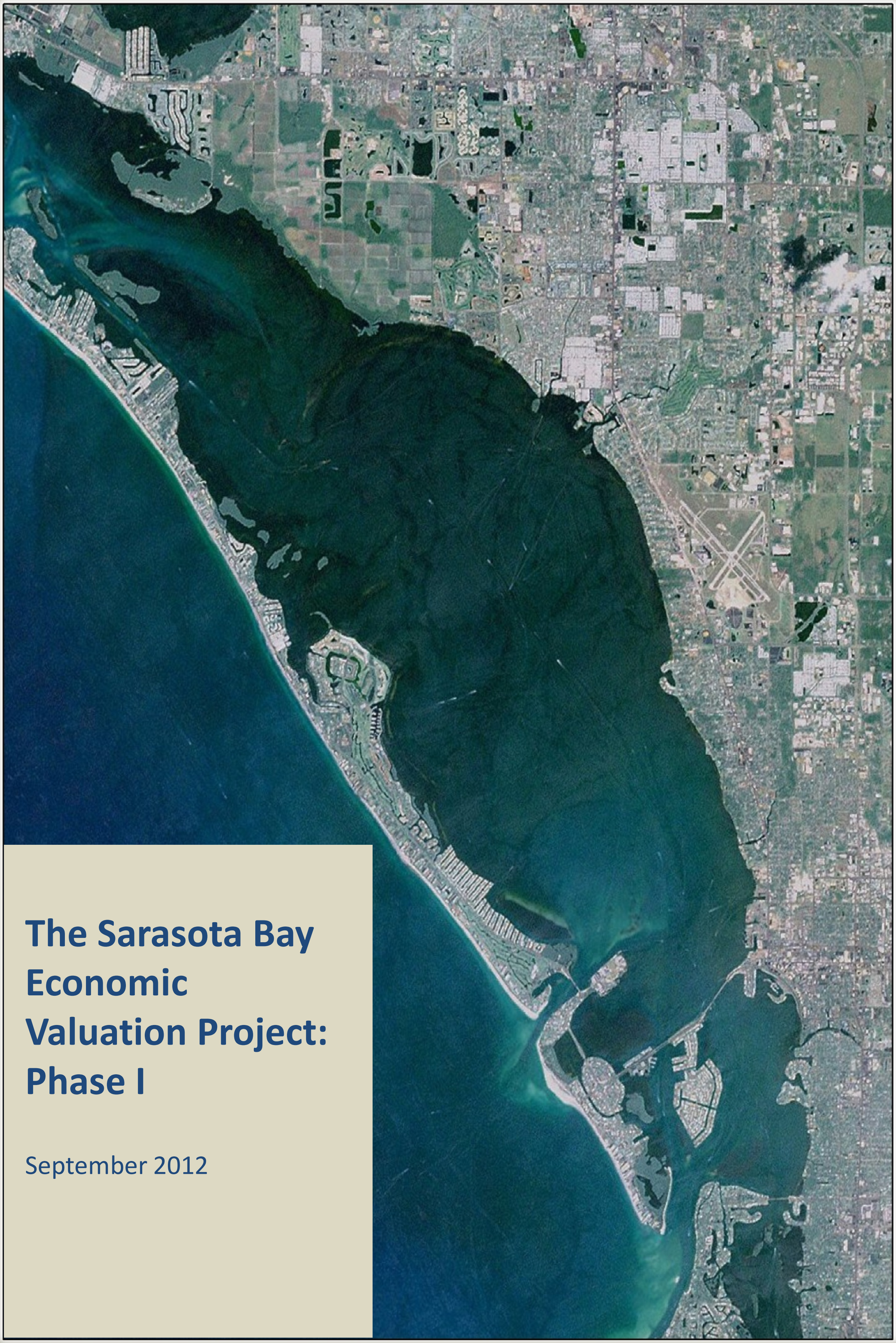

The Sarasota Bay Economic Valuation Project: Phase I

September 2012

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1. Introduction

1.1 Project Overview

The purpose of this study is to provide economic values for environmental resources of the Sarasota Bay Estuary and its adjacent barrier islands. Phase I of this study is comprised of two key components: a benefit transfer application to evaluate direct and indirect use values associated with coastal recreation, and a hedonic property model application to evaluate the direct and indirect use values associated with coastal residential real estate. The study area for this project is the Sarasota Bay Estuary, which encompasses an expansive lagoon system from Anna Maria Sound to the area just north of Venice Inlet as well as adjacent marine resources. This project measures economic values associated with Sarasota and Manatee County residents as well as visitors to this region.

1.1.2 Environmental Goods and Services: Connecting Sarasota Bay to Human Well-being

The Sarasota Bay provides local residents and visitors with access to a wide variety of natural resources. These resources play a key role in explaining the popularity of the Sarasota Bay region. As population pressure grows, it is important we work to better understand society's connection to these resources in order to better meet the needs of the public. The Millennium Ecosystem Assessment (2003) provides one such framework for assessing the complex connections between human societies and ecosystems.

The Millennium Ecosystem Assessment framework begins by accounting for the structure and function of ecosystems. The ecosystem structure and function represent the components of ecosystems and those components' natural processes. The Millennium Ecosystem Assessment connects the structure and function of ecosystem to human beings through ecosystem goods and services. It is ecosystem goods and services which contribute to human well-being. As ecosystems decline (increase), the services those ecosystems provide decline (increase), and human well-being diminishes (increases).

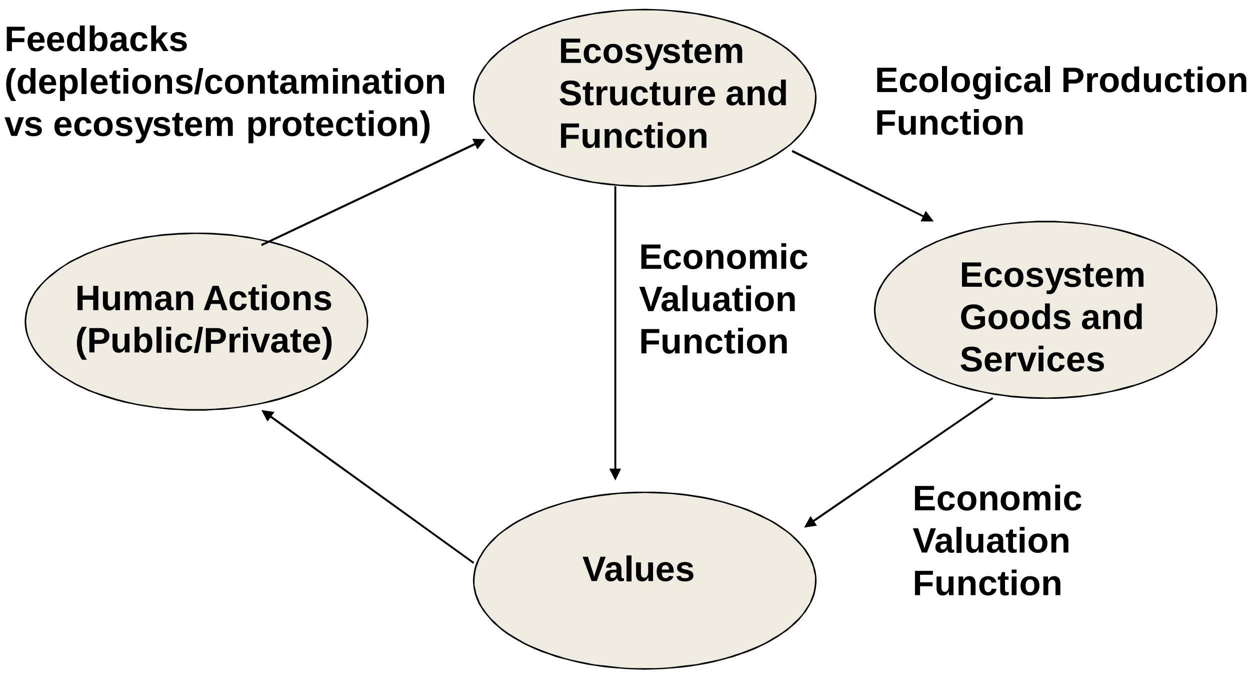
The Millennium Ecosystem Assessment has developed categories for ecosystem goods and services. The classifications are as follows:

- **Provisioning Goods and Services:** These tend to be tangible goods and services provided by ecosystems. Examples include food, water, energy resources, and fuel wood.
- **Regulating Goods and Services:** This represents goods and services resulting from the regulation of ecosystem processes. Examples include climate regulation and natural hazard regulation.
- **Cultural Goods and Services:** These goods and services represent non-material benefits provided to society by ecosystems. Examples include spiritual, recreational, and aesthetic benefits.
- **Supporting Goods and Services:** These represent services necessary for the production of other ecosystem services. Examples include nutrient cycling, soil formation, and primary productivity.

People derive value from ecosystem goods and services and those values influence their future actions. We can view the interactions of people and ecosystems as a feedback loop. Figure 1, seen below, gives a heuristic model of the relationship between ecosystems, human value, and human actions. In this model, the structure and function of ecosystems can be translated into ecosystem goods and services through an ecological production function. People value these ecosystem services by either direct or indirect use. Economists estimate the human value associated with these direct and indirect values by modeling their revealed (actual) and/or stated (anticipated) behavior.

People also value ecosystems because they exist and/or because they want themselves, their neighbors, and their descendants to have the option to use the resource at some future time. This represents non-use values, which can be measured using contingent valuation (a type of stated behavior method). These anthropocentric values (use and non-use) then influence the choices individuals make (private or public). Private and Public actions finish the feedback loop by influencing the ecosystem structure and function.

Figure 1.1: Components of Ecosystem Valuation (Heal et al. 2005)



As an example, a mangrove habitat has specific structure and function associated with the relevant biotic (mangrove types, animal species, etc.) and abiotic (soil composition, water salinity, etc.) factors. This structure and function then translates into ecosystem services which individuals use directly or indirectly. People can use mangroves directly when they use the mangroves natural features to mitigate the risk associated with storm surge. They can use the mangroves indirectly when the mangroves contribute to biodiversity in an estuary. Increased biodiversity improves aesthetics and recreation. In addition to direct and indirect use values, people also value ecosystems because they wish them to exist, even if they do not plan on using them (non-use value).

In Phase I of this study, we plan to provide estimates of marginal value for recreational users and property owners in the Sarasota Bay Estuary region. The estimates provided in this project will contribute to an effort to evaluate the total economic value of the area. Economic Value represents ways in which a resource improves the economic well-being of individuals or society. Think of this value as the benefit individuals or society receives once costs have been accounted for. These costs could represent the costs for individuals or society to produce, provide, or protect the resource. The total economic value of a resource is divided into several components:

- **Direct Use Value:** Goods and Services Consumed by Individuals
    - **Marketed Goods and Services:** Fish (market), timber
    - **Non-marketed Goods and Services:** Recreation, aesthetics, education
- **Indirect Use Value:**
    - **Non-marketed Benefits Derived from Ecosystem Goods & Services**: Storm surge protection, climate regulation, water purification
- **Non-Use Value**
    - **Option Value:** Value associated with the option for future use
    - **Bequest Value:** Value associated with knowing the resource will be passed on to descendants
    - **Philanthropic Value:** Value associated with knowing the resource will be available to other people in the present
    - **Existence Value:** Value associated with knowing the resource exists

This project will work toward allowing policy makers to evaluate the existing natural capital and its associated services the area (total economic value) as well as the impact of changes in natural capital and ecosystem services (marginal value). As an analogy, the total economic value gives us a snapshot of the resources we have and how society values those resources. The marginal value gives us a snapshot of how the well-being of society changes when there is a marginal change in the resource. The marginal value provides the greatest evaluation tool for policy because it allows policymakers to evaluate the trade-offs associated with different alternatives.

1.2 Benefit Transfer Model

In this benefit transfer study, we evaluate several distinct use values for a variety of potential recreation types in the region. The Sarasota Bay is comprised of numerous smaller bays and embayments with diverse biotic and abiotic characteristics. As a result, residents and visitors to these counties visit the Sarasota Bay Estuary and its adjacent resources to enjoy a wide variety of recreational opportunities. The value individuals derive directly from using the Bay's resources for recreational opportunities represents one type of economic value (use value). The problem faced by researchers is how to capture this value. While coastal and marine recreational opportunities provide significant value to residents and visitors, recreation itself is not traded in an explicit market. To overcome the problem, economists have developed a variety of methodologies to estimate the value of recreation for individuals based on their actual (observed) and anticipated (stated) behavior. In this study, we utilize the expansive economic literature on recreation use value to estimate individual's average willingness-to-pay for coastal and marine recreation trips using a methodology called meta-regression benefit transfer.

We estimate a benefit transfer meta-regression model with the goal of obtaining individuals' average willingness-to-pay for recreational trips with 95% confidence intervals. Our model enables us provide 76 estimates combining 19 activity types with trip purpose and trip duration. Table 1.1 lists all 76 average WTP estimates with 95% confidence intervals. Figures 1.2a – 1.2d gives graphical representations of these estimates.

Table 1.1: Estimated Mean Willingness-to-Pay for Recreation Trips by Activity Type (2011 Dollars)[a]

	Day Trip		Multi-Day Trip	
	Single Purpose	Multi-Purpose	Single Purpose	Multi-Purpose
Beach	$23.89 ($21.28, $26.49)	$18.76 ($16.07, $21.44)	$28.05 ($25.40, $30.69)	$22.03 ($19.30, $24.75)
Big Game Hunting	$57.79 ($55.35, $60.22)	$45.38 ($42.84, $47.91)	$67.83 ($65.34, $70.31)	$53.27 ($50.68, $55.85)
Biking	$68.96 ($66.38, $71.53)	$54.16 ($51.52, $56.79)	$80.95 ($78.31, $83.58)	$63.57 ($60.87, $66.26)
Camping	$24.72 ($22.24, $27.19)	$19.41 ($16.83, $21.98)	$29.02 ($26.50, $31.53)	$22.79 ($20.17, $25.40)
Env. Education	$21.19 ($18.37, $24.00)	$16.64 ($13.77, $19.50)	$24.87 ($22.00, $27.73)	$19.53 ($16.61, $22.44)
Freshwater Fishing	$37.47 ($35.04, $39.89)	$29.43 ($26.89, $31.96)	$43.99 ($41.50, $46.47)	$34.54 ($31.95, $37.12)
Motor boating	$37.42 ($34.86, $39.97)	$29.39 ($26.74, $32.03)	$43.93 ($41.31, $46.54)	$34.5 ($31.80, $37.19)
Running/Hiking	$54.42 ($51.96, $56.87)	$42.73 ($40.18, $45.27)	$63.87 ($61.35, $66.38)	$50.16 ($47.56, $52.75)
Kayaking/Canoeing	$44.9 ($42.29, $47.50)	$35.26 ($32.57, $37.94)	$52.7 ($50.05, $55.34)	$41.39 ($38.66, $44.11)
Off-Road Vehicle	$27.35 ($24.80, $29.89)	$21.48 ($18.84, $24.11)	$32.1 ($29.54, $34.65)	$25.21 ($22.56, $27.85)
Picnicking	$29.46 ($27.00, $31.91)	$23.14 ($20.59, $25.68)	$34.58 ($32.07, $37.08)	$27.16 ($24.56, $29.75)
Saltwater Fishing	$65.74 ($63.25, $68.22)	$51.63 ($49.02, $54.23)	$77.16 ($74.61, $79.70)	$60.6 ($57.94, $63.25)
Scuba Diving	$243.37 ($240.24, $246.49)	$191.13 ($187.86, $194.39)	$285.67 ($282.51, $288.82)	$224.34 ($221.04, $227.63)
Sightseeing	$51.25 ($48.74, $53.75)	$40.25 ($37.65, $42.84)	$60.16 ($57.60, $62.71)	$47.24 ($44.59, $49.88)
Small Game Hunting	$31.84 ($29.34, $34.33)	$25 ($22.40, $27.59)	$37.37 ($34.82, $39.91)	$29.35 ($26.71, $31.98)
Snorkeling	$104.18 ($100.34, $108.01)	$81.81 ($77.95, $85.66)	$122.28 ($118.38, $126.17)	$96.03 ($92.12, $99.93)
Swimming	$35.55 ($33.03, $38.06)	$27.92 ($25.32, $30.51)	$41.73 ($39.17, $44.28)	$32.77 ($30.12, $35.41)
Waterfowl Hunting	$40.80 ($38.39, $43.20)	$32.05 ($29.52, $34.57)	$47.9 ($45.43, $50.36)	$37.62 ($35.04, $40.19)
Wildlife Viewing	$35.47 ($33.03, $37.90)	$27.86 ($25.32, $30.39)	$41.64 ($39.14, $44.13)	$32.7 ($30.11, $35.28)

