is newsworthy only in its interaction with the social. It is only when the natural world intervenes in or interferes with the social worlds of human beings does it become the subject of news as opposed to the preserve of science (p. 8).

Journalism, McNair (1998) claims "is revealed truth, *mediated reality*, an account of the existing, real world as appropriated by the journalist and processed in accordance with the particular requirements of the journalistic medium through which it will be disseminated to some section of the public" (p. 8). This argument supports Tuchman's premise that news production is a social construction of reality. An implication of McNair's perspective of journalism is that the reporting of hurricanes is a mediated reality for those who see, hear, and read news reports.

Science in the News

Despite five days of warning, many Floridians were surprised by *Hurricane Charley*. Three days after the August 13, 2004, landfall in Punta Gorda, a USA Today headline proclaimed that the "Storm's course, force catch many Floridians unprepared" (Storm's Course, 2004, p. 1). The Category 4 storm that pounded homes with 145-mile-per-hour winds was expected to hit Tampa, approximately 100 miles to the north. One resident, quoted in the article said, "I was surprised it hit here….They all said it was going to hit Tampa. Then it turned" (p. 1). She was not the only one to cite newscasters' predictions as the reason for surprise but members of the National Hurricane Center claimed that the last minute shift in the direction was not abrupt and that it was still within the "cone of uncertainty" forecasters use to predict storm tracks.

How can there be such a difference of opinion between forecasters and residents? What is obvious to scientists is often oversimplified by newscasters and ultimately misunderstood by the public. The presentation of scientific and technical information in the news is subject to the same pressures as other areas but, Nelkin (1987) purports, science has a special place in America.

Nelkin (1987) suggests that "fair, critical and comprehensive reporting about science and technology is extremely important in a society increasingly dependent on technological expertise" (p. ix). The author contends that media coverage of science falls short of that measure and points to the "relationship between the two influential social institutions of science and the press" (p. x) as one area that needs analysis. One area of analysis is particularly significant, namely, the link between story selection and the financial benefits this can bring (Bliss, 1991; Nelkin, 1987).

Even though science and technology are receiving more coverage, Nelkin (1987) argues that the public has a distorted view of science and technology. Homogeneity in science journalism may be one culprit for the lack of understanding because "most articles on a given subject focus on the same issues, use the same sources of information and interpret the material in similar terms" (p. 9). This is another example of institutionalization of news in that "journalists are bound by similar cultural biases and professional constraints." (p. 9). Scientists themselves are part of the mix in how science is portrayed in the press. "The images of science and technology conveyed to the public reflect the characteristics of the journalistic profession, the judgments of editors, and above all, the controls exercised by the scientific community" (p. 12). Both professions seek to "control the agenda of public communication" (p. 12).

Nelkin (1987) traced the history of press coverage of a number of medical products and techniques including lobotomies and estrogen therapies for menopause. In each of the cases, Nelkin cited the initial "uncritical enthusiasm" (p. 47) of the topic by science writers. For example, reliance on a limited number of experts resulted in early stories that characterized lobotomy as "no worse than removing a tooth" (p. 48). This style of reporting, Nelkin contends, is the result of the aggressive marketing efforts of sources combined with a reporter's desire to deliver good news. "Academic, industrial, and research institutions are eager to promote the latest technologies and therapeutic techniques, and many reporters simply convey their stories of success - especially if they fit with prevailing hopes or beliefs" (p. 52). This heralding of new technologies without discussion of their limitations can be seen in the television promotion of weather forecasting tools such as Doppler radar and vector graphics. These tools might illustrate more storm information; however, without adequate explanation, they can be confusing to viewers (Van Wagener, 2004).

Proclaiming technological success, Nelkin (1987) suggests, is easier than explaining the downside of the risk. "Norms of objectivity and fairness encourage reporters to balance different views - to give a technology's critics and proponents equal time - but such efforts expose them to criticisms from both sides" (p. 54). Some coverage of issues, such as that of fluorocarbons in the 1960's, was characterized by industry as "biased" and "sensational" (Nelkin, 1987). "Yet, with some notable exceptions, we seldom read about the scientific issues involved in risk disputes or methods of risk analysis. Thus we are left with no basis for making meaningful judgments about competing claims" (p. 54). Until the recent surge in the number of weather related websites such as *weather.com* and *intellicast.com* viewers had far fewer outlets to gain information about approaching storms. While these websites provide more venues with better graphics, much of the content is based upon the same information sources as radio and television news, the NWS and the National Hurricane Center.

We want science to decide for us, to give us a definitive answer to our dilemmas. This desire is the result of characterizations of science as an institution that "can provide definitive answers about risk, that 'facts' speak for themselves rather than being open to interpretation and that decisions about what risks are socially acceptable are scientific rather than political judgments" (Nelkin, 1987, p. 59). Nelkin (1987) points to the word choices and metaphors used by journalists for affecting how we view technology and science. These word choices, Nelkin (1987) argues, results in the conveyance of beliefs about institutions like science by "investing them with social meaning and shaping public conceptions of limits and possibilities" (p. 11). The lack of general information about what constitutes a particular risk leaves many citizens dependant upon the coverage an issue may receive. In the case of an approaching hurricane, how viewers perceive the treatment of an imminent storm may be the result of how it is characterized in a newscast. This characterization of a storm, as powerful or non-threatening, may have an even larger impact on viewer perception of risk since, according to Kreimer (1980) many people do not have an understanding of the concepts or terms used by weather forecasters. Many, Kreimer (1980) suggests, fail to even understand the differences between common weather terms, such as *watch* and *warning* or scientists' use of the word *bulletin.* "In esoteric areas of science and technology where readers have little direct information on preexisting knowledge to guide an independent evaluation (e.g., the effect of fluorocarbons on the ozone in the atmosphere), the press, as a major source of information, in effect defines the reality of the situation for them" (Nelkin, 1987, p. 77).

Unless we hear from someone who is currently experiencing a storm predicted to visit us, we must rely upon the media and organizations such as the National Weather Service to warn us of the potential of severe weather. While few would question the reporting of the measures of wind speed and barometric pressure, not everyone would agree on how those measures will affect us.

Communicating Risk in the News

Media are an important source of information about risk. "Most perceptions of risk are mediated by one of three sources: personal experience, direct contact with other people, and indirect contact by way of mass media" (Singer & Endreny, 1993, p. 2). The media affect the perception of risk through story selection and content. According to the authors, the "media select for emphasis hazards that are relatively serious and relatively rare" (p. 82). Risk is not covered as a separate issue but, according to Singer and Endreny (1993) is included as a part of other types of stories. This treatment, the authors assert, results in news stories about hazards that "ordinarily do not provide enough information for rational decisions" (p. 40).

In their 1988 study of media coverage of hazards and the coverage of risk in the news, Singer and Endreny (1993) found a number of discrepancies in the reporting of hazard stories based upon sources such as scholarly journal articles. One reason for these discrepancies, the authors argue, is because the routines of publication simplify science and render it more authoritative than it really is.

The adaptation of information results in an atmosphere where "scientists come across as more authoritative than they really are …[and]… scientific findings are regarded with more confidence than may be warranted" (Singer & Endreny, 1993 p. 158). When these findings are found to be in error or is not confirmed "it may undermine the credibility of the whole structure; and that confidence in the press, as well as in science, may suffer as a result" (p. 158).

When *Hurricane Charley* seemingly veered off course, many citizens faulted forecasters, but the director of the National Hurricane Center, Max Mayfield, placed the blame on the tendency of viewers to focus on the center black line of the center's graphic "cone of uncertainty." Mayfield is quoted in a Virginia Pilot online story:

> The black line in the graphic places too great an emphasis on the iffy computer analysis of a storm's potential path, which is especially problematic when it shows landfall several days in advance. Too many people take that as gospel when all such forecasts have a margin of error. (Stone, 2004, p. 1)

Another area of inconsistency in disaster coverage is in the attribution of blame (Singer & Endreny, 1993). The coverage varied according to the type of hazard reported. "For example, stories about natural hazards were particularly unlikely to include explicit attributions of blame" (p. 166). The authors found this tendency to be constant over time and across media. This finding supports Steinberg's (2000) argument that there are issues, such as unrestricted growth along coastlines, that contribute to increased losses but are rarely discussed.

Singer and Endreny (1993) make clear that their hypothesis that media influence audience perceptions of risk is only one instance in the paradigm of media effects on cognitions and attitudes. However, they do assert that “knowledge and attitudes towards certain hazards are influenced by news coverage” (p. 4).

In their survey of risk perception research, Wahlberg and Sjoberg (2000) report that many scholars share the belief that the media influence risk perception. However, the authors conclude that the media’s role in risk perception may be less than previously thought. “Although many take media’s influence for granted, the evidence points the other way: even for heavy media users, media are probably not a strong causal factor in (especially not personal) risk perception” (p. 31). Wahlberg and Sjoberg (2000) contend that risk perception may be affected by the amount of information viewed but that those effects are mitigated by personal experience. They differentiate between personal and general risk perception and posit that “general risk perception is more easily changed than personal risk perception” (p. 35). The authors reviewed studies that refer to third person effect as well as a variety of other mass communication and related theories and hypotheses. Their content review also examined risk perception through the lens of social amplification theory, impersonal impact hypothesis, and cultivation theory. Wahlberg and Sjoberg (2000) summarized the results of their review:

> (1) Media content: The content of the media is far from objective when it comes to risks, but it is also far from being as biased as has often been thought, both in frequency of reporting about and in presentation of hazards. One of the certain shortcomings of media is that they often present facts outside their contexts, and leave to the public to evaluate them.

> (2) Media influence: Yes, the media do influence (some of) our risk perceptions, but they are only one factor among many.
>
> (3) Availability: Media's most fundamental way of altering people's risk perception is possibly by number and vividness of articles/features. As risk almost always carries some notion of probability and people use availability to estimate this probability, this notion is central to the effect of media on risk perception.
>
> (4) General and personal risk: Media can have an influence on general risk perception, but personal risk judgments appear to be very resistant to change from this source. Direct information from people about their experiences is a much stronger factor, as is personal experience. (p. 44)

Included in Wahlberg and Sjoberg's (2000) review is a comparison of risk perception by type of communication. "When it comes to risk communication, it is uncertain whether intentional information and media campaigns have an impact on risk perception that differs from that of the unintentional risk information that news and entertainment supply" (p. 44). Understanding the difference between these two delivery formats may be of importance to Florida broadcasters who produce hurricane preparation guides and seminars. Although Wahlberg and Sjoberg warn against equating risk perception with resultant behaviors, they highlight some interesting cases such as the 1992 study by Soumerai et al. The study dealt with the media warnings linking aspirin to Reye's syndrome in children. Soumerai, et al., (1992) found:

> the incidence of the disease went down to almost zero, and remained that way while the interest of mass media faded. What happened was presumably that

> people reacted to the risk and changed their behaviour, e.g. they no longer gave aspirin to youngsters with a viral disease, the ‘at-risk’ group. The main risk communicator in this instance must have been the media, as warning labels did not appear on aspirin bottles until after the change, and there were no other mass communication channels at work. (p. 42).

Among these studies and findings, Wahlberg and Sjoberg (2000) highlight a popular concept that the media are only one source of information that we use to form our opinions and make decisions. However, Wahlberg and Sjoberg (2000) do support Singer and Endreny’s (1993) argument that the public does not get all the information it needs to make rational decisions. “The media report about different hazards without putting them in a context or perspective, and often without explaining technical terminology used. The public is left to form its own opinion about the risk based on rather scarce information” (Wahlberg & Sjoberg , 2000, p. 34). In the case of hurricanes, viewers may not remember storm specific terminology such as watch or warnings, and without the aid of map legends or explanations are left to guess at their meanings.

In addition to a scarcity of information about hazards, some disaster researchers have accused the media of perpetuating myths. Quarantelli (1989) argues that while “journalistic accounts seem to stress the negative about individual behavior, there is a tendency to focus on the positive about organizational behavior” (p. 7). Many organizations that come to assist in a disaster, the author argues, often add to the problems at hand. “In fact, one point more often stressed in the literature is that the organizations that converge to help in the emergency situation are frequently not only the locus, but also the source of the problem” (p. 6). This reluctance to point out negative aspects of organizational behavior could lead to a belief, by those without direct personal experience, that our governmental organizations such as Federal Emergency Management Agency (FEMA) are effective and efficient when responding to the needs of populations in crisis - even if that is not the case.

Another theme Quarnetelli (1989) identified in his review of disaster literature is that story content “in media reports of disaster do not reflect reality but are a matter of social construction in the sense that Tuchman (1978) and Altheide (1976) argue is true of most news” (p. 14). While many scholars (Quarantelli, 1989; Wahlberg & Sjoberg, 2000) agree that disaster stories are more factually accurate than previously believed, there is also agreement that the media tend to focus on the most extreme cases of disaster and injury. This inclination to highlight the more graphic examples of pain and destruction may skew our perceptions of what happens in a disaster situation. This tendency also may affect our perceptions of what constitutes a disaster as well. “In fact, many researchers working in the area appear to believe that the definitional process of mass media considerably determines what comes to be or not to be defined as a potential or actual disaster” (Quarantelli, 1989, p.14).

News room routines, including print’s news holes and broadcast time restraints are only two of a multitude of factors that determine what is printed or aired. If a storm is not due to hit a station’s coverage area, it will probably be relegated to a less prominent spot. The decreased coverage does not lessen the size or strength of the storm, but its definition as a threat to life and property will be diminished for the local viewing audience. Risk is relative and its coverage is as well. Whether we heed a media warning also will have to do with how much influence mass media have in our lives.

Media Systems Dependency

How important a role the media play in the development of our sense of reality or our perception of potential threat is affected by how dependent we are on the media for information about our world. Media systems dependency theory is broadly defined as an "idea that the more a person depends on having needs gratified by media use, the more important the media's role will be in the person's life and, therefore, the more influence those media will have" (Baron & Davis, 2003, p. 320). The theory looks at dependency from both a societal and individual point of view. At the macro level the dependency can be explained as a result of increasing social complexity (Perry, 1996). "As societies increase in complexity, the media theoretically tend to perform a greater number of unique functions. Many of these functions differ according to how central they are to society or to groups of its members" (p.60).

This dependency also can be seen from an individual point of view where people make use of media to help them make sense of the world. Media systems dependency theory, however, measures dependency or importance in one's life as a factor of its impact (Baron & Davis, 2003). While "it has not been conclusively demonstrated that the experience of media dependency by average people is strongly related to a broad range of effects" (p. 321), the theory is useful to examine media use and effects during times of turmoil or change. During uncertain times people can become more dependent upon media because people's existing social networks are unable or unavailable to deliver necessary information (Perry, 1996).

"During a severe social disruption there is an unusually high need for information and sense-making by individuals. According to media systems dependency theory, the mass media are generally perceived to best satisfy these needs" (Wilson, 2004, p. 339). Although many scholars cite an increase in media usage and dependency during uncertain times (Baran & Davis, 2003; Hindman, 2004; Quarantelli, 1989), Wilson found, in a 2004 pilot study, that although "the degree that people rely on the media for information is heightened during crises, this is not constant across individuals" (p. 339). In his study that examined dependencies on media after the September 11, 2001, terrorist attacks, Wilson found that "perceived threat and age are the key predictors of overall media dependency, and threat is a particularly important predictor on interpersonal communication about the event" (p. 339).

Whether we are old or young, our perception of reality is bound by both our physical being and our emotional history. How we see things is no exception.

Visual Perception

How we process information depends on how we receive it. Some researchers purport that we receive approximately 80 percent of our information visually (Berger, 2002, p. 1). Many think that the eyes are merely lenses that record images of reality, but scientific evidence indicates that we first process visual information through an emotional part of our brain (Barry, 2005). Vision becomes perception, "the process by which we derive meaning from what we see, is an elaborate symphony that is played first and foremost through the unconscious emotional system" (p. 46). Barry (2005) argues that this emotional processing is "essential for meaning" and is often affected by traumatic events. It remembers past experiences and uses them to react quickly to the similar stimuli. "The greater the impact of the emotional experience, the more deeply the emotional memory is etched" (p. 59). Repetition also works to affect the unconscious memory. “Because our mammalian brain interprets media images as reality and responds emotionally according to the circumstances presented to it, understanding perceptual processing has significant implications for media effects” (p. 59).

In addition to cognitive explanations of visual communication, narrative theory also argues that past experience is the key to media consumers finding media content credible. “Television is the most important storyteller in contemporary life” (Zhou, 2004, p. 237). In a good news story we learn about a significant event. It explains that event in a context that gives readers something to connect the salience of the event to meaning in their lives. Storytelling or narrative “is a way of making sense of the world” (Barbatsis, 2005, p. 329). Television, newspapers, and the WWW, use both narrative and visual texts to explain events. However, to believe the information these media provide, that information must fit with people’s preconceived ideas of the world. “[A] good story makes good sense if its arguments fit with what we know of experience” (p. 333). However, Zhou (2004) points to past studies that “paint a very dismal picture of television as a journalistic and informational medium” (p. 237). Part of the problem lies in how stories are constructed and information is presented. As Messaris and Mariarty (2005) note:

> Understanding a visual image occurs on two levels. On a more fundamental level, understanding involves applying a constellation of basic perceptual principles to the acquisition of meaning from what we see, whether it be a sign, an image, or a graphic representation. On a different, perhaps higher, level, understanding involves deconstruction of the intended meaning in terms of techniques used by the producer of the image to simulate or manipulate certain responses. (p. 483)

Whether residents of Florida and other hurricane-prone areas will evacuate in advance of a predicted storm is dependent upon a number of factors - one of which is how information is processed (Ledingham & Walters, 1989). According to authors, the answer is “related to many variables, including information source and credibility, media use, perceived media accuracy, differing functions of different kinds of communication, the effect of past experience, evacuation decision making, and ethnicity” (p. 35).

Other factors, such as how information is packaged on the news, can also affect viewers’ perceptions. In an online article, Poynter Institute Design Editor Van Wagener (2004) pondered the effect of constantly watching radar graphics during the 2004 hurricane season in St. Petersburg. “The difficulty with many of the local graphics was that they lacked context and explanation. For instance, one could assume that the arrows illustrated wind direction or speed. However, in a high-stress situation, important information could get lost.” Van Wagener worried that the graphics were hard to understand and that they could distract from information vital for survival. Though less noticeable than the high-tech weather graphics, other production techniques also can affect our perceptions.

Media Aesthetics

Applied media aesthetics examines effects of media production techniques on perception (Zettl, 1998). Media variables of lighting, camera movements, types and angles of shots, and sound have effects on how we “see” the world through television and film. Variables such as font, typeface, and paper thickness and texture are most commonly related to print media. However, photo composition variables such as depth of field, cropping, and color balance are also used in television and film. Audio effects such as echoes, channel separation, and channel balance affect quality in radio, television, and film production. Many of these variables generally go unnoticed by the reader or viewer but both producers and audience need to be cognizant of how these techniques can shape our perception of a news item. These media effects, such as the repetition of quick-cut video showing past storm devastation, could act to capture viewer attention, but they also may increase stress in an already nervous audience. “A growing literature reveals that people's ability to learn and recall information is negatively affected by stress” (Thompson, Williams, & Cornelius, 2001, p. 611).

Other factors contribute to what we see. According to Chandler (1997), there are key factors to reflect on when considering visual perception. Two of these factors are the distinctiveness of human vision and the importance we place on our sense of sight. Humans see the world differently from other animals because of the structure of our eyes and the percentage of our brain that is dedicated to processing that information. The importance or primacy we give to sight can be traced to Plato and Aristotle and is evidenced by such expressions as *seeing is believing* and our desire to make sense of what we see. This desire to make meaning, according to Chandler (1997), is fundamental to our visual perception. We look to make patterns out of essentially meaningless visuals and make judgments as to our “reading” of them.

> Some images are more open to interpretation than others. Most of us would see no 'intended reading' in such natural phenomena as flames and clouds (though this wouldn't stop us seeing meaningful patterns in them). We would generally accept that there is typically less openness to interpretation when it comes to images deliberately designed by human beings. The declaration that a road sign is 'open

> to interpretation' is not likely to be much of a difference for ignoring its intended meaning in the eyes of the law! On the other hand, we would usually feel free to be fairly free-ranging in our interpretation of an image which we knew to be intended as a work of art. (Chandler, 1997, p. 1)

Weather scientists' foremost concern is the accuracy of their forecasts, but they also must consider the *accuracy* of the *perceptions* of those forecasts. If a weather graphic is to be disseminated outside of professional communities, a primary concern should be that viewers and readers get the message that officials consider important. Determining what variables can contribute to this "sense-making" is central to reception theory, which suggests that instead of looking at what something means we should look at "how something means" (Barbatsis, 2001, p. 273) as a result of interaction between the reader/viewer and producer. "A question of how something means implies, instead, recognition that there is intention on the part of the producing agent –a painter, a director, a photographer – about how she wants a text – her painting, film photograph –to be read" (p. 273). The second part of the equation is what the viewer constructs from the text.

The literature offers a number of theories for why people perceive the graphic differently. How and what a NWS designer decides to include in graphic depictions of hurricanes and their paths, in what context the graphic is presented, whether there is an explanation by the announcer, the context of its presentation, or even which fonts are used to describe the content can all have an effect on the meaning viewers or readers make. However, even if the presentation of a graphic were standardized, there is still the matter of the viewer.

How people "read" the graphic will be related to their previous experiences (Barbatsis, 2005). Those past experiences are shaped by factors such as age and sex, as well as where they live and the work they perform. Learning to *read* certain types of graphical representations is often the result of acceptance of conventions or rules. These devices or techniques are akin to rhetorical ones and provide an "…interpretive safety net for readers and designers" (p. 193). Kostelnick and Hassett (2003) call for an understanding of visual language that relies on codes to normalize its meaning.

> … visual vocabulary is acquired by users - both the designers who deploy conventional codes and the readers who interpret them. Users are socialized in conventional practices, sometimes through formal training, oftentimes through a process of informal enculturation, until the conventions become habits of mind. Once learned, conventions perform an invaluable service for users by supplying the cohesion that makes visual language familiar, accessible, and imitable. For designers they supply a wealth of ready-made forms that can be adapted to specific situations; for readers, they supply interpretive short-cuts to making meaning. (p. 23)

These conventions are easily identified by users in what Kostelnick and Hassett (2003) refer to as "visual discourse communities" (p. 26). These community members are often trained in the methods of their professions. Engineers easily navigate construction plans, and electricians understand the intricacies of an electrical diagram. But these users have come to their understanding through education and experience.

> …students in agronomy learn how to read soil diagrams; in forestry tree plots and maps and in meteorology, color-enhanced satellite photos. Conventions codified

within disciplines provide a cohesive visual language because the group members share interpretive frameworks that result from their shared learning. (Kostelnick & Hassett 2003, p. 26)

A disconnect can occur, however, when these conventions are used visually to communicate with members outside their communities. Many a parent can attest to the Christmas Eve frustrations of navigating unintelligible assembly instructions based upon engineer drawings. Yet, we depend upon and follow information conveyed by visual design conventions every day. International signs depicting restrooms, two-way roadways, and the yellow triangle of danger are easily understood by many of us. Trouble occurs when we have not been exposed to and learned what these conventions represent.

Conventions “serve readers by providing a collective shorthand for interpreting information” (p. 180). Within discourse communities, the designer and the reader develop what Kostelnick and Hassett (2003) refer to as a quasi-social contract. When conventions are ignored or misused, readers are often confused. A letter typed in all capital letters without punctuation or a telephone book listing numbers numerically will unsettle us or lead us to give up on the reading. Other printing conventions, such as headings help us discern an article’s organization and spot color, help readers scan for important information.

The context in which we view visual information is extremely varied. Kostelnick and Hassett (2003) note that “readers seldom encounter visual language in perceptual, social, or historical vacuums” (p. 3). To achieve mutual understanding, the authors suggest, there must be a cooperative relationship among designers and readers. It is this social contract beneath design conventions, Kostelnick and Hassett (2003) contend, that allows readers to “reliably use their prior experiences as compasses for interpreting conventions” (p. 180). While some interpretations of visuals may be outside of a designer’s control, there is also an opportunity for the misuse of conventions. This can happen, according to Kostelnick and Hassett (2003), when conventions are used “as if they were a neutral, unmediated display of the facts [that] may lead readers to mistake the artificial for the natural, skewing their interpretations” (p. 182). It is this shaping of information for rhetorical ends that makes visual communication a powerful vehicle.

Kostelnick and Hassett (2003) point to the simple pie chart as an example of how design conventions can be used to affect perceptions. If used to display the character and incidence of workplace injuries with the number of serious accidents displayed as a small dark slice, then the design conventions equating size to significance

> removes the reader from the gruesome reality of the situation…..Because the conventional display portrays the problem of accidents causing long-term disabilities as only a marginal, thin slice of all workplace accidents, the design implies that the problem must barely exist. (p. 183).

It is not the data but how data are displayed in the genre of pie chart that determines the visibility of the problem. “Depending upon the rhetorical stance of those deploying the pie chart, the thin slice either protects them from having to address the problem or weakens their argument that it must be solved” (p. 184).

Understanding the processes involved in visual communication can help institutions like the mass media develop methods to prevent miscommunication. Others, who rely on the media to disseminate their messages, should be cognizant of their effects as well.

