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Monetary Valuation of Waterfront Open Space in Coastal Areas of Mississippi and Alabama

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Monetary valuation of waterfront open space in coastal areas of Mississippi and Alabama

By

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Open space provides a wide range of ecosystem services to communities. In growing communities, open space offers relief from congestion and other negative externalities associated with rapid development. To make effective policy and planning decisions pertaining to open space preservation, it is important to estimate monetary values of its benefits. In addition, assessing public opinions regarding open space provides information on demand and how residents value open space. This study estimated the monetary value of open space in Mississippi and Alabama Gulf Coast communities. The study also collected information on coastal residents' attitudes towards open space, working waterfronts, and their willingness to support waterfront open space preservation monetarily. Two methodological approaches were employed to estimate the monetary value of waterfront open space: contingent valuation (CVM) and hedonic price (HPM) methods. Data were collected using a mail survey, the Multiple Listing Service (MLS), and publicly available data sources such as the U.S. Census. Data were analyzed using an interval regression, ordinary least squares, and geographically weighted regression (GWR) models. Mail survey results indicated that the majority of residents valued open space and were willing to pay from $80.52 to $162.14 per household as estimated by four different interval-censored econometric models. Respondent's membership in groups promoting conservation goals, income, age, and residence duration were major factors associated with their willingness to pay. Results from the HPM indicated proximities to waterfronts, with the exception of bayous, were positively related to home prices, suggesting open space produced positive economic benefits. Findings from the HPM analysis using publicly available data were consistent and comparable with the results from the HPM that used MLS data. This similarity of results indicates the use of publicly available data is feasible in HPM analysis, which is important for broad applications of the method during city planning. In addition, GWR estimates provided site specific monetary values of waterfront open space benefits, which will be helpful for policymakers and city planners in developing site specific conservation and preservation strategies. Findings can help formulate future decisions related to alternative development scenarios of coastal areas and conservation efforts to preserve open space.

Keywords: coastal, contingent valuation, ecosystem services, geographically weighted regression, hedonic price method, interval censored model

DEDICATION

I dedicate this dissertation to my family for their constant support and encouragement in every step of my life.

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CHAPTER I

GENERAL INTRODUCTION

1.1 Introduction

Open spaces are permeable surface areas partially or completely covered with trees, grass, water, and other vegetation (Bolitzer and Netusil 2000; Klaiber and Phaneuf 2010). Open space is found within the urban core as well as the periphery and can include both green space (terrestrial open space) and blue space (aquatic open space) (Taylor and Hochuli 2017; Wentworth 2017). An area that has a strong visual of physical connection to water is categorized as waterfront open space (Salina and Nawawi 2009). Open spaces provide numerous benefits and services such as ecosystem services, health and socio-cultural benefits, increased real estate values, and recreational opportunities. These benefits and services enhance human welfare and are thus considered as essential anthropocentric services (Buttoud 2000; Woolley and Rose 2004; Boyd and Banzhaf 2007).

Open space benefits have long been recognized as desirable for a high quality of life. In 1733, James Oglethorpe designed Savannah around twenty-two park like squares intended to encourage equitable land distribution and a sustainable agrarian society. Several decades later, Pierre L' Enfant emphasized "public gardens", "garden-lined public avenues", and plazas expressly so the nation's law-makers and the general public could enjoy open space benefits (Bednar 2006). Elements of the L'Enfant Plan, such as the National Mall, have become part of national identity, in addition to important public gathering places. Open space benefits have been discussed in numerous studies. For example, a critical function of open space is mitigation of the urban heat island effect. A study by Upmanis (2000) found that even small parks can lower air temperature by 2° Celsius in comparison to surrounding areas. In addition, trees in urban open spaces absorb air pollutants from the atmosphere and reduce carbon dioxide (CO_2) accumulation. A study conducted by Nowak et al. (2006) estimated that 711 thousand metric tons of air pollutants were removed annually by urban trees in the U.S., equivalent to $3.8 billion based on the median monetized dollar per ton of externality values used in energy-decision making. Similarly, open spaces encourage residents to engage in recreational activities which provide health benefits such as reduction in obesity rates, improved heart functioning, and stress reduction (Woolley and Rose 2004). As cities grow, and open space becomes scarce, demand for its benefits increases, which motivates decision makers to incorporate open space into planning activities (Woolley and Rose 2004). Including open space in urban planning has also been shown to positively affect property values (Tyrväinen 1997; Breffle et al. 1998; Mahan et al. 2000; Bin 2005). Given the importance of open space benefits to communities, its preservation is crucial to ensuring quality of life and local resilience.

Twenty-six million acres of open space is projected to be paved over by 2030 (Alig and Plantinga 2004). Given this rapid rate of loss, interest over its preservation has grown substantially. State and federal governments, private land trusts, and others have undertaken numerous initiatives with 21 states approving conservation funds of over $3 billion to protect open space in 2016 (Trust for Public Land, 2016). While such spending suggests the importance of open space, it does not provide information about public value and preference and residents' willingness to support its preservation (McConnell and Walls 2005). Quantifying a monetary value of open space benefits will help determine its importance to local communities and provide guidance for policy makers and city planners in planning for its preservation, growth, and maintenance.

Open space economic value is, however, difficult to quantify because its benefits and services are not directly sold in the market. Difficulties in quantifying monetary values of open space result in challenges in demonstrating its benefits to communities; thus, open space benefits are often neglected in decision making. As such, there is a growing need to determine a monetary value of open space. Specifically, there is a need to define open space value using data and methods available to practitioners in addition to academics. To this end, stated preference and revealed preference methods have been employed, which rely on hypothetical and real market transactions, respectively.

Nonmarket values of open space can basically be categorized as use and non-use values. Use values represent values associated with consumption of goods and services, whereas non-use values represent benefits that cannot be directly used by an individual. Stated preference methods, such as contingent valuation method (CVM), can measure both use and nonuse nonmarket values via a hypothetical market posed to respondents. By comparison, revealed preference methods, such as hedonic pricing method (HPM), can measure only use value of nonmarket goods; thus, they do not provide total value of nonmarket benefits of environmental goods such as open space. In short, there are different methodological approaches in valuing different open space values. This study examined values associated with waterfront open spaces using both CVM and HPM approaches. Using these two different methods, a more complete understanding about monetary values of waterfront open space was developed than using only a single method. In addition, this study compared similarities and differences between monetary estimates calculated from the two approaches.

1.2 Rationale of the study

The overall goal of this research was to provide monetary estimates of use and non-use values associated with waterfront open space. In addition, the study examined the extent to which Gulf Coast communities valued waterfront open space preservation versus urban development. Determining whether coastal residents are interested in open space preservation will be helpful to decision makers because this information can help them prioritize and categorize development scenarios while incorporating open space preservation. The study also provides information that contributes to educational and conservation activities for open space preservation. A long-term goal of this research is to improve the understanding of economic and cultural values of waterfront open space to improve community resilience.

Specific objective of this study were to:

1. Estimate the willingness to pay to preserve open space associated with waterfronts using CVM.
2. Quantify monetary values associated with waterfront open space using house sale multiple listing service (MLS) data.
3. Quantify monetary values associated with waterfront open space using publicly available U.S. Census data.

The first study used CVM to estimate respondents' WTP to preserve open space associated with waterfront areas. The CVM has been under scrutiny and criticized in terms of method accuracy and validity because of numerous biases associated with it such as hypothetical, information, non-response, and strategic biases as well as embedding problem (Carson 2012; Hausman 2012; Kling et al. 2012). To overcome biases associated with CVM hypothetical responses, this research utilized a house market transaction data to quantify a monetary value of open space benefits in second and third studies. The house sale price data for the second study was obtained from MLS and contained detailed information on various house characteristics. However, these data might be difficult and costly to acquire. Thus, the third study used publically available U.S. Census data to estimate monetary values of waterfront open space as more readily available alternative. Therefore, the three studies presented in this dissertation are linked with each other in addressing the problem of monetary valuation of nonmarket benefits using data representing different types, sources, and aggregation levels.

1.3 Organization

This dissertation is organized into five chapters. Chapter I is the introductory chapter. The chapter provides an overview of open space benefits, status, problems, and valuation methods. Each specific dissertation objective is discussed in detail in Chapters II, III, and IV. Chapter II contains a study entitled "Estimating the willingness to pay to preserve waterfront open space using a contingent valuation method". This study estimated the willingness to pay to preserve open space associated with waterfronts in four coastal cities in Mississippi and Alabama. The study illustrated how socio-demographic characteristics and respondents' attitudes towards open space influenced their willingness to pay for open space preservation. Chapter III is a study entitled "A hedonic pricing method in estimating value of waterfront open space in the Gulf of Mexico". This study estimated influence of distance to waterfronts on residential value obtained from MLS data as a proxy to measure monetary values associated waterfront open space benefits. Chapter IV contains a study entitled "Monetary values associated with waterfront open space in coastal areas: the use of census data". This study also estimated effect of waterfront proximity on residential value but used various publicly available databases to estimate the monetary value of waterfront open space. Chapter IV used freely available house structural data from the Decennial Census and illustrated feasibility of using publically available data when privately generated data are difficult to acquire. Chapter V presents an overall discussion and conclusion of the three analyses.

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CHAPTER II

ESTIMATING THE WILLINGNESS TO PAY TO PRESERVE WATERFRONT OPEN SPACES USING CONTINGENT VALUATION

2.1 Abstract

In this article, open spaces are socially valued public and private areas with water permeable surfaces, located within or adjacent to populated places, and mostly devoid of built structures. Among the various types of open space, waterfront open spaces are dynamic places that represent an interface between aquatic and terrestrial ecosystems. Waterfront open space provides environmental benefits, recreational opportunities, and prospects for water-dependent economic activities such as working waterfronts. However, with growing populations and associated urbanization, open spaces often compete with roads, shopping centers, industrial development, and residential zones. Growth presents important challenges for elected officials, planners, and natural resource managers because, in addition to many benefits, urban development can increase stress on the landscape and compromise environmental quality and community resilience. This study employed a mail survey and contingent valuation method (CVM) to quantify residents' willingness to pay (WTP) to preserve open space in coastal cities of Mississippi and Alabama. Four different interval censored regression models were constructed to estimate WTP to support open space preservation. Approximately 60% of respondents voted for the proposal, which suggested the majority of residents valued open space preservation. Results indicated that coastal residents were willing to make a one-time payment of $80.52 to $162.14 per household. Respondent's membership in a group promoting conservation goals, income, age, and residence duration were associated with respondent's willingness to pay. Findings will help policy makers and natural resource managers make more informed decisions regarding open space preservation and in maintaining a balance between urban development and waterfront open space, and access to associated benefits of both.

Keywords: Gulf of Mexico, interval censored model, mail survey, nonmarket valuation

2.2 Introduction

In this article, open spaces are socially valued public and private areas with water permeable surfaces, located within or adjacent to populated places, and mostly devoid of built structures. Such areas are partially or completely covered with trees, grass, water, and other vegetation and are often categorized as public parks (state and national parks), playgrounds (football, soccer, and baseball fields, and golf courses), wetlands, cemeteries, beaches, forested land, agricultural land, pastures, and shrub land (Bolitzer and Netusil 2000; Klaiber and Phaneuf 2010). Open space that is terrestrial ground cover is often referred to as green space, whereas aquatic areas can be referred to as blue space (Taylor and Hochuli 2017; Wentworth 2017). In addition, working waterfronts which are lands used for small water dependent activities such as marinas, aquaculture, and fishing docks may also be considered as open space. Open space provides a wide variety of benefits including visual aesthetics, wildlife habitat, recreational opportunities, urban heat island reduction, air quality improvement, storm-water runoff control, energy use reduction, and a potential increase in real estate value (Dwyer et al. 1992; Nowak et al. 2007; Brander and Koetse 2011). In addition, open space provides health and sociocultural benefits (Shabman and Bertelson 1979; Campo 2002; Zhai and Suzuki 2009). Open space benefits have become a vital part of residents' everyday lives, and the value of open space to a high quality of life is increasingly recognized (Woolley and Rose 2004).

In particular, benefits from waterfront open space are critical to coastal communities and people who visit these places. However, with growing populations and urbanization, open space can be threatened by urban development, such as roads, buildings, aeronautical flyways, pollution, and other residuals of growing cities (McDonald et al. 2010; Wu et al. 2013). Population statistics underscore the relevance of urban expansion in natural resource management considerations. More than half (54.4%) of the total population lived in rural areas in 1910, which decreased to less than a quarter (19.3%) in 2010, suggesting a vast shift of population from rural to urban areas in the past century (U.S. Census Bureau, 2016). To accommodate the increase in urban population, urban land is projected to increase from 3.1% in 2000 to 8.1% in 2050 (Nowak et al. 2010). In particular, coastal regions have experienced substantial population gains. For example, the population of coastal counties in the Gulf of Mexico has increased by 150% from 1960 to 2008 (U.S. Census Bureau, 2010). Population increases typically result in land conversion, fragmentation, and parcelization that increase the potential for converting natural land to commercial and residential uses (Harper and Crow 2006). The issue of land conversion, due to anthropogenic activities, to developed land uses is particularly high in coastal areas. Nationwide, the population in coastal counties increased by 43% during 1960-1990, faster than the national average (Ehrenfeld 2000). Underscoring this, 256,100 acres of wetlands were lost in the Gulf of Mexico and 40% of this loss was attributed to urban development between 1996 and 2006 (NOAA 2010). Thus, the changing landscape due to population growth and urbanization will have significant impacts on environmental quality in urban and urbanizing areas. Rapid growth presents challenges to elected officials, planners, and natural resource managers in balancing economic growth and maintaining environmental quality. With increasing urbanization, the preservation and management of open spaces has become an important policy issue (Geoghegan 2002).

Open space benefits are considered public goods (i.e., non-rival and non-exclusive) and are often characterized by inefficient market allocation (Geoghegan 2002; Wolch et al. 2005). Fausold and Lilieholm (1999) categorized open space values as direct benefits from market and nonmarket goods and indirect benefits that positively impact local communities and economies. Benefits and services of open space that are traded in markets, such as timber and crops, can easily be valued monetarily (Mcconnell and Walls 2005). However, environmental benefits that are not directly traded in markets are difficult to quantify in monetary terms (More et al. 1988; Brander and Koetse 2011). Lack of a monetary value associated with environmental benefits makes it difficult to demonstrate their importance and, as a result, these services are often neglected in decision-making processes. Therefore, it is necessary to quantify a monetary value of nonmarket benefits of open space to enable comparison of open space value with other land-use/development alternatives, make decisions pertaining to sufficient provision and conservation of open space benefits, and provide guidance for future land-use decisions.

Monetary valuation helps financial experts, city planners, and policy makers to carry out benefit-cost analyses to guide informed environmental investment decisions and help gain public input into conservation decisions (Lambert, 2003). In addition, a monetary value that society places on ecosystem services indicates the extent to which such services are prioritized which, in turn, informs decision makers regarding proposed conservation activities (Campbell and Brown 2012). Using proper valuation techniques, decision makers can demonstrate environmental benefits per dollar spent and determine trade-offs between various land-development alternatives. For example, city planners and real estate developers can account for trade-offs between open space preservation and development when they have information on how the public values open space areas (Anderson and West 2006). Thus, there are practical applications for quantitative and monetary assessments of the demand for open space preservation.

Economists have used a variety of techniques to quantify monetary values of open space. There are two broad methodological approaches in quantifying monetary values of nonmarket amenities: stated preference and revealed preference methods. A contingent valuation method (CVM) is commonly used as a stated preference approach involving the elicitation of economic value through the use of a hypothetical scenario posed to respondents (Cummings et al. 1995). In CVM, respondents are typically asked how much they are willing to pay (WTP) or accept (WTA) compensation for some change in quality or availability of environmental goods and services (Mitchell and Carson 1989; Hanley et al. 2003). WTP represents the maximum amount of money an individual is willing to pay to preserve an environmental amenity, such as waterfront open space, or improvement in the quality of open space (Carson 2012). Conversely, WTA is the minimum amount of money that an individual is willing to accept as a compensation when the individual is made worse off due to a marginal decrease in environmental quality (Alberini et al. 2003).

The concept of WTP and WTA originates from welfare economic theory which includes consumer surplus, compensating and equivalent variation, and compensating and equivalent surplus. An individual's WTP a particular price depends on the perceived economic value and on the utility of the good (Breidert 2005). WTP is the amount of money represented by the difference between consumer surplus before and after improving any attributes (Rodriguez et al. 2008). Consumer surplus measures welfare from consumption of a good and is defined as the difference between the amount that a consumer is willing to pay and what she/he actually pays for a good (Kolstad 2011). Consumer surplus is associated with ordinary demand, which is a relationship between the quantity of a good demanded and the price for that good where income remains constant and utility changes as price changes. Hicksian demand is an alternative measure of welfare and defined as a relationship between quantity of a good demanded as a function of its price keeping the utility constant (Kolstad 2011). To keep the utility constant, income (budget) should be adjusted so that a consumer remains on the same indifference curve. Hicksian demand is more suitable in contingent valuation survey because responses elicited in such surveys are one in which utility is held constant given an adjustment in income. There are two measures of welfare change in Hicksian demand: compensating variation and equivalent variation. Compensating variation is the amount of money compensated to the individual to maintain the original level of utility after the price change, whereas equivalent variation is the amount of money paid by the individual to avoid price change and yield a new level of utility equivalent to that which would prevail after the price change. As environmental goods usually do not have a market price, compensating and equivalent surplus are the appropriate welfare measure (Kolstad 2011). Thus, the compensating surplus is consumer's WTP and represents the amount an individual will be willing to pay for a change to take place (an increase in environmental quality or quantity) and return the individual to an original utility level (Kolstad 2000).

Many previous studies used the WTP approach to assess monetary value of open space benefits. For example, Breffle et al. (1998) used CVM to estimate the value of 5.5 acres of undeveloped land. In-person interviews were conducted and the respondents were asked how much they will be willing to pay to keep the land undeveloped forever. The authors estimated a mean WTP of $234 per household to preserve the land. The authors found that the amount of WTP was greater than the cost of land when the distance was extrapolated to include one mile of neighborhood property. Lorenzo et al. (2000) estimated WTP to preserve urban forest in Mandeville, Louisiana. Results showed that more than 80% of respondents believed that protection and preservation of urban trees was an important function of the city and they were willing to pay at least $6 per person per year for their protection. Similarly, Loomis et al. (2000) estimated total economic value of restoring ecosystem services such as dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. Authors estimated that households were, on average, willing to pay $21 per month for the additional ecosystem services. The authors concluded that generalizing the benefit of ecosystem services, as estimated by household willingness to pay, would exceed the water leasing cost of $1.13 million and conservation reserve program farmland easement cost of $12.3 million.

In another study, Cho et al. (2005) used tobit and heckit regression models to quantify a monetary value of a hypothetical land conservation easement in Macon County, North Carolina. Their WTP estimates to participate in the program via property tax increase ranged from $10.97 to $21.79 per household. A wide range of factors such as individuals' sociodemographic characteristics, environmental preferences, length of residency in the community, and association with groups promoting conservation or environmental goals were related with WTP. Jim and Chen (2006) conducted a similar study to estimate monetary value of recreational amenity use of urban green space via face-to face interview surveys. The authors found that 96.6% of respondents were willing to pay to use urban green space for leisure activities. The mean WTP was estimated to be $2.11 per person per month, which was higher than the entrance fee. The monetary value of green space was $66.22 million per year when aggregated, which was six times higher than the annual expenditure made on urban green space in the study area. Another study by Majumdar et al. (2011) estimated monetary values of Savannah's (Georgia) urban forest. Estimated median WTP was $2.10 as a fee per visit to access any urban forest resources, and based on this value, the annual value of urban forest was estimated to be $11.5 million. Thus, numerous studies have used CVM and estimated monetary value of nonmarket benefits and services of open space.

This study used the WTP approach to estimate monetary values associated with open spaces in Mississippi-Alabama Gulf Coast areas. All types of open space were considered; however, waterfront open space was of particular interest in this study. The study focused on ecosystem services, including coastal habitat, water quality, and small-scale waterfront businesses. This study explored coastal residents' attitudes towards waterfront open space and commercial and residential growth. As well, the study examined the association of socio-demographic characteristics with WTP to preserve waterfront open space. Information from this study can be used towards open space and coastal preservation and integration of land use planning for resilient coastal communities.

2.3 Material and methods

2.3.1 Study area

The study was conducted in four coastal cities of Mississippi and Alabama, located in the southern United States: Gulfport, Ocean Springs, Mobile, and Daphne (Figure 2.1). Over 19% of the study area is water bodies (U.S. Census Bureau, 2012a and 2012b). From 1990 to 2010, the study area population increased by 14.70% and housing units increased by 23.57% (U.S. Census Bureau, 2012a and 2012b). Between 2000 and 2010, housing growth slowed to 6.37% compared to the previous decade of 16.17% and might be due to impacts from Hurricane Katrina (2005) and the 2007-2009 economic recession.

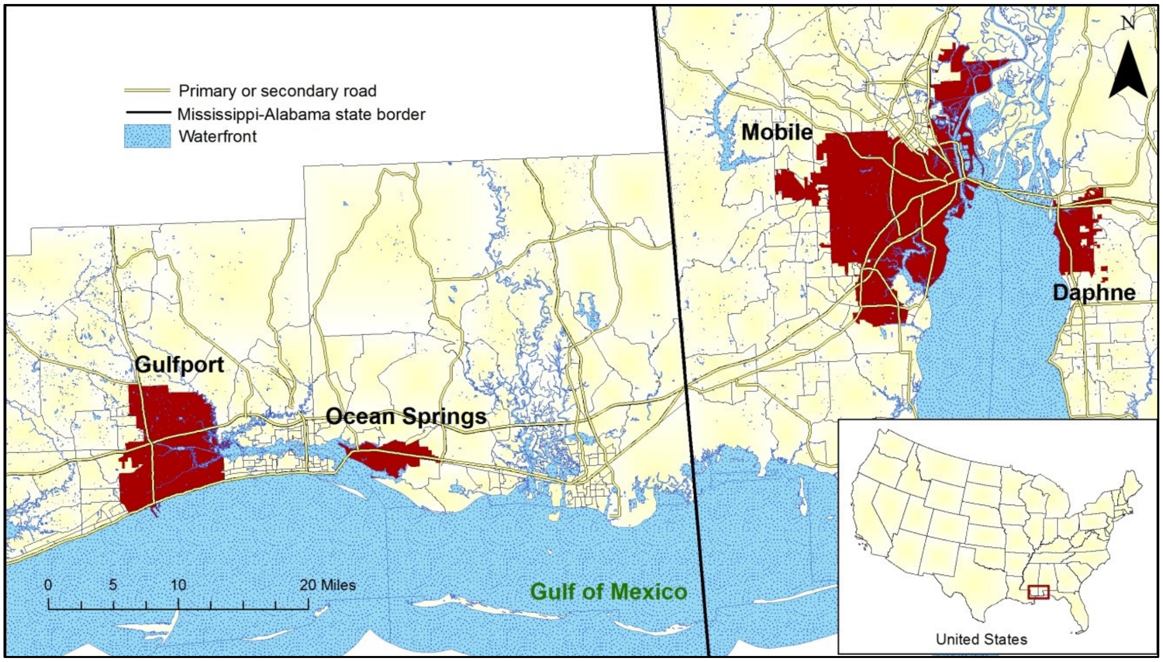

Figure 2.1 Study area location in the Gulf of Mexico.

2.3.2 Data collection

Data for this study were collected via a mail survey sent to 3,999 residents of the four sites in 2015. Each site received a number of surveys proportional to its population. Mailing addresses were obtained from a commercial provider. The mail survey was implemented using a Tailored Design Method (Dillman et al. 2009) in which residents were contacted four times via: (1) an introductory letter describing the research project; (2) a letter with a survey questionnaire; (3) a thank you/reminder postcard; and (4) a follow-up questionnaire. The mail survey questionnaire also included a web-link to an online version of the questionnaire for participants who preferred to participate in the survey electronically. To improve and calibrate the questionnaire, a pilot survey was conducted in person before dispatching the questionnaire to the sample. The questionnaire was composed of different sections which focused on respondents' attitudes towards commercial and residential growth, economic development, and open space; willingness to pay to support open space preservation associated with waterfront areas; and participant socio-demographic characteristics. The questionnaire included definitions of a working waterfront, as defined by the National Working Waterfront Network, and open space. Working waterfront was defined as waterfront lands, infrastructure, and waterways used for small-scale water-dependent activities, whereas open space was defined as socially valued public and private landscape with water permeable ground cover. The survey assumed that open space and working waterfronts were compatible.

