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Beach Users Perception of Design Alternatives of a Man Made Beach

Shelby Hooker Rayburn

Beach users perception of design alternatives of a man made beach

By

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The 42-kilometer beach in Harrison County, Mississippi necessitates continual re-nourishment projects to ensure its survival due to constant erosion events. The stability that the root structures of vegetated beaches provide have been shown to be a countermeasure to these erosion events. It has also been shown that the public will utilize landscapes that they find to be attractive. Therefore, the purpose of this thesis is to ascertain whether beach users find vegetated beaches more attractive than un-vegetated beaches. In several Harrison County communities, beach users were surveyed through the use of a Visual Preference Survey and an accompanying questionnaire to determine their opinions on the design of the beach, its design elements, and the purpose of those elements. Results were mixed, however it was determined that beach users found beaches vegetated with multiple types of florae to be more attractive than non-vegetated beaches.

DEDICATION

I dedicate this thesis to my parents: Elizabeth Hooker Herron, Charles Raymond Herron, Paige Bruce Rayburn and the late Samuel Thomas Rayburn. Without their combined encouragement and help, completing this thesis and obtaining my degree would not have been possible.

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CHAPTER I

INTRODUCTION

1.1   Background

Harrison County, Mississippi's beach (Figure 1-1), a 42 kilometer (26.1 miles) stretch of sand between Henderson Point and Biloxi, borders the Mississippi Sound in the northern Gulf of Mexico, and is one of the longest "man-made" beaches in the United States (Schmid, 2003). The beach requires constant management due to the erosion of sand from both water and wind driven energy (Cathcart & Melby, 2009). The barrier islands of Mississippi (Cat Island, Deer Island, Dog Key Island, Horn Island, Petit Bois Island, and Ship Island) divide the Mississippi Sound from the Gulf of Mexico (Figure 1-2) and cause the mainland beaches to exist in a microtidal, low-energy, riverine-influenced system, and therefore the greatest amount of sand movement results from high-energy events, such as hurricanes, tropical depressions, and other energy events of the lower order (Schmid, 2001). Wind-driven energy events also occur as a result of lack of precipitation (Cathcart & Melby, 2009).

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Figure 1.1   Map of the Study Area

The 26.1 miles of Harrison County, Mississippi Beach extends from the community of Henderson Point in the east to the city of Biloxi in the west, and runs through the cities of Pass Christian, Long Beach, Gulfport, and Mississippi City (Google Earth, 2016).

Figure 1.2   Map of the Mississippi Barrier Islands

The Mississippi Barrier Islands separate the Mississippi Sound from the Gulf of Mexico (BoatUS Magazine).

To describe the 42-kilometer beach in Harrison County, Mississippi as "man-made" may be inaccurate, as photographs from the early 20th century show that the water's edge at that time was largely a thin strip of sand with intermittent saltwater marshes and some terrestrial plants (Figure 1-3). It was after a series of six hurricanes made landfall between 1893-1916, which presumably caused major coastal sand erosion, that some sort of storm protection structure was deemed necessary; and construction of the stepped concrete seawall began in 1923 and was completed in 1927 (Cathcart & Melby, 2009). Following the seawall's completion, a major roadway was constructed which was eventually widened to four-lanes and became what is now known as U.S. Highway 90 (Figure 1-4).

EAST BEACH DRIVE, LONG BEACH. MISS.

Figure 1.3   Long Beach, Mississippi circa 1915

This postcard shows an automobile traveling down East Beach Drive (now U.S. Highway 90) through Long Beach circa 1915. Notice the strip of sand on the right side of the image (Jon Richard Lewis Postcard Collection, Mississippi Gulf Coast Community College Archives).

Figure 1.4   Harrison County Seawall circa 1942

This photograph shows a view of the Harrison County stepped seawall looking west circa 1942 along one of the first sections of U.S. Highway 90 to be four lanes. (Jon Richard Lewis Postcard Collection, Mississippi Gulf Coast Community College Archives)

The Mississippi Legislature and the governments of beachfront communities such as Long Beach, Gulfport, and Biloxi, gained Federal cooperation with beach erosion management projects in 1930 when Congress enacted Public Law 71-520, also known as The River and Harbor Act of 1930, which authorized the U.S. Army Corp of Engineers to assist these agencies (33 USC sec 426). Initially, the Army Corp of Engineers Beach Erosion Board cooperated mainly in the construction of hard features such as seawalls and bulkheads to control erosion (Hillyer, 2003).