[a] 95% Confidence intervals in Parentheses

Figure 1.2a: Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

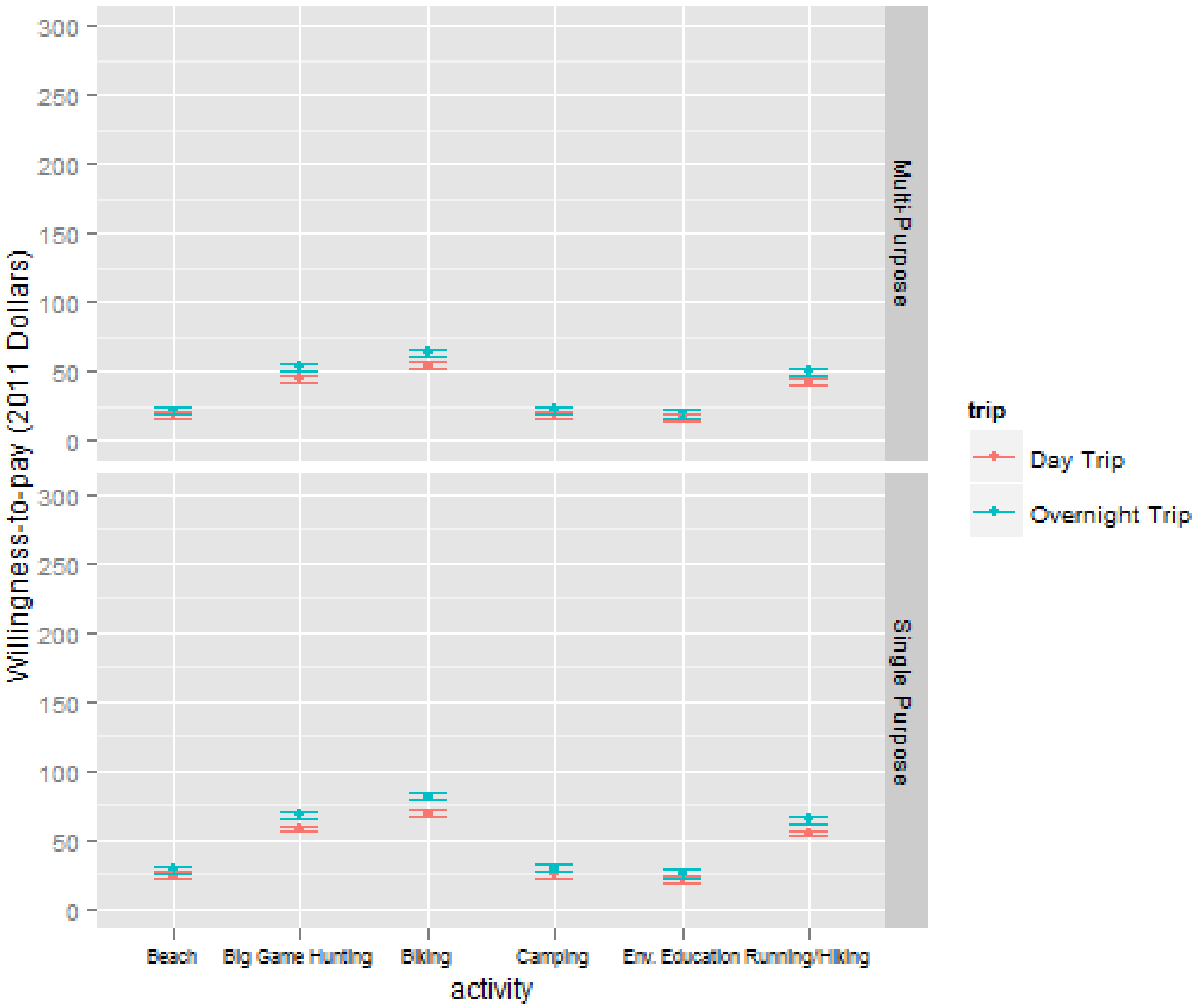


Figure 1.2b: Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

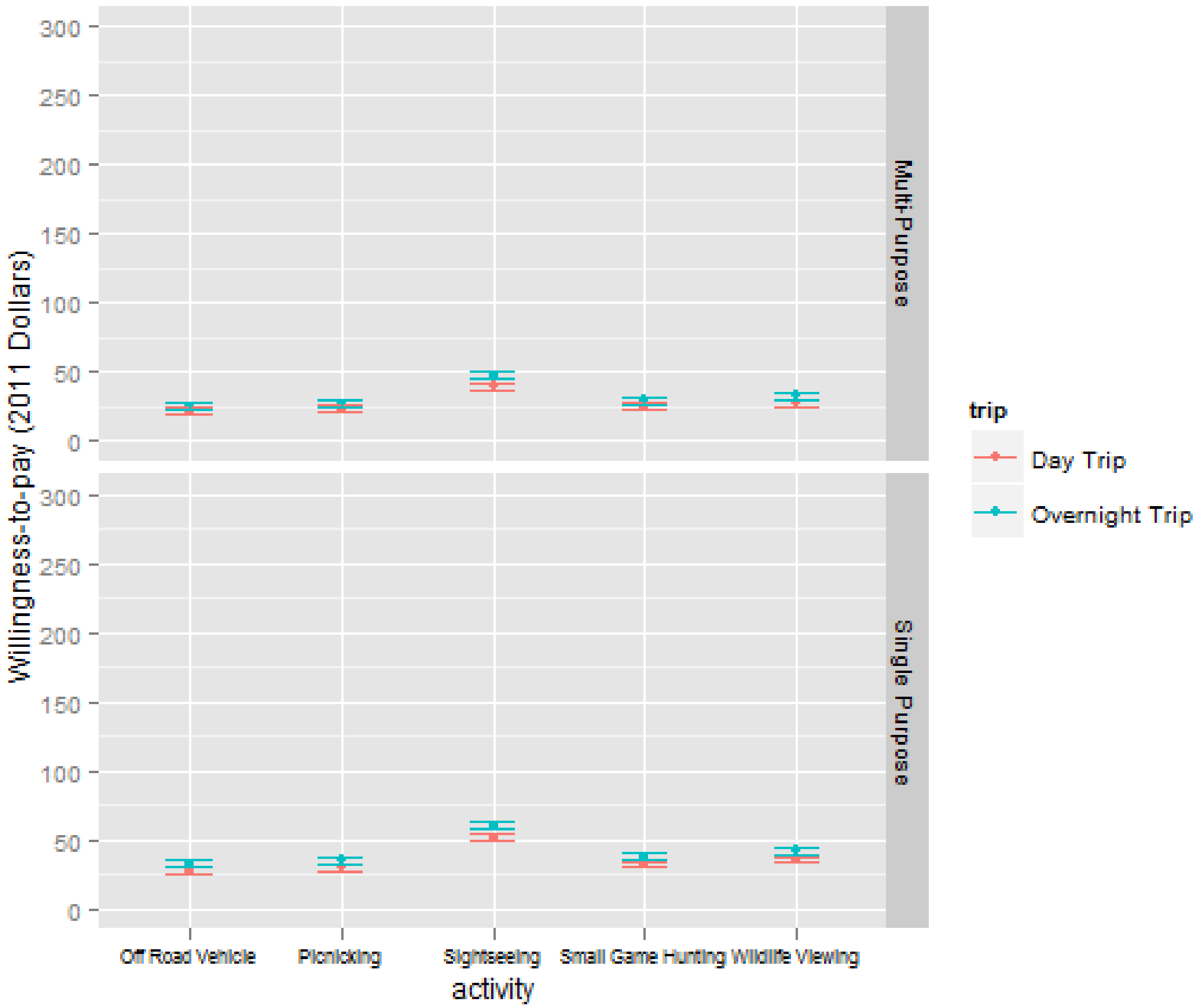


Figure 1.2c: Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

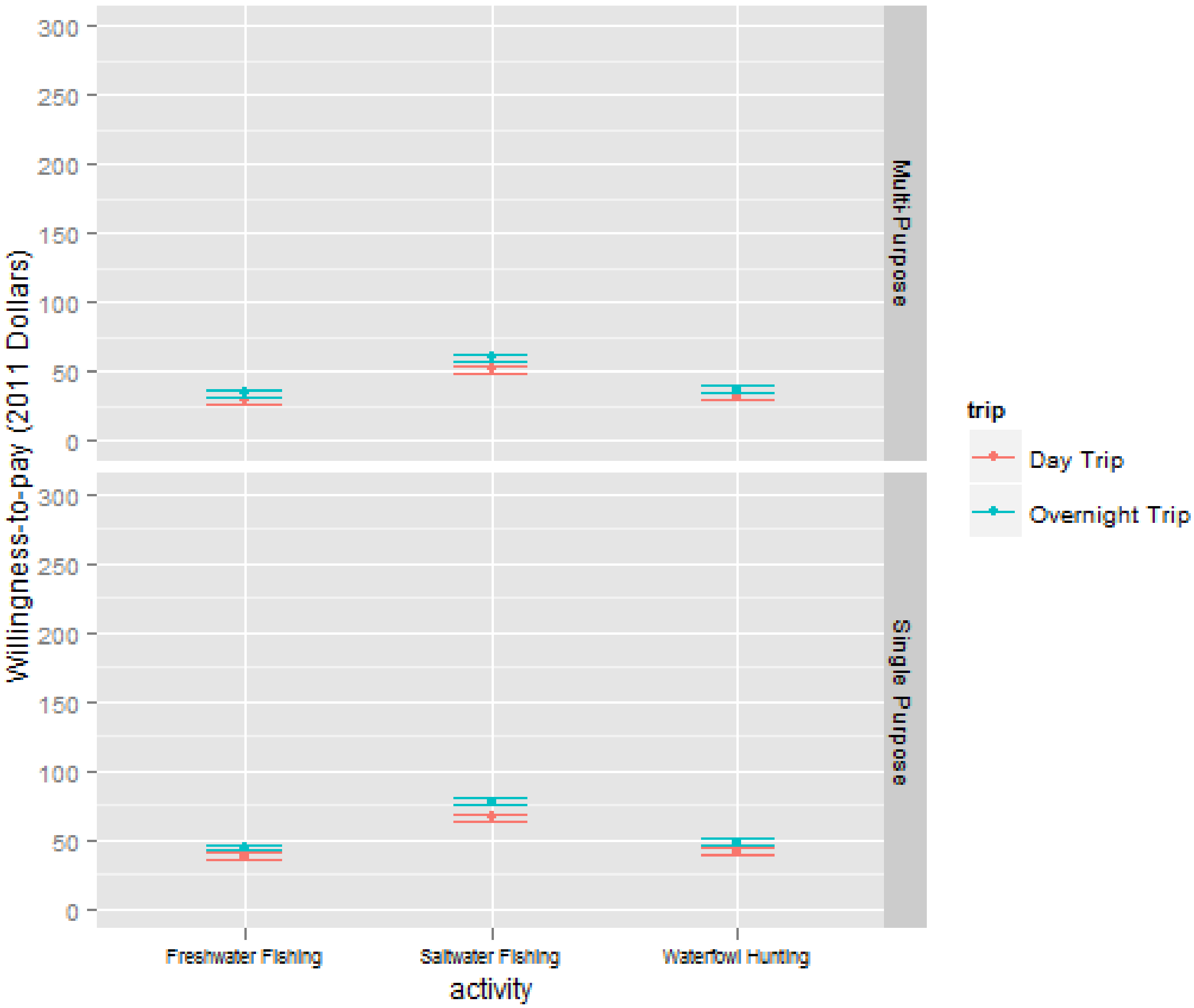
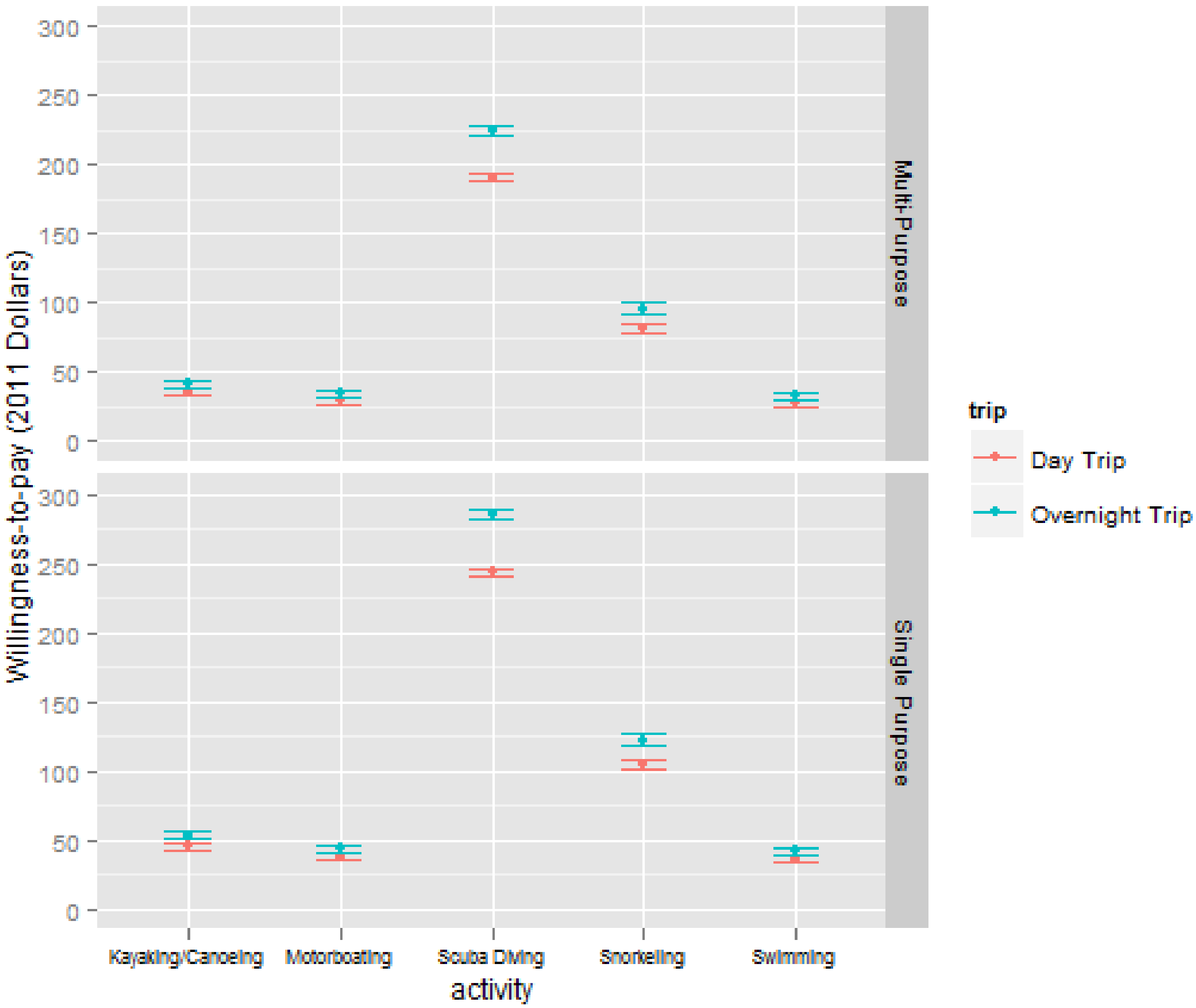


Figure 1.2d: Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals



These average individual values of willingness-to-pay will be combined with future survey results to estimate the recreation use value component of the total economic value of the Sarasota Bay Estuary.

1.3 Hedonic Property Model

The hedonic modeling component of the report summarizes an analysis to determine the effect proximity of Sarasota Bay confers on nearby homeowners' property values. Given the empirical evidence that being located near resources, such as bays, oceans, rivers etc., increases property values, we expect that proximity to Sarasota Bay, for general access and leisure purposes, will have a similar positive value effect. The unique dataset used in the analysis includes detailed information on real estate market sales and housing characteristics, as well as locational and environmental attributes for over 11,000 properties across Sarasota and Manatee counties. An important detail in the data is that we identify the location of each property at a very fine geographic resolution, enabling its proximity to local amenities to be analyzed. Regression analysis is conducted to determine how a home's value is impacted by its proximity to Sarasota Bay, and to quantify the value placed on that proximity.

Results from two statistical models indicate that, on average, being in close proximity to Sarasota Bay increases the value of properties in Sarasota and Manatee counties, holding other factors constant. Based on these findings, we report two economic impact measures. First, we report the estimated marginal value of proximity to the Bay. This represents the mean additional increase in property value attributable to being more proximate to the Bay as opposed to being farther away, all else being equal. In this model we measure the value of proximity to the Gulf of Mexico and the Sarasota Bay Estuary by using categorical distance bands in 1,000 foot increments. In each case, we use the following eight distance bands: 1) homes less than 1,000 feet from Sarasota Bay, 2) homes between 1,000 and 2,000 feet from Sarasota Bay, 3) homes between 2,000 and 3,000 feet from Sarasota Bay, 4) homes between 3,000 and 4,000 feet from

Sarasota Bay, 5) homes less than 1,000 feet from the Gulf of Mexico, 6) homes between 1,000 and 2,000 feet from the Gulf of Mexico, 7) homes between 2,000 and 3,000 feet from the Gulf of Mexico, and 8) homes between 3,000 and 4,000 feet from the Gulf of Mexico. Marginal willingness-to-pay estimates for these proximity measures are summarized in Table 1.2. Figures 1.3a and 1.3b give graphical representations.

Table 1.2. Marginal Willingness-to-Pay Estimates for Proximity to Sarasota Bay and the Gulf of Mexico

	Distance to Bay			
	1,000 Feet	2,000 Feet	3,000 Feet	4,000 Feet
Upper Bound	$113,122	$66,906	$52,402	$37,709
Mean	$90,235	$49,840	$36,774	$26,031
Lower Bound	$67,348	$32,773	$21,145	$14,353
	Distance to Gulf			
	1,000 Feet	2,000 Feet	3,000 Feet	4,000 Feet
Upper Bound	$205,717	$105,952	$53,314	$35,696
Mean	$148,841	$65,823	$24,354	$9,579
Lower Bound	$91,966	$25,694	-$4,605	-$16,537

Figure 1.3a. Distribution of MWTP for Distance Bands to the Sarasota Bay Estuary

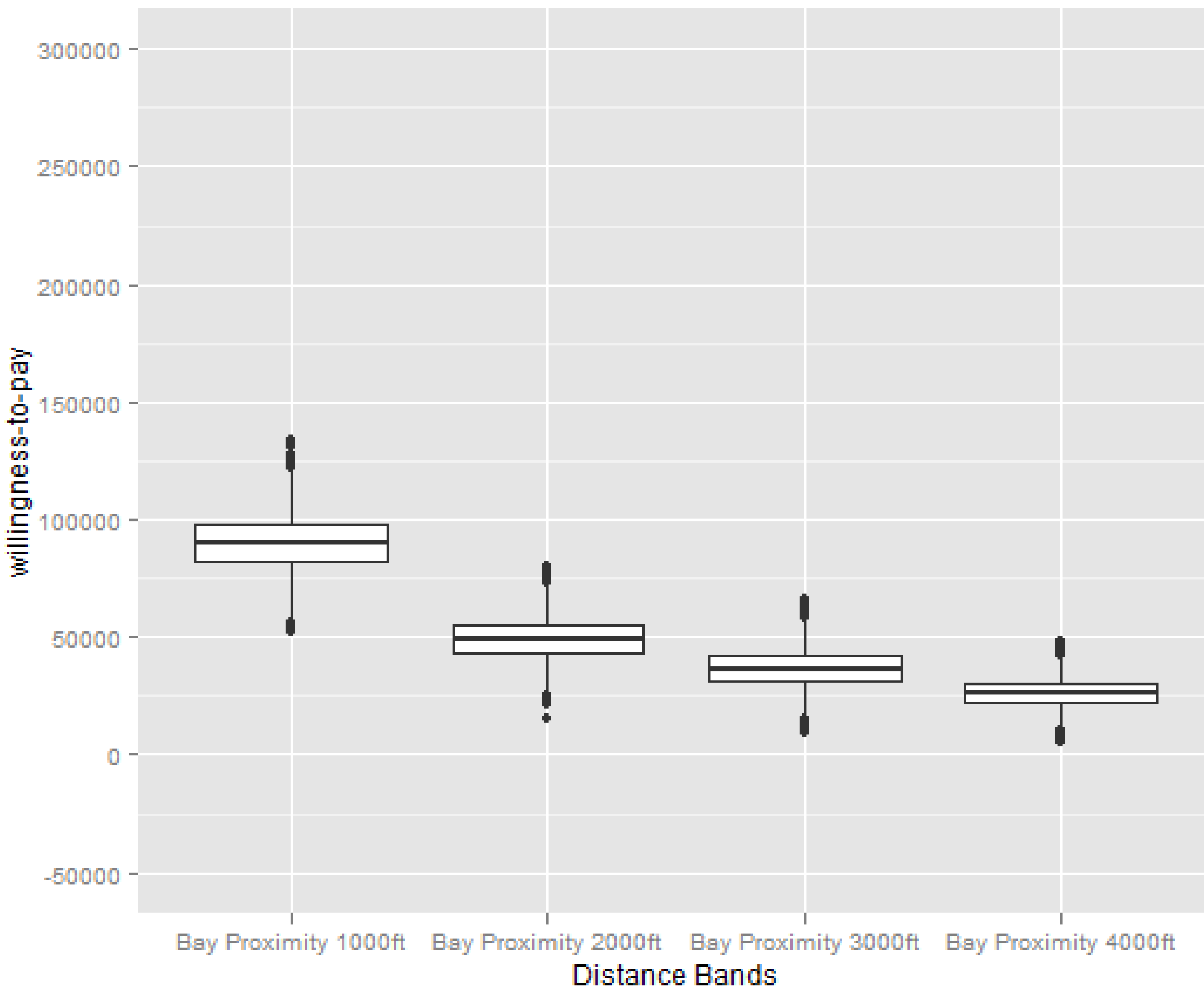
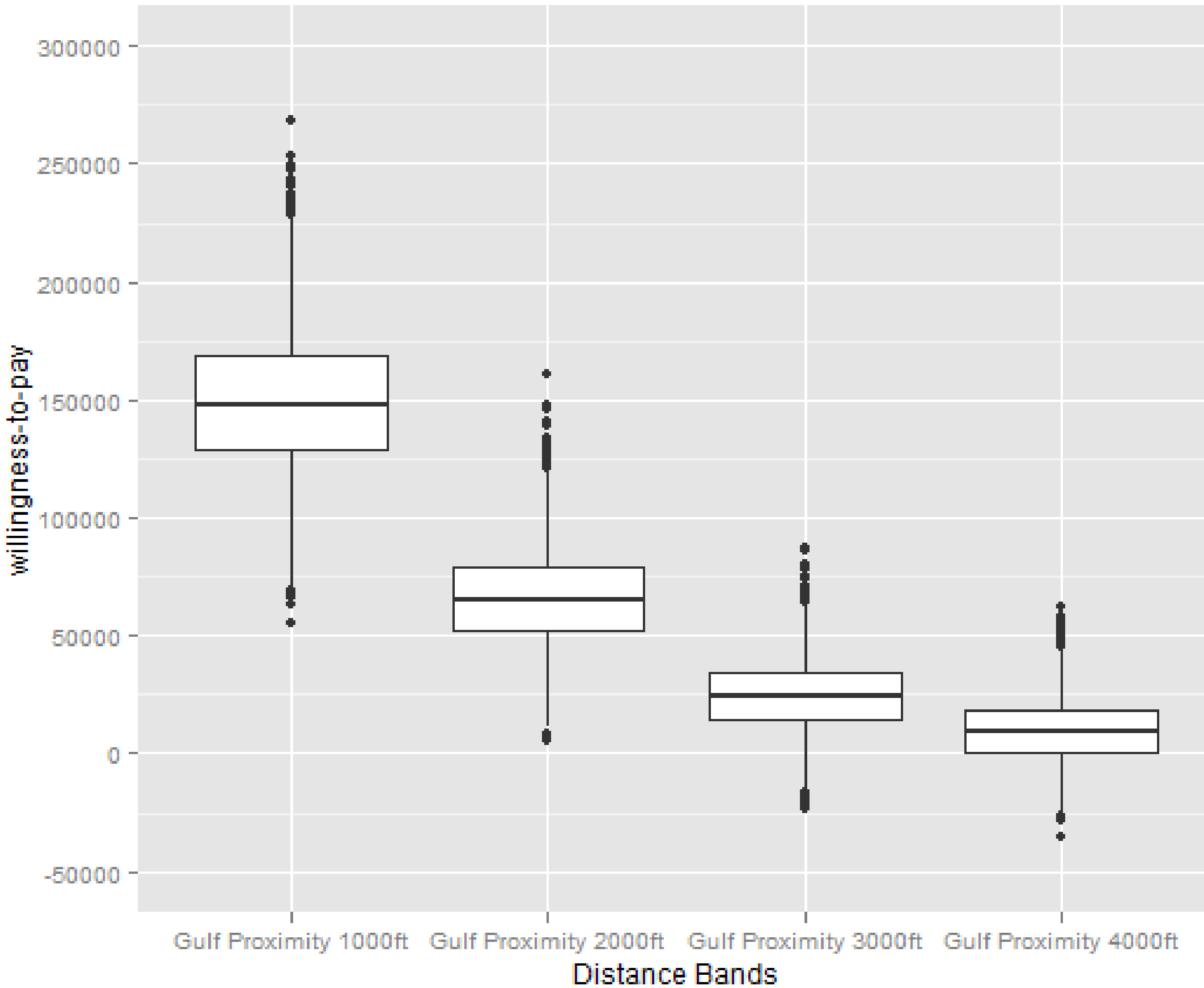


Figure 1.3b. Distribution of MWTP for Distance Bands to the Gulf of Mexico

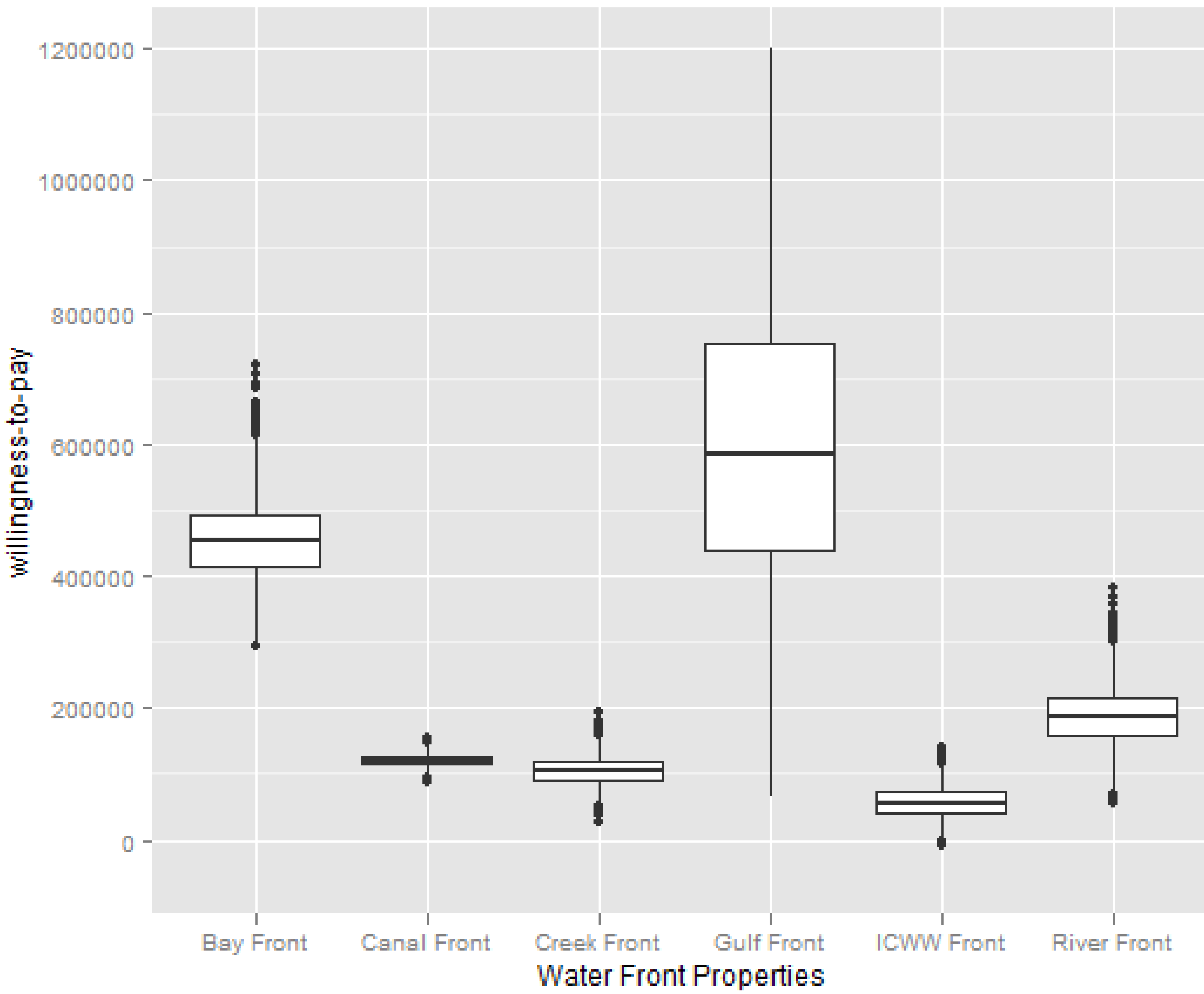


We also account for adjacency to the Gulf of Mexico, Sarasota Bay, and other water bodies in an effort to account for homes that are water front properties. Based on the marginal analysis from our model, the mean willingness to pay for a property less than 1,000 feet from Sarasota Bay is $90,235. The mean willingness to pay for a property less than 1,000 feet from the Gulf of Mexico is $148,841. Marginal willingness-to-pay estimates for these adjacency measures are summarized in Table 1.3. Figure 1.4 gives graphical representations of these estimates.

Table 1.3. Marginal Willingness-to-Pay Estimates for Frontage

	Resource Frontage					
	Bay	Canal	Creek	Gulf	ICWW	River
Upper Bound	$570,701	$140,180	$144,649	$1,087,781	$100,511	$270,808
Mean	$454,809	$121,249	$104,348	$595,141	$57,049	$186,368
Lower Bound	$338,917	$102,318	$64,046	$102,502	$13,588	$101,929

Figure 1.4. Distribution of MWTP for Resource Frontage



The second measure converts impacts into a total “capitalized value” that aggregates the marginal values over properties whose prices are influenced by proximity to the Bay. Based on the total number of properties influenced by proximity to the Bay across the two-county region, the total capitalized value associated with proximity to the Sarasota Bay and its tributaries is $3,122,364,040. With regard to the Gulf of Mexico, the total capitalized value is $500,447,060. The total capitalized value for the two counties is $3,622,811,100.

An important factor to note is that “capitalized value” does not represent the value of what is lost, absent the Bay. Instead, it provides an estimate of the increased property tax base that local communities enjoy as a result of the presence of the Bay and its provision of aesthetic, leisure, and recreational amenities to nearby homeowners. As such, it is important to understand that this value constitutes one component of the overall benefit Sarasota Bay provides to local communities.