A contingent valuation section was included in the questionnaire to determine respondents' WTP for open space preservation associated with waterfront areas. This component included a hypothetical valuation scenario. Respondents were asked to consider a situation in which a local government proposed a dedicated fund to purchase land for the purpose of preserving waterfront open space while also promoting small-scale waterfront business (consistent with the presented definition of a working waterfront). The decision to fund open space/working waterfront proposal would be made through a ballot voting initiative. If the ballot initiative passes, each household would be required to make a one-time payment with their water bill. The land purchase would be completed within the next five years and public access to these properties would be available starting in 2020. The typical payment vehicle used in CVM studies are levies on income taxes, water or land rates, increased park entrance fees, and increased sale taxes (Morrison et al. 2000). Loomis and DuVair (1993), Cameron and Quiggin (1994), and Kim et al. (2012) used income tax, whereas Loomis et al. (2000) used a water bill as the payment vehicle. The selection of a payment vehicle can be challenging as it should be realistic, appropriate, and should remind respondents about their budget constraints so they do not overstate their true WTP (Venkatachalam 2004). An income tax vehicle may suffer from a problem of respondents' resistance to higher taxes (Boyle 2003). For this study, a water bill was selected as an appropriate payment vehicle given the nature of the project and the sociocultural context of Gulf Coast residents, which tend to object to taxes. After a description of the hypothetical scenario, respondents were presented with referendum questions. The name of the respondent's community was included with the CV scenario and each respondent was asked to answer the referendum question referring to her or his community.

2.3.3 Non-response bias test

Survey data may suffer from a non-response bias if non-respondents significantly differ from respondents in terms of observable characteristics that influence WTP leading to unrepresentative responses (Whitehead et al. 1993). Drawing conclusions based on unrepresentative data might generate biased results. To determine if the survey responses suffered from a non-response bias, a non-response bias test was implemented. If a non-response bias is not present then generalizing the response data to the general population is valid (Armstrong and Overton 1977). In order to test for existence of non-response bias, a condensed version of questionnaire with key questions, such as those related to socio-demographic characteristics and attitudes towards open space, was designed and sent after the completion of original mail to a remaining 2,680 non-respondents. Lambert and Harrington (1990) also used this approach in testing for a non-response bias test. A non-response bias test was conducted by comparing responses from a non-response mail survey with the responses obtained from the original mail survey using a t-test and chi-square test, and at the 5% significance level.

2.3.4 Random Utility Model

A random utility model was used to determine the association of different attributes, including respondents' attitudes towards open space, important features of coastal character, and socio-demographic characteristics with respondents' WTP to support waterfront open space preservation. A random utility model is a widely used model and analyzes dichotomous contingent valuation responses. It is based on the hypothesis that an individual is a random decision maker and will maximize her/his utility based on available choices. The theoretical model discussed below follows Haab and McConnell (2002). There were two choices ('For the proposal' and 'Against the proposal') for the respondents in the referendum question and the indirect utility function for the individual j was represented as:

$$u_{ij}=u_i\left(y_j,\bar{z}_j,\ e_{ij}\right) \qquad (2.1)$$

where y_j stands for income, $\bar{z}_j$ represents household characteristics (such as age, race, gender), and e_{ij} is the error (stochastic) term. Furthermore, $i=1$ when respondent voted for the ballot proposal to purchase land to increase open space associated with waterfront areas and $i = 0$ when respondent voted against the ballot proposal (status quo).

An individual respondent j will vote for a ballot proposal at a specified payment level, t_j, if his/her utility of increasing an open space preservation minus the payment (u_1) exceeds the utility of a 'status quo' (u_o):

$$u_1\left(y_j\text{-}t_j,\ \bar{z}_j,\ e_{ij}\right) > u_o\left(y_j,\ \bar{z}_j,\ e_{0j}\right) \qquad (2.2)$$

As the random part of the preference is unknown, only a probability statement about the observed choice, 'For the proposal' and 'Against the proposal', can be made. The probability of a 'For the proposal' response is the probability that the respondent thinks that she/he is better off by incurring the required payment to ensure that the proposed ballot (increase in open space preservation associated with waterfront areas) passes so that $u_1 > u_0$ and the probability that the individual will vote for the proposal can be expressed as:

$$Pr(Yes) = Pr\left[u_1\left(y_j\text{-}t_j,\ \bar{z}_j,\ e_{ij}\right) > u_o\left(y_j,\ \bar{z}_j,\ e_{ij}\right)\right] \tag{2.3}$$

However, Equation 2.3 is too general for parametric estimation and, therefore, two modeling decisions are needed. First, the functional from of utility, $u(y_j,\ \bar{z_j},\ e_{ij})$, must be chosen and second, the distribution of error, e_{ij}, must be specified. The utility can be represented as additively separable into a deterministic part, $v_i\left(y_j,\ \bar{z_j}\right)$, and a stochastic part, e_{ij}:

$$\left(y_j,\bar{z}_j,\ e_{ij}\right) = v_i\left(y_j,\ \bar{z}_j\right) + e_{ij} \tag{2.4}$$

Using the additive specification of Equation 2.4, the probability an individual j will vote for the proposed ballot becomes:

$$Pr\left(Yes_j\right) = Pr\left[v_1\left(y_j\text{-}t_j,\ \bar{z}_j) + e_{ij}\right) > v_o\left(y_j,\ \bar{z}_j) + e_{0j}\right)\right] \tag{2.5}$$

The Equation 2.5 can also be written as:

$$Pr\left(Yes_j\right) = Pr\ [v_1\left(y_j\text{-}t_j,\bar{z}_j\right) - v_0\left(y_j,\bar{z}_j\right) > e_{oj} - e_{1j}] \tag{2.6}$$

As the probability statement in Equation 2.6 is still too general for a parametric estimation, a more specific utility function is required for estimation. Focusing on the linear utility function, which is the simplest and most commonly used form, the estimated function was specified as:

$$v_{ij}\left(y_j\right)=\bar{\alpha}_i\bar{z}_j+\beta_i y_j \quad (2.7)$$

where α_i is an m-dimensional vector of parameters to be estimated, so that $\bar{\alpha}_i\bar{z}_j=\sum_{k=1}^{m}\alpha_{ik}z_{jk}$ and β_i is the parameter coefficient associated with income y_j.

A CV question provided respondents with an option to choose between increased open space preservation associated with waterfront areas at the required payment t_j, and the current state (status quo). The deterministic part of the proposed ballot voting for an increase in open space associated with waterfront areas was specified as:

$$v_{1j}\left(y_j-t_j\right)=\bar{\alpha}_1\bar{z}_j+\beta_1(y_j-t_j) \quad (2.8)$$

while the utility associated with the status quo was expressed as:

$$v_{0j}\left(y_j\right)=\bar{\alpha}_0\bar{z}_j+\beta_0 y_j \quad (2.9)$$

From Equation 2.8 and 2.9, the change in deterministic utility was quantified as:

$$v_{1j}-v_{0j}=\left(\bar{\alpha}_1-\bar{\alpha}_0\right)\bar{z}_j+\beta_1\left(y_j-t_j\right)-\beta_0 y_j \quad (2.10)$$

Equation 2.10 can be further rearranged to the following:

$$v_{1j}-v_{0j}=\left(\bar{\alpha}_1-\bar{\alpha}_0\right)\bar{z}_j+\left(\beta_1-\beta_0\right)y_j-\beta_1 t_j \quad (2.11)$$

It can be assumed that a marginal utility of income is constant between two CV states, where $\beta_1=\beta_0$. Thus, a utility difference between two CV states becomes:

$$v_{1j}-v_{0j}=\bar{\alpha}\bar{z}_j-\beta_1 t_j \quad (2.12)$$

where $\bar{\alpha}=\bar{\alpha}_1-\bar{\alpha}_0$ and $\bar{\alpha}\bar{z}_j=\sum_{k=1}^{m}\alpha_k z_{jk}$. With the deterministic part of the preference specified, probability of responding ‘For the proposal’ becomes:

$$Pr(Yes_j) = Pr\,[\bar{\alpha}\bar{z}_j - \beta_1 t_j + e_j > 0] \tag{2.13}$$

where $e_j \equiv e_{1j} - e_{0j}$

2.3.5 Econometric model

A closed-ended CV question with a dichotomous referendum choice was presented to respondents along with a proposed payment level. A random willingness to pay model, alternative to random utility model, developed by Cameron and James (1987) was followed with the dependent variable representing unobserved WTP as a continuous random variable (Y_i) and independent variables as a vector of the observed variables (X_i):

$$Y_i = X_i^{'}\beta + \varepsilon_i \tag{2.14}$$

where β's are the parameters to be estimated, and ε_i $(\varepsilon \sim N(0,\sigma^2 I))$ is the error term.

There were two referendum questions presented in the survey. The first question was designed as a single referendum (SR) question. Respondents were given three possible options to select as a response to the question: 'For the proposal', 'Against the proposal', and 'Unsure/don't know'. The SR question was constructed as follows:

"If there was a ballot proposal for a one-time payment of $__ added to your water bill to increase open space, would you vote for or against the proposal?"

where a blank space following a $ sign was filled with one of 11 randomly assigned payment amounts (bids): $1, $10, $20, $30, $40, $50, $60, $70, $80, $90, and $100. Payment amounts were determined based on a pilot survey and literature.

A follow-up question was constructed as a double referendum (DR) question and included choices for additional payments. The advantage of including a follow-up question in a survey is that it can help produce more efficient estimates than using the SR question alone (Hanemann et al. 1991; Alberini et al. 2003). The follow-up question was constructed as:

"How much more would you be willing to pay as a one-time payment in addition to the amount specified in the question__?"

where a blank space represented SR question number in the questionnaire. The respondents were given five possible options to select as a response to the DR question: 'None', 'About half', 'The same', 'About twice the amount', and 'More than twice the amount'.

From the responses obtained through the CV question, inference about whether the respondent's WTP was above or below the offered payment amount (t_i) was made. The respondent voted 'For the proposal' if her/his WTP was higher or equal to the required payment amount and voted 'Against the proposal' if her/his WTP was lower than the required payment amount.

The SR dichotomous choice question proposed by Bishop and Heberlein (1979) is is the simplest and most widely used method for eliciting respondents' WTP in CVM studies (Kim et al. 2012). The SR provides one of two bounds on WTP. If the respondent voted 'For the proposal' at the given payment, t_i, her/his WTP was assumed to be greater than or equal to a payment, t_i and was regarded as her/his lower bound. Similarly, if the respondent voted 'Against the proposal' at the given payment, t_i, her/his WTP was assumed to be less than or equal to payment, t_i and was regarded as her/his upper bound:

$t_i \leq WTP;$ if respondent voted 'For the proposal'

$t_i \geq WTP;$ if respondent voted 'Against the proposal'

While the SR is a relatively easy question for respondents to answer, it is often regarded as a less efficient approach because it requires a large sample to attain a specified level of precision (Hanemann et al. 1991). Thus, the estimates acquired through a SR question may or may not represent respondent maximum WTP because it collects a limited information from each respondent (Kim et al. 2012). In response to this limitation, Hanemann et al. (1991) developed a double-referendum (DR) model to improve the efficiency. In the DR model, respondents were asked a second question immediately after answering the first SR question. The payment included in the second question was higher for respondents who answered 'For the proposal' to the first question and lower for respondents who answered 'Against the proposal' to the first question. This information lowers the variance of the estimates of a mean WTP (Haab and McConnell 2002). The DR model increases efficiency over SR model by constraining the part of distribution where respondents report false WTP amounts (Haab and McConnell 2002). The model produced both WTP's lower and upper bounds for each respondent which can be written as:

$t^1 \leq WTP \leq t^2$; for 'For the proposal'-'Against the proposal' responses

$WTP \geq t^2$; for 'For the proposal'-'For the proposal' responses

$t^1 \geq WTP \geq t^2$; for 'Against the proposal'-'For the proposal' responses

$WTP \leq t^2$; for 'Against the proposal'-'Against the proposal' responses

where t^1 and t^2 are payment levels included in the initial SR and a follow-up DR question, respectively. The additional information collected from follow-up DR question was directly incorporated to update the bounds on WTP in DR model.

However, the DR has been criticized by many researchers because of numerous biases associated with it (Cameron and Quiggin 1994; Haab and McConnell 2002). Some of the biases include starting point bias, in which responses to a follow-up question depend on an initial bid amount (Mitchell and Carson 1993; Herriges and Shogren 1996; Flacjaire and Hollard 2006); a shifting-effect bias, in which a respondent interprets a change in payment as a signal of altered quality of the project (Carson et al. 1992; Alberni et al. 1997; Watson and Ryan 2007); and a strategic bias, in which respondents may react to new price in a way they can bargain over the price (Cooper et al. 2002; Carson and Groves 2007).

Designating bound WTP as dependent variable resulted in interval data: a lower and upper bound. The survey in this study included a follow-up question only for the respondents who wished to make an additional payment to increase open space preservation associated with waterfronts areas. Thus, respondents who voted 'For the proposal' in the initial question and 'Against the proposal' in the follow-up question resulted in point data (both lower and upped bound on WTP being same). In a similar fashion, bounds on WTP were developed as interval, left-censored, and right censored. To analyze these data and to estimate marginal WTP to support open space preservation associated with waterfront areas, an interval censored model was used (Hanemann et al. 1991). An interval censored regression model is useful when a researcher knows the ordered categories into which observations fall, but is unaware of each observation's exact value (IDRE, 2017).

Table 2.1 illustrates the type of data that was used in the econometric model to estimate WTP. For example, if the respondents voted 'For the proposal' at a given payment (t^1) in the initial question and 'Against the proposal' in the follow-up question (she/he was not willing to pay any additional amount), then it was regarded as a point data (t^1, t^1). If the respondent voted 'For the proposal' at a given payment (t^1) in the initial question and then was willing to pay an additional amount in the second question ranging from about half to about twice the additional amount (t^2), then these two observations were combined and resulted in interval data (t^1, t^2). If the respondents voted 'Against the proposal' in the initial question then it was left censored data ($-\infty$, t^1) because in this case her/his WTP was less or equal to a payment (t^1) and was considered as her/his upper bound. Similarly, if the respondent was willing to pay more than twice the amount in the second question, then it was right censored data (t^2, ∞) because, her/his WTP was greater than or equal to payment (t^2). Thus, in a case of left-censored data the lower bound was a negative infinity, whereas for the right censored data the upper bound was a positive infinity. For point data, lower and upper payment amounts were considered equal.

Table 2.1 Data types used in the interval-censored model to estimate marginal WTP to increase open space preservation in coastal cities of Alabama and Mississippi.

Type of data		Lower bound	Upper bound
Point data	$A=[t^1,t^1]$	t^1	t^1
Interval data	$A=[t^1,t^2]$	t^1	t^2
Left-censored data	$A=[-\infty,t^1]$	NA	t^1
Right-censored data	$A=[t^2,+\infty]$	t^2	NA

The contribution of likelihood function of an i^{th} individual respondent whose value of WTP was somewhere in the interval (t_{1i} as lower bound and t_{2i} as upper bound) is represented by $\Pr(t_{1i} \leq Y_i \leq t_{2i})$. When no information was gained on the bound of WTP from the CV question, it resulted in being either left-censored for an individual with 'Against the proposal' vote or right-censored with 'For the proposal' vote, and the likelihood function was represented by $\Pr(Y_i \leq t_{Li})$ and $\Pr(Y_i \geq t_{Ri})$, respectively. For the normally distributed error term, $\varepsilon \sim N(0, \sigma^2 I)$, the log-likelihood function is given by:

$$logL = \sum_{i \in L} log\phi\left(\frac{t_{Li}-x_i^{'}\beta}{\sigma}\right) + \sum_{i \in R} log\{1-\phi\left(\frac{t_{Ri}-x_i^{'}\beta}{\sigma}\right)\} + \sum_{i \in I} log\{\phi\left(\frac{t_{2i}-x_i^{'}\beta}{\sigma}\right) - \phi\left(\frac{t_{1i}-x_i^{'}\beta}{\sigma}\right)\} \quad (2.15)$$

where ϕ(.) is the standard cumulative normal distribution, observations $i \in L$, $i \in R$, and $i \in R$ are left-censored, right-censored, and interval, respectively. This study estimated the model using the maximum likelihood estimator. Maximizing the likelihood function produced estimates of the function's parameters (Haab and McConnell 2002).

Having an unbounded model may yield either negative or excessively large WTP and thus a reasonable bound should be placed to estimate WTP (Haab and McConnell 2002). Hanemann and Kanninen (2001) argued that willingness to pay should be bounded at the upper level by income and lower level by zero (zero-income bound). WTP may be negative only when the minimum expenditure necessary to achieve utility at the new CV scenario exceeds the individual's income (Haab and McConnell 2002). As respondents' WTP depends on income (y_i) and the vector ($\overline{z_j}$), the restriction on WTP can be defined as:

$$0 \leq WTP_j \leq y_j \quad (2.16)$$

The payment range was thus updated by replacing negative infinity with zero and positive infinity with the respondents' income following Kim et al. (2012). There is a lack of consensus in the literature regarding bounded and unbounded approaches (Kim et al. 2012). Therefore, this study estimated median WTP under both approaches, bounded and unbounded, and developed four models: (1) a single unbounded interval censored model (using SR question only with left-censored as negative infinity and right-censored as positive infinity); (2) double unbounded interval censored model (using a DR question in addition to a SR question with left-censored as negative infinity and right-censored as positive infinity), (3) single bounded interval censored model (using a SR question only with left-censored as zero and right-censored as respondent's income); and (4) a double bounded interval censored model (using the DR question in addition to the SR question with left-censored as zero and right-censored as respondent's income).

Median WTPs and their confidence intervals were estimated following the Krinsky and Robb (1986) procedure discussed in Haab and McConnell (2002). The Krinsky and Robb procedure in computing welfare estimates has been recommended by many studies (e.g. Park et al. 1991; Haab and McConnell 2002). The procedure relies on the asymptotic properties of maximum likelihood parameter estimates and simulates asymptotic distribution of derived WTPs (Haab and McConnell 2002). The first step in the procedure was to estimate the interval censored model and to obtain parameter estimates $\hat{\beta}$ and variance-covariance matrix $\hat{V}(\hat{\beta})$. The second step was to obtain Cholesky decomposition matrix, *C,* such that $CC' = \hat{V}(\hat{\beta})$. As a next step, a single *K*-vector was drawn from the estimated asymptotic distribution of the parameter β_d as:

$$\beta_d = \hat{\beta} + C' X_K \tag{2.17}$$

where X_K is the random vector drawn from the standard normal distribution. This procedure was repeated 10,000 times for each model to produce a simulation of the full distribution parameter $\hat{\beta}$ distributed $N\left(\hat{\beta}, \hat{V}(\hat{\beta})\right)$ under ideal asymptotic conditions. Finally, WTP was calculated based on a new parameter vector. This process resulted in 10,000 simulated WTP estimates, which were then sorted in ascending order and empirical statistics were calculated such as mean, variance, and a 95% confidence interval.

2.3.6 Variable description

Table 2.2 provides descriptions of variables used in estimating median WTP and their mean values. Respondents who were unsure about their vote and those with missing values in the independent variables were omitted from the analysis, resulting in a total of 245 observations. Three sets of independent variables were used in estimating WTP. The first set included variables representing respondent's attitudes towards open space. This category included four variables. GROUP indicated if a respondent belonged to any group promoting environmental or conservation goals. FUTDEV represented respondent attitudes towards whether future development should preserve the coastal character in the community. OPENUSE measured the frequency of the respondent's use of open space. GOVTRESP referred to whether the respondent felt that the local government had a responsibility to the public to provide usable public open space. The second set of variables included in the model represented the important features of a coastal community character. This category included variables representing environmental attributes (ENVINDEX), gaming and tourism (GTINDEX), and shipping and seafood industry (SSINDEX) indexes. ENVINDEX was measured with different elements of a coastal character such as close to nature, good place for family, and favorable climate. GTINDEX was measured with two separate elements including gaming and tourism. SSINDEX was also measured based on two separate elements including shipping industry and seafood industry. All of these elements were initially measured as a mean grand score based on individual scores for each coastal element measured on a five-point Likert scale: 1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, and 5 – strongly agree. Then a grand score was converted to a binary variable with values above the mean coded as 1 (agree) and 0 (disagree). The third set of variables included respondents' socio-demographic characteristics related to their duration of residence (RESD), age (AGE), gender (GENDER), education (EDU), household income (INC), race (RACE), and renting or owning their dwelling space (RENT). An interaction term between respondents' age and residency (AR) was also included in the model to estimate how WTP was affected by older age residents who lived in the community for a longer period of time. Variables were originally recorded using five-point Likert scales (FUTDEV, ENVINDEX, GTINDEX, and SSINDEX), continuous (AGE and INC), dichotomous (GROUP, GOVTRESP, GENDER, and RENT), nominal (EDU and RACE), and ordinal (OPENUSE and RESD) responses. For analysis purposes, all variables were transformed into binary variables based on a mean of each variable. For example, variables originally measured using Likert scale were recoded into binary variables according to one if the original values being above or equal to the mean, or zero if the value was below the mean.

Table 2.2 Description of variables used in estimating WTP to increase open space preservation associated with waterfront areas in coastal cities of Mississippi and Alabama (N=245).

Variables[1]	Description	Mean
Respondents' attitudes towards open space		
GROUP	Membership in a group promoting environmental or conservation goals. 1 if a respondent belonged to any group promoting environmental or conservation goals, 0 otherwise.	0.229
FUTDEV	Importance of future development to preserve the coastal character. 1 if moderate and major importance and 0 if not at all, slight, and minor importance.	0.971
OPENUSE	Frequency of using local open space. 1 if less than one time per month to more than one time per month, 0 if never to more than one time per year.	0.820
GOVTRESP	Responsibility of local government to provide usable public open space. 1 if respondet thought that it was a responsibility of local government to provide usable public open space , 0 if no.	0.955
Important features of coastal character		
ENVINDEX[2]	Importance to community's coastal character (close to nature, good place for family, favorable climate). 1 if respondent agreed and 0 if disagreed.	0.792
GTINDEX[2]	Importance to gaming and tourism industry (other than gaming) to community's coastal character. 1 if respondent agreed that industry was important and 0 if responded disagreed.	0.371
SSINDEX[2]	Importance of shipping and seafood industries to community's coastal character. 1 if respondent agreed that industry was important and 0 if responded disagreed.	0.706
Respondent's sociodemographic characteristics		
RESD	Number of years a respondent has lived in the community. 1 if 15 years or more and 0 if less than 15 years.	0.714
AGE	Respondent's age. 1 if 65 year or older and 0 if less than 65 years.	0.351
AR	Interaction effect of age and number of years a respondent has lived in the community	0.269
GENDER	Gender. 1 if male and 0 if female	0.543
EDU	Highest education level. 1 if completed bachelor's degree or higher and 0 if less.	0.616
INC	Household income before taxes in 2015 dollars. 1 if income was $65,000 or larger and 0 if less than $65,000.	0.571
RACE	Race of the respondent. 1 if white/Caucasian and 0 if otherwise.	0.812
RENT	Status of dwelling ownership. Recoded as a binary variable: 1 if rented and 0 if owned.	0.131

[1] All of the variables were recoded into binary based on mean of each variable

[2] Initially measured as a mean grand score based on individual score for each of the coastal elements measured on a five-point Likert scale: 1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, and 5 - strongly agree. Then a grand score was converted to a binary variable with values above the mean as 1 (agree), 0 (disagree)

2.4 Results

Of 3,999 mailed questionnaires, 1,079 questionnaires were returned as undeliverable and 49 as refusals or with a respondent reported as deceased, resulting in a sample of 2,871. Respondents returned 438 questionnaires with valid responses resulting in an adjusted response rate of 15.26%. Response was lower than expected; however, a comparison of responses from the original mail survey and a separate non-response mailing indicated there was no non-response bias: age (p=0.531), race/ethnicity (p=0.304), gender (p=0.2051), education (p=0.826), rent/own your dwelling (p=0.536), income (p=0.191), working waterfronts considered as threatened (p=0.2036), and importance of working waterfronts to community's history and culture (p=0.3723).

2.4.1 Demographic overview

Summary statistics of all returned questionnaires indicated gender composition (male vs. female) of respondents was equal (48.33% vs. 48.80%), whereas 2.87% of respondents did not wish to reveal their gender. Average age of the respondents was 59 years old with 47.78% older than 65 years old and 20.44% younger than 45 years old. One third (30.36%) of respondents reported their total household income in 2015 dollars before taxes was less than $45,000, whereas 51.28% had a household income greater than $65,000, which was above mean household income of $60,511 in Alabama and $54,906 in Mississippi for the year 2015 (United Census Bureau 2015). The majority of respondents (56.97%) either had completed a Bachelor's degree or had a post-graduate degree, whereas 9.69% had a high school education. The majority of respondents (74.88%) were Caucasian followed by African American (17.77%), whereas each of the other ethnic groups such as Asian, Native American, and Hispanic/Latino represent less than one percent. The majority of respondents (70.33%) reported that they had lived in their community for more than 15 years, whereas 21.77% of respondents had lived for less than 10 years. The majority of respondents (84.74%) owned their dwelling, whereas 15.26% rented.