On September 19, 1947, a hurricane made landfall near the city of New Orleans, Louisiana and caused a 12' rise in tide along the Mississippi Gulf Coast which stripped away all accumulated sand and caused major damage to the seawall and newly-built highway in a number of locations (Hearn, 2004). In 1950, it was decided that in order to protect the seawall and highway from being undermined by future storms, a sand beach

(Figure 1-5) would be established directly south of the seawall using dredged sand from the Mississippi Sound (Cathcart & Melby, 2009).

The 100 meter width of the sand beach has been sustained by sand re-nourishment, or sand addition, projects since 1951 (Canis, 1985). The constant erosion of the beach has required that these sand re-nourishment projects take place at reduced time intervals (Cathcart & Melby, 2009). The beach plays a critical role in the protection of the sea wall that spans the entire length of the beach, which in turn protects the residential and commercial properties located to the north across U.S. Highway 90. Therefore, these frequent financially, energetically, and environmentally costly sand re-nourishment projects play a vital role to the economy of the coastal county (Cathcart & Melby, 2009).
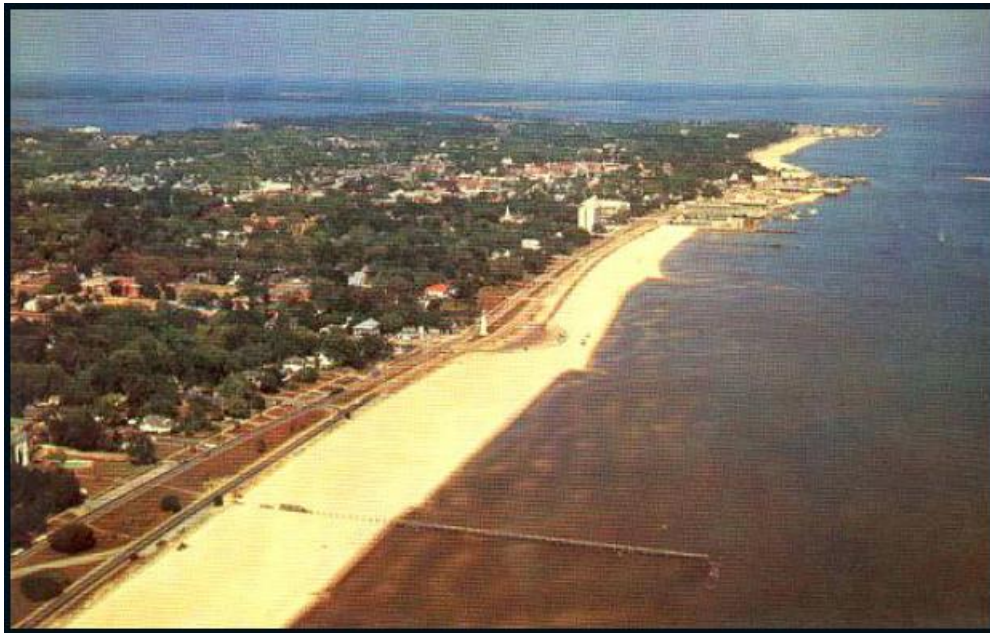
Figure 1.5   Biloxi, Mississippi in 1980

This photograph of an aerial view of the Mississippi Gulf Coast shows the Biloxi Lighthouse, Sand Beaches, and the City of Biloxi prior to the introduction of the Gaming Industry (Private Vintage Postcard Collection).

These re-nourishment projects require the beach to be raked and groomed using heavy equipment, which clears it of any vegetation. Additionally, water and wave reinforcement features, such as seawalls, have ultimately interfered with the natural process of beach sand accumulation and have led to localized erosion events (Shivlani et al., 2003). An alternative solution used in the control and mitigation of coastal erosion is soft engineering (Doody, 2002). One example of soft engineering is the use of native plantings in a beach environment to combat erosion, as vegetated surfaces have been shown to resist erosion much more effectively than those without vegetation (Lancaster & Baas, 1998). Native plant materials are preferred because they have adapted to tolerate the harsh environments that exist along coastal beaches (Garcia-Mora et al., 1999).