1. Introduction

2. Measuring the Value of Recreation Use Value in the Sarasota Bay Region with Benefit Transfer Meta-Regression

2.1 Introduction

This section presents the methods and results of a benefit transfer model, which estimates the value of recreation trips to the Sarasota Bay Estuary and its adjacent resources. The Sarasota Bay Estuary encompasses an expansive lagoon system roughly 56 miles long from Anna Maria Sound to the area just north of Venice Inlet. This coastal lagoonal system includes embayments, tidal tributaries, small creeks, coves, inlets, and passes. The Sarasota Bay watershed covers 455 square miles in total area.

In this benefit transfer study, we plan on evaluating several distinct use values for a variety of potential recreation types in the region. The Sarasota Bay is comprised of numerous smaller bays and embayments with diverse biotic and abiotic characteristics. As a result, residents and visitors to these counties visit the Sarasota Bay Estuary and its adjacent resources to enjoy a wide variety of recreational opportunities. The value individuals derive directly from using the Bay's resources for recreational opportunities represents one type of economic value (use value). The problem faced by researchers is how to capture this value. While coastal and marine recreational opportunities provide significant value to residents and visitors, recreation itself is not traded in an explicit market. To overcome the problem, economists have developed a variety of methodologies to estimate the value of recreation for individuals based on their actual (observed) and anticipated (stated) behavior.

In this study, we utilize the expansive economic literature on recreation use value to estimate individual's average willingness-to-pay for coastal and marine recreation trips using a methodology called meta-regression benefit transfer. These average individual values of willingness-to-pay will be used as one component of the total economic value of the Sarasota Bay Estuary.

2.2 Background

In general, the term “benefit transfer” refers to methods that collect existing information and utilize it in a new context. In natural resource and environmental economics, benefit transfer studies may utilize existing results from the economic literature to estimate non-marketed values (Smith 1992). These methods allow analysts to transfer values from study sites (previous economic studies) to a project site (Sarasota Bay and adjacent regions) through time and/or space. Benefit transfer is a method to evaluate natural resources when primary research is not practical due to budget constraints, time limitations, or unidentifiable resource impacts (Rosenberger and Loomis 2001). In our application, project budget constraints limit our ability to adequately estimate the wide variety of recreational services provided by the Sarasota Bay Estuary and adjacent resources. Instead, our benefit transfer study will target a specific variety of recreational activities such as saltwater angling, boating, and wildlife viewing.

In practice, analysts utilize two different types of benefit transfer: value transfers and function transfers. Value transfers represent a more simplistic methodology, where single values or arithmetic means of multiple values are obtained from study sites that are similar to the policy site. These point estimates can then be transferred to the policy site. While the strength of this methodology is its simplicity, it does not allow analysts to control for differences in studies, recreational users, or sites of interest. The function transfer uses an equation to transfer calibrated value estimates from the study site(s) to the policy site(s). The functional approach includes both preference function approaches using single study sites as well as meta-analytic approaches using multiple study sites. The empirical literature suggests that function approaches outperform simple value transfers (Kirchhoff et al 1997; Rosenberger and Stanley 2006). In this study, we use meta-analysis regression to estimate the value of different types of recreational trips to the Sarasota Bay Estuary using multiple study sites in the United States. Meta-analysis is a reduced-form approach that allows analysts to use multivariate statistical models to control for potentially confounding factors.

2.3 Methodology

2.3.1 Theory

Our first step requires that we develop a theoretical framework for coastal recreational users in the Sarasota Bay region which adequately captures their preferences for recreation, as well as the constraints they may face. We developed a utility theoretic model which estimates Sarasota Bay recreational users' willingness-to-pay for non-marketed commodities and services. Following the general theoretical model outlined by Bergstrom and Taylor (2006), these recreational users will utilize an underlying conditional indirect utility function

$$V = V_{i,j}(P, M_i, Q1_j, Q2_j, S, Z_i, I_i) \qquad (1)$$

where the indirect utility for individual *i* is a function of the price of relevant market goods (P), household income for individual *i* (M_i), the quantity of the nonmarket good or service at site *j* ($Q1_j$), the quality of the good or service at site *j* ($Q2_j$), a measure of substitutes for the quantity of goods and services available (S), household characteristics of individual *i* (Z_i), and the information available to the household (I_i).[1] This conditional indirect utility function (1) can then be utilized to construct a general bid function for willingness-to-pay (WTP) for relevant non-marketed goods and services:

$$WTP = f(P, M_i, Q1_j, Q2_j, S, Z_i, I_i, \tilde{\beta}_{ij}) \qquad (2)$$

where WTP for recreation is estimated from study sites and transferred to policy sites using the individual and study characteristics described in (1) as well as econometric parameter estimates ($\tilde{\beta}_{ij}$).

2.3.2 Data and Conceptual Approach

[1] Bergstrom and Taylor describe three general approaches for empirically representing the underlying utility functions: the strong structural utility theoretic (SSUT) approach, the weak structural utility theoretic (WSUT) approach, and the non-structural utility theoretic (NSUT) approach. Our application utilizes WSUT via a preference function transfer.

This study follows the following five steps as recommended in the EPA's "Guidelines for Preparing Economic Analyses" (2000):

1) Describe the Policy Case
2) Identify existing, relevant studies
3) Review studies for quality and applicability
    - Basic commodities must be equivalent
    - Baseline and extent of change should be similar
    - Affected populations should be similar
4) Transfer benefit estimates
5) Address uncertainty

As stated previously, this study focuses on estimating individual's willingness-to-pay (per person, per activity day) for coastal and marine recreational trips in the counties of Sarasota and Manatee located on the west coast of Florida. In the development of our metadata, we began by utilizing the Recreation Use Values Database for North America (Rosenberger 2011). This extensive, publically available database contains 2,703 economic estimates from 352 different studies between 1958 and 2006. This database includes use values for numerous recreation activities throughout North America. We added 106 value estimates from 19 additional documents.

After identifying relevant economic value estimates we developed the following criteria for our benefit transfer study:

1. Commodity Consistency. Commodity consistency generally means that we have the same measures of value across studies. In each case, we are using the value of a recreation activity day or the value of recreation access per activity day. As such, we have consistency in our measure of WTP. Failure to address commodity consistency can lead to factual sample heterogeneity, where real differences in effect sizes exist between primary studies (Nelson and Kennedy 2009).
2. Welfare Change Measure Consistency. We only utilized studies in which each trip measures the value of recreational trips without identified changes in

environmental conditions; as such, each study utilized the baseline environmental conditions for the relevant area.[2]

3. Study Location. We focus on recreation trips in the United States in order to make sure we target similar types of recreational users. Our model utilizes spatial indicators to control for regional differences in recreational users (variables described below).
4. Activity Type. Studies conducted outside the coastal zone can only be included when they measure the willingness-to-pay for recreation activities that can also be conducted in the coastal zone. For example, snowmobiling and snow skiing are not viable activities in the meta-regression model.
5. Sufficient Information. Any study included in the meta-regression must provide sufficient information related to the activity, site, and study attributes.

After applying the inclusion rules, our metadata includes 2052 observations (economic value estimates) collected from 263 studies between 1964 and 2011. Figure 2.1 depicts observations by year published. Of these, 137 studies are journal articles, 6 are from books or book chapters, 62 studies come from government reports, 20 are from consulting reports, 18 come from graduate theses, 11 are working papers, and 9 studies are proceedings articles. Many studies provide more than one measure of willingness-to-pay (WTP). Individual studies may report multiple measures of WTP for a range of reasons, including varied recreation activities measured, species affected, spatial extents measured, and methods used to elicit WTP. Tables 2.1a – 2.1c describe the variables included in the meta-regression and Tables 2.2a – 2,2b summarize the characteristics of these studies.

[2] One barrier to reaching welfare change measure consistency stems from the fact that welfare measures can differ by economic method, such as Hicksian consumer surplus in contingent valuation studies versus Marshallian consumer surplus in travel cost methods. We rely on the assumption of Shrestha and Loomis (2003), who argue that these differences are likely to be small in some settings. We address potential differences through the inclusion of study indicator variables within our meta-analysis regression.

Figure 2.1: Publication Years for Metadata Studies

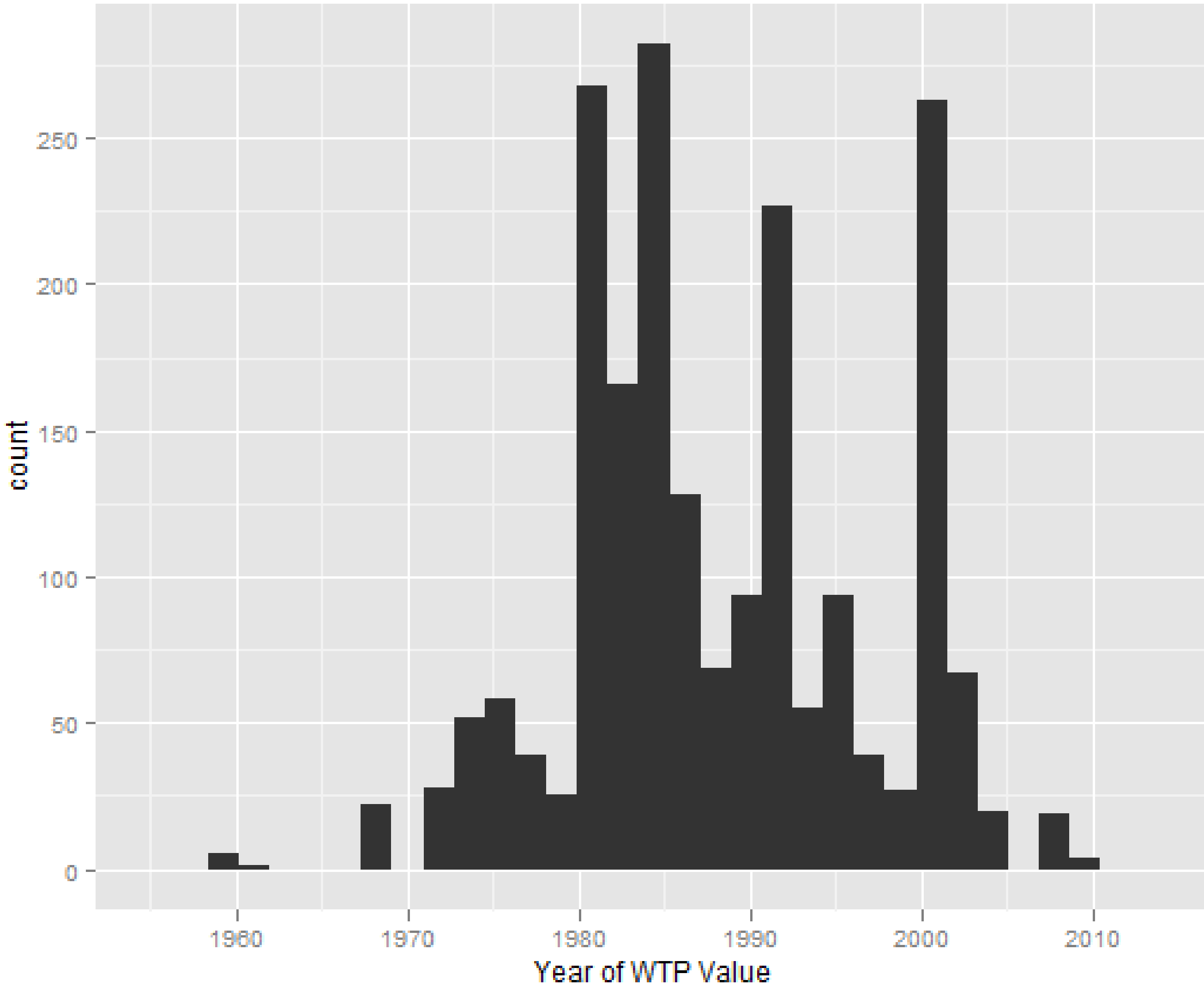


Table 2.1a: Variable Descriptions

Variable	Description	Units/Measurement
Willingness-to-pay (WTP)	Natural log of willingness-to-pay for recreation activities per trip per day, converted to 2011 U.S. dollars.	Dollars ($1.44 - $1010.68)
Document: Book	Binary variable indicating that the study was published as a book or book chapter.	Binary Variable (0 - 1)
Document: Journal Article	Binary variable indicating that the study was published as a journal article.	Binary Variable (0 - 1)
Document: Government Report	Binary variable indicating that the study was published as a government report.	Binary Variable (0 - 1)
Document: Consulting Report	Binary variable indicating that the study was published as a consulting report.	Binary Variable (0 - 1)
Document: Graduate Thesis	Binary variable indicating that the study was published as a graduate thesis or dissertation.	Binary Variable (0 - 1)
Document: Working Paper	Binary variable indicating that the study was a working paper.	Binary Variable (0 - 1)
Document: Proceedings Paper	Binary variable indicating that the study was published in a conference proceedings.	Binary Variable (0 - 1)
Location: South Atlantic and Eastern Gulf of Mexico	Binary variable indicating that the study was conducted in the South Atlantic and/or the Eastern Gulf of Mexico.	Binary Variable (0 - 1)
Location: New England	Binary variable indicating that the study was conducted in New England.	Binary Variable (0 - 1)
Location: Mid Atlantic	Binary variable indicating that the study was conducted in the Mid Atlantic states.	Binary Variable (0 - 1)
Location: Pacific	Binary variable indicating that the study was conducted in the Pacific states.	Binary Variable (0 - 1)
Location: South Central	Binary variable indicating that the study was conducted in the South Central States, including the western Gulf of Mexico.	Binary Variable (0 - 1)
Location: North Central	Binary variable indicating that the study was conducted in the North Central States.	Binary Variable (0 - 1)
Location: Mountain West	Binary variable indicating that the study was conducted in the Mountain West states.	Binary Variable (0 - 1)
Habitat: Coastal/Marine	Binary variable indicating that the study was conducted in a coastal or marine habitat.	Binary Variable (0 - 1)
Habitat: Lake	Binary variable indicating that the study was conducted in a lake or pond habitat.	Binary Variable (0 - 1)
Habitat: Riverine	Binary variable indicating that the study was conducted in a riverine habitat.	Binary Variable (0 - 1)

Table 2.1b: Variable Descriptions Cont.

Variable	Description	Units/Measurement
Activity: Beach	Binary variable indicating that the study surveyed beach recreational users.	Binary Variable (0 - 1)
Activity: Big Game Hunting	Binary variable indicating that the study surveyed big game hunters.	Binary Variable (0 - 1)
Activity: Biking	Binary variable indicating that the study surveyed off-road and road bikers.	Binary Variable (0 - 1)
Activity: Camping	Binary variable indicating that the study surveyed recreational users taking camping trips.	Binary Variable (0 - 1)
Activity: Educational Experience	Binary variable indicating that the study surveyed recreational users experiencing environmental education activities.	Binary Variable (0 - 1)
Activity: Freshwater Fishing	Binary variable indicating that the study surveyed freshwater recreational fishers.	Binary Variable (0 - 1)
Activity: Motor boating	Binary variable indicating that the study surveyed recreational users taking motor boating or jet skiing trips.	Binary Variable (0 - 1)
Activity: Running & Hiking	Binary variable indicating that the study surveyed runners and hikers.	Binary Variable (0 - 1)
Activity: Kayaking & Canoeing	Binary variable indicating that the study surveyed recreational users taking kayaking or canoeing trips.	Binary Variable (0 - 1)
Activity: Off-road Vehicle	Binary variable indicating that the study surveyed recreational users taking motorized off road vehicle trips.	Binary Variable (0 - 1)
Activity: Picnicking	Binary variable indicating that the study surveyed recreational users taking picnics.	Binary Variable (0 - 1)
Activity: Saltwater Fishing	Binary variable indicating that the study surveyed saltwater recreational fishers.	Binary Variable (0 - 1)
Activity: Scuba Diving	Binary variable indicating that the study surveyed scuba divers.	Binary Variable (0 - 1)
Activity: Sightseeing	Binary variable indicating that the study surveyed recreational users taking sightseeing trips.	Binary Variable (0 - 1)
Activity: Small Game Hunting	Binary variable indicating that the study surveyed small game hunters.	Binary Variable (0 - 1)
Activity: Snorkeling	Binary variable indicating that the study surveyed recreational users taking snorkeling trips.	Binary Variable (0 - 1)
Activity: Swimming	Binary variable indicating that the study surveyed recreational users taking swimming trips.	Binary Variable (0 - 1)
Activity: Waterfowl Hunting	Binary variable indicating that the study surveyed waterfowl hunters.	Binary Variable (0 - 1)
Activity: Wildlife Viewing	Binary variable indicating that the study surveyed recreational users taking wildlife viewing trips.	Binary Variable (0 - 1)

Table 2.1c: Variable Descriptions Cont.

Variable	Description	Units/Measurement
Day Trip	Binary variable indicating that the surveyed respondents were on day trips.	Binary Variable (0 - 1)
Night Trip	Binary variable indicating that the surveyed respondents were on overnight trips.	Binary Variable (0 - 1)
Day & Night Trip	Binary variable indicating that the surveyed respondents were on both day and overnight trips.	Binary Variable (0 - 1)
Single Purpose Trip	Binary variable indicating that the purpose of the surveyed respondents' recreational trips was to conduct one activity.	Binary Variable (0 - 1)
Multi-purpose Trip	Binary variable indicating that the purpose of the surveyed respondents' recreational trips was to conduct multiple activities.	Binary Variable (0 - 1)
Single Destination Trip	Binary variable indicating that the purpose of the surveyed respondents' recreational trips was conducted at one location.	Binary Variable (0 - 1)
Multi-destination Trip	Binary variable indicating that the purpose of the surveyed respondents' recreational trips was conducted at multiple locations.	Binary Variable (0 - 1)
Site Aggregation	Binary variable indicating site aggregation during model estimation.	Binary Variable (0 - 1)
Onsite Sample	Binary variable indicating the use of an onsite sample.	Binary Variable (0 - 1)
Onsite Sample Correction	Binary variable indicating the use a correction during statistical modeling in an effort to account for an onsite sampling procedure.	Binary Variable (0 - 1)
Contingent Valuation: Open Ended	Binary variable indicating that WTP was estimated using an open ended contingent valuation instrument (Stated Preference Method).	Binary Variable (0 - 1)
Contingent Valuation: Dichotomous Choice	Binary variable indicating that WTP was estimated using an dichotomous choice contingent valuation instrument (Stated Preference Method).	Binary Variable (0 - 1)
Contingent Valuation: Iterative Bidding	Binary variable indicating that WTP was estimated using an iterative bidding contingent valuation instrument (Stated Preference Method).	Binary Variable (0 - 1)
Other Stated Preference Types	Binary variable indicating that WTP was estimated using a stated preference method such as a choice experiment (Stated Preference Method).	Binary Variable (0 - 1)
Zonal Travel Cost Model	Binary variable indicating that WTP was estimated using a zonal travel cost model (Revealed Preference Method).	Binary Variable (0 - 1)
Hedonic Travel Cost	Binary variable indicating that WTP was estimated using a hedonic travel cost model (Revealed Preference Method).	Binary Variable (0 - 1)
Random Utility Model	Binary variable indicating that WTP was estimated using a random utility model (Revealed Preference Method).	Binary Variable (0 - 1)
RP/SP Models	Binary variable indicating that WTP was estimated using a combined revealed and stated preference method.	Binary Variable (0 - 1)
Sample Control Variable	A variable used to control for bias associated with variation in WTP measures. The variable is estimated as?????	Continuous Variable (0.004 - 0.58)
Year Index	Year in which the study was conducted, converted to an index by subtracting 1958 from study year.	Year Index (1 - 53)
Travel Cost per Mile	The explicit cost of travel used in the travel cost model. Measured as cost per mile.	Dollars per Mile (0 - $0.61)
Wage Rate % in Travel Cost	The implicit cost of travel used in the travel cost model. Measured as a % of the wage rate.	Percentage of Wage (0% - 100%)

Table 2.2a: Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Willingness-to-Pay	2052	66.63	77.49	1.44	1010.68
Document: Journal	2052	0.29	0.45	0	1
Document: Book	2052	0.01	0.08	0	1
Document: Government Report	2052	0.46	0.5	0	1
Document: Consulting Report	2052	0.06	0.23	0	1
Document: Graduate Thesis	2052	0.07	0.26	0	1
Document: Working Paper	2052	0.11	0.31	0	1
Document: Proceedings Paper	2052	0.02	0.13	0	1
Location: South Atlantic	2052	0.17	0.37	0	1
Location: New England	2052	0.12	0.32	0	1
Location: Mid Atlantic	2052	0.08	0.27	0	1
Location: Pacific	2052	0.18	0.39	0	1
Location: South Central	2052	0.14	0.34	0	1
Location: North Central	2052	0.22	0.42	0	1
Location: Mountain West	2052	0.28	0.45	0	1
Activity: Beach	2052	0.05	0.21	0	1
Activity: Big Game Hunting	2052	0.18	0.38	0	1
Activity: Biking	2052	0.02	0.13	0	1
Activity: Camping	2052	0.03	0.18	0	1
Activity: Educational Experience	2052	0	0.05	0	1
Activity: Freshwater Fishing	2052	0.34	0.47	0	1
Activity: Motor boating	2052	0.04	0.19	0	1
Activity: Running & Hiking	2052	0.05	0.21	0	1
Activity: Kayaking & Canoeing	2052	0.03	0.18	0	1
Activity: Off-road Vehicle	2052	0.01	0.08	0	1
Activity: Picnicking	2052	0.01	0.08	0	1
Activity: Saltwater Fishing	2052	0.05	0.21	0	1
Activity: Scuba Diving	2052	0	0.05	0	1
Activity: Sightseeing	2052	0.01	0.1	0	1
Activity: Small Game Hunting	2052	0.02	0.14	0	1
Activity: Snorkeling	2052	0	0.03	0	1
Activity: Swimming	2052	0.01	0.08	0	1
Activity: Waterfowl Hunting	2052	0.05	0.22	0	1
Activity: Wildlife Viewing	2052	0.12	0.32	0	1

Table 2.2b: Descriptive Statistics Cont.

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Day Trip	2052	0.59	0.49	0	1
Night Trip	2052	0.04	0.19	0	1
Day & Night Trip	2052	0.37	0.48	0	1
Single Purpose Trip	2052	0.92	0.27	0	1
Multipurpose Trip	2052	0.08	0.27	0	1
Single Destination Trip	2052	0.87	0.33	0	1
Multi-destination Trip	2052	0.13	0.33	0	1
Site Aggregation	2052	0.67	0.47	0	1
Onsite Sample	2052	0.17	0.38	0	1
Onsite Sample Correction	2052	0.19	0.39	0	1
Contingent Valuation: Open Ended	2052	0.31	0.46	0	1
Contingent Valuation: Dichotomous Choice	2052	0.15	0.35	0	1
Contingent Valuation: Iterative Bidding	2052	0.04	0.2	0	1
Other Stated Preference Types	2052	0	0.04	0	1
Individual Travel Cost Model	2052	0.27	0.44	0	1
Zonal Travel Cost Model	2052	0.19	0.39	0	1
Hedonic Travel Cost	2052	0	0.05	0	1
Random Utility Model	2052	0.05	0.21	0	1
Revealed Preference (RP) Models	2052	0.49	0.5	0	1
Stated Preference (SP) Models	2052	0.48	0.5	0	1
RP/SP Models	2052	0.02	0.15	0	1
Sample Size	2052	708.6	2905.03	3	54324
Sample Control Variable	2052	0.1	0.07	0	0.58
Travel Cost per Mile	2052	0.06	0.11	0	0.61
Wage Rate % in Travel Cost	2052	0.15	0.26	0	1

Findings from economic theory and past empirical studies in meta-analysis benefit transfer lead us to expect that specific attribute types should influence the value surface for coastal/marine recreation trips (Nelson and Kennedy 2009; Johnston and Rosenberger 2010). These attribute types include surveyed attributes of the recreation populations, the recreation type, the geographic location of the recreation activity, and the methodology of the original study.