2.4.2 Attitudes towards open space and working waterfronts

The majority of respondents (96.93%) believed that it was important that future development preserves the coastal character of their community. More than half of respondents (57.21%) thought working waterfronts were very important for their community's history and identity, whereas 11.82% believed it was moderately important. The majority of respondents (71.29%) also believed that working waterfronts composed of small-scale businesses were threatened. More than 65% of respondents believed that commercial development, property taxes, storms, changing economy and offshore energy production were major threats to the existence of working waterfronts (Table 2.3). Most respondents believed coastal storms (88.86%) and a changing economy (81.95%) were the most threatening factors to the existence of working waterfronts, whereas residential growth had relatively less of an impact (46.24%). More than half of respondents (56.91%) regularly used (more than once per month) local open space for various purposes, whereas only 4.42% of respondents had never used open space. The majority of respondents (94.39%) believed that local government had a responsibility to the public to provide usable public open space. One-fifth of respondents (19.43%) belonged to groups promoting environmental conservation (e.g., Ducks Unlimited, Sierra Club, forest landowner associations). In addition, the majority of respondents (40.83%) believed that commercial development was a major growth issue in their community as opposed to residential development (28.12%), people relocating from other places (22.98%), and urban sprawl (22.49%).

Table 2.3 Factors threatening the existence of working waterfronts in the community based on a 2015 mail survey conducted in coastal cities of Alabama and Mississippi.

Factors	Threat to working waterfront existence (%)					Mean Score	Median Score
	None	Very Little	Moderate	High	Very High		
Residential development	15.32	38.44	31.50	9.25	5.49	2.51	2.40
Commercial development	8.93	20.75	37.18	24.78	8.36	3.03	3.05
Property taxes	8.99	21.45	31.88	20.87	16.81	3.15	3.11
Coastal storms	2.57	8.57	29.43	33.14	26.29	3.72	3.78
Changing economy	4.01	14.04	42.98	24.64	14.33	3.31	3.24
Offshore energy production	9.94	22.51	33.92	17.25	16.37	3.08	3.02

More than 80% of respondents agreed that being close to nature, the seafood industry, a good place for family, and favorable climate were the most important elements of their community's coastal character (Table 2.4). Most respondents (74.49%) agreed tourism (other than gaming) was an important element of coastal character, while 68.70% thought it was a shipping industry, and 31.29% indicated the gaming industry was important. Variables such as close to nature, good place for family, and a favorable climate had mean and median scores of more than 4.10 suggesting respondents were more inclined to the aesthetic aspects of open space.

Table 2.4 Importance of different elements of coastal character based on a 2015 mail survey conducted in coastal cities of Alabama and Mississippi.

Coastal elements	Importance of coastal elements (%)					Mean score (%)	Median score (%)
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree		
Close to nature	1.17	3.23	12.90	49.56	33.14	4.10	4.16
Shipping industry	2.03	7.83	21.45	48.12	20.58	3.77	3.89
Seafood industry	0.86	4.30	10.03	46.70	38.11	4.17	4.25
Gaming	22.51	15.79	30.41	20.18	11.11	2.82	2.88
Tourism (other than gaming)	1.45	5.22	18.84	48.99	25.51	3.92	4.00
Good place for family	0.57	1.44	10.92	51.44	35.63	4.20	4.22
Favorable climate	1.15	1.72	7.45	54.44	35.24	4.21	4.43

2.4.3 Willingness to pay to preserve waterfront open space

Of 438 valid returned surveys, 379 contained answers to the contingent valuation scenario question. More than half (58.58%) voted 'For the proposal' to purchase land for open space preservation associated with waterfront areas at any payment level, 21.37% voted 'Against the proposal', and the remainder (20.05%) were unsure (Table 2.5). The number of respondents voting 'For the proposal' was higher at lower payment levels. For example, at the payment level of $1, 82.86% of respondents voted for the proposal, whereas 11.43% against it. However, when the payment amount was increased to $100, 55.56% of respondents voted 'For the proposal' whereas 25.00% voted 'Against the proposal'. Although the number of respondents willing to support the proposal decreased with higher payment levels, the majority of respondents were still willing to make a one-time payment of $70 to $100 to increase open space preservation suggesting that percentage of respondents did not decrease at higher payment levels as expected.

Table 2.5 Respondents' willingness to support a ballot proposal to purchase a land to increase open space at selected payment levels based on a 2015 mail survey conducted in coastal cities of Alabama and Mississippi.

Payment amount ($)	Number of responses in each category						Total responses in a category
	Yes votes		No votes		Unsure votes		
	Frequency	%	Frequency	%	Frequency	%	
1	29	82.86	4	11.43	2	5.71	35
10	28	70.00	9	22.50	3	7.50	40
20	22	70.97	5	16.13	4	12.90	31
30	15	42.86	7	20.00	13	37.14	35
40	26	68.42	7	18.42	5	13.16	38
50	16	51.61	9	29.03	6	19.35	31
60	17	43.59	12	30.77	10	25.64	39
70	19	65.52	6	20.69	4	13.79	29
80	14	48.28	5	17.24	10	34.48	29
90	16	44.44	8	22.22	12	33.33	36
100	20	55.56	9	25.00	7	19.44	36
Total	222	58.58	81	21.37	76	20.05	379

As majority of respondents were still willing to pay a higher amount, a follow-up referendum question was constructed for those respondents who wished to make an additional payment. The majority of respondents (80.18%) who voted 'For the proposal' were willing to make an additional payment, whereas 19.82% did not wish to make any additional payment (Table 2.6). One third of respondents (33.78%) were willing to pay the same amount as they stated in the initial question. About 13.51%, 18.47%, and 14.41% of respondents were willing to pay half, twice, and more than twice the amount, respectively, as an additional payment specified in the SR question.

Table 2.6 Respondents' willingness to make an additional payment in a ballot proposal to purchase a land to increase open space preservation associated with waterfront areas based on a 2015 mail survey conducted in four coastal cities of Alabama and Mississippi.

Payment amount ($)	Number of responses in each category										Total responses in a category
	No		About half the amount		The same amount		About twice the amount		More than twice the amount		
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
1	3	10.34	2	6.90	9	31.03	5	17.24	10	34.48	29
10	3	10.71	2	7.14	6	21.43	8	28.57	9	32.14	28
20	4	18.18	2	9.09	6	27.27	7	31.82	3	13.64	22
30	2	13.33	1	6.67	8	53.33	2	13.33	2	13.33	15
40	5	19.23	5	19.23	10	38.46	5	19.23	1	3.85	26
50	4	25.00	1	6.25	5	31.25	4	25.00	2	12.50	16
60	5	29.41	2	11.76	7	41.18	1	5.88	2	11.76	17
70	5	26.32	3	15.79	9	47.37	1	5.26	1	5.26	19
80	3	21.43	5	35.71	4	28.57	2	14.29	0	0.00	14
90	5	31.25	3	18.75	7	43.75	0	0.00	1	6.25	16
100	5	25.00	4	20.00	4	20.00	6	30.00	1	5.00	20
Total	44	19.82	30	13.51	75	33.78	41	18.47	32	14.41	222

There were numerous reasons reported by respondents for their votes for the ballot proposal (Table 2.7). As presented in Table 2.7, most respondents (91.44%) who voted 'For the proposal' believed waterfront open space provided social benefits, 86% believed it provided environmental benefits, and 77.93% thought it contributed to the coastal character of the community. In terms of those who did not support the ballot, 72.84% of respondents believed there were already too many taxes, 37.04% indicated that the offered bid amount was too high, and 35.80% thought there were more important uses of tax funds. A relatively small proportion of respondents (13.58%) did not understand the scenario, whereas 7.41% believed there was already enough open space in their community.

Table 2.7 Reasons for voting 'For the proposal' or 'Against the proposal' in the ballot proposal to purchase a land to increase open space preservation associated with waterfront area (multi-answer) based on a 2015 mail survey conducted in four coastal cities of Alabama and Mississippi [a].

Reasons	Proportion of respondents who voted 'yes' for the proposal (%)	Proportion of respondents who voted 'no' for the proposal (%)
Provide/increase environmental benefits of open space	86.04	NA
Provide/increase social benefits of open space (e.g., recreation, increased property values, support traditional waterfront uses)	91.44	NA
Retain the coastal character of the community	77.93	NA
There are too many taxes already	NA	72.84
There are more important uses for tax money	NA	35.80
There is already enough open space in my city	NA	23.46
The payment is too high	NA	37.04
Don't know/no answer	NA	7.41
I didn't understand the scenario	NA	13.58

[a] Total can sum up more than 100% as respondents were allowed to select multi-answer

Tables 2.8 and 2.9 illustrate the bounds of WTP (lower and upper) used as a dependent variable in estimating the median WTP for SR and DR models. The tables illustrate the number of respondents to each payment level. In the SR, left-censored represents the total number of respondents (61) who voted 'Against the proposal' at a proposed payment level and right-censored represents the total number of respondents (184) who voted 'For the proposal' at a proposed payment level (Table 2.8). The SR model had unknown bounds on WTP either in a lower bound as represented by negative infinity or an upper bound as represented by positive infinity. Bounds of WTP were later updated using a follow-up referendum question that reduced unknown upper bounds (a positive infinity) from 75.10% to 11.84%; however, a lower bounds (negative infinity) remained same (24.90%) because the survey only consisted of a follow-up question for the respondents who voted ‘For the proposal’. More information on respondents WTP was obtained in the DR as the range of payment level increased to $300 (Table 2.9).

Table 2.8 Bounds on willingness to pay (WTP) for a single referendum (SR) interval-censored model to estimate marginal WTP to support open space preservation associated with waterfront areas in four coastal cities of Alabama and Mississippi based on a 2015 mail survey.

Bid	Lower bound		Upper bound	
	N	%	N	%
Left-censored (- ∞)	61	24.90		
$1	22	8.98	3	1.22
$10	21	8.57	7	2.86
$20	18	7.35	3	1.22
$30	14	5.71	3	1.22
$40	20	8.16	3	1.22
$50	12	4.90	7	2.86
$60	16	6.53	10	4.08
$70	16	6.53	6	2.45
$80	14	5.71	4	1.63
$90	13	5.31	6	2.45
$100	18	7.35	9	3.67
Right-censored (+ ∞)			184	75.10
Total	245		245	

Note: Left-censored and right-censored observations were replaced with $0 and respondent income, respectively, in bounded models.

Table 2.9 Bounds on willingness to pay (WTP) for a double referendum (DR) interval-censored model to estimate marginal WTP to support open space preservation associated with waterfront open areas in four coastal cities of Alabama and Mississippi based on a 2015 mail survey.

	Lower bound		Upper bound	
Bid	N	%	N	%
Left-censored (-∞)	61	24.90		
$1	2	0.82	5	2.04
$1.5	2	0.82	0	0.00
$2	6	2.45	2	0.82
$3	12	4.90	9	3.67
$10	3	1.22	10	4.08
$15	1	0.41	0	0.00
$20	7	2.86	7	2.86
$30	16	6.53	14	5.71
$40	9	3.67	7	2.86
$45	1	0.41	0	0.00
$50	3	1.22	10	4.08
$60	26	10.61	28	11.43
$70	3	1.22	9	3.67
$80	10	4.08	12	4.90
$90	8	3.27	19	7.76
$100	9	3.67	13	5.31
$105	3	1.22	0	0.00
$120	17	6.94	12	4.90
$135	3	1.22	0	0.00
$140	9	3.67	3	1.22
$150	8	3.27	7	2.86
$160	4	1.63	5	2.04
$180	8	3.27	11	4.49
$200	4	1.63	4	1.63
$210	1	0.41	9	3.67
$240	2	0.82	6	2.45
$270	1	0.41	5	2.04
$300	6	2.45	9	3.67
Right-censored (+∞)			29	11.84
Total	245		245	

Note: Left-censored and right-censored observation were replaced with $0 and respondent income, respectively, in bounded models.

Associations of different variables with respondents' WTP were examined at 15% level of significance. Table 2.10 results indicated that all coefficient signs for variables significant at the 15% level were the same for the both SR and DR models. As the DR model used a follow-up question to update a payment range, it produced more precise welfare estimates. Therefore, coefficients in the DR were smaller in magnitude than in SR model. Several variables, including FUTDEV, ENVINDEX, SSINDEX, and RENT, were not significant in either model, suggesting these variables did not have any relation with WTP to preserve waterfront open space.

Six variables including GROUP, GOVTRESP, RESD, AGE, INC, and RACE were related with WTP in both models at the 15% level of significance. For example, respondents who belonged to any group promoting environmental or conservation goals were willing to pay $64.69 and $32.94 more than those who did not belong to such group in SR and DR models, respectively. In terms of government responsibility, respondents who believed that the government had a responsibility to the public to provide usable open space were willing to pay $175 and $68.66 more than who did not believe government had such responsibility in SR and DR models, respectively. Similarly, respondents whose residency in the community was more than 15 years were willing to pay $98.54 (SR) and $46.74 (DR) less than whose residency was shorter than15 years. Respondents who were older than 65 years of age were willing to pay $112.28 (SR) and $56.96 (DR) less than those who were younger than 65 years. Household income had a positive relation with WTP and respondents who earned more than $65,000 were willing to pay $65.81 (SR) and $39.15 (DR) more than who earned less than that. Caucasians were willing to pay $65.87 (SR) and $28.54 (DR) more than other ethnic groups. Three variables, OPENUSE, GENDER, and EDU, were significant at the15% significance level in the SR unbounded model only. Respondents who used open space frequently (at least one time per month) were willing to pay $72.30 more than those who used it seldomly. Similarly, male respondents were willing to pay $58.63 less than female respondents, whereas respondents who had completed a Bachelor's degree or higher were willing to pay $60.11 more than those whose education was lower than a Bachelor degree. Variables, GTINDEX and AR, were significant at 10% level in the DR unbounded model only. Respondents who considered gaming and tourism as an important element of the coastal character were willing to pay $23.27 less than those who did not believed so. Respondents who were older than 65 years and resided more than 15 years in the community were willing to pay $55.60 more than those who were younger than 65 years and resided less than 15 years in the community.

Table 2.10 Estimates for single and double unbounded interval-censored models used to estimate values associated with open space preservation associated with waterfront areas in four coastal cities in Mississippi and Alabama base on a 2015 mail survey (N=245).

Variable	SR unbounded		DR bounded	
	Coef./Marginal WTP	Std. Err.	Coef./ Marginal WTP	Std. Err.
INTERCEPT	-158.968	135.782	-53.359	51.460
GROUP	64.687*	42.251	32.936***	14.176
FUTDEV	63.745	80.492	35.470	37.768
OPENUSE	72.320*	45.481	14.032	16.114
GOVTRESP	175.020**	97.027	68.662***	32.238
ENVINDEX	48.055	39.154	17.819	15.319
GTINDEX	22.389	33.089	-23.467**	12.812
SSINDEX	-61.014	43.985	-9.317	13.697
RESD	-98.535**	56.118	-46.735***	16.086
AGE	-112.277**	74.224	-56.956***	24.906
AR	105.386	75.618	55.599**	28.486
GENDER	-58.632*	37.603	-6.237	11.779
EDU	60.111*	37.078	15.698	12.790
INC	65.815**	38.154	39.152***	12.837
RACE	65.868*	44.714	28.535**	15.870
RENT	0.975	44.513	19.703	19.175
Sigma	130.640	55.641	79.479	4.692
Observation	245		245	
Log likelihood	-104.759		-651.326	
LR chi2 (15)	60.810		56.390	
Prob> chi2	0.000		0.000	

*, **, *** significant at 15%, 10%, and 5% level of significance.

Results for the zero-income bound model are presented in Table 2.11. Variables that were significant in the both SR and DR bounded models included GROUP, RESD, AGE, AR, and INC (Table 2.11). With some exceptions, most of the parameter coefficients in the bounded model were similar to that of the unbounded models in terms of signs and significance. For example, in the SR model, AR was significant in the bounded model only, whereas RACE was significant in the unbounded model only. Similarly, in the DR model, GOVTRESP and RACE were significant in unbounded model only. Estimates from bounded models were lower than that of unbounded models and were interpreted in a similar fashion as of unbounded models.

Table 2.11 Estimates for single and double bounded interval-censored models used to estimate values of open space preservation associated with waterfront areas in four coastal cities in Mississippi and Alabama base on a 2015 mail survey (N=245).

Variable	SR unbounded		DR bounded	
	Coef./Marginal WTP	Std. Err.	Coef./ Marginal WTP	Std. Err.
INTERCEPT	25.156	27.874	27.212	36.568
GROUP	23.277***	11.176	26.761***	11.761
FUTDEV	14.320	20.919	22.560	27.660
OPENUSE	16.118*	10.314	2.190	12.709
GOVTRESP	40.765***	17.248	32.301	22.661
ENVINDEX	10.019	10.490	7.113	12.212
GTINDEX	-1.131	9.828	-23.313***	10.494
SSINDEX	-11.794	10.642	-0.447	11.213
RESD	-37.837***	13.730	-39.455***	13.441
AGE	-32.895**	18.117	-47.275***	20.097
AR	38.433**	20.593	47.065***	23.113
GENDER	-17.536**	8.967	-2.304	9.631
EDU	21.365***	9.280	10.436	10.412
INC	23.009***	9.443	29.380***	10.457
RACE	14.254	10.759	17.589	12.550
RENT	-3.964	13.857	15.258	15.624
Sigma	41.98131	4.286	68.014	3.381
Observation	245		245	
Log likelihood	-145.720		-706.789	
LR chi2 (15)	55.120		45.730	
Prob> chi2	0.000		0.000	

*, **, *** significant at 15%, 10%, and 5% level of significance.

Table 2.12 reports a mean and variance of simulated median WTP estimated using the Krinsky and Robb (1986) approach. A mean WTP obtained from SR unbounded model was $162 with a confidence interval of $68.01 to $258.13. Similarly, in the DR unbounded, mean WTP was $80.52 with confidence interval $69.50 and $91.70. Variance obtained in the SR unbounded model was much larger with a wider confidence interval in comparison to the DR unbounded model. Mean WTP was reduced by half in the DR unbounded model. Mean WTP estimates obtained from SR and DR bounded models were $95.29 (confidence interval: $83.83 to $106.77) and $90.72 (confidence interval: $81.78 to $99.74), respectively. Variance for the SR bounded model was relatively larger than the DR model suggesting the DR model had the ability to reduce the variance. Both means and variances between the SR and DR models were statistically different at the 1% significance level; however, a difference in mean WTP was relatively small ($5). The DR model produced a narrower confidence interval than the SR model in both cases.

Table 2.12 Means, variances, and confidence intervals of median WTP obtained via Krinsky and Robb method (10,000 repetitions) to support open space preservation associated with waterfront areas in four coastal cities in Mississippi and Alabama based on a 2015 mail survey.

Models	Unbounded				Bounded			
	Mean WTP	Variance	95% CI		Mean WTP	Variance	95% CI	
SR*	162.14	2323.46	68.01	258.13	95.29	34.90	83.83	106.77
DR*	80.52	32.07	69.50	91.70	90.72	20.92	81.78	99.74

*Means and variance between SB and DB were significantly different at 1% level of significance

2.5 Discussion

This study demonstrated how attitudes towards open space, an important element of costal character and environmental benefits, and resident characteristics were related to willingness to support waterfront open space preservation via a monetary contribution. Overall, findings suggested that the majority of respondents viewed waterfront open space preservation as a critical aspect of their community's culture and identity, and were willing to pay to support preservation of such spaces. Implementation of findings from this study can be used in city planning in creating combinations of waterfront resources and other land uses that balance waterfront benefits and experience for coastal residents and visitors.

Many communities in the U.S. are facing challenges related to the preservation of open space by limiting urban sprawl while providing commercial and economic growth (Daniels and Lapping 2005). The majority of respondents in this study believed that commercial development was the major growth issue in the community and believed urban development threatened local identity and environmental quality. Thus, a land use policy to preserve open space in maintaining environmental quality is warranted. Local government initiatives in formulating regulatory, such as zoning (Longley et al. 1992) and urban growth boundaries (Frenkel 2004), as well as voluntary actions, such as conservation easements (Cho et al. 2005) would be effective because a majority of respondents believed local government had responsibility in providing useable open space. Moreover, respondents who believed in government responsibility were willing to pay more for open space preservation than who did belong to this category. As well, the majority of respondents believed that elements of open space such as closeness to nature, good place for family, and a favorable climate were more important compared to gaming, suggesting initiatives to build support for open space preservation efforts must also pay significant attention to aesthetic, visual, and environmental dimensions of the program in addition to promotion of gaming industries. The study also revealed that the majority of respondents frequently used open space for various purposes suggesting increasing demand for open space.

For all econometric models, most of the coefficient signs were as expected; however, there were some differences in significance of individual variables across SR and DR models. Regression models suggested that respondent's involvement in conservation-oriented organizations was a significant factor in their willingness to support waterfront open space preservation. Thus, conservation organizations can serve as a platform for disseminating information related to open space preservation (also see Langpap 2004). Duration of residence (more than 15 years) resulted in a smaller WTP. The inverse relationship between residency duration and WTP for open space preservation is consistent with previous findings that newer residents placed relatively high value on amenities and conservation (Healy and Short 1979; Dubbink 1984; Johnston et al. 2003; Cho et al. 2005). Similarly, respondents who were older than 65 years were also less willing to pay for open space preservation suggesting inclination of younger generations towards open space and their awareness towards preservation. By contrast, a positive significant interaction between age and residence length revealed that respondents who were older than 65 years and resided longer duration in the community were willing to pay more to preserve waterfront open space in all models, except the SR unbounded model. A strategy that targets older residents and who resided for longer duration in the community by providing appropriate information on conservation is likely to enhance open space preservation. Findings also indicated that household income was a significant factor in explaining respondents' willingness to support open space preservation. This finding is consistent with economic theory and most CVM studies related to valuation of open space. For example, Breffle et al. (1998) estimated that households with income greater than $65,000 were willing to pay $131 more than a household in $35,000 to $65,000 range to preserve 5.5 acres of undeveloped land. Similarly, Majumdar et al. (2011) reported an increase in WTP based on higher income. In short, respondents' age, income, duration of residency, and association with a conservation group had significant impact on WTP, while other potential explanatory variables played a limited role.

Of the four models used to estimate WTP, only one model (SR unbounded) resulted in substantially larger mean WTP ($162.14), whereas the other three models produced relatively similar mean WTP estimates ($80.52 to $95.29) . The estimates for the bounded model had smaller marginal contribution to WTP compared to unbounded models with the inclusion of restriction in bounds (zero-income bound) (Kim et al. 2012). In addition, specifying bounds for WTP from zero to income insured that expected WTP was non-negative while follow-up WTP question collected more information on WTP distribution and increased efficiency (Haab and McConnell 2002). Thus, estimates from DR models produced narrower confidence intervals with lower variances suggesting these models performed better than the SR models.

The interval censored model was effective in incorporating follow-up question information and produced more efficient WTP estimates. Inclusion of the zero-income bound produced non-negative WTP and follow-up WTP question collected more information on WTP distribution and increased efficiency (Haab and McConnell 2002). Among the four models, the bounded DR model estimated efficient and precise estimates of WTP ($90.72) with narrower confidence interval and substantially reduced variance. Generalizing this WTP estimate to the 2015 households of the study area (U.S. Census Bureau 2017) suggests a total monetary value of $11.35 million, which indicates a potential budget necessary to facilitate preservation of open space and its ecosystem service benefits.

This study did not consider those respondents who voted against the proposal pertaining to open space preservation associated with waterfront areas and assumed their lower willingness to pay to be “zero”. Having follow-up question for the respondent who voted against the proposal might produce more precise WTP estimates. Therefore, future research should include follow-up questions for both types of respondents. In addition, the study’s low response rate might have impacted WTP estimates. The study also did not differentiate between respondents’ preference for working waterfronts vs. another type of waterfront open space. Working waterfronts have substantial contribution to local and state economies as they create jobs. Thus, some residents might prefer working waterfronts over other waterfront open space which might have impacted WTP estimates. Thus, future studies should consider these limitations. In addition, periodic follow-up studies are warranted as it provides information on changing residents’ attitude towards open space and in redesigning conservation programs to meet open space demand.

2.6 Conclusions

State and local governments, city planners, conservation organizations, trusts, and other agencies tasked with open space preservation often have to balance different and potentially competing land uses. Public opinion surveys are thus crucial for policy debates in attempting to balance economic growth with other elements of social well-being. This study quantified monetary estimates of open space value associated with waterfront areas in terms of residents’ WTP for open space land acquisition along with their attitudes towards commercial and residential growth, economic development, and open space. The study also identified factors that were associated with coastal residents' willingness to pay to support open space preservation. Such information is important for budget managers as it helps to quantify the cost necessary for specific conservation objectives and prioritize conservation efforts from a public perspective.

Findings revealed that minimum and maximum WTP were $80.52 and $162.14 per household as single payment to support open space preservation facilitating ecosystem services. The Gulf Coast of Mexico has potential for increasing production of ecosystem services from open space associated with waterfront areas as most respondents were willing to support its preservation. By accounting for the monetary value of open space benefits, the outcome of this study contributed to extant literature on contingent valuation of open space. The study estimated monetary values of open space facilitating multiple ecosystem services which is likely to give an impetus for conservation among coastal residents because it takes into account the broader set of open space values. The study also revealed increasing demand of open space as most of the respondents regularly used it for various purposes. Thus, the study emphasized considering the preservation of open space that has cultural and economic importance to the local communities.