National Weather Service and Public Relations

The NWS 20005-2010 strategic plan motto is *Working Together to Save Lives*. In that document the NWS claims the role as the "sole U.S. official voice for issuing warnings during life-threatening weather situations" (p. 1). From a public relations perspective these two activities place the NWS in the realm of relationship manager and crisis communicator. While a vast amount of its work is in the formation of a database for public and private entities, it is its role as the provider of weather, water, and climate forecasts that is of primary interest for this study. It is also in the performance of is crisis communication function that it is most visible to the general public.

Identifying and defining publics may be central to public relations practice, but relations and relationships are what separate public relations from marketing and advertising. According to Ledingham (2003), "the appropriate domain of public relations is, in fact, relationships" (p. 194). How organizations interact and communicate with people inside and outside of their organization will characterize their relationships. In public relations practice one goal is to identify, manage, and measure these relationships. Theoretically, they are dissected and examined, and new and better ways to build them are proffered. Ledingham believes this relationship management perspective deserves to be a general theory of public relations that can be used as a foundation for research. The author's proffered theory of relationship management is based upon the premise that "public relations balances the interests of organizations and publics through the management of organization-public relationships" (p. 181). Ledingham (2003) contends that "effectively managing organizational-public relationships around common interests and shared goals, over time, results in mutual understanding and benefit for interacting organizations and publics" (p.190). That management, however, extends beyond communication and must include behaviors of both the public and organization (Ledingham, 2003). These behaviors include "public relations functions such as special events, public affairs, development, and press relations," which Ledingham distinguishes from the communication production of news releases and annual reports.

This community interaction and the quality of relationships are key to 21st century corporate success (Wilson, 2001). Wilson predicts that "relationship building will be a strategic function directed by public relations but engaged in by key corporate leaders who participate in building productive relationships emphasizing communities of mutual support and cooperation" (p. 524). This communitarian perspective calls for practitioners to view "all of the organization's publics in terms of the communities we have in common" (p. 525) and follows Moffit's (2001) collapse model where the search is for shared attitudes and behavior. Communitarian philosophy "asserts that the provision of [individual] rights requires responsibility on the part of all members of the community" (p. 523), and businesses must be a player in solving society's problems. For this to happen in the United States, Wilson (2001) argues, businesses would need to "shift from typically bottom-line thinking and evaluation to a more communitarian approach to business and society" (p. 521). Public relations professionals are in the best position to "counsel management on making this shift in strategy" (p. 524). Through their efforts to encourage corporate participation in the community because it is the "morally responsible" course, "public relations counselors will become the organization's conscience in ways never before imagined" (p. 525). Maintaining the moral high road can have dramatic effects on the reputation and viability of organizations, especially in time of trouble.

The NWS and especially the National Hurricane Center, an operational arm of the agency, are all too familiar with the challenges of communicating in times of trouble. They must take the information from their computerized models and deliver the official tropical cyclone forecasts and advisories. They must balance the “science” of forecasting with the propensity of some viewers to focus on a particular model (see NHC/TPC Forecast Model Background and Info, p. 1). The NWS releases only selected material because “our past experience indicates such plots have confused users and detracted from our final message…”(p. 1). Continuous environmental scanning and benefiting from lessons learned pays dividends for organizations like the NWS, especially in times of crisis.

Relationships and Crisis Communications

In times of crisis, established positive relationships, help organizations. According to Fearn-Banks (2001), Johnson and Johnson’s 1982 Tylenol crisis could have been much worst for the company. However, its established relationships with its publics prevented loss of its good reputation. “All of the stakeholders stood by Johnson & Johnson and remained loyal. .. .and this case remains one of the prime examples of how relationships and honesty can help an organization through difficult times” (p. 482). This crisis also ignited an interest in crisis communication planning and identification of best practices often based upon the excellence theory of public relations (L. Grunig, J. Grunig, & Dozier, 2002). These ongoing organizational best practices range from including public relations managers as members of the dominant coalition to developing strong media relationships.

These types of practices have been found, according to Fearn-Banks (2001), to help organizations in measurable ways. Organizations are more likely to "suffer less financial and reputation damage" and "are in a better position to prevent a crisis" or "will suffer less and recover more rapidly from a crisis (p. 481). What constitutes a crisis, however, is often viewed from the position of the organization. The literature seems to offer fewer suggestions for how an organization should or could be ready to respond to a crisis from the perspective of its publics or stakeholders, which could be seen as the critical ingredient of Johnson & Johnson's 1982 success. "At the time, [Johnson & Johnson] did not have crisis communication preparations, although it did live by the company credo that served as a crisis guideline" (p. 484). That credo, according to Fearn-Banks (2001), "spelled out the company's priorities in order – consumers (including medical personnel, employees, communities, and stockholders" along with the company's "already … strong relationships with all their publics helped the company through the crisis " (p. 482).

Not all crisis situations can be predicted, but some general themes about how people react to crisis or disaster can offer more support to an organization spending time developing relationships and multiple modes of communication. In a survey of literature examining citizen response to disasters, Helsloot and Ruitenberg (2004) identified factors that affect how people respond. The perception of risk of disaster, the character of the threat, and a community's previous experience all play roles in citizen response. However, the authors contend, "the best predictor of behaviour in emergency situations is the behaviour prior to the emergency situation" (p. 105). In times of crisis, they recommend organizations use existing structures to their fullest. The implication for public relations activities is that building redundant and formalized means of communication with an organization's publics will serve well in times of emergency.

While reliance on existing systems may help organizations on a practical level, understanding the complexity of a disaster or crisis better can be understood by applying concepts of chaos theory. Chaos theory "attempts to understand the behavior of systems that do not unfold in a linearly predictable, conventional cause and effect manner over time" (Murphy, 1996, p. 96). By definition alone, chaos theory appears as a perfect model to study our rapidly changing world, and it also "provides a particularly good model for crisis situations" (p. 105). Seeger (2002) agrees with that assessment and argues that chaos theory is becoming "increasingly popular as a meta-theoretical framework in the social sciences" that provides a "unifying framework that reaches across disciplinary lines" and spans fields from education and psychology, to economics and disaster management (p. 330). As a meta-theory for organizational crisis, chaos theory does not offer "the promise of simplistic black and white explanations and predictions" (Seeger, 2002, p. 336), but it does provide a more "realistic view of these disrupting, complex, and change inducing events." As the "scientific version of postmodernism" (Murphy, 1996, p. 96) chaos theory embraces the complexity of the world but also can provide a framework for issues managers to "show the interplay between factors as diverse as social concerns, news events, cultural values, and corporate goals, an approach which demands a high level of context sensitivity" (p. 103).

Berkowitz and Turnmire (1994) agree that identification of public issues does not always follow simple demographic characteristics and requires an organization to "proactively build an understanding of a community's issue orientations. This becomes challenging because segmentation does not always follow demographic characteristics alone and because the views of latent publics are difficult to detect" (p. 105). Issues management is "an ongoing two-way symmetrical program handled by the public relations department" (Fearn-Banks, 2001, p. 480). It seeks to "understand both the internal and external environments in which an organization operates" (Pratt, 2001, p. 337) and should provide an organization with an "early warning system" for emerging issues. However, scanning the environment for potential problems and formulating a plan to change or alter a public's opinion is not the only end product of issues management. The intent also should be "to change an organization's practices, making them more responsive to the public interest" (p. 336).

Responding to a public interest or need is often the role of nonprofit or governmental organizations such as the NWS. The Nonprofit Resource Center defines nonprofit organizations as corporations "formed for the purpose of serving a purpose of public or mutual benefit other than the pursuit or accumulation of profits" (http://www.not-for-profit.org/ para 1). A public benefit or mutual benefit implies "public" "relations" and, according to Dyer, Buell, Harrison and Weber (2002), nonprofit organizations have public relations whether they know it or not. However, the authors also claim that "the role of public relations in non-profit organizations is not well developed" (p. 13). In their study of nonprofit PR practitioners, the authors found many of the practitioners often performed a variety of non-public affairs type tasks. But many respondents in their study:

> believed that all employees made large contributions in support of public relations. In other words, everyone in the organization has a public relations responsibility. We believe this is true in the for-profit sector as well, but it is especially true in the non-profit sector because of the nature of their social service delivery and the constraints imposed by scarce organizational resources. (p. 20)

While the NHC/TPC does have a full time public affairs representative, the conferences, news releases, interviews, and weather center open houses attended and supported by NHC/TPC staff attest to a broad based support of public relations activities. These actions also show support for long-term NOAA and NWS educational goals of environmental literacy. To that end, the NWS conducts “outreach and education activities [that] are aimed at making sure the public understands the information we provide and can use it effectively in the decisions they make” (NWS, 2005, p. 1). These efforts, along with promoting myriad partnerships in government and private and public industry worldwide support good organizational relationships. Outreach efforts provide audiences or publics with explanations of NWS processes and products; however, they probably do not provide the specific feedback necessary to evaluate the effectiveness of their communications. “Public relations practitioners typically use public opinion survey results to assess the effectiveness of messages…” (Broom, 1977, p. 110). However, Broom (1977) argues that measurement must go beyond measuring levels of agreement on issues between audiences and organizations if “all the information needed to adequately describe corporate-public relationships on issues of mutual concern" is to be collected (p. 111).

According to Grunig and Hon (1999), "the fundamental goal of public relations is to build and then enhance on-going or long-term relationships with an organization's key constituencies" (p. 2). They proposed that it was only through the measurement of relationships that organizations can garner information that goes beyond particular public relations programs or events. To that effect, they proposed measuring relationships using six items; trust, control mutuality, satisfaction, commitment, and communal and exchange relationships (p. 26).

Thus, measuring the effectiveness of the NWS communications must go beyond measuring simple agreement of the issues relating to severe weather forecasts. It is also necessary that there are measures for levels of understanding of concepts and whether the NWS is seen as a competent, dependable, and principled organization. To adequately warn populations at risk, the NWS must know if they and their audiences share a common understanding of hazardous weather advisories and warnings. They also must know if their publics trust them to be up to the challenge of predicting and communicating that information.

Public Relations Measurement – Coorientation Model

While much communication theory and its practical applications in public relations examine the factors affecting how we communicate, it is the process of cognition and understanding that sets apart one theoretical approach. As first proffered by Newcomb (1953) and later Mcleod and Chaffee (1972), coorientation *theory* posits that "…people and organizations relate to one another successfully to the extent they think similarly about ideas" (Austin & Pinkleton, 2001, p. 271). The coorientation *model* allows for the measurement of those attitudes or impressions. Two parties reach a consensus of understanding when "both parties agree and know they agree" (Austin & Pinkelton, p. 63). Based on the presumption of two-way communication, coorientation is one research tradition in public relations (Botan & Hazleton, 1989). It is particularly salient for public relations practice, according to Grunig (1989), because it allows for the measurement of relationships.

The coorientation theory and model traces to Newcomb (1953) who posited that "communication among humans performs the essential function of enabling two or more individuals to maintain simultaneous orientation toward one another as communicators and toward objects of communication" (p. 393). Thus, *coorientation* is a relational term, and communication is the process by which it is achieved. From this perspective consensus must be studied as an interaction between people rather than as a property of a single individual. This type of interaction is evident in our everyday lives when we ask one another, "Did you see what I just saw?" The resulting conversation that flows back and forth with descriptions and impressions would be an example of two-way communication taken to the next level when, ideally, a consensus of understanding results.

Consensus of understanding takes into account actual agreement as well as the parties' perceptions of agreement (Broom, 1977). Approaches to measuring consensus, according to Botan and Hazleton (1989), were developed by Laing, Phillipson and Lee (1966); McLeod and Chaffee, (1972, 1973); and Scheff, 1967) and were based upon Newcomb's 1953 model. These models focused on interpersonal communication, but

Broom (1977) suggested their application for public relations professionals in the identification of public relation problems as well as in the planning and measurement of program effects. Broom (1977) based his model on Chaffee and McLeod's (1973) Coorientation Measurement Model. That model, according to Botan and Hazleton (1989), is built upon a foundation of the concept of social reality and its associated process of social validation and a common value system.

Broom's 1977 model uses the same three variables of *understanding or agreement*, *congruency*, and *accuracy* and applies them to the measurement of corporate-public consensus. "So rather than measuring simple agreement on the definition of issues, the task becomes one of measuring the relationships between a corporation and its various publics in a consensual framework" (p. 112). Broom (1977) developed a Corporate-Public Consensus of Understanding Model (p. 113) and proposed it as a framework for the organization of data collected by asking four questions:

1. How does corporate management define the issue?
2. How does corporate management think Public A defines the issue?
3. How does Public A define the issue?
4. How does Public A think corporate management defines the issue?

The relationships among these measures are the three variables common to coorientation models and are defined by Broom (1977, p. 114) as:

1. *Mutual understanding* represents the extent to which the corporate definition of the issue is similar to a public's definition of the same issue (agreement-disagreement on the definition of the issue).

2. *Congruency represen*ts the extent to which one group's definition of the issue is similar to its estimate of the other group's definition (perceived agreement-disagreement on the definition of the issue).

3. *Accuracy* represents the extent to which one group's estimate of the other's definition is similar to the other's actual definition of the issue.

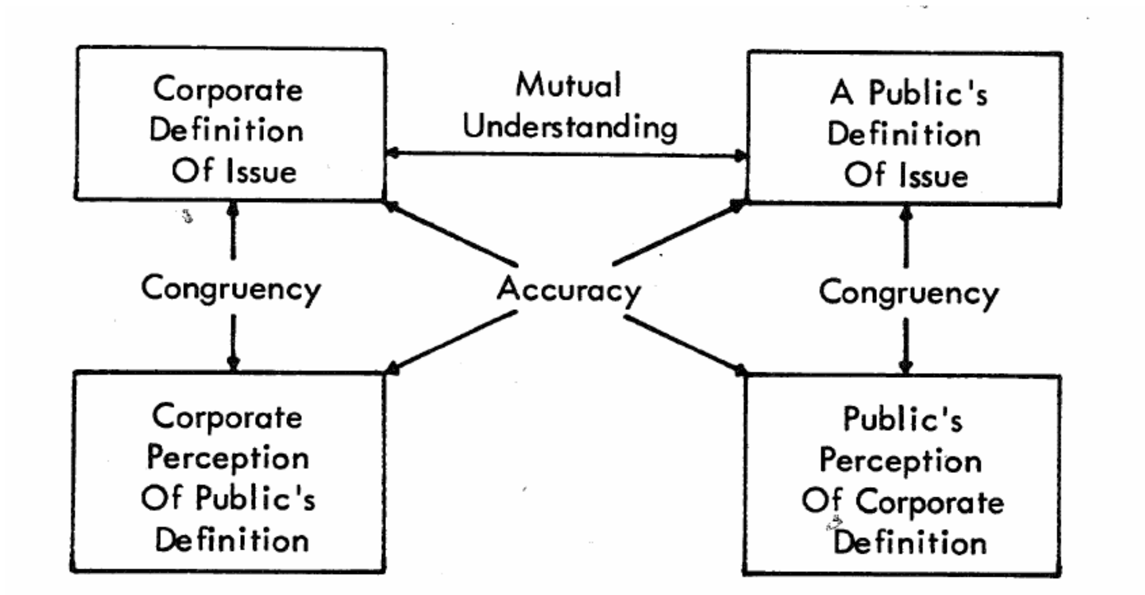

Figure 2: Corporate-Public Consensus of Understanding Model

Broom (1977) Corporate-Public Consensus of Understanding Model. Figure 2 (p. 115)

While the variables of accuracy and agreement or understanding are relational (Botan & Hazleton, 1989), Broom (1977) contends that congruency is not. Congruency is not about the relationship between the public and an organization but "describe sets of expectations brought to the relationship by the two interacting groups" (p. 115).

It is important for an organization and its public to agree on definitions of an issue or concept, but it does not mean they share the same evaluations. “For example, coorienting parties generally may recognize the same elements in a public relations problem, in which case there is understanding, but they may not agree on their respective roles and the appropriate responses” (Botan & Hazleton, 1989, p. 252). In the case of the NWS, the designers of the graphics and the public may agree on the definitions of the essential elements of the tropical cyclone track graphic, but may not share or extrapolate the designer’s intended meaning.

Disagreement is one thing, miscommunication is another. People or organizations and their publics can “agree to disagree” on an issue, but danger lurks in areas of misunderstanding. According to Broom (1977), there are two dimensions of agreement between parties; the first is actual agreement and the other is the perception of agreement. These two states are not necessarily in synch, however, and each combination of these conditions can create very different situations. When people agree and know they agree there is *consensus*. When they disagree and know it, there is *dissensus*. The more troubling situation is when there is agreement, but the parties do not believe they agree, called *pluralistic ignorance*, or if they disagree but think they agree, called *false consensus*. The coorientation model follows Grunig’s prescriptions for the importance of two-way communications for public relations by taking into account both sides of the communication equation.

The coorientation model as a research tool is an especially “good way to diagnose the potential for miscommunication that can hurt attempts at building consensus and damage an organization’s reputation” (Austin & Pinkleton, 2001, p. 62). In the case of the outcry over misunderstanding of the projected path of Hurricane Charley in 2004, it seems that regardless of the anecdotal information that was supplied to the NWS, there was really no verification of whether the culprit was the “center black line” or if other elements were to blame.

New technologies can enhance or confuse communications (Grunig, J. E. & Grunig, L.A., 1989). This may be particularly true in the dissemination of scientific information where the processes of data collection and its analysis are functions of other sciences and technologies. In the case of weather forecasting, engineers from diverse disciplines come together to build systems that monitor the environment, analyze the data, and convert the information into narratives and graphics. How and through what mediums that information is conveyed to the public, may enlighten or confound the reader.

For the NWS it may mean that newer weather surveillance and modeling tools may confuse rather than assist in the communication of weather information. The possibility that prediction tools may not serve as good communication products is evidenced by NWS’ reluctance to release graphics of its storm track models. They made this decision because “some users have also become too reliant in the individual forecast scenarios presented by the many model forecast lines, some of which have little or no chance of being correct. This is not the message the NHC wants to send” (NWS, April 2006). Another example of how conventions can be confusing to the viewer is in the recent introduction of the wind vector and vapor models used by some television outlets. A September 19, 2006 weather forecast aired on NBC-2, Ft. Myers showed a Doppler radar image with the color red representing the heaviest rainfall while the next new vapor map depicted an area of dry air also coded as red.

If successful communication depends upon “accurate perceptions from all parties involved” (Austin & Pinkleton, 2001, p. 62), then the best way to measure success is to evaluate the levels of accuracy and agreement of those perceptions. The NWS has a vast number and variety of relationships with organizations that use their products. For the tropical cyclone graphic alone, the NWS listed its audiences as a continuum starting with federal agencies and the media and ending with the general public. Additionally, each person in these audiences looks through his or her own perceptual looking glass. To add to the complexity is NWS’ multifarious communication environment with its mix of scientific, governmental, and corporate organizational cultures.

While many of us might like to think a visual or graphic representation is fairly straightforward, Kosttelnick and Hassett (2003) remind us that “readers seldom encounter visual language in perceptual, social, or historical vacuums” (p. 3). While designers have little or no control over how their visuals are used, they can work to develop relationships with their publics through the development and use of visual conventions. For NWS graphic designers to efficiently communicate with visual language it will require “constant cooperation among designers and readers” (Kosttelnick & Hassett, 2003, p. 3).

In 2004 when the National Weather Service queried visitors to its website about two alternative versions of the Tropical Storm and Hurricane Warning/Watch graphic, questions centered on opinions about usability, technical accuracy, and preference. The survey did not specifically ask about how constructs such as “potential” or “probable” might be represented or if viewers and designers did share a common meaning.

Measuring understanding of the applicable weather terms is less problematic than measuring understanding of or agreement for their graphic representation.

CHAPTER THREE: METHODOLOGY

Research Design

Pauly and Hutchinson (2001) posit that "to a remarkable degree, the profession of public relations understands itself through case studies" (p. 381) and argue for the importance of using these professional stories as a basis for documenting the history, lessons learned and future study of the profession. The authors further suggest that case studies not only should be demonstrations of "professional distinctions" like community relations or crisis communication but also should work to examine public relations more holistically as in studying one agency across a number of campaigns or one function across a number of organizations.

This study focuses on the NWS and its efforts to redesign a weather product. It is an examination of one process, of the public vetting of experimental products, and one case of the product known as the Tropical Cyclone Watch/Warning graphic. Specifically, this study is an examination of whether the NWS designers and their publics are in fact in agreement about the meaning of the tropical cyclone graphic. Through the measurement of several variables using both quantitative and qualitative data gathering techniques, this research seeks to determine if the NWS and the general public agree in their interpretation of the graphics, if they share an understanding, and if they know it.

Selection of Subjects

The research subjects for this study are classified in two categories – residents of Florida (general public) and Southwest area broadcast meteorologists. The population for the general public questionnaire was initially a convenience sampling of residents of Punta Gorda Metropolitan Statistical Area which encompasses Charlotte County Florida. Using a Public Hearing Contact List supplied by the Punta Gorda City Clerk Office, residents were contacted through their condominium or homeowners association. Even numbered association entries of the contact list were chosen. The city's listing contained 136 associations. One additional association was added by the researcher because of the obvious oversight of such a large homeowner group which resulted in a total of cluster of 137. Association members were contacted primarily through association points of contact and/or boards of directors. Condominium associations, civic associations, and homeowner associations were unable or unwilling to contact membership via email to request participation in the survey. However, one quasi-government group , *Team Punta Gorda*, showed interest in this research and assisted the investigator by sending out a broadcast email to their 500 plus members which ultimately expanded the sample to what became a snowball sample of Florida residents. All 135 respondents participated by completing an online survey hosted on the University of South Florida website. The 135 respondents were less than the 384 required number for a population-corrected sample size necessary for generalization.

The rationale for initially selecting Charlotte County residents as participants stems from Florida's history of severe tropical weather. During the period between 1851 and 2004, Florida sustained 110 of the 273 (or more than 40 percent) of the direct hurricane hits on the mainland U.S. coastline from Maine to Texas. (U.S. Mainland Hurricane Strikes by State, 1851-2004 http://www.nhc.noaa.gov/paststate.shtml). This history also makes Florida a particularly fertile state in which to study risk and crisis communication. The population demographics provide another unique opportunity to measure attitudes of one population since Florida (as of July, 2003) led all states with percentage of residents aged 65 and older at 17%. Charlotte County, Florida, where *Hurricane Charley* made landfall, had the highest proportion in the nation with 34% of its population 65 and older (U.S. Census, 2004).

Both the location and demographics of this area mark its residents as a vulnerable population. This combination of older citizens in a state with a long history of tropical cyclone activity provides a research population in which to measure both the attitudes of this population towards the NWS and their perceptions of what should be a familiar graphic. This study seeks to specifically measure the levels of coorientation or mutual understanding between Florida (with special emphasis on Punta Gorda) residents and the designers of the NWS tropical cyclone graphic.

A second population to participate in this research was Southwest Florida broadcast meteorologists. A census sampling of broadcast meteorologists, taken from a listing of local and regional stations that are available through the local Comcast Cable Service, was compiled using television station websites.

Invitations to participate in the survey were emailed to all broadcasters listed on the websites as meteorologists. After a second email invitation and a third request to participate, the investigator collected qualitative and quantitative information from 7 (out of a total of 19) broadcast meteorologists/weather forecasters. Information collected included broadcaster attitudes relative to the NWS graphic, broadcaster perceptions of public understanding of weather-related constructs and graphics, and the meteorologists' perceptions of the NWS. Rationale for selecting this group of participants relates to their unique position in the dissemination of NWS products to the general public. The investigator explored the possibility that meteorologists' attitudes towards the NWS and its products, as well as their perceptions of the general public's understanding of tropical storm graphics, may provide insights into the public's perception of forecasts information and trust of the NWS.

Instrumentation

This research used two instruments – a quantitative questionnaire used to measure public knowledge and understanding of tropical storm graphics and a combination qualitative/quantitative questionnaire for broadcast meteorologists. The quantitative instrument was administered to a snowball sampling of Florida residents. The other instrument was administered to a census sampling of broadcast meteorologists whose stations can be viewed in the Charlotte County area.

General Public Questionnaire (Appendix C)

Members of the general public were asked to complete a two-section questionnaire designed primarily to capture information about the respondent's knowledge and understanding of tropical storm graphics. Section one contained demographic questions related to the respondent's age, primary residence, sex, and education. Section two of the questionnaire contained 35 questions relative to the respondent's general media usage, understanding of weather and map constructs or conventions, interpretation of graphics, knowledge of weather-related terms, and organizational trust. Questions relating to weather and map constructs were multiple choice. Participants were directed to select one correct response ("pick one") or select all that apply. Questions relating to trust used a Likert-like scale ranging from one to seven with one being completely disagree and seven being completely agree. These questions also provided the respondent to select a no opinion option.

Broadcast Meteorologist Questionnaire (Appendix D)

The broadcaster instrument contained 5 sections and a total of 51 questions of closed and open ended type. Section one of the instrument contained questions relating to education and professional experience. Section two contained questions related to the broadcasters' perception of the public's understanding of weather-related constructs and graphics, and the meteorologist's perception of the NWS and their products. Section three contained questions measuring familiarity and attitudes toward the tropical storm graphic. In section four, broadcasters were asked to predict the general public's responses to questions relating to weather and map constructs. These questions mirrored the public questionnaire and followed the multiple choice format. Questions relating to trust used a Likert-like scale. The last section contained open-ended and closed questions relative to meteorologist opinions about the public interpretation of the tropical storm graphic.