In our experience, the surveyed attributes of the recreation population is the most difficult type of data to obtain in the economic literature. Ideally, information such as average income and demographic information would be freely available from the existing studies. Rosenberger and Loomis (2000) found roughly 3% of recreation studies included average income and only 1% reported average education level attained. We do not include this type of information in our models due to its limited availability.

We include a variety of variables describing the recreation activities of the observations in the metadata. The reason to include different recreational activities within the model is that individuals accrue different use values from the activities. For example, on average, individuals may derive more value from scuba diving than biking. Inclusion of the various activity types allows these differences to be captured. In all, this study accounts for 19 different recreation activities (Beach, Big Game Hunting, Biking, Camping, Educational Experience, Freshwater Fishing, Motor boating, Running and Hiking, Kayaking and Canoeing, Off Road Vehicle Use, Picnicking, Saltwater Fishing, Scuba Diving, Sightseeing, Small Game Hunting, Snorkeling, Swimming, Waterfowl Hunting, and Wildlife Viewing). Freshwater Fishing represented the most common activity among observations.

In addition to the type of activity, we also utilized information related to the type of recreational trip, including whether the trip was a single day trip or a multi-day trip, whether the purpose of the trip was solely for an individual activity or if multiple activities were pursued, and whether the recreation site was the only destination or if there were multiple destinations.

Our model accounts for the geographic region of the study. We include seven regional variables in all (South Atlantic and Gulf of Mexico, New England, Mid Atlantic, Pacific, South Central, North Central, and Mountain West). In some cases, a study may fall within multiple regions. These regional indicator variables should pick up some of the variation attributable to regional environmental characteristics. They may also act as a crude measure representing regional differences in recreation users. In addition to regional indicators, we also include three indicator variables that aim to capture variation in aquatic environments (coastal/marine, riverine, and lake environments). These indicator variables identify the type of environment for aquatic recreation activities. Table 2.3 gives observed WTP values from the metadata by activity.

Table 2.3: Mean Values for Willingness-to-pay for Recreation Trips by Activity and Region in Metadata (2011 Dollars) [a]

	South Atlantic & Gulf of Mexico	Mid Atlantic	New England	East North Central	East South Central	West North Central	West South Central	Mountain West	Pacific	USA
Beach	$85.65 ($71.90)	$75.88 ($46.40)	$9.86 ($ 5.38)	$13.49 ($14.25)	---	---	$13.82 ($18.57)	---	$54.41 ($69.07)	---
Big Game Hunting	$68.79 ($60.21)	$78.37 ($31.70)	$74.46 ($64.47)	$56.05 ($38.49)	$63.84 ($32.21)	$64.35 ($23.43)	$73.37 ($27.50)	$74.62 ($51.83)	$75.62 ($80.94)	$190.83 ($115.55)
Biking	$52.01 ($28.82)	---	$22.06 ($23.37)	---	---	$37.80 ($13.92)	---	$186.38 ($144.53)	---	$26.34 (----)
Camping	$7.11 ($2.82)	$49.40 (----)	$22.06 ($23.37)	$6.62 ($2.57)	$21.82 (----)	$17.25 (----)	---	$22.36 ($16.41)	$29.89 ($51.47)	$17.22 ($1.27)
Env. Education	$33.83 (----)	$7.04 (----)	---	$26.78 ($12.66)	$40.45 (----)	---	---	---	---	---
Freshwater Fishing	$48.00 ($35.30)	$92.90 ($53.05)	$41.58 ($26.33)	$32.20 ($33.77)	$58.23 ($51.03)	$48.67 ($64.83)	$64.67 ($42.97)	$81.48 ($79.33)	$95.03 ($87.57)	$58.63 ($47.79)
Kayaking and Canoeing	$169.18 ($135.47)	---	$40.80 ($6.96)	---	---	$18.67 ($14.73)	---	$148.56 ($138.91)	$37.34 ($40.38)	$25.09 (----)
Motor boating	$27.44 ($28.91)	$55.85 (----)	---	---	---	$32.33 ($37.10)	$24.21 ($14.77)	$14.45 ($18.40)	$116.08 ($197.28)	$32.32 (----)
ORV	$31.35 ($15.21)	---	---	---	---	---	---	$43.35 ($14.41)	---	---
Picnic	$8.46 (----)	---	$9.54 (----)	$11.21 (----)	---	---	---	$20.54 ($4.96)	$18.19 ($7.06)	$23.46 (----)
Running and Hiking	$110.82 ($150.10)	$121.21 (----)	$15.48 (----)	$62.39 (----)	$90.75 ($89.50)	$6.24 (----)	---	$63.15 ($62.77)	$40.03 ($45.46)	$24.37 (----)
Saltwater Fishing	$159.10 ($180.99)	$43.12 ($4.50)	$72.47 ($62.92)	---	---	---	$169.54 ($180.51)	---	$169.45 ($136.37)	$86.41 ($94.55)
Scuba Diving	$174.90 (----)	---	---	---	$354.05 ($408.37)	---	---	---	---	---
Sightseeing	$20.30 ($12.65)	---	---	$31.86 ($13.54)	$173.76 (----)	---	---	$50.94 ($48.21)	$29.90 ($8.89)	$28.18 (----)
Small Game Hunting	$185.06 (----)	---	$35.31 ($33.11)	$37.98 (----)	---	$56.39 ($66.96)	---	$29.11 ($26.36)	$174.51 ($144.97)	$76.42 ($27.95)
Snorkeling	$91.93 ($29.61)	---	---	---	---	---	---	---	---	---
Swimming	$17.71 (----)	$49.55 (----)	---	$20.73 (----)	---	---	$10.66 (-----)	$33.13 ($28.02)	$31.32 ($13.22)	$29.35 (----)
Waterfowl Hunting	$82.78 ($64.68)	$31.11 ($1.87)	$44.70 ($29.99)	$24.11 ($19.90)	$48.96 ($22.32)	$40.19 ($11.02)	$41.52 ($12.13)	$40.57 ($33.98)	$50.51 ($25.40)	$150.52 ($17.74)
Wildlife Viewing	$69.31 ($56.12)	$65.36 ($44.49)	$55.64 ($50.36)	$46.99 ($24.29)	$66.01 ($104.24)	$35.55 ($13.93)	$36.26 ($25.26)	$63.43 ($59.67)	$70.03 ($70.57)	$39.51 ($31.32)

[a] **Standard Deviation in Parentheses.**

Our last general classification of variables represents the characteristics of the study used to estimate the economic value of each recreational activity. In meta-analysis benefit transfer, failure to account for methodological differences in studies (often called methodological sample heterogeneity) can bias project estimates. In this study, we account for numerous methodological differences between studies including sampling characteristics, economic model type, and economic model characteristics.

Sampling characteristics represent the process of collecting information related to recreational users and their activities. These characteristics include the presence of site aggregation and onsite sampling routines. In some instances, researchers aggregate individual sites in order to reduce complexity in the sampling routine or estimation of the statistical model. These site aggregations can lead to biased estimates of WTP (Parsons and Needelman 1992; Haener et al 2004).

Sampling routines also influence WTP measures. The average sample size in our metadata is 708.6. In studies of recreation demand, researchers often deliver survey instruments onsite, via mail, telephone, or over the Internet. In our application, we are specifically interested in addressing biases from onsite sampling (Shaw 1988; Moeltner and Shonkwiler 2005; Hindsley et al 2011). Even a well designed onsite sample represents a random selection of trips rather than recreational users. As a result, the onsite sample is not representative of the larger recreation population; there is a higher probability of selecting recreation users that make more frequent trips or stay onsite for longer periods of time. We include two related variables, one representing studies using onsite samples and another representing studies that made efforts to correct for relevant onsite sampling biases.

In addition to sampling routines, other methodological differences can influence WTP estimates.[3] We make a specific effort to account for revealed preference studies (Individual Travel Cost, Hedonic Travel Cost, Zonal Travel Cost, and Random Utility Models), stated preference studies (Open Ended Contingent Valuation, Dichotomous Choice Contingent Valuation, Iterative Bidding Contingent Valuation, and other stated

[3] Freeman (2003) provides a survey of environmental valuation methods. Haab and McConnell (2002) survey econometric methods for estimating the value of environmental goods and services.

preference studies such as Choice Experiments), and studies that combine revealed and stated preference methods. Revealed preference methods refer to economic studies that utilize observed behavior. This means that the models use data on individuals' actual behavior. For example, a Travel Cost model approach collects data, such as distance travelled and lodging expenses, on trips taken by recreationists to a site or sites. Most revealed preference models measuring recreation demand utilize implicit and explicit travel costs to determine the value of recreation trips and other relevant characteristics. There is an inverse relationship between trip costs and the demand for trips. In comparison, stated preference models use hypothetical markets or scenarios to elicit the preferences of recreation users. So stated preference models involve generating data on expected trip behavior with respondents asked to think about trips that they anticipate taking in the future. Stated preference models allow researchers to gain a better understanding of counter factual conditions but, as they concern anticipated behavior, they must be carefully designed so to minimize strategic and hypothetical biases of respondents. Combined revealed and stated preference models take advantage of the realism of revealed preference models while also accounting for the flexibility of stated preference models (Whitehead et al 2010).

In our meta-analysis regression, we take account of several model characteristics relevant to revealed preference studies. First, we account for the explicit cost of travel to a recreation site with the travel cost per mile. This measure captures gas costs as well as general vehicle wear and tear associated with travel to a recreation site. Next, we account for the percentage wage rate included in the travel cost variable. The wage rate accounts for the implicit costs of travel to a site by incorporating a percentage of the individual's wage rate during travel. Economic theory suggests that accounting for opportunity cost is imperative. In this setting, as individuals travel to a site for recreation, they forego wage-earning opportunities, so the opportunity cost of travel accounts for wages foregone as individuals travel to the site.

One last methodological topic of interest is the effect of publication bias on WTP (Stanley 2001). Functional transformations of sample size can be used to mitigate publication bias (Berlin and Begg 1988; Rosenberger and Stanley 2006). We include a variable, called sample control, with the following functional form: $sample\ control = (sample\ size)^{-0.5}$. Publication bias occurs when there is an identifiable direction of bias in WTP measures that results because of the publication process. Publication bias can take several forms including: 1) bias resulting from editors when they favor results similar to conventional wisdom or theory; 2) bias resulting from authors when they select models and results that coincide with conventional wisdom or theory: and 3) a bias resulting from a tendency to choose findings with statistically significant results (Card and Kreuger 1995). Rosenberger and Loomis (2001) find the existence of publication bias in a negative direction for a previous database of recreation use values.

2.4 Empirical Model

In this study, we utilize meta-regression to estimate the WTP of recreation activities in coastal and marine environments. We estimate a random-effects regression model utilizing the feasible generalized least squares estimator in the Stata statistical software environment.[4] The random-effects model takes the general form:

$$lnWTP_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{k,it} + e_i + u_{it} \qquad (3)$$

where *i* is the number of studies ($i = 1, \ldots, I$), t is the number of WTP estimates in each study so that the total number of studies can be represented as $N = \sum_{t=1}^{T} N_t$,. The general model takes a semi-log form and is specified with k explanatory variables. Because individual estimates are not independent within studies, the random-effects model decomposes the error structure at the study level, u_{it}, and the estimation level, e_i. The study level, u_{it}, and estimation level, e_i, errors are assumed to be normally distributed with zero mean and constant variances $\sigma_e^2$and σ_u^2. In addition to accounting for within-study variation using the random-effect model, we account for

[4] We began by estimating a linear regression model with robust, clustered standard errors, where the clusters were determined by individual studies. We then chose the random-effects model because it exhibited superior results through a comparison of R^2 and transfer error.

heteroskedasticity through the use of robust standard errors (Nelson and Kennedy 2009).[5]

We estimate two models with identical specifications. The first model utilizes all 2052 observations while the second model includes 1727 observations after eliminating observations determined to be outliers (more on this below). In both models, the natural log of WTP per recreation trip per individual is regressed on 52 attributes characterizing the recreation activity, the geographic location of the activity, and the methodology of the original study.

2.4.1 Model 1: Full Model

Results from the full model (Model 1) are presented in Tables 2.4a and 2.4b. In Model 1, a Wald test ($\chi^2_{52} = 489.35$) indicates that the model variables are jointly significant at the .0001 level. Of the 52 variables in Model 1, 26 are statistically significant at the .1 level. Model 1 has an R^2 of .1467 meaning roughly 15% of the variation in WTP is explained by this specification. This random effects model accounts for 263 studies, where the average sized study has 7.8 WTP estimates, the minimum sized study has 1 WTP estimate, and the maximum sized study has 200 WTP estimates.

[5] Breusch and Pagan Lagrangian Multiplier Tests for Random Effects reject the null hypothesis of homoskedasticity (Model 1: $\chi^2 = 396.14$; Model 2: $\chi^2 = 223.88$).

Table 2.4a: Semi-log Random-effects Model with Robust Standard Errors

	Model 1: Full			Model 2: Outliers Eliminated		
	Coefficients	Standard Error	Pvalue	Coefficients	Standard Error	Pvalue
Document: Book	0.448	0.3946	0.256	0.081	0.3136	0.797
Document: Government Report	0.287	0.1471	0.051	0.162	0.1200	0.178
Document: Consulting Report	0.460	0.2282	0.044	0.420	0.2178	0.054
Document: Graduate Thesis	0.273	0.2291	0.233	0.129	0.1837	0.482
Document: Working Paper	-0.224	0.267	0.401	-0.291	0.2139	0.174
Document: Proceedings Paper	0.436	0.3165	0.169	0.600	0.2882	0.037
Location: New England	-0.198	0.0649	0.002	-0.248	0.0519	0.000
Location: Mid Atlantic	0.084	0.0848	0.322	0.052	0.0597	0.382
Location: Pacific	0.124	0.0661	0.061	0.142	0.0516	0.006
Location: South Central	0.016	0.0607	0.795	-0.032	0.0489	0.512
Location: North Central	-0.097	0.0542	0.072	-0.109	0.0393	0.005
Location: Mountain West	0.176	0.0553	0.001	0.140	0.0437	0.001
Habitat: Coastal/Marine	-0.137	0.1128	0.224	0.069	0.0922	0.454
Habitat: Lake	-0.113	0.0803	0.158	-0.040	0.0622	0.522
Habitat: Riverine	0.049	0.1201	0.68	0.077	0.0974	0.428
Activity: Beach	-0.636	0.2689	0.018	-0.450	0.2573	0.08
Activity: Big Game Hunting	0.382	0.0594	0.000	0.433	0.0479	0.000
Activity: Biking	0.654	0.2086	0.002	0.610	0.2338	0.009
Activity: Camping	-0.422	0.1246	0.001	-0.416	0.1031	0.000
Activity: Educational Experience	-0.538	0.4202	0.200	-0.570	0.3095	0.065
Activity: Motor boating	0.068	0.1848	0.711	-0.001	0.1778	0.994
Activity: Running & Hiking	0.068	0.1271	0.592	0.373	0.1182	0.002
Activity: Kayaking & Canoeing	-0.018	0.1562	0.906	0.181	0.2036	0.374
Activity: Off-road Vehicle	-0.286	0.4431	0.519	-0.315	0.1829	0.085
Activity: Picnicking	-0.169	0.1865	0.364	-0.241	0.0966	0.013
Activity: Saltwater Fishing	0.040	0.1513	0.792	0.562	0.1650	0.001
Activity: Scuba Diving	1.531	0.5297	0.004	1.871	0.4526	0.000
Activity: Sightseeing	0.371	0.1653	0.025	0.313	0.1349	0.020
Activity: Small Game Hunting	-0.327	0.1264	0.010	-0.163	0.1249	0.192
Activity: Snorkeling	1.275	0.9227	0.167	1.022	0.6643	0.124
Activity: Swimming	0.012	0.2038	0.952	-0.053	0.1414	0.710
Activity: Waterfowl Hunting	0.086	0.0906	0.343	0.085	0.0796	0.284
Activity: Wildlife Viewing	-0.112	0.0689	0.103	-0.055	0.0647	0.396

Table 2.4b: Random-effects Model Results Continued

	Model 1: Full			Model 2: Outliers Eliminated		
	Coefficients	Standard Error	Pvalue	Coefficients	Standard Error	Pvalue
Night Trip	0.172	0.1071	0.109	0.160	0.1203	0.183
Day & Night Trip	-0.049	0.0974	0.615	0.029	0.0918	0.750
Multipurpose Trip	-0.292	0.1865	0.117	-0.242	0.1619	0.136
Multi-destination Trip	0.256	0.1577	0.104	0.150	0.1505	0.319
Site Aggregation	0.212	0.1185	0.074	0.114	0.0961	0.237
Onsite Sample	-0.334	0.1231	0.007	-0.327	0.0994	0.001
Onsite Sample Correction	-0.274	0.1105	0.013	-0.287	0.1032	0.005
Contingent Valuation: Open Ended	-0.791	0.1416	0.000	-0.710	0.1241	0.000
Contingent Valuation: Dichotomous Choice	-0.053	0.1510	0.727	-0.075	0.1334	0.572
Contingent Valuation: Iterative Bidding	-0.844	0.2215	0.000	-0.842	0.1652	0.000
Other Stated Preference Types	-1.523	0.613	0.013	-1.880	0.2301	0.000
Zonal Travel Cost Model	-0.516	0.1318	0.000	-0.524	0.1109	0.000
Hedonic Travel Cost	1.145	0.6916	0.098	1.230	0.6212	0.048
Random Utility Model	-0.641	0.2284	0.005	-0.359	0.2017	0.075
RP/SP Models	0.860	0.2858	0.003	0.921	0.2945	0.002
Sample Control Variable	0.289	0.3678	0.433	0.692	0.3651	0.058
Year Index	0.009	0.0078	0.242	0.005	0.0065	0.489
Travel Cost per Mile	-1.438	0.4575	0.002	-1.853	0.3597	0.000
Wage Rate % in Travel Cost	0.926	0.1167	0.000	0.888	0.1138	0.000
Intercept	3.537	0.3258	0.000	3.892	0.2885	0.000
Study Level σu	0.7926			0.5838		
Residual σe	0.5548			0.4594		
Wald Chi Square	414.26		0.000	712.03		0.000
R-sq	0.1467			0.3217		
Obs	2052			1727		
Groups	263			241		

Model 1 provides evidence of systematic variation in WTP associated not only with geographic, activity, and methodological fixed effects but also random effects associated with the systematic study-level variance (σ_u^2). The random effects are significant at the .01 level. This indicates that there are components of the systematic variation in WTP that is driven by unobservable attributes.

In Model 1, we test and control for publication bias using study fixed effects and the sample control variable ($sample\ control = (sample\ size)^{-0.5}$). Previous studies have used indicator variables for publication types as a proxy for publication bias (Smith and Huang 1995; Woodward and Wui 2001; Dalhuisen et al 2003; Zelmer 2003; Van Kooten et al 2004). In our specification, we find the coefficients for both government and consulting reports to be positive with significance at the .1 level. The omitted publication group (baseline group) is journal articles, so all publication type variables are relative to this group. This indicates that the WTP values for journal articles are lower than government and consulting reports– a potential indication of publication bias that coincides with the findings of Rosenberger and Loomis (2001). The coefficient for the sample control variable is not statistically significant in Model 1.

The Model 1 specification has 9 location indicator variables to account for regional variation in recreation users and recreation geographic and ecological attributes. Six of the location indicator variables represent regions in the US (New England, Mid-Atlantic, Pacific, South Central and Western Gulf of Mexico, North Central, Mountain West). The South Atlantic and Eastern Gulf of Mexico indicator variable acts as the model baseline. 4 of the 6 regional variables are statistically significant at the .05 level (New England, Pacific, North Central, Mountain West). In addition to the regional variables, 3 aquatic variables are included in the specification (coastal, lake, river). Non-coastal uplands are treated as the baseline condition in this specification. None of these variables are statistically significant.

The Model 1 specification has 18 recreation activity indicator variables to account for potential recreation activities in the Sarasota Bay region (Beach, Big Game Hunting, Biking, Camping, Educational Experience, Motor boating, Running and Hiking, Kayaking and Canoeing, Off-Road Vehicle use, Picnicking, Saltwater Fishing, Scuba Diving, Sightseeing, Small Game Hunting, Snorkeling, Swimming, Waterfowl Hunting, and Wildlife Viewing). Freshwater Fishing is treated as the omitted baseline activity in this model. Seven of the coefficients on the activity variables are statistically significant at the .05 level. In addition to the activity types, we include variables representing overnight trips, multi-purpose trips, and multi-destination trips. None of these variables are statistically significant.

Our last 16 variables relate to the methodologies of the studies in the metadata (Site Aggregation, Onsite Sampling, Onsite Sampling with Statistical Correction, Open Ended Contingent Valuation, Dichotomous Choice Contingent Valuation, Iterative Bidding Contingent Valuation, Other Stated Preference studies, Individual Travel Cost, Hedonic Travel Cost, Zonal Travel Cost, Random Utility Models, Revealed/Stated Preference Models, Sample Control, Year Index, Travel Cost per Mile, % Wage Rate). Twelve of these are significant at the .1 level. These results indicate the importance of controlling for methodological difference in this meta-regression.

When using meta-regression, we need a method for assessing the precision of the benefit transfer function. In our application, we are conducting a benefit transfer study because we lack sufficient primary data to estimate WTP for a wide variety of recreation activity types. As a result, we want to determine how well our meta-regression predicts values within sample. Our meta-regression model estimates a value surface on which study and project sites fall. The within sample prediction of the meta-regression gives insight into the applicability of out-of sample prediction because of the shared value surface. The common best practice in the literature is to calculate the transfer error to assess a meta-regression application (Stapler and Johnston 2009). In our application we use the absolute percent transfer error

$$\delta_n = \frac{|\widehat{WTP}_n - WTP_n|}{WTP_n} \times 100 \qquad (4)$$

where WTP_n is the observed value and $\widehat{WTP}_n$ is the predicted value for a given observation n. Table 2.5 summarizes the absolute percentage transfer error for Model 1. This model results in an average transfer error of 108.3% and a median transfer error of 52.07%. These results indicate that the distribution of the transfer error is skewed by extreme observations. Figures 2.2a and 2.2b give graphical representations of the absolute percentage transfer error for this model. Figure 2.2a provides a histogram of the transfer error and Figure 2.2b graphs transfer error for individual studies.