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CHAPTER III

A HEDONIC PRICING METHOD TO ESTIMATE VALUE OF WATERFRONT OPEN SPACE IN THE GULF OF MEXICO

3.1 Abstract

Open spaces, including waterfront areas, are publicly or privately owned landscapes that provide numerous benefits and services such as opportunities for recreational activities, ecological benefits, and economic development. However, with a rapidly growing population, development pressure on these areas has been increasing, often leading to proposed conflicting land uses. Decision makers need information on the monetary value of environmental amenities provided by these spaces to properly account for this importance to local communities in land-use planning and economic development decisions. This study estimated the monetary value associated with waterfront open spaces using the hedonic pricing method (HPM) and Multiple Listing Service (MLS) real estate data for Mobile and Daphne in Alabama, USA. The price of houses sold during 2001 to 2015 was used as the dependent variable, whereas house structural and neighborhood attributes, and presence of environmental amenities served as independent variables. Results showed that coastal residents considered proximity to waterfronts as one of the most important factors when buying a house and paid higher prices for houses located nearby most waterfront types. This type of information will help guide future decisions related to development of coastal areas, land-use planning, urban forestry, and

open space preservation by balancing opportunities for urban and commercial development as well as providing a public access to open space environmental amenities with close proximity to residential areas.

Keywords: Ecosystem services, land-use planning, marginal implicit price, MLS data, real estate

3.2 Introduction

Open spaces are publicly or privately owned landscapes that are partially or completely covered with vegetation or water (Bolitzer and Netusil 2000; Allen Klaiber and Phaneuf 2010). Importance of open space to human welfare has been extensively discussed within diverse research areas. For example, open spaces provide many benefits and services to residents and their visitors such as recreation opportunities, scenic views, and absence of negative externalities associated with development (Irwin 2002). In addition, open spaces provide ecological benefits such as wildlife habitat, air and water quality improvement, and urban heat island reduction; economic benefits such as increase in real estate values and improved local and regional economies through increased local business activity and tax revenues; and other health and socio-cultural benefits such as places to exercise and socialize (Lowry 1967; Hakim et al. 1999; Anderson and West 2006; Nowak et al. 2006; Brander and Koetse 2011). Therefore, findings revealed that open space needs to be protected and incorporated in urban and commercial development decisions in a way that they can enhance environmental, cultural, and economic values of adjacent areas.

Waterfront open space, areas adjacent to waterfronts, are important open spaces and have been extensively used by societies for travel, trade, and recreational purposes (Seattle Department of Planning and Design 2012). Urban green space near waterfront areas includes scenic sites, wilderness areas, recreational areas, rivers, lakes, and salt marshes. With an increase in population and urbanization, many waterfront open space areas have been developed for commercial and residential purposes leading to their degradation and loss. For example, approximately 50% of wetlands that were present in 48 states at that time of European settlers have been drained (Boyer and Polasky 2004a). Frayer (1991) estimated a total loss of 2.6 million acres of wetland area in the U.S. during 1970-1990. Subsequently, McDonald et al. (2010) estimated that 3.5 million acres of open space (agricultural and natural land cover such as forests and grasslands) in the U.S. were lost during 1990 to 2000. In terms of U.S. forest land alone, approximately 10 million acres of land were converted to development during 1982 to 1997 and additional 26 million is projected to be developed by 2030 (Alig and Plantinga 2004).

Past research suggested that the loss of open space has been highly correlated with population growth and urban development (Schuyt 2005a; McDonald et al. 2010). Disturbances due to urban sprawl cause open space ecosystems to function differently by affecting their capacity to provide goods and ecosystem services (Ehrenfeld 2000). As a result, aquatic and terrestrial habitats as well their environmental and socioeconomic benefits have been lost (Burton et al. 1996; Thurston 1999; Ehrenfeld 2000; Whiteley and Murray 2005). Impacts of such disturbances not only are felt locally where rapid expansion occurs, but are also transported to distant locations via air and water pollution (Faulkner 2004). For example, habitat fragmentation as a result of urban sprawl induces edge effects resulting in a loss of connectivity between habitats and therefore, impacts migration of species, leading some species to threatened status and others to possible extinction (Faulkner 2004). Environmental impacts due to urban sprawl and population growth create challenges for elected officials, policy makers, and natural resource managers because they severely impact the quality and quantity of ecosystem services that open spaces provide.

With increasing urbanization, demand for open space and its benefits has also been increasing, making preservation of open space an important policy and social issue. There have been numerous initiatives at national, state, and local levels to preserve and protect open space (Bengston et al. 2004). For example, according to the Trust for Public Land's report, voters in 21 states approved funds of over $3 billion for open space conservation in 2016 (Trust for Public Land 2016). Such spending suggests the importance of open space to communities. However, this spending does not say anything about the relative value of open space (McConnell and Walls 2005). Knowing a monetary value of open space benefits is thus important for land-use policy development. To design effective and sustainable land-use regulations and policies, city planners and policy makers need precise information on how residents value open spaces. This information will also be valuable to real estate developers to facilitate design of desirable residential communities (Heal 2001).

To encourage communities to adopt policies pertaining to sustainable development in regard to open space utilization and protection, the value of open space should be more clearly quantified (McConnell and Walls 2005). However, estimating a total value of waterfront open space is difficult because it provides both market and nonmarket goods and services (McConnell and Walls 2005). Goods such as crops and timber are traded in the market and their monetary value can be easily determined, whereas nonmarket goods such as clean air, aesthetic value, and health benefits are not directly traded in the market and it is challenging to estimate their monetary value (McConnell and Walls 2005). Benefits that are nonmarket in nature are thus often not accounted for in land-use decisions leading to their degradation and loss. If nonmarket goods and services can be quantified in monetary terms, their value can be compared with and possibly outweigh the value of alternative land uses such as urban development (Boyer and Polasky 2004a). Monetary valuation will help identify types of open spaces that have the greatest importance to residents, compare relative value of these open spaces with other land uses, and permit more informed policy decisions pertaining to their conservation.

Various methods have been developed by economists to estimate the monetary value of nonmarket goods and services. The most common methods used in nonmarket valuation include the contingent valuation method (CVM), the travel cost method (TCM), and the hedonic pricing method (HPM) (McConnell and Walls 2005). The CVM, a stated preference method, is a survey-based approach and uses a hypothetical market scenario to estimate respondents' willingness to pay or accept as a compensation for the change in environmental quality or quantity. The estimates from CVM have often been criticized as misleading because of various biases such as a nonresponse, strategic, hypothetical, and information biases, and an embedding problem (Venkatachalam 2004; Hausman 2012). On other hand, revealed preference methods, such as HPM, utilize data on real market transactions and thus overcome problems associated with hypothetical responses.

HPM relies on information from property purchase behavior to infer values for environmental amenities (McConnell and Walls 2005). It is assumed that a property price, such as a house price, is a function of structural, neighborhood, and environment attributes (McConnell and Walls 2005). Thus, HPM is a commonly used method in quantifying a monetary value of nonmarket benefits, such as those provided by waterfront open spaces (Morancho 2003). For example, Acharya and Bennett (2001), Irwin (2002), Anderson and West (2006), and Poudyal et al. (2009) used HPM to quantify a monetary value of nonmarket benefits provided by open space in different parts of the U.S. Findings from these studies suggested that proximity to open space was positively associated with a property value. The HPM has also been previously used to estimate the value of selected waterfronts such as lakes and reservoirs, rivers and streams, and oceans (Knetsch 1964; Brown and Pollakowski 1977; Young and Teti 1984; Mahan et al. 2000; Costanza et al. 2006). Mahan et al. (2000) used HPM to estimate the monetary value of a wetland in Portland, Oregon and reported that wetland characteristics related to its size and distance to an urban area were related with the value of nearby residential properties. The study reported that the increase in the wetland size by one acre was associated with an increase of the nearby house value by $24.39. Similarly, decreasing a distance to wetland by 1,000 feet was related with a property value increase by $436.17. In another study conducted in Portland, Oregon Bin (2005) estimated the effects of proximity to different types of wetlands on residential property values and reported that proximity to an open water body had a positive effect on property values. A house location within a close proximity (3,000 to 2,000 feet) to a river was associated with a property value increase of US$3,700. Similarly, Costanza et al. (2006) estimated that houses located 100 feet from a beach in New Jersey were sold for $13,000 to US$ 15,000 more than houses located 5 miles away from a beach. Previous studies either quantified values of individual waterfront types such as lakes, beaches, and wetlands or treated them as a composite good. However, values may vary across different types of waterfront open space (McConnell and Walls 2005). Thus, this study quantified monetary values of different waterfront open space types such as bay, river, stream, bayou, and other water body in a single HPM model to facilitate the comparison of their values and relative importance to coastal residents.

This study used 14,000 house sale records obtained from Multiple Listing Service (MLS) to estimate a marginal implicit price of proximity to different waterfront types in two coastal cities near the Gulf of Mexico: Mobile and Daphne, Alabama. Proximity to public parks was also included in the model to measure the subtle difference between proximity to open space associated with waterfronts and general public parks as an open space. The study quantified the monetary value of different waterfront types and determined how proximity to different waterfronts was reflected in house sale prices to demonstrate waterfront open space value to residents. Findings from this study have important policy implications related to designing scenic and publically accessible waterfronts that can draw more people to the shore. Results will facilitate informed planning decisions regarding waterfront open space preservation and alternative development.

3.3 Material and methods

3.3.1 Study area

The study was conducted in the coastal cities of Alabama, Mobile and Daphne (Figure 3.1). Both cities are adjacent to the Gulf of Mexico. The study area covers 197.25 square miles (510.88 km^2), of which 26.97% is covered by water (U.S Census Bureau, 2012). Dog River, Mobile River, and Spanish River are some of the largest rivers flowing across the study area, whereas Mobile Bay and D'Olive Bay are the popular destinations.

Of Mobile's total area 44.74% is commercially and residentially developed, 19.36% is covered by wetlands, 9.43% is covered by forest land, 1.30% is a shrub land, and 0.57% is planted or cultivated (Homer et al. 2015). As of 2010, the total population of Mobile was 195,111 (U.S. Census Bureau 2012). While the population grew by 1.49% during 1990-2000, it has shrunk by 2.05% since 2000. Despite the decrease in population from 1990 to 2010, the number of housing units increased by 7.62% (U.S. Census Bureau 2012). Comparatively, the population and the number of housing units in the state increased during 1990 to 2010 by 18.30% and 30.03%, respectively (U.S. Census Bureau 2012). These statistics indicate the city has been growing at a slower than the state.

Daphne is located on the eastern shoreline of Mobile Bay in the Gulf of Mexico (Figure 3.1). The city covers 17.47 square miles (45.24 km^2), with 16.24 square miles (42.06 km^2) being land and 1.23 square miles (3.18 km^2) being water (U.S. Census Bureau 2012). Of the total area, 50.56% is under residential and commercial development, 26.12% is covered by forests, 10.46% represents planted or cultivated land, 8.74% is covered by wetlands, and 2.43% is shrub land (Homer et al. 2015). As of 2010, the population of Daphne was 21,570, which represented a 30.09% increase since 2000

(U.S. Census Bureau 2012). However, during 1990 to 2000, the city population increased by 46.85%. The population growth was substantially larger than the state average rate of 18.30% (1990-2010) (U.S. Census Bureau 2012). The number of housing units increased during 1990 to 2010 by 107.45% compared to the state average of 30.03% (U.S. Census Bureau 2012). Thus, the city of Daphne has been growing at a rate faster than the state suggesting an increasing loss of open space to accommodate a growing population.

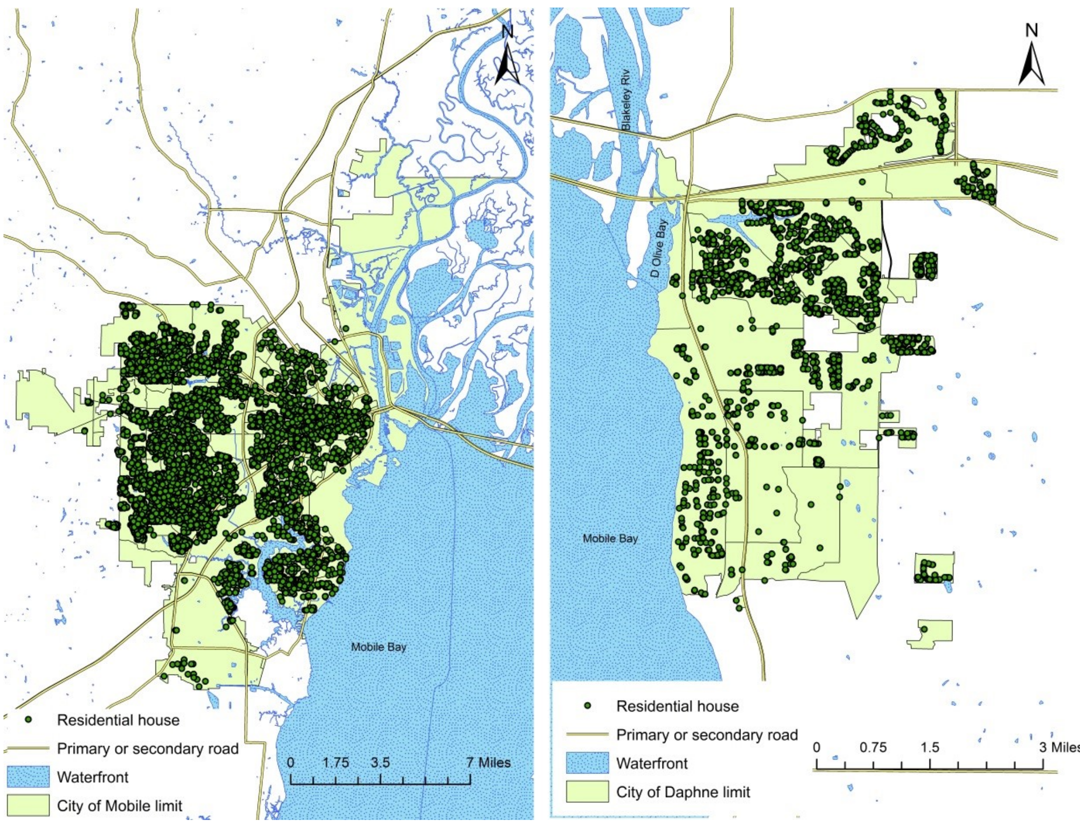

Figure 3.1 A map illustrating a study area in the Gulf of Mexico: Mobile (Left) and Daphne (Right), Alabama.

3.3.2 Data collection

Data were obtained from Alabama Multiple Listing Service, Inc. The MLS dataset included complete information on house sale prices and their structural characteristics. Data were drawn for the period 2001 to 2015 to minimize effects of market fluctuations. For example, Mississippi and Alabama experienced devastating losses due to extreme weather events such as Hurricane Ivan in 2004 and Hurricanes Dennis, Rita, Wilma and Katrina in 2005. More than 275,000 housing units were lost in Mississippi and Alabama due to hurricanes Katrina, Rita, and Wilma (MASGC 2012). Thus, using housing data for an extended period of time helped control these different market fluctuations.

3.3.3 Data preparation

Houses marked as unsold in the MLS dataset were omitted from the analysis. As the data on sold houses was not georeferenced, the dataset was transformed to a Geographic Information System (GIS) format to facilitate geospatial analysis. Location of each sold house unit was geocoded in ArcMap using Alabama address locator obtained from the TIGER/Line geodatabase maintained by the U.S. Census Bureau. A total of 15,463 records representing sold house units were matched for Mobile and 3,748 house records for Daphne. However, 5,018 house records from Mobile and 290 from Daphne did not have complete information about house structural characteristics and, therefore, were not used in the study. The final dataset contained 13,993 complete house sale records for both cities. The house sale prices were then expressed in 2010 U.S. dollars to control for inflation, real estate market fluctuations, and make them comparable with neighborhood data for the Census Year 2010. House sale prices were converted to 2010 U.S. dollars using a housing price index for Alabama obtained from the Federal Housing Finance Agency (FHFA 2017).

Geospatial data such as location of regional airports, primary and secondary roads, railroads, parks, waterfront types, shopping centers, hospitals, and schools were obtained from the TIGER/Line database maintained by the U.S. Census Bureau and open data sources including usa.com, data.gov, expertGPS, and City of Mobile. Euclidean distances from a sold house to the nearest geospatial feature were computed using a proximity tool of ArcMap 10.3.1.

3.3.4 Theoretical foundation of the HPM

The HPM is a widely used nonmarket valuation technique. According to the model, goods and services can be viewed as bundles of attributes (Mcconnell and Walls 2005). For instance, a house is characterized by many attributes affecting its price such as number of bedrooms, bathrooms, and a presence of a garage. Additionally, a house price might be affected by presence of environmental attributes such as proximity to waterfronts and open spaces and locational attributes such as proximity to schools, shopping centers, and hospitals (McConnell and Walls 2005). Buyers often value the presence of environmental amenities and are willing to pay a higher price for a house up to a point where a marginal cost of having access or being closer to an environmental amenity, such as waterfront open space, equals its marginal benefit (Flores 2003). Even though consumers do not purchase environmental amenities directly, their value to consumers is reflected through a price they paid for the house (Taylor 2003). House buyers thus buy a bundle of house attributes (structural, neighborhood, and environmental) when they buy the property. As a result, the total house sale price is a function of market (M) and nonmarket (N) attributes that characterize the house:

P_h=(M,N). A particular house can be described by its structural, locational, and environmental attributes and can be represented by the following vector:

$$Z=(Z_1,Z_2, \ldots\ldots Z_n) \tag{3.1}$$

$$P=P(Z) \tag{3.2}$$

where $i=1, 2, \ldots\ldots,n$ represents the level of attributes describing a house, vector Z stands for the hedonic price function, and P is a house price function of the vector Z.

The implicit price of any attribute characterizing the house is derived as a partial derivative of the hedonic price function (Morancho 2003). It is called an implicit price because it represents a marginal price of an attribute characterizing the house (Taylor 2003). However, the attribute is not purchased directly but rather its monetary value is revealed through the price a buyer pays for the house, of which a particular attribute is a part. Mathematically, an implicit price of a specific house attribute, keeping other characteristics constant, can be expressed as:

$$P_{Z_i}\left(Z_i,Z_{i-1}\right)=\frac{\partial P(Z)}{\partial Z_i} \tag{3.3}$$

where $Z_{=i-1}$ is vector of house attributes other than Z_i.

3.3.5 Econometric model

An ordinary least squares (OLS) regression model was used to estimate implicit prices of environmental attributes associated with houses sold in Mobile and Daphne, Alabama. A separate HPM model was developed for each city to estimate the implicit price because the housing markets may differ between the cities while houses in a particular city may share similar structural and neighborhood attributes. A house sale price was used as the dependent variable. Independent variables included house structural, neighborhood, and environmental attributes. The HPM model was represented as:

$$ln\, H_i = \beta_0 + \sum \beta_j S_{ij} + \sum \beta_k N_{ik} + \sum \beta_l E_{il} + \varepsilon_i \tag{3.4}$$

where lnH_i is a natural log of i^{th} house price expressed in 2010 U.S. dollars, S_{ij} represents j^{th} house structural attributes, N_{ik} stands for k^{th} neighborhood attributes, E_{il} represents l^{th} environmental attributes, β's are the corresponding parameters to be estimated, and ε_i is the error term.

A description of the three groups of independent variables used in the study reflecting structural, neighborhood, and environmental attributes is presented in Table 3.1. House structural attributes included the number of bedrooms and full bathrooms; house age at sale; presence of a garage, fire-place, and porch; and property size. Neighborhood attributes were further categorized into two groups of variables as socioeconomic and government/municipal/locational services. Socioeconomic attributes included population density, percentage of families below the poverty line, median income, median resident age, percentage of vacant houses, and percentage of houses used for recreational or seasonal purposes. These variables were selected to reflect the level of development, economic condition, and prosperity of the neighborhood. These data were collected at the census block group level. Government/municipal/locational services included distance-based variables representing a house's proximity to the nearest public school, active rail road, primary or secondary road, hospital, airport, and shopping center. Environmental attributes included variables representing house proximity to the nearest usable and unusable waterfront open spaces such as river, stream (creek, branch, and fork), bay, bayou, and other water bodies (lake, pond, reservoir, and lagoon). A usable open space refers to area that is accessible, conveniently located, and usable for outdoor living or recreation. The group of environmental attributes also included proximity to the nearest public parks as open space.

The HPM usually suffers from heteroscedasticity problem (Poudyal et al. 2009; Sander and Polasky 2009; Sander et al. 2010) and, therefore, this model was tested for heteroscedasticity and multicollinearity. Heteroscedasticity exists when the variance of all observations is not the same, $Var(e_i)=\sigma_i^2$. When an ordinary least squares (OLS) regression model suffers from heteroscedasticity, it is still unbiased, consistent, and asymptotically normal but is not considered efficient (Greene 2012). In such situations, calculated standard errors and t-statistics are incorrect resulting in inefficient parameters (Greene 2012). The presence of heteroscedasticity was tested for using White's test where residuals were computed using general OLS and then regressed on all independent variables plus their squared and cross-product terms (White 1980):

$$\text{Null Hypothesis, } H_o\text{: } \sigma_i^2=\sigma^2 \tag{3.5}$$

$$\text{Alternative Hypothesis, } H_1\text{: } \sigma_i^2\neq\sigma^2 \tag{3.6}$$

$$Y=\beta_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+e \tag{3.7}$$

where β's are the corresponding coefficients of a vector of X's and Y's are a vector of a dependent variable. From the OLS regression model, residuals were estimated as:

$$\hat{e}=Y\text{-}Xb \tag{3.8}$$

where b's represent the corresponding estimated coefficients. Estimated residuals were regressed as follows:

$$\hat{e}_i^2=\alpha_1+\alpha_2X_2+\alpha_3X_3+\alpha_4X_4+\alpha_5X_5+\alpha_6X_2^2+\alpha_7X_3^2+\ldots+\alpha_{10}X_2X_3+\ldots+V \tag{3.9}$$

If the resulting test statistics were significant at a 5% significance level, heteroscedasticity was considered to be present in the model. In this case, robust standard errors (heteroscedasticity-consistent standard errors) were used to test parameter significance.

Multicollinearity exists when two or more independent variables are correlated with each other. Multicollinearity leads to imprecise estimators, incorrect coefficient signs, and implausible coefficient magnitude (Greene 2012). Variance inflation factor (VIF) was used to test the model for the presence of multicollinearity (Equation 3.10) (Greene 2012). Variables with VIF value greater than ten were regarded as problematic and were omitted from the model.

$$VIF_k = \frac{1}{1-R_j^2} \tag{3.10}$$

where R_j^2 is a multiple correlation coefficient.

As indicated by Taylor (2003), marginal prices estimated by an HPM model might not be constant for all attributes and, therefore, independent variables were transformed to logarithmic, square, and product forms. Thus, the final model consisted of logarithmically-transformed variables for house sale price, house living area, population density, income, and all distance-related variables, whereas all other variables were not transformed. Effects of environmental attributes on a house sale price were measured by six variables in Mobile and four variables in Daphne because Daphne lacked rivers and bayous within the city limits. In addition, Daphne lacked some neighborhood attributes such as distance to airport and hospital within the city limits. Thus, the final models consisted of 25 variables for Mobile model and 20 variables for Daphne.

Table 3.1 Definition and descriptive statistics of variables used to quantify the monetary value of waterfront open space in Mobile and Daphne, Alabama.

