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Changing perceptions of archaeology in post-Katrina New Orleans: a geographic information perspective

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CHANGING PERCEPTIONS OF ARCHAEOLOGY IN POST-KATRINA NEW ORLEANS: A GEOGRAPHIC INFORMATION PERSPECTIVE

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ABSTRACT

Hurricane Katrina had a significant impact on the number and distribution of known archaeological sites in New Orleans, Louisiana. Due to government mandated investigation in heavily damaged areas, many archaeological sites were recorded in geographic locations where there were previously none recorded. This thesis examined the spatial distribution of sites in the context of archaeological predictive modeling to determine the impact of disaster recovery on site location. In addition, decision making processes that led to the discovery of sites were examined to determine how they contributed to spatial bias in the distribution of sites recognized by the Louisiana Division of Archaeology. Sites were categorized based on the types of investigations that led to their discovery: academic research, development or disaster recovery. They were then subjected to spatial and statistical analysis methods to demonstrate geographic differences between categories. Differences in mean elevation and distance to water between site categories were found to be statistically significant. Spatial clusters were identified that were unique to each site category indicating that they were also spatially different. This study indicated that clusters of sites observed within the known site distribution were the result of biased survey methods rather than an accurate representation of the varying density of archaeological deposits throughout New Orleans. As a result, the use of known sites for predictive modeling in New Orleans is highly problematic and needs to be evaluated further. A different conceptual model of New Orleans archaeology was then proposed that considers the city as a single site that can be modeled as having varying degrees of archaeological sensitivity across geographic space.

CHAPTER 1
INTRODUCTION AND LITERATURE REVIEW

New Orleans, Louisiana is as culturally and historically rich as any city in the United States. This is due in large part to two factors: the city's age; founded by European colonists in 1719 but occupied by Native Americans much earlier, and the large number of historic standing structures. Due to the preservation of so many historic structures, there is the potential for undisturbed archaeological deposits beneath the structures. This potential was realized when Hurricane Katrina swept through New Orleans destroying countless historic structures and severely damaging others. In the aftermath, Federal Emergency Management Agency (FEMA) conducted the bulk of disaster cleanup projects. Whenever cleanup required the breaking of ground or removing of historic buildings or debris, archaeological survey was required (FEMA 2006). This in turn led to the discovery and recordation of many archaeological sites.

The purpose of this thesis is to examine how Hurricane Katrina in conjunction with public policy has reshaped the understanding of archaeology in New Orleans. Very little has been written about the effect that a major Hurricane had on the archaeology of one of America's most historic cities. In fact the way in which disasters and government response impact historic preservation is a subject that has scarcely been studied at all. For these reasons, investigating New Orleans, a city rich with history, and the impact of Katrina, one of the worst disasters in U.S. history, is particularly important. The lack of research on this subject means that this study must be informed by many disparate sources of knowledge from multiple disciplines. Inspiration for this project has come from cultural resource management, archaeological predictive modeling, disaster management, and spatial crime analysis. The introduction includes a geographic setting of this project along with a summary of archaeological research in New Orleans. Included is a description of the study area and data used for this thesis.

Geographic Setting

The land that present day New Orleans sits upon is a recent accretion of Mississippi River deposits that accumulated from approximately 2500 B.C. until levees were erected in the 19^{th} and 20^{th} centuries (Saucier 1963). During the formation of the delta, sediment carried by the river overflowed into the marsh cutting off what is now Lake Pontchartrain from the Gulf of Mexico. Prior to this time the North Shore of Lake Pontchartrain would have been the Gulf coast. Over the next 4500 years the land south of Pontchartrain continued to build, creating a vast protrusion into the Gulf known as the St. Bernard delta lobe (Hastings 2009). The Mississippi River's tremendous influence on this region cannot be overstated. While sediment no longer deposits into the delta lobe, the Mississippi River is still the predominant geologic and geographic feature in the New Orleans area (Castille et al. 1986). Due to the richness of river sediments, agriculture was historically limited to the expanses of the Mississippi River natural levee (Saucier 1963). The processes that formed the delta have left New Orleans with a unique geographic setting; the land that is closest to the river channel tends to be higher in elevation than land which is farther away. The same can be said for some of the smaller waterways in the area such as Bayou Sauvage. These smaller channels acted as distributaries of Mississippi sediment and created their own natural levees of high ground just as the River did (Hastings 2009). The major topographic features of New Orleans are the natural levees of the Mississippi River, Metairie Bayou-Bayou Sauvage, which forms the Metairie-Gentilly Ridge, and the Pine Island beach ridge that lines the southern edge of Lake Pontchartrain. Virtually all of the land that is not in close proximity to one of these features is drastically lower in elevation and potentially below sea level (Saucier 1963).

The geographic setting of New Orleans was not ignored by its earliest settlers. Due to frequent flooding of the area, prehistoric populations inhabited the natural levees and the beach ridges south of Lake Pontchartrain while leaving the low-lying swampland vacant (Smith et al. 1983, Gray et al. 2008, White 2009). The first European settlers also found this strategy advantageous and occupied the natural levees first; some of the earliest colonists actually populated old Native American sites (Smith et al 1983). The population remained largely confined to the natural levee of the Mississippi River for much of the first 100 years of European settlement (Castille et al. 1986). Beginning in the antebellum period (1803-1860) immigrants started to settle lower lying areas off of the natural levee due to a lack of high ground to build upon (White 2009). It was not until the 20th century that drainage allowed the lowest-lying parts of New Orleans to be settled (Gray et al. 2008). As a result the settlement of New Orleans tended to start at the bank of the river and move toward the less desirable back swamp as the city expanded (Lee et al. 1997).

New Orleans Archaeology

Archaeology has been formally studied in the New Orleans area since the first half of the 20th century. Prior to Katrina, most of these investigations were either university sponsored research projects or compliance based Cultural Resource Management. While it was impossible to cover all of the archaeological research that has been conducted in New Orleans, some of the more notable examples were illuminated in this section.

The Early Years

Some of the earliest work done in the New Orleans area was accomplished by Ford and Quimby (1945), Saucier (1963) and Gagliano (1969). These researchers predominantly focused on prehistoric sites in the marshes of New Orleans East and the southern shore of Lake Pontchartrain. Some of their most important work was done at Big Oak and Little Oak islands and the Little Woods sites that identified the Tchefuncte Culture as one of the oldest in the lower Mississippi delta (Ford and Quimby 1945). While researching the geomorphology of the Pontchartrain Basin itself, Saucier investigated 140 prehistoric archaeological sites. Radiocarbon dating from these sites was often used to construct chronological sequences for various delta lobes (Saucier 1963).

Cultural Resource Management

Until the National Historic Preservation Act of 1966 (NHPA), archaeology in this region was limited to a few university backed research projects in the researchers' area of interest. With the enactment of NHPA the era of Cultural Resource Management (CRM) was initiated which greatly increased the frequency of investigations (Smith et al. 1983). NHPA was enacted to create a national preservation program during a time of widespread urban renewal that threatened historic resources. One of the outcomes of NHPA was that it induced the creation of the National Register of Historic Places (NRHP) that was directed by the National Park Service. Properties could be placed on the NRHP based on their cultural or historical significance. Section 106 of NHPA was enacted to mandate that NRHP eligible properties be protected from adverse impacts from government projects. CRM was born out of the necessity to study the possible adverse impacts on cultural resources from government action in the same way that negative impacts on the environment were assessed (King 1998). Beginning in the 1970s construction or development projects that involved public land, federal funding or federal permitting required archaeological investigation prior to any ground breaking activity (NHPA). As a result, many historic archaeological sites began to be investigated in the New Orleans area. In the late 1970s Shenkel of University of New Orleans (UNO) conducted some interesting investigations on Congo Square during the development of Louis Armstrong Park. While the site had already been disturbed by park construction, the remnants of a Spanish colonial fort still remained (Shenkel et al. 1979).

A large project that cut through some of New Orleans most historically significant neighborhoods was the construction of the Greater New Orleans Bridge no. 2, now known as the Crescent City Connection. The right-of way for this project intersected the Central Business District and the Warehouse District which resulted in a high potential for encountering archaeological deposits. Due to the large area that needed to be assessed, the project was first addressed by examining the standing architecture within the right-of-way. Archaeological testing was then concentrated on the properties that displayed the most historical significance. The actual placement of excavation units was guided by historic maps which revealed how previous occupations were placed on the lots. Thirteen previously unknown historic archaeological sites were recorded as a result of the GNO Bridge no. 2 project (Castille et. al 1986).

In the early 2000s, Gray of Earth Search Inc. conducted excavations over several years in response to the demolition of the St. Thomas Housing Development and the subsequent placement of the Tchopitoulas St. Wal-Mart. Portions of 13 city blocks were excavated revealing deposits related to predominantly poor immigrant populations inhabiting the riverfront in the 19th century. This project led to the discovery of 16 new archaeological sites (Gray and Yakubik 2010).

Academic Interest in Historic New Orleans

While archaeology in the city would gradually become dominated by compliance based Cultural Resource Management (CRM) projects, academic research on historic archaeology also gained prominence throughout the 1970s and 1980s. The first formal historical archaeology to be completed in the French Quarter was the excavation of the Gallier House by Jack C. Hudson. The Gallier House was built in 1857 and was the home of prominent New Orleans architect James Gallier. While the deposits were somewhat disturbed, the artifact assemblage that was recovered laid the foundation for New Orleans historic archaeology (Hudson n.d.).

In the late 1970s and early 1980s the Hermann-Grima House was excavated in three separate sessions. Two of these projects were sponsored by the University of New Orleans (Shenkel 1977, Lamb and Beavers 1983) and one by Davis (1983) of Tulane University. These excavations served to explore colonial daily life at this National Historic Landmark and National Register of Historic Places (NRHP) listed property. Layers of midden deposits were uncovered in the courtyard of the property representing occupation dating back to the 18th century.

Beginning with her work with the UNO Greater New Orleans Archaeology Program (GNOAP), Shannon Dawdy became very active in the academic research of historic sites in New Orleans. Dawdy followed up on some of Shenkel's work on Madame John's Legacy, a French Colonial era structure in the French Quarter (Dawdy 1998). She also conducted excavations on the 'Rising Sun Hotel' on Conti St. in a joint venture between contractor Earth Search Inc. and the University of Chicago. This site proved to have multiple components of occupation ranging from a proto-historic Native American village, to French and Spanish colonial residences, to a 19th century hotel and brothel. This was also the first Native American site documented in the French Quarter.

Hurricane Katrina

The topics of race, poverty, and inequality were the subject of much of the literature regarding New Orleans after Hurricane Katrina (Hartman and Squires 2006, Cutter et al. 2006). Much of the anthropological literature resulting from Hurricane Katrina focused on the cultural impacts of a city underwater and a people displaced. David Morgan authored a compelling article on commonplace cultural landmarks that were unrecognized by the National Register of Historic Places (Morgan et al. 2006). These landmarks received little consideration from preservation groups because they are not officially designated. In this article Morgan suggested that Hurricane Katrina has shown the need to revise the manner in which National Register of Historic Places (NRHP) nominations are considered. Morgan viewed the lack of representation of certain demographics in New Orleans as evidence of social inequality that was exposed by the storm.

Very little has been written on the effect of Katrina on New Orleans archaeology. Shannon Dawdy addressed the creation of archaeological sites through the compiling of storm debris by residents and relief workers. Her work illuminated the process of archaeological site genesis as a social product. Dawdy's research focused on the decisions made at the time of a disaster and how they affected which materials were buried. Her major theme was the potential of debris to be discovered as an archaeological site in the future (Dawdy 2006a). In another article, Dawdy discussed her time spent working as an archaeologist in the recovery process in New Orleans. She described New Orleans archaeology as a resource that has been historically neglected by researchers. This changed, however when the recovery process began (Dawdy 2006b). Dawdy hinted that federal preservation laws would be pushed to the limit during the cleanup and demolition process. Like Morgan (2006), she suggested that the storm will change the way archaeological investigations and historic preservation are conducted in New Orleans (Dawdy 2006b).

As Dawdy predicted, the catastrophic damage that Hurricane Katrina brought to New Orleans has had a lasting impact on archaeological research in the city (White et al. 2009). In the months following the disaster the City of New Orleans requested that FEMA pay for the demolition of residential structures that were too badly damaged to be rehabilitated. This demolition project required review for Section 106 (NHPA) compliance in order to mitigate adverse impacts to archaeological resources. URS Corporation of Baton Rouge was awarded a contract to oversee the Section 106 review process. Part of the Section 106 compliance review was archaeological monitoring during the demolition of 841 structures within the New Orleans area. The selection of structures for inclusion in the monitoring survey was guided by an archaeological predictive model. This project resulted in the discovery of 167 previously unrecorded archaeological sites (Handley et al. 2010).

Not all of the investigations that took place in the immediate aftermath of Katrina were as a direct result of demolition. FEMA also created temporary housing sites for displaced residents throughout the city. These housing sites often required the installation of utility lines that necessitated archaeological survey to mitigate adverse impacts. One example of a temporary housing site was the Kingsley House site. This empty lot proved to have rich archaeological deposits that were relatively intact (prior to temporary housing site development) dating back to the 18th century. The Kingsley House site yielded a treasure trove of historic domestic artifacts and architectural features. Most interesting was the discovery of Native American deposits affiliated with the Late Mississippian/ European Contact period. The rarity of discovering Native American sites in the city of New Orleans made this an exciting discovery and provided insights into prehistoric adaptations to the Southeast Louisiana environment (Gray et al. 2008).

Archaeological Predictive Modeling

Predictive modeling refers to a group of methods designed to streamline the efforts of archaeologists by focusing their research on a smaller portion of the landscape. These techniques are often used when attempting to study a vast area that cannot be feasibly covered by a complete survey. Archaeological predictive modeling dates back to the 1960's and has continued through the present day. Greater computing power combined with GIS has allowed modelers to produce some of the most sophisticated models to date (Kvamme 2006). At the heart of most predictive modeling methods is the idea that human settlement patterns are based on adaptive strategies employed to best adapt to the environment. Under the assumption that favorable environmental variables can be quantified, correlations are made between environmental variables and the presence or absence of archaeological sites. This is usually done by examining a data set of known archaeological sites and finding environmental and geographical similarities between them (Lock and Harris 2006). In this way specific environmental variables are identified that are considered more favorable for containing archaeological sites. An area that is being studied is then modeled to determine its likelihood of containing archaeological sites across geographic space by looking for combinations of environmental variables (Kvamme 2006).

Predictive modeling has been widely used in CRM due to the necessity of investigating large areas at a low cost (Dore and Wandsnider 2006). The use of predictive modeling in CRM has been criticized over the years due to the lack of empirical testing of models. Models are often created for a specific project and put into use without accuracy testing either before or after completion of the project (Dore and Wandsnider 2006). Despite these criticisms, predictive modeling will continue to be used as a cost and time saving technique. Such was the case when CRM professionals were faced with the enormous task of mitigating recovery projects following Hurricane Katrina.

URS Corporation was awarded a contract to perform archaeological monitoring of FEMA funded demolitions of structures damaged by Hurricane Katrina. In order to address this huge task, an archaeological predictive model was created for the City of New Orleans (Handly et al. 2010). Based on the Secondary Programmatic Agreement between FEMA, state, local, and federal government agencies (FEMA 2006), 25% of all demolitions were monitored for archaeological significance within the context of this project (Handly et al. 2010). Structures were chosen for inclusion in the monitoring project based on an archaeological predictive model.

The particular predictive model used in the demolition project divided the city into three probability zones based on their likelihood of containing archaeological sites. The probability zones were developed using four criteria: geology, the presence of previously recorded sites and NRHP districts, historic maps and research value. When evaluating geology, areas of the city higher than 1 meter above sea level were considered to have a high probability of containing archaeological sites (Handly et al. 2010). In New Orleans these areas are typically the natural levees of the Mississippi River or bayous such as Bayou Sauvage. Natural levees were the preferred landform of both prehistoric people and colonial era settlers making them traditional hot spots for archaeology (Saucier 1963, Smith et al. 1983). The inclusion of previously recorded sites increased the predicted probability of areas with higher densities of known sites. Historic districts were included based on the assumption that they would yield archaeological sites because of the long history of the neighborhood (Handly et al. 2010). The two strongest weighting criteria, geology and previously recorded site location, tend to represent geographically similar areas. Natural levees are the highest elevations found in the area and also contain many of the known archaeological sites (Handly et al. 2010, Saucier 1963).

While geology and previously recorded sites were the strongest weighting criteria in the model, the historic maps were used to identify specific areas that warranted close investigation. This criterion was meant to focus attention on the lesser understood historic settlements within the city (Handly et al. 2010). The research value component was more of a fuzzy criterion based on the length of occupation within that area. Parts of the city with a longer history, spanning many cultural periods were considered to have a greater archaeological potential (Handly et al. 2010). The resulting probability zone map classified the area of New Orleans as being 44.9% high probability, 7.2% moderate probability, and 47.9% low probability. 841 total properties were monitored for archaeological remains during demolition. Of the total, 457 (54.3%) were selected from high probability areas, 242 (28.8%) were selected from moderate probability areas and 131 (15.6%) were selected from low probability areas (Handly et al. 2010).

<u>Assessing the URS Probability Model's Performance</u>

Did the model prove to be an accurate predictor of archaeological deposits? How has the discovery of so many previously unknown archaeological sites changed the way probability modeling will be done in the future? 170 total archaeological sites were identified as a result of this project. 64 sites (37.6%) were found in the high probability zone, 96 (56.5%) in the moderate probability zone, and 10 (5.9%) in the low probability zone. When regarding the performance of the probability zone model it was interesting to note that the majority of sites were recorded in the moderate zone and not in the high zone. This was an unexpected outcome when considering that the moderate probability zone only encompassed 7.2% of New Orleans total land area. The high probability zone encompassed nearly half of the city's land area but only produced slightly more than one third of the sites. The model did prove effective in predicting the low probability areas which contained nearly 48% of the land area but only 6% of the sites (Handly et al. 2010). It was even more interesting that an archaeological site was recorded in one out of every 7.1 monitored demolitions in the high probability zone while 1 site was recorded out of every 2.5 monitored demolitions in the moderate probability zone. The low probability zone only produced a site in 1 out of every 13.1 monitored demolitions. Despite the moderate probability encompassing a much smaller area and having a smaller percentage of monitored demolitions, it produced the most sites per monitoring episode. The seeming reversal of moderate and high probability zones suggested some flaw in the model. It could mean that one or more of the criteria used to create the model were inappropriate. What is clear is that despite intentionally focusing more attention on the high probability areas of the city, the majority of the sites were found in the other areas. This suggests that the contribution of one or more of the variables in the model was not fully understood.