Table 2.5 Absolute Percentage Transfer Error

	Mean	Median	Standard Deviation	Minimum	Maximum
δ_n Full Model	108.03	52.07	163.12	0.03	1690.46
δ_n ATE Outliers Eliminated	55.38	41.32	51.33	0.0001	360.07

Figure 2.2a. Histogram of Absolute Percent Transfer Error for Model 1 (Full Data)

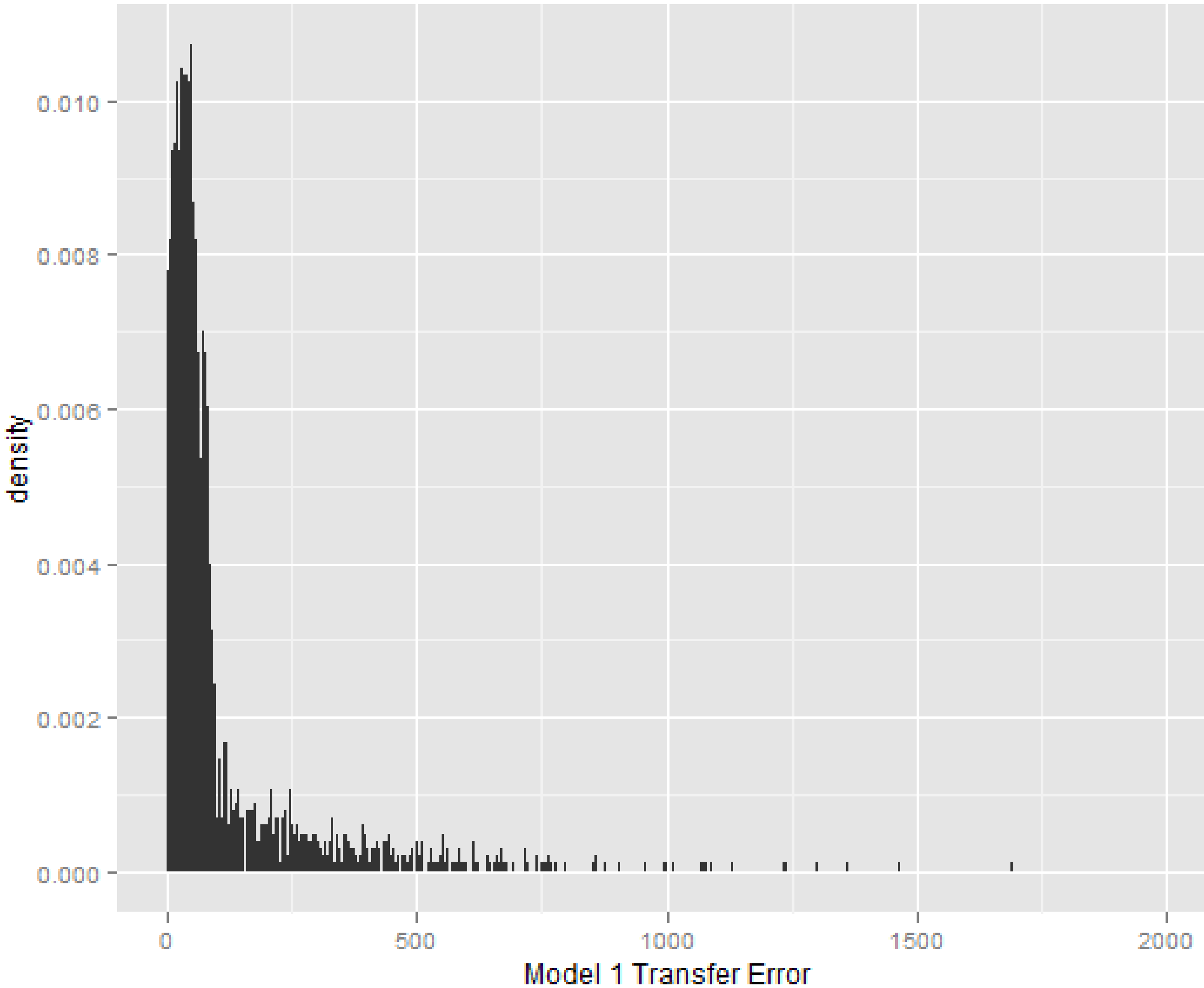
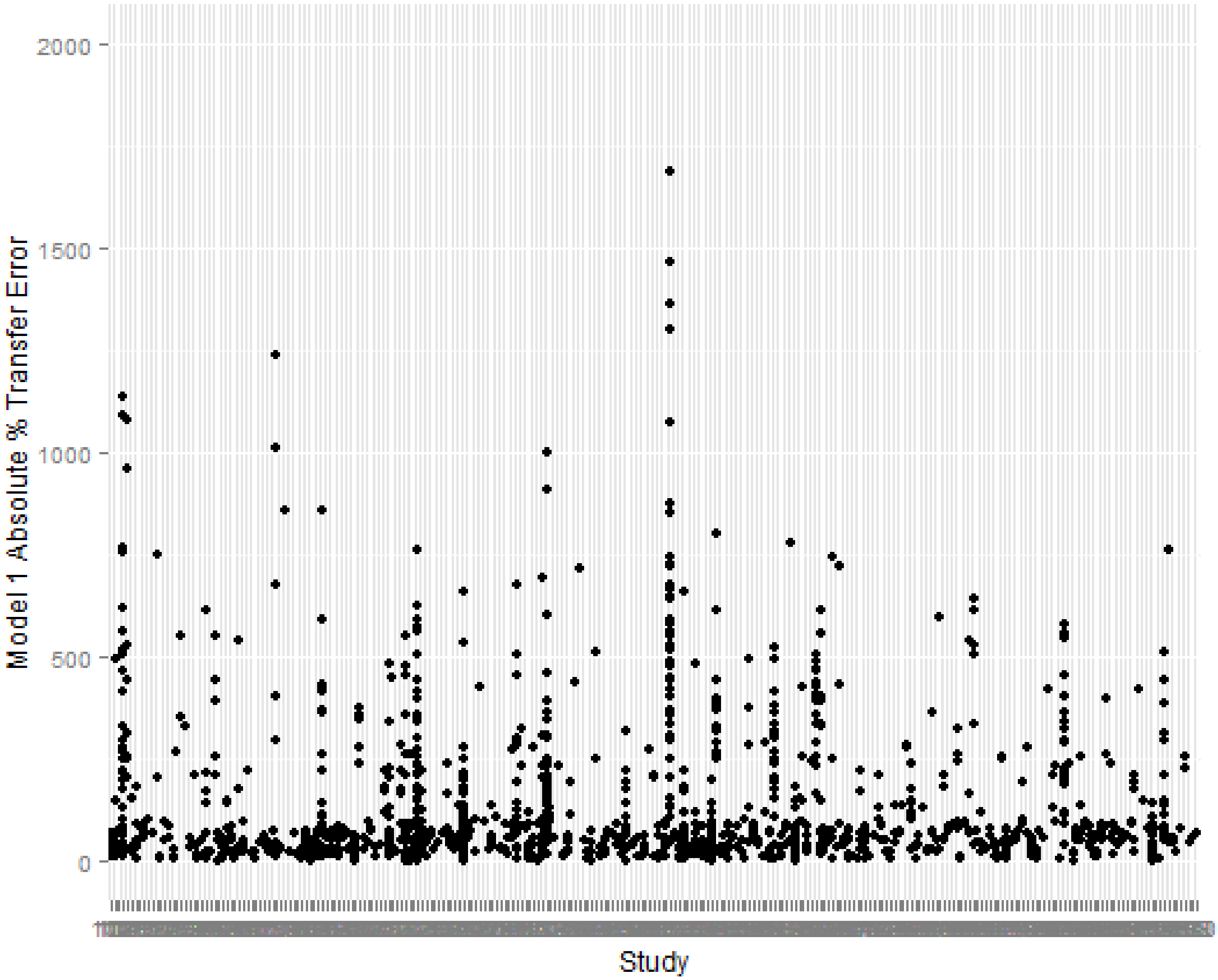


Figure 2.2b. Absolute Percent Transfer Error per Study for Model 1 (Full Data)



2.4.2 Model 2: Model with Eliminated Transfer Error Outliers

The results of Model 1 lead us to the conclusion that our approach needs refinement. In this case, we decided to attempt to reduce the transfer error in our model by eliminating the outliers in the metadata used for Model 1 (full data). Observations are considered outliers when their absolute transfer error falls $1.5 \times Interquartile\ Range$ above the third quartile or below the first quartile. In this case, 325 observations are dropped from Model 1, leaving 1727 observations in Model 2. Stapler and Johnston (2009) use a similar method and found that exclusion of outliers can increase the robustness of a meta-regression.

In Model 2, we use an identical specification as Model 1. A Wald test ($\chi^2_{52} = 712.03$) indicates that the model variables are jointly significant at the .0001 level. Of the 52 variables in Model 2, 30 are statistically significant at the .1 level. Model 2 has an R^2 of .3217 meaning roughly 32% of the variation in WTP is explained by this specification. This random effects model accounts for 241 studies, where the average study has 7.2 WTP estimates, the minimum sized study has 1 WTP estimate, and the maximum sized study has 199 WTP estimates.

Model 2 provides evidence of systematic variation in WTP associated not only with geographic, activity, and methodological fixed effects, but also random effects associated with the systematic study-level variance (σ^2_u). The random effects are significant at the .01 level. This indicates that there are components of the systematic variation in WTP that is driven by unobservable attributes.

As in Model 2, we again test and control for publication bias using study fixed effects and the sample control variable ($sample\ control = (sample\ size)^{-0.5}$). In our specification, we find the coefficients for both consulting reports and conference proceedings to be positive with significance at the .1 level, again indicating the potential for publication bias in a downward direction. The coefficient for the sample control variable is statistically significant at the .1 level. This result indicates a nonlinear, inverse relationship between sample size and WTP, where WTP decreases as sample size increases.

The Model 2 specification has the same 9 location indicator variables to account for regional variation in recreation users and recreation geographic and ecological attributes. Six of the location indicator variables represent regions in the US (New England, Mid-Atlantic, Pacific, South Central and Western Gulf of Mexico, North Central, Mountain West). The South Atlantic and Eastern Gulf of Mexico indicator variable acts as the model baseline. 4 of the 6 regional variables are statistically significant at the .05 level (New England, Pacific, North Central, Mountain West). In addition to the regional variables, the 3 aquatic variables included in the specification (coastal, lake, river) are not statistically significant.

The Model 2 specification has the same 18 recreation activity indicator variables to account for potential recreation activities in the Sarasota Bay region Freshwater Fishing is treated as the baseline activity in this model. Eleven of the coefficients on the activity variables are statistically significant at the .1 level. In addition to the activity types, we include variables representing overnight trips, multi-purpose trips, and multi-destination trips. None of these variables are statistically significant.

Again, the last 16 variables relate to the methodologies of the studies in the metadata. Twelve of these variables are significant at the .1 level. These results again indicate the importance of controlling for methodological difference in this meta-regression.

In Model 2, we again use the absolute percent transfer error (4) to assess a meta-regression application. Table 5 summarizes the absolute percentage transfer error for Model 2. This model results in an average transfer error of 55.38% and a median transfer error of 41.32%. These results indicate that dropping the outliers from Model 1 improved prediction. Figures 3a and 3b give graphical representations of the absolute percentage transfer error for this model. Figure 2.3a provides a histogram of the transfer error and Figure 2.3b graphs transfer error for individual studies.

Figure 2.3a. Histogram of Absolute Percent Transfer Error Model 2 (Outliers Eliminated)

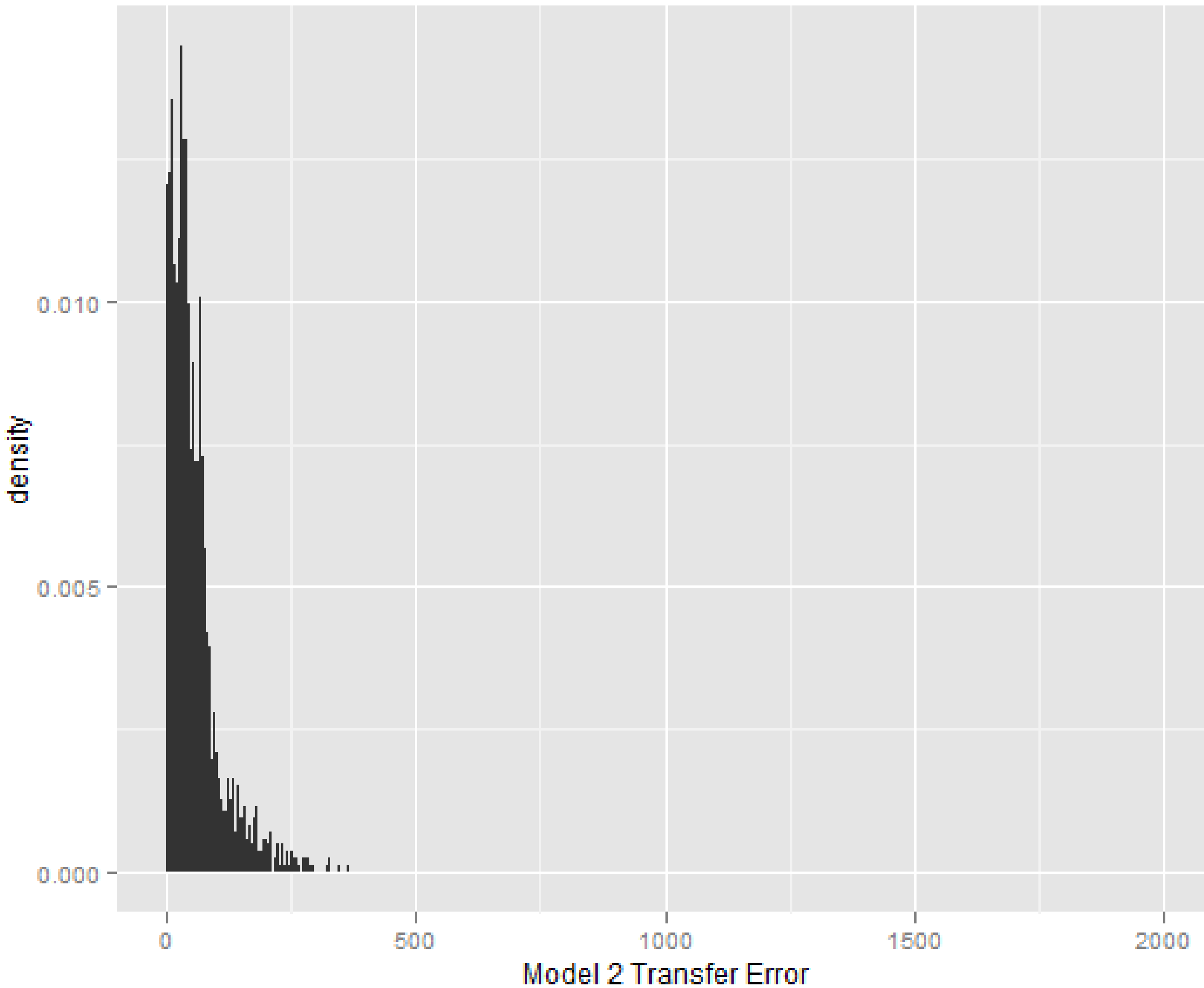
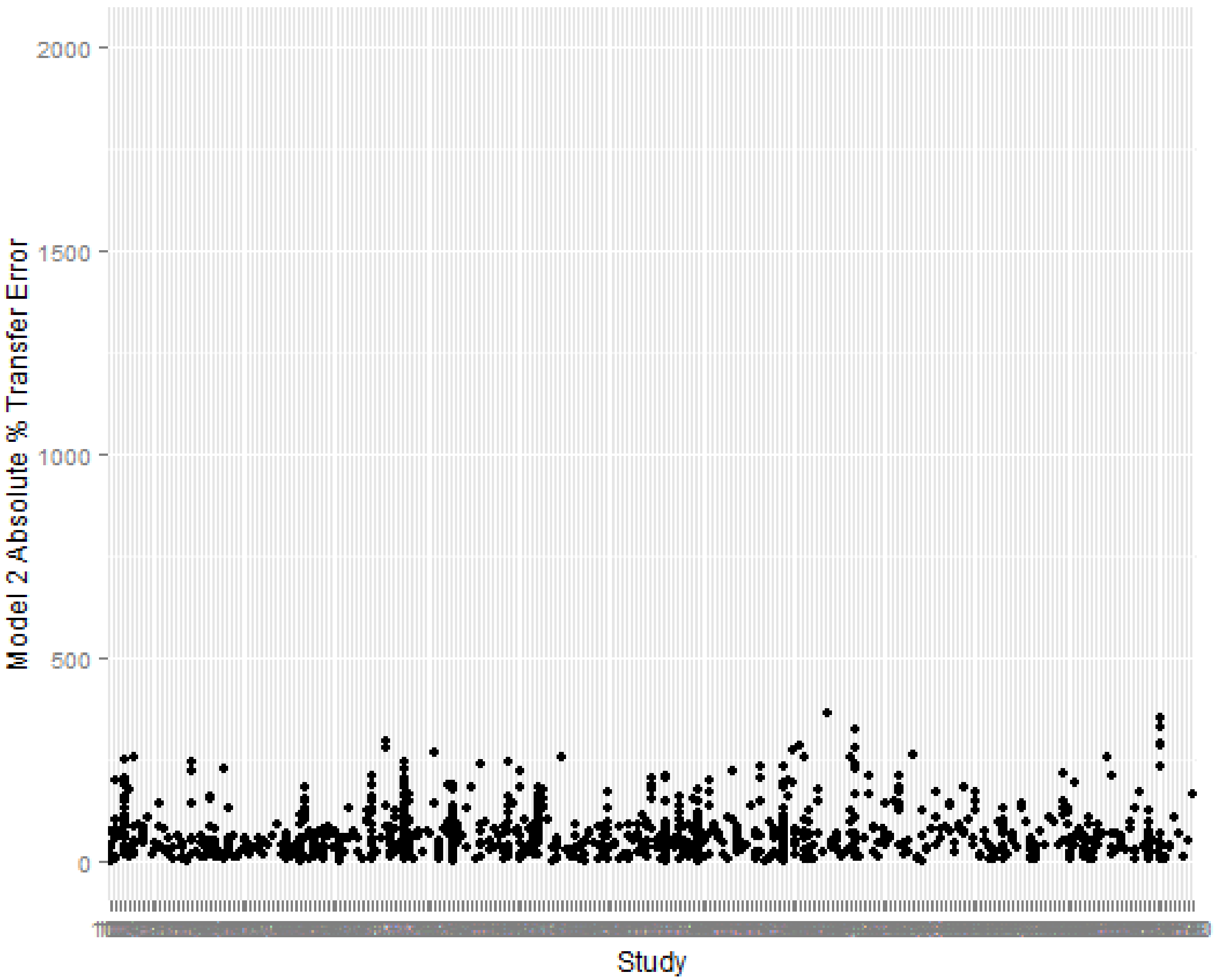


Figure 2.3b. Absolute Percent Transfer Error per Study for Model 2 (Outliers Eliminated)



2.4.3 Willingness-to-Pay Estimates

After assessing the performance of Models 1 and 2, we chose Model 2 as our preferred model for benefit transfer. Model 2 explained more variation with the relevant metadata (R^2=.1467 vs R^2=.3217) and resulted in lower absolute percentage transfer error (mean $te_{model\ 1}$=108.03 vs mean $te_{model\ 2}$=55.38). Table 2.6 presents average WTP for the 19 recreation trip types as well as 95% confidence intervals. We estimate four estimates for each activity type: 1) single day and single purpose trips, 2) single day and multi-purpose trips, 3) multi-day and single purpose trips, and 4) multi-day and multi-purpose trips. Figures 2.4a – 2.4d give graphical depictions of each trip type.

In a comparison of our potential trip types, our model estimates that individuals have higher WTP for multi-day trips as compared to single day trips. We also find that individuals have higher WTP for single purpose trips as compared to multi-purpose trips. Both of these findings follow our preconceived notions of the behavior of recreational users.

Table 2.6. Estimated Mean Willingness-to-Pay for Recreation Trips by Activity Type (2011 Dollars)[a]

	Day Trip		Multi-Day Trip	
	Single Purpose	Multi-Purpose	Single Purpose	Multi-Purpose
Beach	$23.89 ($21.28, $26.49)	$18.76 ($16.07, $21.44)	$28.05 ($25.40, $30.69)	$22.03 ($19.30, $24.75)
Big Game Hunting	$57.79 ($55.35, $60.22)	$45.38 ($42.84, $47.91)	$67.83 ($65.34, $70.31)	$53.27 ($50.68, $55.85)
Biking	$68.96 ($66.38, $71.53)	$54.16 ($51.52, $56.79)	$80.95 ($78.31, $83.58)	$63.57 ($60.87, $66.26)
Camping	$24.72 ($22.24, $27.19)	$19.41 ($16.83, $21.98)	$29.02 ($26.50, $31.53)	$22.79 ($20.17, $25.40)
Env. Education	$21.19 ($18.37, $24.00)	$16.64 ($13.77, $19.50)	$24.87 ($22.00, $27.73)	$19.53 ($16.61, $22.44)
Freshwater Fishing	$37.47 ($35.04, $39.89)	$29.43 ($26.89, $31.96)	$43.99 ($41.50, $46.47)	$34.54 ($31.95, $37.12)
Motor boating	$37.42 ($34.86, $39.97)	$29.39 ($26.74, $32.03)	$43.93 ($41.31, $46.54)	$34.5 ($31.80, $37.19)
Running/Hiking	$54.42 ($51.96, $56.87)	$42.73 ($40.18, $45.27)	$63.87 ($61.35, $66.38)	$50.16 ($47.56, $52.75)
Kayaking/Canoeing	$44.9 ($42.29, $47.50)	$35.26 ($32.57, $37.94)	$52.7 ($50.05, $55.34)	$41.39 ($38.66, $44.11)
Off-Road Vehicle	$27.35 ($24.80, $29.89)	$21.48 ($18.84, $24.11)	$32.1 ($29.54, $34.65)	$25.21 ($22.56, $27.85)
Picnicking	$29.46 ($27.00, $31.91)	$23.14 ($20.59, $25.68)	$34.58 ($32.07, $37.08)	$27.16 ($24.56, $29.75)
Saltwater Fishing	$65.74 ($63.25, $68.22)	$51.63 ($49.02, $54.23)	$77.16 ($74.61, $79.70)	$60.6 ($57.94, $63.25)
Scuba Diving	$243.37 ($240.24, $246.49)	$191.13 ($187.86, $194.39)	$285.67 ($282.51, $288.82)	$224.34 ($221.04, $227.63)
Sightseeing	$51.25 ($48.74, $53.75)	$40.25 ($37.65, $42.84)	$60.16 ($57.60, $62.71)	$47.24 ($44.59, $49.88)
Small Game Hunting	$31.84 ($29.34, $34.33)	$25 ($22.40, $27.59)	$37.37 ($34.82, $39.91)	$29.35 ($26.71, $31.98)
Snorkeling	$104.18 ($100.34, $108.01)	$81.81 ($77.95, $85.66)	$122.28 ($118.38, $126.17)	$96.03 ($92.12, $99.93)
Swimming	$35.55 ($33.03, $38.06)	$27.92 ($25.32, $30.51)	$41.73 ($39.17, $44.28)	$32.77 ($30.12, $35.41)
Waterfowl Hunting	$40.80 ($38.39, $43.20)	$32.05 ($29.52, $34.57)	$47.9 ($45.43, $50.36)	$37.62 ($35.04, $40.19)
Wildlife Viewing	$35.47 ($33.03, $37.90)	$27.86 ($25.32, $30.39)	$41.64 ($39.14, $44.13)	$32.7 ($30.11, $35.28)