Variables	Definitions	Mobile		Daphne	
		Mean	Std. Dev.	Mean	Std. Dev.
Dependent variable					
House price[a]	House sale price (thousand US$)	155.74	134.48	196.06	137.74
Structural attributes					
Bedrooms	Number of bedrooms	3.26	0.73	3.43	0.64
Full baths	Number of full bathrooms	1.98	0.68	2.27	0.58
Stories	Number of stories	1.20	0.39	1.18	0.57
Garage	Dummy variable: 1 if the house had a garage, 0 otherwise)	0.63	0.48	0.93	0.26
Fireplace	Dummy variable: 1 if the house had a fireplace, 0 otherwise)	0.65	0.48	0.84	0.36
Porch	Dummy variable: 1 if the house had porch, 0 otherwise)	0.80	0.40	0.90	0.30
Area[a]	Square footage of the house (thousand)	1.94	0.81	2.16	0.70
House age	House age at the date of sale	72.01	270.22	15.62	13.13
Neighborhood attributes					
Population density[ab]	Number of people per square mile (thousand)	2.77	1.44	1.31	0.97
Poverty[b]	Percentage of families below the poverty line	11.50	11.45	6.52	4.96
Vacancy[b]	Percentage of vacant houses	8.56	4.79	10.94	2.97
Recreational[b]	Percentage of houses used for seasonal, recreational, or occasional purposes	0.41	0.42	1.44	1.07
Median age[b]	Median age of residents	38.26	5.97	39.96	4.37
Income[ab]	Median household income (thousand US$)	52.49	21.25	70.26	22.92
Airport[a]	Distance to the nearest airport	5.53	1.87	NA	NA
Hospitals[a]	Distance to the nearest hospital	4.15	2.50	NA	NA
Railroad[a]	Distance to the nearest active railroad	3.08	2.12	14.81	1.53
Road[a]	Distance to the nearest primary or secondary road	2.18	1.80	1.06	0.74
School[a]	Distance to the nearest public school	1.41	0.96	1.61	0.71
Shopping[a]	Distance to the nearest shopping center	1.01	0.74	2.74	1.31
Environmental amenities					
Park[a]	Distance to the nearest public park	0.87	0.62	1.79	1.15
Stream[a]	Distance to the nearest stream	2.77	1.37	2.45	1.75
River[a]	Distance to the nearest river	6.02	3.28	NA	NA
Bay[a]	Distance to the nearest bay	9.29	3.94	3.01	1.62
Bayou[a]	Distance to the nearest bayou	8.09	3.21	NA	NA
Water[a]	Distance to the nearest other water body	1.22	0.60	1.57	0.73

Note: [a] represents a log-transformed variable. [b] represents a value reported at a census block group level. Distance-related variables were measured in thousand meters (m) from a house location to the nearest corresponding feature. NA indicates that a variable was not applicable.

3.4 Results

White's Test for heteroscedasticity conducted for each of the two models, Mobile and Daphne, indicated the presence of heteroscedasticity at a 5% significance level and, therefore, robust standard errors were used in the analysis. VIF for each variable in both models was not greater than ten indicating multicollinearity was not present in the model, except house age and its squared term. However, these two variables were not omitted from the model because using a squared term reflects a nonlinear relation between age and house price and these two variables have been commonly used in most previous HPM studies (e.g. Troy and Grove 2008; Poudyal et al. 2009; Nilsson 2014). Coefficients of determination (R^2) were 0.6685 and 0.777 for Mobile and Daphne models, respectively. These findings implied that independent variables included in the model accounted for 66.85 % and 77.70% of the variation in house sale prices for Mobile and Daphne, respectively. The F-statistics for the model were 840.3 ($p < 0.001$) (Mobile) and 569.19 ($p < 0.0001$) (Daphne) suggesting that the models fitted the data better than a model with an intercept only.

Table 3.2 Estimates from hedonic price method (HPM) model used to estimate the monetary value of waterfront open space in Mobile and Daphne, Alabama.

Variables	Mobile		Daphne	
	Parameter estimates	White Std. error	Parameter estimates	White Std. error
Intercept	0.564*	0.337	4.844***	0.525
Bedrooms	-0.075***	0.021	-0.023**	0.010
Full Bathrooms	0.138***	0.011	0.087***	0.013
Garage	0.103***	0.009	0.150***	0.027
Fireplace	0.100***	0.012	0.067***	0.014
Porch	0.108***	0.012	0.058***	0.017
ln(Area)	1.043***	0.032	0.871**	0.030
House age	-0.002***	0.000	-0.006**	0.002
House age squared	0.000***	0.000	0.000	0.000
ln(Population density)	0.026**	0.011	-0.083***	0.016
Poverty	-0.005***	0.001	0.011***	0.002
Vacancy	-0.006***	0.002	-0.020***	0.003
Recreation	0.131***	0.013	-0.004	0.010
Median age	-0.004***	0.001	NA	NA
ln(Income)	0.291***	0.020	0.129***	0.034
ln(Airport)	0.104***	0.016	NA	NA
ln(Hospital)	-0.106***	0.012	NA	NA
ln(Road)	0.022***	0.006	-0.042***	0.007
ln(School)	0.020**	0.008	0.032***	0.010
ln(Shopping centers)	-0.007	0.007	0.119***	0.018
ln(park)	-0.003	0.005	0.000	0.018
ln(Stream)	-0.026***	0.009	0.028***	0.010
ln(River)	-0.036***	0.013	NA	NA
ln(Bay)	-0.036*	0.019	-0.127***	0.017
ln(Bayou)	0.070***	0.015	NA	NA
ln(Water)	0.002	0.007	-0.076***	0.010
F value	840.300***		569.190***	
R^2	0.669		0.777	
Adj. R^2	0.668		0.776	
N	10445.000		3287.000	

Note: The dependent variable is ln(housing price), *p<0.10,**p<0.05, ***p<0.01. NA indicates that a variable was not applicable

3.4.1 House structural attributes

Structural attributes had both positive and negative effects on a house sale price. The number of bedrooms was negatively related with a house price in both cities. An increase in the number of bedrooms by one was associated with a house sale price decrease of 7.5% ($p=0.000$) in Mobile and 2.3% ($p=0.022$) in Daphne. However, a number of full bathrooms was positively related with a house price where a one additional full bathroom corresponded with an increase of house sale price by 13.87% in Mobile ($p<0.000$) and 8.7% in Daphne ($p<0.000$). Presence of a garage, fireplace, and porch was associated with a house sale price increase of 10.30% ($p<0.001$), 10.00% ($p<0.001$), and 10.80% ($p<0.001$), respectively, in Mobile and 15.0% ($p < 0.001$), 6.70% ($p < 0.001$), and 5.80% ($p < 0.001$), respectively, in Daphne. Similarly, area of a house was also positively related with its price and the parameter estimates can be interpreted in terms of elasticity as both independent and dependent variables were log-transformed. In Mobile, a one-percent increase in house area corresponded with a house sale price increase of 1.04% ($p<0.001$), whereas in Daphne the price increase was 0.87% ($p<0.001$). House age was negatively related with a house sale price. A one-year increase in house age was associated with its sale price decrease of 0.20% ($p<0.001$) in Mobile and 0.60% ($p<0.001$) in Daphne. A positive sign of house age squared indicated that the house sale price had a non-linear relationship with house age where the house sale price increased after certain age ($p<0.001$) in Mobile; however, the inflection point was beyond a general house life span, whereas there was no such relationship in Daphne.

3.4.2 Neighborhood attributes

Neighborhood variables demonstrated the relationship of locality with the house sale price. Population density was positively related with the house sale price in Mobile and negatively related in Daphne. A one-percent increase in a population density was associated with the house sale price increase of 0.03% ($p=0.013$) in Mobile and the house sale price decrease of 0.08% ($p<0.000$) in Daphne. Similarly, a percentage of families below the poverty line had an opposite relationship with the house sale price in the two cities. In Mobile, a one-percent increase in poverty was related with the house sale price decrease of 0.50% ($p<0.001$), whereas in Daphne, it was associated with the house sale price increase of 1.10% ($p<0.001$). In both cities, the percentage of vacant houses was negatively related with the house sale price. A one-percent increase in vacant houses was associated with a house sale price decrease of 0.60% ($p<0.001$) and 2.00% ($p < 0.001$) in Mobile and Daphne, respectively. The percentage of houses used for recreational purposes was positively related with the house sale price in Mobile but, it was not related in Daphne. An increase in the number of recreational houses by one percent increased the house sale price increase by 13.10% ($p<0.001$). Median resident age was negatively related with the house sale price and a 0.40% ($p<0.001$) drop in the house sale price was observed for a one-year increase in the median resident age in Mobile. Income had a positive relationship with the house sale price in both cities where one-percent increase in median household income was associated with a sale price increase of 0.29% ($p<0.001$) and 0.13% ($p<0.001$) in Mobile and Daphne, respectively. In Mobile, distance to an airport was positively associated with house sale price, whereas distance to hospital was negatively associated with house sale price. With a one-percent increase in distance from a house to the nearest airport, house sale price increased by 0.10% ($p<0.001$), whereas increase in distance from a house to the nearest hospital decreased the house price by 0.11% ($p<0.001$). The distance to the nearest primary or secondary road had a positive association with the house price in Mobile and a negative relationship in Daphne. A one-percent increase in distance to nearest primary or a secondary road was associated with the house sale price increase of 0.02% ($p=0.001$) and a decrease of 0.04% ($p<0.001$) in

Mobile and Daphne, respectively. The distance to the nearest public school was positively associated with the house sale price for both cities and a one-percent increase in distance was related with the house sale price increase of 0.02% ($p=0.017$) and 0.03% ($p=0.001$) in Mobile and Daphne, respectively.

3.4.3 Environmental attributes

Effect of environmental amenities on house sale price varied across waterfront open space types. Distance to the nearest public park was not related with the house price in either city. A one-percent increase in distance to the nearest stream, river, and bay in Mobile was associated with the house sale price decrease of 0.03% ($p=0.003$), 0.04% ($p=0.004$), and 0.04% ($p=0.058$), respectively. The distance to the nearest bayou was positively related with the house sale price in Mobile where a one-percent increase in distance reflected a house sale price increase of 0.07% ($p<0.001$). Distance to the nearest other water body was not related with the house sale price in Mobile. In Daphne, a one-percent increase in distance to the nearest bay and other water body was associated with the house sale price decrease of 0.13% ($p<0.001$) and 0.08% ($p<0.001$), respectively. However, a one-percent increase in distance to a stream was related with a house sale price increase of 0.03% ($p=0.006$) in Daphne.

A marginal implicit price of each statistically significant attribute was evaluated at a mean house sale price of $155,744 and $196,063 in Mobile and Daphne, respectively and a distance of one mile (1609.34 meters) to each waterfront type (Table 3.3). A marginal implicit price of distance to the nearest bay was -$3.53 and -$15.46 per meter in Mobile and Daphne, respectively. This implied that a 100-meter increase in a distance to a bay was associated with the house sale price decrease of $353 and $1,546 in Mobile and Daphne, respectively. Similarly, marginal implicit price of proximity to the river in Mobile was -$3.46 per meter suggesting a 100-meter increase in distance to a river decreased house sale price by $346. A marginal implicit price of proximity to the nearest stream was -$2.49 and $3.47 per meter in Mobile and Daphne, respectively, resulting in the price decrease of $249 and increase of $347 for a 100-meter increase in distance to the stream in Mobile and Daphne, respectively. Similarly, a marginal implicit price of proximity to the nearest other water body was -$9.25 per meter in Daphne and corresponded to a $925 house price decrease for a 100-meter distance increase. A marginal implicit price of proximity to bayou was $6.79 per meter in Mobile and a corresponding house price increase of $679 for a 100-meter distance increase.

Table 3.3 Marginal implicit price of proximity to environmental attributes in Mobile and Daphne, Alabama.

Variables	Parameter estimates		Marginal implicit price per meter	
	Mobile	Daphne	Mobile	Daphne
Distance to bay	-0.036	-0.127	-3.53	-15.46
Distance to river	-0.036	NA[a]	-3.46	NA[a]
Distance to stream	-0.026	0.028	-2.49	3.47
Distance to other water bodies	NA[b]	-0.076	NA[b]	-9.25
Distance to bayous	0.070	NA[a]	6.79	NA[a]

Note: NA[a] indicates that a variable was not applicable; NA[b] indicates that a variable was statistically not significant

The relation between distances to different waterfront types and the house sale price, holding all other variables constant, is presented in Figure 3.2. In Mobile, the relationship was downward sloping between the house sale price and distance to the nearest bay, river, and stream and upward sloping between distance to bayou (Figure3.2 A). In Daphne, a distance to the nearest stream had upward sloping relationship, whereas a distance to a bay and other water body had downward sloping relationship (Figure 3.2 B). A downward sloping relationship implied that houses located nearby a given waterfront type were sold at a higher price than those located farther away, whereas upward slope suggested that houses farther away from a specified waterfront type sold at higher prices. For example, houses in Mobile located near a bay, river, and stream sold at higher prices than those farther away. Similarly, houses near bay and other water body types sold at higher prices in Daphne. However, in the case of bayous in Mobile and stream in Daphne, houses located farther away sold at higher price.

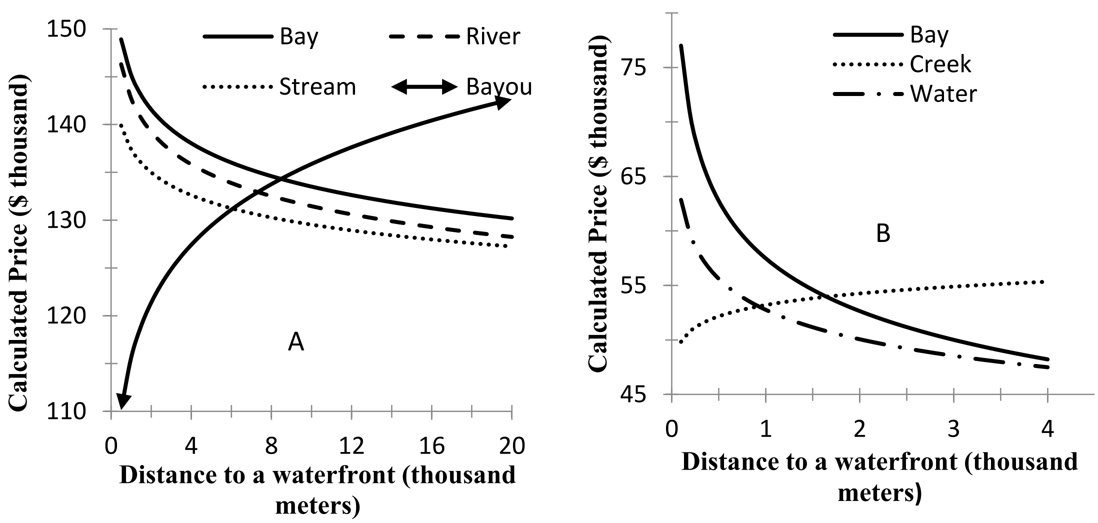

Figure 3.2 Relationships between house sale price and house distance to different waterfront types in Mobile (A) and Daphne (B).

3.5 Discussion

The challenges city planners and developers face in managing urban sprawl and protecting waterfront open spaces often relate to the lack of monetary estimates of waterfront values that would help prioritize their preservation versus other land uses. The study determined how different factors such as house structural, neighborhood, and environmental attributes were related with house sale price. The results indicated that a distance to different waterfront types, in addition to house structural and neighborhood attributes, was a major factor considered by coastal residents when buying a house. Houses near waterfronts, except bayous in Mobile and streams in Daphne, sold at higher prices than those located further away. Most previous studies estimated the value of a single waterfront type or combination of them together as a composite good. However, the value of waterfront open space may depend on its type. Thus, this study provided insights into how waterfront type was valued most by coastal communities.

All structural variables included in the analysis had a positive and statistically significant association with the house sale price, except for number of bedrooms. The exception that the number of bedroom was negatively related with the house sale price might be because people place more value on the relative size of bedrooms than on their number. Thus, a negative relationship of bedroom number with the house sale price possibly indicated that buyers preferred a less fragmented interior space (Bowman et al. 2009). The relationships of other structural variables (full bathroom number; presence of garage, fireplace, and porch; house square footage, and house age) with the house sale price were consistent with existing hedonic studies. For instance, one additional bathroom was reported to increase a home sale price by 6.9% in Portland, Oregon (Bolitzer and Netusil 2000). Similarly, presence of garage and fireplace was associated with home sale price increase of 5.9% and 13.9%, respectively, in Roanoke, Virginia (Poudyal et al. 2009). A one-percent increase in lot size on the other hand increased the house sale price by 0.04% to 0.13% (Geoghegan 2002; Poudyal et al. 2009; Sander et al. 2010). While most house structural attributes were associated with a higher house sale price, house age was linked with the lower house sale price. Bolitzer and Netusil (2000), Poudyal et al. (2009), and Sander et al. (2010) also estimated a drop from 0.2% to 0.7% in house sale price for a one year increase in a house age. However, the house sale price may have nonlinear relationship with its age. For instance, Sander et al. (2010) reported house sale decrease price up to 88 years of house age but increased afterwards. Thus, a level of structural improvements such as number of full bathroom, presence of garage, and house living area were significant factors in determining a house value.

Most neighborhood attributes had an association with the house sale price. Coefficient signs for some neighborhood attributes differed between Mobile and Daphne. For instance, population density was positively related with house sale price in Mobile and negatively related in Daphne. The mean population density in Mobile and Daphne was 2,767.52 and 1,312.71 per square mile, respectively. Thus, population density in Mobile was more than double the population density in Daphne suggesting a higher demand for neighborhood attributes such as demand of recreationally used houses and shopping centers. Geoghegan et al. (2003) argued that population density could have two opposite effects on the house sale price. On one hand, population density can be regarded as a measure of congestion and is considered a negative externality. On the other hand, it can serve as a proxy for density of other goods and services that can attract people and increase house prices. The percentage of vacant houses was negatively related with house price in both cities. Poudyal et al. (2009) and Klaiber and Phaneuf (2010) also reported that the price of a house decreased with an increase in percentage of vacancies. A possible explanation for this trend was be that an increase in the percentage of vacant houses might could been perceived as a safety issue, an unpleasant living environment, and a health hazard resulting in negative impact on the house sale price in the neighborhood (Woolley and Rose 2004; Heynen et al. 2006). In addition, presence of vacant houses might be an indication of house oversupply resulting in decreased house sale prices. Thus, the neighborhood attributes played an important role in the process of determining residential property value as these attributes also required market analysis before arriving at fair market value of any residential property.

Most environmental attributes, which were the main focus of this study, were related with the house sale price and had coefficient signs as expected based on the literature, suggesting that coastal residents valued waterfront open space. Coastal residents were willing to pay a higher price for houses in vicinity to most waterfront types. Study findings were consistent with previous studies. For instance, decreasing a the distance to a wetland by 1,000 feet was related with an increase in property value of $436.17 (Bin 2005). Similarly, Sander and Polasky (2009) reported a relatively small but statistically significant house price increase with decrease in distance to a lake. Chen and Jim (2010) reported that a 1,000-meter increase in distance to a bay reduced the house price by 0.70%. Distance to a park as open space was not significant factor for house sale price increase in both cities. The reason for this trend might be that when both parks and waterfronts were available as open space, coastal residents preferred waterfronts more than parks because of their uniqueness compared to non-coastal areas. This finding was consistent with a similar study conducted by Mahan et al. (2000) who estimated the value of urban wetlands in Portland, Oregon. Authors found that the distance to streams and lakes was related with the house sale price, whereas the distance to the nearest park was not related. Some of the specific waterfront types, however, had positive coefficients indicating that residents preferred houses located away from these waterfronts. For example, distance to a bayou was positively related suggesting that houses located further away from a bayou had a higher selling price. The explanation for this trend might be that bayous were considered as a negative externality by coastal residents because of their specific microclimatic effects and less appealing nature due to marshy character and slow moving water. Another explanation might be that most bayous, such as Bayou Sara, Greenwood Bayou, Hog Bayou, and Shell Bayou are situated in the north-east portion of Mobile and these areas do not have any residential properties because they are classified as flood zone areas. Thus, these findings suggested that residents took into account proximity of environmental amenities when buying a house and their value was reflected in property prices.

In terms of waterfront types, distance to a bay had the largest marginal implicit price followed by a distance to a river and a stream suggesting that coastal residents preferred to live nearby a larger-size water body possibly because of more opportunities for recreation. In addition, the estimated marginal implicit prices of distance to different waterfront types were larger in Daphne than in Mobile. A possible explanation for this trend might be related to the total water coverage in each city. Only 7.04% of the area within the city limit is covered by water in Daphne in contrast to 22.62% in Mobile. Residents of Daphne thus might place a higher value on proximity to waterfronts as it is a scarce environmental amenity in this city. Furthermore, a mean distance to a bay and other water body type in Daphne was 3,008 and 1,572 meters, respectively, in comparison to 9,292 and 1,222 meters in Mobile. Thus, residents of Daphne valued waterfront amenities more than Mobile because of a closer and possibly easier access to environmental amenities. In addition, waterfront space in Mobile tends to be more industrial than Daphne and therefore people prefer to live in Daphne than Mobile. A coefficient for distance to stream was positively associated with house sale prices in Daphne suggesting that houses located away from a stream had a higher selling value. This result can be attributed to the presence of small streams, such as Daphne, D'Olive, and Tiawasee Creeks, which flow west-east in the northern section of the city. It is possible that residents were more attracted to D'Olive bay which lies across these streams and within 1,500 meters from the stream, resulting in lower house values in proximity to streams and higher values in proximity to the bay. Thus, value of waterfront open space varied based on its type. Waterfront open spaces that were more appealing, larger sized, and in closer proximity were valued more than smaller sized, distant, marshy, and slow moving water.

It should be noted that the implicit prices estimated in this study using HPM represent the partial component of the house sale price. These prices are unlikely to capture total value of waterfront open spaces because house buyers may have perceived only partial values of waterfront open space such as those related to recreation, scenic view, and food provision. The estimates presented in this study reflect only the values and services captured by change in house sale (Mahan et al. 2000). Thus, total value of waterfront open space might be larger than estimated in this study. Computing the total value of benefits associated with waterfront open spaces in coastal areas thus remains an important area for future research. Total value estimation will be important for identification of resident preferences towards open spaces and incorporation of these preferences into future land-use and urban development decisions as well as design of urban living areas. In addition, this study examined the relationship between proximity to a waterfront type and house sale prices only within the city limits. However, house sale prices might have been affected by proximity to waterfronts beyond the city limits and, thus, restricting the study area to city limits might have reduced quantified implicit prices. Thus, future research may include attributes outside the city limit to determine their impacts of marginal implicit prices as estimated by this study.

Overall, the study suggested that coastal residents positively valued waterfronts and their monetary value was reflected in house sale prices. Estimating relative values of waterfront open space types yielded useful information that can be used by government decision makers in formulating different conservation goals. With proper design and policies to promote and preserve waterfront open space, demand for its benefits will further increases which will in turn increase government revenue through property taxes. Proximity to different waterfront types is an important feature in city planning and creating a healthy environment. Findings from this study have important policy implications related to creating scenic and publically accessible waterfronts that can draw more people to the shore.

3.6 Conclusions

With increase in population and urbanization, damage to and loss of waterfront open space have been extensive. Yet waterfront open space remains an integral part of urban landscapes. Restoration of waterfront open space is thus necessary. In order to evaluate choices between development needs and waterfront open space preservation, a quantitative measure to establish monetary values for waterfront open space is warranted. This study estimated monetary values of open space represented by different waterfront types in the coastal region of Alabama, USA. The study used a dataset obtained from MLS to determine the relationship of structural, neighborhood, and environmental attributes with the houses sale price.

This study provided strong evidence that waterfront open space had a substantial positive impact on the house sale price suggesting its positive economic benefit to local communities. This study quantified the value of proximity to different waterfront types such as bay, river, stream, bayou, and other water bodies in a single model which provided comprehensive information of monetary values of waterfront open space and facilitated a comparison of relative values each waterfront open space type provides to coastal residents. In addition, findings revealed that larger size waterfronts were valued more than smaller ones. Value scarcity across the study area was demonstrated by higher home values in the city characterized by lower percentage of waterfront area in Mobile than Daphne. This study provided baseline information that can be used by municipal officials for developing guidelines for waterfront open space preservation and maintain a balance between urban development and waterfront development, and providing access to waterfronts and the associated benefits. Future research should focus on additional landscape characteristics such as actual size, quality, and view of waterfront in HPM and extend the current assessment to explore the demand elasticity of residents for waterfront open space.

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CHAPTER IV

MONETARY VALUES ASSOCIATED WITH WATERFRONT OPEN SPACE IN COASTAL AREAS: THE USE OF CENSUS DATA

4.1 Abstract

Open spaces, including waterfronts areas, are critical to many coastal communities due to recreation opportunities, ecological benefits, economic development, and other ecosystem services. As populations in coastal areas grow, demand for open space has been increasing often leading to proposed conflicting land uses. Monetary valuation of waterfront open spaces will help decision makers account for the importance of these areas in land use planning. This study quantified the monetary value of waterfront open space in the coastal counties of Mississippi and Alabama using a hedonic pricing method (HPM). Most previous studies used certified rolls of county property assessors and multiple listing service (MLS) data in hedonic price modeling. However, this approach often involved proprietary data that might be costly and difficult to obtain. This study utilized publically available data from the U.S. Census Bureau. Assessed house value was used as the dependent variable, whereas house structural, neighborhood, and environmental attributes served as independent variables. A traditional HPM and a geographically weighted regression (GWR) method were used to estimate a monetary value of environmental attributes. Results showed that residents of coastal areas valued proximity to different waterfront types such as bays, rivers, streams, and other water bodies, except bayous. In addition, GWR results indicated that value of environmental attributes differed across the study area. The estimated marginal implicit prices of proximity to a bay, stream, river, and other water body were estimated at $4.04 to $5.57, $6.77 to $2.90, $2.80 to $2.46, and $3.43 to $2.29 per meter, respectively, across the study area. Estimates of value of proximity to environmental attributes and information on their geographic variation will help city developers, land-use planners, and other stakeholders make more informed and balanced decisions related to future development of coastal areas, land-use planning, urban forestry, and natural resource preservation. Further, the study also demonstrated the feasibility of using large-scale secondary data in estimating monetary value of waterfront open space attributes when access to fine-scale data is limited.