Assumptions and Limitations

It is an assumption of this study that this sample is more familiar with the hurricane track graphic because of their Florida residence has made them more attentive to the forecasts (J. Grunig, 1997). Additionally, the large number of boaters and boat owners in Florida and Charlotte County are more likely than others to be familiar with the NWS, which may have an effect on the study outcomes. The assumption that this sample will be more familiar with the graphic is also a limitation of the study. The residents of Charlotte County have been exposed to the graphic when, in the instance of *Hurricane Charley,* the storm did not follow what some residents argued was the televised predicted path. This seemingly faulty prediction could have an effect on study results, especially in measures of trust of the NWS because many felt they were not afforded sufficient preparation time.

Another assumption, and possible limitation of this study is that residents of Punta Gorda are representative of the Charlotte County. Although it is the central urban center of the Punta Gorda SMA, differences in demographics such as income and education may affect the study outcomes. However, if residents are better educated, have higher incomes, and more time to watch weather because of a retirement status, their perception of the graphic and other weather related factors, it is assumed they should be more informed than the rest of the Charlotte County population in respect to weather-related terms and concepts.

Another limitation of this study was the online delivery of the questionnaire. Although print copies were offered, no requests were received. Participation may have been reduced for older generations or for those without easy access to the Internet.

Additionally, the researcher was made aware, through inquiries, that many of the respondents were academics or professional communicators. A large number of these participants may skew results because they might view the questions differently due to their familiarity with research instruments.

Finally, there is a possible limitation that respondents may not understand the intended meaning of the questions contained in the instrument.

Research Questions

Using a case study research design, this study includes both quantitative and qualitative data gathering techniques to answer the following five research questions:

RQ1: Does the general public's knowledge of basic weather terms and concepts match the level necessary to understand the meaning of the hurricane graphic?

RQ2: Are the visual conventions used in the creation of the hurricane graphic understood by the general public as they were intended by the designers?

RQ3: Does the general public understand the meaning of the hurricane graphic?

RQ4: Does the general public trust the NWS and its graphical products such as forecasts?

RQ5: Does the public's understanding of the meaning of the hurricane graphic match the broadcasters' perceptions of the public's understanding of the meaning of the hurricane graphic?

Definitions

For the purposes of the study the *Tropical Cyclone Track and Watch/Warning* graphic will be used to measure coorientation between the general public and the NWS. It would be difficult to measure coorientation of all elements of the graphic because it is presented to the public in a variety of modes and media. However, it is the premise of this study that there can be a measure of understanding of constructs or conventions that are used in this particular design. For this study, the constructs to be measured are scale, time, power, probability and institutional trust. The constructs are defined as follows using in part definitions published by US Geological Survey (USGS, 2002). They are:

Scale, relative location, direction and distance: Scale for the purposes of this study will refer to the relative size elements of the cone graphic. This researcher posits that one assumption made by the designers is that viewers will recognize outlines of land mass as particular locations and will have some understanding of its size. If viewers are to extrapolate the distance of the storm from landmass, as well as area that is covered by the actual cone area, they must have some notion of its scale. Populations are also interested in the size of the storm. Although the cone does not depict the size of the storm it may be assumed. Size is a function of scale.

Time: One element of the cone graphic is the display of predicted storm location over time. These indicators, whether they are black dots or overlapping circles provide a gauge for speed of the storm since they indicate the distance the storm has moved or is predicted to move over time.

Probability: The shaded cone of the graphic is perhaps the most important element of the graphic because it indicates the potential area where the center of the storm could make landfall. The level of accuracy for forecasting the location of the center of the storm diminishes over time. The cone is neither an indicator of size nor the force of the storm.

Strength or Power: The graphic indicates the force of the storm by a letter within the time hack dots. The letter D is used to indicate a tropical depression, S for tropical storm, and H for hurricane. The legend provides a scale of wind speeds for the each of these designations but does not quantify hurricanes by Saffir-Simpson Scale on the graphic. It also does not indicate size of wind bands or area covered by the storm.

Current status: The current location of the storm center, its location as a function of latitude and longitude, wind speed and speed of current movement

Trust: As defined by J. Grunig and Hon (1999) it is a measure of "one party's confidence and willingness to open oneself to the other party. There are three dimensions to trust:

- integrity: the belief that an organization is fair and just…
- dependability: the belief that an organization will do what is says it will do and
- competence: the belief that an organization has the ability to do what is says it will do" (p. 3).

The constructs of scale, time, power, probability, were be measured using multiple choice questions relating to two NWS graphics. The "correct" answers were taken directly from the graphic legend, or from common map reading definitions (USGS, 2002). In addition the questionnaire measured the general population's understanding of other terms currently used by the NWS in the graphic legend without the benefit of full definition. Understanding of these terms were measured by multiple choice questions and the "correct" answers were taken from NWS products, glossary (NWS, July 21, 2006) and other published definitions provided in a hurricane awareness brochure produced by WINK News (Wink, 2006). These terms are defined for this study as:

Hurricane: storm with sustained winds greater than 73 miles per hour; a pronounced low-circulation that is given a proper name

Tropical Storm: A low-pressure circulation with highest sustained winds of 39-73 mph and a warm center

Warning: Warning is issued when hurricane or tropical storm conditions are expected within 24 hours

Watch: Watch is issued when hurricane or tropical storm conditions are possible within 36 hours.

Measurement of the construct of trust of the NWS by members of the public followed measurements suggested by Grunig, J. & Hon (1999). Respondents were asked to rate their levels of agreement/disagreement on a scale of one to seven for statements related to their relationship with the NWS and other weather organizations. The questions were patterned after and related to dimensions of integrity, competence and dependability that have been proposed by J. Grunig, and Hon (1999) as measures of the concept of trust.

Tropical Cyclone Track and Watch/Warning Graphic: See Appendix A for technical definition.

The NWS and its parent organization, NOAA, have worked toward building consensus through a variety of outreach efforts. They have also responded to feedback from their customers. One notable occasion was their effort to offer alternatives to the Tropical Cyclone Track and Watch/Warning graphic.

In late 2004, the NWS offered two experimental designs for the cone because some viewers had expressed concern over its "message" prior to the landfall of *Hurricane Charley* in Punta Gorda, FL. While the NWS believed their predictions were correct, comments indicated that the visual "…might overly focus the user on an exact forecast track (the line) and not on the larger potential track area" (NWS, 2004, p. 2). This perception by the NWS, that their graphic was being misunderstood, led them to offer two alternative graphics and queried their views in an on line survey. The public did not *vote* to accept the new designs but the exercise demonstrated a serious attempt by the

NWS to correct any design flaws in the graphic. What the questionnaire failed to measure, however, was if in fact people “misunderstood” the original graphic. Or, if viewers did not perceive the graphic in the same manner, did they know it.

To that end, this study used the corrientation model to measure both the quality of the relationship between the public and the NWS as well as provide a measure of consensus of meaning of the cone graphic. This use of the model for the NWS is in line with Broom’s (1977) suggestion that “coorientational measures can serve three purposes in public relations planning and programming” (p. 117). By measuring the levels of understanding of particular elements of the graphic, as well as some basic scientific assumptions made by the designers, this study will attempt to uncover either the error in the NWS thinking or the disparity of understanding. One area of particular interest is the level of mutual understanding of design conventions used to relate scientific related concepts such as probability or risk.

This type of inquiry is especially important for organizations that are responsible for warning populations at risk. When organizations convey safety related information, intended to help audiences make better decisions, it is vital that the organizations and their audiences understand each other and know that they do. “Without accurate information about the true beliefs of external publics, dangerous misunderstanding can occur” (Cameron, Mitrook, & Sallot, 1997, p. 47). It is also important that the organization enjoys a level of trust with their publics.

Procedures

The visual nature of this study precluded the use of telephone interviews as a manner of data collection. Offering the survey via the World Wide Web was the preferred method. However, due to the common belief that older populations are less likely to use the World Wide Web, the researcher offered the questionnaire in both electronic and print mediums. Although delivery of the survey in two very different formats may confound any results, there were no print surveys completed. A pilot study using both questionnaires was conducted with a limited population (three general public respondents and one former weather professional).

General Public Questionnaire (Appendix C)

Participants for this questionnaire were recruited through a snowball sample method of Florida residents with emphasis on Charlotte County residents. The Punta Gorda Metropolitan Statistical Area (MSA) 39460 encompasses all of Charlotte County and Punta Gorda is its Principal City. According to the definitions and standards of an MSA (OMB, 2005), a Metropolitan Statistical Area is "an area containing a recognized population nucleus and adjacent communities that have a high degree of integration with that nucleus" (p. 82228) and as a "concept has been successful as a statistical representation of the social and economic linkages between urban cores and outlying, integrated areas,' (p. 82228). The population nucleus for Charlotte County is Punta Gorda. It has the highest concentration of population with 1208 persons per square mile (Census, 2002). Using the 2000 U.S. Census figures it was calculated that Punta Gorda City had 11.17% of the housing units and 10.13% of Charlotte County's population. The number of single-family owner-occupied homes in Punta Gorda City is also approximately 11.5% of the county's total. The proportion of male/female populations is nearly identical at 47% male and 52% female. The number of single-family owner-occupied homes in Punta Gorda City is also approximately 11.5% of the county's total.

The median age of Punta Gorda City residents is nine years older than the county median of 54 and the percentage of population in the labor force is significantly less at 28.8% versus 43.0% of the county residents. The differences in age and participation in the workforce may impact the findings of this study, however, it is assumed that an older population who may spend more time at home is more likely to be familiar with weather graphics and terms.

The initial sampling frame for Punta Gorda was resident members and owners of condominiums and homeowner associations. Given that many did not allow solicitation, this study used a listing of condominium contacts supplied by the Punta Gorda City Clerks Office. The list is not exhaustive and contact information was out of date.

Selected associations were contacted either telephonically or email with an explanation of the research. Contacts were asked for permission to disseminate cards and or emails to their membership inviting participation in the online survey. A total of four associations were contacted. Alternatively, permission was sought to be included in association publications and or posted to common areas in three associations. Due to low participation, the investigator produced and disseminated 200 business cards printed with the survey title and URL at a senior expo held in Charlotte County as well as selected businesses in the Punta Gorda area.

Posted flyers instructed participants where to access the questionnaire online (URL of the website) and how to complete the questionnaire online. These instructions were similar to the ones that reside on top of the questionnaire. A written, hardcopy version of the questionnaire was made available but not requested.

Broadcast Meteorologist Questionnaire (Appendix D)

Participants were selected from a group of meteorologists whose broadcast area included Charlotte County. Selected meteorologists were contacted by email first to request their participation in the study. If the meteorologist wished to participate, they were provided with the hyperlink to access the questionnaire electronically. Participation was limited to those who are practicing meteorologists in the state of Florida.

Data Processing and Analysis

Both instruments resided on the Internet using a URL provided by Academic Computing of the University of South Florida. Data from both instruments were collected by Academic Computing and formatted in required fields as specified by the researcher. Results were exported into MS Excel or SPSS version 14.0 as needed.

Results of the public questionnaire were analyzed through conduct of an exploratory factor analysis, crosstabulations, correlations, and a series of one-way ANOVAs. The quantitative results of the meteorologist questionnaire were reported as descriptive statistics and compared to the corresponding public questionnaire results. The qualitative data were analyzed for trends and insights relevant to perceptions of the general public's understanding of weather related constructs, storm graphics, as well as meteorologist perceptions of the NWS.

Both the public and broadcaster instruments yielded information on the understanding of weather related terms as well as the perceived meaning of the storm graphic. This information was compared to the intended meaning as purported by the NWS. What the NWS thinks the graphic means was be taken from their official website description of the graphic and the information contained in the legend. It was not possible to discern what the NWS as an organization *thinks* of the perceptions of the general public, but some assumptions of its position on the public's knowledge was taken from official documents and news reports. Because NOAA and the NWS list promotion of environmental literacy as a goal in their strategic plan, the researcher made the assumption that the NWS and NOAA have some indications that the general population lacks some fundamental knowledge necessary to understand their work and the resultant products. However, the investigator determined that what broadcasters "think" about the public knowledge of weather-related terms would be useful, informative, and contribute to the findings of this research.

Measurements

Residents look to answer some fundamental questions when faced with severe weather. Hurricanes are often forecasted up to five days from landfall. As part of that forecast residents often look to have a number of questions answered. Some of these questions are:

- What are the chances that it will affect me? How will I know if it's coming here?
- How long will it take to get here? How long do I have to get ready?
- How strong will the storm be when it arrives?
- How big is it? How long will I be affected?

The NWS produces a large number of textural forecasts that aim to answer these questions. Their graphics take much of that information and display it visually.

The Graphic

One element the news media uses to define potential disasters is the tropical cyclone graphic. It is often the first time viewers *see* themselves in the path of destruction. Produced by the NWS it is known to the public as the “Cone of Uncertainty.” Its technical name is the *Tropical Cyclone Track and Watch/Warning* graphic. It is described by the NWS as follows (Figure 1):

The Tropical Cyclone Track and Watch/Warning graphic contains the storm's forecast track, a cone along the track based upon the average area of uncertainty for the position of the center, and coastal tropical storm and hurricane watches/warnings.

The coastal watches and warnings display shows an approximate representation of coastal areas under a hurricane warning (red), hurricane watch (pink), tropical storm warning (blue) and tropical storm watch (yellow). The orange circle indicates the current position of the center of the tropical cyclone. The black line and dots show the NHC forecast track of the center at the times indicated. The NHC forecast tracks of the center can be in error, and the white areas indicate the increasing average area of uncertainty for the position of the center as a function of time. This product is also issued for subtropical storms.

The primary audience is the general public but the graphic is used extensively by public as well as governmental planners, the media, and local emergency personnel. While this explanation highlights the particular elements of the graphic and offers an explanation of the designers’ intent, it does not give notice to the considerable assumptions and designer/viewer agreements in the design. Much of the above information, about the meaning of particular elements, is contained in the legend of the

NWS version of the graphic. However, to fully understand the graphic, viewers must also be armed with some basic map reading skills as well as a familiarity with graphic conventions such as scale. The first step is to measure the public's acceptance of the graphic as a representation of a tropical cyclone/storm followed by measuring each of the elements of the graphic. By comparing the information provided by the NWS (cognition or definition of the graphic) and that of respondents, levels of respondent knowledge of weather-related terms and concepts were identified. This section included knowledge of the NWS as well as specific tropical/storm terms such as definitions of a hurricane and Saffir-Simpson Hurricane Scale.

The second step measured whether the public understood basic map reading and graphic design conventions used in the design of the tropical storm/hurricane graphic. This knowledge was measured by asking respondents to correctly identify common conventions such as map direction and use of color coding.

The third step measured the perception of what the public believes to be the meaning of the graphic as designed by the NWS. This will be measured by using the graphic and asking questions that will require some extrapolation of the data provided. While the current graphic products provide additional explanation of the white area and cautions that a storm/hurricane are not points but areas of disturbance, those explanations were not provided when the NWS queried stakeholders about the proposed alternative graphic designs.

The fourth step was the attempted measure of the trust the public has for the NWS. Through questions adapted from Grunig, and Hon (1999) measurement of trust the questionnaire was designed to measure not only the levels of trust (integrity, competence, and dependability) held by the public for the NWS, but it also highlighted those levels in contrast to local media. While the other six factors proposed by Grunig and Hon (1999) are essential to measuring relationships, it is trust that this researcher believes is most important for this study. Although the collection of other measures will provide a more holistic picture of the relationship the NWS has with the public, for the purposes of predicting and communicating the path of a tropical storm or cyclone, trust seems to be the most important element. Moreover, to restrict the instrument's length, it was decided that the demographic information and convention questions needed to be fully covered.

The Model

The coorientation model used for this study was patterned after both McLeod and Chaffee's (1973) and Broom's (1977) coorientation models (Figure 3). The boxes on the top refer to measures of the NWS' definition and understanding of their tropical cyclone graphic and the public's definition and understanding of the same graphic. The bottom boxes are measures of the perceptions held by each group of the others' definition/understanding of the graphic. Comparisons of these states are labeled as understanding/agreement and accuracy. Accuracy relates to how closely the public's perceptions of the graphic match the NWS' understanding of the graphic. Congruency relations to how closely the public and the NWS' understanding of the graphic matches what they perceive to be the other's.

1. *Mutual understanding* represents the extent to which the NWS' definition/intended meaning of The Tropical Cyclone Track and Watch/Warning graphic is similar to a public's definition/understanding of the same graphic (understanding & agreement-disagreement on the meaning of the graphic).

2. *Congruency* represents the extent to which the NWS definition/intended meaning of the graphic is similar to its estimate of the other group's definition/intended meaning (perceived agreement-disagreement on the definition of the issue).

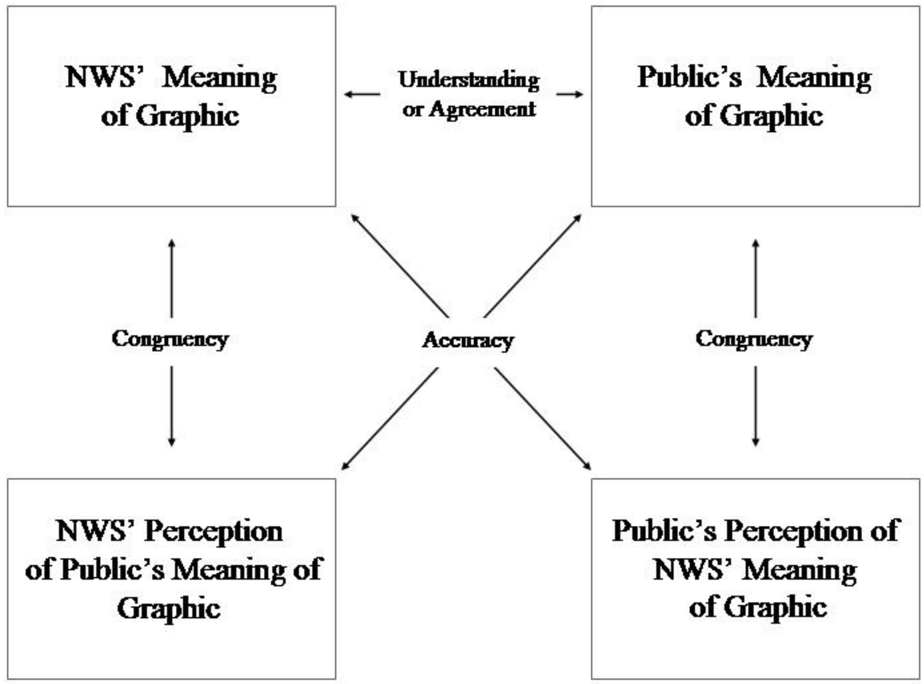

Figure 3: NWS-Public Consensus of Agreement -Understanding Model

3. *Accuracy* represents the extent to which the NWS' estimate of the public's definition/perception is similar to the other's actual definition/intended meaning of the issue (p. 114).

Organizational Trust – The National Weather Service

It is interesting to note that the NWS and its parent organization, NOAA, are located under the umbrella of the Department of Commerce. Both NOAA and the NWS have vision and mission statements are crafted as meeting both social and economic goals. This connection with the world of business or commerce is evident in their descriptions of audiences as customers and their weather predictions as products. But their communication activities are more in the line of good public relations practice.

Measurement of the construct of trust of the NWS by members of the public followed measurements suggested by Grunig & Hon (1999). Respondents were asked to rate their levels of agreement/disagreement on a scale of 1-to-7 for statements related to their relationship with the NWS and other weather organizations. The questions were patterned after and relate to dimensions of integrity, competence and dependability that have been proposed by Grunig and Hon (1999) as measures of the concept of trust.

CHAPTER FOUR: RESULTS

This chapter contains the results of data collection, statistical tests, and data analysis as outlined in Chapter Three. Results from two online questionnaires are reported in separate sections. The first section consists of findings from data gathered from the general public questionnaire. The second contains the data collected from broadcast meteorologists. Both sections contain a summary of findings and include distribution frequencies and descriptive statistics. A third section compares the public's responses to those of the broadcast meteorologists.

This study is an examination of whether the NWS designers and their publics are in agreement about the meaning of the tropical cyclone graphic. Levels of understanding were measured through isolation of several variables, including understanding of weather related terms, interpretation of graphic conventions, and the public's level of trust of the NWS. Specifically, this study proposed the following research questions:

RQ1: Does the general public's knowledge of basic weather terms and concepts match the level necessary to understand the meaning of the hurricane graphic?

RQ2: Are the visual conventions used in the creation of the hurricane graphic understood by the general public as they were intended by the designers?

RQ3: Does the general public understand the meaning of the hurricane graphic?

RQ4: Does the general public trust the NWS and its graphical products such as forecasts?

RQ5: Does the public's understanding of the meaning of the hurricane graphic match the broadcasters' perceptions of the public's understanding of the meaning of the hurricane graphic?

Public Respondents Survey Data

Demographics

Of the 135 people surveyed 76 (56.3%) were female and 57 (42.2%) were male. In terms of age 56 (41.5%) were born between 1925 and 1945, 50 (37%) were born between 1946 and 1964, 17 (12.6%) were born between 1965 and 1977, 9 (6.7%) were born between 1978 and 1988, and 3 (2.2%) were born between 1911 and 1924. A total of 59 (43.7%) of respondents were age 62 or older. An additional 50 (37.0 %) were between the ages of 43 and 61.

A total of 125 respondents or 92.2% reported completion of at least some college while 97 (71.9%) reported completion of a postsecondary degree. One hundred twenty one (89.6%) of respondents claimed Florida as their primary residence with 72 respondents (53.3%) of the sample residing in Charlotte County (see Table 1).

Table 1
Demographic Frequencies General Public

Item	N	%
I was born between:		
1925-1945	56	41.5
1946-1964	50	37.0
1965-1977	17	12.6
1978-1988	9	6.7
1911-1924	3	2.2
Sex		
Female	76	56.3
Male	57	42.2
No Response	2	1.5
Education level completed		
Bachelors Degree	36	26.7
Some college	28	20.7
Graduate School	18	13.3
Some Graduate School	17	12.6
Doctorate	11	8.1
Post Graduate	9	6.7
High School or GED	7	5.2
Associates Degree	6	4.4
Some High School	3	2.2
My primary residence is located		
Charlotte County, FL	72	53.3
Other, FL	49	36.3
Other, US	14	10.4

Note. *N*=135.

Weather Information

The majority of the respondents, 82 (60.7%), reported “generally” getting their weather information from television while 38 (28.1%) “generally” used the internet for their weather needs. Only .7% selected newspapers for their weather forecasts (see Table 2).

Table 2
Weather Information Sources Frequencies - General Public

Item	N	%
I generally get information about the weather from:		
Television	82	60.7
Internet	38	28.1
Radio AM or FM	6	4.4
Weather Radio	4	3.0
Other	2	1.5
Desktop Radio		
Florida Division of Emergency Management		
Newspaper	1	.7
Other people	1	.7
No answer	1	.7

Note. *N*=135.

As per Table 3 the majority of respondents, 102 (75.6%), increase their weather information seeking behaviors when they are aware of an approaching storm. When they know of an approaching storm, a large majority, 107 (79.3%), "usually" go to the internet for forecast information.

Table 3
Weather Information Seeking Frequencies - General Public

Item	N	%
When I hear about an approaching storm I usually… (Pick ALL that apply):		
Check the internet for forecasts	107	79.3
Increase my viewing to include other stations or papers	102	75.6
Talk to my family or friends about it	62	45.9
Stay with my regular television viewing or reading habits	40	29.6

Note. *N*>135 – respondents checked all responses that applied

Knowledge of Weather Terms

The publics' responses to questions relating to weather terms and concepts were graded as correct or incorrect using a key provided by the NWS (see Table 4). The majority of respondents chose the "correct" answer to all 6 items. The majority, 129

(95.6%), indicated that hurricane and tropical storm watches and warnings are issued by the NWS. Most respondents 124 (91.9%) identified hurricanes as storm with winds of more than 73 mph. and the majority, 110 (81.5%) correctly equated the Saffir-Simpson Hurricane Scale with the intensity of the storm. The public (n=105, 77.8%) correctly indicated that *probable, possible,* and *potential* do not basically mean the same thing and 84 respondents (62.2%) correctly indicated that a hurricane *warning* meant hurricane conditions are expected within 24 hours. While the majority of respondents (n=70, 51.9%) chose the same answer, to the item relating to the meaning of a tropical storm watch as the one the NWS supplied, the veracity of the answer is questionable because an error in the construction of the correct answer which should have read 36 rather than 24 hours for a *watch*.