[a] 95% Confidence intervals in Parentheses

Figure 2.4a. Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

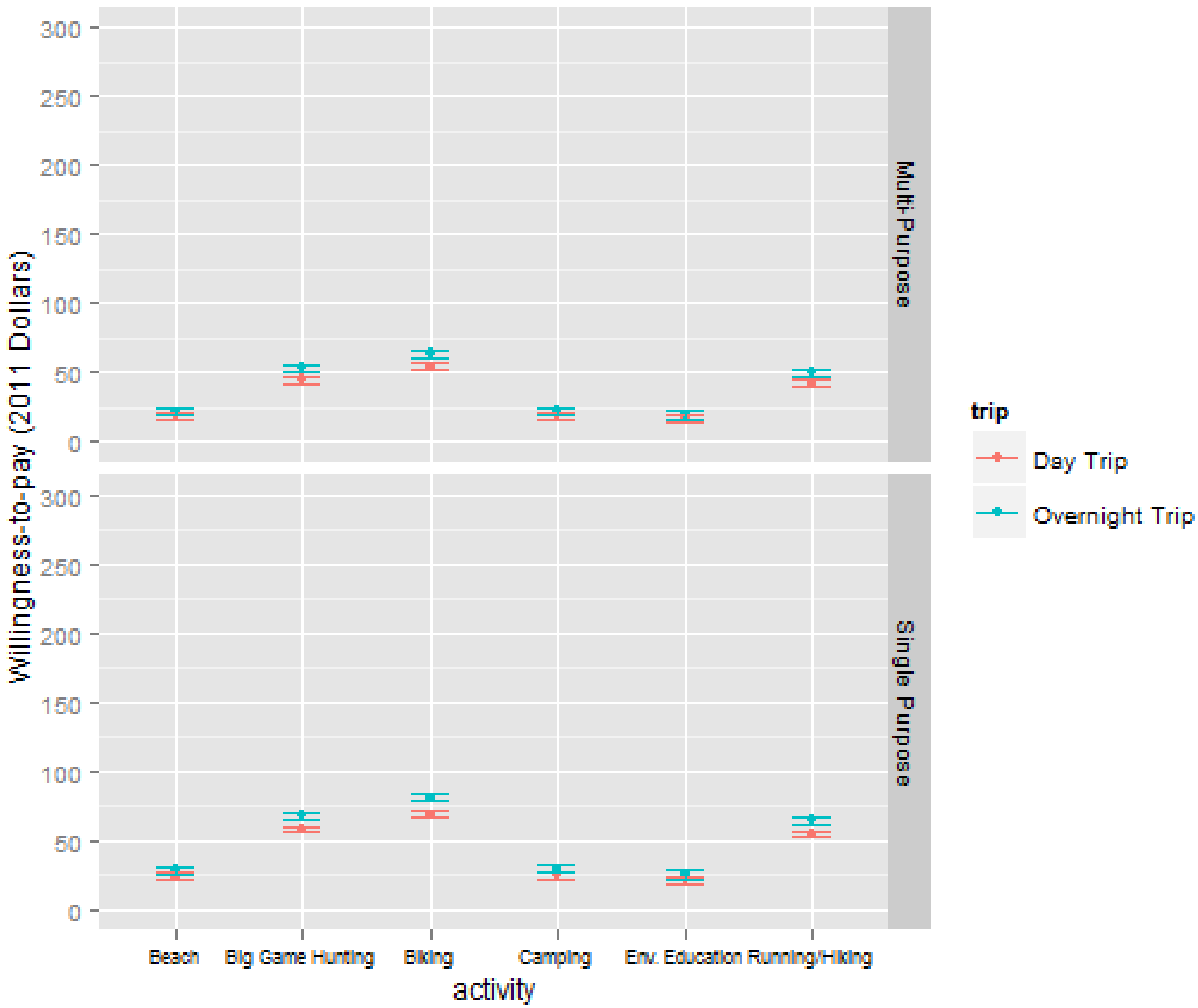


Figure 2.4b. Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

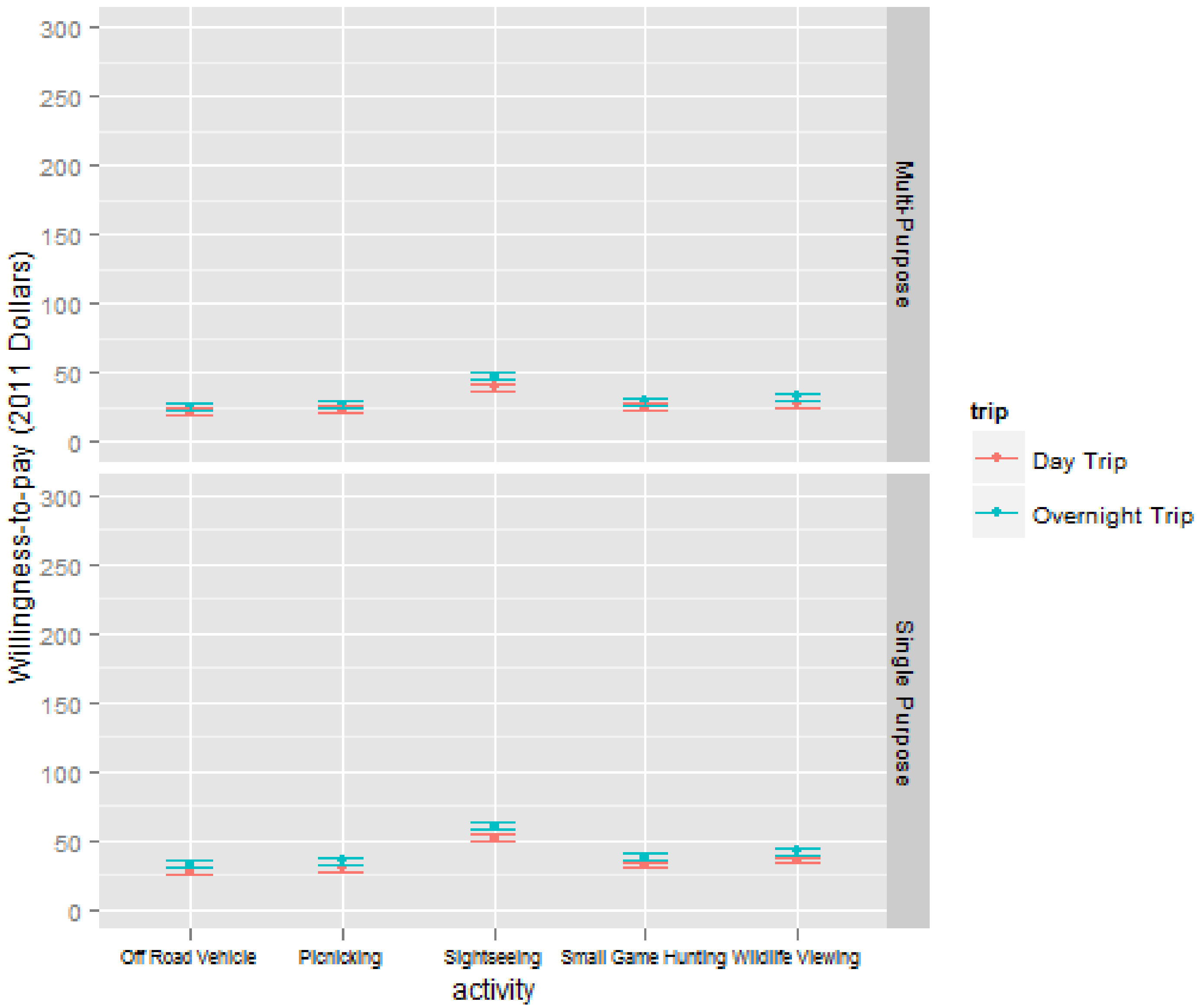


Figure 2.4c. Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals

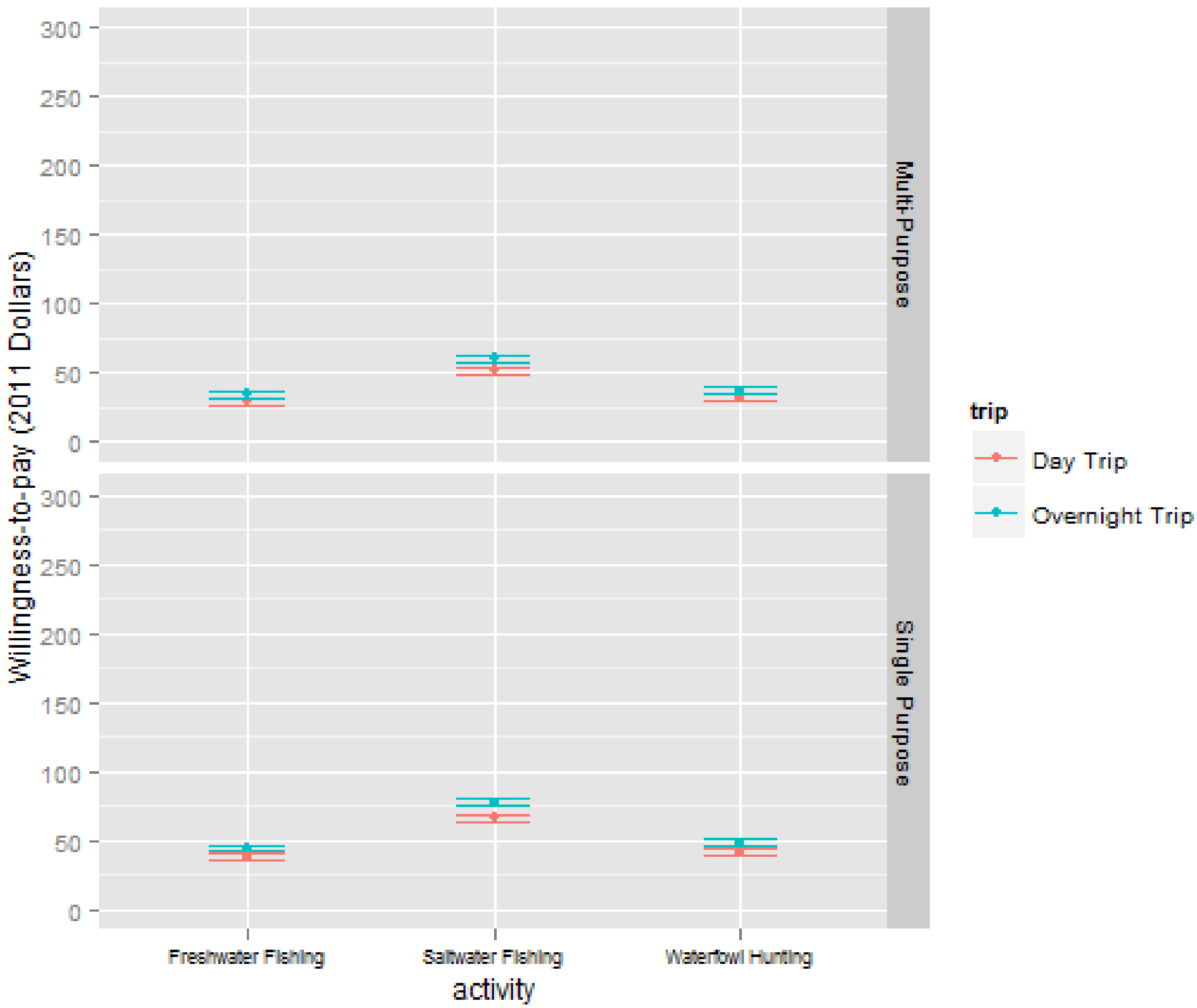
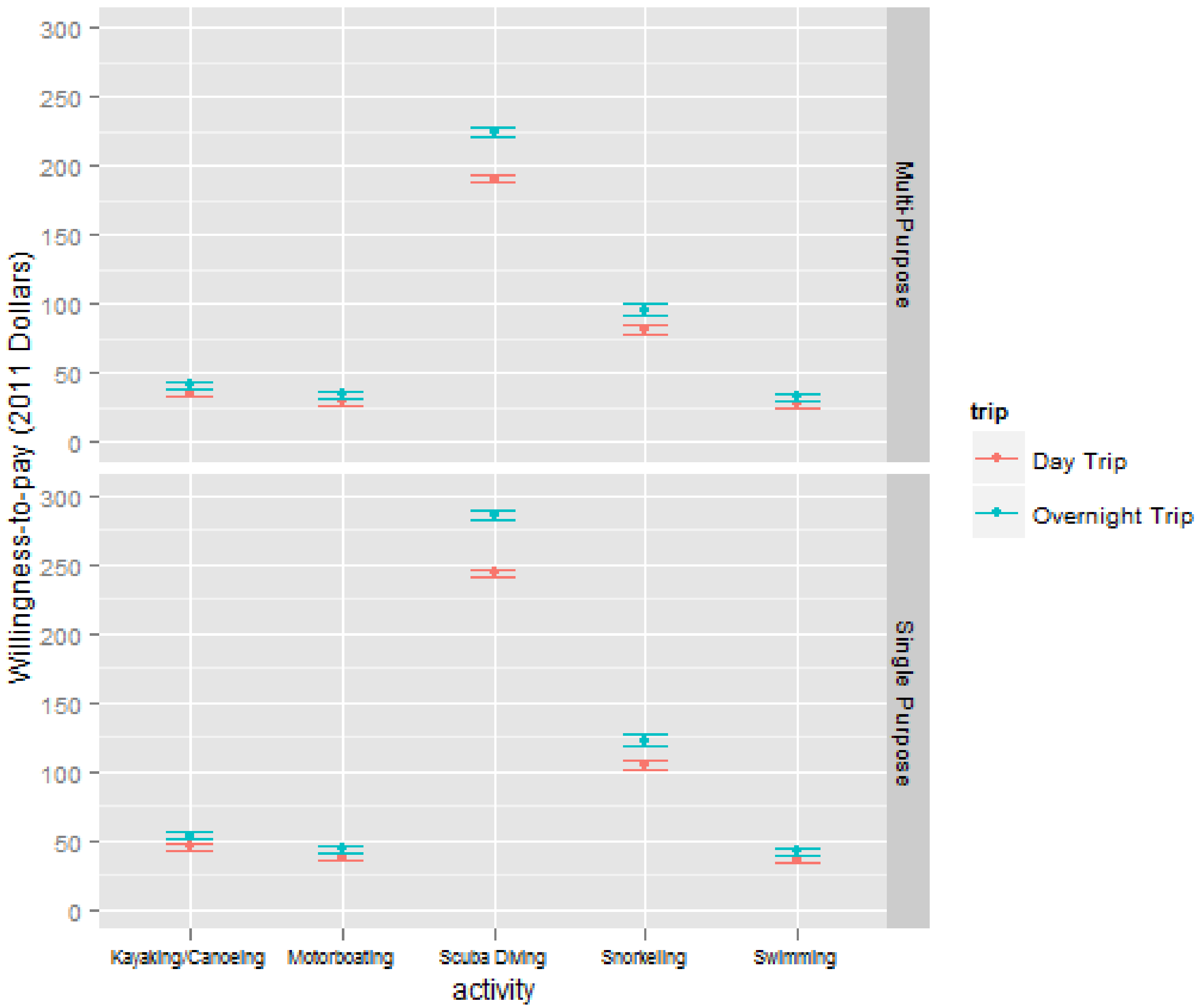


Figure 2.4d. Mean Willingness-to-Pay for Recreation Trips with 95% Confidence Intervals



2.4.4 *Future* Applications of Willingness-to-Pay Estimates

The application of the Benefit Transfer model will be incomplete without a method to develop an aggregate willingness-to-pay (AWTP) measure for recreation use in the Sarasota Bay region. The AWTP measure will connect the marginal willingness-to-pay (MWTP) measures (the value of a recreation trip) to the relevant recreation user population for the Sarasota Bay region. We propose developing a survey methodology to estimate the number of recreational users and their relevant activities for a specific year. We will then combine our MWTP measures with this recreation population estimate in order to estimate the AWTP for recreation use in the Sarasota Bay region.

2. MEASURING THE VALUE OF RECREATION USE VALUE IN THE SARASOTA BAY REGION WITH BENEFIT TRANSFER META-REGRESSION

3. Measuring the Value of Non-marketed Goods and Services to the Sarasota Bay Region's Residential Housing Markets

3.1 Introduction

The purpose of this component of research is to estimate the impact that proximity to Sarasota Bay's recreational and aesthetic amenities confers on housing values. As regional residential property markets capitalize the flow of services from ecosystems and the built environment, analyzing real estate market transactions presents one way that explicit markets reveal home owners' preferences for non-marketed goods and services. In the Sarasota Bay Estuary, factors which contribute to purchasing decisions may include a variety of local environmental public goods, including access or proximity to recreational opportunities, exposure to risk, and varying levels of environmental quality that influence aesthetics and health. This section focuses on one of these attributes– proximity to the Gulf and Bay. In this section of the report we describe the use of an indirect non-market valuation technique called hedonic analysis to quantify this value.

3.2 The Hedonic Modeling Technique and Theoretical Model

In the non-market valuation economics literature, modeling techniques have developed that use real estate market transactions to specifically examine and quantify the relationship between locational or environmental characteristics and property values. These are called hedonic property price models (hereafter, hedonic models).[1] Hedonic modeling is a method for valuing component characteristics of a heterogeneous or differentiated good (goods whose characteristics vary in such a way that there are distinct product varieties even though the commodity is sold in one market) (Rosen 1974).

[1] Palmquist (2005) gives an overview of hedonic property models and the relevant economic literature.

Hedonic pricing techniques are based on a theory of consumer behavior that suggests individuals value a good because they value the characteristics of the good, rather than the good itself. An example can be provided when considering purchasing an automobile. According to the theory, the value an individual places on the car is a function of many attributes; safety, comfort, efficiency, luxury etc. In such an example, as the variation in automobile type gives rise to variations in car prices within each market, an analysis of how car prices vary with changes in the levels of these attributes can reveal the implicit price of each attribute. In a similar manner, the hedonic method for non-market valuation relies on market transactions for differentiated goods to determine the value of key underlying characteristics. Housing prices are related to a variety of characteristics; including structural characteristics (such as the number of bedrooms and bathrooms, size of lot, quality of construction), neighborhood locational characteristics (such as proximity to employment centers, level of crime, and ranking of local schools), and environmental characteristics (such as air quality and proximity to local amenities or disamenities). As household decisions on the level of structural, neighborhood, and environmental attributes are observable to a researcher, the hedonic modeling technique is often applied in examining residential property prices and the implicit values of housing attributes, like proximity to a local bay's resources.

To understand the modeling process, in its simplest sense, consider two identical homes. All the structural, neighborhood, and environmental locational characteristics are identical for both homes—except one characteristic. Assume one home is proximate to a shoreline that offers associated recreational opportunities while the other is located in a typical urban residential development. As all other housing characteristic are identical, consumer behavior theory suggests that demand for the beach-front property will be greater than the comparable property, increasing its property price, and creating a disparity in property price values between the two properties. Now, the property price for the beach-front property exceeds that of the comparable property located in a typical urban setting. If both properties are identical in all attributes except proximity to the beach, then the theory suggests that the implicit value of beach-front property is the difference between the two property prices. So, we indirectly observe the monetary trade-offs individuals are willing to make with respect to changes in this characteristic. As such, the hedonic method is an “indirect” valuation method in which we do not observe the value consumers have for the characteristic directly, but infer it from observable market transactions.

Of course, in reality, properties do not differ by just a single characteristic or attribute, but many. As a result, a more sophisticated technique is required to analyze the statistical relationship between property prices and their attributes. Such a technique is called regression analysis. Regression analysis is a tool that uses statistical techniques to identify otherwise unknown correlations between variables. Correlation is simply a statistical term that indicates whether or not two variables move together. In an analysis of this nature, a residential property value is perhaps expected to be positively correlated with proximity to a water body such as the Sarasota Bay. That is, the price of a residential property is expected to increase the closer its location to the Bay. Such correlations are straight forward enough to identify as long as there are only a couple of variables involved. With multiple variables, the process becomes more difficult.

A hedonic property price model uses data on local property sales and the properties' structural, neighborhood, and environmental attributes to allow correlations to be identified by artificially holding constant every variable in the model except the two that are of concern. The hedonic property price model controls for all variables of interest and allows inferences to be made on which variables are correlated and which are not. Model results indicate the implicit value of the properties' characteristics, and as such, allow inferences to be made regarding the value to residents for many attributes, such as living close to the water, or in a good school district, or away from a hazardous waste site.

The locational characteristic of interest in this report is proximity to the Sarasota Bay. Empirical evidence suggests that coastal properties (and particularly those proximate to a beach) have outperformed most real estate market segments over the past twenty years. Consulting the literature, there is a clear exponential growth in the price premium as proximity to the aesthetic resource increases.

The hedonic model regresses housing price on the component characteristics of structural, neighborhood, and environmental attributes. When we assume a fixed housing supply where prices are demand determined, the equilibrium hedonic price function is

$$P = P(\boldsymbol{S},\boldsymbol{N},\boldsymbol{E}), \qquad (1)$$

where P represents the price of a single-family property, which is a function of vectors of structural (S), neighborhood (N), and environmental (E) characteristics. Because housing supply is assumed to be fixed in the short run, the hedonic price function arises as the consequence of bidding by home buyers. Assuming the hedonic price function is continuously differentiable, Rosen (1974) postulated that the first derivative of equation (1) with respect to any continuous attribute results in an average household's marginal willingness-to-pay (MWTP) for an additional unit of that attribute.

Over the last twenty years, the hedonic literature has placed a growing emphasis on spatial dependence in residential housing markets (Dubin 1988; Anselin and Bera 1998; Kim, Phipps, and Anselin 2003). Traditional estimation methods often fail to account for spatial autocorrelation, even with the inclusion of location-based indicators. Spatial autocorellation means that a home's value is partly a function of its spatial neighbors' values (positive autocorrelation) as well as its own attributes. Failure to account for this spatial dependence between properties can violate the models' assumptions of uncorrelated error terms and lead to biased and inefficient coefficient estimates. In modeling, there are different ways that spatial dependence can be accounted for. The first is called spatial lag dependence. This implies that property *i*'s selling price is a function of property *j*'s selling price (or all homes in the relevant spatial neighborhood). In a hedonic regression, spatial lag dependence can be represented as

$$\boldsymbol{P} = \rho \boldsymbol{W_1} \boldsymbol{P} + \boldsymbol{Z}\boldsymbol{B} + \mu \tag{2}$$

where ***P*** is again an *N* x 1 vector denoting sale price, ***Z*** is an *N* x *K* matrix of property characteristics, ***B*** is a *K* x 1 vector of coefficients, ρ is the (scalar) spatial lag coefficient, $\boldsymbol{W_1}$ is an *N* x *N* spatial weighting matrix describing the spatial lag process, and μ is an *N* x 1 vector of i.i.d error term.

The second process is called spatial error dependence, which occurs when regression residuals are spatially correlated. Spatial error dependence may occur if measurement error is spatially autocorrelated (Anselin and Bera 1998). In a hedonic model, spatial error dependence may be represented as

$$\boldsymbol{P} = \boldsymbol{Z}\boldsymbol{B} + \varepsilon, \text{where } \varepsilon = \lambda \boldsymbol{W_2} \varepsilon + \mu \tag{3}$$

where λ is the (scalar) spatial error coefficient, $\boldsymbol{W_2}$ is an *N* x *N* spatial weighting matrix describing the spatial error process, and ε is an *N* x 1 vector of the spatial error.

Finally, one can also control for spatial dependence using a combined spatial lag and error model that will take the following form (assuming $\boldsymbol{W_1} = \boldsymbol{W_2} = \boldsymbol{W}$):

$$\boldsymbol{P} = (\rho + \lambda)\boldsymbol{W}\boldsymbol{P} - \rho\lambda \boldsymbol{W}^2 \boldsymbol{P} + \boldsymbol{Z}\boldsymbol{B} - \lambda \boldsymbol{W}\boldsymbol{Z}\boldsymbol{B} + \mu \tag{4}$$

Maximum likelihood estimation is used to estimate equations (2) through (4) with the parameters ρ and λ estimated during the regression step. However, the spatial weight matrix, ***W***, must be specified prior to estimation. As suggested by Anselin and Bera (1998), we analyzed the fit of different weights matrices (using different distance measures) in the hedonic. In the estimation, we examine different potential weights matrices based on the geographic nature of the properties in the dataset. Based on this analysis, we use a spatial weights matrix consisting of binary elements equal to 1 if two properties are within 1,303 meters of each other, zero otherwise. The diagonal elements of the weights matrix are set to zero and the row elements are standardized so that they sum to one.

3.3 Literature Review

Since Rosen (1974) provided a theoretical platform for estimating the implicit values of housing attributes, hedonic property price models have been used extensively to estimate the value of structural, locational, or environmental amenity attributes in property markets. A number of studies have estimated the values of different environmental amenities across coastal housing markets.

One important contribution of a number of these studies, and the most relevant to this project, is the quantification of the proximity to water as an amenity value in relation to given resources, such as beaches, lakes, oceans, open space, urban parks, and more (Lansford and Jones 1995; Parsons and Powell 2001; Boyle and Kiel 2001; Parsons and Noailly 2004; Pompe 2008). Generally, hedonic studies capture the proximity amenity value by including either distance-based dummy variables or a linear Euclidean distance variable from the property to the resource as an explanatory variable in the hedonic model (see for example, Tyrväinen 1997; Bin and Polasky 2004; Pompe 2008; Bin, Kruse, and Landry 2008). Distance-based dummy variables allocate each property into a distance band from the resource. These distance bands could be at the block level (such as ocean front, one block back, two blocks back etc.) or by distance cut-offs (such as less than 1,000 feet from the resource, or between 1,000 and 2,000 feet, etc.) In both cases, inclusion of these distance measures allows the value of proximity to the resource (amenity value) to be measured.

