The Florida Society of Geographers was chartered in 1964 as a non-profit organization for the purpose of furthering professionalism in geography through application of geographic techniques in all areas of education, government, and business.

The Society supports these objectives by promoting acquaintance and discussion among its members and with scholars and practitioners in related fields by stimulating research and field investigation, by encouraging publication of scholarly studies, and by performing services to aid the advancement of its members and the field of geography in Florida.

Since 1996 the Florida Geographical Alliance, whose mission is to support geographical education in grades K through 12, has helped pay for the publication and distribution of The Florida Geographer. All members of the Alliance receive the journal, and articles related to geographical education are enthusiastically encouraged.

The Society holds meetings once a year. At this meeting, papers are presented and matters of mutual concern are discussed. Meetings are held in different parts of the state always include field trips to allow participants to gain first-hand knowledge through field experience. This year’s conference will be held January 25-27, 2008 in Miami, Florida.

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Regular membership is $15 per calendar year; student membership is $7.50. Membership includes a subscription to this journal.

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From the Editor

*The Florida Geographer* is the official publication of the Florida Society of Geographers and is distributed free to members of the society. It is a statewide journal with coverage of social and physical geographical topics. Most articles are related to the state, or feature Florida figures as an important component.

Papers are welcomed from all who feel they have research worthy of dissemination. Authors should not be dissuaded from submitting articles for review because of format considerations. It is requested that authors follow the following guidelines when submitting their manuscripts:

- All manuscripts should be sent in electronic form. Text should be submitted as a Microsoft Word document (*.doc) or as a rich text file (*.rtf). Authors should submit the final copy on an IBM compatible disk, a CD, or emailed to the editor.
- Figures and maps, if submitted separately from the text, should be sent as a JPEG (*.jpg) or graphical image file (*.gif). Tables may also be submitted in Excel or Quattro Pro format. Please note that all images will be printed in black and white, and as such should be sent as either black and white or gray-scale images. Please include the figure (table) number, title, and source.
- It is the author’s responsibility to ensure that none of the materials used in the paper are copyright-protected.
- Headings, paragraphs, and references should be consistent in their style.
- Please use in-text citations; footnotes will not be accepted. Endnotes should only be used sparingly.

Please send manuscripts, comments, style guide requests, and questions to:
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*The Map on our Cover:*

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http://gislab.cas.usf.edu/
A comprehensive final exam, using multiple choice questions, is easy to grade and tests another set of skills. It should be based on the text and what has been said in the classroom. Answers must not be telegraphed or highlighted in advance of the exam, because it destroys the validity of the exam. It is sufficient to announce that the exam is based on the text and the classroom lecture or discussion. However, it is well to note that I have never had a perfect score and consider anything at eighty per cent or above as superior performance on this particular exercise.

In summary, multiple methodologies and forms of testing produce the best and most valid results. Areas covered have to reflect the nature of the region and the skills of the instructor. Tests on factual knowledge alone cannot produce the best results, and other means of evaluation enhance the overall sophistication and impact of the course. Films, literature, history, and social science studies make a richer, more interesting, and more rewarding course content.

Note to Readers:

Herewith is the latest edition of The Florida Geographer and, alas, my last as editor. I think we have good quality and diverse papers in this issue and I would like to thank the authors and manuscript reviewers for their efforts toward this end. An additional feature in this edition is an editorial piece by Glenn Anderson concerning the central importance of regional geography to any geography curriculum. This is the first such intervention answering my previous calls for diverse types of manuscripts/notes/book reviews, etc., and thus is perhaps fittingly here in the last edition that I bring to print. It is, of course, up to the new editor whether such pieces will continue to be solicited, although I hope Anderson’s piece elicits some response from readers.

I think we have had a good five year run, thanks to those of you who contributed your time for review and presentation of research. I had hoped to elicit even more participation among members of the Society and other friends of Geography in the state. We still run into the problem of fewer submissions than we would like, which is a pity, given that this is the flagship journal for Geography in Florida. I hope that the next editor, whoever this may be, is more successful than I have been in this regard. In this, I wish her/him the very best.

Finally, I take this opportunity to once again thank my Managing Editor, Kris Bezdecny, now A.B.D. in the Ph.D. program here at the University of South Florida and Visiting Professor at U.S.F. Sarasota-Manatee. Without her help, I would never have been able to publish the five issues that bear my name as editor.

Kevin Archer, PhD.
The Geography of Religious Diversity in Florida

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Geographers have a long-standing engagement with the spatiality of religion. Cultural geographers, of course, have focused on this issue for some time (Zelinsky 1961; Sopher 1981; Levine 1986; Wilson 1993; Park 1994). More recently, the discipline has explored religion as a social and political force deeply intertwined with relations of class, gender, ethnicity, and place (Kong 1990, 2001; Kiong and Kong 2000; Valins 2000; Zelinsky 2001; Vincent and Warf 2002; Hervieu-Léger 2002; Proctor 2006). Globally, this issue has been given additional impetus by the upsurge in religious fundamentalism that arose following the end of the cold war (Stump 2000).

Religion in the U.S. is a particularly pertinent force given the relatively high levels of religiosity found there (compared to secular Europe) and the power role of conservative evangelicals in political circles (Hackett 2003). Various denominations of Christians comprise 84 percent of the total population, but the steady growth of non-Christian faiths, particularly in larger cities, has added to the country’s diversity. Indeed, the U.S. today is perhaps the world’s most religiously diverse country (Eck 2001). The separation of church and state in the U.S., enshrined in the Constitution, generates an unfettered arena in which different faiths compete freely with one another for adherents. Immigration, differential rates of natural growth and decline, conversion from one faith to another, and spatial mobility have conspired to generate an enormously diverse religious landscape (Zelinsky 2001).

This diversity is reflected in the religious geography of the South in general (Vincent, Winsberg and Warf 2006) and in Florida in particular, whose religious landscape is the product of a long and convoluted history. The historical development of religion in Florida is a topic worthy of more consideration and cannot be addressed in depth here (see Gannon 1996), but its major highlights include: the

begin with an inquiry to the appropriate person at some distinguished institution, with a review copy, or with an idea suggested by some professional journal. If a text looks promising, then time can be invested to seriously consider it. Finally, never become too comfortable with a particular text and remain open to a new or different treatment.

Visual learning is important in geography and, especially, in regional geography. Films meet this need and should be part of every regional geography course. Integration into the lecture or discussion enhances the value of films and makes the program more coherent. Testing on the course’s film content emphasizes its importance and highlights significant points.

Foreign students and well traveled students can be used as resources and to validate course content. Regional classes usually have more than their share of such students. Involvement of these students will make the class more entertaining and topical for everyone.

Literature, history, and social science studies serve as valuable adjuncts to the text. Each student should be assigned a different, individual book. Oral presentations based on the books will benefit the entire class. Essays will develop test writing and analytical skills. Obviously, the instructor should be familiar with all of the assigned books and should make the individual assignments based on class rank and major. Allowing the students to pick their books, ignores the instructor’s unique knowledge of the literature and wastes an inordinate amount of time. Properly handled, this part of the course can introduce students to research, public speaking, writing, and facets of the region’s culture.

Acquisition of factual knowledge and construction of an intellectual framework are the sine qua non of regional studies. If the student leaves without that knowledge or framework, the instructor has failed. Consequently, each student must commit to memory a certain body of carefully selected knowledge based on the text and class lectures or discussions. Work sheets and subsequent testing insure that this task is accomplished. The addition of essay topics to the work sheets and tests adds that element to the core content of the course.
How a place or people really functions, of its ambience, or of its character is within the pale. Concomitant with these changes, regional geography has become more nuanced, idiosyncratic, eclectic, and demanding.

Geography has much to lose if it allows regional geography to slip through its fingers. Other disciplines will be only too willing to fill the void created by geographic indifference, prejudice against non-scientific expertise, and inability to acquire the requisite non-geographic skills. Conversely, the blows, sustained by regional geography and to the rich legacy of Sauer, James, Gottmann, Crist, and many others, can be turned to advantage by seizing the opportunity to be bold and innovative and shape a new vision for the vital center of geography. All that is necessary is commitment and preparation.

Once the decision has been made to offer regional courses, an appropriate methodological approach should be selected. Objectives must be established and alternative materials examined. While there is no single way to reach regional geography, some suggestions come to mind.

A Regional Geography: Some Suggestions

A successful course in regional geography must capture the feel, ambience, and essence of a region. There must be no doubt about a region’s raison d’être. Each region and its connecting linkages are unique. Latin America is defined by anthropological and cultural ties; but European unity has historical, economic, and political foundations.

An honest assessment of an instructor’s strengths and weaknesses is important in a sub-discipline which is inherently impressionistic. The course should incorporate his or her areas of expertise. For example, I always use my background in comparative legal systems to highlight that aspect of regional character. Conversely, the text will insure that all areas are covered.

Selecting the right text requires time, but is well worth the effort. It is certainly not good enough to adopt the text everyone uses. An effort should be made to find the right books. The process might

Spanish introduction of Christianity in the 16th century; the rise of Protestantism during the English occupation, which continued after it became a U.S. territory in 1821; the post-Civil War emergence of Baptists, both white and black (Joiner 1972; Howard and Howard 1994); the influx of various groups of Europeans, mostly Catholic (McNally 1982) such as Italians but also Orthodox Greeks; the rise of fundamentalist Protestants in the 1920s; the post-World War II growth of Jews in the greater Miami region; and the influx of Catholic Latinos since the 1960s, including Cubans and Nicaraguans in Miami and Puerto Ricans in Orlando (Winsberg 1993). Other studies have indicated the significance of religion in Florida to presidential politics (Kane, Craig, and Wald 2004). Winsberg’s (2006) cultural atlas of the state points to the prevalence of Catholicism in southern Florida and of Baptists in northern Florida (p. 60), offers numerous maps of various denominations, and culminates in the observation that “A high degree of religious diversity within Florida’s counties is rare” (p. 62).

This paper builds upon previous research by addressing the Florida’s religious diversity quantitatively. It begins with a brief synopsis of the nature of religious competition and its relations to religiosity. Second, it describes the data and quantitative methods utilized to measure religious diversity. The third section analyzes these patterns cartographically, including the distributions of adherents and four major faiths. The conclusion summarizes the principal themes and findings.

Conceptualizing Religious Diversity

Two major schools of thought characterize sociological theory regarding the consequences of religious diversity. The dominant perspective among sociologists of religion approaches denominations as similar to “firms” competing in a market (Finke and Stark 1988; Roof 1999). Thus, denominations are held to “compete” with one another for adherents much as firms compete for customers, often by offering charismatic leaders or educational and recreational services such as Sunday schools (Bruce 2002; Stark and Finke 2000). One extension
of this approach is rational choice models based on utility-maximizing individuals making clear choices (Montgomery 1996, 2003). However, this perspective suffers from several disadvantages. Religions are not, except perhaps under the crassest terms, profit-maximizing institutions and thus cannot be expected to behave in the same way. Further, the religious economies view utterly ignores the profound emotional and occasionally irrational dimensions that underlie people’s choices of faith, including their socialization into families, traditions, and communities.

A second approach views religious diversity through the conceptual lens of social ecology (McPherson 1983). This approach focuses on the local social and spatial context of different faiths, their modes of organization, ability to appeal to different constituencies, and denominations’ abilities to mobilize resources in the pursuit of new members or attempts to prevent current ones from dropping out. This approach lacks the elegance of neoclassical models but comes to terms with the complex, frequently messy world of everyday life, the psychology of religious belief, and their embeddedness in social relations. As Chaves and Giesel (2000, p. 4) contrast the two schools of thought, “In the economic approach, the basic image is one of organizations as firms trying to sell products to individuals who are customers. In the ecological approach, the basic image is one of organizations as organisms trying to maintain themselves by using individuals as resources.”

Deeply entwined with discussions of religious diversity is its relation to religiosity, or intensity of belief and participation in denominational activities. The long-standing view first articulated by Max Weber maintains that over time, the culture of capitalism tends gradually to become more secular (Berger 1967). However, a counterargument articulated by Finke and Stark (1988, 1998) holds that rising religious pluralism in fact stimulates competition among faiths and leads directly to greater religious participation and religiosity. In this view, desecularization should accompany religious diversity, not the decline of faith. This line of thought was opposed by numerous authors, such as Breault (1989a,b), Olson (1998), Chaves and Geography claims to be the “spatial” discipline. Regional geography analyzes and explains space. Further, regional geography is the fulcrum of the geographic world with its feet firmly planted in every sub-discipline. It unites a fragmented discipline and provides a justification for its existence in the minds of the public. Regional studies are a natural capstone for a discipline eager to earn a place at the table and the ideal forum to display its vaunted skills and knowledge.

Regional geography is neither physical geography nor human geography; it partakes of both, and also of several other academic disciplines. It is not only geography’s most inter-disciplinary field, but actually, requires expertise in several non-geographic specialties. That outside expertise must be grounded on graduate level training in fields such as cultural studies, history, and economics. Training in geography alone is simply not enough to achieve true competence.

Renaissance men, not ever more specialized experts in some academic field, are required to teach these courses. Broadly based scholars will reflect a student population notable for the diversity of its interests. Students will be introduced to geography in a setting where international business students, liberal arts majors, and a sprinkling of others pursue interests in real places and real people. It is a canard to claim these courses lack intellectual rigor because they lack specialization. Their focus is simply different.

The variegated nature of student populations in regional geography places heavy demands on potential instructors to possess true competence beyond the confines of traditional geography. Students expect and deserve someone that has a comprehensive knowledge of special places and unique peoples. That knowledge can only be gained by long study, travel, international contacts, and thorough preparation. It is simply not good enough to staff these courses with whoever is available and interested.

Geographic canon formerly defined regional geography as comprised of a checklist of largely physical, economic, and political concerns. Those concerns remain, but today the focus is more cultural. It has acquired “soul.” Any topic which informs the student of
Regional Geography: A Personal View

Glenn Anderson
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Editor’s Note:
Glenn Anderson is a solo-practicing Attorney at Law in Winter Haven. He graduated from the University of Florida School of Law some time ago, and has continued his education ever since, recently acquiring both a Masters Degree in Geography from the University of South Florida and a Masters Degree in History from the University of Central Florida. Throughout his professional career he has been a very strong advocate for the discipline of Geography, having taught the subject at Polk Community College, Florida Southern College, and, quite regularly over recent years, the University of South Florida. His missionary work for Geography also has led him to self-fund an award for promising seventh graders at Grace Lutheran School in Winter Haven, “The Anderson Geography Award”, which is intended to spark interest among students at an early part of their academic careers. His zeal has also convinced his brother, Robert L. Anderson, to fund the “Anderson Visiting Lectureship” in Geography at the University of Florida. In short, Mr. Anderson is just the sort of professional/academic advocate the discipline should recognize and covet at all levels of education. I hope that we hear of more such in future editions.

A resurgent regional geography lacks the coherence of bygone days and is peripheral to the concerns and expertise of most geographers. Today the average geographer neither understands this part of geography’s triad or really values its contribution to the discipline. Only a public interested in that kind of geographic knowledge and the legions of students convinced of its value force a reluctant and timorous acceptance of regional geography within a discipline currently obsessed with technical skills and scientific expertise.

Gorski (2001), and Voas, Olson and Crockett (2002), and Olson and Hadaway (1999), who typically argue that enhanced religious diversity erodes the dense social ties and the tight fabric of communities that are often maintained via a dominant faith. Religion acts as a social as well as ideological phenomenon, and the rising individualism and celebration of the commodity that permeate American society have done little to enhance religiosity. The debate about religiosity continues.

Data and Methodology
Because there are no census data on religion, this paper used data published by the Glenmary Research Center (2002) on Florida’s religious denominations in 2000, which lists numbers of adherents by denomination for each county. While widely used, the Glenmary data do suffer flaws, such as omitting some faiths (e.g., Jehovah’s Witnesses) and the inability to identify adherents who live in one county and worship in another.