1.2   Purpose of the Study

The purpose of this study is to determine general public opinion of the attractiveness of vegetated and non-vegetated design alternatives of the Harrison County Beach. These opinions are important because the beach is an invaluable financial, cultural, and recreational resource to the entire community; and any decisions made concerning its design will be a publicly scrutinized issue. Gaining an understanding of how the public views the attractiveness of various vegetated and non-vegetated beach design alternatives will allow for future beach design and planning to be more readily accepted by the public. Public acceptance of the design of Harrison County Beach is crucial because it is an integral part of daily life for residents along the Mississippi Gulf Coast and also plays a key role in the economic vitality of the region through tourism.

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1.3   Objective of the Study

In order to find out the public's opinion on the attractiveness of vegetated versus non-vegetated beach design alternatives, the goal is to take the following necessary steps to ascertain the public's perception. The first goal is to analyze the relevant existing literature on landscape preference to discover which landscape features (savannahs, forests, plains, etc.) the public has shown a preference. The second goal is to develop a version of a Visual Preference Survey™ that will feature examples of both vegetated and non-vegetated beaches as well as existing and modified beach conditions. The third and final goal is to create an accompanying questionnaire that will gauge the public's opinions on various beach design features as well as their opinions on the ecological benefits or consequences of said design features.

1.4   Addressing the Problem

Beach re-nourishment projects have proven to be energetically and financially costly. Using standard re-nourishment techniques, it requires an average of 0.25 liters of diesel fuel to transport 1 cubic meter of sand to the beach (Cathcart & Melby, 2009). Beach re-nourishment is also environmentally damaging. The 2001 re-nourishment project required a total of 0.84 million cubic meters of sand along the 42 kilometer beach (Cathcart & Melby, 2009). This means that it required approximately 210,000 liters of diesel fuel for the project which resulted in the release of 550 metric tons of greenhouse gases and other pollutants (EPA 2005). The average off-road diesel fuel price in Mississippi for 2001 was $0.889/gallon (U.S. Energy and Information Administration, 2016; U.S. Department of Transportation, 2001; Statista, 2016). Therefore, the estimated fuel cost of the 2001 sand removal project was $49,323.65. Additionally, the sand used in

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these projects is mined from the local seabed, which damages the ecology of the mining sites (Speybroeck et al., 2006).

Continued use of the current seawall to armor the coastal property will require continued maintenance of the sand beach. Therefore, it is paramount to minimize the frequency of these projects; due to the expense, difficulty, and damage associated with them. One possible method to achieve this is through the planting and proper maintenance of vegetation that is adapted to the rigors of the beach environment. Plantings such as native beach grasses, plants, shrubs, and trees can survive in this environment and will inhibit erosion due to wind, storm water runoff, and wave energy.

Therefore, it is important to find out the public's opinion of the attractiveness of vegetated beach designs versus non-vegetated beach designs. The focus of this study is to discover the opinions of beach goers on the attractiveness of vegetated and non-vegetated beach designs; and to discover which, if any, specific elements of vegetated beach designs the public shows a preference.

1.5   Research Implications

Results from this study have potential implications for not only design professionals, but government official and public policy makers, coastal developers, and engineers as well. By understanding the preferences, those involved in these sectors can improve the design of the beach both aesthetically and functionally. Firstly, beach designers will be able to create a beach environment that the overall public will find more attractive and therefore will be inclined to use more often. A better designed, more attractive beach that leads to increased use will result in increased tourism revenue for the area. Secondly, by understanding the public's preference of specific vegetated beach

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design characteristics, beach designers will be able to implement these characteristics more often in their designs, which will lead to the decreased amount of erosion from wind-driven and water-driven energy events; which will, in turn, decrease both the frequency and scale of re-nourishment projects.

On a broader scale, this study could serve as a model for those interested in gaining a better understanding of beach users' aesthetic preferences and collecting a database of those preferences for future study. More specifically, this study could be useful for community leaders and project planners in the adjacent counties along the Mississippi Gulf Coast who could potentially consider the results of this study when deciding future erosion-control programs for their maintenance regimens.