Major et al. (2003) estimate the price premiums for ocean-front and bay-front properties for residential properties in Stone Harbor and Avalon, New Jersey. Results from this particular study are practical for comparison to our area of interest as Avalon is a peninsula that has both ocean-front and bay-front residences similar to Sarasota Bay. Major et al. (2003) estimate substantial price premiums associated with properties immediately adjacent to the water. For example, an ocean-front property's value is

156% higher than a comparable property located away from the shoreline. In a similar study, Bensen et al. (1997) provide similar measures for properties in Point Roberts, Washington. Their results are comparable to those in Major et al. (2003) with ocean-front property price premiums in the region of 147 percent.

Major et al. (2003) and Bensen et al. (1997) both measure the diminishing premiums as properties move farther away from the shoreline. This is another important component of the analysis. As the properties are located farther from the water, one expects the locational price premiums to decline. Major et al. (2003) estimate that the property price premium for residences located one block from the ocean falls to 46 percent, then again to 10.5 percent for properties located two blocks from the shore. Major et al. (2003) also measure the price premiums for properties located on the bay-side of the peninsula. As expected, the price appreciation for bay-front property is not as significant as ocean-front – with bay-front property values, on average, only 15 percent higher (compared to 156 percent higher for ocean front properties) than an identical property located away from the shoreline. Michael et al. (2003) also examine property sales data in Maryland and reveal price premiums for bay-side properties. They estimate price premiums for bay-front properties in the region of 40 percent to 63 percent. Beyond that, they also estimate the premiums fall between 3 percent and 18 percent for every 100 meters that properties are farther from the shore.

Parsons and Noailly use distance-based bands in their analysis of location premiums for properties located in a Delaware coastal community. They use distance-based bands of less than 500 feet up to over 3,500 feet, and find that homes located less than 500 feet from the ocean have a 54% premium over homes located in excess of 3,500 feet. Parsons and Noailly also find premiums diminish with distance from the resource.
For studies that use linear distance measures, Bin, Kruse, and Landry (2008) include the Euclidean distance from properties in their sample of North Carolina properties to the coastline in a spatial autoregressive hedonic model that also incorporates an ocean view measurement variable. They estimate the marginal willingness-to-pay (MWTP) for

a decrease in distance from the property to the shoreline. They find that, on average, households have a MWTP of $854 for a ten-yard decrease in the linear distance to the shoreline. Morgan and Hamilton (2011) also construct a spatial autoregressive hedonic model to capture beach access values for properties on Pensacola Beach, FL. However, their study differs from Bin, Kruse, and Landry (2008) since they hypothesize that having controlled for view, any residual amenity value represents the benefit from accessing the beach for leisure purposes. They argue that as properties closer to the beach typically have better views (fewer obstructions), the two amenities are likely to be highly correlated, so disentangling view and access is problematical. Their hedonic model includes beach access via a network distance parameter in order to mitigate collinearity effects between recreation and aesthetic amenities. They find households' willingness-to-pay of $317 for a one-meter decrease in distance to the nearest public beach access point.

While less applicable to this project, hedonic studies have attempted to value a variety of other environmental goods associated with coastal areas, such as water quality, beach width, and coastal views. To briefly provide some examples, Leggett and Bockstael (2000) examine the impact of fecal coliform contamination on property prices along a portion of the Chesapeake Bay, MD. They found that a 100mL increase in fecal coliform counts reduce Bay property prices by 1.5 percent. Based on the properties used in the sample, this result represents between a $5,114 to $9,824 reduction in property values for a 100 count increase in fecal coliform.

Landry and Hindsley (2011) employ the hedonic model to explore the influence of beach quality on coastal property values. Their findings support the hypothesis that dune and beach width provide recreational opportunities and storm/erosion protection but services are limited by distance from the shoreline. Using a spatial autocorrelation hedonic model, they find that coastal property owners are willing to pay, on average, $71 to $196 for an additional meter of high-tide beach width and coastal property owners are willing to pay, on average, $71 to $196 for an additional meter of high-tide beach width. Further, while MWTP to increases in beach width are greater for households in close proximity to the shoreline, extending the influence of beach quality beyond 300 meters from the shore generally results in statistically insignificant parameter estimates. Also, Bin et al. (2008) use LIDAR (Light Detection And Ranging) data to construct a continuous measure of view which takes into account natural and man-made obstructions. Motivated by the need to disentangle the spatially integrated housing characteristics of view amenities, shoreline access, and flood risk, they include a continuous viewshed measure within their specification. This inclusion enabled separate identification of coastal amenities and risk within the hedonic price function. Using data from North Carolina coastal communities, they estimate a spatial autoregressive hedonic model and calculate that households are willing to pay an average of $995 for a one-degree increase in the view of the Atlantic Ocean.

In a similar study, Hindsley et al. (forthcoming) also use a LIDAR-based measure to estimate the value of a continuous view of the Gulf of Mexico in Pinellas County, Florida. In their study, they investigate different types of view measures which may influence coastal home purchases including the total view and the largest continuous view segment. They estimate a spatial autoregressive hedonic model and calculate that, while households are willing to pay an average of $1300 for a one-degree increase in the total view of the Atlantic Ocean, they are also willing to pay $2015 for a one-degree increase in the largest continuous view segment. Their findings also indicate that distance from view content may influence the amount a homebuyer is willing to pay for a coastal property.

3.4 Variables Used in the Hedonic Model

In the hedonic models, the dependent variable is the log of property price for each household in the sample. Property price and attribute data come from the Sarasota and Manatee County property appraiser offices database of property transactions. Figure 3.1 shows the study area. The dataset contains attribute and sales price information on over 11,000 single family residences, sold between 2008 and 2010. Sales transactions after the economic downturn and associated housing market collapse were selected to avoid confounding issues with using sales data before and after the collapse. The detail of structural attributes in the dataset allows for inclusion of many of the structural housing attributes common to the hedonic literature. Table 1 provides descriptive statistics for all variables included in the models. Due to the large number of variables included in the hedonic models, Table 1 is split into three separate tables to describe the structural, locational, and environmental variables, respectively.

Figure 3.1. Map of Project Study Area

Table 3.1a. Definition of Independent Regression Variables (Structural Variables)

Variable	Description	Mean	Min	Max
Structural Variables				
Price	Property sales price (in 2010 dollars)	252,009	50,000	7,545,268
Sq ft	Property square footage	1,962	420	8,209
Lot Sq ft	Property lot square footage	41,872.33	17.42	562,925.88
Bath	Number of bathrooms	2.18	1.00	7.00
Pool	Dummy variable for pool (1 if property has a pool, 0 otherwise)	0.40	0.00	1.00
Age	Age of property (years)	18.33	1.00	122.00
Steel_Fr	Dummy variable = 1 if property has a steel frame, 0 otherwise	0.00	0.00	1.00
Wood_Fr	Dummy variable = 1 if property has a wood frame, 0 otherwise	0.09	0.00	1.00
Qual_BA	Dummy variable = 1 if property assessed as “below average” quality, 0 otherwise	0.07	0.00	1.00
Qual_AA	Dummy variable = 1 if property assessed as “above average” quality, 0 otherwise	0.34	0.00	1.00
Qual_Ex	Dummy variable = 1 if property assessed as “excellent” quality, 0 otherwise	0.10	0.00	1.00
Qual_Sup	Dummy variable = 1 if property assessed as “superior” quality, 0 otherwise	0.01	0.00	1.00
Sale_08	Dummy variable = 1 if sale year is 2008, 0 otherwise	0.33	0.00	1.00
Sale_09	Dummy variable = 1 if sale year is 2009, 0 otherwise	0.33	0.00	1.00

Table 3.1b. Definition of Independent Regression Variables (Locational Variables)

Variable	Description	Mean	Min	Max
	Locational Variables			
Brad'n Beach	Dummy variable = 1 if property located in Bradenton Beach, 0 otherwise	0.00	0.00	1.00
Cortez	Dummy variable = 1 if property located in Cortez, 0 otherwise	0.00	0.00	1.00
Ellenton	Dummy variable = 1 if property located in Ellenton, 0 otherwise	0.01	0.00	1.00
Englewood	Dummy variable for city location (1 if property located in Englewood, 0 otherwise)	0.02	0.00	1.00
Holmes Beach	Dummy variable = 1 if property located in Holmes Beach, 0 otherwise	0.00	0.00	1.00
Longboat Key	Dummy variable = 1 if property located in Longboat Key, 0 otherwise	0.00	0.00	1.00
Myakka City	Dummy variable = 1 if property located in Myakka City, 0 otherwise	0.01	0.00	1.00
Nokomis	Dummy variable = 1 if property located in Nokomis, 0 otherwise	0.02	0.00	1.00
North Port	Dummy variable = 1 if property located in North Port, 0 otherwise	0.17	0.00	1.00
Osprey	Dummy variable = 1 if property located in Osprey, 0 otherwise	0.01	0.00	1.00
Palmetto	Dummy variable = 1 if property located in Palmetto, 0 otherwise	0.03	0.00	1.00
Parrish	Dummy variable = 1 if property located in Parrish, 0 otherwise	0.07	0.00	1.00
Sarasota	Dummy variable = 1 if property located in Sarasota, 0 otherwise	0.29	0.00	1.00
Terra Ceia	Dummy variable = 1 if property located in Terra Ceia, 0 otherwise	0.00	0.00	1.00
Uni Park	Dummy variable = 1 if property located in University Park, 0 otherwise	0.01	0.00	1.00
Venice	Dummy variable = 1 if property located in Venice, 0 otherwise	0.10	0.00	1.00
Rented	% of homes rented in Census Tract	0.16	0.00	1.00
HH_size	Average household size in Census Tract	2.49	0.00	7.00
HH_60	% of households with owners 60 years of age or above	0.45	0.00	1.00

Table 3.1c. Definition of Independent Regression Variables (Environmental Variables)

Variable	Description	Mean	Min	Max
	Environmental Variables			
Dist_to_Gulf	Distance in feet from property to Gulf	35,579	70.94	128,607
Dist_to_Bay	Distance in feet from property to Bay	29,411	1.00	154,126
Gulfdist_1000	Dummy variable = 1 if distance from property to Gulf is less than 1,000 feet, 0 otherwise	0.01	0.00	1.00
Gulfdist_2000	Dummy variable = 1 if distance from property to Gulf is between 1,000 and 2,000 feet, 0 otherwise	0.01	0.00	1.00
Gulfdist_3000	Dummy variable = 1 if distance from property to Gulf is between 2,000 and 3,000 feet, 0 otherwise	0.01	0.00	1.00
Gulfdist_4000	Dummy variable = 1 if distance from property to Gulf is between 3,000 and 4,000 feet, 0 otherwise	0.01	0.00	1.00
Baydist_1000	Dummy variable = 1 if distance from property to Bay is less than 1,000 feet, 0 otherwise	0.03	0.00	1.00
Baydist_2000	Dummy variable = 1 if distance from property to Bay is between 1,000 and 2,000 feet, 0 otherwise	0.04	0.00	1.00
Baydist_3000	Dummy variable = 1 if distance from property to Bay is between 2,000 and 3,000 feet, 0 otherwise	0.03	0.00	1.00
Baydist_4000	Dummy variable = 1 if distance from property to Bay is between 3,000 and 4,000 feet, 0 otherwise	0.02	0.00	1.00
Bayfront	Dummy variable = 1 if Bay front property, 0 otherwise	0.01	0.00	1.00
Gulffront	Dummy variable = 1 if Gulf-front property, 0 otherwise	0.00	0.00	1.00
Canalfront	Dummy variable = 1 if canal front property, 0 otherwise	0.03	0.00	1.00
Creekfront	Dummy variable = 1 if creek front property, 0 otherwise	0.00	0.00	1.00
Riverfront	Dummy variable = 1 if river front property, 0 otherwise	0.00	0.00	1.00
Iwwfront	Dummy variable = 1 if Intracoastal Waterway front property, 0 otherwise	0.00	0.00	1.00
Int_dist	Distance from property to interstate (miles)	17.78	0.70	34.81
Sar_dist	Distance from property to Sarasota (miles)	13.86	0.50	35.40

For the structural variables, (Table 1a), the average sales price for homes in the sample is approximately $252,000 adjusted to 2010 prices using the consumer price index for housing, with a minimum price of $50,000 and a maximum of over $7.5 million. The average home has 1,962 square feet of heated living space (ranging from 420 feet to over 8,200 feet) with 42,000 square-foot lots, is 18 years of age, with two bathrooms. Approximately one-third of sampled properties have an “above average” property appraisal rating, with a further 10 percent earning an “excellent” quality rating.

Geographic Information Systems (GIS) software was used to identify the locational variables (Table 1b). Each property in the dataset is coded with the appropriate municipality. Also, property transactions data were merged with Census data to account for tract-level socio-demographic variables. The average household size in each Census tract is 2.5 persons with 45 percent of households containing owners aged 60 years or over, and 16 percent of homes rented in each tract.

Environmental variables are presented in Table 1c. Property transactions data were merged with spatial databases retrieved from the GIS departments for the Manatee and Sarasota County governments to enable controlling for spatial autocorrelation in the modeling process. The average distance from a property to the Gulf and Bay is about 36,000 feet and 29,000 feet, respectively. Due to the large sample size, very few properties, as a percentage, are directly adjacent to the water bodies included in the analysis (such as rivers, canals, creeks, and the Intracoastal Waterway). Finally, the average distance to the interstate is 18 miles, and 14 miles to Sarasota.

3.5 Empirical Results

As the functional form of the hedonic model is not known a priori, we examined different standard functional forms (Freeman 1993). As a semi-log model provided a better fit, we estimate and report the results from one spatial autoregressive hedonic property price model with the natural log of property sales price as the dependent variable. Parameters are estimated via maximum likelihood within the R statistical package environment. Our model captures proximity to the Bay and Gulf by using a series of dummy variables that represent distance-based bands that increase in 1,000 foot increments.[2] Figure 3.2 depicts a map with distance-based bands in relation to the Gulf of Mexico. Figure 3.3 provides a map with distance-based bands in relation to the Sarasota Bay Estuary.

[2] In addition to this model, we also estimated models with distance measures in linear, quadratic, and natural log forms. Categorical distance bands appeared to be the most appropriate approach for this project.

Figure 3.2. Distance of Single Family Residences from Gulf of Mexico

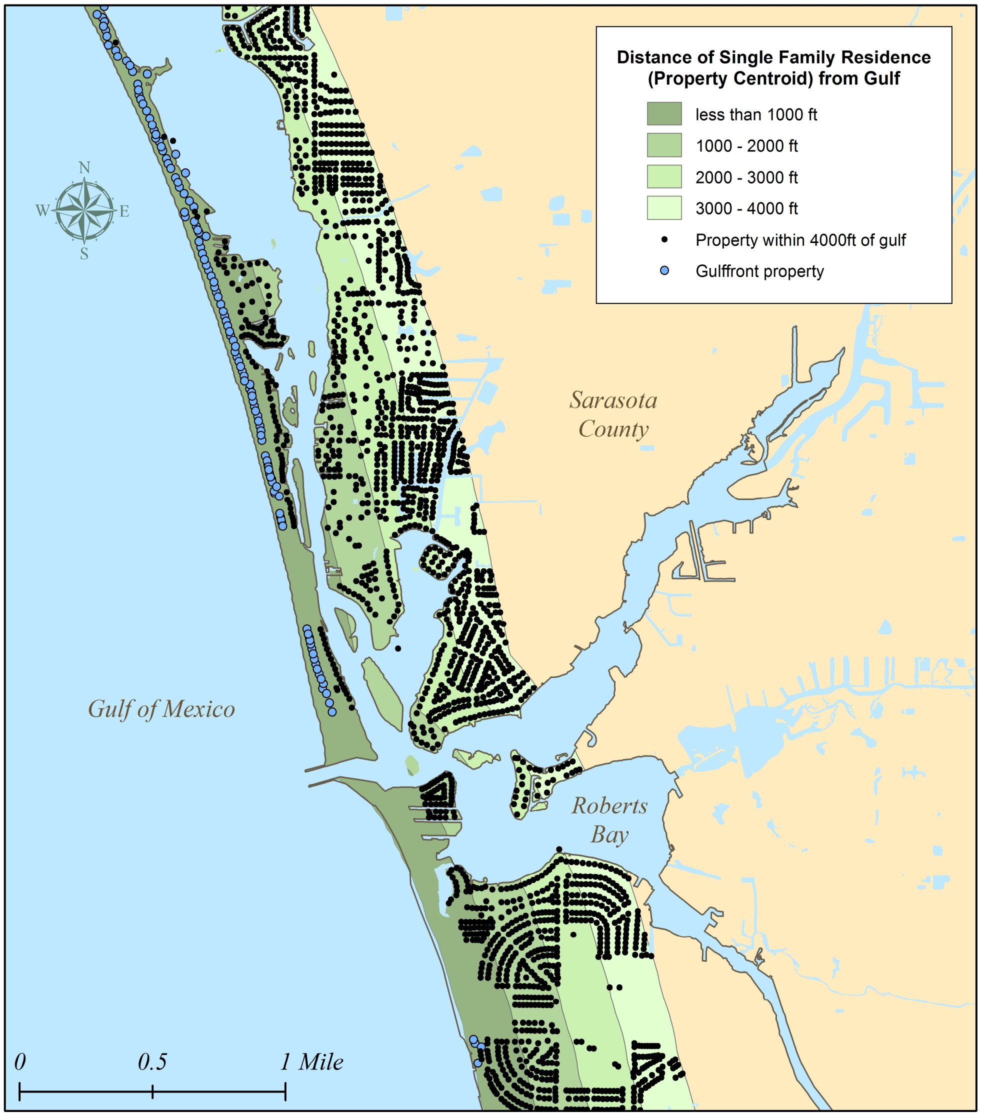
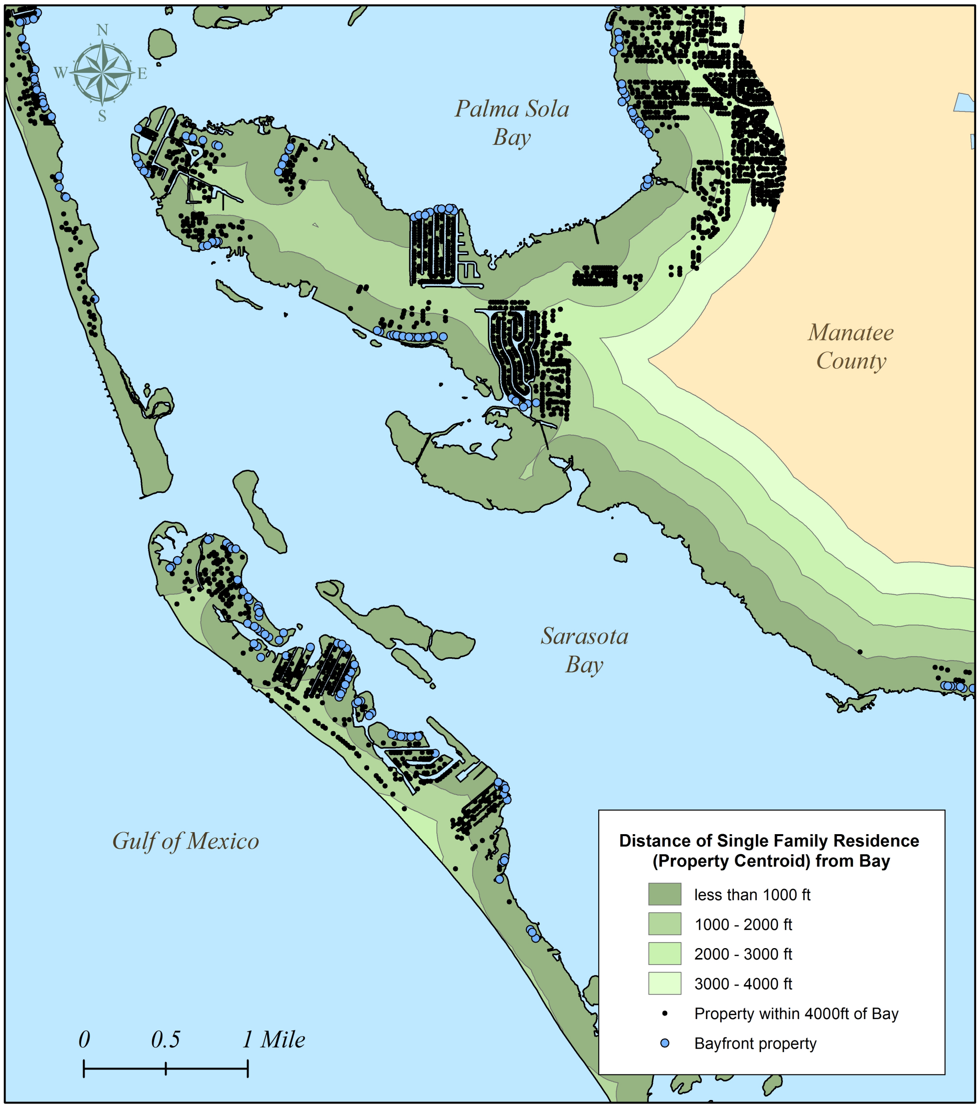


Figure 3.3. Distance of Single Family Residences from Sarasota Bay



3.6 Model Results

Table 3.2 presents the results from Model 1.

Table 3.2. Spatial Autoregressive Hedonic Property Model

Variable	Coefficient	Std. Error	Pvalue
Intercept	-2.980	0.1309	0.0000
Sqft	0.617	0.0154	0.0000
Lot Sqft	0.112	0.0089	0.0000
Bath	0.044	0.0151	0.0023
Pool	0.148	0.0064	0.0304
Age	-0.012	0.0009	0.4800
Age^2	0.000	0.0000	0.0298
Qual_BA	-0.137	0.0151	0.0108
Qual_AA	0.195	0.0115	0.0006
Qual_Ex	0.366	0.0201	0.3491
Qual_Sup	0.503	0.0465	0.8116
Sale_08	0.203	0.0065	0.0000
Sale_09	0.040	0.0060	0.0342
Brad'n Beach	0.249	0.0819	0.0000
Cortez	0.244	0.1129	0.0000
Ellenton	-0.051	0.0724	0.0000
Englewood	-0.123	0.0564	0.7909
Holmes Beach	0.352	0.1380	0.0000
Longboat Key	0.487	0.1426	0.0260
Myakka City	-0.056	0.0594	0.0000
Nokomis	0.011	0.0465	0.0000
North Port	-0.387	0.0307	0.0039
Osprey	0.101	0.0478	0.0000
Palmetto	-0.143	0.0279	0.0000
Parrish	-0.156	0.0155	0.0000
Sarasota	0.146	0.0197	0.0000
Terra Ceia	-0.056	0.2124	0.0000
Uni Park	0.184	0.0380	0.0000
Venice	0.062	0.0280	0.0000
Gulfdist_1000	0.446	0.0710	0.0000
Gulfdist_2000	0.222	0.0619	0.0003
Gulfdist_3000	0.088	0.0505	0.0814
Gulfdist_4000	0.036	0.0476	0.4553
Baydist_1000	0.293	0.0328	0.0000
Baydist_2000	0.173	0.0276	0.0000
Baydist_3000	0.130	0.0263	0.0000
Baydist_4000	0.094	0.0206	0.0000
Bayfront	1.000	0.0812	0.0000
Gulffront	1.178	0.2773	0.0000
Canalfront	0.377	0.0254	0.0000
Creekfront	0.332	0.0561	0.0000
Riverfront	0.533	0.0969	0.0000
Iwwfront	0.195	0.0710	0.0059
Int_dist	-0.002	0.0195	0.9353
Sar_dist	0.010	0.0168	0.5434
Rented	-0.012	0.0237	0.6055
HH_size	-0.015	0.0072	0.0324
HH_60	-0.027	0.0195	0.1660
Lambda	0.456	0.0148	0.0000
Rho	0.048	0.0068	0.0000
Log Likelihood	-986.5357		
Akaike Criterion	2075.1		
Observations	11066		

Before discussing the key environmental variables and associated willingness-to-pay measures, there are some notable findings from the structural variables. Recall in the regression analysis, each individual result reveals the correlation between the variable of interest and property values. For example, we include time dummy variables for properties sold in 2008 and 2009. The omitted year is 2010, so the coefficients on these variables indicate the premium paid for properties in 2008 and 2009 relative to 2010. The positive coefficient on the 2008 dummy variable suggests that, controlling for all other factors, households paid an approximate 20 percent premium for properties in 2008 relative to 2010. In 2009, the premium over 2010 prices is also positive, but smaller than the 2008 premium, at about 4 percent. Other structural variables indicate that, as expected, properties with more square footage, larger lots, more bathrooms, and with a pool all add value to homes. The negative coefficient on age but positive coefficient on the age squared coefficient suggests that properties decline in value with age (i.e., older homes are worth less) but this relationship is not linear. In fact, the effect of age on property value diminishes as homes become older.