Keywords: Census block group, hedonic pricing method, ecosystem services, spatial variability, marginal implicit price

4.2 Introduction

Waterfront open spaces are terrestrial areas adjacent to oceans, bays, lakes, ponds, rivers, canals, and estuaries (Torre 1989; Breen and Rigby 1996). An urban waterfront represents an urban zone that is part of the city and in contact with a substantial water body (Bruttomesso 2001). Waterfront open spaces provide many benefits and services to people. For example, they provide aesthetic benefits as scenic view; ecological benefits such as wildlife habitat, carbon sequestration, and urban heat island reduction; recreational benefits such as picnicking, playing, and hiking; and economic benefits such as increased real estate values (Dwyer et al. 1992; Nowak et al. 2007; Brander and Koetse 2011). As waterfront open space benefits are critical to coastal communities and their visitors, future land-use planning should protect and preserve these areas in ways that enhance cultural, environmental, and economic values of the open space and adjacent areas.

Availability of various waterfront open space benefits have been addressed in numerous natural resource studies. For example, a study done by Barbier et al. (1997) showed that prairie wetlands of North America contained 10% of the total continental bird breeding areas, accounted for 55% of duck production, and were valued by recreationalist, hunters, and ecologists. Similarly, approximately 900 terrestrial animal species used U.S. wetlands for breeding and foraging (May 2001). In addition, waterfront open space areas provide numerous health and sociocultural benefits. For example, they provide residents with an opportunity to engage in recreational activities and lead to health benefits such as obesity reduction, heart problems, and stress reduction (Woolley and Rose 2004). With proper design and maintenance, a waterfront open space can bring a community together and promote social ties as well as provide social and environmental benefits (Woolley and Rose 2004). In addition to aesthetic, sociocultural, and ecosystem benefits, waterfronts open spaces provide economic benefits because they enhance the local economy by providing opportunities for commercial activities such as restaurants, hotels, conference facilities, marinas, shipyards, boardwalks, and bandstands (Burayidi 2001). In addition, the presence of waterfront open space can be associated with increased real estate values of adjacent land and houses because buyers are often willing to pay more for the waterfront's scenic view, recreational opportunities, business prospects, and ecosystem benefits (Woolley and Rose 2004). An accessible, well-planned, and high quality open space can be a major factor influencing people's decision to move into the area (Peiser and Schwann 1993). Findings from various studies, including Mahan et al. (2000), Bin (2005), and Costanza et al. (2006), suggested that proximity to waterfront open space had positive impact on a property prices, suggesting proximity to waterfronts were valued by residents. As well, these studies have demonstrated that waterfront open space has differing effects on adjacent communities depending on the type, size, and distance to open space. In general, open space provides a wide range of benefits and services that improve human welfare.

Increases in population growth and urbanization have several implications for open space preservation. Research has demonstrated that about 44 million acres of undeveloped land were converted into developed land between 1982 and 2012, representing a 59% increase (USDA 2015). On one hand, population growth threatens the quality, quantity, and access to open space (McDonald et al. 2010); on the other hand, growing cities increase demand for open space and its benefits (Poudyal et al. 2009). Similarly, as cities grow a limited area of open space is shared by more individuals resulting in overuse of open space and a decrease in recreational potential and other benefits (Kline 2006; McPherson 2006). Availability of open space is particularly important in urban environments where population is large and land scarce, leading to potential land-use conflicts. Thus, the preservation of open space has become an important policy issue as conversion of open space into residential and commercial uses continues.

The benefits and services provided by open space are important to human welfare however, monetization of such benefits is difficult. Open space benefits are considered public goods and provides nonmarket benefits (Geoghegan 2002; Wolch et al. 2005). The value of benefits and services provided by open space could be determined if they were traded in a market, such as timber and crop commodities (McConnell and Walls 2005). However, it is challenging to quantify a monetary value of nonmarket benefits of open space because many of them are not traded in markets (McConnell and Walls 2005). In addition, the cost of protecting and managing open space can be relatively high and represents an opportunity forgone associated with urban development (Boyer and Polasky 2004a). Lack of monetary estimates of open space benefits limits the ability to demonstrate their economic importance to the community. Therefore, it is necessary to determine the economic value of nonmarket goods to quantify their contribution to human welfare and facilitate quantification of tradeoffs associated with different land-use and urban development scenarios, and prioritize conservation projects.

Environmental economists have used numerous techniques to estimate monetary values of nonmarket goods and services. The most commonly used approaches include stated preference and revealed preference methods (McConnell and Walls 2005). A stated preference method is a survey technique to elicit individual preference, whereas a revealed preference method uses real market transaction data to reveal their underlying preference (Freeman III et al. 2014). Stated preference methods include contingent valuation method (CVM) and contingent choice, whereas revealed preference methods include travel cost method (TCM) and hedonic price method (HPM). The CVM, a stated preference method, uses a survey approach and a hypothetical market scenario to ask people directly what they are willing to pay (WTP) or accept a compensation (WTA) for a change in environmental goods and services (Mitchell and Carson 1989; Cummings et al. 1995; Hanley et al. 2003). Revealed preference methods, such as TCM and HPM, on the other hand use market prices to value environmental goods and services. The advantage of using stated preference method is that it can estimate a total value, consisting of both use and nonuse value, people have for an open space whereas revealed preference method can only measure the use value (Mcconnell and Walls 2005). Although CVM can measure a full value of environmental goods, this method has been criticized for numerous biases such as a hypothetical bias, non-response bias, strategic bias, information bias, and an embedding problem (Venkatachalam 2004; Hausman 2012).On the other side, as revealed preference methods use real market transaction data, they can overcome biases associated with CVM.

A large number of studies have used HPM in quantifying a monetary value of various nonmarket goods and services. For example, Łowicki and Piotrowska (2015) used residential property prices to estimate monetary value of soundscapes. Results indicated that plots located in the zone with exceeded noise limits during night were about 57% cheaper than those located outside the zone. In another study, Li et al. (2016) estimated values associated with environmental amenities particularly air pollution and forest coverage using housing values in Salt Lake City, Utah. Authors indicated that an increase in forest coverage (estimated in terms of normalized difference vegetation index) by one unit increased house values by 0.9% and increases in carbon monoxide and oxides of nitrogen by one ton decreased house values by 1% and 2%, respectively. Similarly King and Sinden (1988) used HPM to estimate value of soil conservation in the farm land market. The author concluded that soil condition (depth of top soil) had an implicit marginal price of $2.28 per ha. The HPM has also been extensively used for open space valuation. For example, Bolitzer and Netusil (2000) used house sale prices to derive a monetary value of open space benefits in Portland, Oregon. Results suggested that open space within 1500 feet distance increased house sale price by $2,105. Similarly, Irwin (2002) conducted a study in central Maryland to estimate the effect of open space (cropland, pastureland, forestland, agricultural easements and conservation areas, non-military open space, and military land) on residential property values. The study revealed that the marginal benefit of preserving open space ranged from $994 to $3,307 per household. Anderson and West (2006) and Poudyal et al. (2009) also implemented similar studies to estimate effects of open space on house sale value. Both studies suggested proximity to open space had a significant impact on house value.

HPM, however, requires market house sale transaction data that is usually maintained by private organizations, such as Multiple Listing Service (MLS), or tax assessors and might not be freely available to the general public. Obtaining MLS or tax assessors data are either costly or time consuming and not readily available in every state and country. Many of these data are not georeferenced making them difficult to directly integrate into a variety of environmental amenity assessments (Shultz and King 2001). The U.S. census data, on the other hand are publicly available data that are seldom used in HPM analysis. In addition, census data are spatially georeferenced via the Topologically Integrated Geographic Encoding and Referencing (TIGER) system and can be easily integrated with spatial data related to availability of environmental amenities using Geographic Information Systems (GIS). The use of census data has, however, potential limitations due to aggregation level, periodical data collection, and less information on house structural attributes. However, despite these limitations, census data can be used in HPM as an alternative data source if MLS or tax assessor data are not available or difficult to acquire and thus provides a low cost valuation alternative.

Many of the earlier valuation studies assumed marginal implicit price were constant across a housing market (e.g. Brown and Pollakowski 1977; Doss and Taff 1996; Bolitzer and Netusil 2000; Mahan et al. 2000; Bates and Santerre 2001; Lutzenhiser and Netusil 2001; Geoghegan 2002; Jim and Chen 2006; Fan and Yang 2010). As house prices vary from location to location, there exists a spatial heterogeneity in the model. Spatial data are not generally independent and thus the ordinary least square regression (OLS) model applied to spatial data is suspicious (Fotheringham et al. 2003). This study attempted to identify the spatial variation of amenity values of waterfront open space in the housing market using a geographically weighted regression (GWR) model. The study attempted to measure values of spatial configuration of waterfront as open space. Marginal implicit prices were calculated and were mapped to illustrate the effect of waterfront open space on housing prices.

This study employed HPM using census data to estimate a monetary value of proximity to waterfront open space in coastal counties of Mississippi and Alabama. The study will increase the understanding of the monetary value of open space preservation and provide decision makers with information necessary to make more informed decisions related to different land uses and urban development. The study produced site specific estimates of monetary values of waterfront attributes which will be crucial for site specific land and resource management decisions. Study findings have several policy implications related to urban land-use planning, waterfront open space preservation, and real estate management. Appropriate planning and management regarding waterfront open space preservation and increased awareness of the ecosystems services provided by waterfront open spaces will help protect these benefits and mitigate degradation of coastal ecosystems. Further, this study also illustrates the feasibility of using publically available housing data from census in estimating amenity value of waterfront open space using HPM.

4.3 Materials and methods

4.3.1 Study area

The study was conducted in Gulf of Mexico coastal counties in Mississippi and Alabama: Hancock, Harrison, Jackson, Mobile, and Baldwin (Figure 4.1). According to the United States Census Bureau (2012a and 2012b), the study area covered 6,243 square miles (16,169 square km) with 4,590 square miles (11,888 square km) being land and 1,654 square miles (4,284 square km) being covered by water. Of the total area, 30.70% is covered by wetlands, 25.21% by forest land, 12.46% by shrub land, 9.90% by planted or cultivated area, and 11.86% by developed. The rest is other land types such as barren and herbaceous land (Homer et al. 2015). During 1990 to 2000, the population in the study area increased from 789,291 to 904,246 (14.60%) and housing units increased from 332,069 to 391,772 (18%), whereas during 2000 to 2010 population increased from 904,246 to 965,959 (6.80%) and housing units increased from 391,772 to 449,345 (14.70%) (U.S. Census Bureau 2012a and 2012b). Despite the recession of 2001 and 2007-2009 and corresponding declines in the housing market, the number of housing units in the study area has increased substantially.

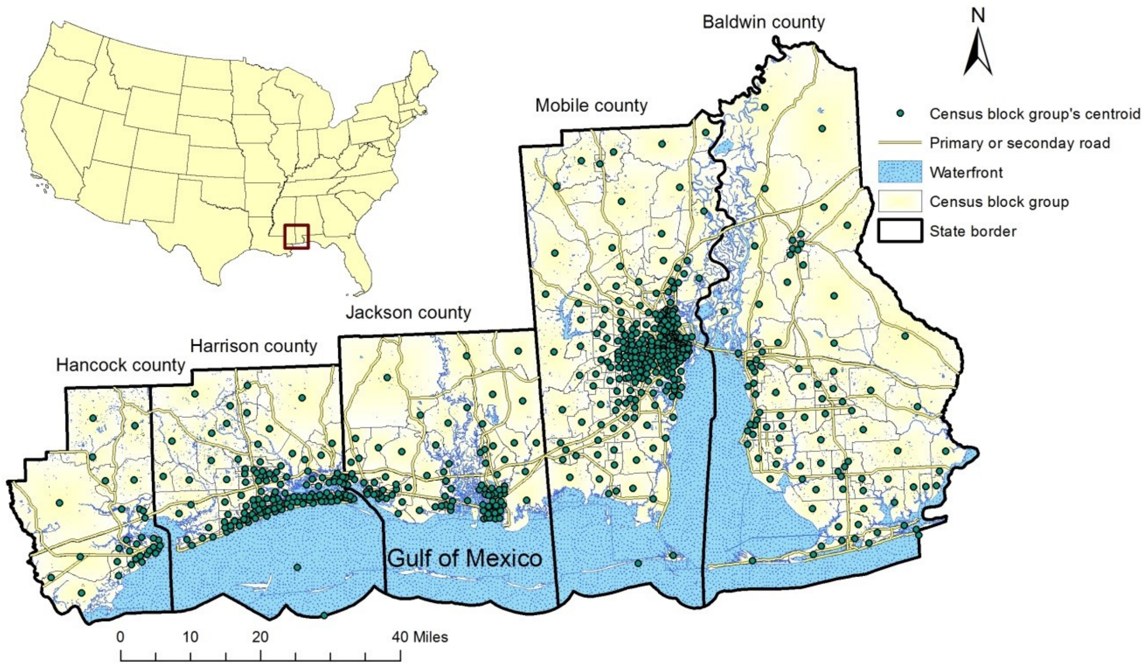

Figure 4.1 Map illustrating a study area in the Gulf of Mexico

4.3.2 Data collection

Data for this study were collected from various sources including the United States Census Bureau, Mississippi Automated Resource Information System (MARIS), USA.com, data.gov, expertGPS, and cityofmobile.org. Median house value was obtained from USA.com which is based in U.S. Census Bureau data. The house value represented respondent's estimate of how much the property would sell for in the current market and might differ from a price at which the property might actually be sold. Independent variables included three types of variables representing information related house structural, neighborhood, and environmental attributes. House structural and neighborhood attributes data were based on 2010 census and obtained from www.usa.com. The data were collected at the census block group level. A census block group is a statistical division of census tract that typically consist of 600 to 3,000 people (Census 2000). A census block group was used in the study because it was the smallest statistical unit with detailed house structural and neighborhood information required for HPM model. Variables representing house structural attributes included number of rooms and house age. Neighborhood attributes included two groups of variables. The first group consisted of neighborhood socioeconomic characteristics representing population density, percentage of families below the poverty line, percentage of vacant houses, percentage of recreationally used houses, median household income, and median resident age. The second group involved government, municipal, and locational services represented by distance to the closest public school, primary or secondary road, railroad, hospital, airport, and shopping center and were obtained from the United States Census Bureau, MARIS, cityofmobile.org, and expertGPS. Neighborhood socioeconomic variables provided quantitative metrics for evaluating neighborhood's socioeconomic performance. These variables reflected the neighborhood development level, economic condition, and prosperity. Similarly, environmental attributes included distance to the nearest public park and different waterfront types such as bay, river, stream, bayou, and other. Information about these environmental attributes was obtained from United States Census Bureau. Definitions of variables used in this study are presented in Table 4.1.

The study area consisted of 633 census block groups; however, three block groups consisted of water only and were omitted from the analysis. Centroids of each census block group were identified using ArcMap 10.3.1 and Euclidian a distance from each census block group centroid and nearest distance-related feature (e.g. road, school, hospital, and waterfront) was measured using the proximity analysis tool in ArcMap 10.3.1.

4.3.3 Model

A hedonic pricing method (HPM), a widely-used nonmarket valuation technique, was used to quantify waterfront open space monetary value. The HPM was derived from Lancaster's (1966) consumer theory and Rosen's (1974) theoretical model of product differentiation based on hedonic prices and reflects the notion that a consumer derives utility from various attributes associated with a specific product (Lancaster 1979). A general idea of HPM model application in monetary valuation of nonmarket goods and services is that they directly affect the price of a market good and this price is known (Mcconnell and Walls 2005). For example, house prices are based on different attributes, such as square footage, number of rooms, and age as well as neighborhood and environmental characteristics (Shultz and King 2001; Irwin 2002; Mcconnell and Walls 2005; Poudyal et al. 2009). Thus, a price of one house relative to another might differ based on the mix of attributes associated with each house. When the data on market good prices, such as house prices, are econometrically evaluated in relation to its attributes, the resulting estimated coefficients represent marginal implicit prices of evaluated good attributes, whereas a relative price of a house is represented by the summation of these marginal prices (Chau and Chin 2003). A marginal price of an attribute associated with a market good, such as a house, can be determined through the price a buyer paid for the property:

$$P_{Z_i}\left(Z_i, Z_{i-1}\right) = \frac{\partial P(Z)}{\partial Z_i} \tag{4.1}$$

where, P is the price function of the vector Z representing house structural, neighborhood, and environmental attribute and $i=1,2,.....,n$ is the level of different attributes describing a house.

The HPM model was first estimated using OLS. Assessed values of houses served as the dependent variable, whereas house structural, neighborhood, and environmental attributes were used as the independent variables. A HPM model was represented as:

$$\ln H_i = \beta_0 + \sum \beta_j S_{ij} + \sum \beta_k N_{ik} + \sum \beta_l E_{il} + \varepsilon_i \quad (4.2)$$

where lnH_i is a natural log of an assessed value of the i^{th} house in 2010 dollars, S_{ij} represents j^{th} house structural attributes, N_{ik} stands for k^{th} neighborhood socioeconomic attributes, E_{il} represents l^{th} environmental attributes, β's are the corresponding parameters to be estimated, and ε_i is the error term. Definitions of explanatory variables and corresponding general statistics are presented in Table 4.1.

The OLS regression model was tested for multicollinearity and heteroscedasticity. If the assumption of a constant error variance is violated, model uncertainty problem arises and in the presence of multicollinearity estimated parameters become less efficient (Greene 2012). Thus, White's Test of heteroscedasticity was used to determine if the variance of error terms was constant, whereas the Variance Inflation Factor (VIF) was used to test for the presence of multicollinearity (Greene 2012). As described by Taylor (2003), marginal prices in HPM model may not be constant for all attributes; therefore, independent variables were transformed (logarithmic and square forms) during model formation. The final model consisted of logarithmically-transformed house value as the dependent variable. Independent variables transformed to a logarithmic form included household income, population density, and all distance-related variables, whereas house age was squared.

A standard global modeling approach, such as OLS or spatial regression models, cannot detect nonstationarity and might obscure the site specific variation between a dependent variable and independent variables. Stationarity refers to a relationship in which independent variables have a constant effect on the dependent variable over space, whereas non-stationarity indicates that the effects of the independent variables vary over space and/or time. Therefore, a GWR model was developed to address spatial non-stationarity in the model. GWR runs a regression for each location producing local coefficients rather than global coefficients to solve the problem of non-stationarity. GWR4 software was used to estimate a geographically weighted regression model. As house pricec might vary due to location, the GWR was used to develop a local model and estimate parameters based on neighborhood density (numbers of observation used in estimating local coefficients). Thus, GWR was used to extend the OLS regression model by producing local rather than global parameters (Fotheringham et al. 2002):

$$y_i = \beta_0(u_i,v_i) + \sum_k \beta_k(u_i,v_i)x_{ik} + \varepsilon_i \quad (4.3)$$

where (u_i,v_i) are the coordinates of the i^{th} point in space represented by a centroid of census block group, $\beta_k(u_i,v_i)$ represents realization of the continuous function $\beta_k(u,v)$, and ε_i is the error term.

Equation 4.3 is the extension of Equation 4.2, in which parameters are assumed to be spatially invariant. In the GWR model, an observation for houses located closer to house i have more influence in the estimation of a local parameter, $\hat{\beta}_k(u_i,v_i)$, than a house located away from location i. Thus, the model can be further represented as:

$$\hat{\beta}_k(u_i,v_i)=(X`W(u_i,v_i)X)^{-1}X`W(u_i,v_i)y \tag{4.4}$$

where $\hat{\beta}_k(u_i,v_i)$ represents an estimate of $\beta(u_i,v_i)$ and $W(u_i,v_i)$ is an $n \times n$ matrix with off-diagonal matrix as zero and diagonal matrix representing the geographical weight of each location (u_i,v_i) as a function of distance from one location to other location for which observations were collected:

$$= \begin{bmatrix} \beta_0(u_1,v_1) & \beta_1(u_1,v_1) & \cdots & \beta_k(u_1,v_1) \\ \beta_0(u_2,v_2) & \beta_1(u_2,v_2) & \cdots & \beta_k(u_2,v_2) \\ \vdots & \vdots & & \vdots \\ \beta_0(u_n,v_n) & \beta_1(u_n,v_n) & \cdots & \beta_k(u_n,v_n) \end{bmatrix} \tag{4.5}$$

The parameters in each row of the above matrix were estimated by:

$$\hat{\beta}(i)=(X`W(i)X)^{-1}X`W(i)Y \tag{4.6}$$

Spatial weighting matrix was represented by:

$$W(i)= \begin{bmatrix} w_{i1} & 0 & \cdots & 0 \\ 0 & w_{i2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & w_{in} \end{bmatrix} \tag{4.7}$$

The Equation 4.7 represents the weighted least square estimator where the weight varies according to the location of i. $W(i)$ was computed with a bi-square kernel function. Bi-square kernel function provides a continuous, near-Gaussian weighting function up to distance b from the regression point and then zero weight to any data point beyond b (Fotheringham et al. 2003). The kernel can either be fixed or adaptive distance. An adaptive distance function was selected because the spatial context of the study area was relatively large and geographic feature distribution was sparse.

$$w_{ij} = \begin{cases} \left[1 - \left(\frac{d_{ij}}{b}\right)^2\right]^2, & d_{ij} < b \\ 0, & d_{ij} > b \end{cases} \quad (4.8)$$

where w_{ij} is the weight function, j is a specific data point in space, i represents any data point in space where a coefficient of local parameter was estimated, d_{ij} is the Euclidean distance between locations i and j, and b is an adaptive bandwidth size defined as the k^{th} nearest neighbor distance. The w_{ij} equals one if j is one of the K^{ths} nearest neighbors of i. The value of K is the number of data points that are included in the local model. Weights for all data points beyond the K^{th} become zero. The selection of d in Equation 4.8 is very important because as d increases, the closer the model solution will be to the OLS solution and as d decreases parameter estimates increasingly depend on observations in close proximity to i and thus increase variance (Fotheringham et al. 2003). There are different criteria in selecting optimum bandwidth. This study used the Golden Section Search routine to identify a bandwidth minimizing the Akaike Information Criterion (AIC) score. The AIC has an advantage of being more general and accounts for model parsimony (Fotheringham et al. 2002). As the classic AIC selects smaller bandwidths which are likely to be undersmoothed, a corrected AIC (AICc) was used as selection criterion (Tomoki et al. 2016). A model with lower a AIC is considered to be the better model because the smaller the AIC score, the closer will it be to the true model (Fotheringham et al. 2003). The AIC was defined as:

$$AIC_c = 2n\log_e(\hat{\sigma}) + n\log_e(2\pi) + n\left\{\frac{n+tr(s)}{n-2-tr(s)}\right\} \quad (4.9)$$

where n is the sample size, $\hat{\sigma}$ is the estimated standard deviation of the error term, and $tr(s)$ represents the trace of the hat matrix (mapping $\hat{y}$ onto y) and is a function of the bandwidth:

$$\hat{y}=sy \tag{4.10}$$

Local standard errors were based on the variance matrix and expressed as:

$$Var[\hat{\beta}(i)]=CC`\sigma^2 \tag{4.11}$$

where C represents the variance-covariance matrix and was defined as:

$$C=(X`W(u_i,v_i)X)^{-1}X`W(u_i,v_i) \tag{4.12}$$

After computing the variance of each parameter estimate, standard errors were obtained as follows:

$$SE(\hat{\beta}_i)=sqrt[Var(\hat{\beta}_i)] \tag{4.13}$$

The weighting matrix addressed the spatial heterogeneity, whereas the statistical significance of each local parameter estimate obtained from the GWR model was evaluated using a t-test. The spatial variability of an estimated local regression was examined to determine underlying spatial heterogeneity in the model. The variability for each coefficient was tested by model comparison between the fitted GWR (estimated y values computed by GWR) and a model in which only the k^{th} coefficient was fixed while others were kept as they were in the fitted GWR. An ANOVA test was conducted to compare OLS and GWR models. The ANOVA tested the null hypothesis that GWR model had no improvement over the OLS model.

Local coefficients generated from the GWR model were mapped to visualize local marginal effects of environmental attributes using inverse distance weighting (IDW) interpolation method. Mennis (2006) was followed in mapping local parameter estimates corresponding local t-values. A surface map illustrating estimated coefficients and local t-values for a selected parameter was created. A t-value data layer was produced with t-values between -1.645 and +1.645 being masked out and t-values smaller than -1.645 or greater than +1.645 set to 100% transparency. Setting transparency for these t-value ranges to 100% allowed data stored in local coefficient layers to be unobstructed, which enabled mapping of local parameters significant at a 10% significance level.

Table 4.1 Definition of variables used to quantify a monetary value of a waterfront open space in coastal counties of Mississippi and Alabama.