Table 4
Knowledge of Weather Related Terms Frequencies - General Public

Item	N	
Probable, possible and potential all basically mean the same thing...(pick ONE)		
False	*105*	*77.8*
True	26	19.3
Unsure	3	2.2
No answer	1	.7
A tropical storm watch for my area means...(pick ONE)		
Tropical storm conditions including winds of 39 to 73 mph are possible within the next 24 hours	*70*	*51.9*
Conditions in my area are conducive to the development of a tropical storm	52	38.5
A tropical storm is likely to hit my area within the next 24 hours	11	8.1
Unsure	1	.7
No answer	1	.7
A hurricane warning for my area means…(pick ONE)		
Hurricane conditions are expected in my area within the next 24 hour	*84*	*62.2*
A hurricane will likely hit my area within the next 2 days	26	19.3
Conditions in my area are conducive to hurricane development	24	17.8
No answer	1	.7
Hurricane and tropical storm watches and warnings are… (check ALL that apply)		
Issued by the National Weather Service	*129*	*95.6*
Are official designations	54	40.0
Issued by local emergency planners	25	18.53
Determined by my local media	3	2.2
Unsure	3	2.2
The Saffir/Simpson Hurricane Scale…(pick ONE)		
Is a scale ranging from 1-5 based on the intensity of the hurricane	*110*	*81.5*
Unsure	20	
Categorizes storms as tropical depressions, storms or hurricanes	2	1.5
Is a scale used to indicated the size of a storm	1	.7
No answer	2	1.5
A hurricane is characterized by…(check ALL that apply)		
Winds of more than 73 mph	*124*	*91.9*
A pronounced low-pressure circulation	80	59.3
A proper name	55	40.7
Unsure	3	2.0
Note.		

Answers in italics and bolded are considered "correct""

Visual Conventions

Table 5 shows respondents' responses to question testing their understanding of visual conventions. The vast majority of the respondents, (n=131, 97%), correctly indicated that the Figure 1 graphic represented the path of a hurricane. A majority, (n=128, 94.8%) know that maps shown in the news are usually oriented to the North and 122 respondents (90.4%) correctly matched the red area of the graphic with that of area under a hurricane warning. Respondents (n=119, 88.1%) indicated correctly that the white area represented the “area of uncertainty.” Respondents were less successful in choosing the correct (n=81, 60%) response that equated the pink area with the definition of a hurricane watch and only (n=53, 39.3%) chose the correct answer to the item related to size of the state of Florida.

Table 5
Understanding of Visual Conventions Frequencies - General Public

Item	N	%
I recognize this graphic (Figure 1) as a representation of the path of a ...		
Hurricane	*131*	*97.0*
Tornado	1	.7
High pressure system	1	.7
Unsure	1	.7
No answer	1	.7
Severe thunderstorm	0	.0
The red area of the Figure 1 graphic represents …(pick ONE)		
Hurricane warning for that area	*122*	*90.4*
Hurricane watch for that area	4	3.0
The direction the storm is expected to more	4	3.0
Tropical storm warning for that area	1	.7
Unsure	1	.7
No answer	3	2.2
The pink area of the Figure 1 graphic …(pick ONE)		
Indicates that hurricane conditions are possible within 36 hours	*81*	*60.0*
Is under a tropical storm watch	41	30.4
Unsure	5	3.7
Is outside of any danger for landfall of the storm	4	3.0
No answer	4	3.0
The solid white area on the map (Figure 1) indicates…(pick ONE)		
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*119*	*88.1*
The area to be affected by hurricane force winds	9	6.7
The predicted size of the storm over time	3	2.2
The only areas predicted to be affected by any hurricane or tropical storm force winds	1	.7
No answer	3	2.2
Unsure	0	0.0
The state of Florida is approximately…(pick ONE)		
100 miles wide at its center	*53*	*39.3*
400 miles long from north to south	51	37.8
Unsure	23	17.0
400 miles from Cuba	5	3.7
No answer	3	2.2
U.S. maps shown in the news (like Figure 1) are usually shown with what direction on top? (pick ONE)		
North	*128*	*94.8*
Varies	2	1.5
South	1	.7
West	1.	.7
No Answer	3	2.2
East	0	0.00

Note. Answers in italics and bolded are considered "correct"

Understanding Hurricane Graphics

Table 6 shows participants' understanding of hurricane graphics. The majority of respondents (n=131, 97.0%) correctly indicated that the Figure 1 graphic represented the path of a hurricane and its design conveyed information of the storms path. Item 33, a measure of the graphics meaning contained four correct choices. Respondents correctly identified key elements of the graphic design with a majority (n=119, 88.1%) indicating that the graphic was an important indicator of the storm's path; 118 respondents (87.4%) indicated that the graphic tells them where and (n=108) and 83.3% of respondents indicated that the graphic tells them when a tropical storm or hurricane is expected. Additionally, 103 (76.3%) of respondents correctly indicated the graphic contained information about the speed of the storm's movement. Of note is the number of respondents (n=37, 27.4%) who incorrectly indicated that the graphic showed the size of a storm and the small percentage (n=22, 16.3%) who believe the graphic represents a "very reliable forecast."

Table 6

Understanding of Hurricane Graphic Frequencies - General Public

Item	N	
I recognize this graphic (Figure 1) as a representation of the path of a ...		
Hurricane	*131*	*97.0*
Tornado	1	.7
High pressure system	1	.7
Unsure	1	.7
No answer	1	.7
Severe thunderstorm	0	.0
The graphic in Figure 1…(check ALL that apply)		
Is an important indicator to me of the storm's path	*119*	*88.1*
Tells me WHERE a tropical storm or hurricane is expected	*118*	*87.4*
Tells me WHEN a tropical storm or hurricane is expected	*108*	*80.0*
Indicates how fast the storm is moving	*103*	*76.3*
Tell me the size of the storm	37	27.4
Is just a guesstimate by meteorologists	32	23.7
Is a very reliable forecast	22	16.3
Unsure what it means	1	.7
According to the graphic in Figure 1…(check ALL that apply)		
The storm is much more likely to make landfall in Florida than in Alabama	*116*	*85.9*
Hurricane winds will not be evident in northern Florida until 8 PM on Wednesday	44	32.6
The size of the storm will grow as it moves north	23	17.0
The intensity of the storm will diminish as it moves towards northern Florida	4	3.0
Unsure what it means	2	1.5
The center black line in the Figure 1 indicates…(pick ONE)		
A forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position	*110*	*81.5*
A guesstimate of center of the hurricane and it's predicted path	18	13.3
A 95% accurate forecast of the storm's path over the next 5 days	5	3.7
Unsure	1	.7
No answer	1	.7
The concentric circles on Figure 2 graphic indicate…(pick ALL that apply)		
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*108*	*80.0*
The area to be affected by hurricane force winds	35	25.9
The predicted size of the storm over time	15	11.1
The only areas predicted to be affected by any hurricane	8	5.9
Unsure what they mean	8	5.9

Note. *N*=135. *Some questions ask for respondents to check "all that apply" and result in N>135*

The majority of the participants (n=116, 85.9%) correctly indicated, that Figure 1 graphic indicated a greater potential for landfall in Florida than in Alabama. The majority, (n=110, 81.5%) of the respondents indicated an understanding of the center black line to be a track within an area of uncertainty, and slightly fewer, (n=108. 80.0%) correctly indicated the concentric circles of the NWS alternative graphic, Figure 2, represented an area of uncertainty for the storm center track.

Factor Analysis

The instrument for the public survey was conceptualized, in part, using items from the Grunig and Hon (1999) Trust scale. Questions from the short scale were reworded to measure the public's perceptions relating to integrity, competence and dependability of NWS and the local media. Grunig and Hon (1999) published reliability of this scale for five organizations with an average Cronbach's Alpha of .86. Only selected items from the scale were chosen and edited to focus on the NWS as a governmental organization and as the designer and provider of weather forecast products.

To determine if any of these 13 opinion variables relating to trust could be grouped into composite variables a factor analysis was conducted using principal factors with iterations rotated to a Varimax solution using a minimum Eigenvalue of 1.0 on the 13 variables representing organizational trust of the NWS and local media. A Rotated Component Matrix revealed two components. A Cronbach coefficient alpha was computed to determine internal consistency and reliability on the first factor's five items. The second component consisted of two items and to test reliability the Pearson coefficient was computed. Table 7 presents the two factor solution, with variable names, factor loadings, communalities, means and standard deviations. The Cronbach's *alpha* is also listed as a measure of internal reliability of the measures. The analysis also allowed the grouping of questions 9, 10, 12, 14 and 15 and questions 19 and 20 into two composite variables.

The four-factor solution explains 64.23% of the variance. Factor 1, Trust in NWS has the strongest loading factors and explains 29.23% of the variance and contains five of the items from the trust scale. Factor 2, Trust in Local Media contains two items from the trust scale and explains 14.97% of the variance. The Pearson Correlation of the two items in Factor 2 are statistically significant with a moderate relationship (r=.49, p<.001). Subsequently the two factors were collapsed into single indices measuring Trust in the NWS and Trust in Local Media respectively. Descriptive statistics indicated the mean for Trust in the NWS was 5.53 and for Trust in Local Media *M*=4.26. The results of Factor 3 were not statistically significant and Factor 4 contained only one item.

Table 7
Means and Standard Deviations for Trust for NWS and Local Media

Factor 1: Trust in NWS (64.23% of variance) M=5.53; SD=.77 α= .78	Factor Loadings*	Commonalities**
The National Weather Service is one organization that I can count on to make important decisions that may affect people like me	.725	.615
I think the National Weather Service does a good job of predicting hurricanes and other severe weather	.711	.613
I feel very confident in the National Weather Service's ability to make storm predictions	.725	..604
I am familiar with the National Weather Service and what it does	.732	.582
The National Weather Service keeps its promises to warn the public about severe storms.	.757	.664
Factor 2: : Trust in Local Media M=4.26; SD=.1.35, r =.49, p<.001		
If I had to choose between the National Weather Service and my local media, I'd rely on my local forecast	.822	.718
My local weather forecasts are generally accurate	.830	.786

**Factor loadings indicate how much weight is assigned to each factor*
***Communalities are the portion of variance in each variable explained by underlying factors.*

ANOVA Interpretation

To assist in the explanation of the sources of variance in the relationship of several demographic variables with levels of trust and attitudes about weather forecasts and graphics, the researcher used one-way analysis of variance (ANOVA). The dependent variables were Trust in the NWS; Trust in Local Media; Item 7, which related to understanding of television graphics; and Item 8, which related to emotional response to hurricane forecasts. The independent variables were generation, sex and education.

There was no statistically significant relationship between the three independent variables and levels of Trust in the NWS. However, generation was found to be statistically significant in levels of Trust of the Local Media (F=2.711, $p<.05$). The youngest of the respondents, Generation Y were far less likely (*M*=2.88) to "trust" their local media than respondents from the Silent Generation (*M*=4.44). Generation Y (*M*=2.88) was also less likely to trust the local media than Baby Boomers (*M*=4.36).

For the two questions relating to attitudes about weather graphics and forecasts, there were only statistically significant differences between the sexes (F=5.820, p<.05) In their responses to question 7, which asked if tropical storm track graphics were informative and easy to understand, men (*M*=6.12) reported more confidence in their understanding than women (*M*=5.64). Men and women were also significantly different in their choices relating to their emotional response to hurricane forecasts with men indicating that forecasts made them less "nervous" (*M*=3.55) than they did women, (*M*=4.58).

Cross Tabulation Analysis

To determine any significant differences between groups in terms of their media habits cross tabulation with chi square analysis was conducted. To determine the direction of the statistically significant differences the expected count had to equal or exceed the observed count. Of the 22 items used in the cross tabulation only three were found to not be statistically significant. Of the remaining 19 items, significant differences in observed frequencies were most notable by generations and educational levels, with sex accounting for the fewest cases.

Media Habits

The results from this study indicate ($\chi^2_{df=24}$ =58.482, p<.01) that television is more likely to be the primary source of weather information for the Silent (n=37, 67.3%) and the Baby Boom (n=34, 68.0%) generations while the Internet appears more likely to be the routine source of weather information for the youngest respondents, namely, Generation X (n=6, 35.3%) and Generation Y (n=8, 88.9%).

Respondents who have completed a Batchelor’s degree and higher levels of formal education are more likely ($\chi^2_{df=48}$ =74.063, p<.01**)** to use the Internet than those reporting less formal education: BA (n=12, 33.3%), Some Graduate School (n=9, 52.9%), Graduate School (n=6, 33.3%), Post Graduate School (n=3, 33.3%), Doctorate (n=4, 36.4%). Respondents with High School (n=4, 66.7%), Some College (n=23, 82.1%) and those reporting Associates Degrees (n=6, 100%) are more likely to get their weather information from television.

There were also generational differences in media use when there is an approaching storm ($\chi^2_{df=4}$ =12.151, p<.05). Respondents from the WWII generation (n=2, 66.7%) and the Silent generation (n=24, 42.9%) indicated a preference for staying with their regular viewing or reading habits. This was also the case for respondents ($\chi^2_{df=8}$ =24.295, p<.01) with lesser formal education, i.e. Some High School (n=3, 100%), High School or GED (n=4, 57.1%), and Some college (n=14, 50.0%). There also were generational differences in the propensity to talk to family and friends as a storm approaches ($\chi^2_{df=4}$ =11.015, p<.05), with Baby Boomers (n= 29, 58.0%) and Generation Xs (n=11, 64.7%) more likely to display this behavior than other generations.

Knowledge of NWS and Weather Terminology

The majority (85%) of respondents indicated that the NWS is a federal agency and part of NOAA but men (93.0%) were more likely than women (78.9%) to make that choice.($\chi^2_{df=1}$=5.022, p<.05). When asked if the words *probable*, *possible and potential mean the same thing*, the majority of respondents (n=103, 79.8%) disagreed but while the results between the sexes (*p*=.058) and generations (*p*=.058) were not statistically significant they may be noteworthy for communicators. Women accounted for 73.1% of the wrong answers and they were twice as likely (n=19, 26.0%) as men (n=7, 12.5%) to incorrectly indicate the terms meant basically the same thing. Older respondents, the WWII (n=2, 100%) and Silent generation (n=12, 28%) were also more likely to equate the terms while 81.6% of Boomers, 87.5% of Gen X's and 88.9% of Gen Y's indicated that the words do *not* basically mean the same thing. The results were statistically significant, however, for differences between levels of education ($\chi^2_{df=8}$ =18.617, p<.05). Respondents with some high school, some college and a Bachelor's degree were more likely to agree that the terms mean the same thing and accounted for 77% of positive responses.

Question 23, which asked for the meaning of a *tropical storm watch*, was not analyzed because of an error in the construction of answers. The researcher erred in the editing of the preferred answer which should have stated that the conditions were possible within the next 36 not 24 hours. That said, only 70 (52%) of respondents chose the “correct” response or the one chosen by a weather professional.

There were statistically significant differences between generations in response to the meaning of a *hurricane warning* ($\chi^2_{df=8}$ =18.690, p<.05). While the three youngest generations were more likely to answer the question correctly only 84 (62.2%) of the respondents chose the correct answer that *hurricane warning* meant that hurricane conditions are expected within 24 hours. The majority (95.6%) of respondents did, however, correctly indicate that watches and warnings were issued by the NWS. There was a statistically significant difference between the sexes in response to this question ($\chi^2_{df=1}$ =3.896, p<.05). Men (100%) were more likely than women (93.4%) to correctly answer the question.

Items 18 and 26 were inadvertent repetitions of the same questions but the results were very close with question 26 having 4 more correct responses. Question 18 was not analyzed. For question 26, men (93.0%) were significantly more likely than women (78.9%) to correctly choose answer 26A ($\chi^2_{df=1}$ =5.022, p<.05), identifying NWS as part of NOAA. There were statistically significant differences between generations ($\chi^2_{df=4}$ =11.708, p<.05) with the youngest respondents more likely to correctly choose answer 26B, identifying NWS as part of the Department of Commerce. Generation X (47.1%) and Generation Y (55.6%) were more likely to make the right choice. Men (38.6%) were also more likely than women (15.8%) to know of the NWS connection to Department of

Commerce ($\chi^2_{df=1}$ =8.904, p<.01). Respondents with some graduate school (64.7%), graduate school (50.0%) and those with doctorates (45.5%) also were more likely to know of the NWS connection to Department of Commerce ($\chi^2_{df=8}$ =35.721, p<.05).

Questions 29, 30 and 31 asked respondents to choose an answer that matched the intended meaning of a colored portion of the map. These questions aimed to measure agreement/understanding of map design conventions that use color coding to indicate gradations of intensity or other specified information. Question 29 asked what the “red area of the Figure 1 graphic represents” and 122 (90.4%) of the respondents chose the correct answer. The correct answer was “hurricane warning for that area” and it was clearly stated in the map’s legend. Question 30 asked respondents to choose an answer relating to the pink area of the graphic. Only 81 (60.0%) of the respondents chose the correct answer, *indicates that hurricane conditions are possible within 36 hours*. In this instance, selecting the correct answer requires respondent knowledge of the definition of a *hurricane watch*, because that information is not included in the legend. The three youngest generations were significantly more likely to choose the correct answer ($\chi^2_{df=8}$ =29.052, p<.01): Baby Boomers (n=34. 70.8%), Generation X (n=14, 82.4%), and Generation Y (n=9, 100%). There were also statistically significant differences in the answers to this question ($\chi^2_{df=16}$=31.095, p<.05) for those claiming an Associates degree (n=4, 66.7%), Bachelors degree (n=26, 76.5%), Some Graduate school (n=15, 93.8%), and Graduate school (n=12, 75%) were more likely to answer correctly.The majority of respondents (n=119, 88.2%) correctly identified the white area of the graphic as the area of uncertainty for the storm track. Younger respondents from Generation X (n=16, 94.1%) and Generation Y (n=9, 100%) respectively were more likely to make the correct choice ($\chi^2_{df=12}$ =28.020, p<.05).

When asked where respondents remembered seeing the graphic, the majority sited television (n=114, 84.4%) but results showed a statistically significant difference among generations ($\chi^2_{df=4}$ =13.902, p<.01). The Silent Generation (n=50, 89.3%) and Generation X (n=16, 94.1%) were more likely to choose television. The second most cited outlet for recall of the graphic was the Internet with 98 (73%) of the respondents making that choice. Among those choosing the Internet, there was a statistically significant difference between generations ($\chi^2_{df=4}$ =26.934, p<.01) with the three youngest groups more likely to make that choice [Baby Boomers (n=43, 84.0%), Generation Xs (94.1%), and Generation Y, 100%].

Question 33 offered respondents seven alternatives (pick all that apply) and was designed as an attempt to measure what meaning viewers derived from the graphic, both as a representation of specific storm information, as well as subjective assessment of its accuracy. The majority of respondents chose the four correct answers relating to the storm's expected track and speed. Of those four there were significant differences between respondents by generations ($\chi^2_{df=4}$ =9.728, p<.05) and education ($\chi^2_{df=8}$ =17.515 p<.05) in associating the graphic with *where* a storm is expected. The three youngest groups were more likely to choose this correct answer [Baby Boomers (n=45, 90.0%), Generation Xs (n=15, 88.2%) and Generation Y, (n=9, 100%]. Those with some high school (n=2, 66.7%), some college (n=7, 25.0%) and those that completed graduate school (n=3, 16.7%) were all more likely to miss this answer. The correct answer to the graphic indicating how *fast* the storm is moving, was chosen by smallest number of respondents (n=103, 76.3%) and pointed to statistically significant differences between generations ($\chi^2_{df=8}$=17.168, p<.05). Again the youngest respondents [Baby Boomers (n=42, 84.0 %) Generation X, (n=16, 94.1%) and Generation Y, (n=8, 88.9%)] were most likely to choose the correct answer.

For the 16.3% of respondents who indicated that the graphic represented a very reliable forecast, those with a high school/GED (n=2, 28.6%) along with those with a Some graduate school (n=3, 17.6%), Graduate school (n=7, 38.9%), Post graduate (n=3, 33.3%, and those with Doctorate degrees (n=3, 27.3%) were significantly more likely to have faith in the graphic as an accurate depiction of a storm forecast ($\chi^2_{df=8}$ =17.168, p<.05).

Question 36 asked respondents to choose answers that would not be easily gleaned from the legend. The majority of respondents (n=116, 85.9%) chose the correct answer, that the storm was much more likely to make landfall in Florida than Alabama, but the more interesting results are from the incorrect choices. Nearly a third (n=44, 32.6%) of the respondents indicated that hurricane winds would not be evident in Florida until 8 p.m. on Wednesday. According to the graphic, at 8 p.m. on Wednesday the storm's *center* is forecasted to be located on the Florida/Alabama line. While these results were significant across generations ($\chi^2_{df=8}$ =23.753, p<.01) there did not seem to be trends or generalizations from the data. Another incorrect answer is the choice made by 23 (17%) of the respondents who incorrectly indicated that the graphic showed the size of the storm would grow as it moves north. The only statistically significant difference of note was between men and women ($\chi^2_{df=1}$=5.064, p<.05). While only 17% of the respondents incorrectly indicated that the size of the storm will grow as it moves north, it was statistically significant and interesting that 18 (78.3%) of these incorrect answers were from women.

Although only 18.5% (n=25) of the respondents did not choose the correct answer relating to the graphic's center black line (Question 38), it was significant ($\chi^2_{df=8}$ =24.944, p<.01) that all of the WWII generation (n=3, 100%) chose the answer that indicated the line was a "guesstimate" of the storm's location. The "correct" answer was that the line was *a forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position.*

The WWII (66.7%) and the Silent (37.5%) generations also departed from the majority of respondents on Question 39 relating to the meaning of the concentric circles on Figure 2. Both of these groups were statistically different ($\chi^2_{df=4}$=12.265, p<.05) than others in interpreting the concentric circles as an area to be affected by hurricane winds rather than an area of uncertainty.

Correlations

To determine possible relationships between Factors of Trust for NWS and Trust of Local Media and questions relating to ease of understanding of graphics and nervous emotional response to severe weather forecasts, a simple correlation statistical test was performed. There were two statistically significant correlations found. Both were weak associations between Question 7, related to the informative nature and ease of understanding of tropical storm graphics, and Trust for NWS (r=.34, p<.01) and Trust of Local Media (r=.19, p<.05). An additional correlation statistical test was performed to determine if an association was evident between Question 19 and Question 20. Question 19 asked respondents if they *had to choose between the NWS and my local media, I'd* *rely on my local forecast*. Question 20 asked respondents *if their local forecasts are generally accurate*. There was a statistically significant correlation found with a moderate relationship between the two questions ($r=.503$, $p<.01$).indicating the reponses are related but did not provide information as how they are related.

Broadcast Meteorologists Survey Data

A meteorologist, according to the American Meteorological Society, is a person with specialized education, “who uses scientific principles to explain, understand, observe, or forecast the earth's atmospheric phenomena and/or how the atmosphere affects the earth and life on the planet *(AMS, 2007, para #3*). For many residents of tropical storm regions, the television’s meteorologist or weather reader is often the face of broadcast meteorology. For many viewers these broadcasters are often the first and foremost purveyor of critical weather information. Many stations use NWS graphics and information in their severe weather forecasts.

As Table 8 indicates, seven working broadcast meteorologists from southwest Florida stations responded to the 51-item online questionnaire. All of the respondents have some college education and three (48%) have completed graduate school or post graduate work. All reported at least six years of weather forecasting experience and all but one had at least six years of weather broadcasting experience. Two of the broadcasters reported more than 20 years involvement in weather broadcasting. Three of the broadcasters reported professional designations afforded by the American Meteorological Society (AMS). Two hold the AMS Seal of Approval and one the CBM. One respondent listed receipt of an Emmy for weather graphics.

Table 8
Demographic Frequencies - Broadcast Meteorologists

Item	N	%
Education level completed		
Bachelors Degree	2	28.6
Graduate School	2	28.6
Some College	1	14.3
Some Graduate School	1	14.3
Post Graduate	1	14.3
I have been involved in weather forecasting *for…*		
6-10 years	2	28.6
16-20 years	2	28.6
11-15 years	1	14.3
21-25 years	1	14.3
26+ years	1	14.3
I have been involved in weather broadcasting *for…*		
6-10 years	2	28.6
1-5 years	1	14.3
11-15 years	1	14.3
16-20 years	1	14.3
21-25 years	1	14.3
26+ years	1	14.3

N=7

The broadcasters who responded to the survey indicated they believe the media do a good job in preparing the public for severe weather (*M*=5.71) and their station's forecasts are extremely important to the public in their decision making (*M*=6.57). As a group they think visuals and graphics are important tools (*M*=6.86) for preparing populations at risk. The Broadcasters indicated the NWS provides them accurate (*M*=5.71) and important forecast information (*M*=6.29) that is easily understood by meteorologists (*M*=6.71).

Table 9
Broadcast Meteorologist Opinions of Severe Weather Forecasting

Item	M	SD
The media do a good job in preparing the general public for severe weather like hurricanes.	5.71	.488
I am happy with the current status of broadcast coverage of severe weather.	5.00	.816
My station's tropical storm/hurricane forecasts are extremely important to the public in their decisions to make storm preparations or plans to evacuate.	6.57	1.134
I think visuals and graphic representations of weather such as radar and tropical storm track graphics are important tools for preparing populations at risk.	6.86	.378
I think the general public understands the basics of meteorology.	4.29	1.496
I think most people rely upon what they *hear* during a weather forecast.	5.29	.756
I think most people rely upon what they s*ee* during a weather forecast.	5.29	1.254
My station has adequate systems to measure audience satisfaction of severe weather forecasts and coverage.	4.14	1.069
I think the information provided by the National Weather Service (NWS) and the National Hurricane Center (NHC) is accurate.	5.71	.488
I think the information/products provided by the National Weather Service and the National Hurricane Center is easily understood by reporters.	3.43	1.512
I think the information/products provided by the National Weather Service and the National Hurricane Center is easily understood by meteorologists	6.71	.488
The NWS/NHC tropical storm and hurricane forecasts are very important to what I broadcast or predict.	6.29	.756
I think the information and graphic products provided by the National Weather Service and the National Hurricane Center are easily understood by members of the general public.	3.71	1.380
The NWS products, such as the tropical storm track, provide the information the general population needs to make better preparation decisions.	4.57	1.397
If the general public had to choose between the National Weather Service and my local media, they rely on their local forecast	5.17	1.722
The general public will say their local weather forecasts are generally accurate	5.43	.976

N=7
Respondents were asked to rate their level of agreement of agreement with the statements on a scale to 1 to 7, with 1 indicating complete disagreement and 7 complete agreement.