Kvamme (2006) raised concerns about the inherent biases that can be introduced through archaeological sampling techniques. Research designs employed by archaeologists have had the tendency to create patterns of site distribution based on where sites were expected to be found. Patterns can also be produced based on the locations of planned development projects that require CRM investigation meaning that heavily developed areas may contain more sites

(Kvamme 2006). In this instance archaeological site distributions may mirror the geographic patterns of modern development.

Without knowing all of the details about how the probability model was created it was unclear why the URS model performed in the way that it did. It would have been reasonable to expect to find more sites located in higher elevation areas and therefore in the high probability zone due to the sampling strategy described above. That was not the case and therefore it was necessary to explore why the high probability zone was a poor predictor of archaeological site location.

The URS model's reliance on elevation and previous site location likely only captured a portion of the distribution of archaeological resources within the City of New Orleans. Both the geology and previously recorded site location criteria were guided by the thrust of previous archaeological research. In other words the idea that archaeological sites are located on higher elevation came from theories formulated by researchers such as McIntire (1958), Kniffen (1936) and Saucier (1963). These theories were predominantly based on prehistoric settlement patterns, which while accurate, may no longer be applicable to modern day New Orleans site prediction. The majority of archaeological sites in New Orleans are historic. Furthermore, when the early theories of site location were being formulated, a large portion of known sites would not have been considered historically significant. In the 1970's archaeological deposits from the 1940's would not have been old enough to be considered relevant. In 2005 any deposit older than 1955 would be considered historic thus making a large part of the city historically significant.

Much of the academic research conducted in New Orleans has been focused on the oldest and highest elevated portions of the city. This inherent geographic bias in academic research has potentially created a pattern of sites that conforms to traditional theories of site distribution. Predictive models that are based on previously recorded site locations focus investigation in certain areas and tend to reproduce the patterns created by previous research design. As stated by Dore and Wandsnider (2006), models created for CRM projects are rarely validated before being put into service. The only model testing is the project for which it was created. The model then becomes self validating because the high probability areas are sampled more intensively thus producing more sites.

It should be noted that only a small portion of recorded archaeological sites in New Orleans were discovered as a result of academic research projects. The majority of sites within the city were recorded during CRM projects mandated by the NHPA. Before Hurricane Katrina most of these projects were development projects conducted by private industry, or city, state and federal government. In the years since Hurricane Katrina many more sites have been recorded during various recovery projects. As a result, development and recovery projects would also have had a heavy influence on where archaeological sites have been discovered. The potential then exists for sites to be spatially patterned based on the type of projects that led to their discovery. Site location would then be less related to human settlement patterns and more dependent upon decisions that directed researchers to that location. This potential was explored further in the decision model section of the methods chapter.

As stated above, the model used by URS was strongly influenced by where sites had been identified prior to Hurricane Katrina. While this is typical of predictive modeling designs, it must be noted that the total number of archaeological sites has more than doubled since 2005. This makes it extremely important to investigate the geographic distributions of archaeological sites recorded after Hurricane Katrina as compared to those that were already recognized.

Predictive modeling has and will continue to be used any time large scale archaeological investigations take place where a 100% survey is not practical, especially in CRM projects. Predictive models are primarily driven by settlement pattern theory, geographic variables and known site databases (Kvamme 2006). It is necessary to study whether the criteria that inform predictive models are indeed appropriate for modern day New Orleans. Since Katrina, the known site database for New Orleans has undergone drastic changes with the total number of sites being than doubled (White 2009). The large increase in recorded sites means that it is essential to understand the implications that the new geographic distribution will have on future modeling attempts.

Research Goals

This thesis project began with the goal of answering the question: How did Hurricane Katrina and government response change the spatial pattern of recorded archaeological sites in New Orleans? Since its inception more questions have evolved out of the initial inspiration. Is the distribution of known archaeological sites representative of the varying density of deposits across geographic space or are patterns attributable to geographically biased research methods? What possible effects do biased site patterns have on archaeological predictive modeling? What alternate conceptual models can provide an accurate understanding of the spatial variation of archaeological sensitivity throughout New Orleans? In order to address these questions pre and post Katrina sites were evaluated based on their geographic position with respect to the landscape of New Orleans. The decision making processes of researchers and policymakers were also examined in order to further understand the influence these decisions had on site distributions. Spatial analysis methods were used to indicate 'hot spots' and clusters that may have appeared as a result of Hurricane Katrina providing valuable information to future modelers. Based on the results of the analysis, this thesis explored alternate policies regarding the management of cultural resources in New Orleans.

Study Area

The study area for this project was the city of New Orleans rather than the entirety of Orleans Parish. While there are archaeological sites located in the marshy eastern extents of the parish, most of the new sites recorded post-Katrina were discovered within the city limits. For this reason the project focused on New Orleans proper. The northern and southern boundaries of the study area were Lake Pontchartrain and the Mississippi River respectively.   The Jefferson Parish line formed the western boundary. The study area includes the Lower 9^{th} Ward from the Industrial Canal to the St. Bernard Parish line and stopping at the Florida Avenue floodwall. Also included was a section of New Orleans East bounded by the south shore of Lake Pontchartrain, Paris Road, Jourdan Road, and the CSX Transportation rail line that follows Chef Menteur Highway. The Industrial Canal and Mississippi River Gulf Outlet (MRGO) as well as the segment of marsh between the New Orleans East and Lower 9^{th} Ward sections were removed from the study area because they are predominantly water and are not appropriate for this study (Figure 1).

Data

The Louisiana Division of Archaeology keeps records of all archaeological sites within the state in the form of paper site forms and also plots the geographic locations of sites on U.S.G.S. quadrangles as well as in a GIS. While the GIS database is perhaps the easiest to use, it is not always the most complete. There is sometimes a lag between when a site is recorded and when it appears in the GIS database. The paper site forms are also considered to be the most

Figure 1. Map showing New Orleans and the study area for this thesis project. The names of pertinent sections of the city are labeled. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

accurate record of site location and are therefore more official than the GIS (personal conversation with Cheraki Williams of Louisiana Division of Archaeology 2009). This study was limited to sites that lie within the area described above and that are terrestrial in nature. Underwater archaeological sites were excluded from this study because they are not modeled in the same way as terrestrial sites. Water bodies were also not subjected to the types of recovery projects that were investigated in this paper.

The initial stage of this project was the creation of a geographic site database. All archaeological sites that are within the study area were digitized into a GIS based on the locations provided on the site forms for each site. First a mosaic of U.S.G.S. 1:24,000 topographic maps was compiled for the entire New Orleans area. The mosaic provided better resolution than a 1:250,000 topographic map but covered far more area than a single quadrangle. In all, six 1:24,000 quadrangles were compiled into the mosaic. Site area polygons were then digitized onto the mosaic in order to capture the site boundaries. This process consisted of extracting site location data from the site forms. The majority of site forms had maps attached showing the location of the site as well as written descriptions of the locations and/or geographic coordinates. Not all site forms had all three forms of geographic information, but most had at least two of the three. As a result, written descriptions were sometimes used in combination with the plotted map locations of the sites. Spatial and statistical analysis required that site center points were used; once the polygons were completed, centroids were generated. Attribute data were collected from a combination of the state’s web-based GIS and the paper site forms. All of these data were entered into a spreadsheet, which was then attached to the geographic data.

Chapter 2
Methods

Geographic Variables

Many predictive modeling methods rely heavily on geographic variables therefore it was necessary to examine the way in which archaeological sites were positioned in relationship to the geography of New Orleans. This was done by selecting a series of geographic variables that could be measured at each site location. The variables were elevation, distance to nearest water (in some cases historic water sources), and flood depth at the time of Hurricane Katrina. These values were measured using tools readily available in ArcGIS (ESRI 2009). Elevation and flood depth were calculated using the "sample" tool in the ArcGIS 'Spatial Analyst Tools' toolbox. The tool sampled a raster dataset at the location of each site and calculated a value based on the raster cell that corresponded to the site. The raster datasets used to calculate elevation were LiDAR (Light Detection and Ranging) digital elevation models (U.S. Army Corps of Engineers 2003). The digital elevation models (DEM) have a spatial resolution of 5 meters (Figure 2). Flood depths were derived from the Depth grid for Orleans, Jefferson and St. Bernard Parishes (U.S. Army Corps of Engineers 2005). The flood raster represents flood depths measured on September 2, 2005 and has a spatial resolution of 25 meters (Figure 3).

Distance to nearest water was estimated by digitizing the major water bodies in the study area. Since the formation of the deltaic lobe on which New Orleans sits, the Mississippi River has been the most important body of water in the vicinity (Castille 1986; Saucier 1963). The river has also been unmatched in terms of its influence on commerce and development since the city's inception (Goodwin et al. 1986). After the Mississippi River, the natural levee of the Bayou Metairie/Bayou Sauvage channel is the most prominent topographic feature in the area

(Saucier 1963). Despite not being a source of fresh water, Lake Pontchartrain was considered to be a highly valuable resource in both prehistoric and historic times (Hastings 2009; Ford and Quimby 1945). Bayou St. John, while not as prominent as Bayou Metairie/Bayou Sauvage, was also an important economic and transportation resource to Native American and European populations (Hastings 2009). For these reasons these four water bodies were chosen for digitization into GIS. Four water features were digitized rather than extracted from an existing hydrology layer because an existing layer would have required considerable preprocessing to use. For instance Bayou Sauvage is no longer extent in New Orleans proper. Also for this study it was necessary to have the bankline of the Mississippi River rather than a centerline because the river forms a boundary of the project area. Bayou St. John has also undergone some alterations that were removed during the digitization process. The digitization of the Mississippi River, Lake Pontchartrain and Bayou St. John were relatively simple as they can be easily defined on U.S.G.S. quadrangles. Bayou Metairie/Bayou Sauvage is largely a relict channel at present and needed more investigation than the other features. This channel was digitized using a combination of satellite imagery (ESRI 2010a), LiDAR DEMs, and Saucier's drawings (1963). The south shore of Lake Pontchartrain was digitized because it forms the northern boundary of the study area. The East Bank of the Mississippi River was digitized because it forms the southern boundary of the study area. The centerlines of Bayous St. John and Metairie/Sauvage were digitized because they cut through the study area and their exact original bank lines are not presently known (Figure 4).

The distance to nearest water for each site was calculated using the 'Near' tool in the ArcGIS 'Analysis' toolbox. These variables were used to compare subsets within the overall dataset of sites to determine if they are statistically different. Initially the dataset was divided

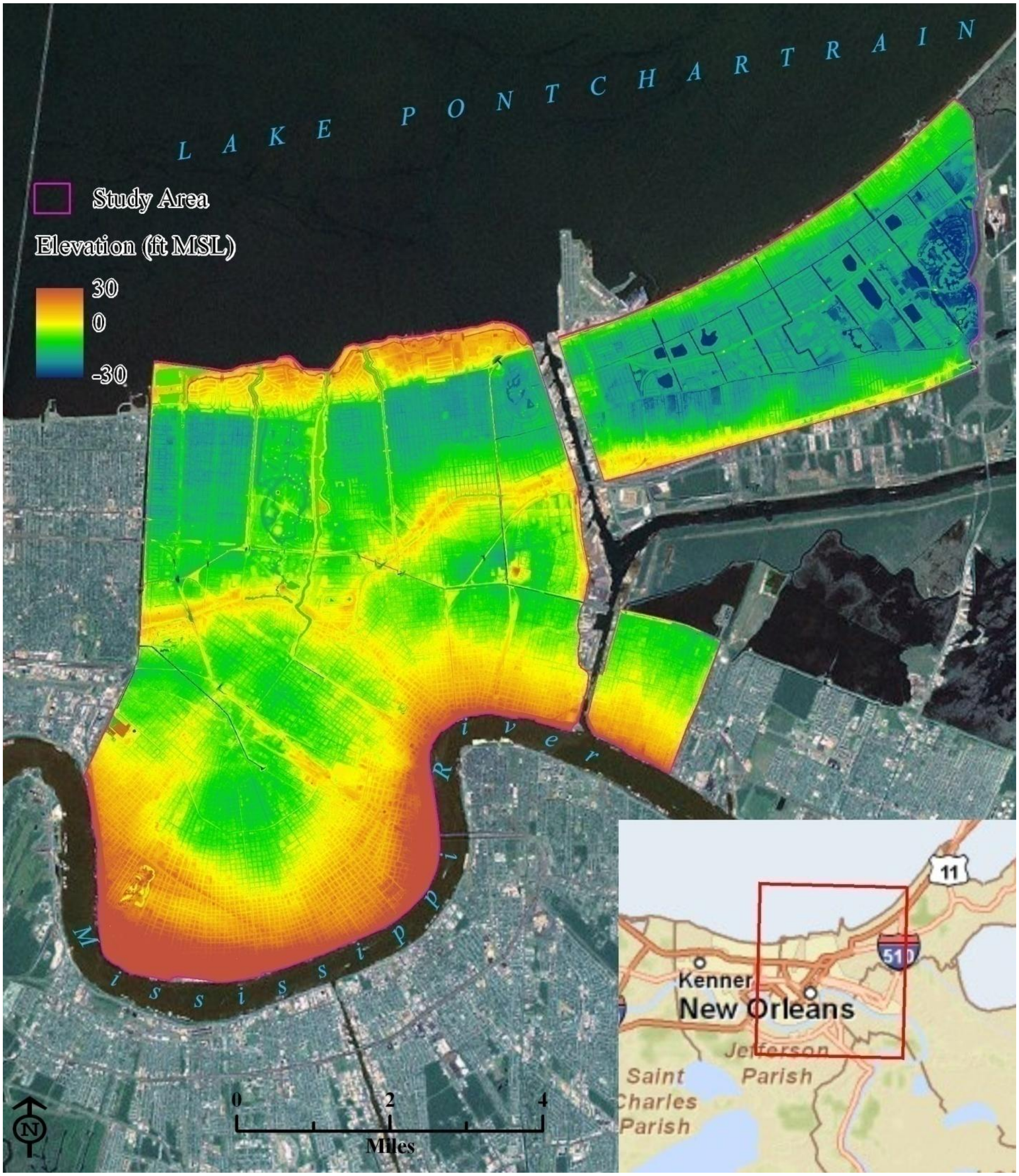

Figure 2. LiDAR elevation data showing the topographical highs and lows in New Orleans. U.S. Army Corps of Engineers 2003, data distributed by LSU Atlas < http://atlas.lsu.edu/>. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

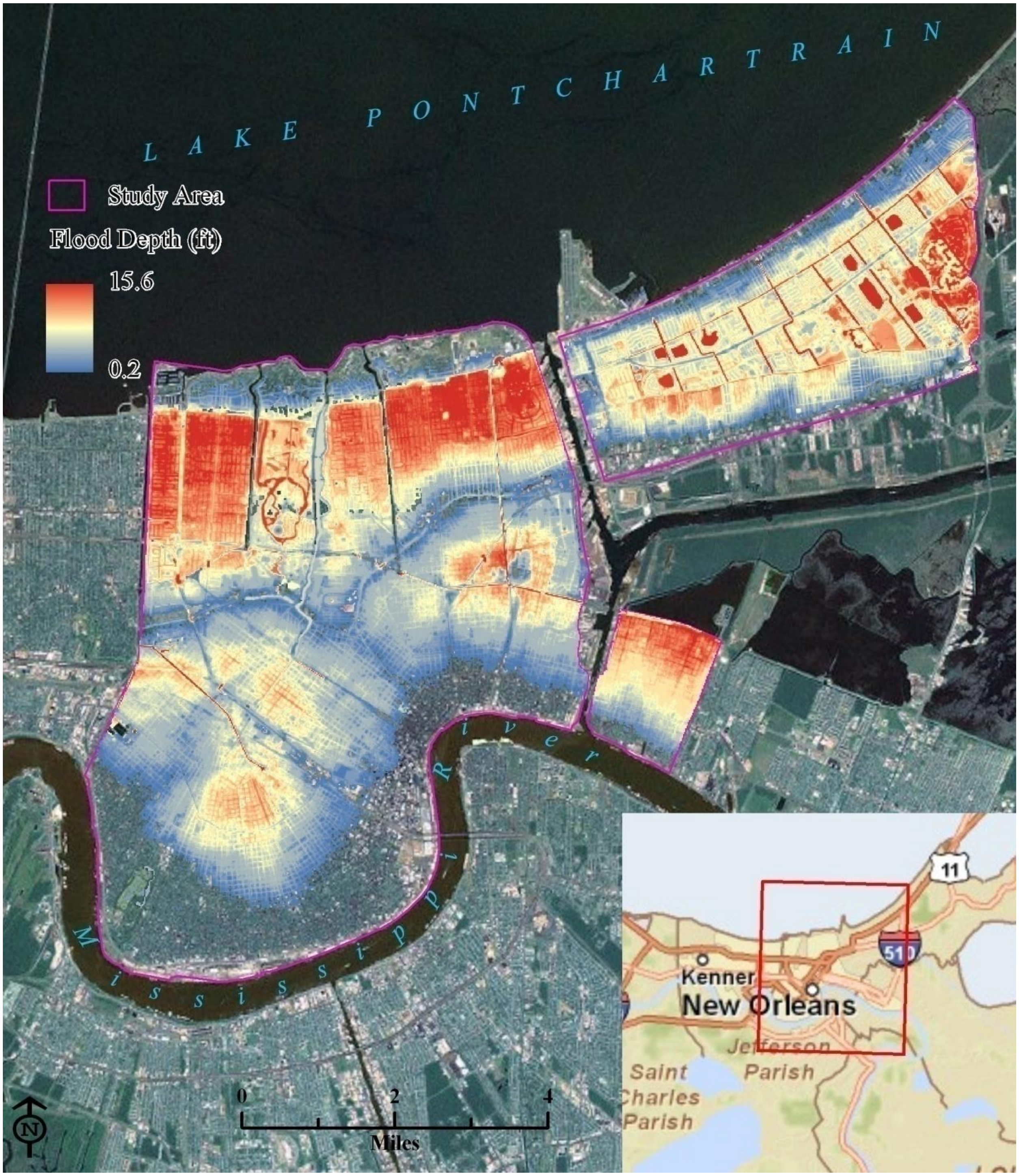

Figure 3. Flood depth raster, U.S. Army Corps of Engineers 2005, was clipped to the study area. Flood depths are representative of data collected on September 2, 2005 and may not reflect peak flood levels. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

Figure 4. Map showing digitized water features used for the distance to nearest water portion of analysis. The bank lines of the Mississippi River and Lake Pontchartrain were digitized whereas the center lines of Bayou St. John and Bayou Metairie/Bayou Sauvage were used. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

into pre and post-Katrina subsets to investigate the geographic effect that Katrina has had on site distribution within New Orleans. The dataset was divided into pre- and post-Katrina based on the "date recorded" field that appears in the site form. Due to the cessation of work after Katrina, there was a period of approximately eight months when no sites were recorded in New Orleans. The last site recorded prior to Hurricane Katrina was on April 4th, 2005 and the first site recorded after Katrina was on December 1st 2005.