Variable	Definition	Mean	Std. Dev.
Dependent variable			
House value[a]	Median house assessed value in 2010 (US$ thousands).	139.20	72.02
Independent variables			
House structural attributes			
Room	Median number of rooms.	5.54	0.80
House age	Median house age.	31.79	15.98
Neighborhood characteristics			
Income[a]	Median household income in (US$ thousands).	44.99	19.64
Resident age	Median resident age.	38.99	6.73
Poverty	Percentage of families below a poverty line.	16.14	14.90
Population density[a]	Number of people per square mile (thousands).	1.55	1.53
Vacant	Percentage of vacant houses.	15.02	11.02
Recreational	Percentage of houses used for seasonal, recreational, or occasional purposes.	2.81	7.45
Road[a]	Distance to the nearest primary or secondary road.	1,798.28	1,867.78
Rail[a]	Distance to the nearest active railroad tract.	6,986.84	11,902.43
School[a]	Distance to the nearest public school.	2,457.16	2,641.52
Shopping[a]	Distance to the nearest shopping center.	6,150.95	7,806.10
Hospital[a]	Distance to the nearest hospital.	8,370.56	7,891.07
Airport[a]	Distance to the nearest airport.	11,153.00	7,157.78
Environmental amenities			
Park[a]	Distance to the nearest public park.	4,254.13	4,974.38
Bay[a]	Distance to the nearest bay.	7,787.85	7,991.89
River[a]	Distance to the nearest river.	6,027.44	4,151.44
Stream[a]	Distance to the nearest stream.	6,506.19	4,898.54
Bayou[a]	Distance to the nearest bayou.	8,055.22	6,312.58
Water[a]	Distance to the nearest water body other than bay, river, stream, and bayou.	995.04	867.39

Note: [a] represents a log-transformed variable. Distance-related variables were measured in meters (m)

4.4 Results

White's test for heteroscedasticity rejected the null hypothesis that the variance of error terms in the OLS (global) model was constant (chi-square statistics =364.09, prob>chi-square=0.00) indicating the presence of heteroscedasticity in the model. Therefore, robust standard errors were used in the OLS model analysis. For most variables in the OLS model, the VIF was not greater than 10 indicating there was no multicollinearity in the model. The exceptions were house age and its squared term. However, these two variables were retained in the model because using squared term allows a nonlinear relationship between house age and its price and also have been jointly used in most previous HPM studies (e.g. Troy and Grove 2008; Poudyal et al. 2009; Nilsson 2014). The coefficient of determination for the GWR (local) model (R^2=0.572 and adj. R^2 =0.530) was higher than for the OLS (global) model (R^2=0.518 and adj. R^2 =0.50), whereas the residual sum of squares (RSS) for the GWR model (61.43) was lower than for the OLS model (69.20) (Table 4.3). Similarly, the AICc of the GWR model (427.54) was lower than for the OLS model (447.86) (Table 4.3). These findings suggested that the GWR model was more suitable than the OLS model because it explained 57.2% of total model variation while maintaining lower a RSS and AICc score. The ANOVA comparison results also indicated that the GWR model outperformed the OLS model with an F-statistics of 2.17 and *p*-value of <0.001 (Table 4.2).

Table 4.2 ANOVA statistics for the comparison between OLS and GWR model used to estimate a monetary value associated with waterfront open space.

Source	SS	DF	MS	F	p
Global Residuals	69.20	598.00			
GWR Residuals	61.43	564.98	0.11	2.17	<0.001
GWR Improvement	7.78	33.02	0.24		

Table 4.3 Parameter estimates from the hedonic pricing model (HPM) used to estimate the monetary value associated with waterfront open space in Mississippi and Alabama, and results of the spatial variability test.

Variables	Global model		Local model					Test for spatial variability (Difference of criterion)[a]
	Parameter coefficient	White Std. Error	Min.	Lower quartile	Median	Upper quartile	Max.	
Intercept	8.647***	0.915	7.523	7.746	7.891	10.040	10.178	1575.438***
Rooms	0.059*	0.031	0.031	0.042	0.049	0.098	0.104	-35.518***
House Age	-0.014***	0.003	-0.017	-0.016	-0.015	-0.014	-0.013	-14.978***
House Age – squared	0.000***	0.000	0.000	0.000	0.000	0.000	0.000	0.432
Ln(Income)	0.420***	0.067	0.266	0.273	0.496	0.507	0.525	5057.518***
Median Age	0.007**	0.003	-0.002	-0.001	0.000	0.014	0.014	-12.500***
Poverty	-0.001	0.002	-0.002	-0.002	-0.001	0.001	0.001	1.059
Ln(Pop den)	0.000	0.021	-0.031	-0.026	0.014	0.021	0.036	-20.126***
Vacant	-0.009**	0.004	-0.012	-0.009	-0.008	-0.008	-0.006	1.249
Recreation	0.019***	0.006	0.009	0.015	0.022	0.024	0.033	-0.832*
Ln(Road)	0.004	0.014	-0.004	0.002	0.004	0.009	0.028	-15.059***
Ln(Rail)	0.013	0.013	-0.021	-0.008	0.011	0.017	0.028	-15.908***
Ln(School)	0.000	0.022	-0.021	-0.016	0.011	0.012	0.016	-49.912***
Ln(Shopping centers)	-0.036*	0.021	-0.051	-0.033	-0.029	-0.024	-0.013	-51.620***
Ln(Hospital)	-0.086***	0.025	-0.157	-0.143	-0.137	-0.055	-0.032	-29.118***
Ln(Airport)	0.006	0.026	0.000	0.016	0.052	0.062	0.076	-149.902***
Ln(Park)	-0.010	0.021	-0.036	-0.032	0.010	0.016	0.023	-37.697***
Ln(Bay)	-0.059***	0.009	-0.064	-0.057	-0.054	-0.052	-0.047	-9.532***
Ln(River)	-0.004	0.012	-0.032	-0.028	-0.025	-0.008	-0.005	-2.123**
Ln(Stream)	-0.030*	0.017	-0.078	-0.059	-0.055	-0.046	-0.033	-76.215***
Ln(Bayou)	0.038**	0.018	0.032	0.036	0.048	0.061	0.073	-47.041***
Ln(Water)	-0.029***	0.011	-0.040	-0.035	-0.015	-0.014	-0.012	-12.116***
R^2	0.518		0.572					
R^2 adj	0.500		0.530					
AICc	447.863		427.544					
CV	0.123		0.120					
Residual Sum of sq.	69.201		61.425					
Bandwidth (m.)			533.083					
N	620.000		620.000					

Note: The dependent variable is ln(housing price), *p<0.10,**p<0.05, ***p<0.01, and [a] negative value of difference criterion suggest a spatial variability

4.4.2 Structural and neighborhood characteristics

House structural attributes had differing effects on house value. OLS results suggested that an increase in the median number of rooms by one was associated with increase in house values of 5.90% whereas GWR results revealed that an increase in the median number of rooms by one increases house values by 3.10% to 10.4% depending on location. House age was negatively associated with house value. A one-year increase in house age decreased house values by 1.4% in OLS and 1.3% to 1.7% in GWR. However, a statistically significant positive sign of squared house age variable indicated that the house value had a nonlinear relationship with house age and the value started increasing after 85 years.

Neighborhood characteristics had both positive and negative effects on house values. Median household income and percentage of houses used for recreational purposes were positively associated with house value in OLS and GWR models. A 1.0% increase in income and percentage of houses used for recreational purpose increased house values by 0.42% and 1.9% respectively in OLS and 0.27% to 0.53% and 0.9% to 3.30% respectively in GWR model. However, the percentage of vacant houses in a census block group was negatively related with house values in both models. A one-percent increase in vacant houses decreased house value by 0.9% in the OLS model and 0.6% to 1.2% in the GWR model. Median household age was positively associated with house values in the OLS model whereas this variable had both positive and negative relationship with house value in GWR model. OLS coefficient for median house hold age was 0.007 whereas GWR coefficient ranged from -0.002 to 0.014. Distance related variables such as distance to the nearest shopping center and hospital were negatively related with house values in both models. Coefficients can be interpreted in similar fashion.

4.4.3 Environmental attributes

Proximities to several environmental attributes were significantly related with house values. The coefficients for four of six variables in the OLS model were significant at the 10% or a better level of significance. Stationarity for each of the six variables was rejected at the 10% significance level. This result indicated that the open space measures were spatially heterogeneous. The OLS model indicated that that proximity to selected waterfront types was associated with increased house values. For example, a one-percent increase in proximity to a bay, stream, and other water body translated to increases in house values of 0.06%, 0.03%, and 0.03%, respectively. However, a one-percent increase in proximity to a bayou related with the house value decrease of 0.04%.

The relationship of proximity to different waterfronts and house values, holding all other variables constant, is plotted in Figure 4.2. In the figure, the y-axis represents house values calculated by solving the estimated hedonic property price equation at the mean value of each attribute except for the proximity to the respective waterfront type. The x-axis represents the distance to different waterfront types. Figure 4.2 shows downward sloping relationships between house values and distance to a bay, river, stream, and other water body and an upward sloping relationship with distance to a bayou suggesting houses near bays, rivers, streams, and other water bodies were assessed a higher value than houses adjacent to a bayou.

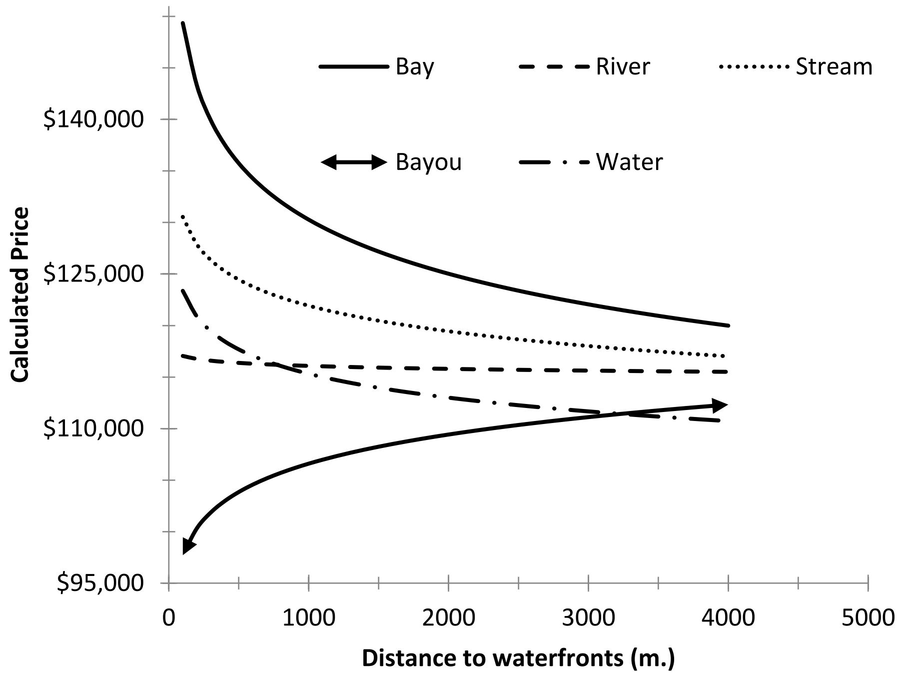

Figure 4.2 Relationships between assessed house values and distance to different waterfront types.

Marginal implicit prices for each of the significant waterfront coefficients for the OLS and GWR models were estimated at the mean home assessed value of $139,204 and distance of one mile (1,609.34 meter) to the selected waterfront types (Table 4.4). In the OLS model, the value of distance to the nearest bay was estimated as -$5.13 per meter. However, GWR model illustrated how the implicit price of distance to a bay varied across the study area (Figure 4.3 A). The local parameter coefficients of distance to a bay estimated by the GWR model were significant throughout the study area suggesting benefits of bay was valued throughout the study area and the implicit price was estimated to be between -$4.04 and -$5.57 per meter (Table 4.4). Thus, the marginal implicit price assumed to be constant across the study area in the OLS model in fact varies between locations. For example, proximity to a bay was valued at a relatively higher rate on peripheries of urban centers than other areas.

A distance to the nearest stream was also valued positively by the coastal residents. In the OLS model, the estimated constant marginal price was -$2.57; however, the GWR model demonstrated variability in the implicit price represented by local parameter estimates ranging from -0.078 to -0.033 (Figure 4.3 B). The estimated marginal implicit price from the GWR model was between -$6.77 and -$2.90 per meter. The figure illustrated that local parameters were not statistically significant throughout the study area (indicated by white color) suggesting distance to stream did not have any effect to house value in some of the location. Proximity to a steam was higher valued in the Mobile County than Baldwin County, whereas it was not associated with house values in the Hancock County and some regions of Harrison County. Proximity to a river was not associated with house values in the OLS model; however, in the GWR model some of the parameters at the southern region of the study area were linked with house values (significant at 10% or better significance level) (Figure 4.3 C). People living near Dog River, East and West Fowl River, and Little River valued proximity to river, whereas in other areas proximity to river did not have any impact on house values. The marginal implicit price was estimated between -$2.80 and -$2.46 per meter. Similarly, Figure 4.3 D illustrated the spatial variability due to distance to other water bodies. The estimated implicit price from GWR model was between -$3.43 and -$2.29 per meter and -$2.53 from OLS model. Proximity to other water bodies was significant in coastal counties of Mississippi but not in Alabama. These findings implied that the proximity to other water bodies was valued by residents where streams and quality bays were relatively scarce as in Hancock and Harrison Counties.

In case of bayous, the OLS model estimated that house values increased by $3.27 per meter away from bayous. An examination of Figure 4.3 E indicated spatial variability in the effect of distance to a bayou on house values. The estimated marginal implicit price from the GWR model was between $6.34 and $3.61 per meter suggesting that a proximity to a bayou was negatively associated with house values. This negative relationship between house values and proximity to a bayou occurred in almost all parts of the study area in Alabama; however, it was mostly statistically insignificant in Mississippi.

Table 4.4 Estimated marginal implicit prices for distance to environmental amenities.

Environmental attributes	Marginal implicit price per meter	
	OLS	GWR
Distance to the nearest bay	-$5.13	-$5.57 to -$4.04
Distance to the nearest stream	-$2.57	-$6.77 to -$2.90
Distance to nearest river	NS	-$2.80 to -$2.46
Distance to the nearest bayou	$3.27	$6.34 to $3.61
Distance to the nearest other water body	-$2.53	-$3.43 to -$2.29

Note: NS represents a statistically insignificant coefficient

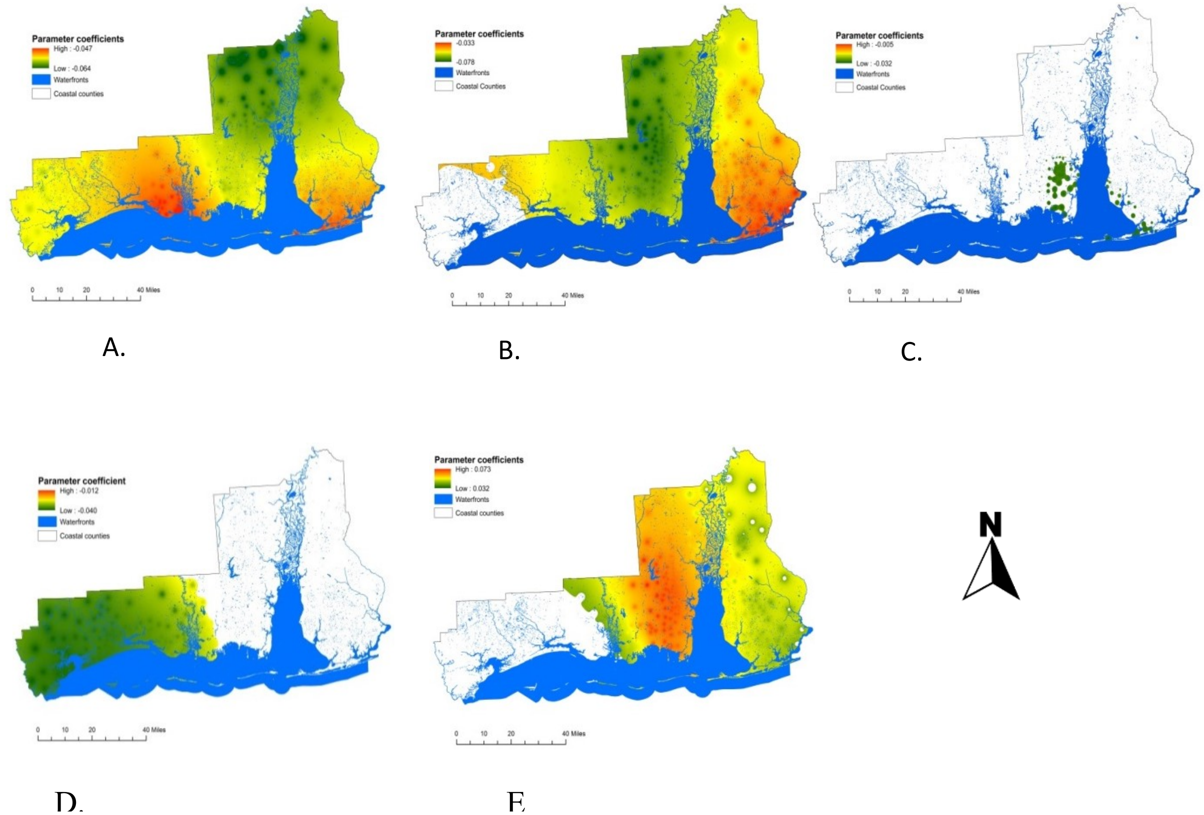

Figure 4.3 Local parameter coefficients of distance to different nearest waterfronts estimated from GWR model that are statistically significant at 10% of better level of significance. A. Local parameter coefficients of distance to bays. B. Local parameter coefficients of distance to streams. C. Local parameter coefficients of distance to rivers. D. Local parameter coefficients of distance to other water bodies. E. Local parameter coefficients of distance to bayous.

4.5 Discussion

With an increasing population growth rate, development pressure on waterfront open spaces has also been increasing, leading to conflicting interests and development perspectives (Boyer and Polasky 2004b; Schuyt 2005b; McDonald et al. 2010). As a result, waterfront open spaces have become more congested and at some point these areas might not exist or might not be capable of producing ecosystem services in sufficient quantities (Kline 2006; Poudyal et al. 2009). Therefore, decision makers and planners need information on how residents value ecosystem services provided by waterfront open spaces to properly account for their importance in land-use planning and urban development.

Waterfront open space provides numerous benefits including water purification and filtration, flood control, wildlife habitat, and recreation and being adjacent to or having access to such areas means properties will be more valuable (Mcconnell and Walls 2005). Results indicated that proximity to most waterfronts were associated with house value. Mahan et al. (2000), Bin (2005), and Sander et al. (2010) also indicated that proximity to nearest waterfront had substantial positive effect on property values. Proximity to bay was positively valued by coastal residents which is consistent with Chen and Jim (2010) who found that with 1,000 meter increase in proximity to bay increases housing price by 0.70%. Proximity to river, stream and other water bodies such as lakes, small ponds, and reservoirs were also valued positively. This result was consistent with previous studies by Mahan et al. (2000) and Sander and Polasky (2009) who estimated 0.004% to 0.01% increases in house value with one-percent increase in proximity to the nearest stream. Bowman et al. (2009) estimated being adjacent to a stream increased home values by 9.60%. Doss and Taff (1996) found that with 10 meter increase in proximity to lake residential property value increases by $187.92. Sander and Polasky (2009) reported 0.01% increase in residential home sale price with one-percent increase in proximity to nearest lake. Similarly, Luttik (2000) estimated that house prices increased by 10% with a water view. Thus, waterfront open spaces are highly desired by coastal residents and in order to enhance existing resources or provide well designed new resources, city planners will need to balance the opportunities and constraints of public access to waterfront open space with commercial and urban development.

Findings also revealed that coastal residents had varying preferences regarding different types of waterfront space. Proximity to a bay was associated with the highest monetary value, followed by a stream and other water body, which suggested that large-size waterfront open spaces were appreciated more than smaller ones. The possible reason might be larger size waterfront provides more benefits and recreational opportunities than smaller size. Mahan et al. (2000) found a similar trend, a $24.39 increase in house value with one acre increase in wetland size. Similarly, Bolitzer and Netusil (2000), Haab and McConnell (2002) and Poudyal et al. (2009) also indicated increase in residential property values with increase in size of open space. In addition, amenity value of bays might have been captured better than other types of waterfronts such as river and stream because the study area is located in the coastal region where access to bay areas is fairly easy.

Traditional regression models such as OLS can hide important local variation in model parameters (Tu and Xia 2008). In most previous studies, the relationship between residential property value and proximity to waterfront represented the average situation by assuming the relationship did not change across the landscape. However, this assumption is not true as revealed by this study. Ignoring the notion that specific sites within the same study area might differ from each other with regard to the nature and extent of environmental attributes lead to generalizations about the entire study area (Gilbert and Chakraborty 2011). Inferences based on results from a global model, where nonstationarity was present, might not be sufficient in local policy setting (Ali et al. 2007). Findings from this study suggested that there was a spatial variation and the global (OLS) model did not capture the geographical variations in house values across the study area. Regression maps displayed hot the intensity and direction of the effects of distance to different waterfronts on house values differed across the study area. In some locations waterfront amenities were positively valued and with a larger magnitude, whereas in other locations they were still valued positively but with a smaller magnitude. Thus, as there exists spatial variation in waterfront open space values across the study area site-specific land use management to fit the local characteristics is warranted.

This study is not without limitation due to lack of data. This study used data at the census block group level and lacked many house structural attributes such as number of bedrooms and bathrooms, presence of garage, fireplace, porch, and center air conditioning system, area of a property, and quality of a house which are crucial in HPM analysis. The data available from census are limited and are presented in either median or average number for a census block group. The land use aggregation (census block group) may have impacted the reliability of estimated marginal implicit price. It is thus recommended that the results estimated from this type of study be confirmed by additional HPM analysis using detailed information obtained from MLS or tax assessors.

However, this type of study is helpful where MLS or tax assessors' information is either unavailable or difficult to acquire.

Further, the present study demonstrated the utility of GWR in addressing spatial nonstationarity. This study considered only spatial heterogeneity however in real world all of the independent variables may not vary with spatial locations (Liu et al. 2016). Therefore, future studies should consider using a mixed geographically weighted regression approach where some of the variables are allowed to be global (stationary) and some to be local (nonstationary). A mixed geographically regression approach can explore spatial variation of some of the independent variables and in addition global effect provides evidence for policy-based linkages and an economically connected housing market (Wei and Qi 2012; Helbich et al. 2014).

4.6 Conclusions

The study demonstrated that in addition to structural and neighborhood attributes, environmental attributes such as waterfront open space were of great importance in explaining variation of house value. The study estimated monetary value of waterfront open spaces by determining how proximity to different waterfront types was related with the house value. Overall, proximity to most waterfronts was resulted in higher assessed house values. Further, proximities to the different types of waterfront open space were valued differently. Larger size waterfronts such as bays were valued more than smaller sized waterfronts.

Marginal implicit prices estimated by this study demonstrated coastal residents' preference towards waterfront open space. The policy makers and urban planners can use this information to develop both municipality-wide land-use guidelines and neighborhood-specific zoning regulations that would provide a sufficient access to waterfront open space areas. In addition, as the study demonstrated that there exists spatial variation in amenity values, site specific land use management is warranted. Site-specific information on waterfront open space values will be highly relevant to guide future urban development. Similarly, real estate developers and city planners can enhance housing values by considering the size, type, and proximity to waterfront open space.

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CHAPTER V

GENERAL CONCLUSIONS

Communities are struggling to preserve open space and limit urban sprawl while still providing affordable and economic growth. In the effort to preserve open space, policy makers and city planners should figure out importance of open space benefits to the communities. In this regard, public opinion regarding open space preservation can serve as important information. Public opinion provides information on how people value open space and economic analyses can provide dollar values of the benefits. Estimates of open space monetary values will be important in the policy debate between need of development and need of open space. This study used two methodological approaches, CVM and HPM, to estimated monetary value of open space associated with waterfronts in Mississippi and Alabama.

Chapter II provides insight into coastal residents' opinion towards open space, working waterfronts, and their willingness to pay to support open space preservation associated with coastal waterfronts. Coastal residents frequently used open space for various purposes suggesting increasing demand of open space. Commercial development was the major growth issues in the community suggesting that development had threatened local identity and environmental quality. In order to increase open space areas residents were willing to make one-time payment along with their water bill. Residents' age, income, duration of residency, and affiliation with conservation group were major factor associated with the willingness to pay. This information will be helpful in designing conservation efforts tailored to specific groups of residents based on their socio-demographic characteristics. In addition, residents believed local government had a responsibility to provide usable public open space. Thus, local government initiatives to develop conservation strategies through regulatory and voluntary actions might be applicable. Residents' were willing to support open space preservation through an average single payment of $90.72 per household added to their water bill. Generalizing the WTP estimates represent total monetary value of $11.35 million and indicates a potential budget that might be needed to conserve waterfront open space for facilitating ecosystem services.