The broadcast meteorologists were much less confident, however, about the general public's understanding of meteorology (*M*=4.29); the public's ability to easily understand information and graphics supplied by NWS and NHC (*M*=3.71); and were even less positive of other reporters' ease of understanding of NWS informational products (*M*=3.43).

Meteorologists seemed to believe the public has some confidence in *accuracy* of local forecasting (*M*=5.43) and that the public would prefer their local forecast to a NWS forecast (*M*=5.17). Broadcasters seemed ambivalent about whether viewers rely on what they *hear* (*M*=5.29) versus what they *see* during a weather forecast (*M*=5.29)

Broadcasters indicated (n=5, 71.4%) that the public would consider the terms *probable*, *possible* and *potential* to basically mean the same thing and expected the public to remember the Saffir-Simpson Hurricane Scale was a measure of hurricane intensity (n=6, 85.7%) to measure. Broadcasters were unanimous in their expectations (n=7, 100%) that the public would know a hurricane packed winds of more than 73 mph but were less confident in the public's correct choice regarding hurricane *warning* (n=5, 71.4%).

(See Tables 10, 11 and 12 for broadcasters' responses and Tables 4, 5, and 6 for the respective public responses to these questions.)

Table 10
Knowledge of Weather Related Terms Frequencies- Broadcast Meteorologists

Item	N	%
The general public will say that.. probable, possible and potential all basically mean the same thing.		
True	5	71.4
False	*2*	*28.6*
Unsure	0	0
No answer	0	0
To the general public a tropical storm watch for their area means...		
Tropical storm conditions including winds of 39 to 73 mph are possible within the next 24 hours	*5*	*71.4*
Conditions in my area are conducive to the development of a tropical storm	0	0
A tropical storm is likely to hit my area within the next 24 hours	2	28.6
Unsure	0	0
No answer	0	0
To the general public a hurricane warning for their area means…		
Hurricane conditions are expected in my area within the next 24 hour	*5*	*71.4*
A hurricane will likely hit my area within the next 2 days	1	14.3
Conditions in my area are conducive to hurricane development	1	14.3
No answer	0	0
The general public will say that hurricane and tropical storm watches and warnings are...		
Issued by the National Weather Service	*6*	*85.7*
Are official designations	3	42.9
Determined by my local media	2	28.6
Unsure	2	28.6
Issued by local emergency planners	1	14.3
The general public will say the Saffir/Simpson Hurricane Scale…		
Is a scale ranging from 1-5 based on the intensity of the hurricane	*6*	*85.7*
No answer	2	28.6
Categorizes storms as tropical depressions, storms or hurricanes	1	14.3
Is a scale used to indicated the size of a storm	1	14.3
Unsure	0	0
The general public will say a hurricane is characterized by…		
Winds of more than 73 mph	*7*	*100*
A proper name	5	71.4
A pronounced low-pressure circulation	3	42.9
Unsure	1	14.3

Note. N=7. *Some questions ask for respondents to check "all that apply" and result in N>7*
Answers in italics and bolded are considered "correct""

Broadcaster results suggest they expect the public to understand basic map reading tenants such as Northerly orientation of news maps (n=6, 85.7%), and use of a legend to explain color coding. Broadcasters expected the public to understand the red area in Figure 1 represented an area under a hurricane warning (n=6, 85.7%), while the white area showed an area of uncertainty for the storm's predicted path (n=5, 71.4%).

Table 11
Understanding of Visual Conventions Frequencies– Broadcast Meteorologists

Item	N	%
The general public will recognize this graphic (Figure 1)as a representation of the path of a ...		
Hurricane	*7*	*100.0*
Tornado	0	0
High pressure system	0	0
Unsure	0	0
No answer	0	0
Severe thunderstorm	0	0
To the general public the red area of the Figure 1 graphic represents...		
Hurricane warning for that area	*6*	*85.7*
Tropical storm warning for that area	1	14.3
Hurricane watch for that area	0	0
The direction the storm is expected to more	0	0
Unsure	0	0
No answer	0	0
To the general public, the pink area of the Figure 1 graphic...		
Indicates that hurricane conditions are possible within 36 hours	*2*	*28.6*
Is under a tropical storm watch	2	28.6
Is outside of any danger for landfall of the storm	2	28.6
Unsure	1	14.3
No answer	0	3.0
To the general public, the solid white area on the map (Figure 1) indicates...		
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*5*	*71.4*
The only areas predicted to be affected by any hurricane or tropical storm force winds	1	14.3
No answer	1	14.3
The area to be affected by hurricane force winds	0	0
The predicted size of the storm over time	0	0
Unsure	0	0
The general public will indicate that the state of Florida is approximately….		
400 miles long from north to south	3	42.9
Unsure	2	28.6
100 miles wide at its center	*1*	*14.3*
No answer	1	14.3
400 miles from Cuba	0	0
The general public will say that US maps shown in the news (like Figure 1) are usually shown with what direction on top?		
North	*6*	*85.7*
No Answer	1	14..3
Varies	0	0
South	0	0
West	0	0
East	0	0
Unsure	0	0

Answers in italics and bolded are considered "correct"

Table 12
Understanding of Hurricane Graphic Frequencies – Broadcast Meteorologists

Item	N	%
The general public will recognize this graphic (Figure 1)as a representation of the path of a ...		
Hurricane	*7*	*100*
Tornado	0	0
High pressure system	0	0
Unsure	0	0
No answer	0	0
Severe thunderstorm	0	0
The general public will indicate that the graphic in Figure 1...		
Is an important indicator to me of the storm's path	*5*	*71.4*
Tells me WHERE a tropical storm or hurricane is expected	*5*	*71.4*
Tells me WHEN a tropical storm or hurricane is expected	*4*	*57.2*
Indicates how fast the storm is moving	*3*	42.9
Is just a guesstimate by meteorologists	3	42.9
Tell me the size of the storm	1	14.3
Unsure what it means	1	14.3
Is a very reliable forecast	0	0
To the general public the graphic (Figure 1)indicates.....		
The storm is much more likely to make landfall in Florida than in Alabama	*6*	*85.7*
Hurricane winds will not be evident in northern Florida until 8 PM on Wednesday	3	42.9
The size of the storm will grow as it moves north	1	14.3
The intensity of the storm will diminish as it moves towards northern Florida	0	0
Unsure what it means	0	0
To the general public the center black line in the Figure 1 graphic indicates...		
A guesstimate of center of the hurricane and it's predicted path	3	42.9
A forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position	*2*	*28.6*
A 95% accurate forecast of the storm's path over the next 5 days	1	14.3
Unsure	1	14.3
No answer	0	0
The general public will say the concentric circles on Figure 2 graphic indicate..		
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*4*	*57.2*
Unsure what they mean	3	42.9
The predicted size of the storm over time	2	28.6
The area to be affected by hurricane force winds	1	14.3
The only areas predicted to be affected by any hurricane	1	14.3

Note. *N=7. Some questions ask for respondents to check "all that apply" and result in N>7*

When asked to predict the public's responses to items related to understanding of the Figure 1 graphic, broadcasters fully expected the public to recognize the graphic as a representation of a hurricane path (n=7, 100%) but expected fewer public respondents to understand it as a prediction of the storm's location (n=5, 71.4%) or it's speed (n=3, 42.9%). Most notably the broadcasters did not expect the public to understand the meaning of the graphic's center black line as a forecast line within a cone of uncertainty. Only 2 (28.6%) of the respondents predicted the public to answer that question correctly while 3 (42.9%) expected the public to consider the line a guesstimate of the storm's path. Additionally, many broadcasters did not expect the public to understand the concentric circles in Figure 2 to represent an area of uncertainty with only 4 (57.2%) indicating the public would be able to understand an unfamiliar graphic (see Table 12).

Broadcasters were asked what they thought (open comment section) were the most effective tools or methods to assist public understanding of weather forecasts. Six of the seven respondents said a combination of graphics and clear and easy to understand explanations were necessary.

Six of the seven Broadcasters also indicated they use the same weather graphics vendor with some also listing the NWS, NHC, and some universities as suppliers. When asked what changes they might make to the NWS Tropical Storm Track graphic, three of the six recommended the removal of the center line.

Coorientation Perceptions

When compared question by question, broadcast meteorologists closely predicted many of the public's responses relating to their knowledge of weather related terms with the exception of the question regarding the terms probable, possible and potential (see Table 13).

Table 13

Knowledge of Weather Related Terms Frequencies- Comparison Public and Broadcasters

Item	N………%	…..	N……..%	
Probable, possible and potential all basically mean the same thing..(pick ONE)				
False	*105*	*77.8*	2	28.6
True	26	19.3	*5*	*71.4*
Unsure	3	2.2	0	0
No answer	1	.7	0	0
A tropical storm watch for my area means...(pick ONE)				
Tropical storm conditions including winds of 39 to 73 mph are possible within the next 24 hours	*70*	*51.9*	*5*	*71.4*
Conditions in my area are conducive to the development of a tropical storm	52	38.5	0	0
A tropical storm is likely to hit my area within the next 24 hours	11	8.1	2	28.6
Unsure	1	.7	0	0
No answer	1	.7	0	0
A hurricane warning for my area means…(pick ONE)				
Hurricane conditions are expected in my area within the next 24 hour	*84*	*62.2*	*5*	*71.4*
A hurricane will likely hit my area within the next 2 days	26	19.3	1	14.3
Conditions in my area are conducive to hurricane development	24	17.8	1	14.3
No answer	1	.7	0	0
Hurricane and tropical storm watches and warnings are… (check ALL that apply)				
Issued by the National Weather Service	*129*	*95.6*	*6*	*85.7*
Are official designations	54	40.0	3	42.9
Issued by local emergency planners	25	18.53	2	28.6
Determined by my local media	3	2.2	2	28.6
Unsure	3	2.2	1	14.3
The Saffir/Simpson Hurricane Scale…(pick ONE)				
Is a scale ranging from 1-5 based on the intensity of the hurricane	*110*	*81.5*	*6*	*85.7*
Unsure	20		2	28.6
Categorizes storms as tropical depressions, storms or hurricanes	2	1.5	1	14.3
Is a scale used to indicated the size of a storm	1	.7	1	14.3
No answer	2	1.5	0	0
A hurricane is characterized by…(check ALL that apply)				
Winds of more than 73 mph	*124*	*91.9*	*7*	*100*
A pronounced low-pressure circulation	80	59.3	5	71.4
A proper name	55	40.7	3	42.9
Unsure	3	2.0	1	14.3

Note. N=135. *Some questions ask for respondents to check "all that apply" and result in N>135*

Answers in italics and bolded are considered "correct""

Five of the seven broadcasters (71.4%) incorrectly predicted the public's response would indicate that they believed the terms have the same meaning when previously reported results indicated that 77.8% of the public did *not* believe the terms have the same meaning. For other terms, such as definition of Saffir-Simpson Hurricane Scale, definition of a hurricane as winds of more than 73 mph, and hurricane *warning* as conditions expected within 24 hours, the meteorologists predicted that more of the general public would answer correctly. However, the public outperformed the meteorologists' predictions when asked questions regarding visual conventions and hurricane graphics (Tables 14 and 15).

Table 14

Understanding of Visual Conventions Frequencies–Comparison	*Public*	*and*	*Broadcasters*	
Item	N	%	N	%
I recognize this graphic (Figure 1) as a representation of the path of a ...				
Hurricane	*131*	*97.0*	*7*	*100.0*
Tornado	1	.7	0	0
High pressure system	1	.7	0	0
Unsure	1	.7	0	0
No answer	1	.7	0	0
Severe thunderstorm	0	.0	0	0
The red area of the Figure 1 graphic represents …(pick ONE)				
Hurricane warning for that area	*122*	*90.4*	*6*	*85.7*
Hurricane watch for that area	4	3.0	1	14.3
The direction the storm is expected to more	4	3.0	0	0
Tropical storm warning for that area	1	.7	0	0
Unsure	1	.7	0	0
No answer	3	2.2	0	0
The pink area of the Figure 1 graphic …(pick ONE)				
Indicates that hurricane conditions are possible within 36 hours	*81*	*60.0*	*2*	*28.6*
Is under a tropical storm watch	41	30.4	2	28.6
Unsure	5	3.7	2	28.6
Is outside of any danger for landfall of the storm	4	3.0	1	14.3
No answer	4	3.0	0	3.0
The solid white area on the map (Figure 1) indicates…(pick ONE)				
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*119*	*88.1*	*5*	*71.4*
The area to be affected by hurricane force winds	9	6.7	1	14.3
The predicted size of the storm over time	3	2.2	1	14.3
The only areas predicted to be affected by any hurricane or tropical storm force winds	1	.7	0	0
No answer	3	2.2	0	0
Unsure	0	0.0	0	0
The state of Florida is approximately…(pick ONE)				
100 miles wide at its center	*53*	*39.3*	3	42.9
400 miles long from north to south	51	37.8	2	28.6
Unsure	23	17.0	*1*	*14.3*
400 miles from Cuba	5	3.7	1	14.3
No answer	3	2.2	0	0
U.S. maps shown in the news (like Figure 1) are usually shown with what direction on top? (pick ONE)				
North	*128*	*94.8*	*6*	*85.7*
Varies	2	1.5	1	14..3
South	1	.7	0	0
West	1.	.7	0	0
No Answer	3	2.2	0	0
East	0	0.00	0	0
Unsure	0	0.00		

Note. *N*=135. *Answers in italics and bolded are considered "correct*

When asked to predict the public's responses to items related to understanding of the Figure 1 graphic, broadcasters fully expected the public to recognize the graphic as a representation of a hurricane path (n=7, 100%) versus the public (n=131, 97%) but expected fewer to understand it as a prediction of the storm's location (n=5, 71.4%) versus the public (n=118, 87.%) when it was expected (n=4, 57.2%), versus the public (n=108, 80.0%), or it's speed (n=3, 42.9%) versus the public (n=103, 76.3%). Most notably the broadcasters did not expect the public to understand the meaning of the graphic's center black line as a forecast line within a cone of uncertainty. Only two or 28.6% of the respondents predicted the public to answer that question correctly versus the 110 or 85.9% who did. The broadcasters (n=3, 42.9%) also expected the public to consider the line a guesstimate of the storm's path versus the 18 or 13.3% who did.

Table 15

Understanding of Hurricane Graphic Frequencies Comparison - Public and Broadcasters

Item	Public N	Public %	Broadcasters N	Broadcasters %
I recognize this graphic (Figure 1) as a representation of the path of a ...				
Hurricane	*131*	*97.0*	*7*	*100*
Tornado	1	.7	0	0
High pressure system	1	.7	0	0
Unsure	1	.7	0	0
No answer	1	.7	0	0
Severe thunderstorm	0	.0	0	0
The graphic in Figure 1…(check ALL that apply)				
Is an important indicator to me of the storm's path	*119*	*88.1*	*5*	*71.4*
Tells me WHERE a tropical storm or hurricane is expected	*118*	*87.4*	*5*	*71.4*
Tells me WHEN a tropical storm or hurricane is expected	*108*	*80.0*	*4*	*57.2*
Indicates how fast the storm is moving	*103*	*76.3*	*3*	42.9
Tell me the size of the storm	37	27.4	3	42.9
Is just a guesstimate by meteorologists	32	23.7	1	14.3
Is a very reliable forecast	22	16.3	1	14.3
Unsure what it means	1	.7	0	0
According to the graphic in Figure 1…(check ALL that apply)				
The storm is much more likely to make landfall in Florida than in Alabama	*116*	*85.9*	*6*	*85.7*
Hurricane winds will not be evident in northern Florida until 8 PM on Wednesday	44	32.6	3	42.9
The size of the storm will grow as it moves north	23	17.0	1	14.3
The intensity of the storm will diminish as it moves towards northern Florida	4	3.0	0	0
Unsure what it means	2	1.5	0	0
The center black line in the Figure 1 indicates…(pick ONE)				
A forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position	*110*	*81.5*	3	42.9
A guesstimate of center of the hurricane and it's predicted path	18	13.3	*2*	*28.6*
A 95% accurate forecast of the storm's path over the next 5 days	5	3.7	1	14.3
Unsure	1	.7	1	14.3
No answer	1	.7	0	0
The concentric circles on Figure 2 graphic indicate…(pick ALL that apply)				
The area of uncertainty or possibility for the center of the storm's track and potential landfall	*108*	*80.0*	*4*	*57.2*
The area to be affected by hurricane force winds	35	25.9	3	42.9
The predicted size of the storm over time	15	11.1	2	28.6
The only areas predicted to be affected by any hurricane	8	5.9	1	14.3
Unsure what they mean	8	5.9	1	14.3

Note. N=135. *Some questions ask for respondents to check "all that apply" and result in N>135*

In general, the results seem to indicate that the broadcasters expected the public to be more conversant with particular severe weather terms but less able to understand the graphic of Figure 1. Many members of the public (M=5.52) considered the storm graphics to be informative and easy to understand, but this contrasts with some of the results, particularly with the aforementioned responses regarding *watches* and *warnings*

Most dangerous of the levels of coorientation according to Broom (1977) is dissensus, where parties think they agree but do not. If the public thinks they understand the graphic but in fact do not and the users of the graphic think the public does not, but for the wrong reasons, then future efforts to alleviate the difference may exacerbate rather than cure the problems.

CHAPTER FIVE: DISCUSSION

It is only through communication that we as individuals, publics and organizations can come to understand each other. Understanding comes not from a single engagement but through a continuous process. In 1953 Newcomb posited coorientation as a relational term to describe a state of “simultaneous orientation toward one another” that required two–way communication. According to Broom (1977) this coorientation results in a consensus of understanding that takes into account actual agreement as well as the parties’ perceptions of agreement. This common understanding depends upon “accurate perceptions from all parties involved” (Austin & Pinkleton, 2001, p. 62). To know if we reach a consensus of understanding we must measure the levels of accuracy and agreement of those perceptions.

In all communication work, especially in the realm of public relations, we must strive to verify a common understanding. In a world that is rapidly changing, with emphasis on diversity and inclusion, verifying a common understanding is vital to creating shared meaning. For organizations such as the National Weather Service (NWS) simply communicating their forecasts is not sufficient. To be effective, they must know people understand their warnings.

The NWS has a vast number and variety of relationships with organizations that use their products. For the tropical cyclone graphic alone, the NWS listed their audiences as a continuum starting with federal agencies and the media and ending with the general public. Additionally, each person in these audiences looks through his or her own perceptual looking glass. To add to the complexity is NWS' multifarious communication environment with its mix of scientific, governmental, and corporate organizational cultures.

While many of us might like to think a visual or graphic representation is fairly straightforward, Kosttelnick and Hassett (2003) remind us that "…readers seldom encounter visual language in perceptual, social or historical vacuums" (p. 3). While designers have little or no control over how their visuals are used, they can work to develop a relationship with their publics through the development and use of visual conventions. For NWS graphic designers to efficiently communicate with visual language it will require "constant cooperation among designers and readers" (Kosttelnick and Hassett, 2003, p. 3).

This research was an effort to use one graphical product of the NWS and query the public for their perceptions of its meaning. Selected broadcasters were also asked for their opinions about severe weather forecasts as well as their perceptions of the public's understanding of forecast products. The instruments were designed to answer five research questions and to see if the graphic's construction holds any clues to those perceptions.

RQ1: Does the general public's knowledge of basic weather terms and concepts match the level necessary to understand the meaning of the hurricane graphic?

The results of this study, as well as the many which preceded it (FEMA & USACE, 2005; Morrow, 2004) lead to the conclusion that the terms *watch* and *warning* are problematic for the general public as well as professionals. Respondents in this study did well (80% or better correct response) with weather-related vocabulary, concepts, and graphic interpretations except when it came to the terms *watch* and *warning*. When one considers the majority of this study's population to be mature, well educated, and predominately residents of a hurricane prone state, these results are especially noteworthy. In view of the errors made in construction of question 23 and the number of incorrect choices made by both professionals and laymen alike, the problem with the terms may point to an issue beyond definition alone. With both words beginning with a "w" and being relatively close in length, it may be possible that visually they may be too alike as well.

The confusion over these terms may have a substantial impact on levels of understanding of the graphic. If one of the central messages of the tropical cyclone graphic is to warn residents of an impending storm landfall, then viewers must understand from the graphic where and when it is forecasted to occur. "Reading" the graphic without the benefit of a narrative would be difficult if residents do not remember the definition of a *watch* as a "conditions are possible within 36 hours" or *warning* that indicates conditions are expected within 24 hours or less.

Levels of knowledge were not consistent, however, across demographic segments. The results of this study revealed that there were differences in levels of knowledge of weather related terms and concepts with the youngest respondents scoring significantly better in some of the knowledge questions. This result may be linked to their significantly higher percentage of Internet use, where graphics can be examined longer, have legends, are sometimes accompanied by a narrative forecast, and in some cases can be enlarged.

RQ2: Are the visual conventions used in the creation of the hurricane graphic understood by the general public as they were intended by the designers?

Overwhelmingly, the respondents recognized Figure 1 as a graphic depiction of a hurricane path (n=131, 97.0%). They overwhelmingly understand (95.8%) that in most news products, U.S. maps are oriented to the North. They seem to understand that colors are used to represent different sectors of information such as tropical watch and warning areas and were used to differentiate landmass from water. Other information may have been gleaned from the graphic and as a result correct answers to questions may not be a measure of knowledge of the graphic components. For instance the title of the legend was “Hurricane Ivan” and explanation of the pink, red and white areas of the graphic were also explained in the legend. However, there was neither compass rose (an indicator of direction such as north or south) nor scale (indicator of distance on the map relative to distance on the ground) evident. The NOAA insignia was prominent on the graphic as was the National Weather Service Logo.

The graphic does not indicate the size of the storm nor does it utilize perspective, to indicate size relative to position, but the results of questions 33 and 36 may indicate some interpreted the graphic that way. Respondents (27.4%) indicated the graphic “tells me the size of the storm” and 17% answered “the size of the storm will grow as it moves north,” which may indicate two distinct or related misinterpretations. The first misinterpretation is that some graphic element shows the size of the storm (possibly the orange center location marker or white area). The second misinterpretation may be a result of misunderstanding of the white area or cone of uncertainty. Instead of interpreting the widening cone, as an increasingly larger area of statistical uncertainty for the storm track, it may be confused with perspective that would indicate "the size of the storm will grow as it moves north."

RQ3: Does the general public understand the meaning of the hurricane graphic?

Question 33 was intended to determine whether the public understood Figure 1 graphic as a forecast product detailing storm specific information. As reported, respondents correctly identified key elements of the graphic design with a majority (n=119, 88.1%) indicating that the graphic was an important indicator of the storm's path. Respondents also (n=118, 87.4%) indicated that the graphic tells them where and (n=118, 87.4%) and the majority of respondents (n= 108, 80.0%) indicated that the graphic tells them when a tropical storm or hurricane is expected. Additionally, 103 (76.3%) of respondents correctly indicated the graphic contained information about the speed of the storm's movement. Question 36 asked respondents storm specific questions and was intended to require respondents to extrapolate meaning from the graphical conventions used in Figure 1 - to conclude where and when the hurricane would most likely make landfall. With 116 or 85.9% of the respondents correctly indicating that the storm was much more likely to make landfall in Florida than in Alabama, it may indicate that the majority of respondents understood the white area overlapping the outline of the state of Florida as the potential landfall area. However, the seeming misinterpretation of the time hacks indicating the storm's center location with arrival of hurricane winds (n=44, 32.6%) is an indicator that those who incorrectly choose that option have not considered the size of the storm as a factor. Additionally, 23 respondents (17%) of the respondents incorrectly indicated that the graphic showed the storm "grow as it moves north." Of those respondents there were a larger percentage of women than men who made that choice.

The answer to this research question is probably a relative one. With so much information included in the graphic it may be a subjective determination that depends upon how much of the “necessary” information included in the graphic is processed and understood. To answer this question definitively would require some benchmarks from the designers, as to what information was critical to *understand* the graphic, as well as consideration of the informational needs of the viewer. In the case of Figure 1, a viewer living in Miami may understand the graphic enough or get sufficient information to dismiss the storm as a threat. A resident of Punta Gorda, however, may not fully satisfy her or his information needs without further information. To decide if the storm is a threat to Punta Gorda, residents may need to more closely examine the graphic for information. To fully understand the forecast, viewers may need additional information such as a map scale to determine the relative proximity of the cone and as well as an idea of the size of the storm.