Decision Models

Examining geographic differences between pre and post-Katrina site distributions highlighted the changes that have occurred as a result of the Hurricane and subsequent government response, but it may be necessary to further examine why sites were recorded in particular locations. In order to understand the site distribution patterns that currently exist in New Orleans, an investigation of the factors that influenced the location of recorded sites was needed. In an area that is as densely developed and that at this point has been heavily surveyed, known site locations were likely influenced by biased survey methods. An alternate way of looking at site distributions was to consider what inspired the recordation of the site, or more accurately what led the researcher to that location. In order for a site to be "discovered" it usually has to be unearthed by some sort of excavation activity whether unintentional or planned. There are different processes that have resulted in the unearthing of sites. Researchers excavated sites in order to address research questions, CRM archaeologists mitigated sites to document resources prior to their destruction by impending development, and preservationists often encountered archaeological finds while restoring historic properties. After Hurricane Katrina, CRM archaeologists were tasked with the documenting of storm damaged portions of the city before and sometimes after their demolition. These processes were driven by decisions made by individuals, preservation societies, private companies and federal, state and local government agencies. Based on this concept, the archaeological sites of New Orleans were categorized into three distinct decision models. The decision models were defined as research/preservation, development and recovery.

Research/Preservation

The research/preservation decision model was based on an individual or group's interest in a particular area, time period, culture, or property. Certain academic archaeologists have sought to answer research questions by focusing their efforts on geographic areas, such as Czajkowski or Ford while others were more interested in certain cultural contexts such as Shannon Dawdy. These research interests have led investigators to excavate certain areas over others which introduced a bias to a geographic distribution of sites.

Also included in this category were those that attempt to preserve a property that they own or have stewardship over. The Historic New Orleans Collection owns several properties in the French Quarter and has diligently sought to preserve historic resources when conducting renovations of their holdings. On several occasions they have partnered with private CRM firms to support the excavation of properties when they are not in any way required to do so (Dawdy et al. 2008). This activity represents an interest in preserving our historical past and recognition of the value of the resources they preside over. Other examples of similar preservation activities were the curators of properties such as the Hermann-Grima House (Lamb and Beavers 1983) and Villa Meilleur (Lee et al. 1997), who sponsored excavations while updating their facilities.

Local citizens have also demonstrated this type of interest in preserving our past by sanctioning the excavation of their properties. Some examples are the owners of the Friedrich

House (Saunders 1994), and the property at 1100 N. Rampart Street who contacted archaeologists out of a sense of responsibility when encountering archaeological deposits on their land. Much of the work that Andrea White has done, while working with the Greater New Orleans Archaeological Program (GNOAP), has been consulting property owners about the significance of findings at their residence. These consultations have resulted in the recordation of many historic sites in New Orleans (White 2009).

What aggregated these processes into a single decision model is that the individual or group of individuals had the assumption of archaeological or historical significance at a particular location. Researchers chose certain areas because of what they expect to find or questions that they wanted to answer. Preservationists often already knew that they were responsible for a historically significant property or they became aware once they began a renovation project. Preservationists were grouped together with academic researchers based on their interests or sense of obligation that were strong enough to lead them to contact an archaeologist when they were in no way required to do so. They were undeterred by the prospect of increasing the duration and expense of their project and motivated to explore the past. Thus the assumption and/or pre-knowledge of the archaeological potential at a certain location, dictated that the investigation be initiated.

<u>Development</u>

The development decision model was defined as resulting from corporate or government decision makers that favored one area over another for some type of construction project. The choice of where to place a development was made predominantly for economic, civil, or logistical reasons. These projects were typical of the type of archaeology in which Cultural Resource Managers participate. Some examples were the Greater New Orleans Bridge to the

West Bank (Castille et al. 1986), floodwall projects on the Mississippi River (Goodwin et al. 1986) or the Tchoupitoulas St. Wal-Mart which resulted in the excavation of several city blocks (Gray and Yakubik 2010). Usually the developer, whether it be municipal, federal, or private did not choose these locations hoping to locate archaeological resources. Rather the location of the development was chosen for commercial reasons such as proximity to population centers such as the Wal-Mart or logistical ones such as the GNO Bridge. In most cases the developer would rather not have to contend with the mitigation of archaeological sites and perceives CRM as a nuisance. Nonetheless, sites were frequently discovered during these projects. Sites recorded in the course of development initiated CRM investigations were grouped into the development decision model.

Recovery

The processes that defined the recovery decision model were the destructive power of Hurricane Katrina and the government response to such an event. The geography of New Orleans and the nature of the storm itself played an important role in where the largest amounts of damage occurred. Parts of the city with lower elevation and that were closer to levee breaches typically sustained the most damage (Brinkley 2006). As FEMA and the U.S. Army Corps of Engineers responded to the devastation by conducting demolitions of structures, they contracted CRM archaeologists to mitigate potential adverse affects to historic resources. In this instance the driving force leading archaeologists to investigate a location was the presence of structures that required demolition. Sites included in this decision model were limited to those discovered while a storm damaged portion of the city was being demolished or repaired. Sites found while clearing debris or demolishing a home were included as would sites found while repairing a flood wall. However sites resulting from levee improvement projects or FEMA temporary housing sites would be included in the development category.

The largest, although not the only example, of a recovery type project was the FEMA-funded demolition project (Handly et al. 2010). This project, which resulted in the recordation of 167 sites in Orleans Parish, consisted of monitoring of the demolition of structures and the subsequent documentation of archaeological resources by CRM professionals. As stated in the introduction, it was not required that all of the locations be monitored and sites were selected for monitoring using a probability model. The use of a probability model introduces some of the expectations of archaeological significance for a particular location that are described in the research/preservation decision model. The recovery decision model is different in that it limits the possible locations of archaeological investigations to where the demolitions are actually taking place**.**

Summary of Decision Models

Every attempt was made to accurately define all of the sites in the study area as being recorded through the implementation of one of the three above decision models. These models are by no means perfect but do provide a reasonable description of the natural, human, academic, and policy derived processes that were driving the discovery of archaeological sites in New Orleans. The method of assigning sites to decision models was focused on the first instance that a site was discovered and subsequent site visits were disregarded. There are certain sites that seem to defy the categories such as those recorded while mitigating FEMA temporary housing sites. While these housing sites were integral to FEMA’s recovery plan, they were not placed on a certain location because of specific damage to property on that lot. Archaeological sites discovered within planned FEMA temporary housing sites were a better fit for the development decision model because the locations were chosen based on logistical considerations. Other examples of sites that tended to straddle one or more decision models were many of the sites recorded by Andrea White and the GNOAP. Many of the citizens that contacted White about discoveries on their property were the recipients of funds from the Historic Building Recovery Program. While these were recovery related funds, the property owners were under no obligation to contact archaeologists upon encountering deposits (White 2009). These individuals called the GNOAP out of a personal interest and sense of duty which placed the resulting sites into the research/preservation decision model.

Statistics

After all the subsets were created, pre-Katrina, post-Katrina, research/preservation, development and recovery categories were exported to database format for analysis in SPSS (SPSS Inc. 2008). An independent sample t-test was run comparing mean elevation between pre- and post-Katrina subsets. A statistical difference in mean elevation between pre- and post-Katrina subsets would indicate that the Hurricane and government response had a transformative effect on the suite of archaeological sites within the study area. It would also indicate that future predictive models would have to contend with these differences in order to attain sufficient accuracy. In addition to mean elevation, the pre- and post-Katrina subsets were tested for statistical differences in mean flood depth during Katrina. A statistical difference would indicate that post Katrina sites were more likely to be located in flooded areas.

The decision model categories were tested for statistical differences in elevation and distance to nearest water using analysis of variance (ANOVA). The prehistoric and historic sub-categories of the research/ preservation category were also tested for difference in mean elevation using an independent sample t-test. Statistical differences between historic and prehistoric sites within the research/ preservation category would indicate that researchers with different interests have the tendency to create different site distributions. Differences in mean distance to nearest water or elevation between the various categories and sub-categories would indicate that unique site distributions are created by the decision models described in this thesis. It would also elucidate differing relationships between archaeological sites and the geographic setting that could be reflected in future predictive models.

Table 1. Summary of statistical tests performed on geographic variables for archaeological site categories

Statistical Comparisons of Categories	Test Used
Pre- and Post-Katrina subsets were tested for statistical differences in mean elevation	Independent Sample t-test
Pre- and Post-Katrina subsets were tested for statistical differences in mean Katrina flood depth	Independent Sample t-test
The Research/Preservation, Development and Recovery categories were tested for differences in mean elevation	ANOVA
The Research/Preservation, Development and Recovery categories were tested for differences in mean distance to nearest water	ANOVA
The Historic and Prehistoric sub-categories of the Research/Preservation category were tested for differences in mean elevation	Independent Sample t-test

Spatial Analysis

The following spatial analysis methods are often used to identify clusters and hot spots in point patterns. These techniques were borrowed from methods typically used in crime analysis and mapping (Eck et al. 2005). In this study, archaeological site locations were represented as discrete points so that point pattern analysis techniques could be used. These methods allow for easier interpretation of a point pattern than visually examining the pattern itself (Eck et al. 2005).

Each point represented the finite instance of an archaeological site in the same way a point represents a single crime on a crime map. Crimestat (Levine 2010) was used to perform the analysis. The results of these tests were used to visually interpret the data as well as to produce statistics in some instances. Each of the following spatial analysis methods was calculated for the pre and post-Katrina subsets and the three decision model categories.

Nearest Neighbor Hierarchical Clustering

Nearest neighbor hierarchical clustering (NNH) is used to identify clusters within a point pattern based on the relative closeness of pairs of points compared to a random distribution. The clusters can be defined based on a fixed or random search distance and a minimum number of points. For this study a random distance was selected and a minimum of 7 points per cluster. The size of the cluster was determined by using a significance level of .01 which insured that only pairs of points with less than 1% chance of being closer than random were included (Levine 2010). The NNH test produced ellipses surrounding the clusters that were visualized in ArcGIS.

Fuzzy Mode

Spatial fuzzy mode was used to find the point in a pattern that has the most other points within a certain distance of it. This is another way of identifying the area in a point pattern with the highest density. For this analysis a distance of 500 meters was selected, thus the point in the pattern with the most other points within 500 meters was considered the fuzzy mode.

Kernel Density Estimation

Kernel density estimation is a method of interpolation for discrete point data that assigns density values to cells in a gridded area based on a kernel function. The kernel function is formed around each point in the dataset and spans a certain width called the bandwidth. The more overlapping kernel functions there are at a certain location the higher the density estimate.

The kernel function can have many shapes including quartic and normal. A quartic kernel function is used here in order to reduce edge effects while maintaining smoothness to the interpolation. The bandwidth can be either a fixed distance or adaptive. An adaptive bandwidth means that the bandwidth changes depending on how tightly clustered the points are. When using adaptive bandwidth a minimum number of points are specified. Each cell in the gridded area is given a density estimate value based on the number of overlapping kernels (Levine 2010). According to the Crimestat Manual (Levine 2010) adaptive bandwidth is preferable because it adapts to local densities rather than applying a global bandwidth to the entire study area. Kernel density estimates were calculated using an adaptive bandwidth and a minimum of 5 points. The Crimestat outputs for all kernel density estimates were shapefiles that were then converted to raster format in ArcGIS (ESRI 2009). All of the decision model point patterns were interpolated to 200 m^2 grids. The pre- and post-Katrina point patterns were interpolated to a 50 m^2 grid so that they would be better suited to the Pearson's correlation coefficient described below.

In addition to visual analysis in a GIS, the density raster datasets were tested for correlation with each other and geographic variables. Pearson's Correlation coefficients were calculated among the pre- and post-Katrina raster datasets, the LiDAR DEMs, and the flood depth raster. In order to perform the correlation coefficient it was necessary to correlate the values of each kernel density cell to a corresponding cell in the flood raster and LiDAR DEMs. This was accomplished by using a regular grid of sample points. Each of the four datasets; pre-Katrina kernel density, post-Katrina kernel density, flood depth and elevation were sampled at the locations of the sample grid points. This required that all of the raster datasets have equal sized cells. To avoid over-generalizing the DEMs and flood data, a smaller cell size was preferable to a larger cell size. At first a 25 m^2 sample grid was attempted but the number of points was too large (561,720 points) for ArcGIS to handle. A 50 m^2 contained only 58,850 points which was small enough to be processed by the software. As a result, the DEM and flood depth datasets had to be re-sampled to a 50 m^2 grid. The product of the sampling routine was a 50 x 50 meter grid of sample points with four values attached to each point. The 58,850 sample locations were then tested for correlations between pre-Katrina density, post-Katrina density, flood depth, and elevation. This point grid was then exported to database format and entered into SPSS (SPSS Inc. 2008) for analysis. Each row of the database represented a geographic location with values for all four variables. To run the Pearson's correlation coefficient a correlation matrix was created for all four variables. Thus each variable was tested for correlation to each of the three other variables.

The 200 m^2 decision model raster datasets were then sampled in the same manner as is described above except using a 200 m^2 point grid. The point grid was then exported to SPSS (SPSS Inc. 2008) to test for Pearson's correlation coefficient between the three layers.

Chapter 3
Results

Decision Models

After a thorough review of the site forms for the 395 archaeological sites included in this project all sites were categorized into pre- and post-Katrina subsets (Figure 5) and assigned to one of the three decision models based on the criteria described above (Figure 6). The research/ preservation category contained 46 sites, 38 of which were recorded before Hurricane Katrina and 8 after Katrina. The development category contained 136 sites, including 95 that were recorded before Hurricane Katrina and 41 recorded after Katrina. The remaining 213 sites comprised the recovery category, all of which were recorded after Katrina. It is interesting to note that the research/ preservation category contained 18 prehistoric sites and 29 historic sites (one of the sites had both prehistoric and historic components). Most of the prehistoric sites in the research/ preservation category were concentrated near the south shore of Lake Pontchartrain while the historic sites were concentrated in the French Quarter and Central Business District. The development category contained only one site with a prehistoric component; namely the Kingsley House site which also had extensive historic deposits. The recovery category did not contain any prehistoric sites. The distribution of development sites was concentrated mainly on the riverfront, the CBD, and the Lower Garden District with a few sites scattered into Mid City. There were 11 development sites in the Lower 9th Ward, all of which were close to the Mississippi River levee. The recovery distribution was concentrated in Central City, Mid City, and New Marigny with the largest concentration in the Lower 9th Ward. Unlike the development

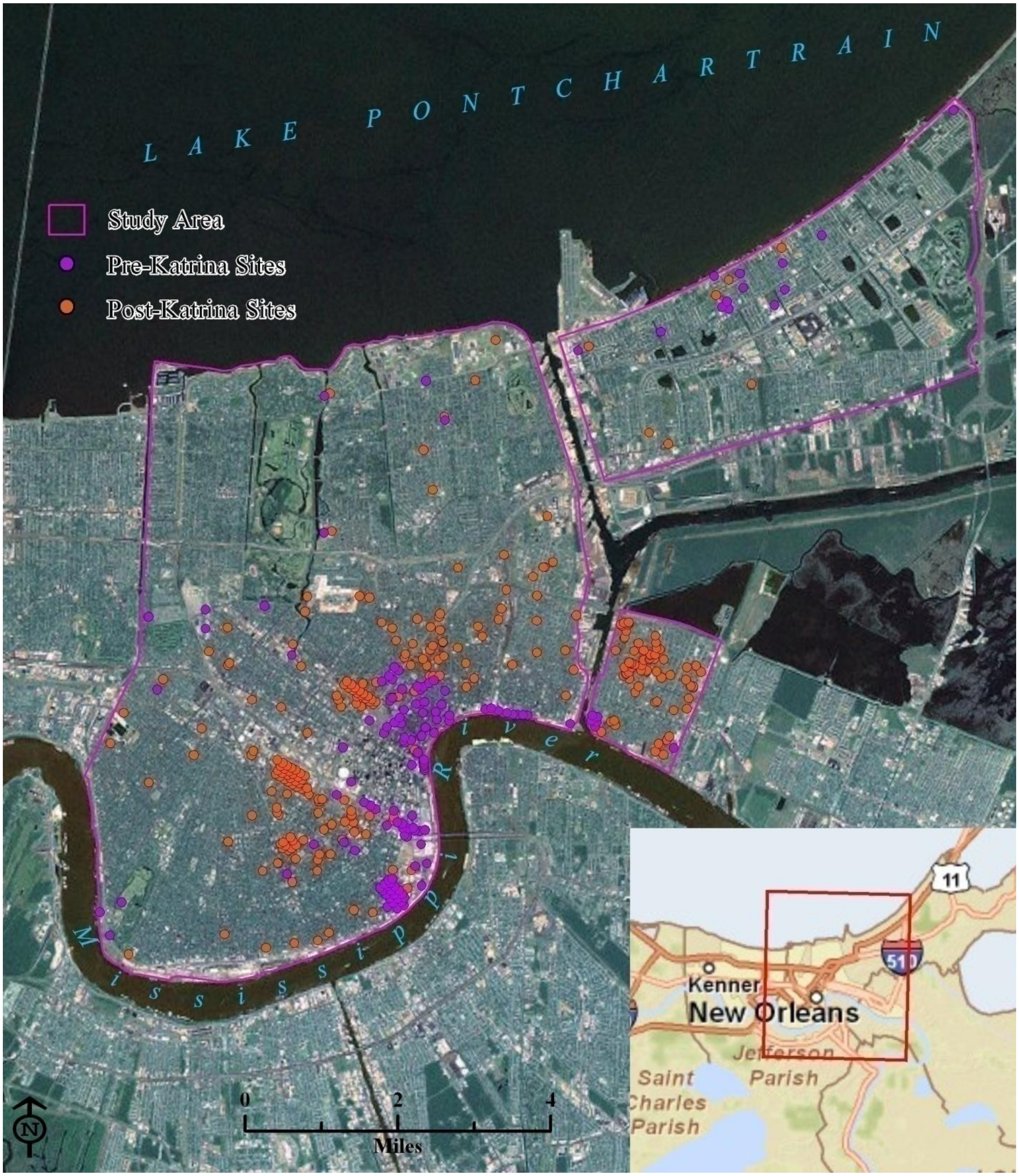

Figure 5. Map showing the division of sites into pre-Katrina and post-Katrina subsets based on date recorded. A visual inspection revealed that pre-Katrina sites are concentrated closer to the Mississippi River in the French Quarter and CBD, while post-Katrina sites are farther away from the river. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