1.6   Methodology Overview

The public's preferences of various vegetated and non-vegetated beach design alternatives were assessed through the use of a Visual Preference Survey™ which featured images of existing vegetated and non-vegetated beach scenes as well as images which had been digitally altered to either include or remove beach vegetation. Survey participants were recruited by the researcher at various spots along the entire length of the 42 kilometer Harrison County Beach over the course of four days in September 2011.

1.7   Organization of the Thesis

The following thesis will be divided into five chapters. First, a review of literature on public perception of landscape design and landscape quality assessment is presented. Second, an explanation of the methodology employed by this study to discover the respondents' preferences of various beach design alternatives is discussed. Third, the

results of the study are presented. Fourth, the results of the study are discussed and compared to the findings of previous studies on landscape visual preference. Fifth and last, there is a discussion of any conclusions that can be drawn from the findings of the study.

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CHAPTER II

LITERATURE REVIEW

2.1   Introduction

This literature review provides an overview of research of public perception of various vegetated and non-vegetated landscapes, the human-environment conflict such as that which arises from the wind-blown sand that covers U.S. Highway 90, and public environmental literacy such as the ecological benefits of saltwater marshes and sand dunes. First, a background of why understanding public perception of landscape design is important to the community is presented. Second, a review of research of Landscape Quality Assessment, or what makes a landscape attractive, is discussed. Third, perception-based valuation methods, such as the Visual Perception Survey™ and other manipulated photograph-based studies are described. Fourth, a review of some of the human-environment conflicts similar to the Mississippi Gulf Coast are discussed. Finally, the results and findings of previous environmental literacy surveys are presented.

2.2   Public Perception of Landscape Design

Understanding public preferences of beach landscape design and what is considered good, attractive, and useful by the consumers, or the people who will be using the beaches various amenities; is central in defining guidelines for future management (Wiggering et al., 2003). Therefore, it is important for designers and policy makers to understand public preferences. The resulting impacts to the environment including

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disruption of the natural sand shoring system, increased turbidity of the near shore environment, the increased use of fossil fuel and the creation of carbon dioxide are all public concerns when determining beach management practices (Rogge et al., 2007).

Sustainable design is creating facilities and land management that works with natural cycles and processes (Wiggering et al., 2003). Gobster et al. (2007) found that landscapes that are perceived as aesthetically pleasing are more likely to be appreciated and protected than are landscapes perceived as undistinguished or ugly, regardless of their less directly perceivable ecological importance. The European Union (1998) stated that public perception of community landscapes is important in order to understand "the outcomes and consequences of change and of landscape planning decisions, both among the public and their elected representatives."

2.3 Landscape Quality Assessment

Appleton (1975) suggests that a preference for a certain type of landscape may be a result of our biological heritage. Through natural selection, humans have adapted an innate attraction to a savannah-type landscape because these more open landscapes provided the best shelter, hunting, and disease-free environments (Appleton, 1975). Baling and Faulk (1982) found that personal experiences and familiarity are highly correlated with landscape preference. Using subjects ranging from grade school to college professors, they found that while savanna and open forest scenes were highly preferred, the distribution of preference as a function of vegetative community varied with age (Baling & Faulk, 1892).In their study, the strongest preference for savanna was found among the two youngest age groups. The third and fifth grade children rated the savanna scenes significantly higher than either the deciduous or coniferous forests, and

they judged the latter two very similarly. However, by mid-adolescence and continuing throughout adulthood, the mean preferences for savanna, deciduous forest, and coniferous forest were statistically indistinguishable. As the subjects grew older, they became more familiar with the floristic elements of non-savanna biomes, either through living in or near them, and the overall preference for savanna seen in childhood disappeared (Baling & Faulk, 1982).

Humans by far prefer a natural environment to a built one (Kaplan et al., 1972). In their study, the nature material was so vastly preferred over the urban slides that the distributions barely overlap (Kaplan et al., 1972). In fact, with a single exception, the least preferred nature slide was favored over the most preferred urban slide (Kaplan et al., 1972). In a 2009 study, Ode et al. showed naturalness to have a strong relationship with preference scores. A natural environment has been defined in terms of the absence of man-made constructions, such as roads, fences, buildings or power lines, but not in terms of the absence of management (Balling & Faulk, 1982). Tveit et al. (2006) went on to define naturalness as a concept of how closely a landscape relates to its perceived natural state, which is not its actual, ecological natural state.