As an attempt to measure understanding of another NWS graphic, the last question asked the public to examine a previously offered alternative watch/warning graphic that was likely to be unfamiliar to respondents. Almost as many respondents -- 80% for Figure 2 versus 81% for Figure 1 -- answered the question correctly. This result could point to the importance of a clear legend to understanding of a graphic. This conclusion could also be supported by comparison of the number of correct responses to Questions 29, and Question 30. The first asked for an answer which was explicitly provided in the legend, and 90.4% (n=122) of the respondents chose the correct answer. In contrast, Question 30 asked respondents to answer without all the necessary information available in the legend and only 81 or 61% of the respondents correctly chose -hurricane conditions are possible within 36 hours - as an answer.

Although there were significant differences between groups in a large number of the questions, the results of the public questionnaire seem to indicate that the respondents do give meaning to the graphic in ways consistent with the designers' (NWS) intent. The public looks to the graphic, as evidenced by the results of Question 33, with an expectation of learning the predicted path of a storm and when it was expected to make landfall. While they may understand what the graphic should tell them, they may not do as well in gleaning storm specific information. This may be compounded by some respondents' attitudes about the forecast behind the graphic with only 22 (16.3%) of respondents indicating that they believe the graphic to be a *very reliable forecast*.

The oldest respondents seemed to choose more incorrect answers to the graphics questions than other groups. This may be related to their reported reliance on television weather where graphics are only shown for a limited time, and sometimes without the benefit of verbal or textural explanation.

RQ4: Does the general public trust the NWS and its graphical products such as forecasts?

The respondents to this survey, regardless of sex, education or age, are familiar with the NWS (M=5.58), believe the NWS does a good job of predicting hurricanes and other severe weather (M=5.59) and is an organization *that I can count on to make important decisions that may affect people like me* (*M*=5.38). Respondents indicated that they would rely more on a NWS than local forecast and in general held the NWS to a higher level of trust (M=5.52) than the local media (M=4.28). Although levels of trust of the NWS were level across generations, there was a statistically significant difference between generations in levels of trust of local stations with the youngest generation expressing the least amount of trust. Generation Ys were far less likely *(M*=2.88) to "trust" their local media than respondents from the Silent Generation (*M*=4.44). Generation Y (*M*=2.88) was also less likely to trust the local media than Baby Boomers (*M*=4.36). This result could be related to a much higher Internet usage level for weather information among this group. Levels of trust did not seem to be related to accuracy of forecasts. While competence is a factor of the Grunig and Hon's (1999) trust scale, weather prediction may be still be viewed by respondents as a difficult and inexact science and thus NWS is given some leeway for accuracy of its predictions.

> **RQ5**: Does the public's understanding of the meaning of the hurricane graphic match the broadcasters' perceptions of the public's understanding of the meaning of the hurricane graphic?

Although a major focus of this study is the visual components of a hurricane graphic, it seems that the accompanying voice track on broadcasts and explanatory text included in graphic legends are critical to the communication of severe weather information. Six of the seven broadcasters cited the importance of knowledgeable explanations by broadcasters, but both the public and meteorologists, as groups, seemed ambivalent in their responses regarding the primacy of visual or audio information from a broadcast forecast.

Considering this uncertainty, one of the more surprising and interesting results was the difference between the professionals' expectations and the general public's responses regarding the terms *probable, potential and possible*. The majority of broadcasters predicted that the terms were interchangeable as far as the public was concerned while 78% of the public disagreed. This result is interesting because it seems to indicate that broadcasters may need to be as precise in their word choices as they are in their graphic depictions. This dichotomy of emphasis on verbal versus visual explanations is evident when study results from Hurricane Charley are examined.

When broadcasters were asked in this study to choose a cause for the public's confusion of Charley's landfall, 71% chose the public's misinterpretation of the NWS' track graphic as the culprit while 14.3% said it was the public's misinterpretation of the local forecast. One respondent placed the miscues on "poor communication by NHC." These results are interesting when compared to the results of Morrow's (2004) field research in the aftermath of the storm.

In a study (Morrow, 2004) conducted in the aftermath of Hurricane Charley's landfall in Punta Gorda, "nearly everyone interviewed said they thought the storm was going to hit Tampa" (p. 10) and a number of meteorologists placed the blame on the public's misplaced emphasis on the graphic's center line. However, in four of the five exemplary quotes chosen by the researcher, the interviewees were quoted using the words "they said,' "we kept hearing" and "I heard" when referring to the storm's predicted landfall in Tampa rather than "I saw." The author goes on to say that the residents' complaints regarding the predictions were in contrast to the reality of the accuracy of the NHC's forecast and that "in reality, the National Hurricane Center did an excellent job of forecasting the storm" (p. 10). Morrow (2004) suggests the disconnect may be the public's response to a history of warnings (cry-wolf effect) with no serious impact or "too much attention to the center of the forecast track" (p. 10). Perhaps the misunderstanding can be traced to word choices of the meteorologists to explain the predicted path rather than in the forecast graphic details.

From results of this study, meteorologists seemed to believe the public has more confidence in *accuracy* of local forecasting (*M*=5.43) than the public reported (*M*=4.82). The broadcasters (*M*=5.17) also overestimated the public's preference (*M*=3.68) for local versus NWS weather forecasts.

While it seems that the general public does not recall hurricane related definitions and concepts as well as predicted by the meteorologists, it appears the respondents to this study do understand aspects of the hurricane graphic better than meteorologists expected. Respondents understand the graphic as a representation of a hurricane track and look to it for information of its speed and forecasted landfall. Of particular note is the number of correct responses to the meaning of the graphic's center black line. Broadcasters expected only 42.9% of the public to correctly answer that question while 81.5% of the respondents answered correctly. This may be more significant than some of the other results because the legend does not directly address the meaning of the line.

Since Hurricane Charley, several scholars and meteorologists have expressed concern over the effects of the graphic's center black line on viewers' expectations of storm tracks. This study's results may indicate that, when it comes to the public's understanding of the graphic, there is what Bloom (1977) refers to as *false consensus* (when parties disagree but think they agree) between broadcasters and the NWS and the public regarding their understanding of the graphic

While the public (M=5.84) indicated that the graphics are informative and easy to understand, broadcasters (M=3.43) indicate that they are not well understood by the public.

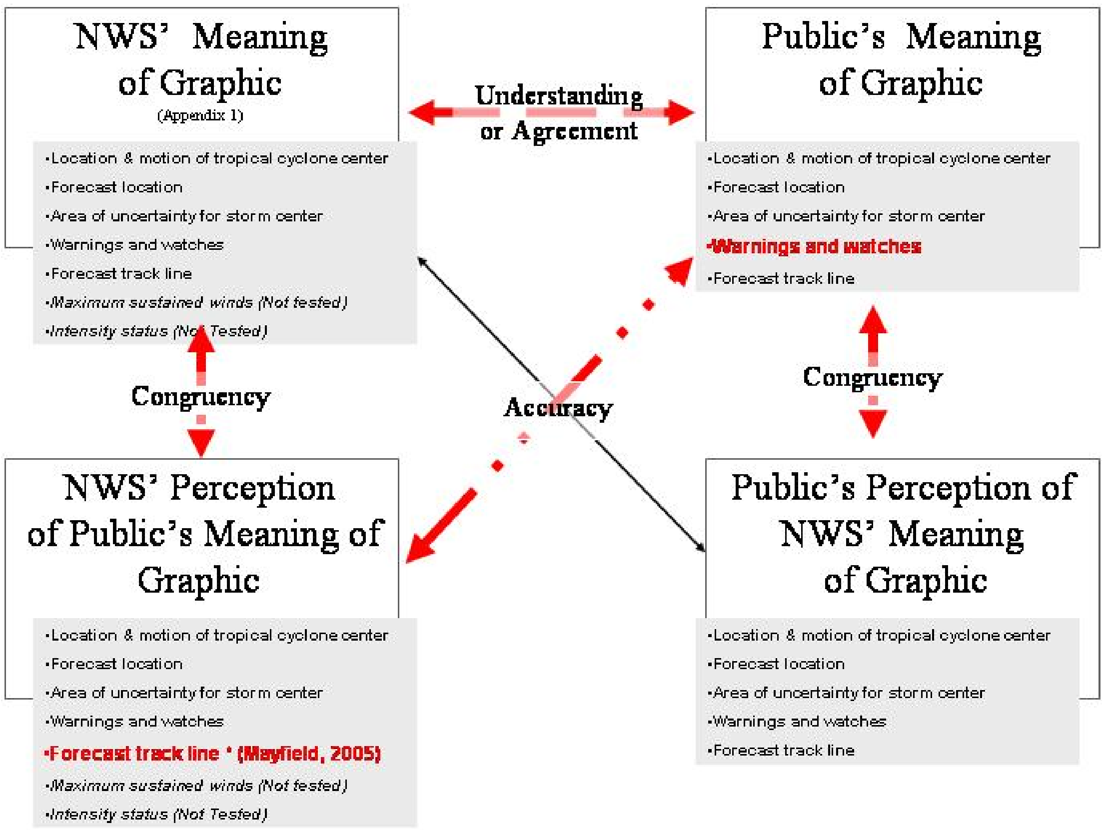

Figure 4: NWS-Public Consensus of Agreement - Understanding Model Results

Coorientation Model

Applying the coorientation model to this study's results indicate that there are areas of misunderstanding that impact levels of agreement between the NWS and the public. Results also indicate that there are problems with congruency as well as accuracy of perceptions.

According to Broom (1997) these results indicate that there is a lack of consensus between the NWS and the public regarding the meaning of the Tropical Cyclone Track Watch/Warning Graphic. It appears that the public thinks they understand (as indicated by the few unsure responses to the survey) the graphic as intended by the NWS but answers to the questionnaire indicate the public does not understand many items including the critical terms *Watch* and *Warning*. Additionally, the NWS' believes the public misinterprets the meaning of the graphic because of a focus on the center black line while results indicate the public does understand the meaning of the line but misreads the graphic's indication of *watches* and *warnings.* It seems the public easily uses the graphic legend to determine where the watches and warnings are in effect, but they do not seem to understand the meaning of these designations, particularly when it comes to time frames for possible or probable landfall.

These results indicate there is disagreement between the NWS and the public on the meaning of the graphic, but more troubling is the possibility of a state of *false consensus*. With such dire consequences resulting from misunderstanding of severe storm warnings, it is important that the NWS, emergency planners, and broadcast meteorologists know if there is disagreement among them. They also must know and agree on why they disagree if efforts to improve consensus are to be effective.

CHAPTER SIX: CONCLUSIONS

The results of this study are important to providers of emergency information must be aware of how their messages are interpreted and understood. Misunderstanding of critical information can lead to loss of life. Results of this study indicate that the general public and the National Weather Service do not share a common understanding of selected weather related terms and meaning of a NWS informational graphic. While the vast majority of respondents recognized the Tropical Cyclone Track Watch/Warning Graphic and understood much of the information it conveyed, 38% of study respondents did not seem to remember or understand the meaning of the terms *Watch* and *Warning*. These results indicate that too many members of the public would be subject to unnecessary risk due to a preventable misunderstanding. While these terms or conditions are only one aspect of the graphic they represent critical information for populations at risk. Additionally, the results of this study indicate that weather forecasting professionals' perceptions of the public's understanding of the graphic are inaccurate. Their perceptions that the publics' misunderstanding of the graphic is the result of misinterpretation of the center black line may not be correct. That the NWS, and the broadcast meteorologists seemingly share this presumption may result in misplaced efforts to improve public understanding.

The results of this study indicate an overwhelming majority of the public recognized the Figure 1 graphic as a representation of a path of a hurricane. Respondents readily (relatively few “unsure” responses) answered questions regarding the meteorological constructs of tropical storms and hurricanes as well as ones aimed at their associated traits of wind and movement. Respondents seemed to accept the graphic as representation of a storm that could or had existed outside of their immediate environment and seemed to agree with the representations of many of the conventions used by map makers such as color coding, scale, and cardinal direction.

Although only seven broadcasters responded to the second questionnaire, and it is unknown as to how many stations they represent, it is notable that six of the seven reported using the same graphic package vendor for their station’s graphics. Many also reported that the information they receive from the NWS and the NHC is used in the development of their forecasts. These limited resources for graphics and forecast information appears to support Nelkin’s (1987) contention that much of what we hear from the media about risk and scientific information is often the result of few authoritative sources.

The results of this study support others (FEMA, 2005) that report most people still initially hear about severe weather from television. The majority of respondents from this study generally rely upon television for their weather information. As active audiences who become information seeking (Grunig, J. E., 1997) an even larger majority increase their viewing to include other stations or papers in light of an approaching storm while a large majority reported checking the internet for forecasts. Additionally many respondents reported talking to friends or family about an approaching storm, which supports Singer and Endreny’s (1993) assertion that perceptions of risk are mediated by more than a single factor.

The results of this study indicate that the National Weather Service enjoys a good reputation among respondents and is trusted by the public and meteorologists alike. What is also evident is that both the NWS and meteorologists believe there is a difference between their understanding of the hurricane graphic and those of the public. It is interesting to note that the *fault* of the misunderstanding is often left at the feet of the receivers rather than the senders of the information. As long as the NWS and the NHC continue efforts to engage their publics in product design and delivery, the organizations may be able to maintain their high levels of public trust. But diligence on the part of designers and scientists alike must be maintained if a consensus of understanding is to be built and maintained among forecasters and their critical audiences of emergency planners and the general public.

While respondents generally rate the NWS as a reliable and competent agency, they do not consistently rate their local weather providers as well. What is not known, and is probably worthy of further investigation, is what, if any, relationship the loss of a familiar NHC director, Mr. Max Mayfield will have on the public's levels of trust for the center. It seems NHC staffers are aware acutely aware of the possibility that spokespersons do effect public trust. In an unusual move in a governmental organization, the staff publicly revolted against Maxfield's replacement and precipitated his recent removal (July 2007).

In addition to changes in leadership, private sector competition may challenge the NHC and NWS as well. With the advent of newer technologies and more private weather prediction entities, it will be interesting to see if the NWS can maintain its position as a trusted purveyor of severe weather forecasting. As local media begin to do more of their own forecasting and present more detailed and dramatic graphic displays, the NWS' reputation may suffer.

Local media, however, may take a page from the NWS' public outreach efforts and their policy of limiting public access to some of their forecast models. While a number of southwest Florida media outlets spend considerable time and money on hurricane awareness campaigns, they may also need to examine how their forecasts are perceived. Research, by either the stations or the vendors of broadcast graphics, might benefit public understanding if broadcasters and viewers are both prepared for new graphics packages *before* substantive format changes are made. One recent case is the adoption of a new graphic package that is intended to show moisture levels. This new model uses red to represent dry air. This can be confusing to viewers who are used to red meaning high levels of disturbances as in the case of thunderstorms, which are often accompanied by large amounts of rain.

Confusion in communication between generations has always been fraught with difficulties. New communication technologies are exacerbating the problem. Email, blogs, and text messaging are indicators of a growing communication culture that relies on abbreviated and informal content. Coupled with the use of hyperbole and sensational media content this de-formalization of language my affect understanding of technical language and may be an area of concern for emergency communicators, especially in the descriptions of potential risk. While weather scientists' foremost concern may be the accuracy of their forecasts, they also must consider the *accuracy* of the *perceptions* of those forecasts if they are to be effective in warning populations at risk of severe weather.

Recommendations

Results from this study indicate that the National Weather Service should continuously endeavor to thoroughly research the clarity and understanding of the communiqués. This study particularly recommends that the NWS should clarify and or change its use of the terms of *Watch* and *Warning*. The NWS may also look to deconstruct and prioritize the ideas or concepts it wishes to convey in their Watch/Warning Track graphic especially as appears to the general public. As evidenced by the seemingly large difference between responses to questions 29 and 30, perhaps the Watch/Warning graphic as well as broadcasted and written forecasts could be changed as an interim step to improve understanding. If the NWS considers time to be a critical element of *watches* and *warnings* then the addition of the time frames of 24 and 36 hours to graphic legends and textural or broadcasted forecasts might focus viewers on time considerations in their decisions to evacuate or prepare in advance of for severe weather.

Another area worthy of research may be in the examination of the words, such as *probable* and *possible*, used to explain severe weather forecasts. Not only could the words used by broadcast meteorologists be examined for their effects but the text version of forecasts supplied by the NWS may yield insight into public perceptions as well. According to the National Weather Service, forecasts were formerly developed using atmospheric data measures, which were then prepared in narrative form. The written forecasts were used as the basis for graphic development. Today, forecasts are first developed graphically and then converted by computer program into textural versions for dissemination (S. Kiser, personal communication, January 31, 2007). This would indicate that the language used is consistent across similar type storms and could provide a good opportunity to examine how choices might affect perceptions of forecasts

This study explores an area of communication research that has not been evident in much of the work done in the area of disaster studies and risk communication. If we must rely upon graphic depictions of risk to guide our behaviors, then the graphics must make sense to us. This study identifies areas that deserve further research and provides at least a start in the cross discipline work that will be necessary for the development of measures that can contribute to the building and maintenance of consensus between organizations and their publics.

This study is limited by the lack of probability sampling, self reporting by respondents, no restrictions to participation, and the exclusionary effects on participation due to its online delivery. It is also limited by the presentation of only one storm track of an actual storm, which was fairly straightforward and may have been familiar to respondents. Examining viewer perceptions of visuals, like this graphic, is confounded by the nature of the instrument which cannot replicate an actual broadcast nor induce the emotional state of the viewers who may be facing a natural disaster. Additionally, forecasts are often "heard" over time and perceptions of storm tracks could be significantly different depending upon where viewers see graphics. Perceptions of storm track could also be effected by other information viewers may have heard or read about the storm prior to viewing the graphics.

The use of the coorientation model seems to an effective tool in measuring levels of consensus of meaning when it comes to visual communication. However, the addition of diverse focus groups, experimental design to test new graphic options, and presentation of alternative modes of delivery would add to understanding of how graphics are perceived. Understanding of viewers perceptions many help designers develop new and better ways to communicate concepts as complex as risk.

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Appendices

Appendix A

Alternative Tropical Cyclone Graphics: Solicitation for Comments

Alternative Tropical Cyclone Graphics (Text)

Solicitation For Comments

Background

Customers have asked the National Weather Service (NWS) to modify its Tropical Storm Track and Watch/Warning Graphic (graphic example #1). Specifically, the current graphic may focus too heavily on an exact forecast track (the line) and not on the larger area affected by the tropical storm. To ensure we have the best possible product, we are asking your opinion of the current and proposed graphics. If we determine one of the alternative graphics is preferred, it will replace the current graphic beginning with the 2005 hurricane season.

Three graphics are displayed. One is the current operational graphic and the other two are alternatives. Each of these three graphics is displayed for two 2004 hurricanes, Ivan and Jeanne. The reason for the selection of these two storms is that Ivan moved forward in a fairly consistent manner while Jeanne meandered.

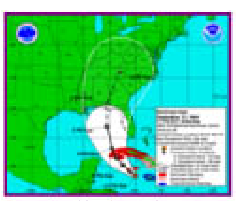
The following is a brief description of the graphics, In the following descriptions "tropical cyclone" refers to a tropical depression, tropical storm, or hurricane.

Graphic 1

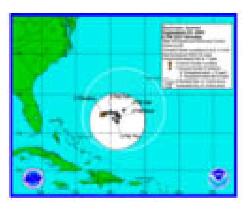
This is the current operational graphic. This graphic contains:

- The location and motion of the tropical cyclone center at the product issuance time
- The maximum sustained winds at the product issuance time
- The forecast location of the tropical cyclone center and the intensity status (i.e. depression, storm, or hurricane) at 12, 24, 36, 48, 72, 96, and 120 hours
- An area of uncertainty depicting the average track forecast error of the center of the tropical cyclone
- When in effect, tropical cyclone watches and warnings
- A forecast track line

Examples of Graphics (click to enlarge)



1a: Hurricane Ivan



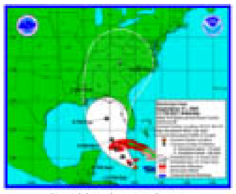
1b: Hurricane Jeanne

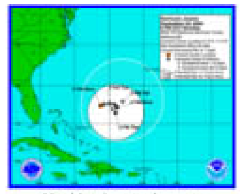
Graphic 2

This alternative graphic contains:

- The identical forecast information as in Graphic 1, except the track line depicting the forecast track of the tropical cyclone center is omitted.

Examples of Graphics (click to enlarge)


2a: Hurricane Ivan

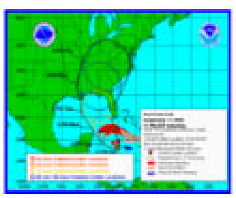

2b: Hurricane Jeanne

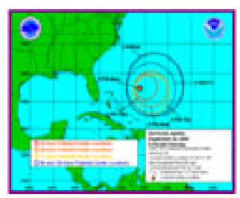
Graphic 3

This alternative graphic contains:

- The location and motion of the tropical cyclone center at the product issuance time
- The maximum sustained winds at the product issuance time
- The potential forecast location of the tropical cyclone center at 24, 48, 72, 96, and 120 hours as displayed with colored circles.
- An "area of uncertainty" depicting the average track forecast error of the center of the tropical cyclone
- When in effect, tropical cyclone watches and warnings

Examples of Graphics (click to enlarge)


3a: Hurricane Ivan


3b: Hurricane Jeanne

Product Description Document

The Product Description Document (PDD) for the Tropical Cyclone Track and Watch/Warning Graphic -- Experimental Alternatives is available here (PDF format).

Comments

NOAA seeks comments on these tropical cyclone track and watch/warning graphics. We would like to know which graphic is the most effective for use in upcoming hurricane seasons. We are interested in receiving any additional comments or recommendations you may have concerning our tropical cyclone track and watch/warning graphics.

Comments will be accepted through January 18, 2005.

Electronic submission of comments is encouraged. **Please submit comments to: trackchart@noaa.gov**

Written comments may be addressed to:

Tropical Cyclone Program Manager
NOAA National Weather Service
1325 East West Highway, Room 13126
Silver Spring, MD 20910

Comments may also be faxed to: 301-713-1520

For further information contact: Scott Kiser, 301-713-1677 extension 121

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National Centers for Environmental Prediction
National Hurricane Center
Tropical Prediction Center
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Todd.Spindler@noaa.gov
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Appendix B

NOAA Press Release (April 9, 2005)

NEWS FROM NOAA

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION • US DEPARTMENT OF COMMERCE

NOAA'S NATIONAL WEATHER SERVICE TO CONTINUE EXISTING TRACK MAP FOR TROPICAL CYCLONES

NOAA's National Hurricane Center will continue to use its existing track map for hurricanes, tropical storms and tropical depressions during the 2005 Atlantic Hurricane Season. Results of a recent online survey on proposed changes to the track map show the majority of respondents prefer to maintain the current format.

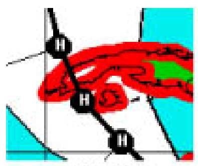

Chart 1

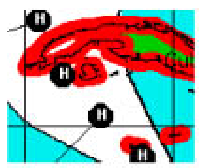

Chart 2

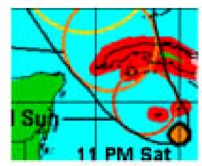

Chart 3

Of the nearly 1,000 survey participants, 63 percent favored the existing track map (Chart 1 on the survey), consisting of forecast points for the center of the storm at various times, a line connecting the points, watches/warnings and a white-colored cone indicating the potential track area.

Chart 2 resembled Chart 1, but did not include the line for the projected path. This option attracted the fewest respondents (14 percent).

The third and final chart provided the potential forecast location, as displayed by colored circles indicating the margin of error, and was preferred by 23 percent of the participants.

For the 2005 hurricane season, NOAA's National Hurricane Center will provide a more convenient presentation of all graphical forecast products for each storm on its web site: http://www.nhc.noaa.gov/.

Users are encouraged to use the full suite of National Hurricane Center products in order to make informed decisions and to listen to local authorities when severe weather threatens.

Experimental graphics and text products indicating the probability of winds of 39, 58 and 74 mph (34, 50, and 64 knots, respectively) also will be available this year. Feedback will be solicited under the "Top News of the Day" on the National Hurricane Center's Web site this summer. Those responses will determine whether this product becomes fully operational for the 2006 hurricane season.

Media contact:
Chris Vaccaro
NOAA's National Weather Service
301-713-0622

Appendix C

General Public Questionnaire

Tropical Storm and Hurricane Forecast Questionnaire

This questionnaire is sponsored by the University of South Florida School of Mass Communications. It is an effort to garner your opinion about terms and graphics used by the mass media to warn residents of severe weather. Your comments are important and your voluntary participation is appreciated. No personal information will be collected and your answers and comments will remain confidential.

Please take a few moments to fill out this survey. If you would prefer to fill out a hand written survey, please contact L.M. Geggis at lgeggis@mail.usf.edu and we will send you a copy. You may also use that email address to provide any additional comments.

The results of this questionnaire will be published in a master's thesis and its findings may contribute to the understanding of visual communication. Please answer every question, including those that require a short written response. Thank you in advance for your valuable input.

SECTION I
This first section will allow us to get to know a little bit about you.