The locational variables are a series of dummy variables for each municipality in the two-county area. These locational dummies control for differences in housing markets across the region. For example, homeowners may prefer properties in Bradenton Beach over another city, and so equivalent homes may sell for more in that municipality. Most of the locational dummy variables are significant at least at the 10 percent confidence level. The omitted city is Bradenton, so all results are relative to that location. For example, positive coefficients (such as for Cortez and Holmes Beach) indicate premiums for properties in those locations relative to Bradenton, while negative coefficients (such as for North Port and Palmetto) indicate that properties in these municipalities all sell at a discount compared to properties in Bradenton, holding all other factors constant. As locational variables, we also include some U.S. Census-based data on socio-demographic variation across the sample. Of these, only household size is significant, with its negative coefficient indicating that areas with larger average household sizes tend to have lower property values.

For this study, it's the environmental variables that we are particularly interested in. Results on these variables provide a means to understand the values of the environmental amenities associated with Sarasota Bay. All of the amenity frontage dummy variables are positive and highly significant, indicating that locating a property directly adjacent to a water body is valuable to homeowners, and this result holds for different resource types. Results strongly indicate that homeowners will pay a premium for homes located on the Gulf, Bay, canal, creek, river or Intracoastal Waterway. Further, as all frontage coefficients are significant, the sizes of these coefficients inform of the relative valuations that households place on frontage. For example, notice that the coefficient on Gulf-front properties is the largest. This implies that the premium households pay for a Gulf-front property is greater than for other resource types.

In terms of proximity effects, recall that Model 1 uses a series of indicator variables based on different distances from the Gulf and Bay to each property. Distance to the Gulf and Bay is captured with four separate measures of distance bands in 1,000 foot increments (1,000 ft, 2,000 ft, 3,000 ft, and 4,000 ft). For both the Gulf and Bay, the first distance based indicator variable represents homes within 1,000 feet of the Gulf or Bay, with the second representing homes between 1,000 and 2,000 feet, and so on. These measures are meant to capture the marginal effect of proximity to the Bay and Gulf for homes within different distance bands. In line with other empirical evidence from other areas, results show that, the marginal effect diminishes as distance to the Bay and Gulf increases. That is, the coefficients associated with each distance band are smaller in magnitude as the distance from the resource increases. This indicates that, as expected, proximity to either resource has a positive effect on property prices, holding all other factors constant.

3.7 Economic Impacts

For both models, we present the economic impacts that proximity to the Bay confers on local property owners. All monetary values are reported in 2010 dollars. We present two types of measures: marginal values and total capitalized impacts. Before presenting both, we describe each and their correct interpretation.

3.8 Marginal Value

The first measure that we report is the estimated marginal value of proximity to the Bay. This represents the mean additional increase in property value attributable to being more proximate to the Bay as opposed to being farther away, all else being equal. The marginal value represents the average household's marginal willingness-to-pay (MWTP) for have their property located incrementally closer to the Bay. These values are also referred to as implicit prices. As suggested by Halvorsen and Palmquist (1980), in our model where we are using distance-based binary variables, MWTP is estimated by $\frac{P \cdot \{\exp(\beta)-1)}{(1-\rho)}$, where *P* is the average property sales price, ρ is the spatial autoregressive lag parameter, and β is the coefficient on the distance-based indicator. In calculating the distribution of MWTP values, we use a well-known bootstrapping procedure that generates confidence intervals for the MWTP (Krinsky and Robb 1986). The procedure generates 5,000 random variables from the distribution of the estimated parameters and computes 5,000 MWTP estimates. The MWTP estimates are sorted in ascending order, and the 95% confidence bounds are found by dropping the top and bottom 2.5% of the estimates.

Table 3.3 presents the mean marginal values, plus upper and lower bound estimates associated with proximity to both the Bay and Gulf.

Table 3.3. Marginal Willingness-to-Pay Estimates

	Distance to Bay			
	1,000 Feet	2,000 Feet	3,000 Feet	4,000 Feet
Upper Bound	$113,122	$66,906	$52,402	$37,709
Mean	$90,235	$49,840	$36,774	$26,031
Lower Bound	$67,348	$32,773	$21,145	$14,353
	Distance to Gulf			
	1,000 Feet	2,000 Feet	3,000 Feet	4,000 Feet
Upper Bound	$205,717	$105,952	$53,314	$35,696
Mean	$148,841	$65,823	$24,354	$9,579
Lower Bound	$91,966	$25,694	-$4,605	-$16,537

In terms of Bay proximity, the mean Marginal Willingness-to-Pay (MWTP) for properties within 1,000 feet of the Bay is $90,235. This decreases to $49,840 for properties between 1,000 and 2,000 feet from the Bay, and decreases further to $36,774 and $26,031 for properties at least 3,000 feet and 4,000 feet from the Bay, respectively. For properties influenced by distance to the Gulf, we see the same effect; however, the mean MWTP point estimate for properties less than 1,000 feet from the Gulf is $148,841, larger than for the same distance to the Bay. As distance from the Gulf increases past 2,000 feet, we are unable to determine if a positive impact on MWTP from Gulf proximity exits.

The diminishing effect of proximity value on properties is highlighted in Figures 3.4 and 3.5. These figures present graphical depictions of the distribution of MWTP for proximity to both the Bay and Gulf. The distributions are estimated using the Krinsky-Robb procedure described above. Considering both figures clearly identifies the diminishing proximity effect as distance from either resource increases. They also highlight the greater impact on proximity to the Gulf over the Bay and that the drop off in Gulf proximity effect is more pronounced. Also notice that the distributions of values for Bay proximity effects are narrower, principally because there are more properties closer to the Bay than the Gulf, so the variance in marginal values is reduced.

Figure 3.4. Distribution of MWTP for Distance Bands to the Sarasota Bay Estuary

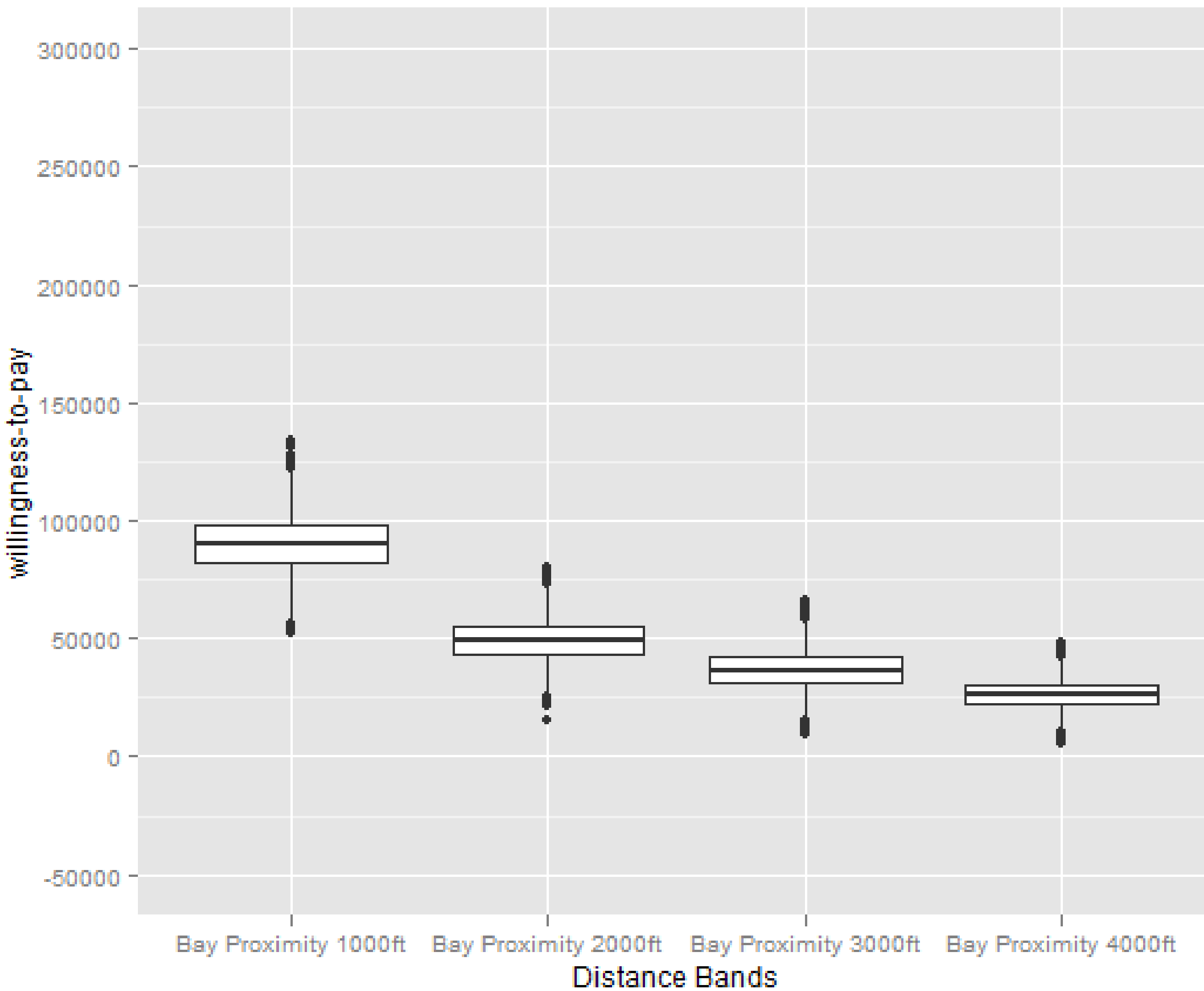
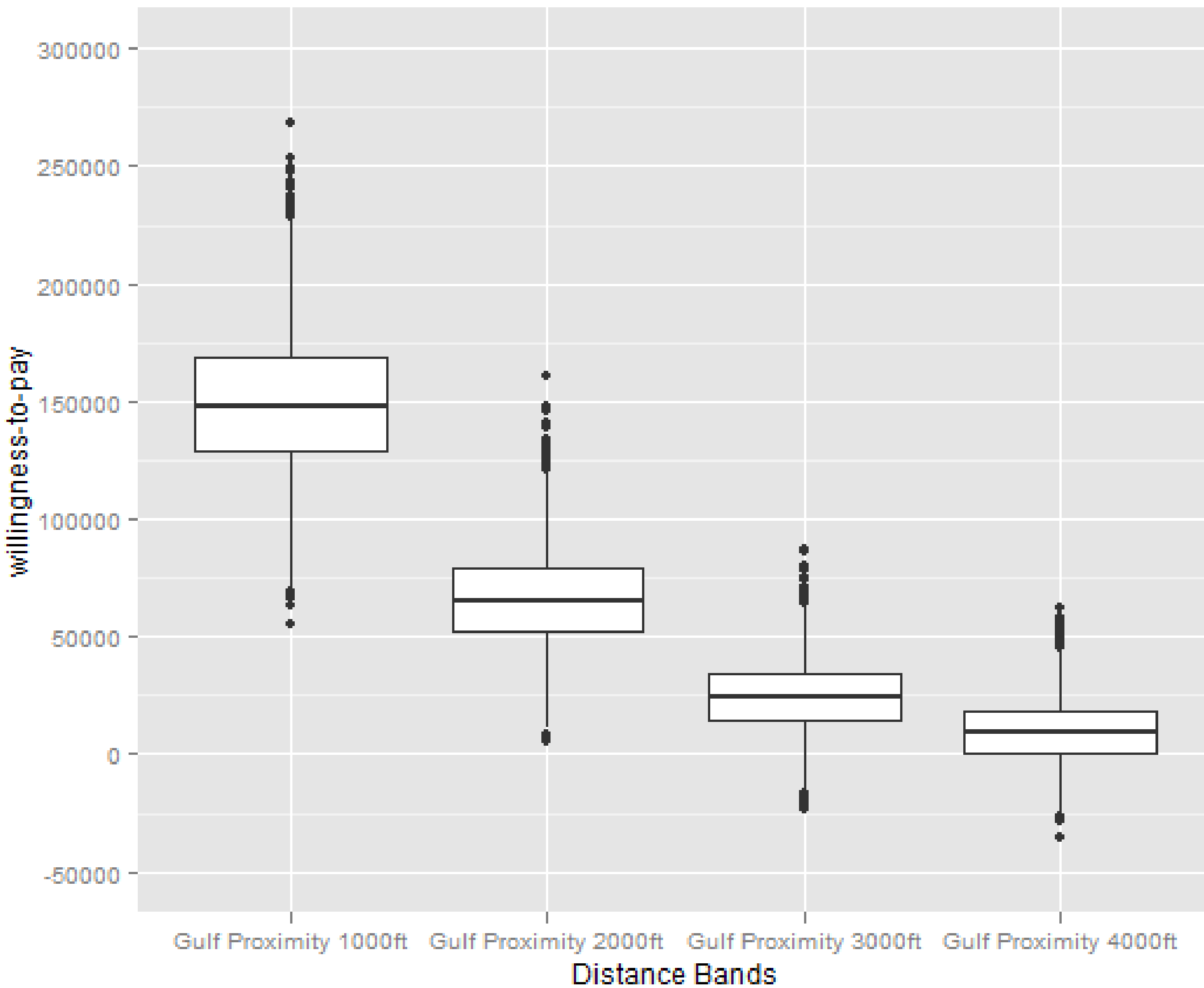


Figure 3.5. Distribution of MWTP for Distance Bands to the Gulf of Mexico

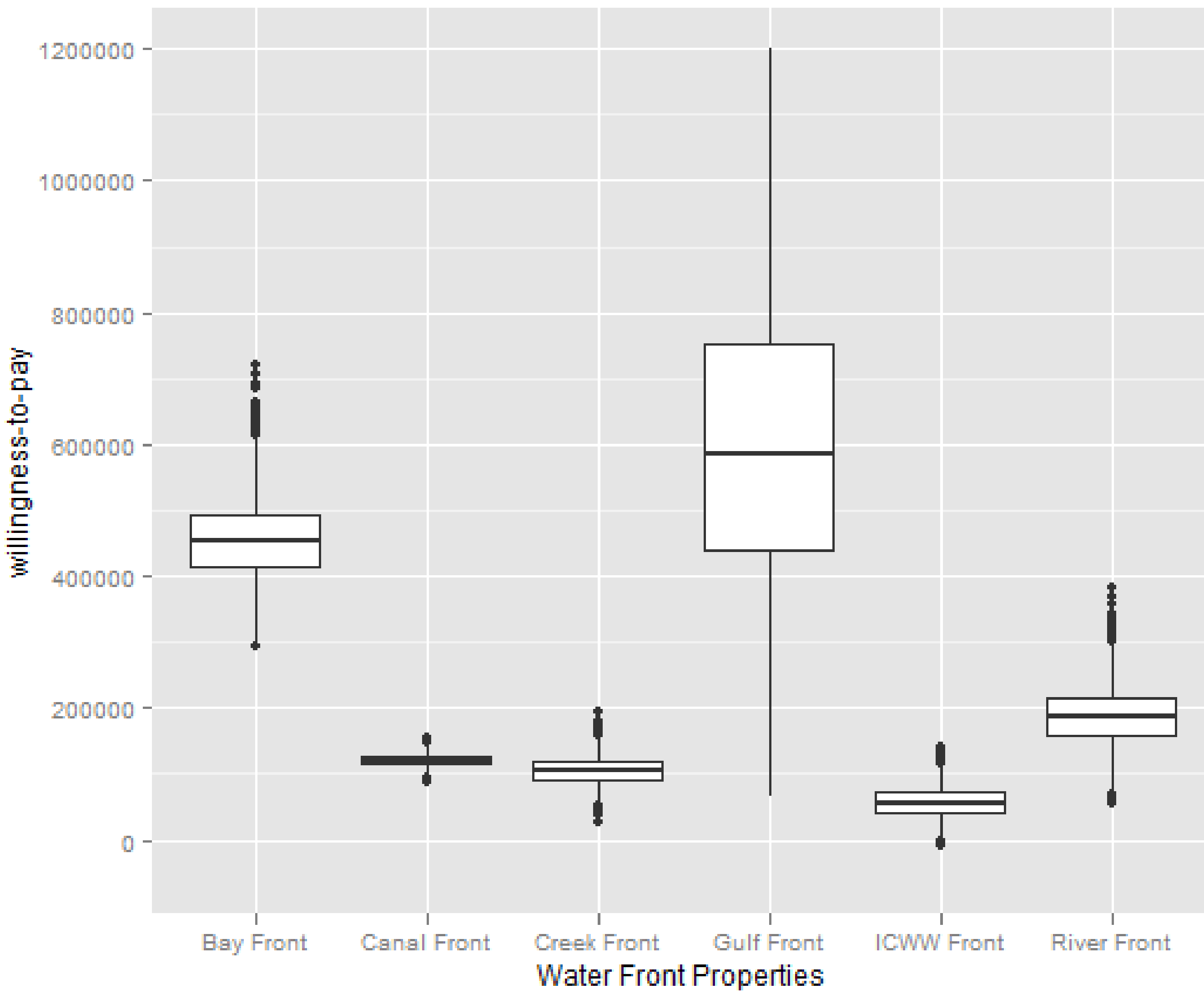


Using the model results, in a similar fashion, we also estimate the value of locating a property directly on the water front for all the resources in the dataset. Table 3.4 and Figure 3.6 provide the detail and a graphical presentation of the distribution of MWTP estimates helps provide some insight into the relative values of these resources.

Table 3.4. Marginal Willingness-to-Pay Estimates for Frontage

	Resource Frontage					
	Bay	Canal	Creek	Gulf	ICWW	River
Upper Bound	$570,701	$140,180	$144,649	$1,087,781	$100,511	$270,808
Mean	$454,809	$121,249	$104,348	$595,141	$57,049	$186,368
Lower Bound	$338,917	$102,318	$64,046	$102,502	$13,588	$101,929

Figure 3.6. Distribution of MWTP for Resource Frontage



As shown, the value to households of a Gulf-front property is greater than for the other resources. The average premium that households pay for a Gulf-front property is $595,141. For a Bay front property, the premium is $454,809. As an addendum, as the 95 percent confidence interval on Gulf-front MWTP overlaps the Bay front MWTP confidence interval, we cannot say with statistical certainty, that this effect is significant. However, we can say that the mane MWTP for Gulf and Bay front properties is statistically greater than for frontage on the other resource types. The lowest frontage premium ($57,049) is for homes on the Intracoastal Waterway.

3.9 Total Capitalized Value *(*TCV*)*

The second measure converts impacts into the total "capitalized value" (TCV) that aggregates the marginal values over properties whose prices are influenced by proximity to the Bay. TCV is estimated by taking the marginal values (of any attribute), or implicit prices, and summing these values across all properties impacted by proximity to the Bay to calculate the market value of this attribute (proximity) as they are currently distributed around the Bay. As such, the TCV may be computed for any housing feature for which we estimate an implicit price. To provide an example, if we estimate that a pool adds $5,000 to the value of a house, this marginal value can be used to compute the total value that pools add to the capital stock. For simplicity, assume that there are 50,000 homes in the region with pools, then the total capitalized value of pools in the region is $250 million. In the same manner, the TCV of proximity to the Bay is estimated as its marginal value summed across all households. We present one estimate of the TCV associated with proximity to the Bay and Gulf. The TCV estimate is based on results from our model where the averaged marginal value for water front properties as well as properties in each distance ban are summed across all properties in that band.

TCV analysis is a useful tool for examining how property tax revenues are impacted by the presence of Sarasota Bay. Since tax revenues are linked directly to property values, the amount of current tax revenue that is generated by the Bay's presence can be estimated. However, the TCV cannot be interpreted as representing the lost value absent the Bay, but rather, as an estimate of the increased property tax base that local communities enjoy as a result of the presence of the Bay and its provision of leisure and recreational amenities to nearby homeowners.

Results of our analysis can be found in Table 3.5. Information from the Florida Department of Revenue indicates that there are 145,870 single family homes in Sarasota and Manatee Counties with homestead exemptions. GIS analysis shows that 27,801 homes have at least one proximity measure as a home attribute.[3] In some cases, homes may have multiple proximity measures influencing home value. A total of 34,895 proximity measures make the TCV of proximity to the Sarasota Bay and Gulf of Mexico. The TCV for proximity to Sarasota Bay and the Gulf of Mexico is $3,622,811,100 (95% Confidence Interval: $2,443,012,545 - $4,802,600,482). Based on the total number of properties influenced by proximity to the Bay across the two-county region, the total capitalized value associated with proximity to the Sarasota Bay and its tributaries is $3,122,364,040 (95% Confidence Interval: $2,263,430,169 - $3,981,287,338). With regard to the Gulf of Mexico, the total capitalized value is $500,447,060 (95% Confidence Interval: $179,582,376 - $821,313,144).

[3] We found that 3220 single family homes had Gulf of Mexico proximity measures, 27,143 homes had proximity measures from the Sarasota Bay and its tributaries, and 27,801 properties had Gulf of Mexico and/or Sarasota Bay Estuary proximity measures.

Table 3.5. Components of the Total Capitalized Value of Proximity to Sarasota Bay and the Gulf of Mexico [a]

	Manatee County				Sarasota County			
	Count	Lower Bound Value	Mean Value	Upper Bound Value	Count	Lower Bound Value	Mean Value	Upper Bound Value
Gulf Front	67	$6,867,634	$39,874,447	$72,881,327	319	$32,698,138	$189,849,979	$347,002,139
Distance from Gulf: < 1000ft	436	$40,097,176	$64,894,676	$89,692,612	578	$53,156,348	$86,030,098	$118,904,426
Distance from Gulf: 1001ft - 2000ft	559	$14,362,946	$36,795,057	$59,227,168	1261	$32,400,134	$83,002,803	$133,605,472
Bay Front	758	$256,899,086	$344,745,222	$432,591,358	1510	$511,764,670	$686,761,590	$861,758,510
Distance from Bay: < 1000ft	2874	$193,558,152	$259,335,390	$325,112,628	3958	$266,563,384	$357,150,130	$447,736,876
Distance from Bay: 1001ft - 2000ft	2413	$79,081,249	$120,263,920	$161,444,178	3502	$114,771,046	$174,539,680	$234,304,812
Distance from Bay: 2001ft - 3000ft	1932	$40,852,140	$71,047,368	$101,240,664	2900	$61,320,500	$106,644,600	$151,965,800
Distance from Bay: 3001ft - 4000ft	1663	$23,869,039	$43,289,553	$62,710,067	3168	$45,470,304	$82,466,208	$119,462,112
Canal Front	2657	$271,858,926	$322,158,593	$372,458,260	2552	$261,115,536	$309,427,448	$357,739,360
River Front	729	$74,306,241	$135,862,272	$197,419,032	78	$7,950,462	$14,536,704	$21,123,024
Creek Front	4	$256,184	$417,392	$578,596	803	$51,428,938	$83,791,444	$116,153,147
Intracoastal Waterway Front	0	$0	$0	$0	174	$2,364,312	$9,926,526	$17,488,914
Total	14092	$1,002,008,773	$1,438,683,890	$1,875,355,890	20803	$1,441,003,772	$2,184,127,210	$2,927,244,592

[a] The upper and lower bound estimates represent the upper and lower bounds of the 95% confidence intervals for the MWTP estimates.

3. MEASURING THE VALUE OF NON-MARKETED GOODS AND SERVICES TO THE SARASOTA BAY REGION'S RESIDENTIAL HOUSING MARKETS

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