Measuring diversity is not easy. Simple measures may not do justice to the complexity of distributions, including the relative abundance of different faiths. For example, is a county with 10 faiths each of which has 10 percent of adherents more or less diversity than a county with 15 faiths but in which 80 percent of adherents belong to only one? In biogeography, these issues are widely recognized as different measures of species richness (Magurran 2004). This paper employed four empirical measures of religious diversity:

1. The simple number of denominations present in each county, n, which summarizes the suite of options available to individuals in given areas.

2. The proportion of total adherents who belong to the county’s largest denomination, i.e., \( n_{\text{max}} / N \), where \( N = \) total number of adherents.

3. Shannon’s index (H), derived from entropy maximization, which quantifies the diversity of religions based on two components: the number of denominations and their proportional distribution. The Shannon index is calculated by summing the proportion of adher-
ents per denomination multiplied by the natural logarithm of that proportion, that is,

\[ H = -\sum (p_i \ln p_i) \]  

(1)

in which \( p \) is the proportion of a county’s adherents found in denomination \( i \) (Magurran 2004). The maximum value is reached when all denominations have the same distribution.

4. Simpson’s index (\( D \)), invented by Simpson (1949), is based on probability theory, specifically, the likelihood of two individuals drawn at random from a county will be in the same denomination. It is defined as

\[ D = \sum p_i^2 \]  

(2)

in which \( p \) is the proportion of a county’s adherents found in denomination \( i \). It ranges from zero to one.

To the extent that these measures capture the complexity of religious diversity across the state, their spatial distributions should resemble one another.

Results

In 2001, about 10.3 million people, or 65 percent of the state’s population, belonged to one of 17 major faiths (Table 1). Notably, the state also had 5.6 million non-adherents, including atheists, agnostics, or people who belonged to no formal denomination. Christians of various sorts accounted for 95 percent of all adherents, whereas only five percent (771,000 people) were non-Christian, including Jews, Muslims, and a variety of faiths that Glenmary lumps under the unfortunate label of “Eastern Religions.” The largest denominations included Catholics (16 percent), Baptists (8.5 percent), Historically African-American Protestant denominations (seven percent), and several smaller faiths grouped together as “Other Christian” (18 percent).

Figure 1 portrays religious adherents as a proportion of the total population of each Florida county. Ranging from 24 to 84 percent, it reflects the wide variation within the state of the degree to which residents hold to one faith or another, and thus serves as a rough index of the geography of religiosity. Areas with the highest

References


River from the Wekiva River.

Alternatively, the high total alkalinity water of the Wekiva River may be causing alkalitrophy and subsequently high levels of biologic production in the St. Johns River leading to an increase in ammonium concentration. The higher levels of dissolved oxygen entering the St. Johns River from the Wekiva River may also lead to increased levels of biologic respiration of organisms in the St. Johns River and would also subsequently increase ammonium concentration. Both inflow of high total alkalinity and elevated dissolved oxygen may have a combined effect in raising ammonium concentration in the St. Johns River. However, further testing of the water at and around the junction of these rivers is required before the exact cause of increased ammonium levels can be stated definitively. Further sampling efforts may include benthic invertebrate population comparisons with other areas of the St. Johns River to give an indication of potentially high biologic productivity at the confluence. Manipulative experiments could also be conducted in a lab environment to test if variation of dissolved oxygen or total alkalinity levels in an invertebrate tank affect ammonium concentrations. Seasonality may also play a large part in ammonium production due to variations in both water temperature and productivity at different times of the year. Therefore sampling efforts should encompass these seasonal differences.

### Table 1. Distribution of major religious denominations in Florida, 2002.

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Adherents</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Christian</td>
<td>2,911,408</td>
<td>18.2</td>
</tr>
<tr>
<td>Catholic</td>
<td>2,596,148</td>
<td>16.2</td>
</tr>
<tr>
<td>Baptist</td>
<td>1,352,470</td>
<td>8.5</td>
</tr>
<tr>
<td>Historically African-American Protestant</td>
<td>1,125,530</td>
<td>7.0</td>
</tr>
<tr>
<td>Jewish</td>
<td>628,485</td>
<td>3.9</td>
</tr>
<tr>
<td>Pentecostal</td>
<td>467,290</td>
<td>2.9</td>
</tr>
<tr>
<td>Methodist</td>
<td>458,623</td>
<td>2.9</td>
</tr>
<tr>
<td>Presbyterian</td>
<td>157,751</td>
<td>1.0</td>
</tr>
<tr>
<td>Episcopal</td>
<td>152,526</td>
<td>1.0</td>
</tr>
<tr>
<td>Confessional</td>
<td>140,788</td>
<td>0.9</td>
</tr>
<tr>
<td>Eastern Religions</td>
<td>111,030</td>
<td>0.7</td>
</tr>
<tr>
<td>Orthodox</td>
<td>108,189</td>
<td>0.7</td>
</tr>
<tr>
<td>Latter-day Saints (Mormons)</td>
<td>75,620</td>
<td>0.5</td>
</tr>
<tr>
<td>Muslim</td>
<td>31,661</td>
<td>0.2</td>
</tr>
<tr>
<td>Pietists</td>
<td>11,586</td>
<td>0.1</td>
</tr>
<tr>
<td>Non-adherents</td>
<td>5,653,273</td>
<td>35.4</td>
</tr>
<tr>
<td>Total</td>
<td>15,982,378</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: calculated by author from Glenmary data.

Proportions of adherents (above 60 percent) include Palm Beach county, Duval county and Jacksonville, and several counties in the Panhandle, such as Taylor, Madison, Suwannee, and Gadsden. Conversely, regions with relatively low proportions of adherents (less than 44 percent) include much of the state’s Gulf coast, such as the Everglades region of Monroe, Hendry, Charlotte, and Lee counties as well as the region north of Tampa (Levy, Marion, and Citrus counties). This pattern may reflect, among other things, the differential streams of migrants to the state from varying parts of the U.S. and abroad.
Florida exhibits significant variations in the distributions of several of its largest and best known denominations (Figure 2). Catholics and Jews, for example, are heavily concentrated in the greater Miami/Dade county-Ft. Lauderdale region, which undoubtedly reflects the large numbers of Latinos and elderly in-migrants from the Northeast, respectively. Conversely, northern Florida, particularly the Panhandle, is dominated by Baptists and, to a lesser extent, Methodists.

Finally, the four measures of diversity deployed here yield a
the two rivers was of a similar magnitude to the ratio of their flow. 

Total alkalinity was found to be high in the spring fed Wekiva River as one might expect due to the alkaline limestone watershed (Goldman and Horne, 1994). Total alkalinity was relatively low in the St. Johns River. Again, the combining of these two different water types has the effect of raising the total alkalinity in the larger, less totally alkaline, St. Johns River by dilution with the smaller, more totally alkaline, Wekiva River (Figure 4).

Ammonium concentration was found to be relatively constant in the upstream St. Johns River samples (stations 1-6) and in the Wekiva River (station 8). However, ammonium concentration was of a highly increased level in the St. Johns River downstream from the Wekiva River (Figure 5). This increase may be due to agricultural run off from the surrounding area but I find this unlikely as no such similarly elevated levels of ammonium were sampled at any other sta-
denomination in each county similarly indicates that dominant faiths tend to be most heavily represented in relatively rural areas (e.g., Dixie, Levy, Lafayette, Gilchrist counties at the base of the Panhandle, or Calhoun and Holmes counties farther west) and comprise a much smaller proportion of residents in large cities. The Shannon and Simpson diversity indices lend further weight to these observations by including the relative distribution of faiths within each county: the Shannon index is highest in Pinellas, Leon, Alachua, and Orange counties, whereas the Simpson index reaches its maximum levels in these as well as Duval, Hillsborough, Polk, and Highlands.

Concluding Thoughts
Religion has become too important a force in American public and private life for geographers to ignore. The sheer size and complexity of the U.S., with streams of immigrants from around the world as well as home-grown faiths (e.g., the Latter-day Saints, or Mormons) makes understanding the religious landscape a daunting task.

Two-thirds of Floridians belong to an organized religious denomination. Florida remains an overwhelmingly Christian state, in which 95 percent of adherents belong to one Christian denomination or another. Of Christians, Protestants comprise 72 percent, Catholics and additional 16, and Orthodox Christians less than one. Spatially, the state exhibits profound contrasts between northern Florida, in which Baptists and Methodists dominate, and southern Florida, characterized by large numbers of Jews and Catholics. As measured by the four indices employed here, religious diversity in Florida is closely associated with city size: invariably, large metropolitan counties (the Miami region, Tampa-St. Petersburg, Jacksonville) exhibit a broader array of faiths than do small, rural ones. Thus, in addition to the long-standing north-south dichotomy, a rural-urban one is significant. Because religion is deeply intertwined with political behavior, social mores, and everyday life, these patterns are important in deciphering other vital aspects of Florida’s evolving social geography.
Discussions

The minimum average flow of the St. Johns River is established to be 2050 cubic feet per second (cfs) (SJRWMD, 2006). The minimum average flow of the Wekiva River is established to be 240 cfs (SJRWMD, 2006). Despite the far lesser discharge of the Wekiva River it is still of a magnitude capable of effecting some aspects of the St. Johns River water chemistry.

The St. Johns River is highly colored which is consistent with it being considered a blackwater ecosystem (Clewell, 1991). The Wekiva River is sourced to a spring which indicates low water color values. The combining of these two different water types has the effect of

Figure 4. Total alkalinity per station in the St. Johns River, central Florida, 15 November 2006.

References


Figure 3. Water color per station in the St. Johns River, central Florida, 15 November 2006.

The ammonium concentration was found to be relatively constant at sampling stations on the St. Johns River upstream from its junction with the Wekiva River (Figure 5). The ammonium concentration at the Wekiva River sampling station is of a similar magnitude to stations 1 through 6 on the St. Johns River (Table 2). The ammonium concentration at station 7 on the St. Johns River (downstream from the Wekiva River junction) is the highest of all sampling stations on the St. Johns River (Figure 5).

Comparing Figure 6 with Table 2, the dissolved oxygen concentration was determined to be higher in the Wekiva River (station 8) than at any other station on the St. Johns River. There was little variation in dissolved oxygen concentrations at all stations on the St. Johns River (Figure 6). Tannin and turbidity levels were found to be lower in the Wekiva River (station 8) than in the St. Johns River and
Table 1. Sampling data per station for the St. Johns and Wekiva Rivers, Central Florida, 15 November 2006.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Station 1</th>
<th>Station 2</th>
<th>Station 3</th>
<th>Station 4</th>
<th>Station 5</th>
<th>Station 6</th>
<th>Station 7</th>
<th>Station 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secchi Disc (m)</td>
<td>0.77</td>
<td>0.84</td>
<td>0.73</td>
<td>0.75</td>
<td>0.71</td>
<td>0.74</td>
<td>0.74</td>
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<tr>
<td>Water Temp. (C)</td>
<td>21.8</td>
<td>21</td>
<td>21.2</td>
<td>21.4</td>
<td>21.2</td>
<td>20.9</td>
<td>20.8</td>
<td>18.9</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>3.9</td>
<td>2.4</td>
<td>2.4</td>
<td>2.8</td>
<td>2.8</td>
<td>2.6</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Tannin (ppm)</td>
<td>6.54</td>
<td>6.4</td>
<td>6.4</td>
<td>6.27</td>
<td>6.4</td>
<td>6.27</td>
<td>6.27</td>
<td>1.85</td>
</tr>
<tr>
<td>Water Color (Pt-Co)</td>
<td>119.8</td>
<td>119.8</td>
<td>119.8</td>
<td>116.1</td>
<td>117.4</td>
<td>116.1</td>
<td>114.1</td>
<td>20.2</td>
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<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>5.6</td>
<td>5.3</td>
<td>5.3</td>
<td>6.0</td>
<td>5.8</td>
<td>5.1</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
<td>6.85</td>
<td>6.83</td>
<td>6.84</td>
<td>6.9</td>
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<td>Carbon Dioxide (mg/L)</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>9</td>
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<tr>
<td>Total-Alk (mg/L CaCO₃)</td>
<td>70</td>
<td>80</td>
<td>79</td>
<td>81</td>
<td>81</td>
<td>81</td>
<td>85</td>
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<td>Sp Cond (μmhos/cm)</td>
<td>1085</td>
<td>1082</td>
<td>1085</td>
<td>1081</td>
<td>1080</td>
<td>1068</td>
<td>1066</td>
<td>855</td>
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<tr>
<td>Ammonium (NH₄) (ppm)</td>
<td>0.91</td>
<td>0.91</td>
<td>0.78</td>
<td>1.04</td>
<td>1.04</td>
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<tr>
<td>NO₂-N (ppm)</td>
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<td>0</td>
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<td>0</td>
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<td>0</td>
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<td>0</td>
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<tr>
<td>OPO₄ (ppm)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

River was found to be high at 145 mg/L CaCO₃ (Table 2). The total alkalinity of the St. Johns River at sampling station 7 (downstream from the Wekiva River junction) is the highest of all sampling stations on the St. Johns River (Figure 4).


The Geography of Religious Diversity in Florida

Warf


The Florida Geographer

light penetration (Welch, 1948). Sampling took place on 15 November, 2006 between 11:30 am and 1:00 pm.

Water Chemistry Analyses

The water samples were then analyzed in the lab at 3:00 pm on 15 November, 2006. The water samples were tested for total alkalinity using Standard Methods and a Corning pH meter model 125 (APHA, 1992). Water color and turbidity was tested using Standard Methods and a Hach Turbidimeter model 16800 (APHA, 1981). Ammonium, nitrate, and nitrite concentrations were tested using a Hach test kit model NI-8. Tannin and orthophosphate concentrations were determined using Standard Methods and a Milton Ray Spectronic 20+ model LR45227 spectrophotometer (APHA, 1981). Dissolved oxygen was tested using the modified Winkler Method (APHA, 1981). Free carbon dioxide was determined using Standard Methods (APHA, 1975). Water samples were also analyzed for pH using a Corning pH meter model 125.

Results

Table 1 shows all physiochemical parameters which were tested for at each sampling station on the St. Johns and Wekiva Rivers. Having examined these data it was found that no parameters other than water color, total alkalinity, ammonium, and dissolved oxygen exhibited significant variation between sampling stations on either the St. Johns or Wekiva Rivers. As a result only those parameters which exhibited variation were focused on as a part of this study.

Water color was found to be high (>50 Pt-Co) throughout the sampling area of the St. Johns River upstream from its junction with the Wekiva River. Water color was found to be low (<50 Pt-Co) at the Wekiva River sampling station (Table 2). Water color was lower at sampling station 7 (located on the St. Johns River downstream from its junction with the Wekiva River) than any other sampling station on the St. Johns River (Figure 3).

Total alkalinity values were found to be relatively constant at the sampling stations on the St. Johns River upstream from its junction with the Wekiva River (Figure 4). Total alkalinity in the Wekiva
temperature and specific conductivity was taken at each station and a 20 cm diameter Secchi Disc was utilized to determine the extent of


Marco Island: Tropical Paradise or Environmental Disaster

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Introduction

Deltona Corporation was one of several large land development companies that specialized in selling recreational and retirement property to a distant clientele. Much of this type of so-called “land development” activity took place during the decades of the 1950s, 1960s, and early 1970s prior to the implementation of laws and regulations designed to monitor land sales activity and to promote wise land use development techniques (Finotti, 1996). Deltona’s Marco Island project began in 1964 and is a good example of problems that occur when developers make poor site selection decisions and then stubbornly adhere to their original development plan in spite of growing concern over the environmental and economic value of the property that had been selected for development.