I was born between:

- ☐ 1911-1924
- ☐ 1925-1945
- ☐ 1946-1964
- ☐ 1965-1977
- ☐ 1978-1988

My primary residence is located in...(FILL in the blanks)

State: ________

County: ________

I am

- male
- female

I have completed the following level of education

- Some High School
- High School or GED
- Some college
- Associates Degree
- Bachelors Degree
- Some Graduate School
- Graduate School
- Post Graduate
- Doctorate

SECTION II
In this next we will ask about how and where you get your weather related information and how you would rate it.

I generally get information about the weather from...(pick one)

- Television
- Newspaper
- Radio AM or FM
- Other people
- Weather Radio
- Internet
- Other:

When I hear about an approaching storm I usually..(check ALL the boxes that apply)

- Stay with my regular television viewing or reading habits
- Increase my viewing to include other stations or papers
- Check the Internet for forecasts
- Talk to my family or friends about it
- Unsure

In this section we will ask you to rate your level of agreement with the following statements.
Please choose an answer from a scale of 1 to 7, with 1 indicating totally disagree and 7 completely agree.

The graphics used on television and the Internet to show tropical storm/hurricane tracts are informative and easy to understand.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

Weather forecasts about hurricanes make me nervous.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

The National Weather Service is one organization that I can count on to make important decisions that may affect people like me.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

I think the National Weather Service does a good job of predicting hurricanes and other severe weather.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

I think the news media uses the hurricane season as a way to improve their audience size.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

I feel very confident in the National Weather Service's ability to make storm predictions.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

The National Weather Service is more interested in commercial ventures than they are about people like me.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

I am familiar with the National Weather Service and what it does.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

The National Weather Service keeps its promises to warn the public about severe storms.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

The National Weather Service is twice as good at predicting big storms, like hurricanes, as they were ten years ago.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

The National Weather Service treats people like me fairly and justly.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

The National Weather Service is ...(check ALL that apply)

- a federal agency that is part of NOAA - the National Oceanic and Atmospheric Administration
- part of the Department of Commerce
- a private organization that produces the Weather Channel
- unsure

If I had to choose between the National Weather Service and my local media, I'd rely on my local forecast.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

My local weather forcasts are generally accurate.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

SECTION III
This section asks your opinion about weather forecasts

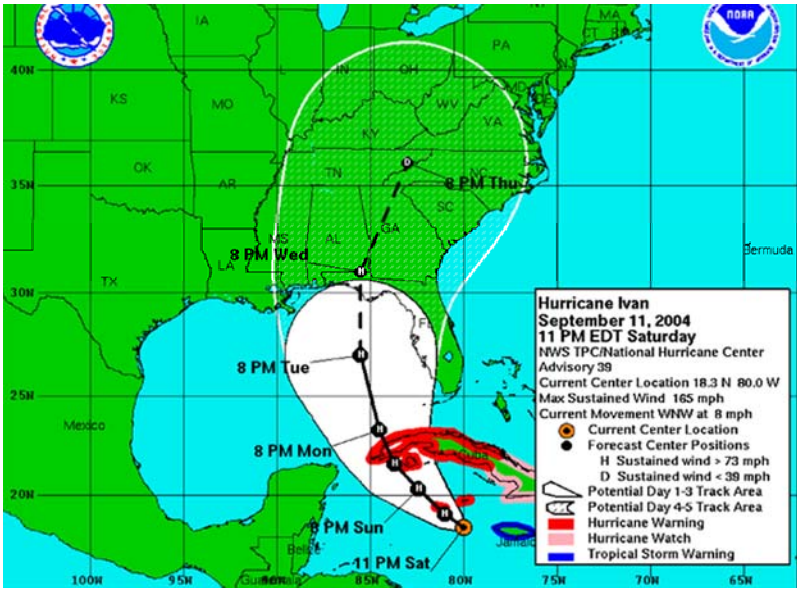

Figure 1

I recognize this graphic (Figure 1)as a representation of the path of a ...(pick ONE)

☐ Hurricane

☐ Tornado

☐ Severe thunderstorm

☐ High pressure system

☐ Unsure

Probable, possible and potential all basically mean the same thing...(pick ONE)

☐ True

☐ False

☐ Unsure

A tropical storm watch for my area means...(pick ONE)

☐ A tropical storm is likely to hit my area within the next 24 hours

☐ Tropical storm conditions including winds of 39 to 73 mph are possible within the next 24 hours

☐ Conditions in my area are condusive to the development of a tropical storm

☐ Unsure

A hurricane warning for my area means...(pick ONE)

- Hurricane conditions are expected in my area within the next 24 hours
- Conditions in my area are conducive to hurricane development
- A hurricane will likely hit my area within the next 2 days
- Unsure

Hurricane and tropical storm watches and warnings are...(check ALL that apply)

- Issued by the National Weather Service
- Are official designations
- Determined by my local media
- Issued by local emergency planners
- Unsure

The National Weather Service is...(check ALL that apply)

- a federal agency that is part of NOAA - the National Oceanic and Atmospheric Administration
- part of the Department of Commerce
- a private organization that produces the Weather Channel
- Unsure

The Saffir/Simpson Hurricane Scale...(pick ONE)

- is a scale ranging from 1-5 based on the the intensity of the hurricane
- is a scale used to indicate the size of a storm
- categorizes storms as tropical depressions, storms or hurricanes
- Unsure

A hurricane is characterized by...(check ALL that apply)

- a pronounced low-pressure circulation
- winds of more than 73 mph
- a proper name
- Unsure

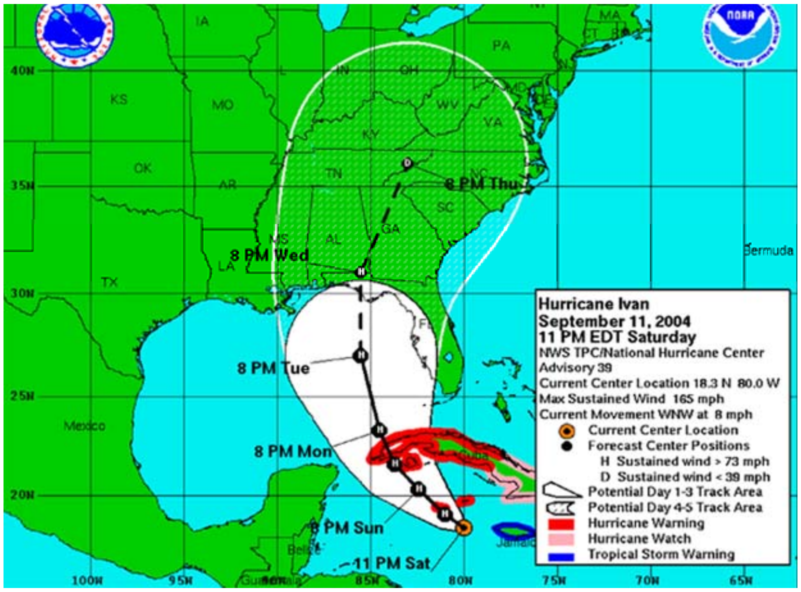

Figure 1

The red area of the Figure 1 graphic represents...(pick ONE)

- ☐ hurricane warning for that area
- ☐ tropical storm warning for that area
- ☐ hurricane watch for that area
- ☐ the direction the storm is expected to move
- ☐ Unsure

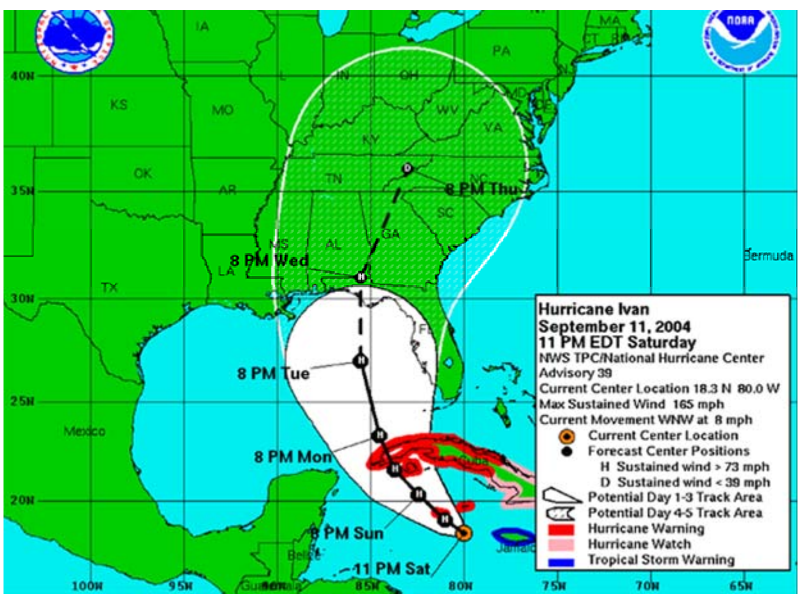

Figure 1

The pink area of the Figure 1 graphic...(pick ONE)

- ☐ is under a tropical storm watch
- ☐ indicates that hurricane conditions are possible within 36 hours
- ☐ is outside of any danger for landfall of the storm
- ☐ Unsure

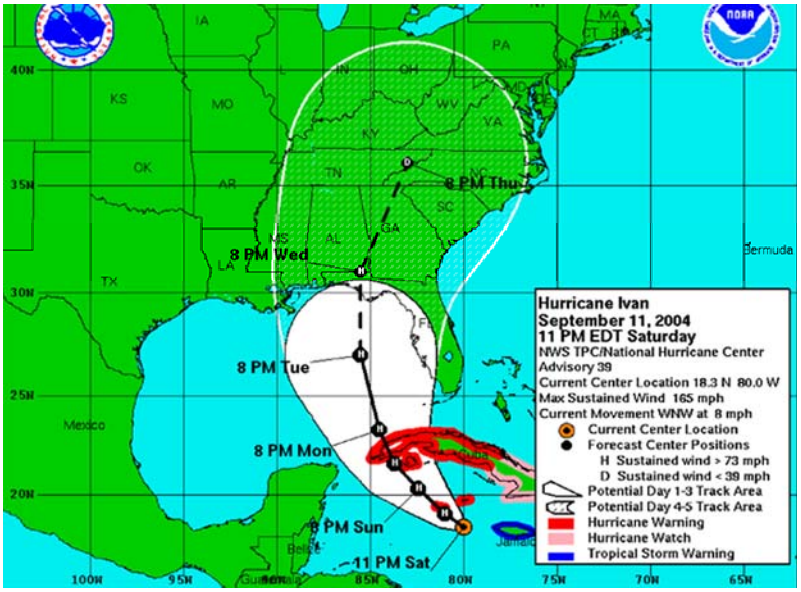

Figure 1

The solid white area on the map (Figure 1) indicates...(pick ONE)

- ☐ the area to be affected by hurricane force winds
- ☐ the predicted size of the storm over time
- ☐ the area of uncertainty or possibility for the center of the storm's track and potential landfall
- ☐ the only areas predicted to be affected by any hurricane or tropical storm force winds
- ☐ Unsure

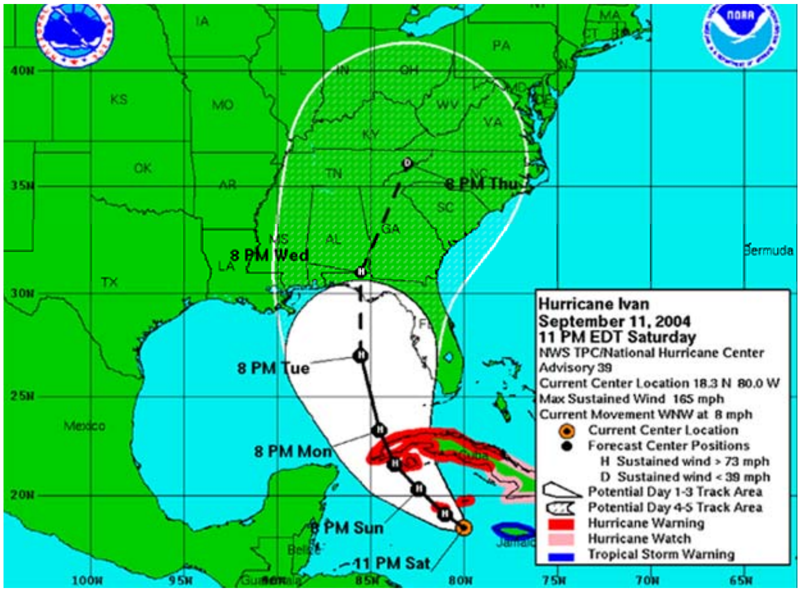

Figure 1

I remember seeing this graphic on... (check ALL that apply)

- ☐ television
- ☐ newspapers
- ☐ Internet
- ☐ I do not recognize it

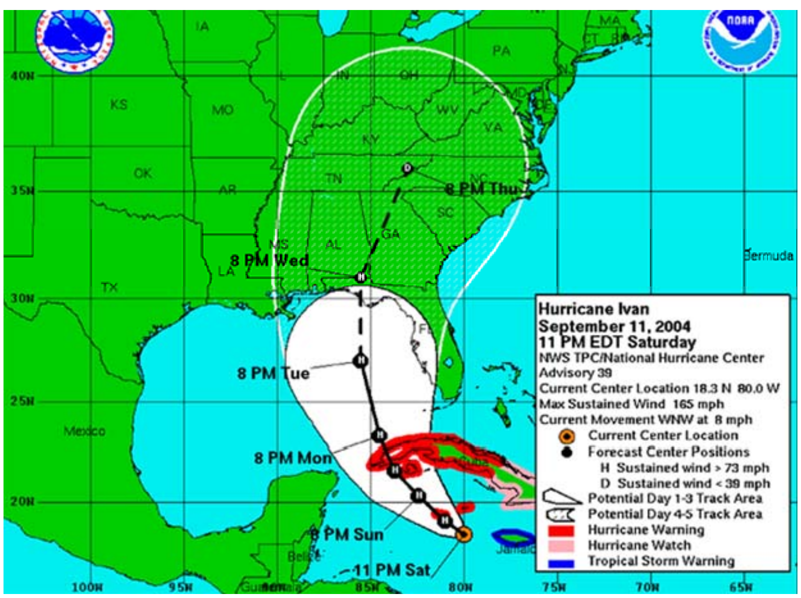

Figure 1

The graphic in Figure 1...(check ALL that apply)

- ☐ tells me WHEN a tropical storm or hurricane is expected
- ☐ tells me WHERE tropical storm or hurricane is expected
- ☐ is a very reliable forecast
- ☐ is just a guesstimate by meteorologists
- ☐ is an important indicator to me of the storm's path
- ☐ tells me the size of the storm
- ☐ indicates how fast the storm is moving
- ☐ Unsure what it means

The state of Florida is approximately...(pick ONE)

- ○ 100 miles wide at it's center
- ○ 400 miles long from north to south
- ○ 400 miles from Cuba
- ○ Unsure

US maps shown in the news (like Figure 1) are usually shown with what direction on top? (pick ONE)

- ○ North
- ○ South
- ○ East
- ○ West
- ○ Varies
- ○ Unsure

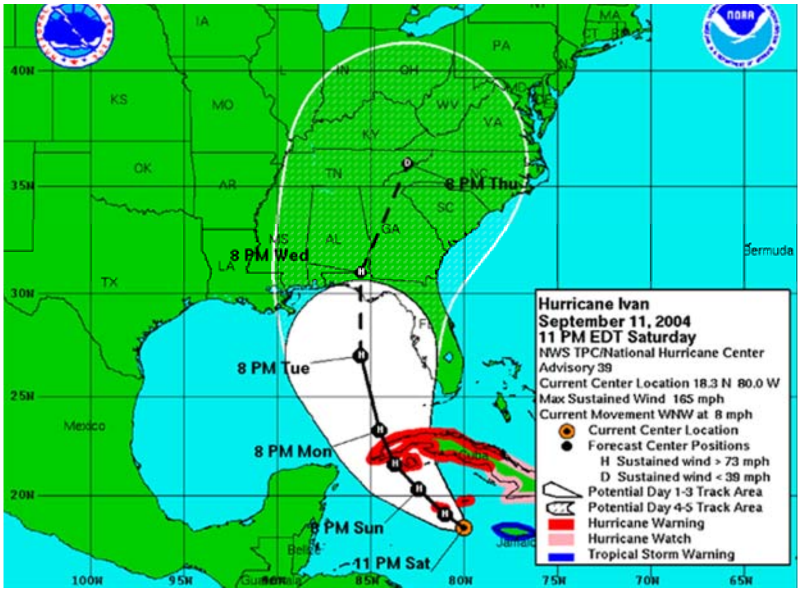

Figure 1

According to the graphic Figure 1..(check ALL that apply)

- ☐ the storm is much more likely to make landfall in Florida than in Alabama
- ☐ hurricane winds will not be evident in northern Florida until 8 PM on Wednesday
- ☐ the size of the storm will grow as it moves north
- ☐ the intensity of the storm will diminish as it moves towards northern Florida
- ☐ Unsure what it means

I pay more attention to the weather forecaster than I do to any graphics I see. (choose ONE answer that matches your level of agreement)

- ○ 1. Totally disagree
- ○ 2.
- ○ 3.
- ○ 4.
- ○ 5.
- ○ 6.
- ○ 7. Completely agree
- ○ No Opinion

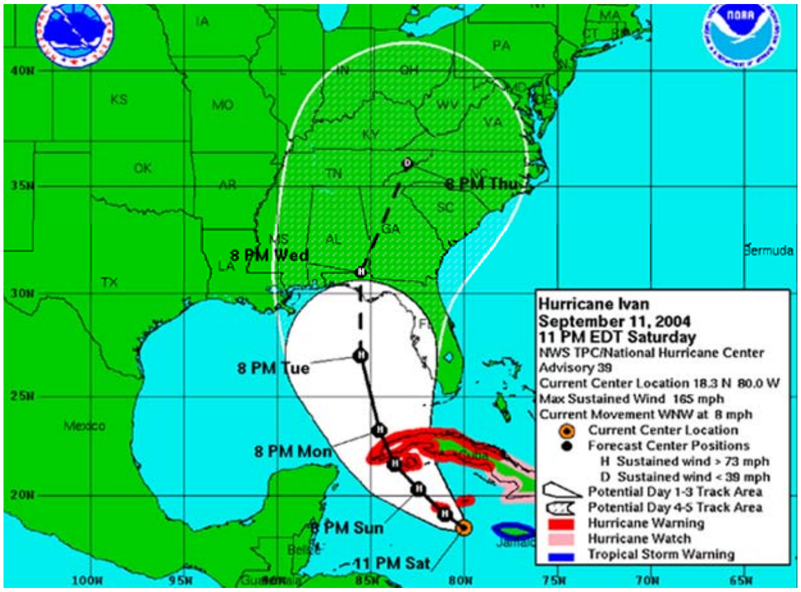

Figure 1

The center black line in the Figure 1 graphic indicates... (pick ONE)

- ☐ a 95% accurate forecast of the storms' path over the next 5 days
- ☐ a forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position
- ☐ a guesstimate of center of the hurricane and its predicted path
- ☐ Unsure

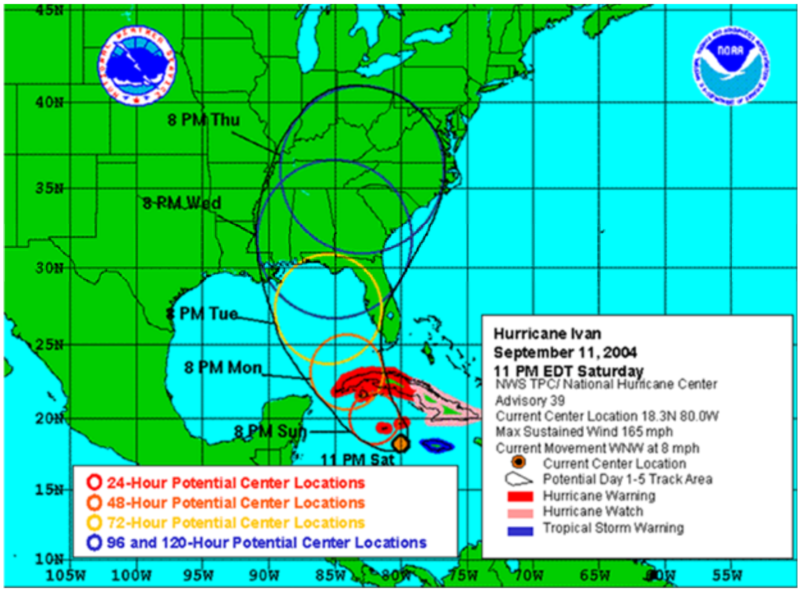

Figure 2

The concentric circles on Figure 2 graphic indicate..(pick ALL that apply)

☐ the area to be affected by hurricane force winds

☐ the predicted size of the storm over time

☐ the area of uncertainty or possibility for the center of the storm's track and potential landfall

☐ the only areas predicted to be affected by any hurricane

☐ Unsure what they mean

Appendix D

Broadcast Meteorologist Questionnaire

Severe Weather Forecasts

Broadcast Meteorologists' Perceptions of Public Understanding

This questionnaire is sponsored by the University of South Florida's School of Mass Communications. It is an effort to garner your opinion about the general public's understanding of tropical storm forecasts. It also seeks to obtain your opinion of two National Weather Service graphical products.

Your comments are important and your voluntary participation is appreciated. No personal information will be collected and your answers and comments will remain confidential. Please take a few moments to fill out this survey. If you would prefer to fill out a hand written survey, please contact L.M. Geggis at lgeggis@mail.usf.edu and we will send you a copy. You may also use that email address to provide any additional comments you may have.

The results of this questionnaire will be published, along with a results of second questionnaire aimed at the general public, in a master's thesis. Please answer every question.

Thank you in advance for your valuable input.

SECTION I
This first section will allow us to get to know a little bit about you.

I have completed the following level of education...(pick ONE)

- Some High School
- High School or GED
- Some college
- Associates Degree
- Bachelors Degree
- Some Graduate School
- Graduate School
- Post Graduate
- Doctorate

I have been involved in weather *forecasting* for...(pick ONE)

- 1-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21-25 years
- 26+ years
- other:

I have been involved in weather *broadcasting* for...(pick ONE)

- 1-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21-25 years
- 26+ years

Please list any professional designations you hold.

SECTION II

This next section asks for your opinion of severe weather forecasting. In some cases we will ask you to rate your level of agreement with the statements. For those questions please choose an answer from a scale to 1 to 7, with 1 indicating complete disagreement and 7 complete agreement.

Other questions will ask you to fill in your comments and opinions.

The media do a good job in preparing the general public for severe weather like hurricanes.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

I am happy with the current status of broadcast coverage of severe weather.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

My station's tropical storm / hurricane forecasts are extremely important to the public in their decisions to make storm preparations or plans to evacuate.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

I think visuals and graphic representations of weather such as radar and tropical storm track graphics are important tools for preparing populations at risk.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree

- No Opinion

I think the general public understands the basics of meteorology.

- 7. Completely Aagree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

In your opinion what are the most effective tools or methods that can be used to help the public understand weather forecasts?

I think most people rely upon what they *hear* during a weather forecast.

- 7. Completely Agree
- 6.
- 5.
- 4.

- 3.
- 2.
- 1. Completely Disagree
- No Opinion

I think most people rely upon what they *see* during a weather forecast.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

My station has adequate systems to measure audience satisfaction of severe weather forecasts and coverage.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

What kind of feedback have you or your station received about severe weather forecasts or coverage? Please note both positive and negative comments from the public and other sources.

I think the information provided by the National Weather Service (NWS) and the National Hurricane Center (NHC) is accurate

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

I think the information/products provided by the National Weather Service and the National Hurricane Center is easily understood by reporters.

- ☐ 7. Completely Agree
- ☐ 6.
- ☐ 5.
- ☐ 4.
- ☐ 3.
- ☐ 2.
- ☐ 1. Completely Disagree
- ☐ No Opinion

I think the information/products provided by the National Weather Service and the National Hurricane Center is easily understood by meteorologists.

- ☐ 7. Completely Agree
- ☐ 6.
- ☐ 5.
- ☐ 4.
- ☐ 3.
- ☐ 2.
- ☐ 1. Completely Disagree
- ☐ No Opinion

What "suppliers" of weather data or products do/did you rely upon for your forecasts? Do you prefer any one over another? If so, why?

The NWS/NHC tropical storm and hurricane forecasts are very important to what I broadcast or predict.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

I think the information and graphic products provided by the National Weather Service and the National Hurricane Center are easily understood by members of the general public.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

The NWS products, such as the tropical storm track, provide the information the general population needs to make better preparation decisions.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No. Opinion

Section III
This section of the questionnaire concerns the
National Weather Service (NWS) Tropical Cyclone Track and Watch/Warning Graphic.