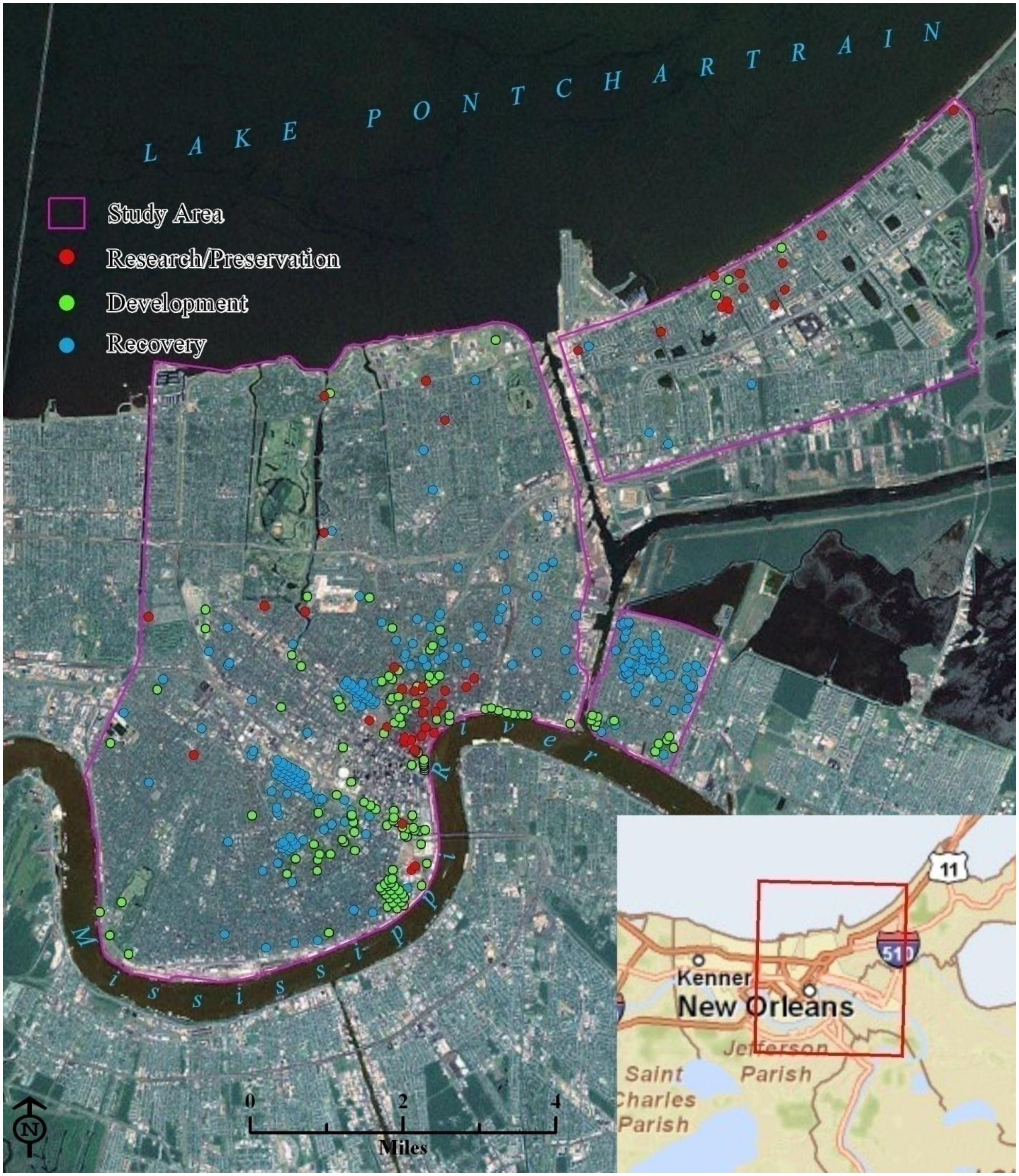

Figure 6. Map showing the categorization of sites based on the three decision model categories including research/preservation, development and recovery. Visual inspection indicated that the three categories were concentrated in geographically different parts of the city. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

sites, the recovery sites were predominantly in the northern section of the Lower 9th Ward away from the Mississippi River Levee.

Upon visual inspection, these site categories appeared to display geographic differences. When the historic and prehistoric research sites were considered separately they were grouped into two very distinct clusters. These clusters included prehistoric sites near the Lake and historic sites near the bend in the river at the French Quarter. The development and recovery categories tend to mirror each other. Both categories follow the course of the Mississippi River however the recovery sites tend to be farther away from the river.

Site Subsets Compared to URS Probability Model

Once the points representing all of the archaeological sites included in this study were divided into the various subsets and categories, GIS overlay and spatial queries were able to define which of these sites are associated with the probability zones as laid out by URS. The probability model was designed specifically for the URS project and was not utilized for other recovery projects, however it was designed to be a probability model for the city of New Orleans and therefore its effectiveness as such should be examined. 92% of the sites included in the pre-Katrina subset were within the high probability zone. This was not surprising since these are the sites that would have been used to create the model. 5% of the pre-Katrina sites were within the moderate probability and 2% in the low probability zone. The post-Katrina subset displayed a drastically different pattern with 33% of the sites are within the high probability, 62% in the moderate, and 5% in the low probability zone. These numbers are strikingly similar to what was reported by URS upon completion of the demolition survey namely 37% high, 56% moderate, and 6% low (Handly 2010). It should be noted that even though the URS/FEMA survey was not the only one taking place after Hurricane Katrina, 152 out of 213 post-Katrina sites were recorded by URS. This suggested that sites were being recorded in similar geographic locations throughout the city during all of the recovery projects.

The inclusion of only 33% of post-Katrina sites in the high probability zone demonstrates that the URS model was not an accurate predictor of areas that would produce the highest site densities. The large percentage of sites was located in the moderate probability, despite its limited land area. In addition, the fact that this zone contained approximately half the amount of monitored demolitions when compared to the high probability zone suggested that future models would need to recognize this area as having a higher probability than previously thought. The results of the low probability zone were likely more in line with the model designers expectations. The low probability zone was large (encompassing 47.9% of the city) and yet it produced very few sites.

The decision model categories also demonstrated interesting correlations when compared to the URS probability model. 89% of the research/preservation sites were located in the high probability zone, 4% in the moderate probability zone, and 7% in the low probability zone. 86% of the development sites were located within the high probability zone, 13% in the moderate and 1% in the low probability zone. 24% of the recovery sites were located within the high probability zone, 70% in the moderate, and 5% in the low probability zone. The high percentage of research sites within the high probability zone is attributable to the theoretical design of the model. As discussed in the introduction, it has long been theorized that sites are most often located on higher elevations such as natural levees. These are the same theories that guide researchers to specific locations to look for sites. The development category also had a large percentage of sites in the high probability zone. This was likely due to a greater number of these sites being in close proximity to the Mississippi River. The riverfront is the portion of New

Orleans that has always sustained the most economic development. As stated by Smith et al. (1983) the riverfront has historically been both the focus of commerce as well as a preferred area for settlement. The recovery category was even slightly more biased towards the moderate probability than what was observed during the URS study. This was likely due to URS's greater appropriation of resources to the high probability zone. What was evident is that sites that were recorded during recovery projects did not conform to the theoretical framework commonly accepted prior to Hurricane Katrina. They also did not conform to predictions of site location that are based on previously recorded sites.

Statistics

Statistical analysis was used to determine if these categories were truly different in the way that they relate to their geographic environment. This is necessary because predictive modeling tends to be heavily reliant on how sites are positioned with respect to terrain. Variables such as elevation and distance to nearest water are generally considered to be good predictors of the presence of archaeological sites.

Pre- versus Post-Katrina

Means were compared in SPSS using independent sample t-tests. The first test compared pre-Katrina mean flood depth and post-Katrina mean flood depth. The pre-Katrina and post-Katrina datasets contained 133 and 262 sites respectively, therefore the degrees of freedom was 394. Mean flood depth for all pre-Katrina sites was .65 feet with a standard deviation of 1.30 feet, while mean flood depth for all post-Katrina sites was 3.06 feet with a standard deviation of 2.15 feet. The two datasets were found to be statistically different in terms of mean flood depth ($p < .001$). Mean elevation for all pre-Katrina sites was 5.98 feet with a standard deviation of

5.80 feet, while mean elevation for all post-Katrina sites was -.07 feet with a standard deviation of 3.17 feet. Post-Katrina sites were found to be statistically different in terms of mean elevation than pre-Katrina sites ($p < .001$).

Decision Model Categories

Mean Elevation

Similarly to the pre and post-Katrina subsets, all of the decision model categories were compared in terms of mean elevation to determine if they were statistically different. The first t-test was a comparison of historic and prehistoric sites within the research/preservation category. Mean elevation for the historic group was 5.25 feet with a standard deviation of 2.89 feet. Mean elevation for the prehistoric group was -2.99 feet with a standard deviation of 4.97 feet. These two groups were found to be statistically different with a p value of < .001.

Table 2. Mean elevation of decision model categories (* the Research/Preservation category contains one site with both historic and prehistoric components)

Category	n	Mean Elevation (ft)	Standard Deviation (ft)
Research/Preservation	46	1.98	5.54
Historic	29*	5.25	2.89
Prehistoric	18*	-2.99	4.97
Development	136	6.05	5.17
Recovery	213	-0.64	2.77
All non-Recovery sites	182	5.02	5.54

The research/preservation category had a mean elevation of 1.98 feet with a standard deviation of 5.54 feet while the development category had a mean elevation of 6.05 feet with a standard deviation of 5.17 feet. The recovery category was much lower in elevation as expected with a mean elevation of -.64 feet with a standard deviation of 2.77 feet. A combination of the research/preservation and development categories which represents all non-recovery sites had a mean elevation of 5.02 feet with a standard deviation of 5.54 feet.

The ANOVA test for difference in mean elevation between the research/preservation, development and recovery categories produced an $F = 109.83$ ($p < .001$). This indicated that at least one of the three categories was different. A Scheffe post-hoc test indicated that all three categories were unique in terms of mean elevation.

Distance to Nearest Water

The research/preservation category had the smallest mean distance because most of the sites were either located near the Mississippi River or near Lake Pontchartrain. The recovery category had the largest mean distance to nearest water (1724 m) out of the three decision models. These results were consistent with the other analysis methods which show that the recovery sites were more likely to be located in the interior of New Orleans than the other two categories.

Table 3. Mean distance to nearest water for decision model categories

Category	n	Mean distance (meters)	Standard Deviation (meters)
Research/Preservation	46	615	453
Development	136	772	643
Recovery	213	1724	678

The ANOVA test for mean distance to nearest water indicated that at least one of the three categories was different ($F = 117.37$, $p < .001$). The Scheffe post-hoc test grouped the research/preservation and development categories as the same but indicated that recovery was different. This indicated that recovery sites were located in different geographical areas in relationship to New Orleans' major water bodies.

Spatial Analysis

Nearest Neighbor Hierarchical Clustering

When the pre and post-Katrina subsets were subjected to NNH some obvious trends in cluster locations were observable. The pre-Katrina subset produced four clusters including two in the French Quarter area, one along the Greater New Orleans Bridge and one that encompassed the former St. Thomas Housing Project in the Lower Garden District. All four were extremely close to the Mississippi River levee. The post-Katrina subset produced eight clusters. Five of the eight post-Katrina clusters were somewhat close to the pre-Katrina clusters however they were farther away from the river and more towards the center of the city. The remaining three post-Katrina clusters were located in the Lower 9th Ward where there were no pre-Katrina clusters (Figure 7).

The research category produced two large very distinct clusters, one near the Lakefront and one in the French Quarter. The development category produced four clusters that were very similar to the pre-Katrina clusters. In addition the recovery category produced six clusters that were similar to the post-Katrina clusters (Figure 8). This was not altogether surprising because the pre-Katrina subset was dominated by development sites (95 of 133), while the post-Katrina subset was dominated by recovery sites (213 of 262).

Fuzzy Mode

The research/preservation f-mode was located at the Cabildo Site (16OR129) in the French Quarter. When historic and prehistoric sites within the research/preservation category were considered separately, the historic f-mode was the Cabildo site. The prehistoric f-mode is one of the Little Woods sites (16OR5) near Lake Pontchartrain. The development f-mode is one of the sites associated with the former St. Thomas Housing Project (16OR162) while the recovery f-mode is in the Lower 9^{th} Ward (16OR415). In each case the fuzzy mode fell within one of the NNH clusters. The clusters indentified high density areas of each distribution however the fuzzy mode confirmed a particular cluster as the highest density of all.

Kernel Density Estimation

The results of the kernel density estimates were visualized in ArcGIS (Figures 9 and 10). They agreed nicely with the NNH analysis with the highest density areas corresponding to NNH clusters. Aside from visual interpretation, the kernel density estimates were also used to quantify spatial patterns for statistical analysis. Table 3 displays the results of a Pearson's correlation matrix between each possible pair of variables within pre-Katrina site density, post-Katrina site density, flood depth, and elevation. As can be expected, flood depth was highly negatively correlated to elevation with an $r = -.77$ ($p = .01$). Pre-Katrina site density was positively correlated to elevation ($r = .31$, $p = .01$). This was likely due to the majority of pre-Katrina sites being in close proximity to the Mississippi River. Pre-Katrina site density was also negatively correlated to flooding ($r = -.246$, $p = .01$). Surprisingly, post-Katrina site density was slightly positively correlated with elevation ($r = .072$, $p = .01$) and slightly negatively correlated to flood depth ($r = -.008$, $p = .054$). This result was unanticipated due to the statistical difference in mean elevation and flood depth.

Figure 7. Map showing pre and post-Katrina NNH clusters and fuzzy modes. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

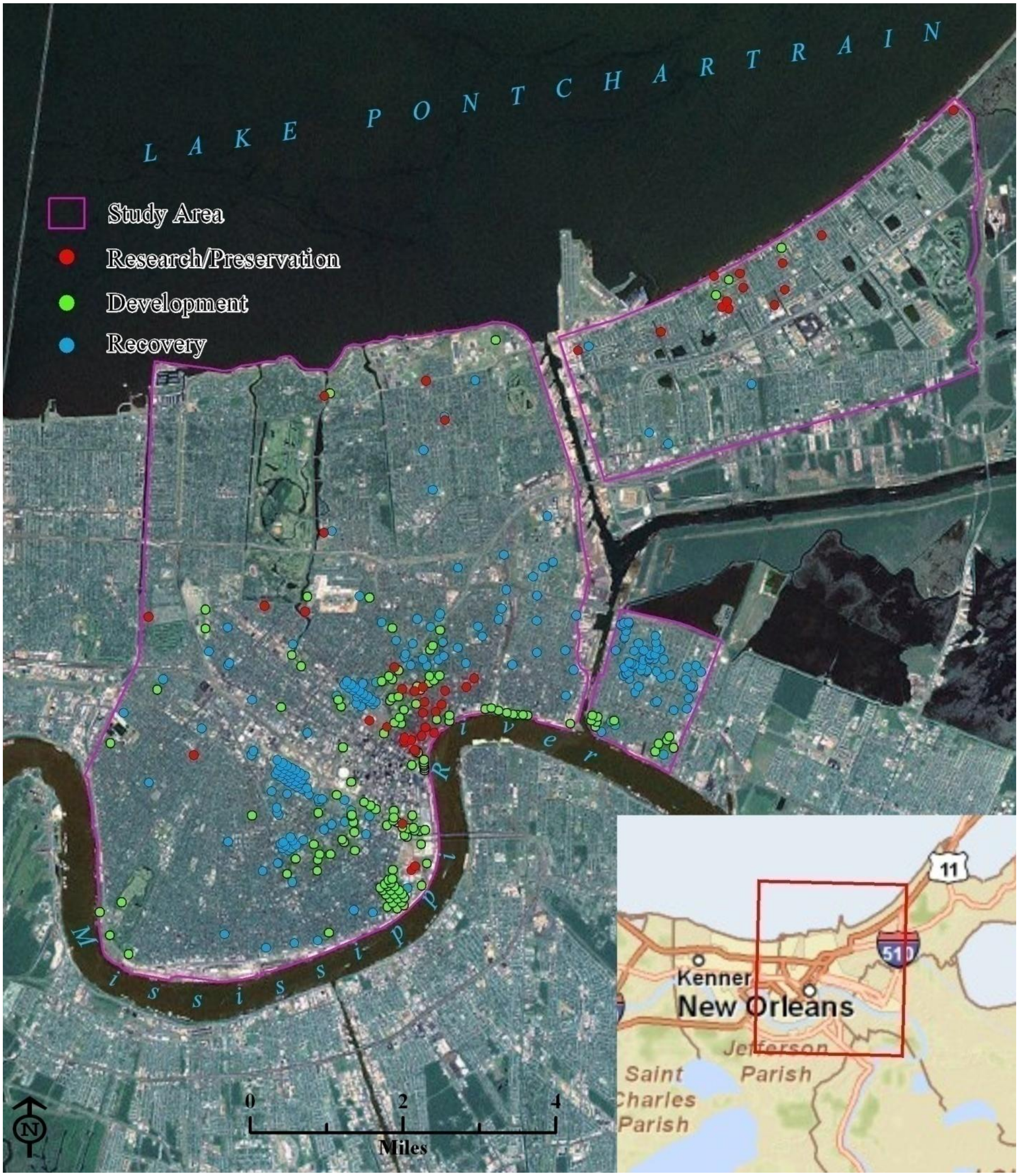

Figure 8. Map showing decision model clusters and fuzzy modes. The research/preservation category was further divided into historic and prehistoric sub-categories. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services

All of the previous statistical tests tended to conform to the hypotheses driving this study; that post-Katrina sites would have a lower elevation and be in areas that were subjected to more intense flooding. Both the NNH clustering and spatial fuzzy mode tests showed that pre-Katrina sites tended to be located farther away from the Mississippi River and away from the natural levee. This tends to place them in areas with a lower elevation and therefore a higher potential for flooding. The kernel density estimates showed the same geographic pattern as the fuzzy mode and NNH. The lack of strong correlation between post-Katrina density and flooding could have been due to the use of the predictive model during the URS project. The model had the tendency to direct more resources to higher elevation areas which neutralized flooding as a guiding agent for site discovery.

The independent sample t-test showed that the two datasets are statistically different in terms of mean elevation and mean flood depth. Despite all of these factors, no correlation was found between post-Katrina site density and flood depth. A possible reason for this is that these variables are locally correlated but the relationships are not uniform across the entire study area. In other words certain sections of the city are behaving differently than others. The Lakefront and New Orleans East are large geographic areas that have few sites pre- or post-Katrina. Both of these areas also tend to be lower in elevation and thus had large degrees of flooding. It is possible that these areas are behaving contrary to the rest of the city in terms of where sites have been recorded post-Katrina. Further Statistical analysis would be needed to explore the differences in relationships between flooding and site depth post-Katrina. These tests would need to investigate if these relationships are unique within certain areas of the city and not in others. The relationship may be continually varying across geographic space; however these questions would have to be addressed in further research efforts.

Figure 9. The quartic kernel density estimates for the pre and post-Katrina subsets are classified by natural breaks (Jenks) into 10 classes. The two lowest density classes for each category are not shown because the values are too low to be significant. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services/

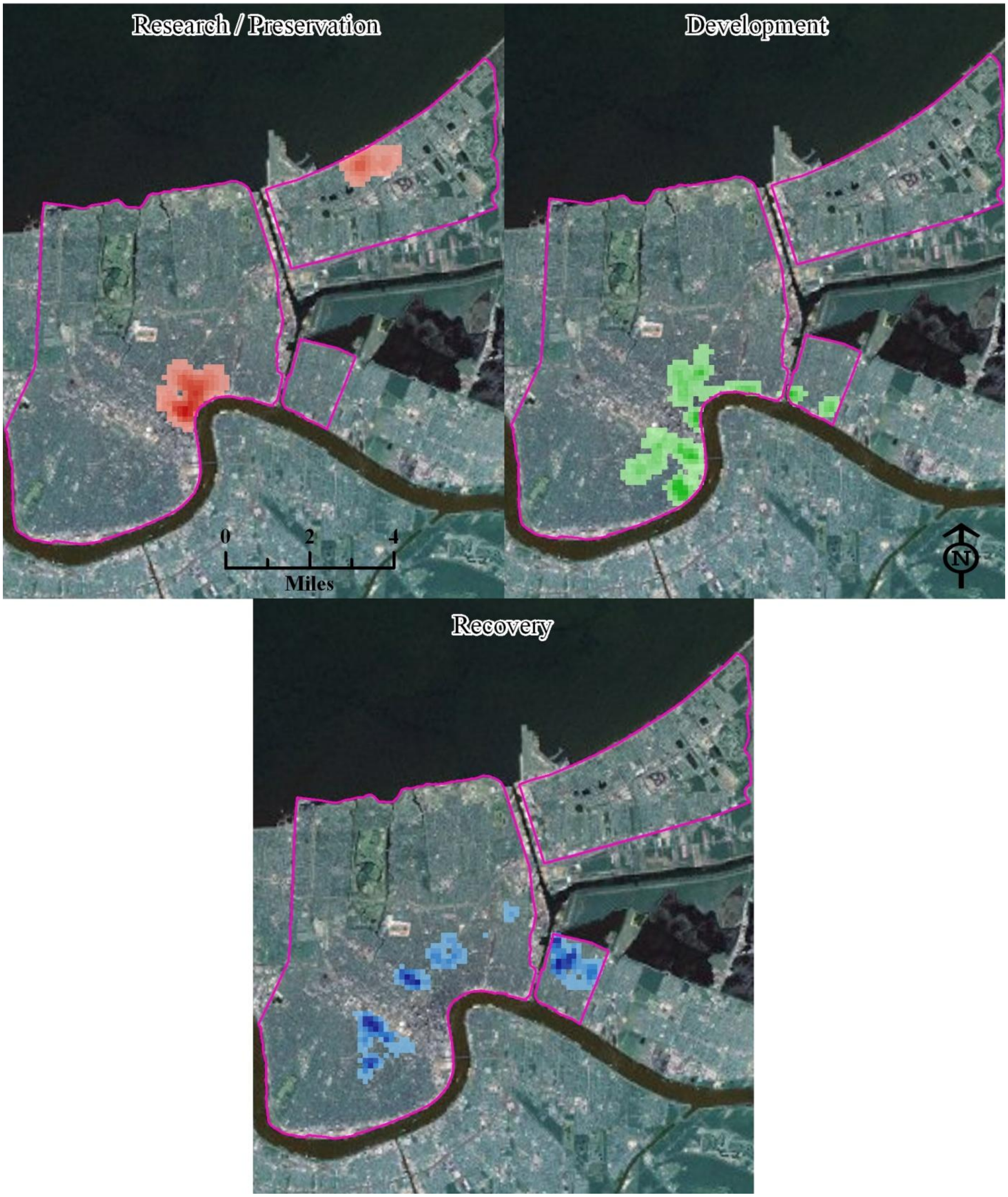

Figure 10. Map showing the results of kernel density estimates for the research/preservation, development, and recovery categories. The quartic kernel density estimates for each of the three decision models are classified by natural breaks (Jenks) into 10 classes. The two lowest density classes for each category are not shown because the values are too low to be significant. Base maps courtesy of ESRI 2010, http://server.arcgisonline.com/arcgis/services/

Table 4. Matrix of Pearson's Correlation coefficients comparing pre-Katrina density, post-Katrina density, flood depth and elevation (n = 58,850)

	Elevation	Pre-Katrina	Post-Katrina
Flood Depth	-.770***	-.246***	-0.008*
Elevation		.310***	.072***
Post-Katrina		.110***	

*. Correlation is significant at the 0.1 level (2-tailed).
***. Correlation is significant at the 0.01 level (2-tailed).

The results of the Pearson's Correlation Coefficient between the three decision model categories indicated were weak at best (Table 4). The only significant correlation was a weak positive correlation between the research/preservation and development categories ($r = .154$, $p < .001$). The recovery category had a weak negative correlation to the research/preservation category ($r = -.008$, $p = .64$) and a weak positive to the development category ($r = .026$, $p = .12$), neither of which were statistically significant.

Table 5. Matrix of Pearson's Correlation coefficients comparing decision model categories (n = 3,467)

Categories	Development	Recovery
Research/ Preservation	.154***	-0.008
Development		0.026

***. Correlation is significant at the 0.01 level (2-tailed).

Chapter 4
Discussion

Initially this thesis was designed to simply investigate the geographic differences between archaeological sites that were recorded before Hurricane Katrina and those recorded after the storm. Since its inception, the project has evolved into research that attempts to explain why sites are recorded in certain locations in the first place. The statistical and spatial analysis comparing pre and post-Katrina subsets indicated that these two groups are different. Most noticeably the post-Katrina sites are located in lower elevation portions of New Orleans than pre-Katrina sites. This is due to many of these sites being recorded as a result of FEMA demolition of flooded properties whereas the pre-Katrina sites were recorded by research and development projects which favored high elevation. While no correlation could be statistically proven between post-Katrina site density and flood depth, the mean flood depth at post-Katrina site locations was statistically greater than at pre-Katrina sites. Likely the lack of correlation was due to too much noise in the dataset in the form of large areas with high flooding and very few sites such as the Lakefront. These areas have the potential to cloud the relationship between flooding and site density. Post-Katrina sites tended to be in areas with greater flood depths; however areas with large amounts of flooding do not necessarily contain sites.

It is possible that the variables pre-Katrina site density, post-Katrina site density, flood depth and elevation had different correlations in different parts of New Orleans. If so, then partitioning the study area into smaller geographic segments may have revealed these different relationships. Another possible method would have been to calculate a geographically weighted regression, which would have shown the strength of correlations at each geographic location.

The only significant correlation between decision model categories was among the research/preservation and development categories. This was likely due to these types of sites often occupying similar geographic areas. In general attempts to find correlations positive or negative between categories in this study were problematic. This is because the correlations were based on spatial relationships between site densities of different categories. Spatially the categories were not different enough to illuminate statistical differences. However geographic differences should not be defined by purely spatial methods. In New Orleans the wedge shape of the landform means that proximity to the Mississippi River and as a result elevation are perhaps more important measures of site location.

What the analysis of pre- and post-Katrina sites indicated is that the Hurricane and federal response have had a significant effect on the geographic distribution of archaeological sites in New Orleans. Spatial analysis methods such as fuzzy mode, NNH and kernel density estimates showed that the distribution of post-Katrina sites is concentrated more in the center of the city and farther away from the Mississippi River. Geographically this means that these sites have moved off of the natural levee and into the formerly swampy interior of New Orleans. These differences have serious implications for the future of predictive modeling in New Orleans. The change in the elevation profile of archaeological sites will change the way high, moderate and low probability zones are defined in the future.

The geographic differences between pre- and post-Katrina sites were also illuminated by the performance of the probability model used by URS when only 37% of the sites recorded during the demolition project fell into the high probability zone. Based on these results it can be assumed that the sites recorded during this project were recorded in unexpected locations.

Future models based on known site location would need to address some of these areas as higher probability that was once thought.

In their paper "Modeling for Management in a Compliance World", Dore and Wandsnider (2006) warned against using the locations of known sites for predictive modeling. They argue that many available data sets are biased by previous survey methodology and will produce a biased model. This certainly seems to be the case in New Orleans. The performance of the model may have been due to archaeologists ignoring the low-lying areas prior to Hurricane Katrina. As a result the model was based on a data set that was biased towards higher elevation portions of the city. Hurricane Katrina along with FEMA survey strategy forced investigations in those low-lying areas of New Orleans and thus sites were discovered where there previously had been none.

The categorization of archaeological sites based on decision models has provided possible explanations as to why sites were recorded in certain locations. Particularly interesting was the further division of the research/preservation category into historic and prehistoric sub-categories. Of all the groupings, these were the most distinct. In terms of elevation they were quite different and spatially they represented two distinct clusters. These two distinct clusters were likely produced by certain researchers focusing on distinct geographical areas. All but one of the prehistoric sites was recorded by 1958 and all but one by four archaeologists: Saucier, Gagliano, Ford and Czajkowski. The one later site (16OR225) was recorded by Shannon Dawdy in 2005; however this was only one prehistoric component of a historic site. It is not likely that Dawdy was seeking to find a prehistoric site in the French Quarter; rather this was an unexpected and welcomed surprise.

Twenty of the 29 historic sites were recorded by four researchers or groups: Andrea White/GNOAP (6), Shannon Dawdy (6), Richard Shenkel (4), Yakubik and Franks/ Earth Search Inc. (4). All of these archaeologists focused their research on historic New Orleans archaeology. The fact that these two sub-categories were so spatially and geographically different demonstrated how the interests of particular researchers can contribute to observed clusters within the overall site distribution. This in turn has the tendency to influence the design of future research by informing investigators about where sites are likely to be found.

Statistical analysis indicated that the three decision model categories were different in terms of mean elevation. This means that different types of investigation have the tendency to produce clusters of sites that are geographically unique. Site elevation was directly related to the position of the site in relationship to the natural levees of the area. The development category had the highest elevation (6.05 ft) of all the categories. This was due to these sites being clustered near the Mississippi River and occupying positions on the crest of the natural levee. These findings were consistent with historic research stating that the Mississippi River has always been the hub of commerce and development since New Orleans was first settled. The research/preservation category was the second highest in elevation (1.98 ft). Interestingly the historic sites had an elevation of 5.25 ft but the prehistoric sites had an elevation of -2.99 ft. Without the prehistoric component, the research/preservation category would be similar to the development category in mean elevation. As stated above the research/preservation category is the product of two realms of archaeological knowledge. The idea that prehistoric people favored the shores of Lake Pontchartrain is exemplified by the prehistoric distribution. Contrarily historic research shows that New Orleans was first inhabited along the natural levee of the Mississippi River which is where the historic sites within the research/preservation category were clustered. The recovery category was the lowest (-.64 ft) which was due to these sites being clustered in the lower interior of the city away from the natural levee. What was interesting about the recovery category was that it defied the accepted theories of archaeological site location. As was discussed in the introduction, some of the recovery sites would not have been considered historic until recently. The floodwaters then destroyed large amounts of architecture in the city which caused so many sites to be recorded in a part of the city that was previously ignored. Due to these factors, the database of known sites in New Orleans must be understood as a product of the types of investigation that led to the discovery of sites. Undoubtedly there are variations in archaeological deposits in different parts of the city but the patterns observed in this thesis were influenced by geographic biases in archaeological investigations.

The most important concept to take away from this research is the relationship between theories about where archaeological sites are located and how they affect the geographical distribution of known sites (Figure 11). Theories are usually based on past research in which deposits were located in certain geographic settings. In the case of New Orleans, the areas with the most sites are the areas that tend to be developed most frequently throughout history. As a result the distribution of known sites tends to conform to a predictable pattern; higher elevation areas on the natural levee of the Mississippi River. This pattern is then reinforced by both the research interests of academic archaeologists and by developers who uncover new finds in similar geographic settings. This process tends to create a general geographic profile of where an archaeological site should be located. Predictive models are often based on just such a geographic pattern and then implemented without validation. Models can then sometimes be self validated by reproducing the same patterns that they were modeled after. In the case of New

Orleans after Katrina, the Hurricane served to break the conventional pattern by directing investigations into neglected areas. By defying the expected pattern, recovery surveys have exposed the biased sampling that has taken place in previous years.

One way to counter some of the bias that exists in the known site database for New Orleans is to fundamentally change the way in which we conceptualize archaeology in the city. In the aftermath of Hurricane Katrina, before the FEMA demolition project began, an alternative research plan was proposed to FEMA. This proposal, prepared by Jason Emory, Shannon Dawdy and Rob Mann, was known as New Orleans Research Proposal for Archaeological Treatment Measures (Emery et al. 2005, Appendix B). It detailed a plan to treat the City of New Orleans as a single archaeological site which could then be investigated to address certain research questions. The proposal suggested seven research themes that could be addressed in particular geographic segments of the city. The proposal was complete with a design for archival research, field methods, laboratory analysis, budgets, and even a time table. Despite the best efforts of those that created it, the proposal was rejected by FEMA in favor of the demolition monitoring project. What was most promising about the proposal was the concept of the single site model of New Orleans. The city has been continually occupied by Europeans for nearly three hundred years. Based on Tchefuncte period archaeological finds it had been occupied by Native American groups for thousands of years before the Europeans arrived. Emery et al. (2005) referred to New Orleans as being "chronologically stratified, both horizontally and vertically" meaning that deposits progress from youngest to oldest as one digs down into the layers and from oldest to youngest radiating out from the river bend at the French Quarter. The single site model viewed in profile would resemble a funnel shape with oldest deposits being at the bottom center and youngest deposits extending to the upper edges (Figure 12).

The real value of the single site model would be the ability of archaeologists to extract meaningful data out of the destruction of a natural disaster. In contrast, the FEMA survey produced little useful data, aside from recording numerous historic features. Typically the goal of any cultural resource project is to determine the significance and NRHP eligibility of an archaeological resource so that it can be properly mitigated. Of the 170 archaeological sites assessed during the URS/FEMA survey, only three were evaluated for eligibility and those three were previously recorded sites. None of the new sites found during the demolition project were evaluated because sub-surface testing was not required. When debris was removed archaeologists noted the presence of features or artifacts and recorded the site but were not required to investigate further. If any future development of an area that includes one of these site locations were to take place the site would have to be re-evaluated to determine the significance of the find (Handly 2010). This means that all the time and money spent monitoring demolitions produced very little in terms of results. Essentially the work will have to be repeated in order to proceed with future development at the location of any of the recorded sites. The URS/FEMA survey was approached from a pure compliance perspective where only the bare minimum of investigation was attempted in order to fulfill the regulations. For a similar sum of money and probably a comparable amount of time, real meaningful research could have been accomplished which would have fulfilled compliance requirements and addressed the question of eligibility. Research questions would also have been addressed in addition to the work being completed to a level that would allow future development.

Based on the geographic bias in archaeological site location reported here and the lack of meaningful data that came out of Katrina, it is the conclusion of this thesis that New Orleans

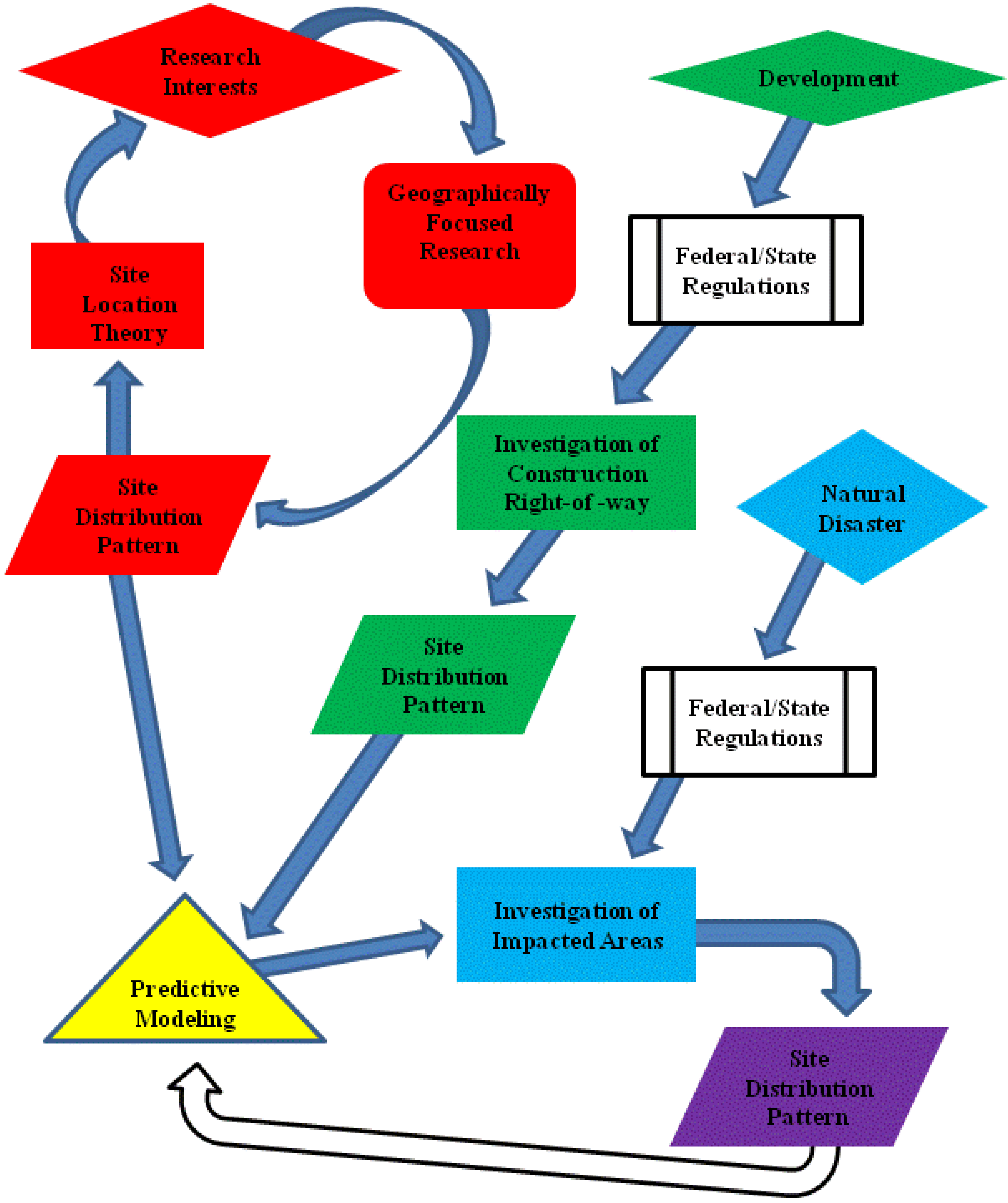

Figure 11. Conceptual model of effects of Decision Models on predictive modeling

should be conceptualized as a single archaeological site in the future. At present many of the limits of archaeological sites in New Orleans seem to be arbitrarily defined. Particularly in the Lower 9th Ward and the former B.W. Cooper and Laffite Housing Developments, there are sites that are literally next door to each other. Archaeological deposits in adjacent lots should certainly be considered as one site. While there are many types of sites, an archaeological site representing the remains of a settlement should include all of the continuous material deposits of that settlement. The argument for New Orleans being a single archaeological site is one of scale and dimension. The archaeologist in southeast Louisiana has been trained to look for archaeological sites on the high crests and flanks of natural levees of the Mississippi River and its distributaries. The single site model argues that the site has already been found. It is called New Orleans.