As evidence of the value of its property mounted, Deltona found it harder and harder to obtain government permits to dredge and fill. Yet it continued to sell lots until mid-1973, promising that the land would someday be raised above the water level. Early in 1976, the U.S. Army Corp of Engineers, in a nearly unprecedented decision, refused Deltona permission to dredge and fill over 2,000 acres of mangrove swamp planned for conversion into 4,300 home sites on the eastern side of the island. Consequently, the company’s plans for its star development were dealt a shattering blow. In the meantime, consumers had invested millions of dollars in land which in its natural state is uninhabitable. For these consumers and for Deltona itself, the consequences of the Corps’ decision to deny permits

Figure 1. St. Johns and Wekiva River confluence.

Source: Author Photograph.

Methods and Materials

Field Data

Seven sample stations were evenly located on the St. Johns River in the center of the channel approximately 1 km apart (Figure 2). Six of these stations (stations 1-6) were located upstream of the confluence of the St. Johns River with the Wekiva River. Station 1 was located in Lake Monroe near its outlet into the St. Johns River. One station (station 8) was located approximately 0.5 km upstream from the junction of the Wekiva River with the St. Johns River in the center of the Wekiva channel. One station (station 7) was located in the St. Johns River (center of channel) approximately 1 km downstream from its junction with the Wekiva River. At each of these stations water samples were collected from 1 m depths using a bilge pump and plastic tubing to obtain uncompromised samples. Water
Physiochemical Effects of the Wekiva River on the St. Johns River, Central Florida

David Keellings
University of Central Florida

Introduction
The St. Johns River is a 6th order river which flows north from its headwaters in Indian River County a distance of 310 miles to its outlet with the Atlantic Ocean in Duval County. It is a slow moving meandering river which widens into several lakes throughout its flow and has an average elevation change of less than 1 inch per mile. The St. Johns River is considered to be a blackwater river (Clewell, 1991). Blackwater rivers are characterized by tea-colored water caused by high concentrations of Dissolved Organic Matter (Meyer, 1990). The Wekiva River is a calcareous river fed by Wekiwa Spring and Rock Spring. It joins the St. Johns River as a single channel where the boundaries of Seminole, Lake, and Volusia Counties meet (Figure 1). The surrounding river bank is forested with wetland species including cypress (Taxodium sp.) and red maple (Acer rubrum) transitioning to upland oak communities through cabbage palm (Sabal palmetto).

This confluence of water provides an opportunity to observe the effect on water chemistry when a spring fed river joins a blackwater river. Physiochemical properties of water were measured at eight stations. Six of these stations were located in the St. Johns River upstream from its confluence with the Wekiva River. One station was placed in the Wekiva River upstream from its confluence with the St. Johns River and one station was placed in the St. Johns River downstream from the confluence with the Wekiva River. Stations were located in this manner to determine how physiochemical properties of the St. Johns River are affected by water inflowing from the Wekiva River. Specific attention was given to water color, total alkalinity, ammonium, and dissolved oxygen. Sampling was conducted on 15 November, 2006.
chosen for development. In the case of Marco Island, the destruction has been particularly devastating. This paper provides a brief history of the conflict that arose between the developer, governmental officials, and environmentalists, assesses the more significant environmental problems that were created and examines mitigation techniques the city is using to rectify some of the many mistakes made by the original developer.

The Conflict

Marco Island itself, a 7,300 to 8,400-acre barrier island, includes the substantially developed Marco River and Roberts Bay ar-


Perception of the Hurricane Forecasting, Warning and Response System

The eastern end of the island is Barfield Bay and Big Key area where over 2,500 acres have been subdivided into 4,000 home sites. These lots have been sold but not developed since dredge and fill permits were denied (Allan, Kuder and Oakes, 1976).

Unfortunately for Deltona, the conflict over the development of Marco Island coincided with the evolution of environmental awareness in South Florida. Just when the land development company was poised to make substantial "progress" toward completion of the project, the value of barrier islands and estuaries emerged from the esoterica of academia to a frequent topic in daily newspapers. Barrier islands, when left undisturbed, were now viewed as vital to the protection of coastal wetlands against the forces of the wind, hurricane surges, and ocean waves. Energy from oncoming hurricanes or tidal surges are absorbed or deflected by these islands, thus protecting the mainland from storm damage. Mangrove swamps, which were dismissed in 1964, the year the development began, as noxious and mosquito-laden, by 1970 were understood to be the keystone of a unique and complex ecological system. Such systems are ideal nesting sites for shorebirds and nurture and protect a majority of Florida’s commercial and sports fish. Florida’s coastal wetland region was now considered to be an essential component of Florida’s economy and ecology rather than developable land. The beaches, dunes, and wetlands within coastal zones also provide desirable habitat for various recreational activities (Milk, 2005 and Stone, Sheremet, and Braud, 1997).

The Marco Island Development Corporation (MIDC), a Deltona subsidiary, initially purchased 10,327 acres of uplands and submerged lands on and around Marco Island. At the time, developers were only required to obtain approval in three specific areas. These included the bulk head line from the county and the Trustees of the Internal Improvement Trust Fund; approval of dredge and fill activity in navigable waters from the Army Corps of Engineers; and approval of the right to sell lots from the Florida Land Sales Board (now the Division of Florida Land Sales). At the time, none of these agencies...
put a high priority on preserving wetlands. The County’s primary concern was that the land be filled sufficiently to limit flooding. The Trustees’ concern was that it be paid for the fill dredged from state-owned bottom lands and that there was no trespassing on state lands. The Corps of Engineers wanted only to be sure that development would not interfere with navigation (Allan, Kuder and Oakes, 1976).

Based on prevailing attitudes at the time, it is not surprising that the company received approval to proceed with the project. The Collier County Commission reviewed the master plan for the Marco Island development project and established the bulkhead lines which the Trustees approved. Deltona recorded its plats with the County and posted corporate bonds for the completion of development. And the Florida Land Sales Board approved the company’s sales materials. As a result, Deltona was able to begin selling its submerged home sites in 1965. It needed only the Corps of Engineers’ permission to convert them into habitable land.

Permits from the Corps of Engineers’ were limited to a three-year period. Since Marco Island was so large and required such extensive dredging and filling, Deltona divided it into five sections: Marco River, Roberts Bay, Barfield Bay, Big Key and Collier Bay. The company planned to apply for the necessary permits one section at a time. In October, 1964, the Corps routinely issued a permit for the Marco River section, the first phase of the dredge and fill operation.

Deltona experienced fairly smooth sailing for the next two years. However, as the Naples Star later recounted, it was not long before “a revolution” was underway, catching Deltona in the middle holding a half developed island (Drake, 1974). Mangroves suddenly became important and, by 1967, the ecological value of estuaries was more widely appreciated. The company’s efforts to develop environmentally sensitive land encountered a changing attitude concerning wetlands with its application to begin dredging and filling the second area of Marco Island. In September, 1967, it requested permission to dredge 10 million cubic yards of fill from Roberts Bay. While the Florida Trustees issued the permit in April, 1968, the Corps delayed.
References


Under the Memorandum of Understanding, the Department of the Interior, Bureau of Sports Fisheries and Wildlife (now the U. S. Fish and Wildlife Service), had to review the plans before the Corps could approve the project. In September, 1968, after months of meetings and discussions with Deltona, the Director of the Bureau’s Southeast Regional Office informed Deltona that his agency regarded any dredging as detrimental to conservation in the area. According to a Deltona statement, the company understood this to mean that the agency would recommend denial of any dredge and fill permit (Allan, Kuder and Oakes, 1976).

Although Deltona continued to subdivide and sell lots, it did, in February of 1969, agree to make design changes to accommodate some of the Bureau’s objections. The changes included reducing the 306-acre area to be dredged by a third, creating, by transplant, a 10-acre mangrove island, installing a sanitary sewer system, and employing an ecologist on the project. The Bureau’s objections continued, however, and the issue went up the ranks of the Department of the Interior.

Deltona chose to ignore several warnings from regulatory agencies and the accumulation of extensive evidence of the environmental consequences of creating lots from coastal wetlands. They also ignored the vast evidence that dredge and fill permission would no longer be a routine matter. In spite of all that had happened, the company continued to sell submerged lots on Marco Island and began plans to subdivide other parcels of land off the island.

As the years passed, Deltona was finding it necessary to apply to the appropriate authorities for renewal of its permits in the first two development areas: the Marco River and Roberts Bay sections of Marco Island. Because of the two-year delay in obtaining federal approval of Roberts Bay, Deltona had not been able to complete the work that had already been authorized. In 1971, Deltona asked for an extension of both the Marco River and Roberts Bay permits. This request for renewal and extension began a lengthy controversy.

A major part of the controversy was associated with a request by Deltona in 1971 that the state reissue permits that should have not
been issued in the first place. Unfortunately, lots had already been sold in these areas despite official warnings against the practice of prematurely subdividing and selling land.

Mounting opposition from the Audubon Society and the Florida Department of Natural Resources forced Deltona to retreat and regroup. The company, rather than attempt to obtain dredge and fill permits for new areas, decided to concentrate on getting approval to continue and complete the development of Marco Island itself. This included Collier Bay on the northwestern side of the island and Big Key and Barfield Bay on the east, where lots had been sold but no dredging and filling had occurred. Deltona marshaled teams of scientists who conducted studies and slightly modified some of the company’s original plans. These studies and plans were presented to the Pollution Control Board in an attempt to obtain state certification.

The Department of Pollution Control staff reviewed all of Deltona’s new plans and studies and prepared an official presentation for its Board in February, 1974. It reported that the proposed project would disturb 2,200 acres of mangrove vegetation. The staff estimated the economic value of the affected mangrove areas and indicated that considerable deterioration of water quality could result from their destruction. In view of these negative consequences, the Department’s staff recommended that the project, as proposed, be denied. Interestingly, the Pollution Control Board, despite the negative recommendations of its own expert staff, approved Deltona’s plans for development in April, 1974. The Board certified that the proposed development would comply with applicable state water-quality standards. Approval hinged on the modification of tributary canals so that mid-canal depths would not exceed 6 feet during mean low tide at distances beyond 800 feet from the mouth of the canal (Allan, Kuder and Oakes, 1976).

The next step was for the Corps of Engineers to review the proposed project. During 1975 the Corps prepared Environmental Impact Statements that included a discussion of the adverse impact associated with the loss of 2,200 acres of mangroves and consequent disruption of the total natural productivity of the area. Despite the

Implications and Practical Applications

This research provides insight into one small community and its perceptions and responses to a forecasting, warning and response system. The research does support some of the previous findings of how different demographic factors are related and influence individuals’ behaviors (Wisner et al. 2004, Tobin and Montz 1997, Morrow 1999), but certainly not all. The results of this research can be used in the future development of forecasting, warning and response systems by taking what has been found here and applying it to new models. For example, older individuals may need more time and assistance to respond to a warning. By already knowing that older individuals need more time, once a warning is issued assistance can be dispatched to those who need it. Also, those of lower socioeconomic status may not have the financial resources to respond adequately to a warning. Therefore, after a warning is issued supplies could be disbursed to those in need. Thus, the focus in developing effective forecasting, warning and response systems should not only incorporate understandable warning messages but also target messages to particular audiences.

Future research should investigate additional communities and how different characteristics of individuals influence their understanding and response to warnings to determine to what extent generalizations can be made from community to community. It is hoped that this research will contribute to the understanding of how different characteristics of individuals influence their understanding and response to warnings, which may have practical applications when designing future forecasting, warning and response systems. In addition, while this research was applied to a hurricane forecasting, warning and response system, it could very well be used for other hazard warning systems that can have similar lead times such as floods or volcanoes.
homes than others ($p = 0.001$). This may be due to the fact that those earning less than $40,000 annually may reside in mobile homes and less well constructed homes and therefore need to evacuate for safety. Those of lower socioeconomic status may reside in more vulnerable locations.

**Conclusion**

This study supports the literature regarding how age, education and income influence perceptions, responses to hurricane warnings. For instance, it was found that both younger and older residents appear to respond favorably to hurricane warnings, although younger respondents gave more favorable ratings to the actions and information surrounding the warnings. This is encouraging in that all residents do appear to listen and heed the warnings given by officials. However, when trying to respond to the warnings, older individuals may require the help of others, making the process more difficult for them and causing them not to rate the actions and information surrounding the warnings as highly. Similarly, those with higher levels of education and income also demonstrated greater understanding of the warning information and more favorable responses to events. It should be stressed, though, that they were also less likely to evacuate. This aspect requires further study to determine if these individuals are less vulnerable in terms of their housing structures. Gender, on the other hand, has no influence on perception and behavior in this study. The hypothesis, stating that females are more likely to respond to warning messages than males, cannot be substantiated within this context.

Furthermore, income and level of education were positively correlated with each other. The likelihood ratio between income and level of education was 77.4, which is significant at the 0.01 level. The results are consistent showing that income and level of education influence individuals and the ways they perceive and respond to warnings. The results suggest therefore, that poor households have insufficient resources in order to prepare for the event.

widespread destruction that was occurring, the Corps’ discussion tended to favor the development. Criticism of the Corps’ Environmental Impact Statement emerged rapidly from several private and governmental agencies. Some of the greatest opposition to the development came from the National and Florida Audubon Societies, the Environmental Defense Fund, and the Natural Resources Defense Council. The end result was a compromise whereby the Corps granted permission for Deltona to complete the development of Collier Bay but denied permission to dredge and fill the more environmentally productive and valuable Big Key and Barfield Bay areas on the eastern side of the island (Allan, Kuder and Oakes, 1976).

**Mitigation or Status Quo**

Obviously, many of the problems created by Deltona are associated with the extreme environmental sensitivity of the site chosen for development. In its natural state, Deltona’s property was a wet wilderness composed of barrier islands and keys separated by bays, marshes, mangrove swamps, and flooded lowlands. Much of the property was underwater during high tide, it was vital aquatic habitat, contained nine significant archeological sites, and supported many endangered species. The inhabitants included innumerable species of birds, crustaceans, fish, reptiles, and animals. It also lies almost entirely in a hurricane zone and flood-hazard area. These and other limitations provide a strong indication as to why the development should not have taken place. The extent of this area’s inhospitality to man without radical transformation is evidenced by the fact that 85% of the land platted at Marco Island required fill to raise it to 5.5 feet above mean sea level (Milik, 2005).

Deltona did plan to develop the site in phases, a generally accepted very sound planning method. With development taking place a step at a time, Deltona could have revised its original Marco Island design to be consistent with the emerging awareness of the importance of estuarine resources. Yet, the company did not limit contracts to five-year or shorter periods, nor did it coordinate its contracts with receipt of the necessary dredge-and-fill permits. By selling thousands
of lots on two- to twelve-year contracts before receiving state and federal permission to create them, Deltona locked itself into an outmoded plan and left itself vulnerable to unforeseen events. Consequently, the Marco Island project was unable to adapt to the ever more stringent regulation of coastal wetlands (South Florida Water Management District, 2006).

The site’s basic layout would be labeled poor by most environmentally concerned planners. Lots and streets are arranged in what is essentially a grid pattern within the network of finger canals. Clustering, which would have allowed preservation of significant natural areas and parks, was not employed.

Not surprisingly, Deltona did not conform to any of the basic sound land use practices at Marco Island. One of the significant issues is associated with the development of areas of critical environmental concern that included wetlands, beaches and dunes, habitats of endangered species, and prime aesthetic, archeological, and recreational resources. Moreover, it has created an entire subdivision in an area hazardous for building. Since Marco Island is in Florida’s hurricane zone, its coastal location and low elevation pose a special flood risk for residents. The mangrove zones have, in the past, acted as buffers, slowing down massive tides produced by hurricanes. Without these mangrove and island buffers, hurricane-produced waves and tides will buffet the development.

Land alteration is another significant problem. The dredging and filling of wetlands inevitably resulted in the wholesale de-vegetation of the areas involved. Because the natural soils were covered with sand dredged from the bottoms of bays, re-vegetation, an important technique to prevent soil erosion, was extremely difficult and slow. While Deltona re-vegetated rights-of-way after road and utility construction, lot owners were responsible for re-vegetating home sites. This policy meant that lots would remain barren for a long period of time. Although re-vegetation remains an issue today, it is not as significant as it was earlier. Most of the vacant lots are now covered with a natural or native grass that flourishes in part because of the long rainy season and temperate climate. Some of the lots even that they had appropriate time for action and that they would do the same in the future. This is consistent with the hypothesis that those with higher incomes would have access to the resources needed to take appropriate and timely action and response.

There was no significant difference in responses related to the amount of information the respondents received in the form of warning messages, but those with higher incomes were more likely to rate the information accurate and report better understanding. However, as previously stated socioeconomic status and level of education are often correlated; therefore, one might expect the higher income group to understand the warning messages better, although there was no significant difference found, based on socioeconomic status, in the respondents’ rating of post-event information. In addition, respondents earning $40,000 or more annually were more satisfied that officials took quick enough action after the events. Again, those earning less than $40,000 annually may have been more dependent on the help offered by officials, possibly making them more critical of response time.

With respect to perceived future actions, those earning $40,000 or more annually reported being less likely to evacuate their
ported that they more fully understood the information than those with a high school diploma or less. This supports the contention that those with higher levels of education will more fully comprehend what the warning message says and what action needs to be undertaken than those with less education. Of course, the suggestion here is that these individuals truly understand the information. Another hurricane warning will test this assumption. There were no significant differences found regarding post-event information and action by officials. Both groups felt that the information available to them after the hurricanes was good and the respondents had a neutral to good rating about the timeliness of the officials after the events.

When examining perceived views, there was no significant difference found between the two groups in whether or not residents plan to take action or in knowledge of what action to take when future hurricane warnings are issued. However, there was a significant difference, at the 0.01 level, found in the decision of whether or not respondents plan to evacuate following a hurricane warning. Those with higher levels of education were less likely to evacuate their homes than those with a lower level of formal education. Level of education is usually correlated with income, so it is possible that those with more than a high school diploma may reside in areas and in dwellings where evacuation is not always necessary. Their homes may be less vulnerable than those with less education.

Income - Socioeconomic Status

Respondents were placed into one of two categories based on the median income: those whose annual household income was less than $40,000, and those whose annual household income equaled or exceeded $40,000.

No significant difference was found in taking action in 2004 based on income (Table 9). However, when asked about the time to take action, whether or not they felt like they took the correct response, and whether or not they would repeat the same response again, there were significant differences between the two groups. Those with higher incomes reported more confidence in their actions, have trees (Blalock, 2007). The grass-covered vacant lots are home to the burrowing owl. In fact, Marco Island currently has approximately 100 burrows per nesting season with 65% of these producing chicks (Rickie, 2007).

Deltona’s water resources protection practices were nearly as inadequate as its land use practices. Most of the subdivision’s waterways are canals, many of which were not designed to minimize stagnation. Deltona also failed to utilize numerous known techniques to protect canals and nearby waters from pollution caused by runoff and sewage effluent.

The canals are artificial, deep, and dead-end with little current or tidal flushing action. As a result, they tend to stagnate and become foul-smelling, mosquito-laden lagoons which can be a source of disease as well as discomfort. The City has made a few “cut-throughs” to help alleviate the stagnation problem. While these have helped, city officials seem to think that there will always be a canal stagnation problem at Marco Island (Blalock, 2007).

Deltona’s difficulty in maintaining water quality in the canals is exacerbated by its failure to use many of the techniques available for preventing pollution from runoff. Failure to provide an adequate number of buffer filter strips, retention ponds, and swales has created significant problems particularly during periods of heavy rain. This problem is being slowly corrected since the City requires swales for all new single family development and retention basins for all new commercial, multi-family, and any re-development “mixed-use” properties.

Another significant problem is created by pollution from sewage. Deltona provided a central sewage-treatment facility but it served only a small portion of the development. Most homeowners had to rely on individual septic systems. A high density of septic tanks in a relatively small area is often a source of what could become a serious water pollution problem. Now that the city is extending a central system to all lots, many lot owners will pay twice for sewage disposal. One significant expense was for the installation of an individual septic system. A second expense will occur when individuals
are assessed for their share of the central system. A recent decision by city officials illustrates just how expensive it can be to correct some of the shortcomings of the original developer. Homeowners (lot owners) at Marco Island are being assessed more than $20,000 as their individual share of the cost of the mandatory connection to the central waste disposal system designed to cover the entire island (McCann, 2005; Milk, 2005). As would be expected, the septic replacement program is being met with some opposition by current residents who think it is unnecessary or believes that the City should bare the cost of the installation rather than individual property owners (Blalock, 2007).

**Summary and Conclusion**

Although the development of Marco Island got caught in a period of greater environmental awareness and concern over protection of wetlands, the developers succeeded in completing a significant portion of their original plans. The numerous attempts to save Marco Island from development largely failed (Christopherson, 2006). It is now an incorporated city of 15,000 permanent residents and a peak winter season population of 35,000. Marco Island serves as a prime example of how difficult it is to protect an area of critical concern after the fact (i.e. after land development plans have been set in motion). It also shows what persistence on the part of a land development company can mean even in the face of mounting pressure from numerous environmental groups and concerned citizens (Patterson, 1986).

Fortunately, Marco Island is a relatively small project compared to many interstate land sales subdivisions. Yet, in many ways, its environmental impact has been greater than some larger projects in less environmentally sensitive locations. Marco Island’s extremely valuable estuarine resource made it incompatible in virtually every way with traditional subdivision and development. Deltona’s original plan would have transformed thousands of acres of productive mangrove swamps and bay bottoms into potential home sites and eliminated the habitat of many endangered species and economically vital

### Table 8. Education - Action and Response.

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>HS Diploma or less Mean</th>
<th>More than HS Diploma Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take any action</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>Time to take action</td>
<td>3.92</td>
<td>4.43</td>
<td>.001*</td>
</tr>
<tr>
<td>Correct Response</td>
<td>-</td>
<td>-</td>
<td>.006*</td>
</tr>
<tr>
<td>Repeat Response</td>
<td>3.79</td>
<td>4.43</td>
<td>.001*</td>
</tr>
<tr>
<td>Amount of Information</td>
<td>2.97</td>
<td>3.14</td>
<td>.24</td>
</tr>
<tr>
<td>Accuracy of Information</td>
<td>2.97</td>
<td>3.46</td>
<td>.007*</td>
</tr>
<tr>
<td>Understanding of Information</td>
<td>3.71</td>
<td>4.11</td>
<td>.02**</td>
</tr>
</tbody>
</table>

*Significant at 0.01 level (2-tailed); **Significant at 0.05 level (2-tailed)

However, when residents were asked whether or not they had time to take action, if they felt they took the correct response, and if they would repeat the same response for the next warning, there were significant differences at the 0.01 level for all three questions (Table 8). Those individuals with more than a high school diploma gave a higher score to the question about time to take action as opposed to those with less than a high school diploma. Similarly, those with higher education were more confident that they took the correct response last time and that they would repeat the same response next time. Again, this may result from those having more than a high school diploma being more able to understand correctly and to act appropriately in response to a hurricane warning.

No significant differences were found in responses related to the amount of information received in the 2004 warning messages based on education levels (Table 8). In contrast, when asked how they rated the accuracy of the information and whether or not they understood the information, there were significant differences at the 0.01 and 0.05 levels, respectively. The group with more than a high school diploma rated the accuracy of the warning messages higher and re-
regarding action taken, or whether respondents felt they had taken the appropriate action. To some extent, females were more likely to take the same action in future events ($p = 0.1$), but further study is needed to establish the significance of this difference. Furthermore, there were no significant differences based on gender in terms of perceived accuracy of information, in understanding the information, or in the timeliness of the information; both males and females seem to perceive this information similarly.

When examining the differences in responses with gender, there were no significant differences found when residents were asked if they would take any action in response to future hurricane warnings and whether or not they know what action they should take. Respondents reported that they did plan to take action when a hurricane warning was issued and felt like they did know what action to take when faced with a hurricane warning. This then does not support the hypothesis that females are more likely to respond to a warning message than males. However, a significant difference at the 0.05 level was found when asked about whether or not respondents would evacuate their homes. Males were more likely than females to evacuate their homes. Initially, this was surprising since the literature suggests that males invariably seek to ‘fight’ the disaster while females first seek safety. However, this result may stem from the fact that women often take on the responsibility of caregiver and hence might be more reluctant to evacuate in order to stay home with any dependents. This aspect, however, warrants further research in order to determine if this is actually reflective of the study areas.

**Level of Education**

Level of education was also hypothesized to have an affect on perception and response. In this analysis respondents were divided into two groups, those with a high school diploma or less, and those with more than a high school diploma.

There was no significant difference in whether or not the residents took action in response to the hurricane warnings issued in 2004; all respondents did something after the warnings were issued. fish and shellfish. Although the subdivision is smaller than the developer’s original plan, it has placed thousands of people in an area prone to dangerous flooding, particularly during hurricanes. This was clearly evident during the relatively recent strike by Hurricane Rita. The number of vulnerable property owners and the destruction of valuable wetlands would have been higher if the U. S. Army Corps of Engineers had not denied the dredge and fill permits for the eastern portion of the island.

The result of Deltona’s long history of subdividing and selling environmentally valuable lands in the hope that regulations would bend to accommodate its practices have been disastrous. Through lack of foresight in a business which puts a premium on an ability to deal with long time spans, Deltona embroiled itself, thousands of consumers, and numerous state and federal agencies in a massive controversy that took years to resolve. The end result of the controversy was the permission to dredge and fill approximately 80% of the island which allowed more than 7,000 home sites to be raised to 5.5 feet above mean sea level. These home sites are being developed at a steady pace with approximately 250 homes being built per year over the last seven years (Milk, 2005). As the island approaches build-out, city officials must do what they can to protect the city from hazards created by many ill-conceived land development practices.

The residents of Marco Island, as other platted lands communities have done in the past, opted to incorporate in August of 1997 as a means to cope with many of the needs of a growing community (McCann, 2005). The council-manager form of government was chosen to address serious island infrastructure problems and issues associated with the layout and design of the community. Some of the most significant problems include bridge and road repair, storm drainage problems, the elimination of septic tanks, the provision of a reliable water supply, increased water treatment capacity, and expansion of the waste water collection system. These needs plus the need to protect residents from hurricanes and frequent flooding are all part of the legacy created by the Mackle brothers and the Deltona Corporation. While this sun-drenched island is considered to be a “tropical
paradise” for some, there are many problems that are yet to be resolved and there is no way to alleviate all of the damage that was done to this environmentally sensitive coastal zone.

One of the few remaining options for city officials and local residents is to tackle one problem at a time and slowly correct some of the many mistakes of the past. Examples include the septic tank elimination plan, efforts to reduce canal stagnation, and reduce the intensity of storm water runoff. Other concerns include the availability of an adequate water supply to meet future needs, problems associated with the lot density reduction program, and the need to provide better protection for the burrowing owl. All of these problems or issues are being addressed by the current city government although progress in some areas has been slow.

Since the Everglades was dedicated as a park back in 1947, the re-plumbing of south Florida has placed the region on ecological life support (Sartore and Levin, 2007). While Marco Island is not technically within the Everglades, it is situated along the southwestern fringe and is part of the development that has led to the re-plumbing of the region. Unfortunately, according to Sartore and Levin, as much as $10 billion has been pledged to repair at least some of the damage but restoration languishes. While some progress has been made with several different Everglades restoration projects such South Golden Gate Estates, a huge failed subdivision located a few miles to the east of Marco Island, it is extremely difficult to implement an environmental restoration plan after an area is occupied by a substantial permanent population such as the City of Marco Island. As a result, local officials must do the best they can to resolve problems in a piecemeal fashion.

Table 7. Age - Action and Response.

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>18-54 Mean</th>
<th>55 and older Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take any action</td>
<td>-</td>
<td>-</td>
<td>.10</td>
</tr>
<tr>
<td>Time to take action</td>
<td>4.30</td>
<td>3.93</td>
<td>.01*</td>
</tr>
<tr>
<td>Correct Response</td>
<td>-</td>
<td>-</td>
<td>.60</td>
</tr>
<tr>
<td>Repeat Response</td>
<td>4.22</td>
<td>3.86</td>
<td>.06</td>
</tr>
</tbody>
</table>

*Significant at 0.01 level (2-tailed)

received, the younger group gave higher ratings and reportedly understood the information better as compared to the older group. However, these were not significantly different ($p = 0.1$). The older group may have rated these two categories somewhat lower because they were more dependent on action by officials and their assistance. The older group did report experiencing more loss and receiving more aid from officials after the events in comparison to the younger group. Both age groups felt that the information provided after the events was adequate and that officials, for the most part, did act quickly enough.

When asked whether or not the respondents would take action in response to future hurricane warnings, no significant difference was found. Both groups were equally likely to take some sort of action. To some degree older individuals reported more often that they knew what action to take in response to a hurricane warning ($p = 0.1$). It is possible that older individuals have more experience with hurricane warnings or are merely more confident in their own abilities. But, it was also found that there was no significant difference with regard to the two age categories and evacuation. Most of the respondents reported that they are either unlikely to evacuate their home or are undecided about the issue. It would appear, then, that other factors than age enter into evacuation decisions.

**Gender**

Gender provided few insights into hurricane warning perception and response. There were no significant differences found re-
Data Analyses and Discussion

Age

The respondents were separated into two categories based on the median age group, 18 to 54 years, and 55 and older to test the hypothesis regarding age. No significant difference was found in whether or not the residents took action in response to the hurricane warnings issued in 2004 with all respondents doing something (Table 7). Similarly, there was no significant difference in whether or not respondents felt like they took the correct response. However, when asked whether or not they had enough time to take any action, the younger respondents were more likely to say they had enough time. The two group’s responses were significantly different at the 0.01 level. It is suggested that older respondents may be more dependent on others to help them prepare causing them to rate the time issue differently. In addition, the likelihood of residents taking the same response next time, while not significantly different, showed that some of younger group were more likely to respond the same way next time as compared to the older group. Older respondents may not have been as satisfied with the actions they took, especially if they required outside help.

There was no significant difference found between the two age groups regarding the amount of information they received in 2004 with both age groups reporting that the information they received was just the right amount. Regarding accuracy of the information re-

Table 6. Likelihood to Evacuate.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Unlikely</td>
<td>18</td>
<td>23.7</td>
</tr>
<tr>
<td>Unlikely</td>
<td>16</td>
<td>21.1</td>
</tr>
<tr>
<td>Undecided</td>
<td>29</td>
<td>38.2</td>
</tr>
<tr>
<td>Likely</td>
<td>9</td>
<td>11.8</td>
</tr>
<tr>
<td>Very Likely</td>
<td>4</td>
<td>5.3</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>100.0</td>
</tr>
</tbody>
</table>

References


and only one person was unlikely to take action. In addition, 87% thought that they knew what action to take when a hurricane warning is issued; the rest were unsure. While these answers demonstrate an awareness and confidence in response activities, only 17.1% were likely or very likely to evacuate their homes. Reasons given as to why people would not evacuate included that the individuals felt like they already lived in a safe and well built home, that it was too expensive to evacuate, they had no transportation to evacuate, or they were reluctant to leave because of dependents and/or pets. However, the most common response (38.2%) about evacuation was that the participants were undecided about whether or not they would evacuate (Table 6). Some reported that they would base the decision of whether or not to evacuate on the intensity of the storm and on advice from others.

<table>
<thead>
<tr>
<th>Table 4. Rating of Information Post-Event.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Poor</td>
</tr>
<tr>
<td>Okay</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Very Good</td>
</tr>
<tr>
<td>Excellent</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5. Timeliness of Officials Post-Event.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Completely Disagree</td>
</tr>
<tr>
<td>Somewhat Disagree</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Somewhat Agree</td>
</tr>
<tr>
<td>Completely Agree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
varied with regard to the rating of post-event information, most residents (50%) agreed to some extent that officials acted quickly enough during the post-event period (Table 5).

When asked about the warning information itself, the majority of the participants (79%) felt as if the amount of information was just the right amount. Also, most of the participants, agreed that the accuracy of the information was either good (49%) or very good (30%) although 18% thought it was just okay. In terms of understanding the information, the majority (67%) either somewhat agreed or completely agreed that they understood the information provided to them in the warnings. Very few (3.9%) disagreed with the statement.

**Perceived Views of Future Warning and Response**

Respondents were asked how likely they were to take action in the event of a hurricane warning. Over ninety percent reported that they were likely or very likely to undertake some form of remedial action
Hurricane Season Wind Damage in an Urban Landscape: A Case Study of Jacksonville University Campus

Jeff Martin
Department of Geography
Jacksonville University

Introduction

Under a scenario of predicted increases in tropical storms Florida is now more susceptible to wind damage than in past decades (Goldenberg et al., 2001; Landsea et al., 1999). No location in the Southeast is free from tropical storm damage, but Florida with its southerly location and peninsular setting is the most vulnerable. Consistent with this geography, Florida was impacted by more tropical systems than any other state during the intense 2004 and 2005 hurricane seasons. Even though 2005 received more notoriety as the busiest and the most costly hurricane season on record, it was the 2004 season that was more devastating to Florida. During 2004 virtually no region in the state escaped tropical storm damage. Indeed, several locations were impacted on numerous occasions, and some cities were hit multiple times within a one month period.

The tropical storm paths of 2004 suggest that Jacksonville and the northeast coast of Florida were largely spared of significant damage (Fig. 1). However, two of the 2004 season hurricanes, Frances and Jeanne, were spatially large systems, and while they were somewhat distant from Jacksonville, they exposed the city to long periods of high winds. Consequently, Jacksonville accrued damage well into the millions of dollars from these two events: power was lost, traffic was disrupted, schools and businesses were closed, and many areas were flooded. This all happened despite the fact that the two first order reporting stations in the city, Naval Air Station Jacksonville (NASJAX) and the Jacksonville International Airport (JIA), only reported one tropical storm force wind reading for each hurricane (34 kt for Frances and 35 for Jeanne).

Table 1. Loss and Damage.

<table>
<thead>
<tr>
<th>Loss Questions</th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience Loss</td>
<td>95.3%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Roof Damage</td>
<td>76.2%</td>
<td>23.8%</td>
</tr>
<tr>
<td>Fence Damage</td>
<td>9.5%</td>
<td>90.5%</td>
</tr>
<tr>
<td>Vehicle Damage</td>
<td>11.1%</td>
<td>88.9%</td>
</tr>
<tr>
<td>Other Damage</td>
<td>61.9%</td>
<td>38.1%</td>
</tr>
</tbody>
</table>

took up to a week or more for power to be restored to their homes and businesses after the storms.

When asked about aid after the hurricanes, including monetary support or structural items such as a tarp to cover roof damage, 67% reported that they had received help. Most respondents said that such aid came from the federal government and the Federal Emergency Management Agency (FEMA), although some did not know or did not remember where the aid came from. However, most (75%) felt that the aid was at least somewhat appropriate.

All 66 individuals residing in Lake Wales during the 2004 hurricane season stated that they took some sort of remedial action in response to the hurricane warnings. Eighty-two percent of these believed that they had taken the correct action after receiving the hurricane warnings, and only one person thought the action inappropriate. In fact, 64% said that they were likely or very likely to repeat the same response next time (Table 2). In terms of timing, most respondents agreed that they had had enough time to take action before the event occurred, although, some residents reported that they had less time to prepare for Hurricane Charley as compared to the latter two hurricanes, Frances and Jeanne (Table 3). Residents also recalled more details about Hurricane Charley, whereas they discussed Hurricanes Frances and Jeanne collectively.

Responses were more varied among participants when asked how they rated the post-event information they received (Table 4). Over 33% regarded the information as okay or poor, while 30% said it was very good or excellent. However, even though responses were
not require the assumption that the differences between the two samples are normally distributed.

**Results**

Three sections are reported on here: demographic data, impact and experience of the 2004 hurricanes, and perception of future forecasting, warning and response systems.

**Demographic Characteristics**

The survey respondents comprised a diverse group: 63% were female and 37% male; 30% reported themselves as black, 7% as Hispanic and 63% as white. The age of respondents ranged from 18 to over 75 years with a median of 45 to 54 years. The age makeup of the respondents was comparable to that of the city of Lake Wales, which has 24.3% of its residents who are 60 years old or older. Formal education of respondents ranged from 9th grade to graduate level and professional degrees, but the vast majority, over 82%, have high school diplomas or higher. The percentage of adults with no high school diploma is larger within the city of Lake Wales (26.9%) (US Census Bureau 2000) compared to the data found with the questionnaire survey (17.1%). Annual household income ranged from under $10,000 to over $60,000 annually. However, there is a larger percentage (36.8%) of households earning $50,000 annually or more within the surveyed population compared to Lake Wales; the 2000 census data reported 22.6% of households earning $50,000 annually or more.

**Damage and Response in 2004**

Sixty-six of the 76 individuals surveyed resided in Lake Wales during the 2004 hurricane season and were asked questions related their experiences. Ninety-five percent of these reported losses due to the hurricanes with the most common being roof damage followed by fence and vehicle damage (Table 1). Many residents said that their roofs had to be partially or fully replaced. Also, 62% experienced other types of damage such as broken windows, garage doors, and other damage around their homes. Most residents reported that it

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**Figure 1. Paths of tropical systems in Florida during the 2004 hurricane season.**

Source: National Oceanic and Atmospheric Administration Coastal Services Center.

The sources of damage from landfalling tropical events are storm surge, flooding from heavy rain, and wind damage. Of these causes wind driven tree blowover is a major component of the mean annual $7 billion damage cost of storms across the nation, and this was certainly the case for Jacksonville during Hurricanes Frances and Jeanne (Meade, 2004). Tree blowover is a function of multiple parameters:
wind speed, gustiness, shelter, soil type, soil water content, topography, tree species, tree stem size, ice buildup, parasitic infestation, and others (Alexander, 1964; Swanson, 1988; Foster and Bose, 1992; Everham et al., 1996; Wesley et al., 1998; Clinton and Baker, 2000; Kramer et al., 2001; and Veblen et al., 2001).

This research examines tree blowover in an urban setting by assessing the damage that occurred on Jacksonville University in September of 2004. This damage resulted from two tropical systems, Hurricanes Frances and Jeanne, and one localized microburst occurring between these two major events. The storm events are compared and the characteristics of the tree blowover area analyzed.

Terrestrial Setting

With a population of 735,000 Jacksonville is the fourth largest metropolitan region in the state (U.S. Census, 2000). The city contains a variety of land covers to include natural wetlands, forest, timber farms, residential, industrial, and business. Centrally located in the North Atlantic hurricane region Jacksonville is predisposed to tropical systems. However, the last hurricane to make landfall in Jacksonville was Gloria in 1964. Therefore, it is hypothesized that in this absence of major storms Jacksonville’s vegetation has experienced uninterrupted growth creating a landscape that has abundant weak and diseased trees prone to future storm damage.

Jacksonville University, the study area for this research, is in the north central region of the city. The western boundary of the campus is the St. Johns River and the eastern boundary is along a well-traveled boulevard with numerous trees and buildings ranging in height from five to fifteen meters. An unforested and unobstructed golf course extends along the western edge of the campus adjacent to the river. Hence, the western aspect is open with a roughness length ($z_0$) of .03 m, while the eastern aspect is well sheltered with a roughness length of 1.0 m. Campus elevation is from 6 m along the river to 17 m on the eastern edge of the campus. However, the elevation change is abrupt with it all occurring within a horizontal distance of 60 m at an escarpment approximately 300 m east of the St. Johns. Consequently, aid available. Also, more than 4,330 Polk County residents received tarps from the Army Corps of Engineers “Operation Blue Roof” (Polk County Annual Report 2004).

Methodology

To obtain data on public perception and opinions, a face-to-face questionnaire survey was conducted with residents in Lake Wales. Residences were selected using a random sample in two census block groups with different demographic characteristics: one in the eastern part of the city and one in the north. The sample was stratified by street location with a coin toss deciding which side of the street to interview; interviews were then conducted at every third house with whoever was residing in the house who was at least 18 years of age and who had had the most recent birthday. Seventy-six questionnaire surveys were successfully completed between December 2006 and January 2007. Five individuals declined to participate.

The questionnaire survey comprised three sections with both closed and open ended questions. The first section contained questions related to the public’s perceived views of forecasting, warning and response, such as what they think should be done and on what timescale. The second section contained questions about the persons’ actual response, such as what they actually did when warnings were issued and what they did during and after the event. The survey concluded with a section collecting demographic information, including age, gender, socio-economic status, and level of education. A pilot study was conducted in early December 2006 with a sample population in Lakeland, Florida to check for the validity and effectiveness of the survey questions.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS). The Mann-Whitney non-parametric test was employed because most of the data were in nominal and ordinal format and also because of the relatively small sample size. This test is one of the most powerful nonparametric tests for comparing two populations. It assesses whether the difference in medians between two samples of observations is statistically significant. This test does
August 13, 2004, the day Hurricane Charley came through Lake Wales (Polk County Annual Report 2004). This information line was staffed 24 hours a day and 7 days a week. Between August 13th and September 30th, the line received 175,000 calls for information regarding everything from shelter locations, FEMA information, food, ice, housing repairs, to general assistance (Polk County Annual Report 2004). In addition, more than 40,000 information flyers were distributed to help keep citizens informed about the different sources of help.
with an average of .43 a year (Landreneau, 2003). However, due to track variability, it is not abnormal for specific locations in Florida to experience several decades without a direct hit by a hurricane. Even with these long absences it is hypothesized that tropical systems have a significant impact on the natural landscape and environmental stability in Florida.

From 1886-1992 the annual mean number of tropical storms was 8.4, and the mean number of hurricanes was 4.9 (National Hurricane Center, 2006). However, conditions favoring tropical storm formation vary between years and even assume decennial periodicity (Goldenberg et al., 2001). The active 2004-2005 tropical seasons had 45 tropical systems, 23 of which were hurricanes. More importantly, research indicates that after three decades of reduced tropical storm activity, the Atlantic hurricane region is now entering a cycle of increased storm frequency and intensity (Goldenberg et al., 2001). At the same time population growth and development in the Southeast has soared. The annual cost of tropical storm damage in the ten years prior to 2004 was 5 billion dollars annually, and that number is small compared to the damage from the 2004 and 2005 seasons (Meade, 2004). However, Pilke and Landsea (1998) indicate that when tropical storm damage is normalized by population growth, development, and inflation, the cost of hurricane damage in the late 1990's was no greater than in the 1940's, another period of heightened tropical activity. Consequently, extreme hurricane damage is not a new phenomenon, but awareness may be heightened because of the transition from a period of reduced activity to a period of increased activity.

**Hurricanes Frances and Jeanne in September 2004**

Hurricane Frances was the sixth tropical event in the north Atlantic during 2004 and the fifth hurricane. Its winds were 125 kt at its strongest level making it a Category 4 hurricane on the Saffir-Simpson Scale. Formation occurred on 25 August and it dissipated to an extra-tropical system on 10 September. Landfall was from the east southeast at Hutchinson Island on the central Florida coast on 5 September as a Category 2 hurricane (Fig. 1). In interior Florida it turned

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**Figure 1. Polk County, Florida.**

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age Survey 2004). However, while the airport was closed it was still used as a staging area for getting relief and recovery supplies to those who needed them.

To assist the residents of Polk County, Florida during the 2004 hurricane season a citizen’s information line was opened on Au-
response to a warning than individuals with a lower socioeconomic status. Higher socioeconomic status should give greater access to resources and hence facilitate action. Income is usually positively correlated with education, so similar outcomes were expected.

Study Site

The study was conducted in Lake Wales, located in Polk County, Florida, 28 miles southeast of Lakeland and about 60 miles east of Tampa (Figure 1). Lake Wales was affected by three hurricanes (Charley, Frances, and Jeanne) during the 2004 hurricane season, the first city on record to have three direct hits in one season. Thus, this city is familiar with forecasting, warning and response to hurricanes.

According to the census, Lake Wales had an estimated population of 12,964 in 2005. Of this population, 4,791 (47%) were males and 5,403 (53%) were females; 7,451 (73.1%) were 18 years of age and over and 2,476 (24.3%) were 60 years of age and over; 26.9% of adults 25 years and older did not have a high school diploma or its equivalency, while 18.1% of the population had earned at least a Bachelor’s degree (US Census Bureau 2000). There were 4,065 households in the city of Lake Wales. Eighteen percent of the households were living on less than $10,000 per year, while 11.4% were living on more than $75,000 per year. The median household income for Lake Wales was $26,884 which was lower than the median household incomes for both Polk County and Florida which reported $36,036 and $38,819, respectively (US Census Bureau 2000).

Lake Wales received heavy losses from Hurricanes Charley, Frances, and Jeanne (Figure 2). Most homes in Lake Wales suffered damage to some degree and a public housing facility in Northeast Lake Wales was completely destroyed. Some commercial buildings, such as the Wausau Homes Manufacturing facility, also experienced catastrophic losses. Some businesses did not recover. In addition, the Lake Wales Municipal Airport sustained major damage and was closed for a period of time after the hurricanes (Florida Airport Dam-

to the northwest into the Gulf of Mexico, and then moved north making landfall again in the Florida Panhandle. Even though it appeared that Frances was some distance from Jacksonville, it was spatially a very large storm, and the area it impacted was extensive. Consequently, Jacksonville experienced potentially damaging winds for a 35 hour period.

Hurricane Jeanne formed on 13 September 2004, and it dissipated into a tropical depression on 27 September. Like Frances, Hurricane Jeanne made landfall at Hutchinson Island on the central Florida Coast. It was a Category 2 hurricane at landfall with winds of 105 kt. Jeanne’s direction of impact was from the east, and like its landfall, its path across Florida was much like that of Hurricane Frances moving inland and then turning north along the west coast of Florida (Fig. 1). Although it was not as large as Frances, it was a spatially large. It was also a very wet system exposing the interior of Florida, Georgia, South Carolina, North Carolina, and Virginia with large amounts of precipitation and local flooding.

The following characteristics made Hurricanes Frances and Jeanne similar systems; 1) landfall, 2) path through Florida, 3) intensity and winds, 4) size, 5) duration in Florida, and 6) rainfall amounts. Hence, both storms impacted the city of Jacksonville in a like manner and within three week period, providing an opportunity to compare the damage from two distinct systems in succession.

Methodology

Wind induced tree blow over was inventoried on the Jacksonville University campus and then juxtaposed with the wind profile for both Hurricanes Frances and Jeanne. All limbs and trees in excess of four inches were counted. The threshold of four inches was used as a sufficient standard to induce an insurance claim or monetary loss. Downed trees and limbs were cataloged within twelve hours of the of the storm passage to insure accountability prior to clean-up. Parameters assessed were:

1) Type of tree damage ........Uprooting, trunk failure, limb damage.
2) Direction of fall .......... Measured with compass. Damaged trees often twist as they fall. This provides a good estimate.
3) Species of tree .......... Some tree species are more prone to damage than others.
4) Location of damage .......... Determined by GPS.
5) Spatial pattern................. Nearest Neighbor analysis.

Wind and gust observations used here are from the Automated Surface Observing System (ASOS) at the Jacksonville International Airport (JIA), the closest (15 km) and most thorough source of wind data. Sustained winds are the hourly one minute average given in knots, and gusts are defined as increases in wind in excess of 10 kt for 5 seconds. Gust observations were especially important because these instantaneous pulses of energy are a primary source of tree blow over (Kondo, Tsuchiya, and Sanada, 2002). Frequency counts of hourly winds and gusts by direction were determined for each storm.

Specific wind parameters examined here were; 1) storm duration, where duration is defined by the first to last sustained 20 kt wind, 2) the frequency count of hours of sustained winds above 20 kt, 3) the frequency count of all observed gusts above 20 kt, 4) additionally, all hourly winds and gusts were placed in billets of 10 kt increments and counted, starting at 20 kt and going up to the highest wind gusts of 60 kt, and 5) all winds and gusts were counted by direction. Though it does not typically cause damage, 20 kt was used as threshold because it exceeds the mean wind by a factor of more than two, and it provides a signature of a distinctive atmospheric event.

Results
Hurricanes Frances and Jeanne were similar wind events for the city of Jacksonville (Table 1). The highest wind for Frances at JIA was 34 kt, and the highest for Jeanne was 35 kt. These were the only two readings at tropical storm force (34 kt) during the entire 96 hour period of both storms. Frances had a longer duration, but the fre-
unrealistic. It is recognized that many factors play a large part in determining the risks people encounter, whether and how they prepare for disasters, and how they fare when disasters occur (Mileti 1999). Schwarze (1982) and Foster (1980) both state that individual responses to warnings have been shown to be conditioned by age, education level, cultural background, and knowledge or experience of previous events or situations. Tobin and Montz (1997) add to this, stating that social factors (e.g. economic, social, and cultural) affect perceptions of a hazard which in turn may limit choices that ultimately are made. Generally those individuals living in poverty do not have the access to resources to respond properly (Morrow 1999). Also, women, broadly speaking, are more vulnerable because they are often disproportionately poor (Wisner et al. 2004). Women’s vulnerability may also increase because they are more likely to stay with family members and children in emergencies to nurture, assist, and protect them (Cutter et al. 1992; Mileti 1999; Morrow 1999). Mileti (1999) and Sorensen (1990) also found that age, socioeconomic status, gender, education, family size, and having children also influences response.

People who receive warnings of impending events typically go through various stages that shape their risk perception and behavior (Mileti and O’Brien 1992). Mileti (1995) suggests a five phase social-psychological process: (i) individuals hear the warning; (ii) they form an understanding of what the warning means; (iii) they decide their level of belief in the risk; (iv) they will or will not personalize the message to themselves or others; and (v) they decide what if any action they should take. A better understanding of how people interpret and react to warnings, then, is essential (Montz and Grunfest 2002). In addition, behavioral responses can be modified, either positively or negatively, by disaster experience, depending on previous outcomes (Mileti and Krane 1973; Siudak 2001; Tobin and Montz 1997). Prior activities if successful are likely to be repeated even if circumstances differ for the coming crisis. False alarms can also change perception and behavior in many ways; the end result is unclear how this operates.

Table 1. Wind characteristics observed at the Jacksonville International Airport.

A) High wind column is the highest wind observed for each storm (kt). Duration is the number hours from the first to last 20 kt reading (hrs). Hours of High Wind is the count of hours of winds above 20 kt during the duration of the storm. Gusts is the count of gusts above 20 kt for each bin given in kt.

<table>
<thead>
<tr>
<th></th>
<th>High Wind</th>
<th>Duration</th>
<th>Hours of High Wind</th>
<th>Gusts &gt;20&lt;30</th>
<th>Gusts &gt;30&lt;40</th>
<th>Gusts &gt;40&lt;50</th>
<th>Gusts &gt;50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frances</td>
<td>34</td>
<td>56 hrs</td>
<td>32</td>
<td>108</td>
<td>42</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Jeanne</td>
<td>35</td>
<td>38 hrs</td>
<td>33</td>
<td>64</td>
<td>39</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

B) The count of hours above 20 kt from the identified direction.

<table>
<thead>
<tr>
<th></th>
<th>NNE</th>
<th>NE</th>
<th>ENE</th>
<th>E</th>
<th>ESE</th>
<th>SE</th>
<th>SSE</th>
<th>S</th>
<th>SSW</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frances</td>
<td>9</td>
<td>13</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jeanne</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Frequency of hours that reported sustained winds above 20 kt was similar for both storms. Indeed, Jeanne had one more hour of winds above 20 kt than Frances. Gusts on the other hand were much more frequent during Frances than Jeanne. This is partly a consequence of the 20 kt wind threshold used in this research. Frances had a longer duration in Jacksonville than Jeanne, but in that period there were more hours with wind observations below the 20 kt threshold for Frances. Hence, Frances had more opportunities to induce low value gust events between 20 and 30 kt that originated from unreported winds below 20 kt. Indeed, the 20-30 kt gust bin provided a substantially higher number of gusts for Frances, with 108 gusts in this category, as compared to 64 for Jeanne. In the higher gust bins, those bins that would induce more damage, the frequency between the two storms was much closer. Nevertheless, Frances had more gusts above 40 kt and two gusts above 50 kt, while Jeanne had no gusts at JIA.
above 50 kt. From this it is reasonable to suggest that Frances was a stronger wind event than Jeanne in Jacksonville, but not substantially.

High winds in Jacksonville from Frances and Jeanne began with north to northeasterly winds and ended with southerly winds. Because of its large size and slow initial speed Frances induced a longer period of winds from the northeast. However, after turning north in central Florida, Frances exited the state farther west and more rapidly than Jeanne, resulting in fewer southerly winds. In comparison, Jeanne’s path rotated around Jacksonville providing an equal number of winds from north and south. During Frances 22 of the 32 hours of the winds above 20 kt were from the northeast to east and only 1 hour was from the south. Conversely, Jeanne had 17 out of 33 hours of winds with a southerly component. Because of the long fetch of water to the south of Jacksonville and the high frequency of southerly winds, substantially more flooding occurred during Jeanne, the weaker event, highlighting the importance of wind direction in storm events.

Substantially more tree damage occurred in the study area during Hurricane Frances than Jeanne (Table 2). Of the 26 trees and limbs damaged during Frances 25 fell to the southwest resulting from northeast winds. The lone tree that went down to the northeast was surrounded by numerous two and three story academic buildings, and its divergent direction may have been induced by turbulent eddies. By far the tree species affected most by Frances was the water oak (*quercus nigra*), 24 of the 26 trees damaged. The Nearest Neighbor disasters than had once been possible. Current warning messages are also more sophisticated and can be specific, pinpointing the areas that may be affected (Keys 1997). This is valuable, but development overall has been sketchy and problematic rather than carefully and purposefully planned (Keys 1997, Sorensen 2000, Handmer 2002). Many communities, for instance, still do not have the ability to provide citizens with effective warning messages because of inadequate resources (Mileti 1999). A major failing, then, has been in social science research to ensure that warning information will be taken seriously and responded to in a timely manner (Gruntfest and Carse 2000; Gruntfest and Handmer 2001). This research looks at some of these concerns, in the context of hurricanes in central Florida.

**Forecasting, Warning and Response Systems**

Forecasting, warning and response systems can be divided into four basic stages: collection and evaluation of data; decision-making and formation of the warning message; dissemination of the warning message; and response which encompasses not only the response from the public but public officials as well. Each component must work efficiently and cooperatively if the system is to be effective in reducing losses. Unfortunately, least attention has been given to understanding how people both comprehend and respond to warning messages; it is after all response that provides the legitimacy to the strategy (Gruntfest and Handmer 2001). The message itself, therefore, is very important, and as Sorensen (2001) points out the style and content of a message can have a dramatic impact on public response. It is argued that the warning message should be specific, consistent, and accurate, contain certainty, and be very clear (Fishchoff 1995). Warnings are increasingly anticipated by those at risk and they are expected to be timely and accurate (Handmer 2002). When warning messages are either unclear or do not arrive quickly enough, the public does not have the opportunity to choose the proper response.

Response activities must also be addressed. Understanding what action to take in an impending crisis is of paramount importance, and simply assuming that people will take appropriate action is
Introduction

Forecasting, warning and response systems provide alerts of impending problems for individuals and organizations; the goal being to precipitate remedial action to save lives and property. There have been remarkable successes in recent years, with reductions in death and injuries throughout much of the United States (Sorensen 2000). On the other hand, they have not been demonstrated to have any significant impact on reducing damage to social infrastructure or private property or on reducing economic disruption. In fact, because of population growth, in some areas, economic losses are increasing (Sorensen 2000). Furthermore, the outcomes of Hurricane Katrina also highlighted some of the inherent weaknesses of these systems and certainly exposed the difficulties of facilitating effective responses (Hartman and Squires 2006). It is clear that the complexity of these systems, that involve the interaction of physical, technological, and social factors, create conditions that can lead to confusion and foster unsatisfactory behavior on the part of public officials and disaster survivors. Furthermore, forecasting, warning and response systems require regular evaluation to keep up with the ever changing needs of society (Parker and Fordham 1996).

There have been a number of improvements in forecasting, warning and response systems, particularly in data collection and warning dissemination associated with developments in communication technology. Indeed, understanding of geo-physical processes now permits more accurate and timely forecasts for many impending
oak grove in the central part of campus circled on Fig. 2, and the observed clustering of downed trees in this area is noteworthy. Hence, the overall pattern of downed trees throughout the campus during Frances was neither clustered nor random. Importantly, 18 out of the 26 trees and limbs brought down during Frances were determined to be diseased, structurally weak, or already damaged, and the 9 remaining trees exhibited conditions of poor quality.

Tree damage during Jeanne was decidedly different. Here only 8 trees were damaged as compared to 26 in Frances, and only one tree fell, the rest were destroyed limbs. Furthermore, all damage occurred in various directions and the seven limbs that fell were in a straight line in one small area (Fig. 3). The one fallen tree occurred 400 meters from the area of concentrated damage and is considered to be an outlier. Indeed, a nearest neighbor coefficient of .81 for all the damaged trees during Jeanne indicates that the damage was more random. But if the outlier is removed that value goes to .4 indicating more clustering. Finally, the damaged species included 5 Live Oak (*quercus virginiana*), a particularly sturdy tree, but a tree that has large, heavy, and horizontal limbs.

**Discussion**

No trees were uprooted during Hurricane Frances, the first storm assessed here. All damaged trees were sheared at ground level, along the trunk, or at a large limb. Furthermore, all damage occurred because of decayed or deteriorating wood (Fig. 4). Since Hurricane Frances was the first tropical system to impact Jacksonville since 1964, it is hypothesized that Frances culled the old, damaged, and weak trees leaving healthier trees more capable of withstanding future high wind events. Frances induced damage also highlights the importance of tree species. Water oak are known for their short lives and poor structural quality, while other trees, such as the live oak are more preferred in built-up areas. Homeowners, city administrators, and other agencies responsible for property should know the tree species in the area under their control. However, as increased duration between catastrophic events creates a physical environment more


**Figure 3. Trees downed during Hurricane Jeanne on the Jacksonville University campus.**

*Graphics as Figure 2.*

prone to damage, it also induces a lapse of knowledge about the characteristics of trees, topography, aspect, and land cover which may also contribute to storm destruction (McCure, 1993).

With Hurricane Frances’ initial high wind impact from the northeast, it is not surprising that all trees and limbs, except for one, fell to the southwest. It is not possible to discern a preferred wind direction for damage from one season of activity, especially since cyclones are counterclockwise flowing phenomena. But tropical storms have their highest winds in the right front quadrant of movement, and a typical
path for Atlantic region tropical systems is from east to west in the tropics, then curving north around the Bermuda High. Combining this typical storm path with the counterclockwise flow, it is hypothesized that northeast winds may cause the greatest damage in the southeastern United States (Martin and Konrad, 2006). The prevailing direction of damage from Frances in no way validates this hypothesis, but it is compatible with it. It is also noteworthy that the greatest damage occurred from the direction that is the most protected from wind. Conversely, the least sheltered and most vulnerable direction, south-southwest to northwest, had little discernable damage, even though there were 13 hours of high winds from this directions during Jeanne.
panies, who have historically been reluctant to share it. The existence of publicly-available information—like the FGS sinkhole database, for example—may not be widely known among the general public.

Of course, regardless of its relatively low public profile, the FGS sinkhole database is still not a complete list of sinkholes within the state. The database relies on information provided by individuals who find a sinkhole and report it. In order for this to happen, a person with information on the location of a sinkhole must know where to report it, or to report it at all. Additionally, database maintenance often depends on the provision of adequate funding by the state government, which is volatile from year to year. The inherent shortcomings of this database may have resulted in an inaccurate picture of sinkhole location and density across the region.

Finally, some sinkholes may be used as “water features” in new residential developments, as a means of adding value to nearby properties. Most homebuyers are unlikely to distinguish between a man-made lake or pond, or a previously-existing sinkhole that has been intentionally converted to that purpose. Because of that, and because these water features are often seen as desirable amenities among homebuyers, it is at least conceivable that any negative impacts of sinkhole proximity on home prices in other areas (particularly, in areas without newer, high-end developments making use of water features) have been obscured.

This paper has demonstrated a lack of statistical evidence pointing to any relationship between home values and the presence of sinkholes in the Tampa Bay area. These results could be due to homebuyer preferences, accessibility of relevant information, or a lack of available data for analysis. Any future research into the question of how sinkholes influence real estate markets should attempt to shed some light onto the underlying cause of the results presented here.

References
this general time frame at the JIA. Considering the extent of the damage, combined with personal observation of the event, the winds were no evidence contradicting the results of the OLS regression. Here, the median structure age and total housing units variables are both statistically significant and show the expected signs: positive for total housing units, negative for median structural age. These results lend some support for the hypotheses that sinkhole reporting is tied to population (sinkholes are more likely to be reported in areas where there are more people to find them). Median home value—our variable of interest in this regression—is not statistically significant at p=0.05, thus confirming the results of the OLS regression.

County-by-county regressions (table 3) were included here to account for the localized nature of housing markets; it seemed possible that any statistically significant relationship between sinkhole density and home values could potentially be obscured by examining the results only at the wider regional level. However, the results of the county-by-county regressions mirrored those of the regionwide analysis. The only explanatory variable that was significant for each countywide regression was median household income, which displayed a positive correlation with the dependent variable in each case. Conversely, the only dependent variable to show no statistical significance in any of the countywide regressions was sinkhole density.

Based on these results, it seems likely that there is no significant relationship between home values and sinkhole location or density at anything greater than an extremely localized scale.

Possible explanations, and potential directions for future research

The most obvious possible explanation for the results described here is that homeowners and homebuyers may not generally consider sinkholes to be a significant threat to their property. This possibility presents an obvious and straightforward avenue for additional research, which could be addressed via surveys and focus groups of homeowners and potential homebuyers in sinkhole-prone areas.

It is also possible that homebuyers may not generally be aware of the locations of sinkholes. The most accurate information on sinkhole locations is often proprietary information held by insurance com-
Table 3. County-by-county OLS estimates.
Dependent variable: median home value.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hernando</th>
<th>Hillsborough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>31735.2</td>
<td>55360.2</td>
</tr>
<tr>
<td>Coeff.</td>
<td>1.1587</td>
<td>5.9406</td>
</tr>
<tr>
<td>Sinkhole density</td>
<td>-3099.19</td>
<td>741.351</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-1.1186</td>
<td>0.4497</td>
</tr>
<tr>
<td>Median household income</td>
<td>2.29319</td>
<td>2.4366</td>
</tr>
<tr>
<td>Coeff.</td>
<td>5.4061*</td>
<td>18.1359*</td>
</tr>
<tr>
<td>Vacancy rate</td>
<td>345.571</td>
<td>186.415</td>
</tr>
<tr>
<td>Coeff.</td>
<td>1.4545</td>
<td>0.8851</td>
</tr>
<tr>
<td>Nonwhite population (pct. of total)</td>
<td>36.8033</td>
<td>-175.021</td>
</tr>
<tr>
<td>Coeff.</td>
<td>0.1801</td>
<td>-2.8967*</td>
</tr>
<tr>
<td>Homes with one or two bedrooms (pct. of total)</td>
<td>-213.233</td>
<td>-373.12</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-0.8374</td>
<td>-3.2903*</td>
</tr>
<tr>
<td>Homes with three or four bedrooms (pct. total)</td>
<td>-7.96901</td>
<td>-720.688</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-0.0298</td>
<td>-7.5710*</td>
</tr>
<tr>
<td>Homes with five or more bedrooms (pct. total)</td>
<td>1217.25</td>
<td>1817.31</td>
</tr>
<tr>
<td>Coeff.</td>
<td>0.7610</td>
<td>3.1781*</td>
</tr>
<tr>
<td>Median age of housing units</td>
<td>-1036.7</td>
<td>-25.8778</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-3.2087*</td>
<td>-0.2473</td>
</tr>
<tr>
<td>n = 79</td>
<td>0.59</td>
<td>0.59</td>
</tr>
<tr>
<td>Adj. R²:</td>
<td>0.509</td>
<td>0.523</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pasco</th>
<th>Pinellas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>46384.1</td>
<td>4241.16</td>
</tr>
<tr>
<td>Coeff.</td>
<td>2.6189</td>
<td>0.5373</td>
</tr>
<tr>
<td>Sinkhole density</td>
<td>-977.498</td>
<td>-2155.6</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-0.8833</td>
<td>-0.6799</td>
</tr>
<tr>
<td>Median household income</td>
<td>1.1523</td>
<td>3.7057</td>
</tr>
<tr>
<td>Coeff.</td>
<td>3.2194*</td>
<td>20.9963*</td>
</tr>
<tr>
<td>Vacancy rate</td>
<td>517.546</td>
<td>820.553</td>
</tr>
<tr>
<td>Coeff.</td>
<td>2.5159*</td>
<td>5.7169*</td>
</tr>
<tr>
<td>Nonwhite population (pct. of total)</td>
<td>-281.261</td>
<td>8.95306</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-2.0141*</td>
<td>0.1567</td>
</tr>
<tr>
<td>Homes with one or two bedrooms (pct. of total)</td>
<td>-69.4777</td>
<td>-218.262</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-0.4504</td>
<td>-2.6124*</td>
</tr>
<tr>
<td>Homes with three or four bedrooms (pct. total)</td>
<td>213.011</td>
<td>-636.588</td>
</tr>
<tr>
<td>Coeff.</td>
<td>1.1446</td>
<td>-6.3491*</td>
</tr>
<tr>
<td>Homes with five or more bedrooms (pct of total)</td>
<td>423.644</td>
<td>1925.19</td>
</tr>
<tr>
<td>Coeff.</td>
<td>0.3693</td>
<td>3.9087*</td>
</tr>
<tr>
<td>Median age of housing units</td>
<td>-1035.5</td>
<td>-363.374</td>
</tr>
<tr>
<td>Coeff.</td>
<td>-4.7487*</td>
<td>-3.3427*</td>
</tr>
<tr>
<td>n = 148</td>
<td>0.705</td>
<td>0.704</td>
</tr>
<tr>
<td>Adj. R²:</td>
<td>0.598</td>
<td>0.568</td>
</tr>
</tbody>
</table>

*significant at p=0.05

will not be discussed here.

A Probit regression, using the binary variable sinks_present as its dependent variable, was run in order to generate a second set of results to compare with the OLS results. The Probit regression offered estimated to be well in excess of 40 kt.

From this it is surmised that the tree damage induced by the first system, Hurricane Frances, culled the unhealthy and weak trees, leaving stronger trees that were capable of resisting later wind events. When a microburst followed Frances by only three days the damage was to healthy trees, but it was caused by a combination of saturated soil and high winds. Finally, three weeks after Frances, Jeanne experienced relatively little tree damage. Additionally, if it is true that the tree damage during Jeanne was caused by a small tornadic event, as suggested here, then virtually no damage was caused by straight line tropical storm winds during Jeanne, even though it was a similar wind event as Hurricane Frances.

Conclusion

As observed with Hurricanes Frances and Jeanne, locations even on the periphery of the storm can have substantial damage. Jacksonville, Florida experienced only minimum tropical storm winds, and then only two times out of 96 hour period. Yet, out of a population of 1100 trees in one urban setting 34 trees were damaged or destroyed, 26 in the initial storm, 3 per cent of the population. Since tropical systems are frequent in the southeast United States this type of damage represents an important component of the natural environment. Tropical storms cull out weak vegetation that may either be already diseased, decayed, or dead. In the case of the 2004 tropical season in Jacksonville, Florida, the first system, Frances, targeted the weak and deteriorating trees leaving strong vegetation that could withstand the following wind events.

However, tropical storm impact in an urban landscape causes substantial damage to human development, and it is important for residents in areas prone to tropical systems to have an understanding of the potential threats. The damage from Hurricane Frances and Jeanne on the campus of Jacksonville University indicates that having an understanding of tree species is critical when preparing for tropical storm damage. In the case of the southern coastal regions of the south, water oaks are especially vulnerable, and home owners would
be wise to determine their position, age, and condition if present on one’s property. The damage from the 2004 season in Jacksonville also suggests further research, especially in terms of prevailing directions for wind damage. The dominant direction of damage in this one season was from northeasterly winds. If this could be validated through longer term analyses the benefit to Southeastern communities would substantial.

Human memory is typically less than a generation, while climate patterns function in blocks of decades, centuries, millennia, and longer. Population in coastal regions of the southeastern United States has exploded in the past few decades, and now that a new cycle of increased tropical storm activity has been breached the public seems to only accept the view that it is anomalous, when in reality tropical systems are frequent phenomena in the Southeast and an important component of the landscape.

References


Table 1. Regionwide OLS estimates. Dependent variable: median home value.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>34459.4</td>
<td>5.9670</td>
</tr>
<tr>
<td>Sinkhole density</td>
<td>-1004.23</td>
<td>-0.9534</td>
</tr>
<tr>
<td>Median household income</td>
<td>2.69503</td>
<td>28.8575*</td>
</tr>
<tr>
<td>Vacancy rate</td>
<td>521.565</td>
<td>5.0075*</td>
</tr>
<tr>
<td>Nonwhite population (pct. of total)</td>
<td>-114.312</td>
<td>-2.9157*</td>
</tr>
<tr>
<td>Homes with one or two bedrooms (pct. of total)</td>
<td>-275.316</td>
<td>-4.5196*</td>
</tr>
<tr>
<td>Homes with three or four bedrooms (pct. of total)</td>
<td>-535.285</td>
<td>-8.8066*</td>
</tr>
<tr>
<td>Homes with five or more bedrooms (pct. of total)</td>
<td>2139.38</td>
<td>5.9000*</td>
</tr>
<tr>
<td>Median age of housing units</td>
<td>-234.38</td>
<td>-3.4488*</td>
</tr>
</tbody>
</table>

\( n = 1483 \)

Adjusted \( R^2 = 0.566116 \)

*significant at \( p=0.05 \)

Table 2. Probit estimates using binary dependent variable \( \text{sink\_present} \).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-0.186665</td>
<td>-1.2109</td>
</tr>
<tr>
<td>Total housing units</td>
<td>0.000214976</td>
<td>3.9162*</td>
</tr>
<tr>
<td>Median home value</td>
<td>-1.66425e-06</td>
<td>-1.5712</td>
</tr>
<tr>
<td>Median age of homes</td>
<td>-0.0418238</td>
<td>-8.8272*</td>
</tr>
</tbody>
</table>

\( n = 1491 \)

Akaike information criterion (AIC) = 1176.9
Schwarz Bayesian criterion (BIC) = 1198.13

McFadden’s pseudo-\( R^2 = 0.113904 \)

*significant at \( p=0.05 \)
groups with no reported sinkholes.

- **Total housing units**: This is included as an explanatory variable in the Probit regression. It is included as a means of controlling for the greater likelihood of sinkhole reporting in block groups with higher populations, as well as the possibility of new sinkhole generation brought on by higher levels of new construction in growing areas.

This analysis makes use of a level of aggregation that some readers might find troubling. Specifically, both sinkhole occurrence and median home values are measured at the Census block group level; some might ask why the actual sale prices of individual homes were not plotted and mapped in relation to the nearest reported sinkhole. While this almost certainly would have been the preferred method of proceeding, data limitations forced this approach. For one thing, home sale data in Hillsborough County is no longer available for years prior to the late 1990s; for another, the FGS sinkhole database has always depended on voluntary reporting of sinkholes, and therefore suffers from a certain lack of comprehensiveness (the 1990s in particular were lean years for the database, as funding for database maintenance dried up for much of that decade). These two factors led to the development of the methodology used here, one that is not as precise as the ideal method but can still tell us something about the relationship between sinkhole density and home values.

**Results**

Regionwide, both the OLS (table 1) and the Probit regressions (table 2) generated statistically significant results; however, in no case were any of the variables of interest significant. While median home value in a given block group shows a statistical relationship to every other explanatory variable in the model, there does not seem to be a connection between median home values and sinkhole densities. This suggests that the discounting predicted by economic theory did not occur here. (Some of the other explanatory variables—in particular, the vacancy rate—did not generate the kinds of results we might have expected before running the regressions. And while these results merit examination, they go beyond the scope of this paper, and thus


[http://www.srh.noaa.gov/lrh/research/tropical.htm](http://www.srh.noaa.gov/lrh/research/tropical.htm)


- **Number of bedrooms**: Because median square footage data were not available, aggregate counts of homes organized by number of bedrooms were included to serve as proxies for home size.
- **Nonwhite population**: Neighborhoods with significant non-white populations can have lower property values than white-dominated neighborhoods; however, such a relationship is by no means inevitable (Palmore, 1966; Boston, et al, 1972). This variable is included as a means of separating out any race-based home value disparities that may occur. The variable is formatted as a percentage.
- **Median household income**: Neighborhoods in which residents are wealthier tend to have higher property values. It is possible to make a causal argument in either direction (are the high property values the result of the wealth of the neighborhood’s residents, or are wealthier residents attracted by the higher property values); however, the exact nature of the relationship between income and home prices is not relevant here.
- **Vacancy rates**: This variable is formatted as a percent of each block group’s housing stock that was vacant in 1990. This variable is included as a means to identify block groups with large numbers of abandoned or empty houses. Intuitively, we would expect block groups with higher vacancy rates to have less demand for residential property, which should have a negative impact on housing value.
- **Median structural age**: As homes age, their values generally decline relative to newer homes. However, because new construction can lead directly to the formation of new sinkholes (White, 1988; Patton and DeHan, 1998; Soriano and Simon, 2002), it is difficult to predict beforehand how this variable will interact with the rest of the data.
- **Sinks present**: This is a binary indicator variable used as the dependent variable in the Probit regression. It is not included in the OLS regression. Its value is 1 for block groups where a sinkhole had been reported prior to 1991, and is 0 for block
Figure 2. Sinkhole density, Tampa Bay, Florida (1990).

key explanatory variable in the OLS model. Sinkhole density across the Tampa Bay region is shown in figure 2.

The Vernacular Neighborhoods of Jacksonville, Florida: Can GIS Help Determine their Boundaries?

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As geographers, we classify and describe regions based on their physical and cultural characteristics, and how those characteristics interact with each other. There are several distinct types of regions including: formal, functional and perceptual.

Formal regions can be defined by their internal sameness such as similar demographics, voting habits or language. Functional regions are marked by an internal structure and usually are focused on a central location such as a city which may receive raw materials from outlying farms and rural areas and, in turn, supply its surrounding suburbs and outlying cities with goods and services (de Blij and Muller, 1997). Vernacular regions are based on peoples’ perceptions. The regions themselves can be defined by the people who live there and how they characterize themselves and their culture. For example, a “Northerner” may be from the Midwest while a “Southerner” might hail from Dixie and may have different ideas about each other and themselves based on their perceptions of each others regions.

Geographers have devoted much time to studying vernacular areas at the national scale such as the Midwest or Southwest and smaller regions such as New England or the Gulf Coast (Zelinsky, 1980; Bigelow, 1980). Studies have also been conducted at the state level in Texas (Jordan, 1978) and in Florida (Lamme and Meindl, 2002) among others. At the local level, such as metropolitan areas, there is a gap waiting to be filled in with examinations of microregions or neighborhoods (Zelinsky, 1992).

Background

Zelinsky has contributed a great deal of research to this subfield of cultural geography. Zelinsky studied the vernacular regions of North America in an effort to determine where different regions of North America are located and some of their cultural characteristics.
ine questions related to the impact of various hazards on home prices (see Nourse, 1967; Palm, 1981; Brookshire, et al, 1985; Tobin and Montz, 1994; Kiel and McClain, 1995; Dale, et al, 1999; among others). Results obtained using hedonic regression models often contradict those of other studies using different models, which suggests that the specific nature of the hazard may be a crucial factor. A search of the literature did not turn up hedonic studies of any potential relationship between sinkholes and home prices.

Data sources used for this analysis were the Florida Geological Survey’s sinkhole database and the 1990 US Census. Block-group-level Census data (described below) for the four counties of the Tampa Bay area (Hernando, Hillsborough, Pasco and Pinellas) were used. All sinkholes reported in the four-county area between 1964 and 1990 were included in this analysis; sinkholes reported after 1990 or observations lacking a reporting year were dropped. Sinkhole locations were entered into ArcGIS, and were linked to the block group in which they were located. Ordinary least squares (OLS) and Probit regressions were then run in order to characterize any potential relationship between sinkhole location and home values. These regressions were run once using regionwide data; the OLS regressions were also run once for each county.

The OLS and Probit regressions actually examine different, yet still related, questions. The OLS regressions investigate the relationship of home values to sinkhole density within each block group; the Probit regression instead focuses on the mere presence of sinkholes in a block group, with no adjustment for either the number of sinkholes or the geographic size of the block group. The median home value variable is included in both the OLS and Probit regressions, though as the dependent variable in the former and as an explanatory variable in the latter. Figure 1 illustrates the distribution of median home values across the region in 1990.

In addition to median home value, the following variables are included in the model:

- **Sinkhole density**: The value for this variable is derived from dividing the number of sinkholes reported in each county by the total number of block groups within that county.

Other studies include Bigelow (1980) who used data such as race, ethnicity, religion, and voting behavior as well as others, to develop maps showing a multitude of different types of perceptual regions, large and small, across the United States. A map of cultural regions broke the United States into regional levels from the primary to the quaternary. For example, the Northern Realm (primary) broke down into three regions including the Northeast, Midwest and Florida (secondary) regions. Those regions were again divided into subregions (tertiary) which were finally broken down into two or three other subregions (quaternary). The Northern Realm was not presented as being contiguous, but was split by the Southern Realm, leaving the Florida Region separated from the North, an occurrence which was not discussed except to say that Florida was a lesser region.

At the state level, a study of Florida conducted by Lamme and Oldakowski culminated in a map of the popular vernacular regions of Florida (2007). Their map was comprised of vernacular regions based on popular terms used by Floridians to describe different areas of the state. Another examination of Florida includes an updated examination of the understanding of the “U” shaped cultural boundary discussed by Zelinsky (1992) which separates the Florida peninsula from the rest of the state north of Orlando based on the peninsula’s uncertain affiliation with other regions. Based on historic census data and migration patterns over nearly a century, Lamme and Meindl (2002) proposed that the “U” shaped cultural boundary actually extends much deeper into the Florida peninsula yet still includes some areas which remain unaffiliated with any particular perceptual region. While they propose a change in the cultural boundary, Lamme and Meindl suggest that their boundary is more of a zone than a feature as definite as a line and that the zone includes a mixture of ethnicities and socioeconomic conditions.

Various methods have been used in the study of vernacular
regions. These methods include surveying the population of the area in question along with personal observation through immersion in the area (Zelinsky, 1980). This method has been used by researchers in the study of the popular regions of Virginia, parts of Missouri, and other regions not mentioned by Zelinsky as commonly thought of regions of the United States.

College students represent a common and convenient population to survey for information regarding vernacular regions. This has been done in Southern Indiana as well as with over two dozen colleges in Texas (Zelinsky, 1980). One interesting and more extensive method used was a mailing to postmasters general across the nation. The recipients of these questionnaires provided a more indepth view of various regions across the U.S. that were smaller than the regions Zelinsky described.

For his research Zelinsky (1980) used telephone directories to examine the spatial distribution of businesses within major cities of the U.S. and Canada. Oldakowski and Lamme took the same approach in an effort to answer the question “Does the South end in North Florida?” (Oldakowski & Lamme, 2002). For ease and accuracy, they used electronic telephone directories for the state of Florida to seek businesses with words such as South and Dixie. A telephone survey of the general population was also conducted to gather data to determine how residents in different parts of Florida referred to the area in which they lived. In order to determine the extent of the South and Dixie, Oldakowski and Lamme examined the spatial distribution of respondents and business listings. Their results showed the term “South” was homogenous across the state, however, there were certain areas where “Dixie” was more commonly used.

Zelinsky (1992: pp 133-134) discusses lesser-order culture areas which are visible based upon ethnicity or religion as determined by the researchers who have examined these areas. Some of these areas include small religious cultures in Pennsylvania, parts of Chicago, San Francisco and parts of rural America. He states that, “…clearly there remains an imposing agenda of unfinished business for the cultural and social geographer working at the microscopic level place a reinsurance facility that could cover the risk of property loss to sinkholes. At that point, Florida homeowners in sinkhole-prone areas had two options: they could either purchase sinkhole insurance, or they could gamble that their property would not be damaged by sinkholes. Either way, the risk of living in a sinkhole-prone environment was borne entirely by the homeowner. However, very few people purchased this optional available coverage (Maroney, et al, 2005), and in 1991 the Florida Statutes were amended to automatically include sinkhole coverage in every homeowner’s insurance policy, at no specified additional cost (Eastman, et al, 1995). Even though a 1993 study found that the problem of sinkhole losses was largely confined to the Tampa Bay area, the amended statutes made no distinction between homeowner policies issued for sinkhole-prone areas, and those issued for parts of the state where sinkholes were all but unknown (Maroney, et al, 2005).

Though it was probably not the intent of the Florida Legislature to do so, by passing this piece of legislation lawmakers actually enacted a mechanism to encourage people to engage in a higher-risk behavior—purchasing a home in a sinkhole-prone area—while the full costs of those behaviors are distributed among people who choose not to engage in that same higher-risk behavior. Because homebuyers will be forced to pay for sinkhole insurance (a cost which is undoubtedly built into the price of each policy), they have no incentive to minimize their own risk by moving to an area where sinkholes are less likely to damage their property. The distribution of sinkhole risk was therefore altered and is now shared by those homeowners who face little to no risk of sinkhole damage, but are still obligated to pay into the insurance pool. Thus, the cost of living in sinkhole-prone areas is artificially lowered, which means that homebuyers are theoretically more likely to relocate there than they otherwise may have been.

Methodology and data

In real estate economics, hedonic regression models are often used when a researcher wishes to control for the value of amenities such as square footage, number of bedrooms, and location, among others. For this reason, hedonic models are frequently used to exam-
Are Home Values Affected by Sinkhole Proximity?
Results of a Hedonic Price Model

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Introduction
With its limestone bedrock, warm climate and high precipitation levels, Florida provides near-ideal conditions for sinkhole development. Additional contributing factors in certain areas include high rates of urbanization and overpumping of groundwater to meet agricultural demand. While sinkholes can be found throughout Florida, distribution is not even across the state, with the highest concentrations occurring in the west-central region, to the north and east of Tampa Bay (USGS, 1999).

Though they lack the high profile and sheer destructive force of hurricanes, floods, and other natural hazards, sinkholes have on occasion generated significant damage to buildings, roads, and other human-built structures, and should be considered natural hazards in their own right. In sinkhole-prone areas where market insurance against sinkhole damage is available, economic theory suggests that homes located there should be valued somewhat lower than homes located in areas where sinkholes are rare or nonexistent, in recognition of both the risk faced by the homeowner in a sinkhole-prone area, and the cost of insuring one’s property against that risk. Working with sinkhole and Census data from the Tampa Bay, Florida region in 1990, this paper uses a hedonic price model to look for a statistically significant relationship between the presence of sinkholes (and, in a separate set of regressions, the density of sinkholes) in a neighborhood and the value of homes in that neighborhood. The model did not find evidence of either type relationship.

Background
The decision to use 1990 data for this analysis has its roots in a policy decision made in 1991. In 1969, the state of Florida put into in Anglo-America.”

Below the state level, little research has been conducted despite prompting from cultural geographers such as Zelinsky (1992). However, an interesting project called Bio Mapping has been developed to create an emotional map of several major cities around the world (Nold, 2004). Christian Nold, an art student from the United Kingdom, has created emotional maps of cities using GPS technology and instruments similar to polygraph machines. Both instruments were attached to human subjects who spent a part of their day walking around their neighborhoods. As the subjects interacted with the city, the GPS recorded their location while the polygraph recorded “physiological arousal.” When subjects returned from their strolls through the city, the data were taken and represented in 3-D on top of a road map of the city. These maps showed how strongly people felt about their neighborhoods and helped to visualize the social space of the community. He has conducted his project in several cities in England as well as San Francisco, California, and will be starting a mapping project of Tokyo. A surprising aspect of the Bio Mapping website is that it does not mention the use of a Geographic Information System (GIS) to analyze any of the data (Nold 2004).

In addition, the Environmental Systems Research Institute (ESRI), which produces ArcGIS, is involved in a project called the Community Atlas. This project involves students from the elementary to the high school level who create community profiles with maps and other documents which show the important aspects of their respective communities. Additionally, students arrive at a consensus as to how to describe or represent their community based on the community’s size, natural landscape, demographics and any other spatial data (ESRI, 2007).

GIS is an excellent tool for studying spatial distributions as it can perform functions such as density analysis and geocoding, both very accurate methods of determining the location of a unit of analysis. In King County, Washington, real estate market vector data were analyzed using choropleth maps which displayed data bounded by administrative boundaries such as ZIP codes and census tracts. The
data were then analyzed using spatial interpolation to produce continuous surface models which were unbounded by any administrative boundaries (Price, 1997). The resulting surface analysis fit local economic theory with more straightforward output and a higher resolution of the data which was not required to be bounded by any sort of administrative boundaries. This use of GIS stands out in that it examines data which is not restricted to boundaries or subject to analysis only by census tract or voting precinct, similar to data used to analyze the boundaries of vernacular regions.

**Jacksonville, Florida**

Normally, there are five major neighborhoods which are often referred to in the media as well as observed on local maps. For instance, a Jacksonville news station often refers to five major areas of the city, but does not base their determination of the location of the five areas using any particular method. Instead, the reporters rely on bystanders’ opinions or a map which is often used by a local real estate agency (First Coast News, 2007).

These five areas are Arlington, the Beaches, Northside, Southside, and Westside. Similar to vernacular regions in larger study areas such as Florida or the U.S., some of these areas have directional names, something common in many regions no matter what their size.

In area, Jacksonville is the second largest city in the United States covering more than 770 square miles of Northeastern Florida in Duval County (University of Florida, 2005). Jacksonville is unique as it is one of few cities in the United States whose boundaries are mostly shared with the county. It also contains the municipalities of Baldwin, Jacksonville Beach, Atlantic Beach and Neptune Beach (Crooks, 2004). Prior to 1968, with a population of over 200,000, Jacksonville was located in the center of Duval County and spread out approximately five miles from where Interstates 95 and 10 now meet. Figure 1 shows Duval County, whose borders coincide with Jacksonville’s current borders, as well as the four municipalities within Jacksonville. After consolidation, Jacksonville’s population of


be impossible to get every citizen of the city to agree with any map generated by this study. This is not the purpose of defining vernacular regions. Hopefully methods such as these can be used to examine what the major vernacular areas of any geographic area are, large or small, followed by an examination of any geographic data such as census data, income, education level, voting habits, etc. Since these data are broken up by political and administrative boundaries, it could be useful to examine how the data are grouped by vernacular area and how political and administrative areas are divided across vernacular areas.

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References


Figure 1.

Source: Author.

over 520,000, which included all of Duval County, increased by almost 260,000 to almost 780,000 from 1970 to 2000 (Crooks, 2004).

Methodology and Results

The names and addresses used for analysis were collected from a Compact Disc (CD) called businessinfo from infoUSA (2000). The CD included a telephone listing of virtually all businesses in the
The data collection began by searching the CD for businesses in Jacksonville, Florida, followed by a narrowing of the search by querying the data for only businesses whose names included at least one of the five major neighborhoods in Jacksonville. A search for businesses including Arlington in their name yielded over 90 results. This search was also run using the names of the other areas; the Beaches, Northside, Southside, and the Westside. Table 1 shows the results of each search.

A database was created for each of the vernacular regions containing both the name and address of each business as well as an additional column to code the business based on what area it fell into. Using GIS, the business addresses were geocoded. Geocoding is essentially the same process as running an address search on the internet using an Internet Mapping Service (IMS) such as www.MapQuest.com. The benefit of using a GIS is that it is possible to match up multiple addresses to respective points on earth at the same time, rather than one-by-one. The result of the geocoding process is shown in Figure 2 and shows the result of geocoding the addresses of the business from the Northside data set.

Not all of the businesses from each region of the study area were included in the analysis. This project encountered a problem similar to one that Oldakowski and Lamme came upon in their study of where the South ended in Florida. They discovered a highway in Southeast Florida was called “Dixie Highway” and so some of the businesses had to be discounted (because their name was associated with the name of the highway) to prevent a skewing of the data (Oldakowski & Lamme, 2002). Again, this project follows that same the lines drawn on these other maps. Although the boundaries drawn in Figure 4 are not as inclusive as the boundaries of Figure 6, Figure 4 is more specific showing only the areas immediately surrounding the businesses of that area.

Studying perceptual regions at the local level is made relatively easy with the aid of GIS. Because the area being studied is much smaller, in this case a city with a population of less than one million, GIS increases the ability to analyze smaller areas at the street level using tools such as geocoding and IDW. Because the study of national or large states’ perceptual regions would use smaller scale maps, less detail needs to be paid to such features as rivers or roads and highways which allows for more variation in the perception of those regions. This is in contrast to local vernacular regions whose perceived extents would vary less based on the opinion of the local population.

The first method, using a vector-based approach based on what area points fall under is less objective, although an observer’s personal experience and observations may yield a more precise map which could be deemed undesirable since the purpose is to understand what the general extent of the vernacular regions is (however, as far as the final product is concerned, this method may provide a more understandable idea of where the five major areas of Jacksonville are to a person not from the area). The first method produced a result similar to Figure 6 which was created based on local real estate and apartment hunting maps. Figure 6 shows a few extra areas such as Orange Park, Clay County, as well as Mandarin south of Southside, and the Downtown area of Jacksonville which may not as easily be called a vernacular area.

Using Inverse Distance Weighted analysis is a more objective approach. A GIS will not be influenced by personal observations and the results provide transitions from one area to the next which appears to be better suited at showing the less distinct areas such as where Arlington and Southside merge as gray areas.

Certainly none of the methods used provide perfect representations of the five major vernacular areas of Jacksonville and it would
tence of the five areas in question. Not only due to the number of businesses associated with each of the areas, but also the fact that they are geographically distinct from each other. In a comparison of the maps in Figures 4, 5a and 5b, which were generated using GIS, it is clear that using either a vector or raster analysis is a consistent approach. Also, when compared to other maps of Jacksonville, whether it is an apartment hunting website’s map of Jacksonville or a map used by a local news agency, the results of using GIS closely follow
were clearly beyond the limits of the vernacular neighborhood. In the area of Jacksonville known as Arlington there is a road named Arlington Road; however, no businesses’ names appeared to be associated with that road. A second reason for discounting other businesses is they were clearly outliers. This was most prevalent with Arlington businesses although Southside and Beaches businesses each had at least one outlier which was removed. Outliers in the Arlington dataset included two businesses which were located on the west side of

Figure 3a.

Source: Author.

Figure 5b.

Source: Author.

side spreads out more to the East and West and merges rather abruptly with Arlington to the North.

Conclusions

The purpose of this study was twofold, to begin to examine the vernacular areas (neighborhoods) of Jacksonville, Florida, and to begin to examine how GIS may be utilized in an effort to determine the general extent of vernacular areas. The results verify the exis-
Each of these maps used a different shapefile to represent the data. Figure 5a used a data set that contained all of the business with the simple coding mentioned earlier. Figure 5b used a different method of coding which used each business twice and used the inverse of the code used the first time the business appeared in the data set. The main reason this was done was to try and achieve an average of zero across the area in question. The most noticeable difference between Figure 5a and 5b is the Southside area. In Figure 5b, Southside

Source: Author.

the St Johns River which is a definite boundary to the north and west of Arlington; and a third business called Arlington Computer Products which is located south of where most of the Southside businesses are located. Finally, there were several businesses, such as Arlington Beaches Roofing, which were listed in both datasets.

The first method used to determine the general boundaries of these vernacular regions of Jacksonville was a subjective analysis based on the location of the businesses in each of the five areas. Us-
The Vernacular Neighborhoods of Jacksonville, Florida

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This is due to the fact that the businesses of these two areas of town merged together in that small section. Other studies have shown overlap with areas such as the Midwest and Northeast, and the North and South in places such as Kentucky, and Southern Ohio, Indiana and Illinois (Zelinsky, 1980). This vector-based approach resulted in rather distinct boundaries and overlapping of vernacular areas; for this reason, it seems logical to conduct a raster analysis, or spatial interpolation, to create a continuous surface. So a second method was used to examine the extent of vernacular areas in Jacksonville.

The second method uses a spatial analysis tool called Inverse Distance Weighted (IDW) analysis in ArcGIS. IDW is a spatial interpolation method used to estimate the unknown value of a point based on the known values of neighboring points. The basis of IDW is that points closer together are more closely related than points separated by larger distances. One use of IDW is to estimate the amount of rainfall in areas where precipitation amounts are not recorded such as in remote areas. IDW has also been used to determine potential sites for discovering Aboriginal artwork in Australia (Jones, Hole, Benwell, and Fryer, 2001). For this study, each set of businesses was categorized with a number one through five; a ‘1’ for all the Arlington businesses, a ‘2’ for the Beaches, ‘3’ for the Northside, etc. With this in mind comes the problem that Arlington, the Beaches, the Northside, Southside and the Westside are not quantifiable in the same way as, for example, precipitation values and the question is whether or not it can be estimated that a particular location is more closely associated with a particular area of town. The result of the IDW analysis is shown in Figures 5a and 5b. Figure 5a shows the result of using five categories with the estimated values separated using equal intervals. Figure 5b shows the same data using a stretched grayscale ramp with white equal to a value of one (representing areas more likely to be associated with Arlington), black representing a value of five (areas more likely to be associated with Westside) and all shades in between representing all other values between one and five transitioning from one area to another without defined boundaries.

Source: Author.