Chapter III focused on revealed preference method, HPM, to estimate monetary values associated with waterfront open space using Multiple Listing Service (MLS) data. Proximities to waterfronts were used as proxy to measure waterfront open space benefits. The empirical findings from this study suggested that coastal residents positively valued waterfront open space and they paid higher prices for houses located nearby most waterfront types. Results revealed that larger size waterfronts were valued most than smaller size. Value scarcity across the study area was demonstrated by higher home values in city characterized by lower percentage of waterfront area in Daphne than Mobile. Findings from this study have important policy implication related in designing scenic and publically accessible waterfronts that can draw more people to the shore. Results will facilitate informed planning decisions regarding waterfront open space preservation and alternative development in coastal cities of Alabama.

Chapter IV also used revealed preference method but different database in estimating implicit price of waterfront open space. Database for this study was obtained from publically available sources such as census data. Overall, the study determined that proximity to most waterfronts had a positive relationship with house value suggesting its positive economic benefit to local communities. Results from Chapter IV were consistent with Chapter III suggesting feasibility of publically available data in HPM analysis. In addition, this study used GWR model to address the problem of non-stationarity. GWR results suggested that intensity and direction of the effect of distance to different waterfronts on house value differ across the study area. The study provided site specific dollar value of waterfront proximities. This information will be helpful for policy makers and city planners in developing site specific conservation strategies.

Overall, the three studies presented in this dissertation are linked conceptually. First, information on coastal residents' attitudes and opinions towards open space provide decision makers with a guideline on existing condition and demand of open space. In addition, estimates in terms of dollar value of open space benefits associated with coastal waterfronts will help carryout benefit-cost analyses during environmental investment decisions. To this end, findings from the first study emphasized the importance open space to coastal communities and the residents' willingness to pay to support open space conservation associated with coastal waterfronts. However, these estimates may be biased because of hypothetical responses. Therefore, second and third studies utilized real house market transaction data as a proxy to measure an economic value of proximity to different waterfront types. Findings from second and third studies showed that coastal residents valued waterfront open space benefits and a monetary value of such benefits was reflected in house sale prices. While the CVM indicated a monetary value of open space, the HPM suggested that the value varied with the proximity of residence to different types of waterfront open space. In general, both CVM and HPM studies showed that coastal residents valued waterfront open space and provided indicators of potential budgets for their preservation. The house sales data used in the second study was obtained from MLS and might be difficult to obtain, costly, and not be available to non-members. To overcome this problem, the third study used publicly available house value data from the U.S. Census Bureau. The third study illustrated that when detailed property information is absent or difficult to acquire, publicly available data can be used as a low cost valuation alternative and still provide reliable estimates.

Values estimated using CVM and HPM in this study vary because these approaches may estimate different benefits associated with waterfront open space. HPM provided estimates of the marginal value living nearby waterfront open space. In addition, the monetary value differed based on type of waterfront open space and the value was even negative for certain type of waterfront open space as bayou. Moreover, marginal value estimated from HPM did not account full range of benefits because this method can only measure the use value of waterfront open space. Although HPM have limited application in capturing value of open space benefits, this method still provided important information to city planners and developers about type and location of open space that has higher value. CVM, in other hand, captured a more comprehensive set of benefits, both use and nonuse nonmarket values of open space. However, CVM estimated open space associated with waterfronts had value, regardless of its types. In addition, CVM did not account the effect of location during monetary estimation because value may vary across location, for example the value may be higher in urban than rural area as estimated by HPM. Nevertheless, CVM used survey method to capture public opinion and collected detailed information about values of open space. This information can be useful for local planners and policymakers trying to decide what lands to targets for preservation. To estimate total values of open space benefits, HPM and CVM can be used as supplementary to each other because HPM can capture the use value whereas CVM can capture the nonuse values of open space.

Although this study met all of its objectives, there are limitations to be noted. The referendum questions constructed in contingent valuation scenario in second chapter did not include follow-up referendum question for those respondents who voted against the proposal and assumed their lower minimum willingness to pay as “zero”. Having follow-up question for the respondent who voted against the proposal might produce more precise WTP. In addition, lower response rate (15.26%) might have impacted the WTP estimates. The third chapter did not estimate marginal price of proximities to waterfront for Gulfport and Ocean Springs of Mississippi because MLS data were difficult to acquire when this study was conducted. Having included these two cities, findings would have been directly comparable with the results from Chapter II and Chapter IV. The fourth chapter evaluated marginal implicit price of proximities to waterfronts using publically available census data. The data available from census were limited in terms of house structural attributes and were available only at aggregated level limiting reliability of estimated marginal price. Finally, a follow-up study of coastal residents’ opinion are warranted in identifying changing residents’ attitude and redesigning conservation program over time to meet waterfront open space demand.

APPENDIX A

A.1 Overall Reference List

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A.2 Survey Instrument

Survey #: 31647

RESEARCH TO HELP MISSISSIPPI AND ALABAMA COASTAL COMMUNITIES PLAN FOR GROWTH

> If you would prefer to complete this survey online please go to
> **www.cfr.msstate.edu/openspace/70**
> and enter the Survey Number (#) at the top of this page when prompted.

PLEASE READ THESE KEY DEFINITIONS BEFORE CONTINUING

Working Waterfront – According to the National Working Waterfront Network, a working waterfront is defined as waterfront lands, waterfront infrastructure, and waterways that are used for a water-dependent activity. Working waterfronts range from small single employee operations to hundreds of employees. Examples of working waterfront operations include marinas, storage facilities, boat repair facilities, waterfront restaurant's with public beach access, shrimp boat fleet owner, shrimp boat dock, boating club, fresh seafood market, fueling facilities, boatyards, sail repair and canvas shop, bait and tackle shop, boat rental, aquaculture, and a marine supply for commercial fishing.

Open Space – In this study, open space includes socially valued public and private landscapes with water permeable ground cover and which are adjacent to your community. Examples include local parks, golf courses, athletic fields, wildlife management areas, state and federal forests and grasslands, national seashores, historic sites, river greenways, cemeteries, and botanical gardens.

Please answer the following questions to the best of your ability.

Sea Grant Mississippi-Alabama | USA | Mississippi State University | JSU Jackson State University

Survey #: 31647

PART 1: We would like to know your opinions about commercial and residential growth in your community.

1 Please indicate if you think either of the following types of growth is a *major* issue in your community?

	Not at all	Somewhat	Very Much
Commercial development	☐	☐	☐
Residential development	☐	☐	☐
Urban sprawl	☐	☐	☐
People relocating here from other places	☐	☐	☐

2 For each category below, rank the acceptable level of future growth for your community.

	None	Very Little	Moderate	High	Very High
Residential	☐	☐	☐	☐	☐
Commercial	☐	☐	☐	☐	☐
Population	☐	☐	☐	☐	☐
Industrial (in general)	☐	☐	☐	☐	☐
Seafood industry	☐	☐	☐	☐	☐
Shipping industry	☐	☐	☐	☐	☐
Tourism industry	☐	☐	☐	☐	☐
Gaming industry	☐	☐	☐	☐	☐

3 What, if any, are the reasons for placing limits on growth and development?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Control government spending	☐	☐	☐	☐	☐
Prevent environmental degradation	☐	☐	☐	☐	☐
Preserve the character of the community	☐	☐	☐	☐	☐
Maintain real estate values	☐	☐	☐	☐	☐
Avoid traffic congestion	☐	☐	☐	☐	☐

4 Rank the terms from *best (1)* to *worst (8)* reflecting your ideas about "smart growth" for a community.

More local planning ______
Better local planning ______
Regional planning ______
Focus on generating income ______
Promote development of land within an already built-up area (in-fill) ______
Control urban sprawl ______
Preserve existing open space ______
Create new open space as the city grows ______

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Part 2: This section asks about your attitudes towards open space in your community.
Please refer to the definition of open space on the first page.

5 What do you feel are the *community* benefits of open space (if any)?

		Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	Provide aesthetics/beauty	□	□	□	□	□
2	Provide a place for recreation/relaxing/exercise	□	□	□	□	□
3	Increase property values	□	□	□	□	□
4	Help to mitigate stormwater impacts (e.g., prevent flood damage)	□	□	□	□	□
5	Remediate polluted soils	□	□	□	□	□
6	Create a sense of place, sense of community	□	□	□	□	□
7	Provide historical record	□	□	□	□	□
8	Reduce air pollution	□	□	□	□	□
9	Conserve energy	□	□	□	□	□
10	Buffer storm effects	□	□	□	□	□
11	Create wildlife habitat	□	□	□	□	□
12	Boost tourism, stimulate commercial growth, attract investment	□	□	□	□	□
13	Stimulate creativity in local arts and culture	□	□	□	□	□
14	Help prevent costs of unplanned development	□	□	□	□	□
15	No Benefits	□	□	□	□	□
16	Other (specify) _____	□	□	□	□	□

6 Of the characteristics above, which do you think is the single most important benefit of open space in your community?
(Indicate a number, 1-16) _____

7 How often do you/your family use local open spaces as they are defined on the first page?

Less than one time per month	□
More than one time per month	□
Just once per year	□
More than one time per year	□
Once in the last couple of years	□
Once in the last five years	□
Never	□

8 Do you think local government has a responsibility to the public to provide usable *public* open space?

Yes □ No □

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9 What do you feel are the problems associated with your community's open space (if any)?

		None	Very Little	Moderate	High	Very High
1	Safety/crime	☐	☐	☐	☐	☐
2	Lack of maintenance/litter	☐	☐	☐	☐	☐
3	Trees or tree branches falling	☐	☐	☐	☐	☐
4	Erosion	☐	☐	☐	☐	☐
5	Invasive species	☐	☐	☐	☐	☐
6	Wildlife nuisances	☐	☐	☐	☐	☐
7	Other (specify) _____	☐	☐	☐	☐	☐

10 Of the problems above, which is your biggest concern? (Indicate a number, 1-7) _____

11 To what degree do you agree or disagree with the following about open space in your community?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
There is an adequate number of open spaces	☐	☐	☐	☐	☐
There is a sufficient amount of area in open space	☐	☐	☐	☐	☐
The quality of my community's open space is adequate	☐	☐	☐	☐	☐
It is possible to balance open space preservation and commercial/residential development	☐	☐	☐	☐	☐
Additional open space needs to be acquired	☐	☐	☐	☐	☐
More open space should be acquired by raising taxes over a defined period of time	☐	☐	☐	☐	☐

12 To what extent do you agree with the following statements about land use planning in your community?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
There needs to be land use planning in my community	☐	☐	☐	☐	☐
Cities should cooperate more when planning for growth	☐	☐	☐	☐	☐
Private land use should be based on what the owner wants rather than being restricted by zoning	☐	☐	☐	☐	☐
Zoning restrictions hurt more than they help an area	☐	☐	☐	☐	☐
Public policy should ensure adequate public access to open space	☐	☐	☐	☐	☐
Current planning assures preservation of enough open space	☐	☐	☐	☐	☐
Land use planning at the local level increases local control of development issues	☐	☐	☐	☐	☐
The benefits of economic development outweigh the costs	☐	☐	☐	☐	☐

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13 **Keeping in mind our definition of open space, think of one OPEN SPACE in your community that you visit and that is special to you. Please write the name of your special place on the line.**

____

14 **Indicate your agreement with how the statements match your attitude about your special place.**

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I feel that this place is a part of me.	☐	☐	☐	☐	☐
This place is the best place for what I like to do.	☐	☐	☐	☐	☐
This place is very special to me.	☐	☐	☐	☐	☐
No other place can compare to this place.	☐	☐	☐	☐	☐
I identify strongly with this place.	☐	☐	☐	☐	☐
I get more satisfaction out of being at this place than at any other.	☐	☐	☐	☐	☐
I am very attached to this place.	☐	☐	☐	☐	☐
Doing what I do at this place is more important to me than doing it in any other place.	☐	☐	☐	☐	☐
Being at this place says a lot about who I am.	☐	☐	☐	☐	☐
I wouldn't substitute any other area for doing the types of things I do at this place.	☐	☐	☐	☐	☐
This place means a lot to me.	☐	☐	☐	☐	☐
The things I do at this place I would enjoy doing just as much at a similar site.	☐	☐	☐	☐	☐

Part 3: The next questions address working waterfronts.
Please refer to the definition of working waterfront on the first page.

15 **What are the most important elements of your community's coastal character?**

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Close to nature	☐	☐	☐	☐	☐
Shipping industry	☐	☐	☐	☐	☐
Seafood industry	☐	☐	☐	☐	☐
Gaming	☐	☐	☐	☐	☐
Tourism (other than gaming)	☐	☐	☐	☐	☐
Good place for family	☐	☐	☐	☐	☐
Favorable climate	☐	☐	☐	☐	☐

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16 **How important is it that future development preserve the coastal character of your community?**

Not at all	Slight	Minor	Moderate	Major
□	□	□	□	□

17 **How important do you think working waterfronts are to your community's history and culture?**

- Very Unimportant □
- Moderately Unimportant □
- Neither Important/ Unimportant □
- Moderately Important □
- Very Important □
- Don't Know □

18 **Are working waterfronts in your community threatened (e.g., by development, property taxes, storms, changing economy)?**

Not at all	Slight	Minor	Moderate	Major
□	□	□	□	□

19 **In your opinion, how much do each of the following threaten the existence of working waterfronts in your community?**

	None	Very Little	Moderate	High	Very High
Residential development	□	□	□	□	□
Commercial development	□	□	□	□	□
Property taxes	□	□	□	□	□
Coastal storms	□	□	□	□	□
Changing economy	□	□	□	□	□
Offshore energy production	□	□	□	□	□

20 **How can working waterfronts best be protected? (Rank from *best=1* to *worst=6*)**

- Tax deferral to property owners ______
- Treat like agriculture for property tax assessment purposes ______
- Purchase cultural easements through public bonds ______
- Public initiatives (in general) ______
- Private investment (in general) ______
- Other (specify) ______ ______

21 **Do you think government has a responsibility to the public to maintain working waterfronts as defined here?**

Yes □ No □

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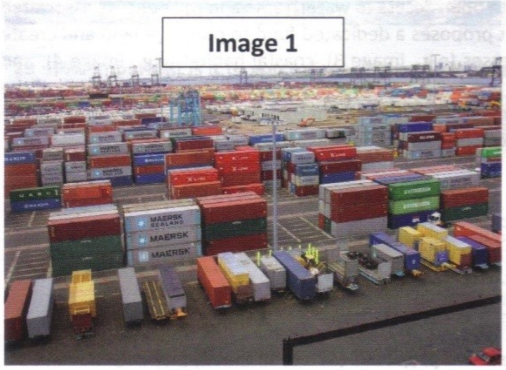
22 Complete the sentence: "Working waterfronts in my community ..."

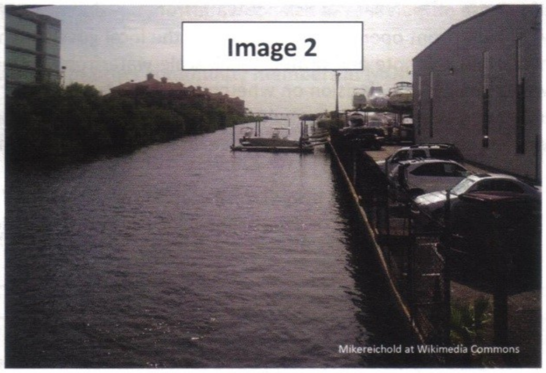
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
...should be protected at any cost.	□	□	□	□	□
....should be protected only using private initiatives.	□	□	□	□	□
...should be protected using public and private initiatives.	□	□	□	□	□
...may be forced to disappear.	□	□	□	□	□
...are not worth protecting.	□	□	□	□	□

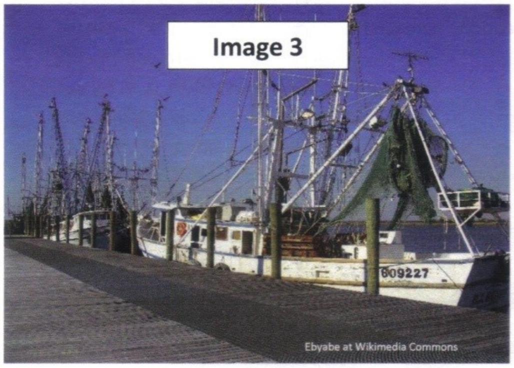
For the next two questions, please refer to these four images.

23 Of the four images, which one best represents your vision of an ideal waterfront landscape in your community.

Image 1 □ Image 2 □ Image 3 □ Image 4 □ None □







24 The images illustrate four degrees of waterfront development. Which image is most like the current character of waterfront in your community?

	Not at all	Very Little	Moderate	High	Very High
Image 1	☐	☐	☐	☐	☐
Image 2	☐	☐	☐	☐	☐
Image 3	☐	☐	☐	☐	☐
Image 4	☐	☐	☐	☐	☐

Part 4: In this section, we would like to ask you questions about your willingness to support efforts to preserve open space associated with coastal waterfronts. The following questions refer to your community of MOBILE.

For the last several years, MOBILE has been experiencing population growth, as well as tourism and commercial development. While property values have increased, the number of locally-owned working waterfront businesses has decreased. The local elected officials support continued growth; however, several officials are concerned about potential loss of traditional waterfront and surrounding marshlands, and the impact such losses may have on citizens' quality of life. These officials seek to balance waterfront development with open access to waterfronts and the benefits associated with waterfront open space. To this end, the local government proposes a dedicated fund to purchase land and create areas that promote and protect small-scale waterfront businesses (e.g., Image 3), coastal habitat (e.g., Image 4), and water quality. The decision on whether the fund is created or not will be made through a ballot voting initiative. If the initiative passes, each household will be required to make a one-time payment with their water bill. The land purchase will be completed in the next five years and public access to these properties will be available starting in 2020.

25 If there was a ballot proposal for a one-time payment of $70 added to your water bill to increase open space, would you vote for or against the proposal? (Please indicate only one)

For the proposal ☐ Against the proposal ☐ Unsure/Don't know ☐

26 Please explain the reason you voted FOR or AGAINST the ballot proposal? (Select all that apply)

Provide/increase environmental benefits of open space	☐
Provide/increase social benefits of open space (e.g., recreation, increased property values, support traditional waterfront uses)	☐
Retain the coastal character of the community	☐
There are too many taxes already	☐
There are more important uses for tax money	☐
There is already enough open space in my city	☐
The payment is too high	☐
Don't know/no answer	☐
I didn't understand the scenario	☐
Other (specify) _____	☐

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27 How much more would you be willing to pay as a one-time payment in addition to the amount specified in Question 25 ($70)?

None	About half ($35)	The same ($70)	About twice the amount ($140)	More than $140
☐	☐	☐	☐	☐

28 If you are given an opportunity to fund an open space preservation initiative, in what ways would you prefer to fund it? (Select all that apply)

By making a voluntary donation to environmental/conservation organization(s).	☐
By making a voluntary donation when paying utility bills.	☐
By paying a higher local tax to the city or county.	☐
By paying a new local tax into a conservation program.	☐
I do not want to fund for conservation of open space.	☐
Other (specify): _____	☐

Part 5: This set of questions addresses some important considerations about the city you live in.

29 How important is it to you to feel a sense of community with other community members in MOBILE?

Very Unimportant	Moderately Unimportant	Neither Important/ Unimportant	Moderately Important	Very Important	Prefer not to be part of this community
☐	☐	☐	☐	☐	☐

30 In your opinion, how serious of a problem is each of the following issues in your community?

	Not Serious	Moderately Serious	Very Serious	Don't Know
Not enough jobs	☐	☐	☐	☐
Low wages/salaries	☐	☐	☐	☐
Environmental quality	☐	☐	☐	☐
Quality of education	☐	☐	☐	☐
Quality health care	☐	☐	☐	☐
Health (e.g., diabetes, nutrition, obesity)	☐	☐	☐	☐
Use of illegal drugs	☐	☐	☐	☐
The need for public transportation	☐	☐	☐	☐
Availability of affordable housing	☐	☐	☐	☐
Loitering in public areas	☐	☐	☐	☐
Unfair political representation	☐	☐	☐	☐
Quality of housing	☐	☐	☐	☐
Worker rights	☐	☐	☐	☐
Youth problems (e.g., gangs)	☐	☐	☐	☐
Other (specify) ____	☐	☐	☐	☐

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31 How much confidence do you have in local government to make good decisions about the following local issues?

	None	Very Little	Some	Complete
Educational quality	☐	☐	☐	☐
Business development	☐	☐	☐	☐
Environmental quality	☐	☐	☐	☐
Crime prevention	☐	☐	☐	☐
Civil liberties protection	☐	☐	☐	☐
Housing availability	☐	☐	☐	☐

32 Indicate how much each statement matches your feelings about the community of MOBILE.

	Not at All	Somewhat	Mostly	Completely
Important needs of mine are met because I'm part of this community.	☐	☐	☐	☐
Community members and I value the same things.	☐	☐	☐	☐
This community is successful in meeting the needs of its members.	☐	☐	☐	☐
Being a member of this community makes me feel good.	☐	☐	☐	☐
I can talk about my problems with community members.	☐	☐	☐	☐
People in this community have similar priorities and goals.	☐	☐	☐	☐
I can trust people in this community.	☐	☐	☐	☐
I can recognize most of the members of this community.	☐	☐	☐	☐
Most community members know me.	☐	☐	☐	☐
This community has symbols and expressions of membership such as clothes, signs, art, architecture, logos, landmarks, and flags that people can recognize.	☐	☐	☐	☐
I invest time and effort into being part of this community.	☐	☐	☐	☐
Being a member of this community is a part of my identity.	☐	☐	☐	☐
Fitting into this community is important to me.	☐	☐	☐	☐
This community can influence other communities.	☐	☐	☐	☐
I care about what other community members think of me.	☐	☐	☐	☐
I have influence over what this community is like.	☐	☐	☐	☐
If there is a problem in this community, we can get it solved.	☐	☐	☐	☐
This community has good leaders.	☐	☐	☐	☐
It is very important to me to be a part of this community.	☐	☐	☐	☐
I'm often with other residents and enjoy being with them.	☐	☐	☐	☐
I expect to be a part of this community for a long time.	☐	☐	☐	☐
Members of this community have shared important events together, such as holidays, celebrations, or disasters.	☐	☐	☐	☐
I feel hopeful about the future of this community.	☐	☐	☐	☐
Members of this community care about each other.	☐	☐	☐	☐

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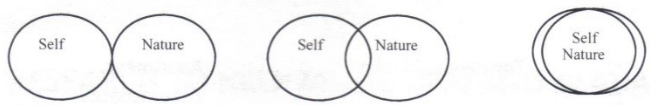
Part 6: The next several questions ask about your background. We use these questions to look for trends in our sample of survey participants. Please remember that all responses are anonymous.

33 **Do you belong to any groups promoting environmental or conservation goals** (e.g., Ducks Unlimited, Sierra Club, Forest Landowners Association, Audubon, Nature Conservancy, Mobile Baykeeper)?

Yes ☐
No ☐

34 **In the following diagrams, one circle represents yourself, and the other circle represents nature. Please place an X on the diagram that best describes the extent to which you feel that you and nature are the same.**



35 **Indicate if you or someone you know is employed in the shipping, seafood, or charter boat industries.**

Shipping ☐ Seafood ☐ Charter boat ☐

36 **Do you own undeveloped investment property or otherwise have a financial interest in developing vacant property in MOBILE?**

Yes ☐
No ☐

37 **How many years have you lived in your community?**

Less than 1 year	☐	11-15 years	☐
1-5 years	☐	16-20 years	☐
6-10 years	☐	more than 20 years	☐

38 **In what year were you born?** _________ (Year)

39 **What is your gender?**

Male ☐ Female ☐ I do not wish to say ☐

40 What is your race/ethnicity? (Select all that apply)

White / Caucasian ☐ Asian ☐
Black / African American ☐ Other (specify) _____ ☐
Hispanic / Latino ☐ I do not wish to say ☐
Native American ☐

41 What is your highest level of education?

None ☐ Some college ☐ Completed college (Bachelor's degree) ☐
High School ☐ Technical school/GED ☐ Post-graduate degree ☐

42 What kind of home do you live in?

Single family house ☐ Townhouse/duplex ☐ Apartment ☐
Mobile home/trailer ☐ Other (specify) ________ ☐

43 Do you rent or own your dwelling?

Rent ☐ Own ☐ Other (specify) ________ ☐

44 How do you describe yourself politically?

Liberal ☐ Moderate ☐ Moderate Conservative ☐
Moderate Liberal ☐ Conservative ☐

45 Did you vote in the last presidential election?

Yes ☐ No ☐

46 Will you vote in the next presidential election?

Yes ☐ Maybe ☐ No ☐

47 What was the total income of your household (before taxes) last year?

Less than $45,000 ☐ $85,000 to $104,999 ☐ $145,000 to $164,999 ☐
$45,000 to $64,999 ☐ $105,000 to $124,999 ☐ $165,000 to $184,999 ☐
$65,000 to $84,999 ☐ $125,000 to $144,999 ☐ $185,000 and above ☐

Please fold and insert the survey into the included pre-paid reply envelope

Thank you for your time and input