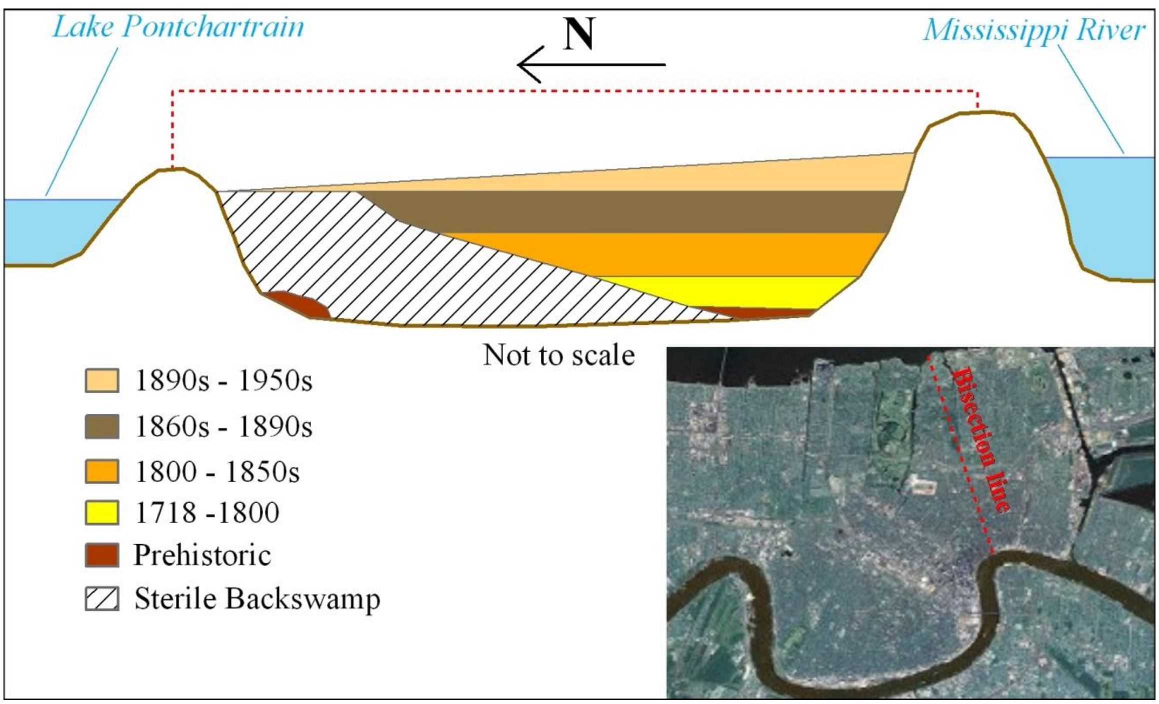

Figure 12. Author's representation of theoretical single site model of New Orleans.

Future Research

Large development projects and future natural disasters will require widespread investigations into the archaeology of New Orleans. Cultural Resource Managers will need to model archaeological potential in order to design studies that can anticipate the significance of deposits in any one area. Archaeologists in New Orleans should move away from so called predictive or probability modeling because it implies that the presence of sites is an uncertainty. When viewing the whole of New Orleans as an archaeological site, sensitivity modeling should be utilized that assumes that deposits are everywhere but attempts to model the depth and significance of those deposits across geographic space. Andrea White of the GNOAP is currently working on a model based primarily on historic maps and archival research that would reflect the depth of deposit and length of occupation at a location. Using GIS overlay of historic resources, locations can be gauged as to their archaeological sensitivity based on the number of cultural contexts that overlap. This type of model could be developed and refined over time as more data emerge, eventually becoming the standard archaeological sensitivity map of New Orleans. Different levels of mitigation could then be instituted based on predetermined sensitivity rankings. Having a generally accepted model in place before a disaster event takes place would avoid the rush and confusion that occurred after Katrina.

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APPENDIX A: STUDY SITES

Pre-Katrina Archaeological Sites

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR001	-6.43	Unknown	Saucier and Gagliano	1957	Research/ Preservation
16OR002	-7.24	Unknown	Ford	1945	Research/ Preservation
16OR003	-3.99	Unknown	Ford	1945	Research/ Preservation
16OR004	-6.54	Unknown	Saucier	1952	Research/ Preservation
16OR005	-5.02	Unknown	Ford	1945	Research/ Preservation
16OR008	-4.44	Unknown	Ford	1945	Research/ Preservation
16OR009	-6.24	Unknown	Czajkowski & Ford	1945	Research/ Preservation
16OR010	-7.56	Unknown	Czajkowski & Ford	1945	Research/ Preservation
16OR015	-1.90	Unknown	Saucier and Gagliano, LSU	1957	Research/ Preservation
16OR019	2.40	NRHP Listed	Saucier	1952	Research/ Preservation
16OR020	-2.20	Unknown	Saucier and Gagliano	1954	Research/ Preservation
16OR024	10.44	Unknown	Gagliano & Saucier, LSU	1951	Research/ Preservation
16OR025	-2.21	Unknown	Saucier, LSU	1958	Research/ Preservation
16OR026	-6.52	Unknown	Saucier, LSU	1958	Research/ Preservation
16OR027	-5.75	Unknown	Saucier & Gagliano, LSU	1957	Research/ Preservation

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR035	-4.65	Not Eligible	Saucier & Gagliano, LSU	1957	Research/ Preservation
16OR036	-3.19	Unknown	Saucier & Gagliano, LSU	1957	Research/ Preservation
16OR045	5.28	Not Determined	Beavers & Lamb	1992	Research/ Preservation
16OR046	6.16	Not Determined	Shenkel	1979	Research/ Preservation
16OR047	2.89	Unknown	Shenkel	1980	Development
16OR048	3.69	Unknown	J. R. Shenkel; UNO	1978	Development
16OR049	8.28	Not Determined	Shannon Dawdy, ESI	1995	Development
16OR051	7.24	NRHP Listed	Shenkel	1971	Research/ Preservation
16OR052	8.51	NRHP Listed	Castille/ Gibbens	1978	Development
16OR062	4.57	Unknown	J. R. Shenkel	1979	Research/ Preservation
16OR063	3.81	Unknown	Christovich and Evans	1977	Development
16OR064	4.17	Not Eligible	Christovich, Evan, Toledano	1977	Development
16OR067	9.90	NRHP Listed	J. Richard Shenkel	1981	Research/ Preservation
16OR069	9.08	Unknown	G. Castille	1981	Development
16OR072	4.78	NRHP Listed	Emily H. Vincent	1981	Research/ Preservation
16OR073	1.83	NRHP Listed	Marjorie Friedman	1982	Research/ Preservation
16OR074	10.73	Unknown	George Castille	1984	Development
16OR075	15.55	Unknown	CEI, Inc.	1984	Development
16OR076	12.13	Declared Eligible	CEI, Inc.	1984	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR077	10.68	Unknown	CEI, Inc.	1984	Development
16OR078	9.34	Declared Eligible	CEI, Inc.	1984	Development
16OR079	9.44	Declared Eligible	CEI, Inc.	1983	Development
16OR080	7.64	Unknown	CEI, Inc.	1983	Development
16OR081	10.10	Declared Eligible	CEI, Inc.	1983	Development
16OR082	6.83	Unknown	CEI, Inc.	1983	Development
16OR083	6.53	Unknown	CEI, Inc.	1984	Development
16OR084	4.55	Unknown	CEI, Inc.	1983	Development
16OR085	3.88	Declared Eligible	CEI, Inc.	1983	Development
16OR086	-1.17	Unknown	CEI, Inc.	1983	Development
16OR087	12.76	Unknown	CEI, Inc.	1983	Development
16OR088	2.30	Unknown	CEI, Inc.	1983	Development
16OR089	5.84	Unknown	CEI, Inc.	1984	Development
16OR092	4.11	Not Eligible	C. Orser	1984	Development
16OR095	0.40	NRHP Listed	Susan D. deFrance	1984	Research/ Preservation
16OR096	13.10	Unknown	Gendel/Goodwin	1983	Development
16OR098	13.07	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR099	12.54	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR100	12.16	Not Eligible	Christopher Goodwin & Assoc.	1985	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR101	12.01	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR102	12.44	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR103	12.42	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR104	16.49	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR105	9.65	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR106	10.26	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR107	12.66	Not Eligible	Christopher Goodwin & Assoc.	1985	Development
16OR108	1.22	Unknown	Beavers, Lamb & Greene	1985	Development
16OR109	17.83	Not Eligible	Carol J. Poplin	1987	Development
16OR110	18.20	Not Eligible	Carol J. Poplin	1987	Development
16OR111	15.82	Not Eligible	Carol J. Poplin	1987	Development
16OR112	11.99	Not Eligible	Carol J. Poplin	1987	Development
16OR113	18.37	Not Eligible	Carol J. Poplin	1987	Development
16OR114	18.44	Not Eligible	Carol J. Poplin	1987	Development
16OR115	1.09	Not Eligible	Mary Manhein	1987	Development
16OR116	11.86	Potentially Significant	Goodwin & Associates	1987	Development
16OR117	13.60	Not Eligible	Kenneth R. Jones, ESI	1991	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR126	2.44	Unknown	Earth Search(Yakubik&Franks)	1989	Research/ Preservation
16OR127	6.21	Not Eligible	Earth Search(Yakubik&Franks)	1989	Development
16OR128	8.99	Potentially Significant	Elizabeth M. Boggess	1990	Development
16OR129	8.00	Not determined	H.A. Franks	1990	Research/ Preservation
16OR130	6.90	Declared Eligible	Jill-Karen Yakubik	1991	Development
16OR131	6.38	Declared Eligible	Jill-Karen Yakubik	1991	Development
16OR132	5.57	Declared Eligible	Jill-Karen Yakubik	1991	Development
16OR133	4.81	Declared Eligible	Jill-Karen Yakubik	1991	Development
16OR134	5.70	Declared Eligible	Jill-Karen Yakubik	1991	Development
16OR135	2.74	Not Eligible	Herschel A. Franks	1991	Development
16OR136	6.48	Not determined	Jill-Karen Yakubik,Earth Search	1991	Research/ Preservation
16OR138	6.31	Not determined	Kenneth R. Jones (ESI)	1994	Development
16OR139	3.95	Potentially Significant	Rebecca Saunders	1993	Research/ Preservation
16OR140	5.45	Potentially Significant	Shannon Lee Dawdy	1996	Research/ Preservation
16OR141	6.79	Potentially Significant	Shannon Lee Dawdy	1996	Research/ Preservation
16OR142	3.28	Declared Eligible	Aubra L. Lee	1997	Research/ Preservation
16OR144	10.88	Unknown	Shannon Lee Dawdy	1997	Research/ Preservation
16OR145	0.93	Not Eligible	Aubra L. Lee	1997	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR146	3.69	Not Eligible	Shannon Lee Dawdy	1998	Research/ Preservation
16OR147	6.13	Unknown	Christopher N. Matthews	1998	Research/ Preservation
16OR148	3.73	Unknown	Shannon Lee Dawdy	2002	Research/ Preservation
16OR152	-2.47	Not Eligible	Michael Godzinski	1999	Development
16OR153	7.33	Potentially Significant	D. Ryan Gray	2001	Development
16OR154	8.91	Potentially Significant	D. Ryan Gray	2001	Development
16OR155	9.01	Potentially Significant	D. Ryan Gray	2001	Development
16OR156	7.51	Potentially Significant	D. Ryan Gray	2001	Development
16OR157	7.66	Potentially Significant	D. Ryan Gray	2001	Development
16OR158	7.58	Declared Eligible	D. Ryan Gray	2001	Development
16OR159	9.22	Declared Eligible	D. Ryan Gray	2001	Development
16OR160	7.15	Declared Eligible	D. Ryan Gray	2001	Development
16OR161	9.10	Declared Eligible	D. Ryan Gray	2001	Development
16OR162	9.50	Declared Eligible	D. Ryan Gray	2001	Development
16OR163	9.80	Declared Eligible	D. Ryan Gray	2001	Development
16OR164	8.45	Declared Eligible	D. Ryan Gray	2001	Development
16OR165	8.04	Declared Eligible	D. Ryan Gray	2001	Development
16OR166	8.58	Declared Eligible	D. Ryan Gray	2001	Development
16OR167	8.93	Declared Eligible	D. Ryan Gray	2001	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR168	6.64	Declared Eligible	D. Ryan Gray	2001	Development
16OR169	7.47	Not Eligible	Malcolm Shuman	2001	Development
16OR170	13.36	Declared Eligible	D. Ryan Gray	2001	Development
16OR171	10.27	Potentially Significant	D. Ryan Gray	2001	Development
16OR172	3.19	Declared Eligible	Rhonda L. Smith	2002	Development
16OR173	3.10	Declared Eligible	Rhonda L. Smith	2002	Development
16OR174	2.37	Potentially Significant	Michael Godzinski	2002	Development
16OR175	1.32	Declared Eligible	J. Richard Shenkel and J. Ibanez	2003	Development
16OR176	7.80	Potentially Significant	R. Steven Kidd	2003	Development
16OR177	10.99	Declared Eligible	D. Ryan Gray	2003	Development
16OR178	10.63	Declared Eligible	D. Ryan Gray	2003	Development
16OR179	1.69	NRHP listed	Melissa R. Braud	2003	Research/ Preservation
16OR180	1.47	Declared Eligible	Earth Search Inc.	2003	Development
16OR181	17.41	Not Eligible	R. Christopher Goodwin and Associates	2004	Development
16OR182	3.56	Potentially Significant	D. Ryan Gray	2004	Development
16OR183	0.92	Declared Eligible	D. Ryan Gray	2004	Development
16OR184	1.65	Declared Eligible	D. Ryan Gray	2004	Development
16OR185	-0.20	Potentially Significant	D. Ryan Gray	2004	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR186	3.27	Unknown	D. Ryan Gray	2004	Development
16OR187	3.31	Declared Eligible	D. Ryan Gray	2004	Development
16OR188	1.63	Unknown	D. Ryan Gray	2004	Development
16OR208	1.79	Not Eligible		2004	Development
16OR209	11.13	Declared Eligible	Jason Emery	2004	Research/ Preservation
16OR210	5.20	Declared Eligible	D. Ryan Gray	2004	Development
16OR211	6.69	Not Eligible	Earth Search Inc.	2005	Development
16OR212	3.48	Declared Eligible	A. Kraushaar and D. Morgan	2005	Development