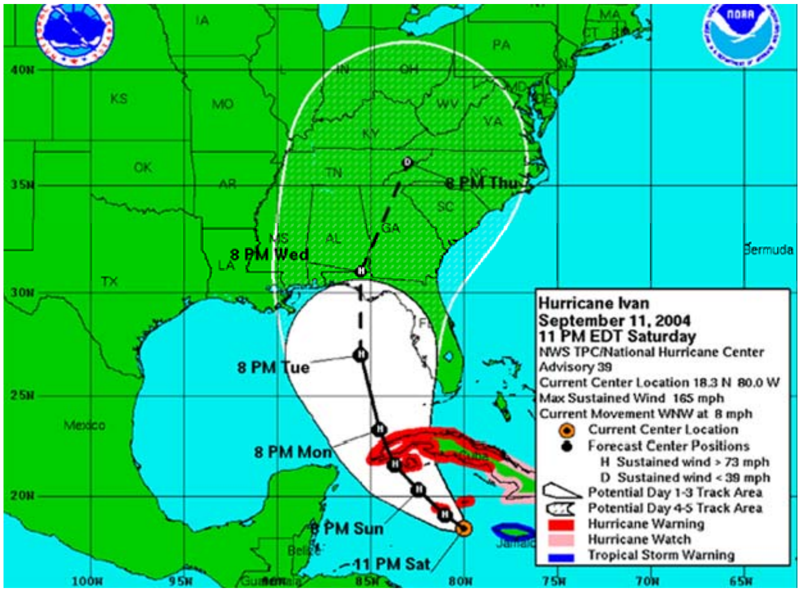

Figure 1

I am familiar with the NWS Tropical Cyclone Track and Watch / Warning graphic (Figure 1) often referred to as the "Cone of Uncertainty"

- Yes
- No
- Unsure

What do you consider to be the key information contained in the NWS (Figure 1) graphic?

Are there any changes to the components of this graphic (Figure 1) that you have adopted or would like the NWS to consider (i.e. color, shading, etc.)?

If you could invent or design a graphic that described the path of a tropical storm or hurricane, what information would you include for the general public?

Section IV
This section is intended to capture your perceptions of the general public's understanding of weather related terms and graphics.

Please answer the following questions *as you think the general public will answer them.*

If the general public had to choose between the National Weather Service and my local media, they'd rely on their local forecast.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No opinion

The general public will say their local weather forecasts are generally accurate.

- 7. Completely Agree
- 6.
- 5.
- 4.
- 3.
- 2.
- 1. Completely Disagree
- No Opinion

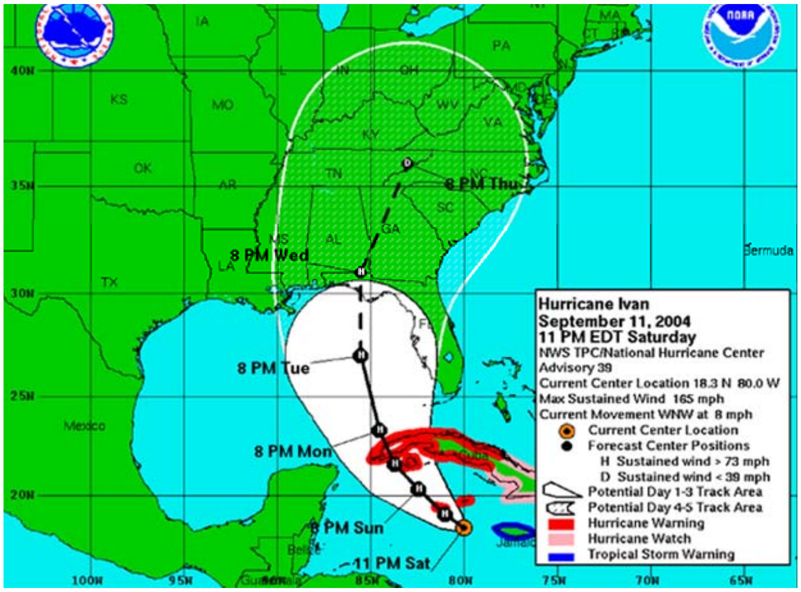

Figure 1

The general public will recognize this graphic (Figure 1)as a representation of the path of a ...(pick ONE)

- ☐ Hurricane
- ☐ Tornado
- ☐ Severe thunderstorm
- ☐ High pressure system
- ☐ Unsure

The general public will say that..probable, possible and potential all basically mean the same thing...(pick ONE)

- ☐ True
- ☐ False
- ☐ Unsure

To the general public a tropical storm watch for their area means...(pick ONE)

- ☐ A tropical storm is likely to hit my area within the next 24 hours
- ☐ Tropical storm conditions including winds of 39 to 73 mph are expected within the next 24 hours
- ☐ Conditions in my area are conducive to the development of a tropical storm
- ☐ Unsure

To the general public a hurricane warning for their area means...(pick ONE)

- ○ Hurricane conditions are expected in my area within the next 24 hours
- ○ Conditions in my area are conducive to hurricane development
- ○ A hurricane will likely hit my area within the next 2 days
- ○ Unsure

The general public will say that hurricane and tropical storm watches and warnings are...(check ALL that apply)

- ☐ Issued by the National Weather Service
- ☐ Are official designations
- ☐ Determined by my local media
- ☐ Issued by local emergency planners
- ☐ Unsure

The general public will say the Saffir/Simpson Hurricane Scale...(pick ONE)

- ○ is a scale ranging from 1-5 based on the intensity of the hurricane
- ○ is a scale used to indicate the size of a storm
- ○ categorizes storms as tropical depressions, storms or hurricanes
- ○ Unsure

The general public will say a hurricane is characterized by...(check ALL that apply)

- ☐ a pronounced low-pressure circulation
- ☐ winds of more than 73 mph
- ☐ a proper name
- ☐ Unsure

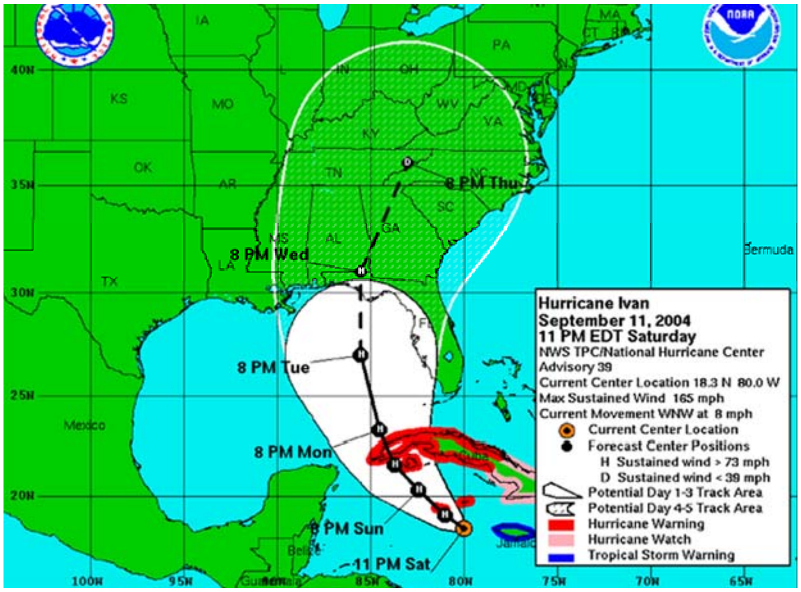

Figure 1

To the general public the red area of the Figure 1 graphic represents...(pick ONE)

- hurricane warning for that area
- tropical storm warning for that area
- hurricane watch for that area
- the direction the storm is expected to move
- Unsure

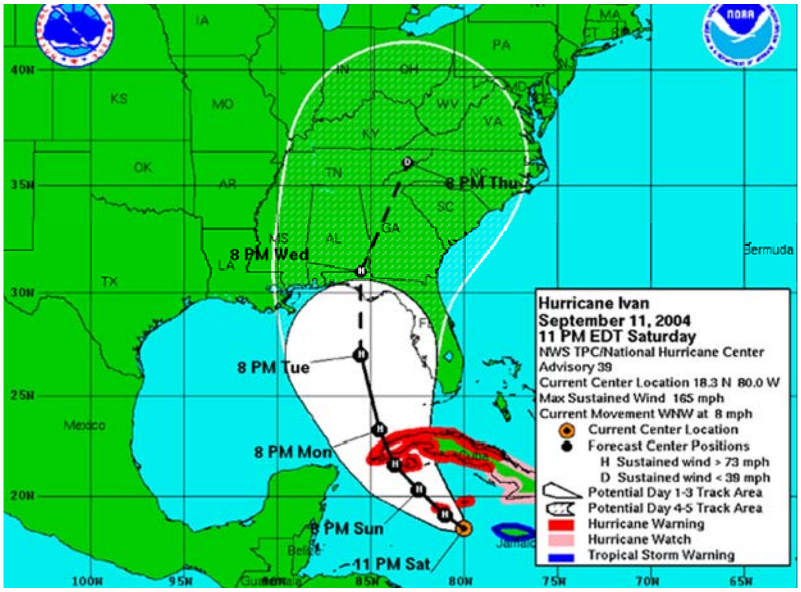

Figure 1

To the general public, the pink area of the Figure 1 graphic...(pick ONE)

- ☐ is under a tropical storm watch
- ☐ indicates that hurricane conditions are possible within 36 hours
- ☐ is outside of any danger for landfall of the storm
- ☐ Unsure

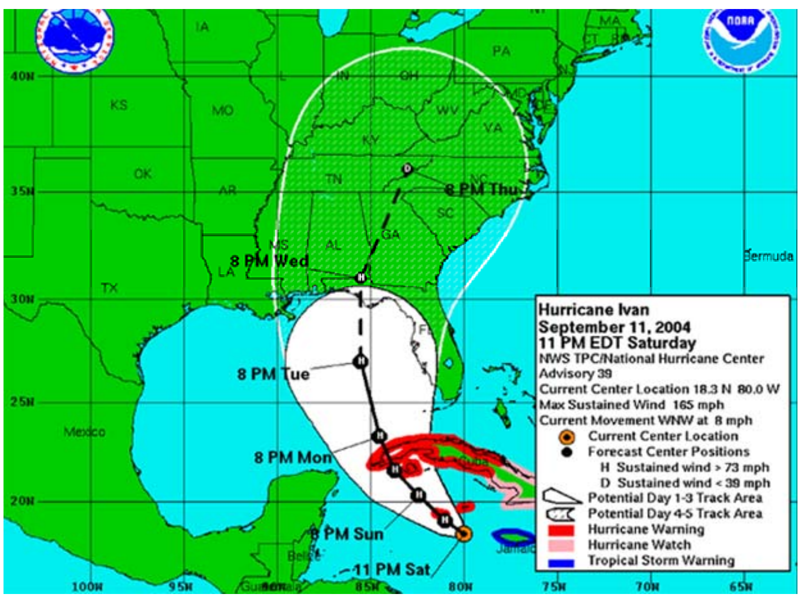

Figure 1

To the general public, the solid white area on the map (Figure 1) indicates...(pick ONE)

- ☐ the area to be affected by hurricane force winds
- ☐ the predicted size of the storm over time

☐ the area of uncertainty or possibility for the center of the storm's track and potential landfall

☐ the only areas predicted to be affected by any hurricane or tropical storm force winds

☐ Unsure

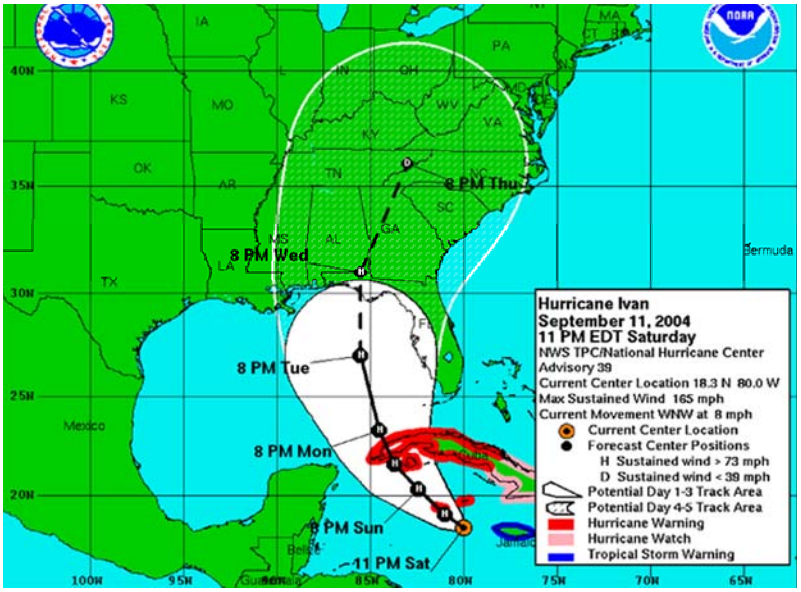

Figure 1

Members of the general public will say they remember seeing this graphic (Figure 1) on... (check ALL that apply)

☐ television

☐ newspapers

☐ world wide web

☐ I do not recognize it

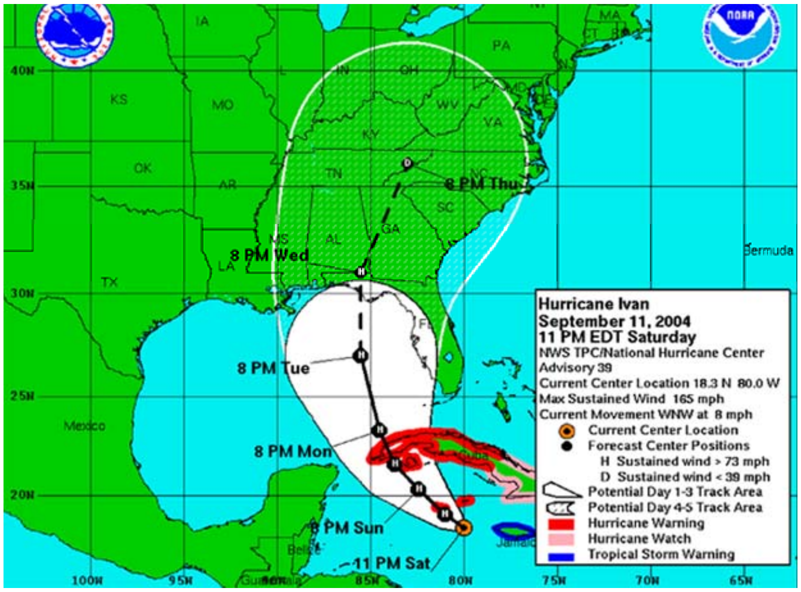

Figure 1

The general public will indicate that the graphic in Figure 1...(check ALL that apply)

- ☐ tells them WHEN a tropical storm or hurricane is expected
- ☐ tells them WHERE tropical storm or hurricane is expected
- ☐ is a very reliable forecast
- ☐ is just a guesstimate by meteorologists
- ☐ is an important indicator to them of the storm's path
- ☐ tells them the size of the storm
- ☐ indicates how fast the storm is moving
- ☐ Unsure what it means

The general public will indicate that the state of Florida is approximately...(pick ONE)

- ○ 100 miles wide at it's center
- ○ 400 miles long from north to south
- ○ 400 miles from Cuba
- ○ Unsure

The general public will say that US maps shown in the news (like Figure 1) are usually shown with what direction on top? (pick ONE)

- ☐ North
- ☐ South
- ☐ East
- ☐ West
- ☐ Varies
- ☐ Unsure

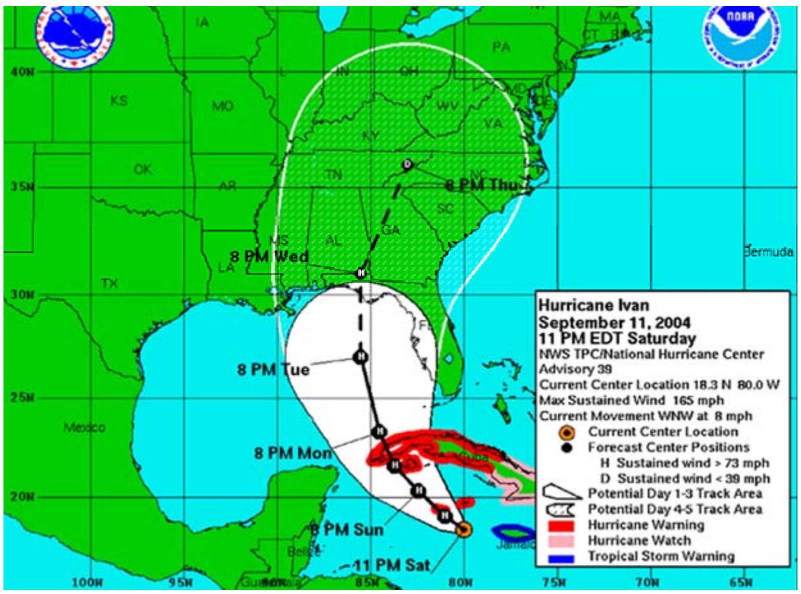

Figure 1

To the general public the graphic (Figure 1)indicates..(check ALL that apply)

- ☐ the storm is much more likely to make landfall in Florida than in Alabama
- ☐ hurricane winds will not be evident in northern Florida until 8 PM on Wednesday
- ☐ the size of the storm will grow as it moves north
- ☐ the intensity of the storm will diminish as it moves towards northern Florida
- ☐ Unsure what it means

The general public will say they pay more attention to the weather forecaster than they do to any graphics they see. (choose ONE answer that matches your level of agreement)

- ☐ 1. Totally disagree
- ☐ 2.
- ☐ 3.
- ☐ 4.

- [ ] 5.
- [ ] 6.
- [ ] 7. Completely agree
- [ ] No Opinion

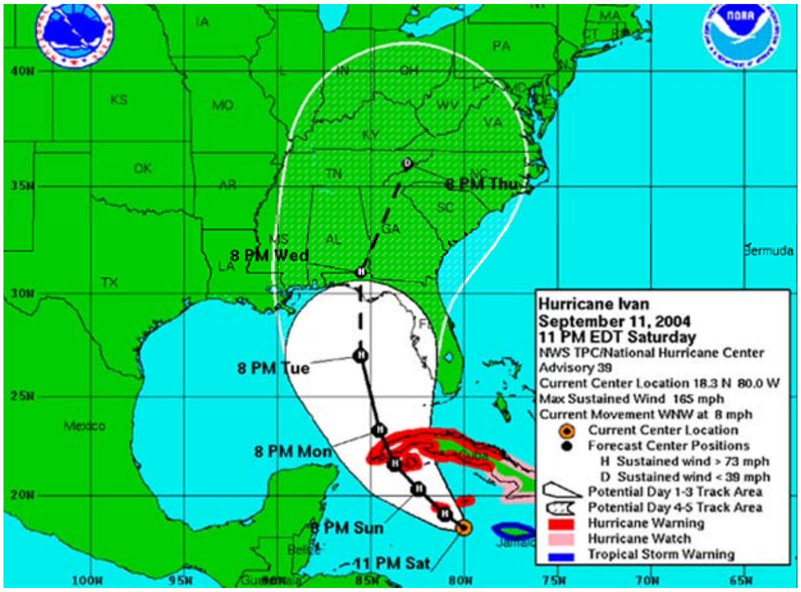

Figure 1

To the general public the center black line in the Figure 1 graphic indicates... (pick ONE)

- [ ] a 95% accurate forecast of the storms' path over the next 5 days
- [ ] a forecast of the storm's track within a cone which represents an average area of uncertainty for the storm's center position
- [ ] a guestimate of center of the hurricane and its predicted path
- [ ] Unsure

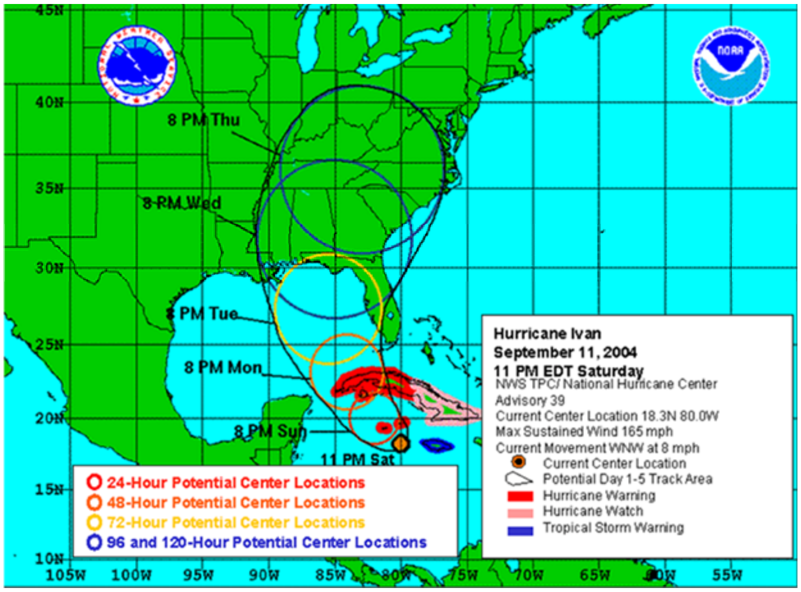

Figure 2

The general public will say the concentric circles on Figure 2 graphic indicate..(pick ALL that apply)

- ☐ the area to be affected by hurricane force winds
- ☐ the predicted size of the storm over time
- ☐ the area of uncertainty or possibility for the center of the storm's track and potential landfall
- ☐ the only areas predicted to be affected by any hurricane
- ☐ Unsure what they mean

If the general public had to choose between the National Weather Service and their local media, they'd rely on their local forecast.

- ○ 7. Completely Agree
- ○ 6.
- ○ 5.
- ○ 4.
- ○ 3.
- ○ 2.
- ○ 1. Completely Disagree
- ○ No Opinion

SECTION V

This last section asks for your opinions about the the NWS Tropical Cyclone Track Watch / Warning graphic.

Do you think the general public interprets this graphic (Figure 1) in the same way that you do? Why or why not?

What do you think people miss, if anything, when they see weather graphics like the tropical storm / hurricane track graphic?

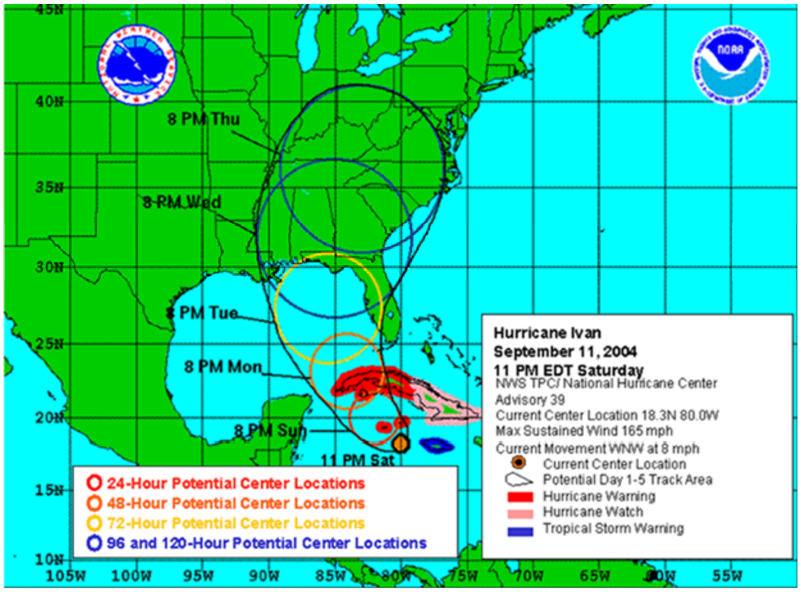

Figure 2

Are you familiar with this (Figure 2)previously proposed alternative to the tropical cyclone graphic?

- ☐ Yes
- ☐ No
- ☐ Unsure

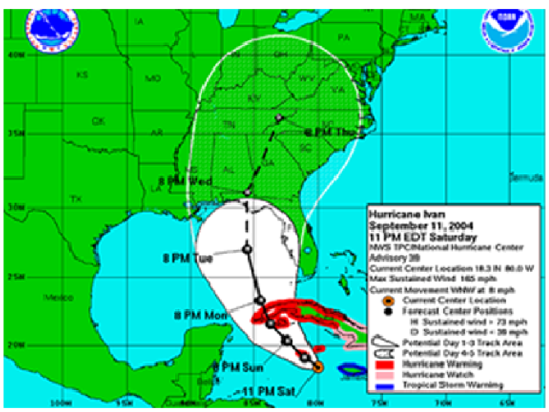

Figure 1

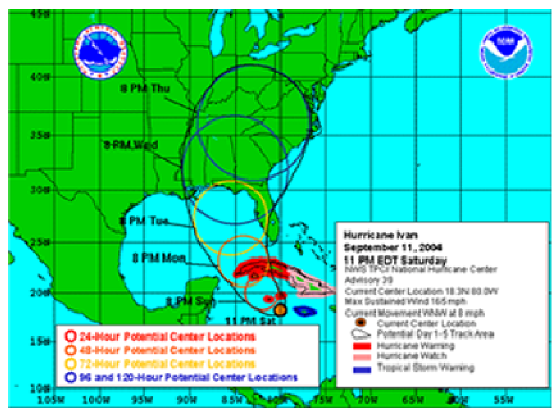

Figure 2

Do you believe one of these graphics (Figure 1, Figure 2) conveys storm track and watch warning information better than the other? If so, which one and why.

In your opinion was the confusion over where Hurricane Charley (2004)would make landfall the result of:

- ○ local meteorologist’s forecasting errors
- ○ local meteorologists misinterpretation of the NWS's tropical storm/hurricane graphic
- ○ public's misinterpretation of the NWS's tropical storm/ hurricane track graphic
- ○ forecasting errors by NWS
- ○ public's misinterpretation of local meteorologist’s forecast
- ○ no opinion/unfamiliar with issues of confusion about Hurricane Charley forecast
- ◉ other: