

VISUALIZING HISTORIC GEOGRAPHIC CHANGE OVER TIME:

CONSTRUCTING AN HISTORICAL-GIS

NANTUCKET, MASSACHUSETTS

1950-2000

THESIS

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by

Alexis A. Buckley, B.A.

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CHAPTER I

INTRODUCTION TO THE STUDY

Geographic information technologies (GIT) are ideally suited for representing the spatial and thematic attributes of geographic data; however, they are not used frequently in representing the temporal attributes. One reason for this relates to the difficulty of demonstrating geographic change over time using GIT. This project explores the challenges of representing spatial-temporal change with GIT, by developing a series of spatially related maps, databases, text, and images depicting the change. This method allows the user to sift visually through the data, synthesize and analyze the images, and draw conclusions regarding how a location changed over time. Ideally, this may be achieved through multimedia cartography; however, there are several challenges involved. A goal of this project is to address some of these challenges by incorporating a sequence of maps with a range of historic and contemporary documents (both images and text) in a multimedia presentation that allows users to visualize, analyze, and interpret the process of change. The location and timeframe of study is Nantucket, Massachusetts from 1950-2000. During that time, Nantucket has evolved from a sleepy fishing village, to a bustling upper-income seasonal, residential retreat and tourist attraction.

Using Geographic Information Technologies (GIT) and multimedia techniques, this project creates an interactive and updatable GIS that demonstrates the historic change of the last half century, when tourism began to impact Nantucket. The scenarios

examined include: 1) the analysis of changes in housing stock; 2) identifying homes that are part of the National Registry of Historic Places; 3) chronicling changes in housing tenure and cost 4) identifying homes based on year round or seasonal occupancy; and 5) locating homes closest to land set aside for conservation and/or preservation. The GIS is included as Appendix A in compact disc form along with user guidelines; and requires ArcGIS software to run. It will also be included as part of a larger project posted on the internet.

Another area of focus is on the general land use, including: areas protected through conservation and preservation movements; areas designated as public access; commercial areas; and areas used for agricultural purposes. This research provides the opportunity to chronicle significant land-use and planning policies as well as regulations (Massachusetts General Laws Chapter 40A and 40B Zoning and Regional Planning, respectively) and see the impacts of the policies. Such data offers an deeper perspective on the historic development of the island.

Incorporating maps, images, and text provides the multimedia experience (See Figure 1). The user is able to access detailed databases digitally connected to various points, lines, or polygons on the base map, to make queries about particular locations at a particular time or times within the set parameters. For example, one can select a building point to access a real estate database chronicling transactions from 1950 and images of that property; or one might use such a GIS to analyze the impact of the zoning by-laws of the 1970s. This type of geographic information, in this format, provides geographers with access to layers of information pertinent to historical studies; and this model may uncover answers or help pose questions not easily discernable using traditional methodologies. As

Gregory (2002) writes, “[o]nly by having multiple routes through space and time can the full complexity of the world be understood.”

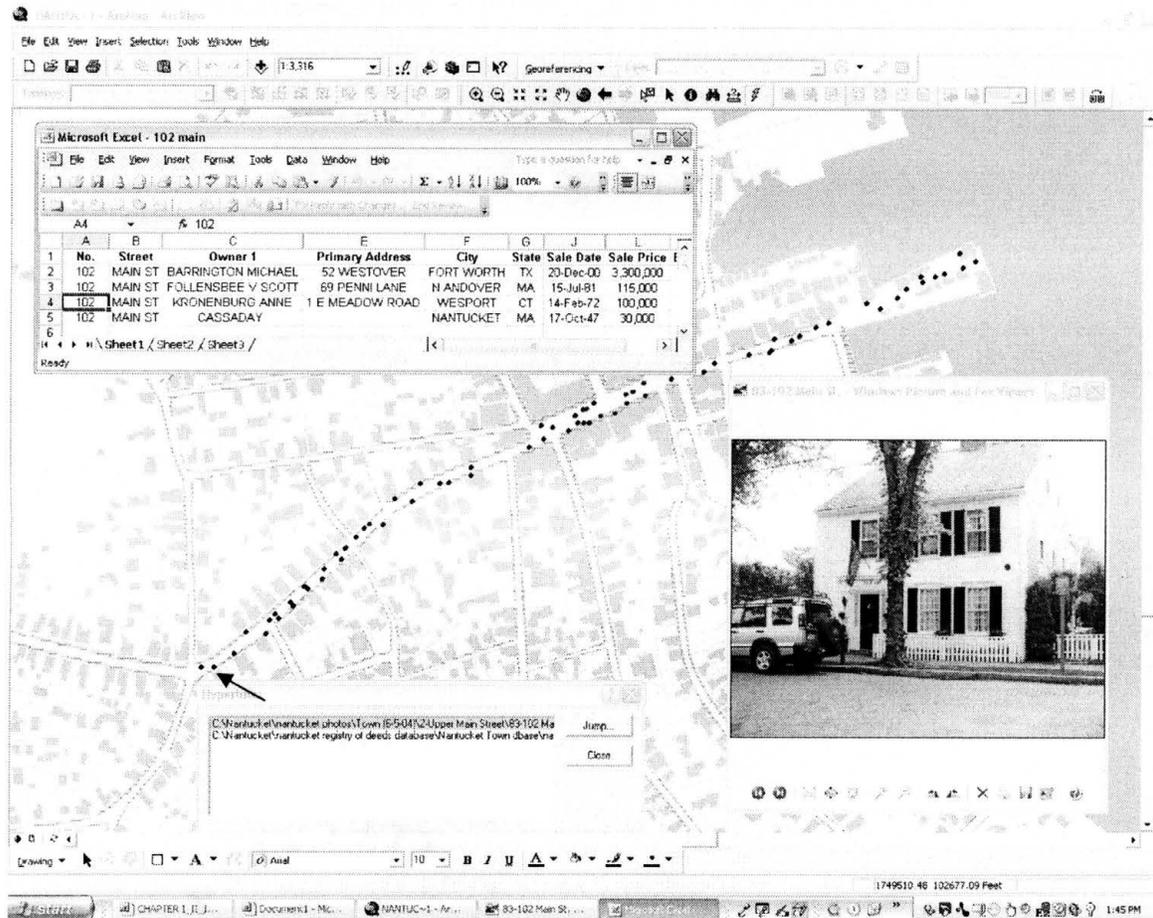


Figure 1: 102 Main Street – Base map of Historic Downtown Nantucket with examples of hyperlinks (images, database) accessed by selecting royal blue points

In an effort to uncover intricate patterns, the geographic data is organized for analysis at small, intermediate, and large scales. Mapping this specific data at multiple scales offers a perspective of the historical distribution of social, economic, and political influence. To demonstrate the potential for such analysis, part of this research involves interpreting the geographic information using Anthony Giddens’ structuration theory which explores the interrelationship between social organization and individuals.

Nantucket has a remarkable history, with a strong sense of place, and has substantial data sets conducive to constructing an historical GIS; therefore, the audience to which the project is geared is mainly historical geographers, but the end product may well offer insights to city planners, environmentalists, academics, and anyone else wishing to gain a better understanding of development on Nantucket in the last half of the twentieth century. It is also important to note, that if the design of this model is successful, and historical geographers may find advantages in utilizing GIT in their analyses, the benefits shall clearly extend beyond Nantucket. Using Multimedia cartography and GIT to communicate visually the historic geographic change may contribute to the discipline as well.

Background and Context: Nantucket, Massachusetts

Nantucket is an island located 30 miles off the coast of Cape Cod, Massachusetts. Its land area is approximately 50 square miles. Nantucket was inhabited initially by members of the Wampanoag tribe, until a group of English wishing to avoid religious persecution on the mainland in Massachusetts, settled there in the in the mid- to late seventeenth century. After years of forbidding the construction of a church anywhere on Nantucket, the majority of the community became Quakers when, in 1702, a Quaker minister called John Richardson deeply inspired Mary Coffin Starbuck, one of the first and most influential settlers, to join the Quaker faith (Philbrick 1996, 2001). The Quaker culture promoted simplicity in design, but always with the utmost artisanship and quality of materials. The community carefully developed the land to represent their unassuming and quite practical nature.

Nantucket thrived in the eighteenth and early nineteenth century because of the whaling industry. For a time, Nantucket was one of the wealthiest towns in the country; but after the decline of the whaling industry and the great fire of 1846, Nantucket quickly lost its economic status. It became a quiet fishing town, with a very small but affluent tourist set (Holtz-Kay 1986).

The community of Nantucket has undergone a strategic transformation since the 1950s when a select group of people began investing in waterfront property with the intention of revitalizing the area from a weathered, yet charming fishing village to an opulent summer retreat for the moneyed few. This group of property owners recognized the vast potential for tourism and transformed the island in an effort to attract a small target audience of prosperous tourists who would bring in more money and make less of an environmental impact. One of the most prominent of this group was Walter Beinecke Jr., a Connecticut businessperson with an ardent interest in preservation and conservation. It is important to note that Beinecke's focus was not limited to buildings: He and his associates had a keen awareness of the relationship between preservation, conservation, and the amenity value associated with property within and around such pristine areas: And by the year 2000, the island had been transformed, while at the same time maintaining the historic Quaker sentiment. This shift has had significant impacts on the socio-economic structure of the island, as well as on the environment. It is this historic transition that is so well suited for analysis through an historical GIS.

Conservation and Preservation

As mentioned earlier, the plan for tourism development was rather calculated. The community was well aware that in order to attract and sustain the target clientele, maintaining the natural aesthetic of the island was essential. Conservation and preservation were key elements in the master plan. From 1965 to 2000, the various conservation organizations gradually acquired forty-two percent of the land. In 1955, National Historic Legislation was enacted, and in 1966, the Department of the Interior acknowledged the nearly 2500 historic structures located on Nantucket, and designated the island as a national historic landmark (Moore-Booker, Gonnella, and Butler 2003).

Nantucket is home to numerous conservation, preservation, and environmental organizations. These efforts to set aside land and preserve historic homes began as early as 1894 when a group of islanders established the Nantucket Historical Association in an effort to maintain the historic charm they believed made Nantucket unique (Moore-Booker, Gonnella, and Butler 2003). In the late 1930s, a group of over thirty architects, builders, realtors, and residents formed an alliance to assist new builders with architectural and design plans based on an analysis of over 320 historic homes on the island (Moore-Booker, Gonnella, and Butler 2003). A byproduct of this collaborative effort was a book published by Everett U. Crosby, "95% Perfect: The Older Residence at Nantucket" in 1951. Despite such efforts, Nantucket was still suffering steady economic decline, making it difficult to fund sufficiently the preservation efforts. In the 1950s, the prosperous summer resident and self ascribed preservationist, Walter Beinecke Jr., arrived on Nantucket with a master plan for revitalizing and preserving the island's waterfront. In 1966, Walter Beinecke and his company, Sherburne Associates, began to

put their plan into motion; rehabilitating the waterfront, beginning with Straight Wharf (Stanton 2001). It was at this point that Nantucket began to take the form for which it is so famous today. The bait and tackle shops that lined the pier were converted into upscale restaurants and boutiques. Beinecke's target audience was the wealthy. He planned to attract fewer tourists to spend much more money than a day-tripper could or would choose to spend (Moore-Booker, Gonnella, and Butler 2003; Stanton 2001; and Holtz-Kay 1986).

An integral part of Beinecke's plan was to maintain the aesthetic beauty of the island; he therefore advocated for stringent conservation and preservation guidelines. The Nantucket Historical Trust was founded in the 1950s in an effort to preserve the island's historical integrity; and the Nantucket Conservation Foundation was established in 1965 in an effort to protect the treasured trails, fields, and other open space. The foundation's fundamental purposes was, and still is, the conservation, preservation and maintenance of beaches, marshlands, meadows, swamplands, wetlands, etc., and open areas and the animal and plant life in these areas (Stanton 2001; NCF 2003). The foundation also works to preserve historical sites; areas of archeological, geological or other scientific significance; the island's natural charm; and the island's water resources (Stanton 2001, MACC 2004). Despite the noble efforts of such conservation groups, the amount of developed land has tripled since 1987 (NSDC 2003).

Over the past fifty years, but more dramatically within the last twenty years, the percentage of developed land has increased considerably, while areas of conservation have remained fairly constant (NSDC 2003). In 2003, the ratio of land use was forty-one percent developed land; forty-two percent conserved land; and the remaining seventeen

percent potentially developable (NSDC 2003). These figures are significant in that Nantucket relies on the natural physical beauty of the island for economic, social, and environmental sustainability. Nantucket has been able to draw its tourists and residents because of the pristine environment. People are willing to pay more money to holiday or live on an island with expansive, well maintained greenways, no traffic lights, and no franchises such as McDonald's restaurants. The conservation movement has been a collective effort, funded through public and private funds by those within the community who recognize the importance of preserving Nantucket's charm. Such efforts and conservation successes have helped to preserve Nantucket's aesthetic and environment to a point; but at the same time, it is what is drawing more off-islanders to want to build in the town. It is precisely the proximity to the protected open areas and the demand for housing that drive up the property costs (NSDC 2003; Nantucket Comprehensive Plan 2003; and Stanton 2001).

Studies have shown that there is a direct correlation between high property values and proximity to open space or conservation land (Lacy 1990). For example, a study conducted in Boulder, Colorado found that housing prices decreased \$4.20 per square foot on average for every foot away from a significant area of open space up to 3,200 feet. And in another area, the amount was as high as \$10.20 per square foot for each foot away from the open space. This study demonstrated that, all other things being equal, the average property value of land abutting the open space was thirty-two percent higher than the properties located beyond the 3,200 foot line (Correll, Lillydahl, and Singell 1978).

Housing Issues on Nantucket

The simultaneous development, preservation, and conservation on the island have attracted more and more residents, both seasonal and year round, to the island; many of whom are wealthy. The dramatic increase in population over the past thirty years has had a tremendous impact on the housing market (Ryan 2003). This growth pressure is exacerbated by the limited availability for new development. Only seventeen percent of the land has not been either developed or conserved. There has been a “gold rush” mentality developing where many seasonal tourists are actively searching for property to buy before the island is built out (Nantucket Comprehensive Plan 2003).

In 2000, Nantucket’s median home price was roughly \$800,000, triple the cost since 1990. This is enormously significant for a family who earns its income on the island itself, and likely earns close to the median-income (\$73,000 for a family of four). A family of this economic status could possibly qualify for the debt service on a \$200,000 mortgage; and then the family would need to come up with a down payment of approximately \$600,000. This is an exorbitant affordability gap that puts homeownership out of reach for most middle-income Nantucketers (NSDC 2003). Those who already own homes often have to work two jobs just to pay the mortgage and taxes (Nantucket Comprehensive Plan 2003).

According to the Massachusetts Department of Housing and Community Development (DHCD) in 2000, there were 9,210 houses on Nantucket; of the total units only 3,699 were occupied year round; 341 were vacant, and 5,170 were seasonal homes. Of the 3,699 year-round residences, 2,334 were owner occupied and 1,365 were rented units. These numbers are astonishing; not only for the affordability limitations, but also

because unlike other resort towns, the people who live and work on the island cannot easily move to a more affordable neighboring town and continue to work on island. The housing crisis, “caused by the escalation of real estate prices, lies at the heart of most of Nantucket’s economic, social, and even environmental problems” (Nantucket Comprehensive Plan 2003). The problem is so desperate that the school department had to build staff housing to fill 30 teaching positions (Journal of Housing and Community Development, 2004). Since the 1960s, there have been an additional 4,000 homes constructed, many of which are mansions used as second homes for the wealthy (Nantucket Comprehensive Plan 2003). Many of these seasonal mansions were purchased with deed restrictions that prevent owners from renting at all, which means that a significant percentage of the newly constructed homes remain vacant for close to ten months a year.

One indication of the marginalization of the local community is that these same people could afford a sizeable home in a middle class community on the mainland. Housing is one of the most contentious issues on the island at this time. These changes have had impacts on the community, its history, and the environment; and we believe it would be helpful to understand the processes by integrating them into a multimedia cartography. These demographics incorporated into an historical GIS of the island development over the past fifty years are used to illustrate the historic evolution of real estate, conservation, and historic preservation. Such visualizations may shed light on relationships between the variables that have contributed to the affordability crisis that exists on the island.

Over the past twenty-five years the cost of housing nationwide, either rented or owned, has increased steadily, as have the size and amenities associated with homes. During this time, the national median cost of a single family home has increased by 346%: and the median rent for new apartments in buildings with five or more units increased by 300% (Simmons 2001). While median housing costs in general inflated by 323% since 1975, general prices, as measured by the Consumer Price Index, rose 238% (Simmons 2001). This national trend is exacerbated in resort communities such as Nantucket, Massachusetts; Aspen, Colorado; and Jupiter Island, Florida. In Nantucket, the cost of living is roughly 15% higher than in a similarly developed community on mainland Massachusetts (NSDC 2003). Nantucket is the fastest growing county in the Commonwealth of Massachusetts. Year round population has doubled since 1980 and tripled since 1970. In the 1990s, the population growth was ten times that of Massachusetts as a whole (Ryan 2003).

CHAPTER II

THE FUNCTION OF GIS AND MULTIMEDIA CARTOGRAPHY IN HISTORICAL GEOGRAPHY

Mapping changes in housing patterns is quite useful in visualizing socio-economic change over time. Housing stock, availability, costs, and occupancy function well as indicators of how a community has evolved or devolved. These variables are well suited for the historical GIS, and will function well with the multimedia capabilities to visualize patterns in the development.

While the primary target audience is historians and historical geographers, the end product could very much benefit planners and local decision makers as well. The multimedia cartography product may help the community to conceptualize the historic spatial-temporal distribution and to visualize the change in land use patterns (Brail and Klosterman 2001). Historical geographers, planners, conservationists, and decision makers alike are becoming more accustomed to analyzing complex patterns of development and spatial distribution using integrated methods (Geertman and Stillwell 2003). A dynamic mapping system should prove to be an invaluable tool.

The disciplines of geography and history are correlative fields of study: both are fundamentally rooted in analyzing spatial-temporal patterns in relation to places and events. Butlin (1993) offers a detailed perspective of the workings of historical geographers:

The perspective focuses on relationships between history and geography that have influenced the human condition and political events of the past. It focuses on relationships which have shaped the evolution of place and landscape (p. 89)

It is exactly this type of relationship that may be analyzed better by incorporating multimedia capabilities in an historic cartographic design.

Historical geographers often take substantive approaches to broader processes such as economic, cultural, or political change; analyzing the impacts on a particularly local scale; and in geographical histories that are more contemporary, they may also search for interconnectedness between places (Nash and Graham 2000). Such a search for spatial-temporal patterns and relationships are ideally suited to an historical GIS.

Combining historic maps, documents, demographics, and images into one searchable, interactive product may allow for the uncovering of new perspectives.

There has been significant resistance in integrating GIS and historical geography.

Dennis (2001) writes:

Other kinds of historical geography, and especially anything quantitative, are marginalised or, at best, partitioned into a separate territory of 'historical GIS' where, with few honourable exceptions, the emphasis has been more on technical wizardry than the historical significance of the questions being asked or the patterns being generated (p. 19).

Dennis also voices concern for the reliability of the historical GIS claiming:

Credibility refers to the accurate representation of experiences dependability focuses on the researcher as instrument and the degree to which interpretation is made in a consistent manner (p. 20).

Such attitudes were reaffirmed at various historical geography conferences (Giordano and Gelpke, 2003); however, others are more welcoming. Colten (1996) appeals to historical geographers and GIS specialists alike to bridge the gap between the two subfields. His

call for collaboration aimed to pique interest in each other's field; with the historical specialists learning new methodologies, and the GIScientists exploring a new way to apply techniques.

While some traditionalists are wary of the transition to GIS utilization for research, there are still others who are willing to advocate for the alliance. As Harris, Weiner, Warner, and Levin (1995) write:

Our argument for participatory GIS is intended to demonstrate a GIS application where local knowledge, community needs, and specific social histories are appreciated and incorporated into the development process and "expertise" is viewed as interactive. In this way the production of information is not viewed solely as a top down operation but one whereby local knowledge arising from social narratives is converted into data within a GIS for research and policy formulation (p. 200)

The fundamental nature of cartography is to depict and effectively communicate selected real-world elements through abstraction. We conceptualize the world based on information acquired through such abstractions using maps (Peterson 1999). It is with this in mind that one may begin to understand the potential for multimedia capabilities in cartographic visualization. With the advent of such technologies as GIS, computer animation, and database systems, multimedia cartography allows for dynamic representations of numerous facets of the real-world. The product is no longer just a map, but an organizational tool for a broad range of "place based" data (Fraser Taylor 2003). It is also important to recognize that, according to several studies, multimedia applications vastly improve retention of information and knowledge (Peterson 1999). In other words, interactivity and visualization enhance ones ability to understand and process information.

Cartographic communication theory is derived from communication theory; and argues that maps communicate spatial information through a series of steps. It also states that with each step the potential for misinterpretation increases. That is to say, the intended message of the cartographer is at risk of various ranges of distortion based on the map user's knowledge. Maps communicate graphically, and the message communicated is subject to the readers understanding of the message (Peterson 1999). Therefore, it is the goal of the cartographer to project optimal visualization to communicate most effectively. While such strategic planning is nearly impossible when targeting a broad audience, say on the internet; the task is far less daunting when the clientele are historical geographers.

In the contemporary cartographic sense, visualization speaks to the computer generated or displayed images that represent real-world, scientific data to be interpreted by the user (Peterson 1999). It is a technological, visual approach to structure, organize, and analyze data. The concept of cartographic visualization is centered on one's ability to impose order and identify patterns through related images, text, and graphics (Peterson 1994; Dransch 1999). It is also argued that one's ability to process cognitively spatial patterns is based on past experience, or "pre-knowledge" (Dransch 1999; Peterson 1999): Therefore, when creating an historical GIS, the designers must be well researched in the traditional methodologies of historical geographers.

Much discussion has taken place surrounding the difficulties of representing spatial-temporal change. Despite the tremendous advancements in GIS over the past two decades, visualizing geographic change over time still presents problems. Multimedia is one of the most effective methods to overcome such constraints; however, it is not

without its own challenges. A significant concern is to understand how best to organize the large amounts of data (Fraser Taylor 2003). Since it has been made apparent that historical geographers in general tend to avoid the technical tools, the multimedia product should be created in such a way that is intuitively navigable to historians. Multimedia cartography incorporates cultural, socio-economic, demographic and environmental data into an interactive tool that allows the user to examine potential trends and relationships in ways not typically explored by human geographers (Fraser Taylor 2003). It is with this in mind that the model is constructed.

It is clear that in order to produce an effective multimedia cartographic project one must carefully construct each component with the end user in mind. To attract successfully historical geographers to more technology based analyses, the design of the multimedia GIS should be strategically planned. Careful construction and inclusion of maps, tables, images and interface are essential. Visualizing spatial-temporal relationships to socio-economic, land use, and environmental data that have not been mapped before will help to demonstrate the capabilities of historical GIS (Fraser Taylor 2003).

CHAPTER III

METHODOLOGY

The ultimate goal of this research is to conceptualize a model, presenting a process by which those interested in geo-historical analysis might utilize GIS and multimedia cartography technology to enhance spatial analysis of locations rich in history. The components of the model form the steps researchers may systematically follow to incorporate this visual technology.

This research chronicles the recent history of spatial changes using geographic and multimedia technologies. The temporal changes in the physical, historical, cultural, and economic geography are determined using both qualitative and quantitative data. Historical and contemporary maps, images, documents, and GIS are used to study the geographic change over the past fifty years. The historical documents have been scanned and georeferenced or digitized which allowed them to be incorporated into the GIS to provide more accurate results. The study is at multiple geographical scales, and focuses mainly on the harbor and the central part of the town where much data exists on real estate, historical preservation, and conservation. To gain a more authentic perspective on social, economic, and environmental transformations, interviews have been conducted with local residents and scholars. To frame the study, the history of environmental conservation on the island is chronicled by mapping the areas that have come under

regulations for preservation through the acquisitions of the Nantucket Conservation Foundation, the LandBank, and other island organizations.

Historical maps, images and photographs, as well as real estate data on the island are required to complete the study accurately. This data is complemented by US Census data from 1950-2000: Specifically, real estate data including number of homes, owner occupied units, rented units, seasonal homes (for years data is available), and cost of housing. Ultimately, this research provides historians, historical geographers, and other interested persons with a multimedia tool that may be used to study the recent history on the island, and in particular to understand its recent transformations. Because these transformations are spatial, geographic information technologies joined with multimedia capabilities, are the ideal tools to aid these studies. As Lowe and Burns (1999) explain:

digitizing or georeferencing historical maps because every point on the historic map corresponds to a real world location, researchers can query the coordinates for a house site or an earthwork, enter the coordinates into their GPS unit, navigate to that location, map what survives, and enter the information back into the database.

Historical geography is an ideal starting point to merge the technical geographers and the human geographers. There is great potential for multimedia cartography and GIS to offer viable options to manage large amounts of spatial and temporal data. The objective of the model for this thesis is to collate pertinent data to represent the historic, spatial-temporal, geographic change within a given span of time. The model visualizes the geographic change at small, intermediate, and large scales. The input for the small scale representation is comprised of decennial census block group data including: housing data, income data, and population data from 1950 to 2000; conservation and open space development by year acquired by various conservation associations; and state and

local zoning and land use regulations. The inputs on a larger scale incorporate detailed data such as; specific real estate transaction dates, values, and ownership information.

An important function of this GIS is to organize diverse data in an effort to provide a method for dynamic analysis. One way to achieve this goal is to create hyperlinks. Images and text are not easily mappable, but often in historical analysis, these data have spatial significance. A hyperlink provides a digital connection or link from these data to particular points, lines, or polygons on a map. For this project, hyperlinks connect to geodatabases containing real estate and conservation information, images of buildings, personal histories, and other text. These hyperlinks are accessible at various scales by clicking on the appropriate point, line, or polygon. Such points and polygons connected to hyperlinks illuminate when one selects the icon of a lightning bolt in ArcGIS. Clicking on the hyperlinks provides a list of options from which to choose relative texts, images, or databases associated with that particular place. For the web version, the table of contents lists the location of hyperlinks at the various scales.

Another significant facet of this model is the ability to overlay GIS layers visualizing various attributes to gain a fuller perspective of the spatial-temporal change. The map is comprised of multiple layers. The top layer consists of the GIS files representing the island including; parcels, buildings, roads, hydrology, and GPS points of buildings. Underneath this map lie the georeferenced topographic maps in reverse chronological order from 2000 to 1950. Beneath the topographic maps lie the georeferenced aerial photographs, also in reverse chronological order. All of these layers have fixed coordinate systems allowing the user to sift visually through the spatial temporal data. For example, the 1951 georeferenced aerial photograph of Mid-island

shows that there were no buildings in the area at this time. Activating the GPS points layer or the buildings layer over the aerial photographs is one way of visualizing the geographic change since 1951. The user may choose from a number of similar options in overlaying data. Providing the user with interactive options for analysis may prompt questions that may otherwise be overlooked.

The output consists of several animation options including: decennial change in housing, income, and population by neighborhoods; conservation and open space development; and changes in land use and zoning. Figures 6, 9, 10, 14, 16, 18, and 20 in Chapters four and five are images of the animated charts that depict this data. The user is able to search the extensive database for a date or span of time within the specified range of the study. This model is much more than a mapping tool. There are historical and contemporary images of significant changes to enhance the user's understanding of the historical development. Overall, the objective of the model is to chronicle historical geographic change in an effort to gain a broader perspective of land use change and its impacts on the community.

CHAPTER IV

DATA COLLECTION AND ORGANIZATION

Once the theoretical design was established, the actual collecting and collating of the primary and secondary source data began. It is important to mention that GIScientists and historical geographers define primary and secondary source data differently. In GIS, a primary source refers to data gathered and incorporated into the GIS directly from the real world; for example, satellite data collected from a Global Positioning System (GPS) and satellite imagery. Secondary source data, in GIS, refers to data obtained from documents and maps. Historical geographers typically consider original documents, such as historical maps, as primary sources (Butler 1993; Gregory 2002).

There are many challenges inherent in the data associated with historical geography especially in terms of completeness, accuracy, and varying scales (Butlin 1993). This project attempts to address some of these challenges by structuring the data in an historical GIS. The interactive function proves most useful in addressing the issue of varying scale. Navigating through and synthesizing data at multiple scales offers the potential to uncover patterns or answer questions that may have gone unnoticed if traditional methods were applied (Gregory 2002).

Data collection began with a detailed base map of the island and pertinent ArcGIS files, as well as secondary source data including aerial photographs from 1938, 1951, 1960, 1971, 1994, and 2000; and topographic maps from 1887, 1945/51, and 1970s.

Fieldwork on Nantucket included interviews and conversations with local planners, conservationists, and residents, which provided insight necessary to select significant areas of study – Downtown, Mid-island, Pocomo Road, and Siasconset (often abbreviated to *Sconset*). Additional fieldwork consisted of capturing GPS points to link known addresses within the selected areas with specific buildings, and taking photographs to visualize each property. Further research involved extracting pertinent data from recorded and registered land documents from the Nantucket Registry of Deeds as well as conservation data from maps and databases from local conservation groups. These sets of data provide a strong foundation for geographic analysis.

A detailed analysis of the island requires the use of data at small, intermediate, and large scales. It should also be noted that cartographers define scale in the mathematical sense, where a larger fraction (smaller numbers) is referred to as large scale, i.e., 1:24,000 is large scale, and 1:500,000 is a small scale; as opposed to the traditional definition held by human geographers, which causes a bit of confusion when integrating sub-disciplines (Sheppard and McMaster 2004). As computer mapping is the foundation for this project, when discussing scale, the cartographic definition applies.

Organizing the data at multiple scales provides a more nuanced analysis of the development and conservation on the island. The smallest cartographic scale of the project (approximately 1:110,000) offers a more generalized analysis. At this scale, decennial data provides a broad depiction of the transformation of the island socially, economically, and environmentally. The intermediate cartographic scale (roughly 1:7,500) represents the data at a more localized level. As mentioned earlier, research and conversations with those familiar with the island led to the selection of four sections of

the island that represent the unique range of properties, for both year round and seasonal use. The intermediate scale captures the collective data relative to these regions. The largest cartographic scale relates to each individual point or parcel, either developed or conserved, mainly within the chosen areas.

Base Map and ArcGIS Files

As explained earlier, one of the reasons Nantucket became the focus of this research was easy access to exceptional resources, such as the extensive GIS base map with detailed ArcGIS files including buildings, sidewalks, parking lots, driveways, parcels, docks, hydrology, the airport, and the 2000 US Census in Block Group and Tract levels. The Nantucket GIS Coordinator created the GIS to assist the Municipal, Planning, Building, and Conservation Departments as well as the Town Clerk's and Assessor's Offices among others; and shares many of the ArcGIS files with other on island organizations such as the Nantucket Conservation Foundation, Audubon Society, and University of Massachusetts-Boston. Such coordination of data afforded a relatively easy and inexpensive way to integrate the supplementary real estate and conservation data relevant to this study; and offered a foundation for additional ArcGIS files and databases created specifically for and from this research.

Aerial Photographs and Topographic Maps

The sets of aerial photographs used from 1938 to 1971 required digitizing georeferencing, or preferably orthorectifying. Scanning simply digitizes the images. Georeferencing entails assigning map coordinates to the images by matching pixels of the

digitized images with known points on orthophotographs. Initially, orthorectification was the recommended method for incorporating these photographs into the GIS. This is the process used to ensure that each pixel is in the precise geographic location; and mathematically compensates for any distortion incurred through manipulating the image (Robinson et al 1995). Orthorectifying allows for seamless integration of aerial photographs into a GIS. Unfortunately, each set of images presented insurmountable challenges for this procedure. The initial methodology included georeferencing all individual aerial photographs; however, the individual images, once georeferenced using ArcGIS, included a white trim around the perimeter due to the necessary distortion encountered when fixing the image to known points; making it impossible to overlay the images seamlessly. Due to this discovery, only images within the study area were



Figure 2: 1960 Straight Wharf and Main Street Georeferenced Aerial Photograph

georeferenced. These rectified images display the white border (see Figure 2), making it difficult to view areas in their entirety, yet when viewed one photograph at a time, in

conjunction with the GPS building points, proved useful for analyzing the geographic change over time in select locations.

The Massachusetts Audubon Society provided a set of aerial photographs, dated November 21, 1938, although this date cannot be verified thus far, the timeframe seems accurate compared to other USGS flights in the area. The nearly complete set consists of 183 mostly high quality black and white images at a 1:9600 scale (image 145 is missing). These images lacked the fiducial marks and focal length required to orthorectify them properly, as a result, only the images relative to the intermediate scale analysis were georeferenced using ArcGIS.

Both the 1951 and 1971 sets of images originated from the MacConnell remote sensing and land coverage study conducted at the University of Massachusetts-Amherst. The purpose of this flight was for analyzing the change in vegetation coverage throughout the state of Massachusetts using remote sensing data spanning twenty years. The MacConnell photos are old enough to include fiducial marks imprinted on the film; however, during the many years of use, somehow the corners where the tie-points were to be had been cut off.

These images offered additional challenges beyond the lack of fiducial marks. It is important to recognize the intended purpose of the original image and the impact they have on future users. The function of the MacConnell was to determine the vegetative land cover in Massachusetts: For this reason, MacConnell flew during the spring when all the trees and vegetation were in full bloom. This vegetation, while ideally suited for the original purpose, makes it more difficult to see changes in real estate development. Also, both sets of images, but predominantly the 1951 group, included the analyst's interpretive

markings, which increased the degree of difficulty in both analyzing for our purposes and rectifying (see Figure 3).



Figure 3: 1951 Interpreted MacConnell photo (with white border from distortion)

The 1960 partial set of aerial photographs came from the Massachusetts Highway Department. This set contains the west side of island, which excludes Pocomo Road and Siasconset on the east. This would likely have demonstrated development because, according to real estate records, Pocomo Road began to develop more rapidly during the sixties, and the images should have demonstrated the evolution of this section.

Despite the challenges with georeferencing, this range of aerial photographs provides useful spatial information spanning decades, which is tremendously helpful in constructing the historical GIS and using it for geographic analysis. Each set of images was accompanied by an index allowing alignment of the images in proper order. These images were useful in visualizing the areas of the island that have undergone significant transformations as well as the areas that have been purposefully preserved. The

MacConnell images show that between 1951 and 1971 urban areas on Nantucket had doubled. In 1951, 1,148 acres of the island was urban land with 17 acres of this used for industrial and commercial purposes. By 1971, it was 2,361 acres, 107 of which served as industrial and commercial land. During this period, the greatest increase in land use was for medium to light density seasonal housing (MacConnell 1974).

Orthorectifying the topographic maps went more smoothly than the aerial photographs; mainly because the orientation of the original map did not change as it did with the aerial photographs due to changing flight paths. The original maps came from the USGS. Massachusetts Geographic Information Systems (MassGIS) and the University of New Hampshire posted the digital versions.

As with the aerial photographs, the topographic maps are quite effective in visualizing geographic change, especially when incorporated into an historical GIS and

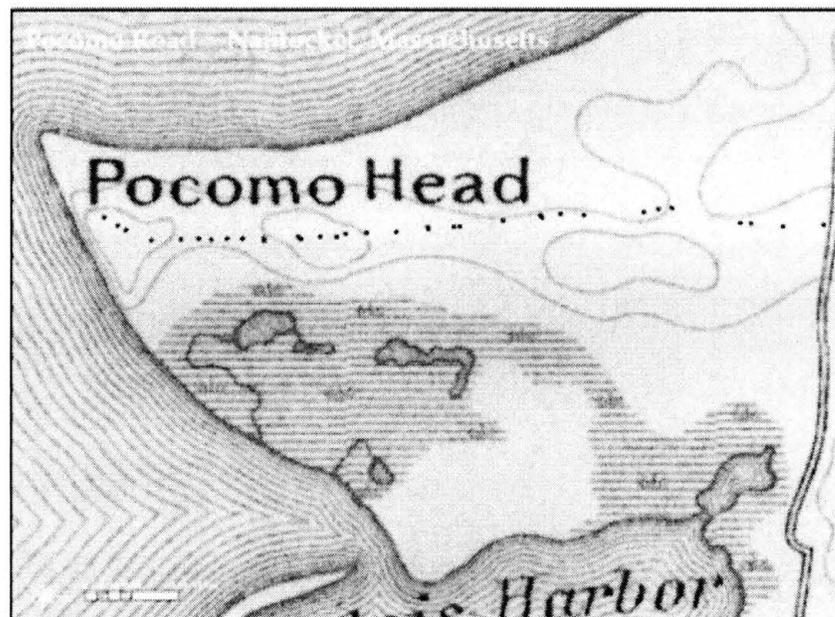


Figure 4: 1887 Topographic Map with GPS Points Overlay

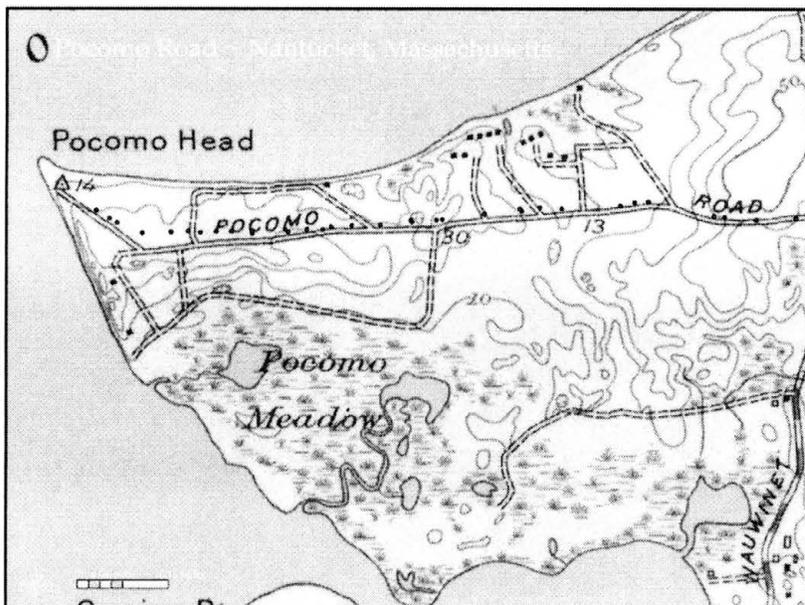


Figure 5: 1951 Topographic Map with GPS Points Overlay

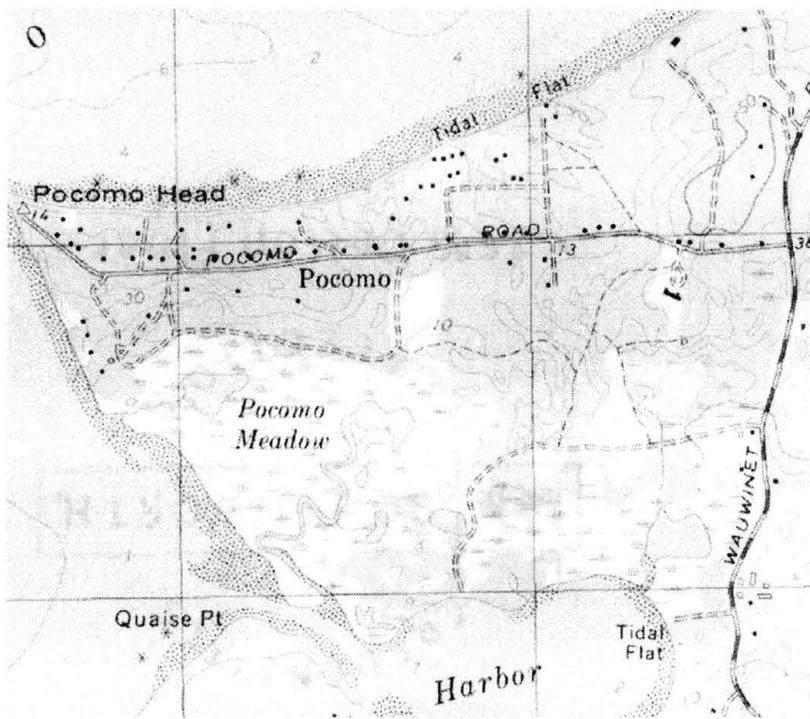


Figure 6: 1977 Topographic Map with GPS Points Overlay

combined with contemporary overlays, such as the GPS points taken in the field to represent buildings within the study (see Figures 4, 5, and 6). These figures show the land

on Pocomo Road as uninhabited in 1887; then show gradual development – increase in roads and buildings – and the conservation of wetlands from the 1880s to the 1950s.

The aerial photographs and topographic maps are useful in representing geographic change on both small and intermediate cartographic scales; however, they are most useful at the latter scale where more detail is available.

Real Estate and Conservation Data

Time did not allow for the research to cover the entire island in terms of real estate data; however, the sample areas present a realistic perspective of the island evolution. Conversations and interviews with the local professionals and residents helped determine the developed areas on which to focus.

To generate a truly representative product, the research must sample the breadth of the local population, which includes a relatively small middle class who live and work on the island year round; a wealthy seasonal tourist set living in newly developed mansions, another seasonal set – typically staying in homes that have been in the family for years; and the downtown area. Originally, the focus was on the historic downtown and the harbor regions; but after surveying the island, it seemed logical to add the Mid-island and seasonal historic district as well.

Historical and contemporary data for properties within these four areas including: records of 584 Real Estate transactions for 232 properties since 1950, which were extracted from registered and recorded land documents from the Nantucket County Registry of Deeds; as well as records of 398 Conservation Land donations and acquisitions from the Nantucket Conservation Foundation. Databases were created using

the historical data from the Nantucket County Registry of Deeds, Assessor's Office, and Conservation Organizations.

Information was transcribed from both recorded and registered land documents from the Registry of Deeds. The records include dates and costs associated with the real estate transactions, the owner's name and primary address, the map and lot number, and any deed restriction associated with the property. This information was entered into a database format to be joined to the base map through hyperlinks.

Similarly, data were retrieved from the Nantucket Conservation Foundation including; the name of the donor, the primary address of the donor, the value of the parcel at the time of the acquisition, location, size of the property, and the year it was acquired, all of which was used to create another database to be attached to the Conservation ArcGIS files. This information relates only to the land owned and conserved by the Nantucket Conservation Foundation; however, smaller databases exist with the current owner, acreage, and year acquired for all other conservation parcels on the island.

Both the real estate and conservation data are useful on multiple scales. The small scale depiction of the real estate data shows the change in average costs of housing from 1950 to 2000 in graph form (see Figure 7). On the small scale, the conservation data depicts the age range of particular parcels of conserved land (see Figure 8). Change in hue and saturation are used as a visual variable to represent the age of the conservation land, with darker shades of green indicating a longer period of conservation and lighter illustrating the newer acquisitions. In an interactive historical GIS, there is the potential for the user to prompt the animation feature to watch the conservation parcels appear at a five second interval, signifying the range of years in which the land was conserved.

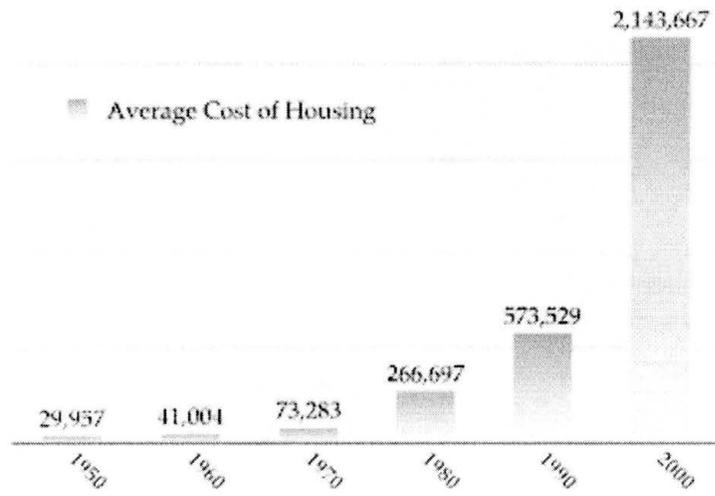


Figure 7: Average Cost of Housing within Four Selected Areas 1950-2000



Figure 8: Conservation Land by Year Acquired

While the small scale representations offer insight into the status of island housing and conservation, the data sets are best suited for the intermediate cartographic scale. A larger scale clearly provides more detail. One can determine how densely built the area is, the proximity to conservation land, and the approximate length of time the land has been conserved. At this scale, the user may also query the abovementioned conservation and real estate databases (see Table 1). The real estate databases function best as hyperlinks because the visual variable to which they are linked are points, and the data are complex, thereby making it difficult to visualize well.

It is important to note that both the real estate and conservation records posed significant challenges with consistency and accuracy. The issue found with real estate data, acquired at the Nantucket Registry of Deeds, is in the discrepancies between recorded and registered land. There are minimal requirements governing the process of recording land at the Registry of Deeds. For example, the notarization of signatures required for recorded land does not offer the purchaser a title to the land. It is the buyer's responsibility to ensure that the transaction was lawful. The Registry of Deeds will not authenticate the information. Registered land, however, has gone through the county Land Court. Once the Land Court approves the transaction, including confirming surveys and title search, boundary lines are indisputable and the buyer is awarded a Certificate of Title. Clearly, this is a prohibitive process that is far more time consuming and costly, and most likely only undertaken by the wealthier buyers. Most buyers record land rather than register it; therefore, there is a greater margin of error in the documents. Also, many of the Land Court documents that were used in this project provided less information about the transaction than did the recorded deeds.

No.	Street	Owner	Primary Address	City	St	Sale Date	Sale Price
2	MAIN	NANTUCKET	PO BOX 13	NANTUCKET	MA		
4	MAIN	DONATO MARK	PO BOX 19	NANTUCKET	MA	9/23/1999	425,000
4	MAIN	McKINSTRY PAMELA	PO BOX 6617	CARMEL	CA	11/20/1981	85,000
4	MAIN	TALSI CONSTRUCTION CORP	35 WILLIAM PATH	W BARNSTABLE	MA	5/1/1981	135,000
4	MAIN	PELESO ROBERT	317 RUSHMORE AVE	HAMAROMECK	NY	10/9/1967	11,040
4	MAIN	McCARTHY HARRIET	1125 WHITMAN ST	PITTSBURG	PA	7/30/1966	13,241
4	MAIN	STALIAITA HENRY		FOREST HILLS	NY	7/3/1948	0
5	MAIN	EVANS MARYLIN	PO BOX 17	NANTUCKET	MA	6/29/1990	630,000
5	MAIN	PERELMAN FRANCES	3 MACY LANE	NANTUCKET	MA	3/14/1986	335,000
5	MAIN	FRANK IVAN	46-02 BROADWAY	ASTORIA	NY	6/20/1977	315,000
5	MAIN	MITCHELL ROBERT		NANTUCKET	MA		
6	MAIN	COFFIN RICHARD	P O BOX 1	NANTUCKET	MA	11/20/1997	27,000
6	MAIN	HUNNEFIELD WILLIAM	150 E 60th ST	NEW YORK	NY	7/15/1965	20,391
6	MAIN	MORRIS PHILLIP		NANTUCKET	MA	12/20/1957	0
6	MAIN	MURRAY CLINTON		NANTUCKET	MA	11/7/1949	3,000
8	MAIN	BKBY JACQUELINE	PO BOX 67	NANTUCKET	MA	5/16/1983	175,000
8	MAIN	McELDERRY JOHN	22 INWOOD RD	CHATHAM	NJ	4/17/1969	15,790
8	MAIN	SIASCONSET BOOK STORE		NANTUCKET	MA	10/27/1949	0
19	MAIN	LYNCH KAREN	33 HOMESDALE RD	BRONXVILLE	NY	3/16/2000	1,175,000
19	MAIN	POTTER HELEN	605 S MAIN ST	LEXINGTON	VA	9/2/1983	267,500
19	MAIN	HILL KATHERINE		NANTUCKET	MA	8/28/1943	199
20	MAIN	RHODES JO	PO BOX 80	BALLSTON	NY		
22	MAIN	KELLY ART	20 S CLAR	CHICAGO	IL		
23	MAIN	PALEY WILLIAM	1133 CHAIN BRIDGE RD	MCLEAN	VA		2,300,000
23	MAIN	KREITLER RICHARD	1131 MARION DR	CHARLOTTESVILLE	VA	9/15/1996	600,000
23	MAIN	BRADSTREET EDWARD	167 McKINLEY AVENEU	NEW HAVEN	CT	5/3/1988	700,000
23	MAIN	TOOLE EDWARD	905 RIDGE ROAD	HAMDEN	CT	1/26/1984	350,000
23	MAIN	CAHOON CHARLES		NANTUCKET	MA		0
26	MAIN	VEGHTE RO	1300 NORT	WILMINGTON	DE		
27	MAIN	LOURIE SH	PO BOX 37	NANTUCKET	MA		
28	MAIN	ARNOFF ARNOLD	67 STAG L	GREENWICH	CT	12/23/1959	18,000
28	MAIN	FAGLEY GRACE		GROSSE POINTE	MI		0
29	MAIN	NEWQUIST AILEEN	300 EL BR	PALM BEACH	FL	8/22/2001	2,400,000
29	MAIN	LEEHAN EVELYN	2871 N OCEAN BLVD	HOBE SOUND	FL	9/2/1999	2,200,000
29	MAIN	BRADLEE GENE	700 NH AVE NW	WASHINGTON	DC	6/18/1987	645,000
29	MAIN	LARSON MARGARET	254 MAIN STREET	SOUTHPORT	CT	10/15/1982	277,000
29	MAIN	FAWCETT BARNES MARGARET		SAN DIEGO	CA	9/25/1900	1

Table 1: Intermediate Scale - Real Estate Transactions 1950-2000 Main Street Siasconset

Another challenge with the real estate data is that many of the transactions have taken place intra-family, and the sales prices are often under a dollar or much lower than market value. While this does not accurately represent the increase in property values, it does tell a part of Nantucket history and the sentimental value placed on the land.

The concern with the conservation data lies in the accuracy with which the year of acquisition was recorded. As mentioned earlier, the data were extracted from a database compiled by the Nantucket Conservation Foundation. The current staff did not collate this data, and stated that there may be some inconsistencies. To confirm the transactions, the database was cross-referenced with paper maps put out by the Nantucket Conservation Foundation. These maps contain parcels owned by other conservation organizations as well. After much research, it became evident that many of the parcels were transferred from organization to organization for either political or managerial reasons. These transactions were not clearly presented through the database or maps; therefore, there are likely some inaccuracies that may be cleared up by consulting the other conservation organizations. A few attempts were made to access data from the other agencies, but to no avail.

GPS and Digital Photography

Each of the properties within the four study areas was precisely located with GPS readings. Readings were taken at the center of each driveway, flush with the edge of pavement. Occasionally, properties shared a driveway. In these instances, the GPS point represents each of the buildings accessed by the driveway. When a property did not have a driveway, we took the location at the edge of pavement parallel with the center of the front door. For the occasions when buildings or tree coverage blocked satellite readings, we positioned ourselves directly across the street from the appropriate point.

While taking the GPS points, the project team took photographs of each individual property and the back and front views of the street. The historical GIS has

hyperlinks to these photos, providing the user an accurate portrayal of the actual site. Selecting the lightning bolt in ArcGIS illuminates the GPS points. Clicking on the illuminated points allows the user to choose which of the images to view. The photos of the streets capture the general aesthetic of the neighborhoods, and the images of the specific properties demonstrate the variety of influences on land values such as location, size, occupancy, and proximity to open space. One may speak of a seasonal cottage on the beach costing roughly two million dollars, but the photograph of a small three room property located a few feet from the next house, on either side, really emphasizes the value placed on location or status.

Decennial Data

The United States Census Bureau's methods of aggregating data evolved decennially. Most of the census data available for the timeframe of the study are available only by county, which for Nantucket is the entire island; therefore, to visualize the spatial temporal patterns consistently, the project captures the change in demographics, island wide from 1950 to 2000. This representation includes: 1) change in number of housing units, 2) change in population, 3) change in median household income, 4) the average cost of housing (based on data collected for the four selected areas of study), 5) properties within the old Historic District, and 6) the change in conserved land in acres. Also included at this scale is the town's zoning map. This type of data at this small scale provides a general but meaningful overview of the significant changes in land use over the past fifty years. Sources for these data include: Federal and State Census; Nantucket Planning and Economic Development Department; Nantucket Conservation Foundation;

MassGIS; Nantucket Historic District Commission. Visualization of the decennial data takes place using animation and multimedia software, such as Macromedia Flash.

Supplementary Resources

In addition to the ArcGIS files, aerial photographs, GPS points, and georeferenced maps, this Nantucket Historical GIS contains links to excerpts from interviews, oral histories, and other text; for example, documents containing information regarding deed restrictions, and zoning bylaws.

The oral histories and personal interviews are an important part of the analysis because they humanize the data and offer insight into the attitudes of and motivation behind those who have influenced the island development, and also communicate the views of those impacted by the changes. For example, reflecting back to the beginning of his revitalization scheme, Walter Beinecke Jr. claims to have been inspired to plan tourism by a federal report promoting tourism as a source of economic development; an approach not considered viable until after World War II. Mr. Beinecke also recalls some creative approaches to deal with undesirable real estate speculations before the zoning bylaws were adopted (Newhouse 2002). For example, someone had proposed a taproom on Main Street, which many within the community found inappropriate. In 1955, a group of concerned and well established citizens approached the Nantucket Historical Association to ask them to purchase the building, “not to keep but to tie it up and put deed restrictions on it” (Newhouse 2002). When they realized the process would take too long, Mr. Beinecke along with George Jones and Henry Coleman formed the Nantucket

Historical Trust; purchased the building with funds from a commercial mortgage; and sold the building with a deed restriction attached just days later (Newhouse 2002).

Around 1984, a man called Jesser Benn Wainright advocated for changing the one acre zoning around Polpis Road (near Pocomo Road) to three acre zoning to keep down the density of buildings. The town meeting rejected the proposal, primarily because Mr. Wainright was not a longtime Nantucket resident. However, after serving several years as a consultant to the board of selectmen, Mr. Wainright's status changed, and the zoning plan was accepted (Newhouse 2002).

Many of the published interviews and oral histories reveal the impacts and outlooks of the more affluent and influential members of the community. This, of course, provides a biased perspective of the changes on the island. For a more balanced examination, we conducted interviews and conversations with the average year round citizen. Through such talks, it became apparent that despite the high cost of living, even people of moderate means place a high value on limiting development and continuing conservation efforts. For example, Peggy Lubin, a longtime resident of Mid-island rents a room to an unrelated woman and her child and another room to an unrelated man in her small home to earn the income required to live on the island. When asked about developing land and the prices of real estate, Peggy stated she would not have it any other way. She scorns any mention of construction on island; and says she feels safe there and takes great pleasure in the natural aesthetic beauty around her. Peggy started summering in Siasconset as a young child with her family to escape the heat of Manhattan where they resided the rest of the year. It was during her summer holidays that Peggy became enchanted with the quiet island and the tremendous sense of community and safety she

felt during each visit. Peggy also spoke highly of the relationships she formed with other families who returned each summer as well.

While these data are not easily mappable, they are relevant to the historical and geographic analysis and interpretation. These data are accessible at multiple scales as well. If the oral history or zoning ordinance relates to one of the four selected areas, one may access the available documents through a hyperlink within the related area polygon. If the information pertains to the island as a whole, it will be available through a link in the Table of Contents under “Supplementary Materials” (See Appendix B). Some of these items are chronicled decennially, if it is applicable. For example, the first zoning committee formed and appeared in front of the Board of Selectmen in the 1950s, however, the selectmen voted down their proposal to supervise development. It was not until March of 1972 that zoning bylaws were enacted (Mooney 2000). The historical fact will be listed under “1950” and the second under “1970”.

The supplementary materials are designed to enhance the potential for dynamic analysis, which should provide a more balanced understanding of the historical geographic change.

CHAPTER V

THE FUNCTION OF THE NANTUCKET HISTORICAL-GIS

The function of the historical GIS is to organize and contain the heterogeneous sources so frequently used by historical geographers. Historical geographers try to understand the past and the influence it has on the present (Nash and Graham 2000). This historical GIS is constructed to capture these distinct data sets for more accurate analysis and interpretation. Layering the GIS parcel, building, conservation and GPS point layers over the georeferenced historical maps and aerial photographs; and allowing the user to activate and deactivate the various layers as well as connecting to spatially referenced supplementary databases, text, and images provides for dynamic analyses of the island's evolution. Providing historical geographers a way in which to encapsulate a multitude of geographic data; and allowing them to select which variables to represent at a particular time, offers the potential to prompt new questions concerning the social, economic and environmental structure of a place.

Incorporating Social Theory

Historical geographers traditionally draw on various social theories in their research to help organize and understand the less distinguishable human components of spatial variability. It is the nature of geography to explore, represent, and justify the driving forces of geographic change (Cutter, Golledge and Graf 2002). In an effort to

incorporate social theory into this historical GIS, an emergent attempt is made to use Anthony Giddens' structuration theory as a theoretical framework to interpret the spatial change on Nantucket from 1950 to 2000. This project explores the potential to map the variables associated with such analyses. Giddens' theory is integrated because he promotes a particular geographic and historical focus. He stresses the importance of spatial temporal patterns reflective of the distribution of power and enduring social structure (Harris 1991; Giddens and Pierson 1998). Giddens' structuration theory offers an abstract perspective for analyzing the relationship between the individual and agency (Harris 1991). He emphasizes the duality inherent in society where individuals create the institutions that govern them through recursive social behaviors (Giddens 1984). He explains:

'Society' can be understood as a complex of recurrent practices which form institutions. Those practices depend upon the habits and forms of life which individuals adopt. Individuals don't just 'use' these in their activity but these life practices constitute what the activity is. (p. 76-7).

For Nantucket, this demonstrates the value the community places on its heritage and historical amenities; the institutions created to maintain and support these features; and the repercussions such attitudes and organizations have had on the society (See Figure 9).

Sense of Place – Individuals: As explained in chapter one, in the late nineteenth century, after the whaling industry declined, and many affluent residents moved off the island Nantucketers continued to maintain their strong sense of place. They had a great affinity for the Quaker traditions that shaped the development of the island, and this appeal still holds today

To provide the end user with a deeper understanding of the traditional mindset of the community, it is important to capture these significant sentiments in this project. Historical and contemporary images, interviews, and oral histories are tangible ways to represent the strong sense of place that is such a part of Nantucket culture. One can see, by sifting through the images and historical narratives that despite periods of rapid development, the effort to retain the historical aesthetic has prevailed.

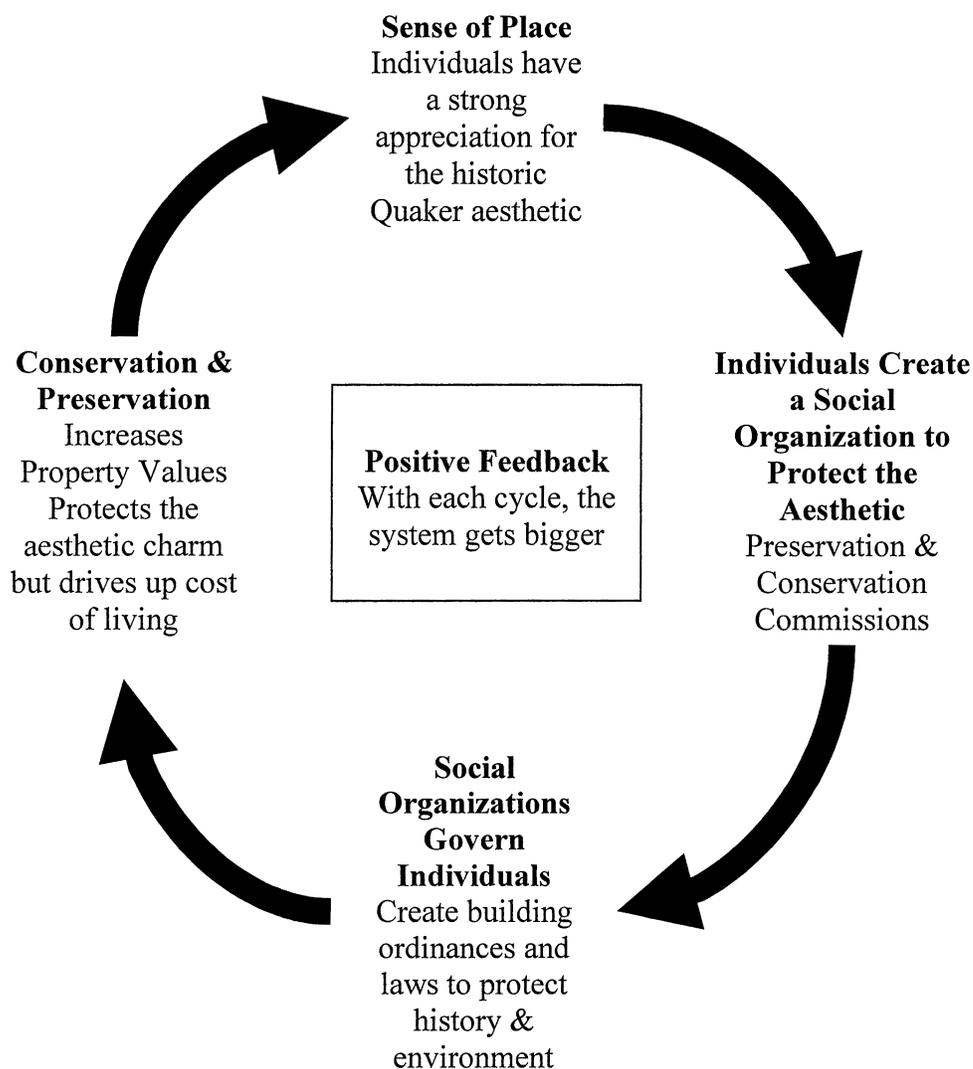


Figure 9: Nantucket Structuration Cycle based on Anthony Giddens' Structuration Theory

Individuals Create Social Organizations· To protect the historical aesthetic, Nantucketers founded numerous social organizations beginning as early as 1894 when a group of concerned citizens formed the Nantucket Historical Association. Nantucket was one of the first communities to place importance on protecting their heritage and environment. Organizations with similar objectives have continued to form over the years including; the Historic District Commission – 1955, the Land Preservation Trust – 1974, the Nantucket Preservation Trust – 1997, and the Nantucket Preservation Alliance – 1999. These organizations have worked to raise money to purchase, restore, and maintain historic buildings; as well as to encourage traditional building practices.

In addition to, and perhaps motivated by, the focus on historic building Nantucketers also established many conservation organizations. Instead of simply promoting traditional building practices, the community also put forth tremendous efforts to conserve the open space that residents and tourists value so much. In 1963, the Nantucket Conservation Foundation was formed; and in 1983, the people voted to adopt legislation to establish the Nantucket Land Bank, which allows the Town of Nantucket to add a two percent tax on real estate transactions to purchase open space.

The historical GIS illustrates these community shaping movements in a number of ways. The GIS includes data files that capture the impact of the historical and conservational organizations including an outline of the Historic Districts in Historic Downtown Nantucket and Siasconset and conservation parcels to map the island development. There is also a searchable database of conservation parcels that one may use to determine when a particular parcel became part of the open space inventory; how

much the parcel was worth at the time of acquisition; who donated the land; and the donor's primary residence.

Social Organizations Govern Individuals Such social organizations as the above mentioned conservation and preservation groups have had tremendous influence on the community. Beyond the visualization of the conservation and preservation efforts, the multimedia project provides links to relative laws, ordinances, and guidelines put forth by or due to the work of these organizations including; Massachusetts General Laws (MGL) Chapter 40A and 40B Zoning and Regional Planning; the Nantucket Land Bank's two percent taxation towards conservation land (MGL Chapter 3 § 39); and the publication of various guides to building and preservation on the island.

Conservation and Preservation Limits Development and Promotes Sense of Place: The long standing culture of protecting the aesthetic charm of the island has clearly shaped the land use patterns on Nantucket. A significant objective of this project is to visualize the impacts of the conservation and preservation movements on the island. Nantucket's efforts to remain the same have driven up the cost of living, which the dramatic increase in the cost of housing best exemplifies.

The historical GIS represents the change in housing costs and land use patterns through GPS points that indicate the 232 properties in the four selected areas of study. Each GPS point and each area links to historical and contemporary aerial photographs, images, maps, databases, documents, and websites that document the history of that property or location from 1950-2000. There is a database listing each available real estate transaction within those fifty years for each point. This database includes the value of the

property at the time of transaction, the owner, the owner's primary address; and date of transaction.

Collectively, the databases chronicling changes in property values and conservation land; the links to the various laws and regulations; and the oral histories captured in the historical GIS demonstrate that the more emphasis placed on preserving the aesthetic charm and strong sense of place so deeply associated with Nantucket, the higher property values and the cost of living escalate.

The historical GIS consolidates data that represents such patterns into one hub for synthesized interpretation with a particular emphasis on multi-scale analysis. Scale is an important challenge to historical geographers who often integrate data from varying scales in their research (Butlin 1993). "Scale is fundamental in our cognition, measurement, representation, and presentation of geographic information (Brown et al, 2000, p. 357)."

Small Scale

Straightforward analysis at the small scale provides a general overview of the island wide trends from 1950 to 2000 including: ratio of conserved to developed land; property values; household income; and population. Viewing the map and using the animated features demonstrates a significant increase in conservation land since 1965. The charts show a significant change in median household income, population, and cost of housing. Consider Figures 10 and 11 in conjunction with Figures 12 and 13 below.

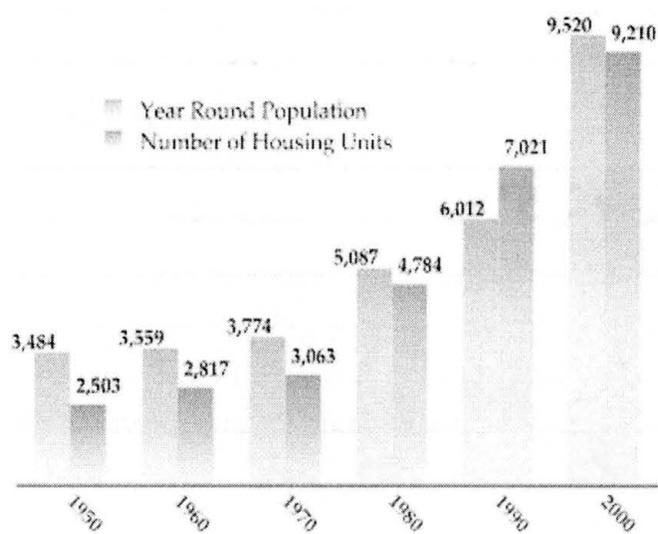


Figure 10: Change in Population and Number of Housing Units 1950-2000

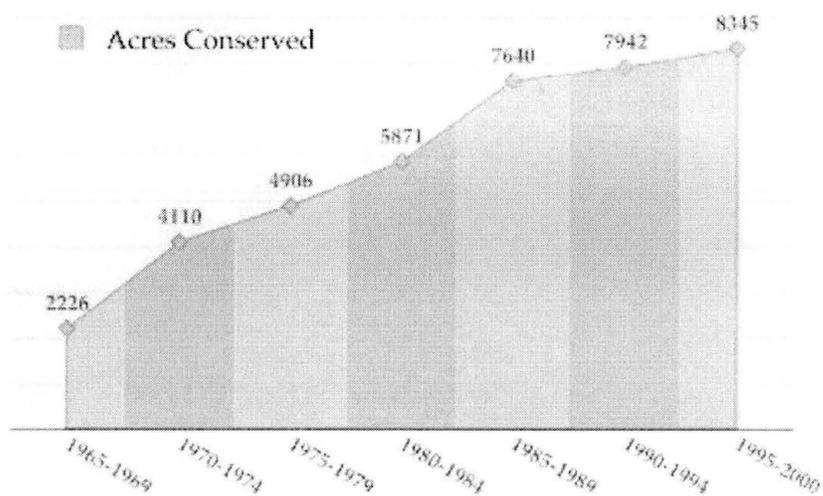


Figure 11: Conservation in Acres Nantucket, MA, 1965-2000

Based on this information, one could surmise that population and the housing stock grew steadily until the 1990s when there was a greater increase; gain a rough idea of

development and conservation patterns, and establish that there was a significant increase in the cost of housing.

The zoning maps are useful for island wide analysis. At the small cartographic scale, one may examine the relationship between the zoning laws, instituted in February 1972, and conservation land (See Figures: 12 and 13). Figure 12 shows a substantial portion of the island zoned as Limited Use General – 1, 2, and 3 (LUG-1, LUG-2, and LUG-3), which includes the study area, Pocomo Road. Without prior knowledge of the bylaws associated with each zoning code one may still infer that the land located within the LUG zones would be more valuable based on the fact that so much of the land within this zone is conservation land as seen in Figure 13. One may also deduce that the properties within the historic districts would be more valuable than the properties located in Residential – 10 (R-10) due to the proximity to the coast, the nearness to the airport, as well as the fact that Downtown and Siasconset are part of the Old Historic District (the entire island is registered as a National Historic Place, but Downtown and Siasconset are noted as particularly historical.) This is all useful information, and offers insight into the development and conservation trends. However, the generalizations required for such a small scale representation limit the potential for accurate detailed analysis. To refine assumptions made at the small scale, it is necessary to approach further analysis at a larger scale.

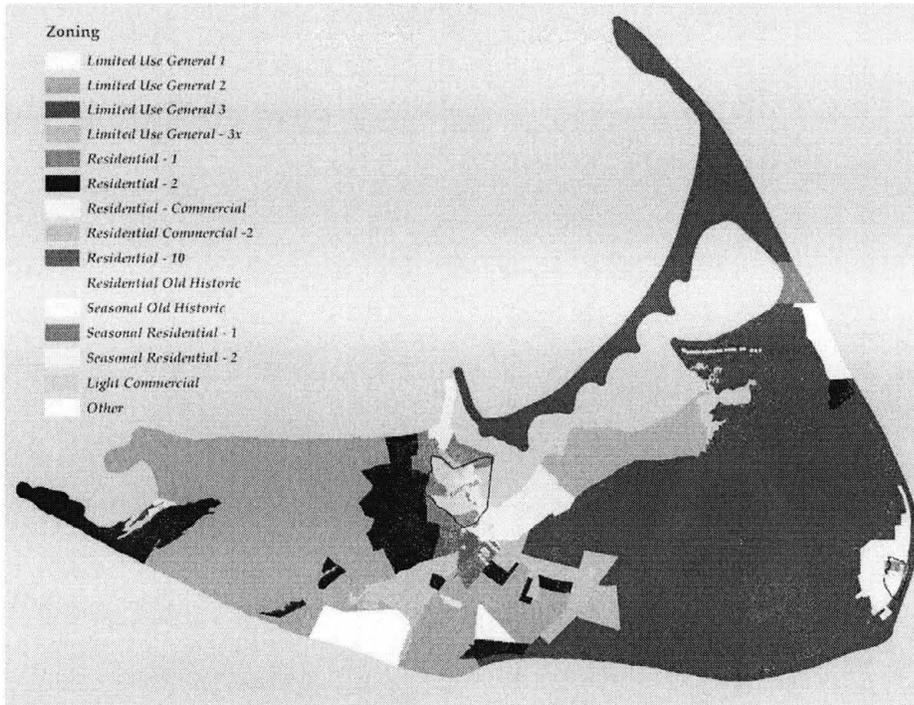


Figure 12: Nantucket Zoning

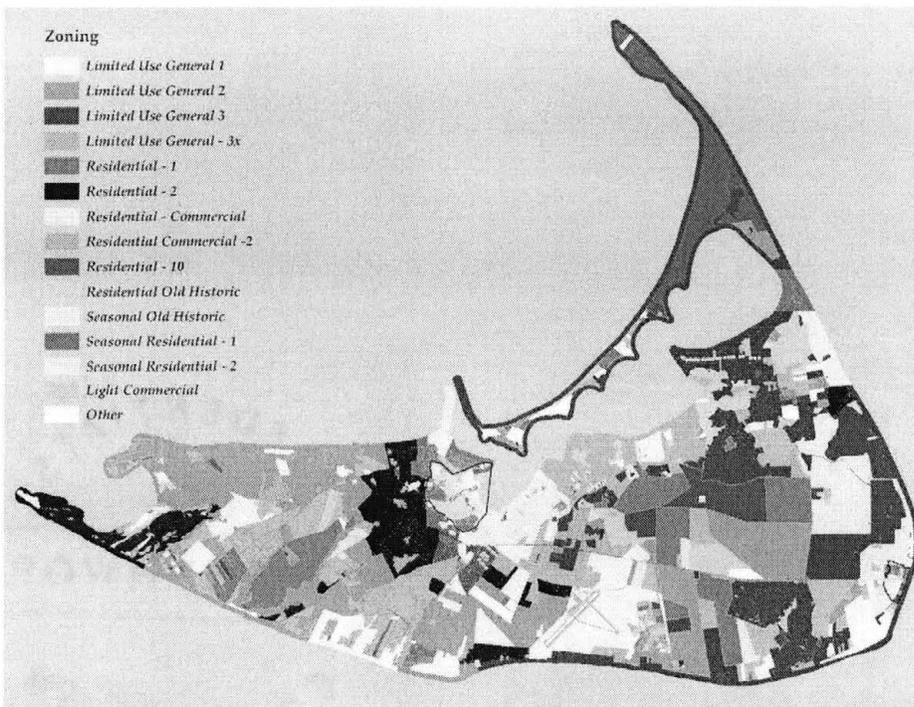


Figure 13: Nantucket Zoning with Conservation Land Overlay

Intermediate Scale

A more detailed analysis is possible at an intermediate cartographic scale. There is, of course, less generalization with this larger scale, which may make patterns in the data more discernible. Looking at the intermediate scale maps of the four selected areas – Historic Downtown, Mid-island, Pocomo Road, and Siasconset – one may notice significant differences in the density and sizes of buildings; or the proximity to long standing versus newly acquired conservation land. At this scale, from the maps alone, it becomes evident that there is considerable difference between the land use in Mid-island and Pocomo Road as well as between Historic Downtown and Historic Siasconset. Mid-island has smaller parcels and buildings located much closer together than the coastal properties along Pocomo Road. (Figures 14, 16, 18, and 20 are all of the same scale).

The charts representing the average cost of housing for each of the four selected areas show that property values in the Historic Downtown region and Pocomo Road have very similar patterns of change (See figures 15, 17, 19, and 21). Both areas witnessed standard price increases until the 1980s when real estate prices escalated nationally, but Historic Downtown increased at a much faster rate. The intermediate scale charts show a dramatic difference in sales prices for the four selected areas in the 1990s and 2000.

At the intermediate scale, the historical and contemporary topographic maps best visualize the spatial temporal change on the island. The maps of 1887 show few roads and structures outside of Historic Downtown and Siasconset. The 1945 and 1951 maps show the built environment on the island expanding with roads near Pocomo Road and Mid-island. The most contemporary topographic maps from the 1970s show a dramatic change in built up areas.

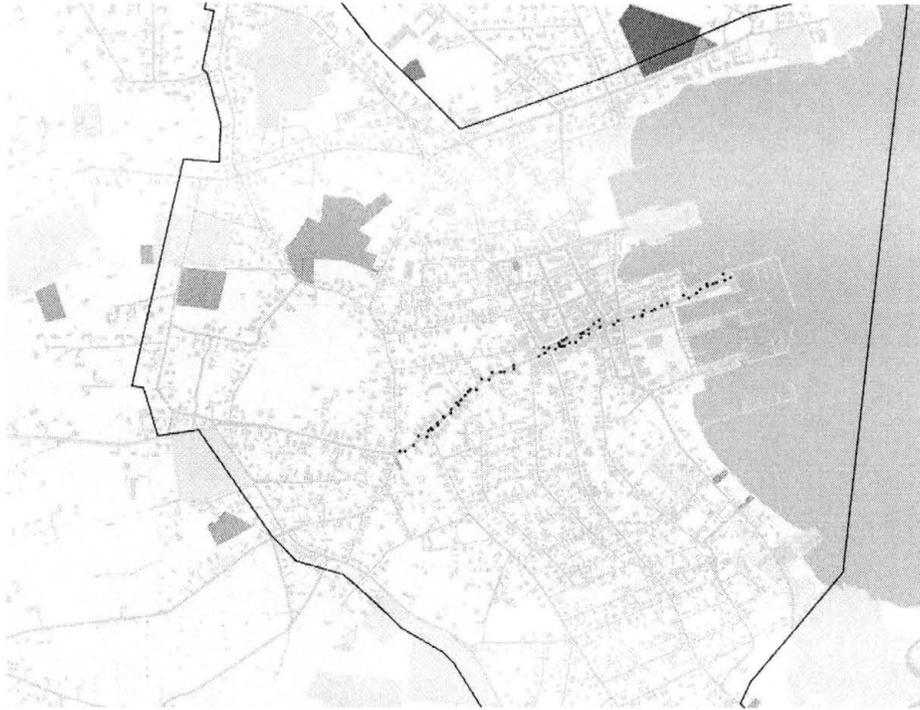


Figure 14: Intermediate Cartographic Scale – Historic Downtown Nantucket

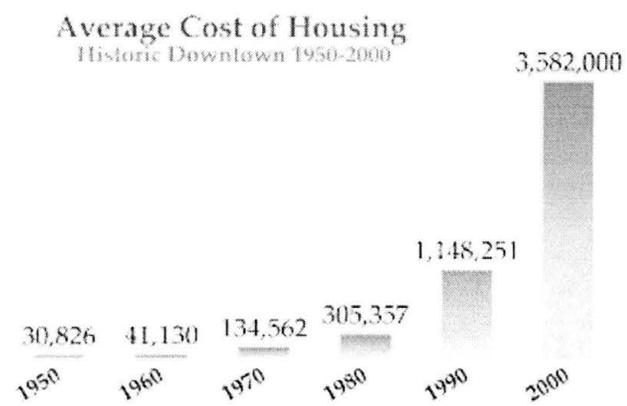


Figure 15: Average Cost of Housing - Historic Downtown Nantucket



Figure 16: Intermediate Cartographic Scale – Mid-island

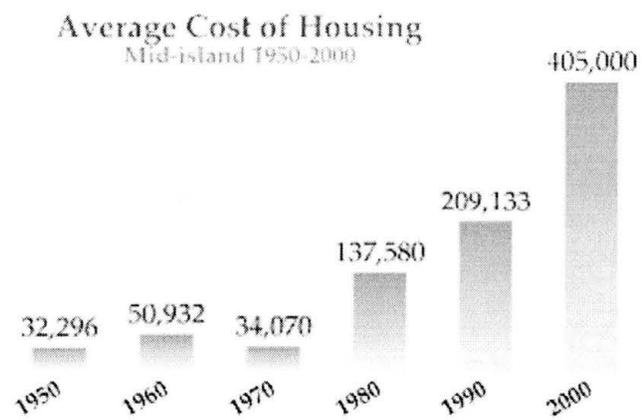


Figure 17: Average Cost of Housing – Mid-island

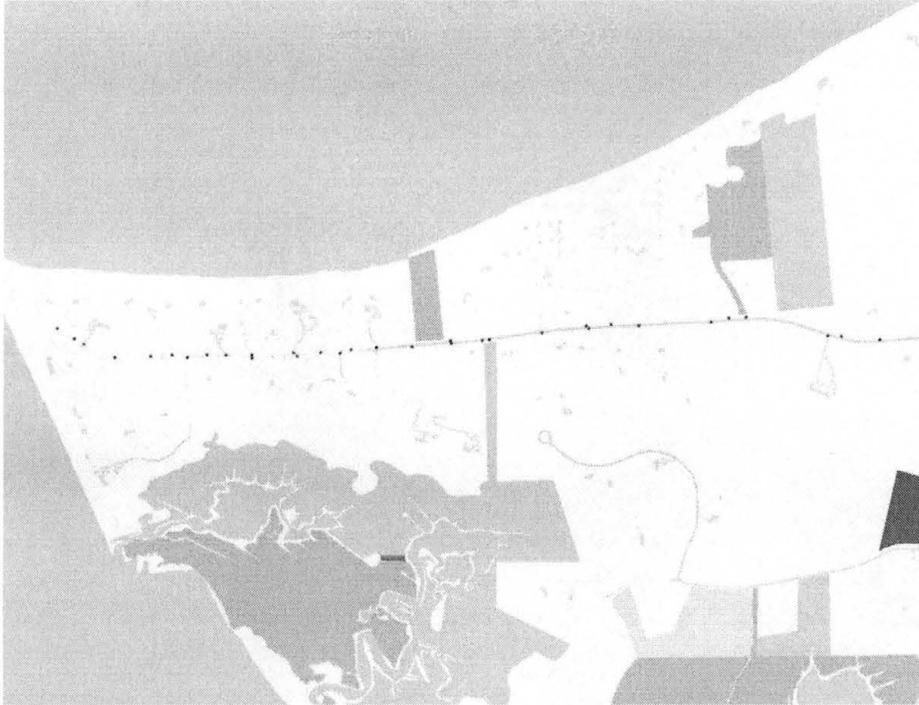


Figure 18: Intermediate Cartographic Scale – Pocomo Road

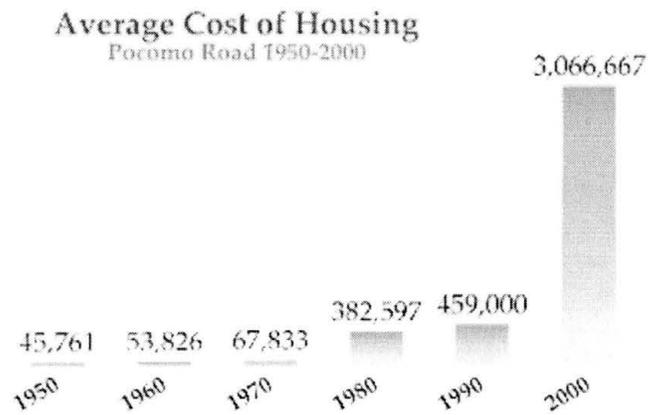


Figure 19: Average Cost of Housing – Pocomo Road

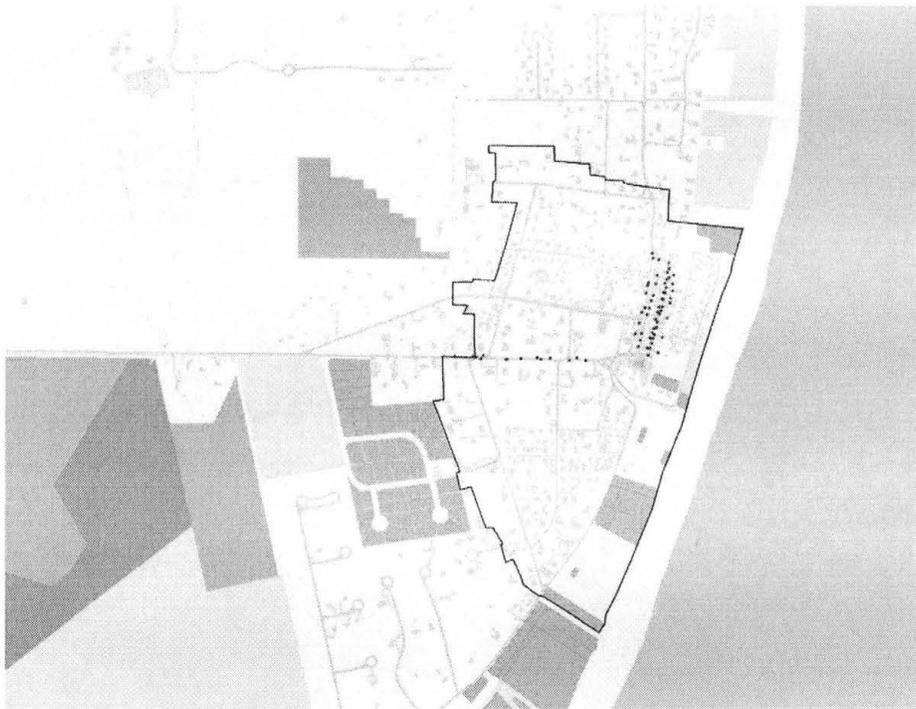


Figure 20: Intermediate Cartographic Scale – Siasconset

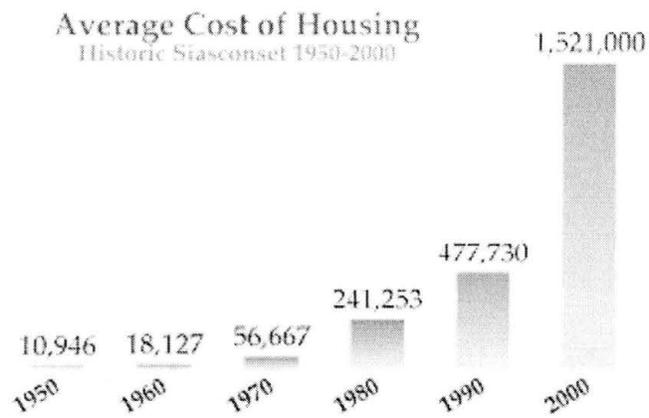


Figure 21: Average Cost of Housing – Siasconset

The visualizations afforded through the use of the georeferenced aerial photographs, which represent well the spatial temporal change further support the empirical analysis (See Figures: 22, 23, 24, and 25). From these images, one can see that in 1951, the Mid-island was not developed; however, by 1960, roads were constructed and housing began to build up. By 1971, the area became more densely populated; and in 1998, Mid-island was a fully developed residential area. The georeferenced images with the GPS overlay demonstrate the temporal pattern of development of Mid-island.

Studying these diverse sources at the intermediate scale may prompt questions about the development of each of the different regions within the study. Real estate databases exist for each of the four areas. Querying or sorting these spatially referenced databases may reveal patterns in the evolution of the island.



Figure 22: Mid-island 1951



Figure 23: Mid-island 1960



Figure 24: Mid-island 1971



Figure 25: Mid-island 1998

Based on the 1950s data, one can begin to distinguish between the social and environmental significance of each of the four areas. According to the real estate records, Siasconset was the most affordably priced property with an average cost of \$10,946. There were eighteen transactions, five of which were less than one hundred dollars, implying intra-family transfers (average costs do not include any transactions well below the market value). An important distinction is that local residents with Historic Downtown addresses owned all but two of the properties in Siasconset; comparing this information with the images of the houses, it becomes evident that these function as seasonal vacation homes. In downtown Nantucket, there were twenty-one real estate transactions circa 1950, nine of which were intra-family. The average cost for these

properties was \$30,826. Only four of the properties were owned by off-islanders, and only two of the owners were from out of state. The average sales prices were the second most affordable on the island at this time. Mid-island offered the next most affordable land purchases with the average of \$32,296. Here there were four real estate transactions, only two of which included buildings. An important distinction is that all sales transpired between local residents. Pocomo Road, on the other hand, had five sales all of which were for vacant land purchased by off islanders for an average price of \$45,761. While none of the land was officially conserved, there were large expanses of open space surrounding both Pocomo Road and Mid-island at this time. The advantage the Pocomo Road area has over the Mid-island area is access to ocean views. In the 1950s, there were neither zoning laws nor conservation organizations to protect the land in either area.

In the 1960s, Siasconset was still the most affordable section of the four selected areas with properties costing an average of \$18,127. There were twenty-six real estate transactions out of the properties surveyed in the study only one of which was intra-family. The biggest change in information was that most recently only two of the primary addresses for owners are from Nantucket. Historic Downtown continued to be the second most affordable, based on the selected data with an average price of \$41,130. For this timeframe, there were twenty transactions with two intra-family. The number of off-island ownership increased from four to nine. This was the point in time and area in Nantucket history when and where Walter Beinecke and his associates began to have a major impact on Nantucket, economically, socially, and environmentally. Five of the twenty purchases were by Sherburne and Associates, a company co-owned by Mr. Beinecke and Lawrence Miller; and Osceola Operating Company, another corporation of

Walter Beinecke, Jr., bought two more properties. There were twenty-seven sales on Mid-island, nine being intra-family transfers, and two of which sold to off-islanders. The average cost of housing in this section was \$50,932. The trend in this area, during the 1960s was one family buying several neighboring lots or one large lot and dividing it into smaller lots. The 1960s saw fourteen real estate transactions on Pocomo Road, with three purchased by Nantucketers and four selling for less than one thousand dollars. The average cost for Pocomo Road was \$53,826.

The 1970s saw average sales prices decrease to \$34,070 in Mid-island making it the most affordable area of the study during this time period. There were twelve transactions, eight of which sold for fifteen thousand dollars or less and three of those sold for less than one dollar. All properties sold to local owners. Similar to the pattern of the 1960s, owners divided the land at Mid-island into smaller lots, which explains the decrease in price. Siasconset was the second most affordable location with an average cost of \$56,667; yet it is important to remember that this was seasonal housing. There were nineteen transactions two of which sold for less than one hundred dollars. All but two homes sold to off islanders. Pocomo Road had eight sales with the average sale price of \$67,833 in the 1970s three of which went for less than a dollar. One lot sold to a Nantucket resident. In the 1970s, downtown Nantucket had the most expensive transactions of the study areas with prices averaging \$134,562. There were thirteen transactions, three for less than one hundred dollars including a property purchased by Walter Beinecke for \$56,000 and sold two days later for \$99. Nantucket residents made four of the sales.

Mid-island remained the most affordable area of the study in the 1980s with an average housing cost of \$137,580. There were twenty-four transactions in the area. Off islanders purchased six of these properties. Siasconset land values were the second most affordable selling at an average of \$241,253. Nineteen transactions took place; three of which transferred for less than a dollar. Two properties sold to locals. Downtown Nantucket saw eighteen transactions with average costs of \$305,357. One property was donated to the Nantucket Historical Association. Pocomo Road became the most expensive location with sixteen properties sold at an average sale price of \$382,597; three of these for less than one dollar; and only one purchased by a Nantucketer.

Mid-island remained the most affordable area of the study in the 1990s with the average cost of housing at \$209,133. There were fifteen transactions with only two purchasers from off island and one transfer below one dollar. Seasonal housing in Pocomo Road became the second most affordable with average costs at \$459,000, but only six sales, none by locals. Seasonal housing in Siasconset prices averaged \$477,730 with twenty-seven sales, four of which were less than a dollar. Downtown Nantucket became the most expensive section of town with twenty sales averaging \$1,148,251. There were, however, two intra-family transactions below a dollar.

In 2000, prices increased dramatically. Two sales at Mid-island averaged \$405,000. Seasonal housing in Siasconset went for \$1,521,000 for five transactions. Pocomo Road sales indicated three transactions with an average price of \$3,066,667. Finally, downtown Nantucket had five sales with an average cost of \$3,582,000.

The fluctuation in Nantucket real estate trends over the past fifty years are represented well by the spatially referenced databases. Sifting through the records, clear

patterns of development are established. The historic districts of Downtown and Siasconset grew in popularity and price due to the efforts Walter Beinecke Jr. and his associates. As these historic waterfronts gained in status, year-round residents took advantage of the escalating prices and either moved off island or relocated to a more affordable neighborhood. Pocomo Road and Mid-island began to develop during the same timeframe; however, owners on Pocomo Road built fewer, albeit much larger, seasonal homes on larger plots of land while owners at Mid-island gradually divided up lots and the area became more thickly settled.

By incorporating the zoning maps, and the picture becomes more defined. These zoning maps combined with the hyperlink to the zoning bylaws and deed restrictions confirm that while all real estate values are high overall on the island, there is still a hierarchy in Nantucket real estate. The properties located on Pocomo Road are within the LUG-3 zoning district, which means they have a fifty foot minimum buffer of “permanently restricted and undisturbed open land between proposed lot line” (Nantucket Zoning Bylaws 1972). The only relief from the requirements in LUG-3 zoning district is if the zoning board finds the topography has changed, perhaps due to erosion or accretion, or they find it necessary to protect the natural resources.

The properties located on and around Pocomo Road also have deed restrictions, which prevent the owners from renting their summer homes to anyone. The association of residents instated this restriction to prevent environmental degradation and to keep the population density at a minimum. With the deed restriction in place, it is likely that many of the mansions constructed along Pocomo Road remain vacant for the majority of the year. Such restrictions add to the appeal of the area as well as the value of the land for

those who can afford it and simultaneously promote feelings of exclusion for those who cannot.

The zoning code for the study area in Mid-island is Residential – 10 (R-20). R-10 zoning allows for two dwellings per lot as long as one of the two is a secondary dwelling and that the two dwellings are under the same ownership. Year-round residents primarily occupy the Mid-island area many of whom take advantage of the R-10 zoning to earn income, by either renting or running a business out of the secondary dwelling. Setback requirements are also smaller in R-10 than in LUG-3. These facets of the historical GIS demonstrate the disparity between the opportunities afforded the affluent seasonal residents and the moderate income year-round residents.



**Figure 26: Zoning Map – Historic Downtown
(Residential Old Historic and Residential Commercial)**

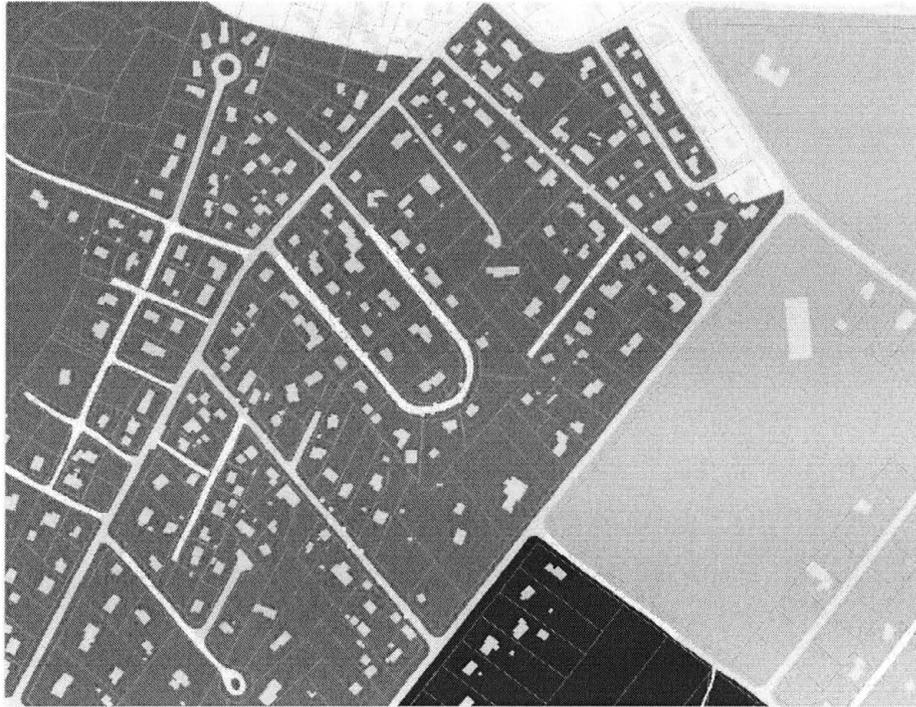


Figure 27: Zoning Map – Mid-island (Residential 10)

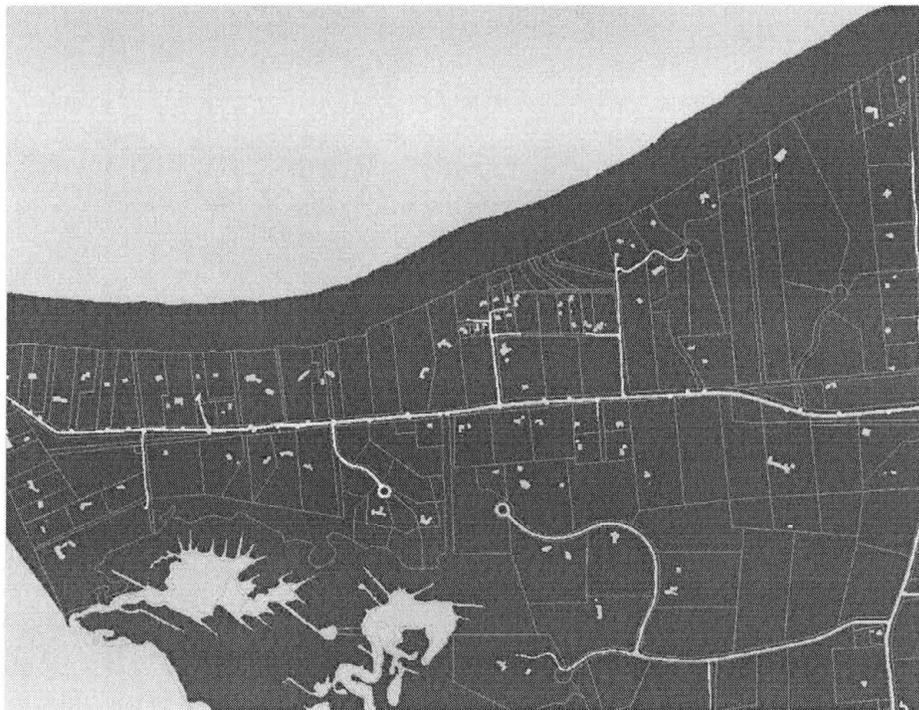


Figure 28: Zoning Map – Pocomo Road (Limited Use General - 3)



Figure 29: Zoning Map – Siasconset (Seasonal Old Historic, Seasonal Residential 1 and 2)

Large Scale

At the large cartographic scale, data includes individual property databases within the four selected areas. Each database contains all available real estate transactions between 1950 and 2000, including the date of transaction, sale price, primary address of the owners, and contemporary images of the individual buildings. Each conservation parcel links to an individual database indicating the organization that owns the land and the year they acquired it. A more detailed database exists for the parcels owned by the Nantucket Conservation Foundation.



Figure 30: Hyperlinks to GPS Points – Large Scale Analysis

The 232 selected properties have hyperlinks to relative images, databases, documents and URLs. For example, in ArcGIS, one may select the lightning bolt icon to activate the points with hyperlinks. At this scale, the GPS Points will change color. Selecting one of these points prompts a list of links to appear. The user may then choose to view the databases, images, and texts associated with that particular property (see Figure 30). This provides the user with a real world depiction to associate with the textual

and cartographic representations. This is particularly significant in a place such as Nantucket where it is not always easy to grasp the value of the home through an image. A sale price in excess of one million dollars conjures up visions of extravagance, which is not always the case in Nantucket as seen in some of the Siasconset images and real estate records.

Each increase in scale reveals more detail. The small scale analysis presents a broad overview of the island wide trends since 1950. The general synopsis prompts important questions about the development and conservation on Nantucket, but one must explore the data at a larger scale for a more accurate depiction. The intermediate scale reveals facets of the development process specific to each unique location in the study. The large scale provides insight into individual perspectives by accessing accounts from individual oral histories and interviews under “Supplementary Materials.” Multimedia GIS allows the user to aggregate the data in a number of ways, offering multifaceted perspectives of spatial temporal changes. Using the diverse sources, and a multitude of options with which to approach analysis, one may uncover patterns of development not clearly evident when analyzing a problem using traditional methods.

CHAPTER VI

CONCLUSION

This multimedia approach offers the user a way to analyze spatially-referenced traditional historical data sets. Georeferencing the historical maps and photographs, linking to supplementary materials based on location at multiple scales, and allowing the user to query data and select which layers to represent at a particular time offers a technique for dynamic analysis. The study of the changes in the Pocomo Road and Mid-island areas illustrate these capabilities well. Both areas began to develop at the same time. Initially, land in each location sold for comparable prices. Besides proximity to the ocean, the 1950s topographic maps and aerial photographs illustrate fairly similar topography with little to no development. Selecting and viewing the 1971 aerial photographs shows both areas developing. The links to the real estate databases and the conservation acquisition data show how these areas began to differ in development in the 1970s and 1980s, but it is not exactly clear why it is so. Activating other options such as the zoning code layer as well as the GPS points layer may show the differences in land use and building density. Querying the bylaws and personal histories may elaborate on differences. Such a computer-based method of containing, processing, querying, and interpreting data offers a user-driven visualization and analysis of geographic information.

The data sets that have been selected are well suited to depict the historic geographic change on Nantucket; however, the project would be more balanced if it chronicled the change in assessed property values as well as the sale price acquired from the Registry of Deeds. It is true that sometimes assessed values are skewed mainly due to local politics, and are not wholly reliable, but these data in conjunction with the registered and recorded property records would offer a more realistic account of the island development and politics: One of the objectives of the project was to visualize the direct correlation between proximity to conservation land and property values. It was believed that the more affluent areas would have higher property values and closer access to conserved land. After collating the data, it became evident that this hypothesis would be difficult to promote because so much of the land is conserved or preserved, most developed or developable land is within close proximity to protected areas. On a smaller scale, however, one could argue that this is a significant factor in why property values are so high overall on Nantucket.

The zoning maps demonstrated more of the social and economic disparity on the island, and the personal accounts of the historic development helped verify assumptions drawn from the data. Collectively, the heterogeneous sources encapsulated in the historical GIS help to reveal hidden or less obvious patterns of change. These data at multiple scales prove useful in the implementation of a theoretical framework such as Giddens' structuration theory. Visualizing and connecting to traditional historical data sets offers a cohesive way in which to analyze power structures within a society.

This historical GIS has provides a strong foundation from which future research may be conducted. The GIS proves to be useful in containing and organizing historical geographic data for analysis and interpretation, producing geographic information by allowing the user to query and structure spatially referenced geographic data in such a way that provides a view that might otherwise go unnoticed. The use of multiple scales and data sources combined with the ability to interact and query the records produces a powerful analytical and interpretive tool that offers insight into how the island has evolved since 1950.

Future Research

While the project covers a lot of material, some of the concepts are still fairly nascent. There are several directions in which this research could progress. Fortunately, this is an updatable model. Future research might include a close examination of assessed values and tax abatements. To compensate for high cost of living, predominantly obvious in the cost of housing, the town offers abatements to year round residents; and it is said that assessed values are especially low in relation to sales prices. Chronicling the assessed values over time in conjunction with historical taxing patterns would broaden the understanding of the social and political dynamics of the island.

The project would also be enhanced by including more oral and written personal histories. Nantucket is an island with an exceptionally engaged community, with well established historical resources including a number of books and recordings of Nantucketers from many walks of life. It would be interesting and important to

incorporate the perspectives of the population who rent housing, including the large community of immigrant and transient workers.

Another option is to research the history of zoning on Nantucket to determine the impacts of zoning bylaws and subsequent changes since 1972. The contemporary zoning overlay is one of the most effective visual representations of the gap between those who can afford the seasonal mansion and those who housed Mid-island, working several jobs and renting part of their home to afford to live on island. Chronicling the progression of zoning ordinances would greatly enhance the potential for the dynamic analysis of the historical spatial temporal change.

Accessing data from the other conservation groups would certainly help to address any inconsistencies in that database. It would also be useful to incorporate historical and contemporary images of the conservation parcels. Other options with the conservation data include creating buffers to demonstrate the proximity of the properties with the conservation land, and then compare the locations with the values. A geographic weighted regression may enhance the findings as well.

The last, and possibly one of the most important suggestions for future research is to continue work on orthorectifying the extraordinary sets of aerial photographs. There are so many facets to this research, that perhaps a project like this is best undertaken in a collaborative effort. The rectifying of these images would be an incredible applied research project for one primarily interested in remote sensing; and the end product would greatly enhance the overall historical GIS.

APPENDIX A

NANTUCKET HISTORICAL GIS USER GUIDE

INSTALLATION INSTRUCTIONS

It is important to follow the installation instructions below carefully for the project to load properly:

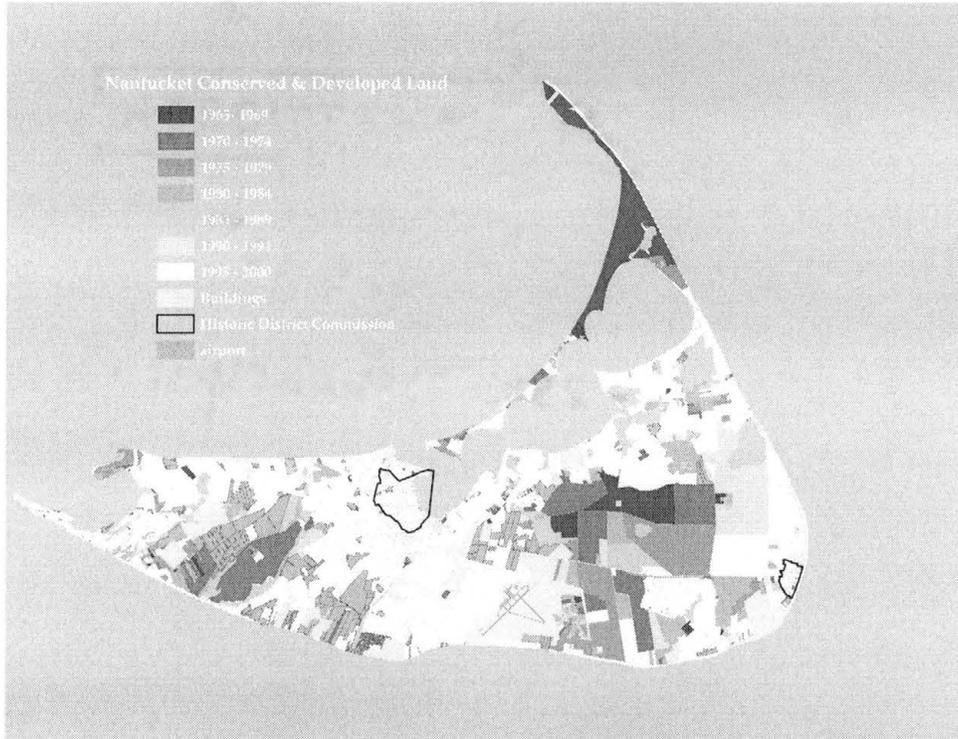
1. Create a folder called “Nantucket” in your C: drive
2. Copy the entire contents of each of the discs to C:\Nantucket
3. Open “Nantucket GIS” (you must have ArcGIS to run this project).

You cannot open the project directly from the disc because it requires files contained on the other discs.

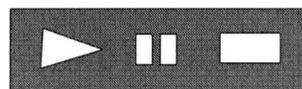
HELPFUL HINTS FOR INTERACTIVITY

1. To activate or deactivate layers simply click on the box with (or without) the check mark.
2. To access the hyperlinks, select the lightning bolt icon on the tool bar at the top of the screen, then select any of the illuminated fields.
3. Use the magnifying glass icons to zoom in and out of areas on the map.
4. To go back to the previous view(s), use the blue arrow on the tool bar

APPENDIX B



To view an animation of conservation acquisitions use the buttons below



Play Pause Stop

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Deed Restrictions
 Zoning Bylaws

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VITA

Alexis A. Buckley was born in Winchester, Massachusetts, on September 3, 1968. She is the daughter of Robert D. Buckley and Celeste L. Buckley. In 1994, she entered the University of Massachusetts-Boston and earned her degree while working full time. During academic year 2000/2001, she attended the Albert Ludwig Universität in Freiburg Germany. She received the degree of Bachelor of Arts from the University of Massachusetts in 2002. In September 2003, she entered the Graduate College of Texas State University-San Marcos where she also worked as a Graduate Assistant and Teaching Assistant, teaching the Laboratory for Water Resources Management.

Permanent Address: 200 Ledgewood Drive 608
Stoneham, Massachusetts 02180

This thesis was typed by Alexis A. Buckley.