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Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR213	4.85	Unknown	D. Ryan Gray	2005	Recovery
16OR214	-1.34	Not Eligible	D. Ryan Gray	2005	Recovery
16OR215	1.23	Unknown	J. Cramer (CEI)	2005	Recovery
16OR216	10.33	Declared Eligible	D. Ryan Gray	2006	Recovery
16OR217	1.58	Not Eligible	Douglass Wells	2006	Recovery
16OR218	13.51	Unknown		2006	Development
16OR219	3.48	Not Eligible	ESI	2006	Development
16OR220	2.11	Not Eligible	Donald G. Hunter	2006	Recovery
16OR221	9.09	Declared Eligible	D. Ryan Gray	2006	Development
16OR222	-1.81	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR223	-1.66	Unknown	Sharla C. Azizi	2006	Recovery
16OR224	2.96	NRHP Listed	Andrea White	2005	Research/ Preservation
16OR225	7.22	Declared Eligible	Shannon L. Dawdy	2005	Research/ Preservation
16OR227	-0.42	Unknown	Kevin Mock, Jason Emery and Cesar Rodriquez	2006	Recovery
16OR228	-1.91	Unknown	Sharla C. Azizi	2006	Recovery
16OR229	-3.67	Unknown	Sharla C. Azizi	2006	Recovery
16OR230	-2.12	Unknown	Sharla C. Azizi	2006	Recovery
16OR231	-0.71	Unknown	Sharla C. Azizi	2006	Recovery
16OR232	-4.43	Unknown	Sharla C. Azizi	2006	Recovery
16OR233	-3.62	Unknown	Sharla C. Azizi	2006	Recovery
16OR234	-3.55	Unknown	Sharla C. Azizi	2006	Recovery
16OR235	-3.49	Unknown	Sharla C. Azizi	2006	Recovery
16OR236	0.18	Unknown	Sharla C. Azizi	2006	Recovery
16OR237	-2.61	Unknown	Sharla C. Azizi	2006	Recovery
16OR238	-2.05	Unknown	Sharla C. Azizi	2006	Recovery
16OR239	-3.56	Unknown	Sharla C. Azizi	2006	Recovery
16OR240	-0.75	Unknown	Sharla C. Azizi	2006	Recovery
16OR241	-0.36	Unknown	Sharla C. Azizi	2006	Recovery
16OR242	-1.15	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR243	6.65	Unknown	Sharla C. Azizi	2006	Recovery
16OR244	-0.64	Unknown	Sharla C. Azizi	2006	Recovery
16OR245	8.21	Unknown	Sharla C. Azizi	2006	Recovery
16OR246	1.69	Unknown	Sharla C. Azizi	2006	Recovery
16OR247	-0.91	Unknown	Sharla C. Azizi	2006	Recovery
16OR249	4.50	Unknown	Sharla C. Azizi	2006	Recovery
16OR250	1.21	Unknown	Sharla C. Azizi	2006	Recovery
16OR251	1.17	Unknown	Sharla C. Azizi	2006	Recovery
16OR252	0.79	Unknown	Sharla C. Azizi	2006	Recovery
16OR253	-2.36	Unknown	Sharla C. Azizi	2006	Recovery
16OR254	-2.62	Unknown	Sharla C. Azizi	2006	Recovery
16OR255	-0.98	Unknown	Sharla C. Azizi	2006	Recovery
16OR256	4.81	Unknown	Sharla C. Azizi	2006	Recovery
16OR257	-4.06	Unknown	Sharla C. Azizi	2006	Recovery
16OR258	-3.44	Unknown	Sharla C. Azizi	2006	Recovery
16OR259	2.84	Potentially Significant	Dennis Jones	2007	Research/ Preservation
16OR260	0.71	Potentially Significant	Dale Wolke, Greg Moore and Jarame Cramer	2007	Recovery
16OR261	6.81	Declared Eligible	D. Ryan Gray	2007	Development
16OR262	6.72	Declared Eligible	D. Ryan Gray	2007	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR263	-2.60	Not Eligible	Sarah Paulson	2008	Recovery
16OR265	-2.19	Not Eligible	Sarah Paulson	2008	Recovery
16OR266	-2.99	Not Eligible	Sarah Paulson	2008	Recovery
16OR267	-2.68	Not Eligible	Sarah Paulson	2008	Recovery
16OR268	-2.88	Not Eligible	Sarah Paulson	2008	Recovery
16OR269	1.76	Not Eligible	Sarah Paulson	2008	Recovery
16OR270	0.78	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR271	-0.77	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR272	-1.65	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR273	-0.68	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR274	0.22	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR275	-0.22	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR276	0.48	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR277	-0.66	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR278	-1.40	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR279	-1.22	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR280	0.75	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR281	-1.62	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR282	-2.43	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR283	-0.77	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR284	-0.81	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR285	-1.47	Not Eligible	Sarah Paulson	2008	Recovery
16OR286	-3.62	Not Eligible	Sarah Paulson	2008	Recovery
16OR287	-1.79	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR288	-3.46	Not Eligible	Sarah Paulson, Anthony White	2009	Recovery
16OR289	0.79	Potentially Significant	Michael Godzinski	2008	Recovery
16OR290	-0.02	Potentially Significant	Michael Godzinski	2008	Recovery
16OR291	0.04	Potentially Significant	Michael Godzinski	2008	Recovery
16OR292	0.63	Potentially Significant	Michael Godzinski	2008	Recovery
16OR293	0.05	Potentially Significant	Michael Godzinski	2008	Recovery
16OR294	-0.40	Potentially Significant	Michael Godzinski	2008	Recovery
16OR295	0.06	Potentially Significant	Michael Godzinski	2008	Recovery
16OR296	-0.68	Potentially Significant	Michael Godzinski	2008	Recovery
16OR297	0.06	Potentially Significant	Michael Godzinski	2008	Recovery
16OR298	-0.98	Not Eligible	Michael Godzinski	2009	Recovery
16OR299	-1.25	Potentially Significant	Michael Godzinski	2009	Recovery
16OR300	-0.80	Declared Eligible	Anthony White	2009	Recovery
16OR301	-0.77	Not Eligible	Anthony White	2009	Recovery
16OR302	-1.10	Not Eligible	Anthony White	2009	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR303	-1.14	Declared Eligible	Anthony White	2009	Recovery
16OR304	-0.79	Declared Eligible	Aidan McCarty	2009	Recovery
16OR305	-1.85	Declared Eligible	Michael Godzinski	2009	Recovery
16OR306	-1.44	Declared Eligible	Aidan McCarty	2009	Recovery
16OR307	-1.98	Declared Eligible	Aidan McCarty	2009	Recovery
16OR308	-0.92	Declared Eligible	Aidan McCarty	2009	Recovery
16OR309	-1.44	Declared Eligible	Aidan McCarty	2009	Recovery
16OR310	-0.54	Declared Eligible	Aidan McCarty	2009	Recovery
16OR311	-0.88	Declared Eligible	Aidan McCarty	2009	Recovery
16OR312	0.30	Declared Eligible	Aidan McCarty	2009	Recovery
16OR313	-1.96	Declared Eligible	Michael Godzinski	2009	Recovery
16OR316	5.57	Unknown	Sharla C. Azizi	2006	Recovery
16OR317	-1.62	Unknown	Sharla C. Azizi	2006	Recovery
16OR318	-2.13	Unknown	Sharla C. Azizi	2006	Recovery
16OR319	0.18	Unknown	Sharla C. Azizi	2006	Recovery
16OR320	-1.15	Unknown	Sharla C. Azizi	2006	Recovery
16OR321	7.22	Unknown	Sharla C. Azizi	2006	Recovery
16OR322	-1.72	Unknown	Sharla C. Azizi	2006	Recovery
16OR323	-4.34	Unknown	Sharla C. Azizi	2006	Recovery
16OR324	-7.55	Unknown	Sharla C. Azizi	2006	Recovery
16OR325	0.91	Unknown	Sharla C. Azizi	2006	Recovery
16OR326	0.21	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR327	-2.22	Unknown	Sharla C. Azizi	2006	Recovery
16OR328	10.18	Unknown	Sharla C. Azizi	2006	Recovery
16OR329	-2.69	Unknown	Sharla C. Azizi	2006	Recovery
16OR330	0.20	Unknown	Sharla C. Azizi	2006	Recovery
16OR331	-0.07	Unknown	Sharla C. Azizi	2006	Recovery
16OR332	0.33	Unknown	Sharla C. Azizi	2006	Recovery
16OR334	-0.11	Unknown	Sharla C. Azizi	2006	Recovery
16OR335	-1.40	Unknown	Sharla C. Azizi	2006	Recovery
16OR336	-1.43	Unknown	Sharla C. Azizi	2006	Recovery
16OR337	-4.81	Unknown	Sharla C. Azizi	2006	Recovery
16OR338	-4.07	Unknown	Sharla C. Azizi	2006	Recovery
16OR339	-4.92	Unknown	Sharla C. Azizi	2006	Recovery
16OR340	-3.38	Unknown	Sharla C. Azizi	2006	Recovery
16OR341	0.43	Unknown	Sharla C. Azizi	2006	Recovery
16OR342	-6.12	Unknown	Sharla C. Azizi	2006	Recovery
16OR343	-5.34	Unknown	Sharla C. Azizi	2006	Recovery
16OR344	-6.16	Unknown	Sharla C. Azizi	2006	Recovery
16OR345	-6.93	Unknown	Sharla C. Azizi	2006	Recovery
16OR346	-3.33	Unknown	Sharla C. Azizi	2006	Recovery
16OR347	-3.30	Unknown	Sharla C. Azizi	2006	Recovery
16OR348	-3.80	Unknown	Sharla C. Azizi	2006	Recovery
16OR349	0.55	Unknown	Sharla C. Azizi	2006	Recovery
16OR350	-2.91	Unknown	Sharla C. Azizi	2006	Recovery
16OR351	-2.26	Unknown	Sharla C. Azizi	2006	Recovery
16OR352	-2.54	Unknown	Sharla C. Azizi	2006	Recovery
16OR353	-1.47	Unknown	Sharla C. Azizi	2006	Recovery
16OR354	-3.46	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR355	8.97	Unknown	Gareth Foster, Andrea White	2008	Research/ Preservation
16OR356	1.65	Unknown	Sharla C. Azizi	2006	Recovery
16OR357	-1.45	Unknown	Sharla C. Azizi	2006	Recovery
16OR358	-3.22	Unknown	Sharla C. Azizi	2006	Recovery
16OR359	-1.06	Unknown	Sharla C. Azizi	2006	Recovery
16OR360	-2.97	Unknown	Sharla C. Azizi	2006	Recovery
16OR361	-1.85	Unknown	Sharla C. Azizi	2006	Recovery
16OR362	-0.12	Unknown	Sharla C. Azizi	2006	Recovery
16OR363	-1.40	Unknown	Sharla C. Azizi	2006	Recovery
16OR364	1.22	Unknown	Sharla C. Azizi	2006	Recovery
16OR365	-0.66	Unknown	Sharla C. Azizi	2006	Recovery
16OR366	0.26	Unknown	Sharla C. Azizi	2006	Recovery
16OR367	0.80	Unknown	Sharla C. Azizi	2006	Recovery
16OR368	5.64	Unknown	Sharla C. Azizi	2006	Recovery
16OR369	-4.61	Unknown	Sharla C. Azizi	2006	Recovery
16OR370	-5.54	Unknown	Sharla C. Azizi	2006	Recovery
16OR371	-1.99	Unknown	Sharla C. Azizi	2006	Recovery
16OR372	-1.87	Unknown	Sharla C. Azizi	2006	Recovery
16OR373	-0.68	Unknown	Sharla C. Azizi	2006	Recovery
16OR374	-2.90	Unknown	Sharla C. Azizi	2006	Recovery
16OR375	-2.65	Unknown	Sharla C. Azizi	2006	Recovery
16OR376	-3.49	Unknown	Sharla C. Azizi	2006	Recovery
16OR377	-2.53	Unknown	Sharla C. Azizi	2006	Recovery
16OR378	-1.02	Unknown	Sharla C. Azizi	2006	Recovery
16OR379	0.79	Unknown	Sharla C. Azizi	2006	Recovery
16OR380	0.16	Unknown	Sharla C. Azizi	2006	Recovery
16OR381	-0.84	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR382	-0.70	Unknown	Sharla C. Azizi	2006	Recovery
16OR383	-4.67	Unknown	Sharla C. Azizi	2006	Recovery
16OR384	-0.09	Unknown	Sharla C. Azizi	2006	Recovery
16OR385	2.65	Unknown	Sharla C. Azizi	2006	Recovery
16OR386	8.37	Unknown	Sharla C. Azizi	2006	Recovery
16OR387	-0.21	Unknown	Sharla C. Azizi	2006	Recovery
16OR388	-0.52	Unknown	Sharla C. Azizi	2006	Recovery
16OR389	1.39	Unknown	Sharla C. Azizi	2006	Recovery
16OR390	1.02	Unknown	Sharla C. Azizi	2006	Recovery
16OR391	-2.41	Unknown	Sharla C. Azizi	2006	Recovery
16OR392	-0.56	Unknown	Sharla C. Azizi	2006	Recovery
16OR393	0.67	Unknown	Sharla C. Azizi	2006	Recovery
16OR394	-1.37	Unknown	Sharla C. Azizi	2006	Recovery
16OR395	-2.85	Unknown	Sharla C. Azizi	2006	Recovery
16OR396	0.31	Unknown	Sharla C. Azizi	2006	Recovery
16OR397	-2.26	Unknown	Sharla C. Azizi	2006	Recovery
16OR398	0.32	Unknown	Sharla C. Azizi	2006	Recovery
16OR399	-3.07	Unknown	Sharla C. Azizi	2006	Recovery
16OR400	-1.38	Unknown	Sharla C. Azizi	2006	Recovery
16OR401	-0.53	Unknown	Sharla C. Azizi	2006	Recovery
16OR402	4.35	Unknown	Sharla C. Azizi	2006	Recovery
16OR403	-0.36	Unknown	Sharla C. Azizi	2006	Recovery
16OR404	2.16	Unknown	Sharla C. Azizi	2006	Recovery
16OR405	0.35	Unknown	Sharla C. Azizi	2006	Recovery
16OR406	7.61	Unknown	Sharla C. Azizi	2006	Recovery
16OR407	-1.64	Unknown	Sharla C. Azizi	2006	Recovery
16OR408	-0.34	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR409	-1.86	Unknown	Sharla C. Azizi	2006	Recovery
16OR411	3.04	Unknown	Sharla C. Azizi	2006	Recovery
16OR412	-3.55	Unknown	Sharla C. Azizi	2006	Recovery
16OR413	2.03	Unknown	Sharla C. Azizi	2006	Recovery
16OR414	1.60	Unknown	Sharla C. Azizi	2006	Recovery
16OR415	-1.12	Unknown	Sharla C. Azizi	2006	Recovery
16OR416	1.17	Unknown	Sharla C. Azizi	2006	Recovery
16OR417	-0.29	Unknown	Sharla C. Azizi	2006	Recovery
16OR418	0.43	Unknown	Sharla C. Azizi	2006	Recovery
16OR419	0.96	Unknown	Sharla C. Azizi	2006	Recovery
16OR420	1.05	Unknown	Sharla C. Azizi	2006	Recovery
16OR421	-0.70	Unknown	Sharla C. Azizi	2006	Recovery
16OR422	0.25	Unknown	Sharla C. Azizi	2006	Recovery
16OR423	-2.07	Unknown	Sharla C. Azizi	2006	Recovery
16OR424	-1.61	Unknown	Sharla C. Azizi	2006	Recovery
16OR425	-2.03	Unknown	Sharla C. Azizi	2006	Recovery
16OR426	-2.70	Unknown	Sharla C. Azizi	2006	Recovery
16OR430	1.79	Unknown	Sharla C. Azizi	2006	Recovery
16OR431	2.96	Unknown	Sharla C. Azizi	2006	Recovery
16OR432	-0.82	Unknown	Sharla C. Azizi	2006	Recovery
16OR433	0.94	Unknown	Sharla C. Azizi	2006	Recovery
16OR434	0.23	Unknown	Sharla C. Azizi	2006	Recovery
16OR435	1.54	Unknown	Sharla C. Azizi	2006	Recovery
16OR436	-1.65	Unknown	Sharla C. Azizi	2006	Recovery
16OR437	-2.17	Unknown	Sharla C. Azizi	2006	Recovery
16OR438	4.73	Unknown	Sharla C. Azizi	2006	Recovery

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR439	-0.06	Unknown	Sharla C. Azizi	2006	Recovery
16OR440	-0.73	Unknown		2006	Recovery
16OR441	-2.30	Unknown	Matt DeLoof	2008	Recovery
16OR444	-4.56	Not Eligible	Katy Guyon & Danielle Wheeler	2008	Development
16OR445	-2.89	Unknown	Katy guyon & Tyler Leben	2008	Development
16OR446	-1.93	Not Eligible	N. Heller & Katy Guyon	2008	Development
16OR448	-0.36	Potentially Significant	N. Heller & Katy Guyon	2008	Development
16OR455	1.63	Potentially Significant	Justin Bradshaw	2009	Development
16OR456	3.85	Unknown	Justin Bradshaw	2009	Development
16OR457	2.47	Not Eligible	Justin Bradshaw	2009	Development
16OR458	1.75	Not Eligible	Justin Bradshaw	2009	Development
16OR459	2.95	Not Eligible	Justin Bradshaw	2009	Development
16OR460	1.04	Not Eligible	Justin Bradshaw	2009	Development
16OR461	0.74	Potentially Significant	Justin Bradshaw	2009	Development
16OR462	2.90	Potentially Significant	Justin Bradshaw	2009	Development
16OR463	3.84	Not Eligible	Justin Bradshaw	2009	Development
16OR464	2.19	Unknown	Justin Bradshaw	2009	Development
16OR465	7.25	Potentially Significant	Justin Bradshaw	2009	Development
16OR466	4.14	Not Eligible	Andrea White, Greater New Orleans Archaeology Program	2008	Research/ Preservation
16OR467	8.09	Declared Eligible	Andrea White, Greater New Orleans Archaeology Program	2009	Research/ Preservation

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR468	3.67	Unknown	Andrea White, Greater New Orleans Archaeology Program	2008	Research/ Preservation
16OR469	0.58	Unknown	Andrea White, Greater New Orleans Archaeology Program	2008	Research/ Preservation
16OR470	0.86	Unknown	Justin Bradshaw	2009	Development
16OR471	-2.84	Unknown	CEI	2009	Recovery
16OR499	2.35	Declared Eligible	Michael Godzinski	2009	Development
16OR500	-0.06	Not Eligible	Harry Brignac, Jr.	2009	Development
16OR501	2.41	Potentially Significant	D. Ryan Gray	2009	Development
16OR513	0.27	Potentially Significant	Michael Godzinski	2009	Development
16OR514	8.00	Unknown	M. Wilder (FEMA)	2009	Recovery
16OR515	3.71	Not Eligible	Lucinda Freeman	2009	Development
16OR516	5.40	Not Eligible	Lucinda Freeman	2009	Development
16OR517	2.35	Not Eligible	Lucinda Freeman	2009	Development
16OR518	3.06	Not Eligible	Lucinda Freeman	2009	Development
16OR519	2.25	Not Eligible	Lucinda Freeman	2009	Development
16OR520	-0.46	Not Eligible	Lucinda Freeman	2009	Development
16OR521	-0.74	Not Eligible	Lucinda Freeman	2009	Development
16OR522	0.78	Not Eligible	Lucinda Freeman	2009	Development
16OR523	0.09	Not Eligible	Lucinda Freeman	2009	Development
16OR524	1.30	Unknown	Sharla C. Azizi	2006	Recovery
16OR525	-0.36	Not Eligible	Lucinda Freeman	2009	Development
16OR526	-0.73	Not Eligible	Lucinda Freeman	2009	Development
16OR527	-4.95	Not Eligible	Lucinda Freeman	2009	Development
16OR528	5.32	Not Eligible	Lucinda Freeman	2009	Development

Site #	Elevation (ft MSL)	NRHP Status	Recorder	Year	Decision Model
16OR529	3.02	Not Eligible	Lucinda Freeman	2009	Development
16OR530	-1.67	Not Eligible	Lucinda Freeman	2009	Development
16OR531	-3.53	Not Eligible	David Bruner, ESI	2009	Development

APPENDIX B:
NEW ORLEANS RESEARCH PROPOSAL FOR ARCHAEOLOGICAL TREATMENT MEASURES

2005

Jason Emery, Rob Mann and Shannon Dawdy

Introduction

Hurricane Katrina arrived in Louisiana as a Category 4 Hurricane leaving massive destruction in her wake. Sustained hurricane-force winds in excess of 130 miles per hour and associated tidal surge buffeted the City of New Orleans and virtually all of Southeast Louisiana's coastline. The storm caused multiple levee failures in and around the City of New Orleans leaving approximately 80 percent of the city inundated with water. The associated flooding and wind damage caused widespread damage to housing stock all over the city, including the City's twenty (20) National Register of Historic Places-listed Historic Districts that comprise approximately 35 to 45 percent of the city. Additionally it inundated the majority of the 212 identified archaeological sites in the parish: these sites range in time between the Poverty Point Culture (ca. 1730 to 1350 B.C.) and the Historic period (ca. 1700 to 1955 A.D.). The majority of the recorded sites date from the Historic period and are linked to the development of the City of New Orleans. They represent privies, foundations, refuse collections, and other features that compliment the historic structures of New Orleans. The structures and their associated features convey the significance of New Orleans to the world, and are one of the central pillars of New Orleans' tourist industry.

Through the Stafford Act (Public Law 106-390), the Federal Emergency Management Agency (FEMA) is charged with assisting state and local governments with their disaster relief efforts. The implementation of FEMA's various disaster-recovery programs will have cumulative impacts to the historic fabric of New Orleans, both above-ground and below-ground. For example, the proposed Demolition of Privately Owned Residential Buildings within Orleans Parish will result in an adverse affect to the archaeological landscape, which includes above-ground or built environment features. That is, the demolition of above-ground structures will have an adverse effect upon the setting and association of archaeological features associated with said structure, as well as presenting reasonable and foreseeable cumulative impacts to undocumented archaeological sites. In order to address FEMA's responsibilities under Section 106 of the National Historic Preservation Act (16 U.S.C. 470 et seq.), the Louisiana State Historic Preservation Office proposes that several archaeological excavations be undertaken within Orleans Parish. To facilitate the discussion, we have attached hereto several research proposals for your consideration.

The Research Site

For the purposes of developing archaeological mitigation, it is essential to conceive of the *current* city as a whole (Figure B.1). That is, the City of New Orleans is a large multi-component site that is chronologically stratified, both horizontally and vertically. While occupied during the pre-contact period, the City of New Orleans finds its beginnings in 1718 under Bienville. It has developed steadily through time, based on geography, technological innovation, and waves of immigration. By conceiving of it as an "integrated whole," this dynamic and diverse urban center can be examined through archaeological methods to bridge gaps in the current understanding of the City of New Orleans (Benedict 1934). In fact, these efforts should be understood in the context of research to provide the archaeological data for a nomination of the City of New Orleans as an archaeological site (see nomination literature to substantiate).

Viewing the City of New Orleans as one archaeological site with various components makes the methodology of excavations tied to research themes a practical possibility. Of course, this means that specific research themes need to be enumerated, as well as specific locations within the City of New Orleans-site where these themes can be addressed. The State Historic Preservation Office proposes that a designated number of square meters be tied to each of the research themes in more-or-less specific geographic areas. General methodologies will be discussed below and specific methods will be presented in the context of each research theme.

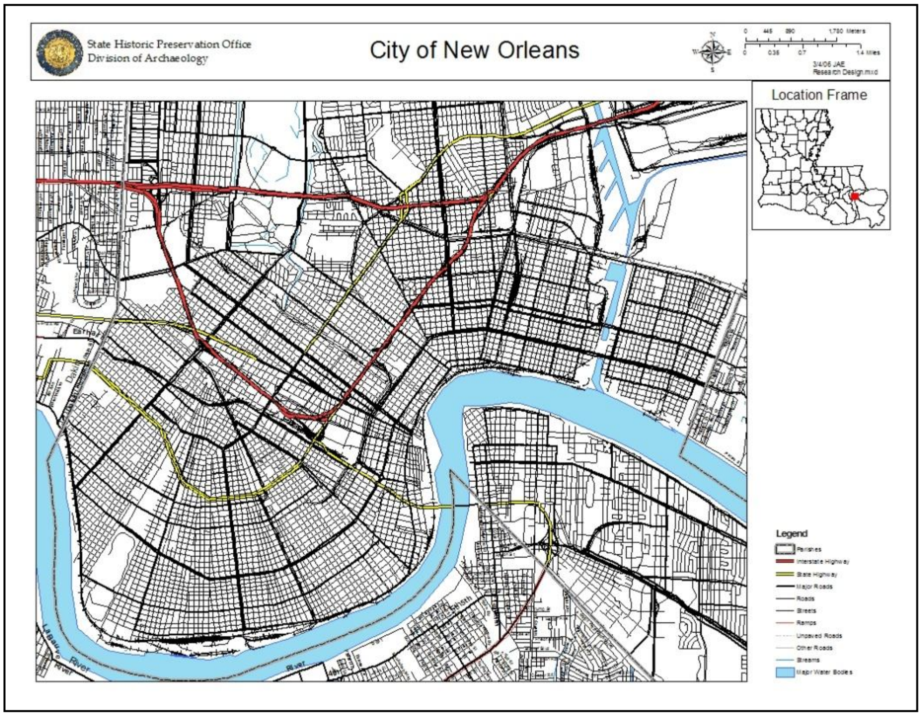

Figure B.1. City of New Orleans as an Archaeological Site

In consultation with several other Historic Archaeologists, we have begun to develop two avenues of thought regarding the geographic and thematic areas of research interest. The first avenue is to define Major Research Questions and the second is to define areas that are endangered through on-going development or re-development based on storm damage. At base, this is research-driven archaeology targeted at endangered locations; however, the specific research project locations will be determined in consultation between SHPO and FEMA.

Viewing the City of New Orleans as one archaeological site with various components makes the methodology of excavations tied to research themes a practical possibility. Of course, this means that specific research themes need to be enumerated, as well as specific locations within the City of New Orleans-site where these themes can be addressed. State Historic Preservation Office wants a designated number of square meters tied to each of the research themes in more-or-less specific geographic areas. General methodologies will be discussed below and specific methods will be presented the context of each research theme.

Major Research Questions

The following research questions drive the area specific research questions. These questions highlight thematic areas which are gaps in the archaeological and historical knowledge relating to the City of New Orleans. They are intended to be narrow enough to focus the research, but broad enough to be flexible at multiple locations. The following research priorities highlight gaps in our archaeological and historical knowledge of New Orleans. Each thematic priority or major research question drives a subset of loci-specific research questions

1. What was the nature and extent of pre-Contact and Colonial-period Native American settlement in the area?

2. What was the nature of daily interactions amongst and between the various segments of New Orleans' population during the Aboriginal, French Colonial, Spanish Colonial, and American periods—paying particular attention to the dimensions of ethnic and socio-economic interactions?

3. What are the material dimensions of socio-cultural change throughout New Orleans' history, represented by such processes as Creolization, Americanization, and ethnogenesis?

4. What was the nature of the local society and domestic economy in the French colonial period?

5. What were the daily dimensions of slavery and freedom over the course of New Orleans' history for urban slaves, free people of color, and emancipated slaves?

6. What were the effects of commercial and industrial activities upon daily life and social processes throughout the different periods of New Orleans' history?

7. What is the nature of transportation systems in New Orleans through time and their effects upon the city's local, regional, and global connections?

Endangered Areas

Recognizing the City of New Orleans as an archaeological site does not alleviate the need to specifically identify areas that are endangered. These endangered areas are portions of the city that will likely be redeveloped causing further harm to the limited archaeological database (Figure 2). These areas should be examined to fill the void of historical knowledge before redevelopment happens:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- Housing Authority of New Orleans (HANO) properties
- The Bywater river corridor
- The Holycross School area
- The Lower 9th Ward area

Additionally, there is a significant need to conduct research in a few critically understudied areas of the city where preservation conditions are unknown but the potential for significant sites is projected to be high. These include: the banks of Bayou St. John, the Metairie/Gentilly Ridge, Tremé, and Marigny.

Figure 2: The location of Endangered Areas and Potentially Significant Sites

General Methodologies

Below are methodologies which should be utilized in addressing the major research questions: an interdisciplinary approach is recommended in which both macro-scale and micro-scale methodologies are applied, as appropriate.

Consistent with an interdisciplinary approach, extensive archival research should be undertaken in advance of and in conjunction with archaeological field investigations. Below, we provide a preliminary listing of archival resources (for more information see Dawdy 1996: 93).

Archival Sources

Historic New Orleans Collection, Williams Research Center (HNOC)

Louisiana collection, Earl Long Library, University of New Orleans (LAUNO)

Louisiana Collection, Howard Tilton Memorial Library, Tulane University (LATU)

Louisiana State Museum (LSM)

New Orleans City Hall Archives (NOCH)

New Orleans Notarial Archives (NONA)

New Orleans Public Library (NOPL)

Samuel Wilson Collection (SWC)

Southeastern Architectural Archive, Tulane University (SEAA)

Vieux Carré Commission (VCC)

Vieux Carré Survey Archive (VCSA)

Louisiana and the Lower Mississippi Valley Collections, Hill Memorial Library, Louisiana State University

In addition, detailed census data for each project area investigated should be collected to compliment the development of a comprehensive chain-of-title. These data sets should be discussed in a narrative, as well as a graphic, format: one good graphic representation of this data can be seen in Yakubik and Franks, Figures 3 and 4 (1992: 53-54).

Map Resources

A significant macro-level methodology for identifying the location of known and potential sites is utilization of the joint FEMA-SHPO Historic Map GIS Database and the *Louisiana Cultural Resources Map*. As these two projects are not complete, additional maps should be consulted from the above-listed resources (for a sampling of specific map titles and locations see Dawdy 1996:94-96).

Field Methodologies

As a compliment to map data and depending upon site conditions, appropriate remote sensing techniques such as ground-penetrating radar, resistivity, gradiometry, magnetometry, side-scan sonar, etc., should be utilized in order to maximize archaeological excavation methodologies. These methods are utilized as an adjunct to the limited excavations and data collection of field archaeologists. They guide the research in the case of terrestrial archaeology, and in the case of a submerged site, the side-scan sonar helps effectively locate potential historic properties.

In addition, unit excavation, mechanical trenching, augering should be deployed to gain a better understanding of soil stratigraphy and site integrity in these relatively untested areas. After site integrity has been established, and where appropriate to the major research question and more specific research proposal, mechanical stripping for feature recognition and subsequent excavation should be undertaken on a minor scale. Finally, advanced laboratory analyses should be employed to investigate environmental conditions and subsistence strategies, methods including macro- and micro-botanical and faunal analyses, floatation, palynology, and soil chemistry shoulde be used. For investigations of consumption habits residue analysis should be utilized. Additionally, ceramic sourcing should be utilized on ceramics dating from the Aboriginal and Colonial periods for evidence of manufacture location or raw materials (for Colonial era ceramics Olin et al. (2002) provides methodology; for Aboriginal ceramics Giardinao (1985) provides methodology). Finally, if pre-Contact or Aboriginal components are encountered with the absence of Colonial materials, radiocarbon (C14) or other reliable dating method should be employed to determine the chronological position of the component. Detailed photography and recordation should occur if human remains are encountered; however, they will not be excavated as part of this work. Of course, not all of these methods will be utilized for each project site chosen, but these methods represent the necessary baseline data collection that should happen in the contexts of research-driven archaeology.

Proposed Budget

As a proposed budge per major research question, we recommend that each funded project receive at a minimum $300,000. This money would fund the excavation, analysis, curation, and report preparation.

Time Frame

Once project areas are determined in consultation between FEMA and SHPO, there would be not more than eight (8) weeks of fieldwork per question. If six questions are funded, the fieldwork would run concurrently. This field time would include remote sensing, unit excavation, mechanical trenching and stripping, and feature recordation and recovery. The post-fieldwork artifact analysis and report preparation will extend for 50 weeks after the end of fieldwork, at which time a draft report will be submitted to FEMA and SHPO for review. After a 45-day review period, comments will be submitted to the authors of the document. Any clarifications or editorial corrections will be completed within 30 days, when a final report will be submitted to the FEMA and SHPO. The final report will meet the Louisiana State Historic Preservation Offices' Standards for Report Preparation. The overall process will take 481 days or just over one and one-third years from project initiation to completion of the research.

Major and Corollary Research Questions

This section presents the major research questions and provides corollary questions drawn from *Louisiana's Comprehensive Archaeological Plan*, *New Orleans Archaeological Preservation Plan: Looking Forward to Its Past*, and from discussions with other Historical Archaeologists. Not all research proposals currently have corollary questions. This is due to the timeframe for development of this document. Also each research proposal indicates which endangered and under-researched areas could be utilized to help answer the major research question. While it is recommend that the major research questions can be can answered through excavations in the specified areas there is no clear one-to-one relationship between questions and areas. That is, one area often has the resources to answer multiple questions.

Research Proposal 1

1. What was the nature and extent of prehistoric and Contact-period Native American settlement in the area?

There is very little information regarding the nature of prehistoric settlement in New Orleans. The research that has been conducted is based on locational aspects of pre-contact Native settlement. While Native American ceramics have been located at Madame John's Legacy (16OR51) (Dawdy 1998, Shenkel 1971), the Tremé site (Matthews in prep), and the House of the Rising Sun (Dawdy in prep) there is but a small sample at each site. There is, as yet, little understanding of where pre-Contact and Contact-period settlements were located within the city, nor whether they can be firmly associated with known prehistoric cultures or recorded historic groups.

Corollary Questions:

- Per Smith et al. (1983:228-229), research questions related to the these historic Native American villages would be:
    1. Locate historic Indian villages associated with historic tribes. At least two are known from historic maps to have existed in Orleans Parish: Acolapissa/ Quinipissa (some sources suggest these are two separate groups, some suggest they are the same) and Houma; Chawash and Washa sites may have also existed in Orleans Parish.
    2. What are the distribution of these tribes at the time of first contact with Europeans?
    3. What are the characteristics of their artifact assemblages? Are there characteristics that distinguish New Orleans area groups from others in the lower Mississippi valley and Gulf Coast regions?
    4. What were the effects of European trade goods on the social and economic practices of these groups? What was the extent and nature of this trade? How does archaeological evidence of this trade compare to the historical record (for example, as reported by Usner 1987, 1992, and 1999).
    5. What was the subsistence/settlement system of historic Indian tribes at contact and how were they transformed by colonialism?
    6. define the role of trade with Europeans in the colonial period
    7. What were the interactions of Christianity on Native American culture?
    8. What were the effects of European diseases upon contact-period Native Americans?

Possible Research Areas:

- Vieux Carré or French Quarter
- Riverfront
- The Bywater river corridor
- Holycross School Area?
- Banks of Bayou St. John

- The Metairie/Gentilly Ridge
- Tremé

Research Question 2

2. What was the nature of daily interactions amongst and between the various segments of New Orleans' population during the Aboriginal, French Colonial, Spanish Colonial, and American periods—paying particular attention to the dimensions of ethnic and socio-economic interactions?

The research that has taken place in New Orleans has focused on discrete sites or has not attempted to answer questions relating the interactions of various segments (e.g. ethnic or socio-economic). While some efforts have been directed towards these questions, they have not been fully explored in a sustained way. Admittedly, this question is very broad, but its intent was to generate descriptions of assemblages at one point in time by one group or another (identified through the historical record) and require the comparison with either a contemporaneous group (a synchronic perspective) or with a prior or subsequent group (a diachronic perspective). Both are accessible through archaeology. Also, it would direct efforts towards the periods of transition without presuming a theoretical position as many terms do.

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Housing Authority of New Orleans (HANO) properties
- The Bywater river corridor
- The Holycross School area
- The Lower 9th Ward area
- Banks of Bayou St. John
- The Metairie/Gentilly Ridge
- Tremé
- Marigny

Research Question 3

3. What are the material dimensions of socio-cultural change throughout New Orleans' history, represented by such processes as Creolization, Americanization, and ethnogenesis?

Corollary Questions:

- With regard to Creolization
    1. What is the changing nature of the archaeological landscape, how are spatial templates re-interpreted through time?

- With regard to Americanization
    1. There is a different qualitative and quantitative experience for different segments of the population. What are the material dimensions?
    2. What does Americanization mean in terms of a shift of material culture? Is it a difference in kind or in quantity?
    3. What implications did the population explosion of New Orleans from the first American control to the 1830s have for site formation process and preservation of Colonial archaeological features?

- With regard to structuring ideals such as Victorianism
    1. How was the expression of Victorianism as an ideal both similar and different in New Orleans?
    2. Did it express itself in a unique way in New Orleans?
    3. Is it different in the French/Spanish households versus the Anglo households?
    4. How does it play into the rapidly Americanizing New Orleans.

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- Housing Authority of New Orleans (HANO) properties
- The Bywater river corridor
- The Holycross School area
- Banks of Bayou St. John
- The Metairie/Gentilly Ridge
- Tremé
- Marigny

Research Question 4

4. What was the nature of the local society and the domestic economy in the French colonial period?

Corollary Questions:

- Obtain basic locational data on early colonial sites including colonial agricultural complexes such as:
    1. Indigo works and plantations
    2. Tobacco plantations (Smith et al. 1983: 241).

- Examine the development of the plantation from 1706 to 1769.
    1. What Old world traits were adapted to Louisiana plantations?
    2. What early industries were found on colonial plantations, in addition to the nominal purpose of the plantation?
    3. How did the classic settlement patterns develop?
    4. To what degree were the early plantations dependent on European goods?
    5. What was the nature of social interactions on the plantations between planters, overseers, employees, engagés, forced convicts, and slaves?
    6. Were there significant differences between publicly-owned (Royal, Company, and joint venture) and privately-owned plantations?

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- The Bywater river corridor
- The Holycross School area
- Banks of Bayou St. John
- Tremé
- Marigny

Research Question 5

5. What were the daily dimensions of slavery and freedom over the course of New Orleans history for urban slaves, free people of color, and emancipated slaves?

Examining these issues allows us to understand how we came to the pre-Katrina social landscape of New Orleans. These issues lead us to the historical moment in time just pre-Katrina, and they help us understand the tragedy in the long-term historical perspective.

Corollary Questions:

- Post-bellum emancipated slaves and the Jim Crow South
    1. For these populations during the post-bellum and early modern periods, what were the influence of the new “health and welfare” approaches to city planning?
    2. Additionally, what was the effect upon the African American population during the urban revitalization programs of the 1930s?

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- Housing Authority of New Orleans (HANO) properties
- The Lower 9th Ward area
- Banks of Bayou St. John
- The Metairie/Gentilly Ridge
- Tremé
- Marigny

Research Question 6

6. What were effects of commercial and industrial activities upon daily life and social processes throughout the different periods of New Orleans' history?

This question lends itself to the examination of Class, Labor, and Gender Divisions.

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- Housing Authority of New Orleans (HANO) properties

- The Bywater river corridor
- The Holycross School area
- The Lower 9th Ward area
- Banks of Bayou St. John
- The Metairie/Gentilly Ridge
- Tremé
- Marigny

Research Question 7

7. What is the nature of transportation systems in New Orleans through time and their effects upon the city's local, regional, and global connections?

The transportation systems drive not only the delivery of goods and services to a desirous population; they also shape the pathways of growth. They determine to a certain degree the nature and pattern of urban development. Their investigation has a scant representation in the site records for Orleans Parish.

- Development of the riverfront/Batture area is critical to the city
    1. What shape did it take?
    2. What were the ordering principles that allowed it to act as the conduit to the local, regional, and global material economies?

Possible Research Areas:

- The Vieux Carré or French Quarter
- The Faubourg Ste. Mary (American Sector)
- Riverfront/Batture/Riverbottom
- The Bywater river corridor
- The Lower 9th Ward area
- Banks of Bayou St. John

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Vita

David Harlan was born in New Orleans, Louisiana, in 1978. He received a bachelor's degree in anthropology from Auburn University in 2001. After college, Mr. Harlan worked as a field archaeologist at Earth Search Inc. of New Orleans where he participated in countless archaeological investigations. During his time at Earth Search, Mr. Harlan developed an interest in GIS and mapping techniques. When Hurricane Katrina devastated New Orleans in August of 2005, Mr. Harlan responded by conducting archaeological investigations on damaged parts of the city in cooperation with federal recovery programs. In January of 2009, Mr. Harlan began his master of science program with the Department of Geography and Anthropology at Louisiana State University. During this time Mr. Harlan sought to find new methods that utilize the power of GIS to understand archaeology. In November of 2009 he was awarded a research assistantship with Disaster Science Management and was selected to be the lab manager for the Disaster Resistant University Multi-Hazard Mitigation Plan. Mr. Harlan expects to complete the degree of Master of Science in geography in December of 2010.