Landscape aesthetics has also shown a relationship with preference. Kaplan and Kaplan (1989) proposed The Preference Matrix, which is an evolutionary theory based on the assumption that the ability for aesthetic appraisal has evolved to encourage adaptive habitat selection. Daniel (2001) went on to propose that aesthetic responses originate between the interplay between objective, quantifiable landscape features and the subjective appraisal of these features. He explained that landscape visual quality is a product of visible features of the landscape interacting with relevant perceptual, cognitive

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and emotional processes in the human observer. In other words, direct, or objective methods compare the scenery preference of users to establish a unifying quality while indirect, or subjective methods assess landscape visual quality on the presence of pre-given features which have a quantifiable value that has been established by "experts" (Daniel, 2001). In recent years, holistic methods, which utilize both direct and indirect methods, have been used to determine the relationship between observers' scenery preferences (Daniel, 2001).

2.4   Perception-based Valuation of Landscape Preference

The Preference Matrix proposed by Kaplan and Kaplan in 1989 is an example of a perception-based approach to explaining landscape aesthetics. However, the most widely used perception-based method is an image-survey known as the Visual Preference Survey™, or VPS™, which is trademarked by Anton C. Nelessen Associates, Inc. and was first used in 1979 (Crisman, 2006). The VPS™ is a technique used in research which utilizes photographic images, evaluation forms, and optional questionnaires to assess the perceptive value of a given scene (Nelessen, 1994). The use of visualization tools such as the VPS™ provide a valuable way that non-professional people are able to evaluate in terms of preference and perception (Bell, 2001).

Photographs, such as those used in a VPS™, have been shown to be one of the commonly used visual support tools for identifying users' preferences about landscapes (Pinto-Correia et al., 2011). Photograph-based surveys are also advantageous for providing better control over the experience of viewing the landscape and of involving larger samples of observers and landscapes (Ode et al., 2009). Ode et al. (2009) found three landscape indicators that showed a statistically significant relationship with

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preference: level of succession, number of woodland patches, and shape index of edges. Level of succession refers to the conversion of agricultural, or open, land to a more semi-natural habitat through the growth of scrub and woodland; number of woodland patches describes the level of fragmentation in the landscape; and shape index of edges describes the geometry of vegetation patches (Ode et al., 2009). Their results suggested that, regardless of background, those three landscape indicators were important in the formation of visual preference, and that they were universal in the type of landscape represented in their study (Ode et al., 2009). Images which depicted landscapes with a low level of succession species in the open land were not preferred as much as images which depicted landscapes with a medium to high level of borders of succession species in open land (Ode et al., 2009). Images which showed fragmented landscapes with many small patches had the lowest mean preference score, while images representing a landscape with large forest blocks had the highest mean preference score (Ode et al., 2009). Finally, images which represented landscapes with a low to medium level of shape complexity received the highest preference scores, while images with high shape complexity received a lower mean preference score (Ode et al., 2009).

Several variables must be considered in designing photographic simulations for preference research (Nassauer, 1983). The first is the use of color or black and white photographs. Color photographs have been used almost exclusively since the late 1970s (Buhyoff et al., 1978). The reason for this is black and white photographs have shown a lower correlation with field responses than color photographs, and also have been shown to elicit more extreme responses (Shuttlesworth, 1980).

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The angle of vertical direction of view must also be considered when designing photographic simulations. Photographs taken from "eye-level" have been used almost universally (Nassauer, 1983). The extensive views that result from this vertical direction would be the most representative of field experience (Nassauer, 1983). The universal intent to show landscapes viewed "from eye-level" has not created a universal, uniform effect. Meaning that it would be incredibly difficult to achieve uniform vertical direction, and even the smallest margin of error could result in considerable difference in the placement of the horizon line in each simulation (Nassauer, 1983). In addition to the angle of vertical direction of view, the extent of horizontal angle of view must also be considered when designing image simulations for research. Wide angle and panoramic formats have been shown to closely approximate the field experience (Zube et al., 1974).

The extent of the horizontal angle of view, combined with the scene selection of the photographer, results in another factor to be considered when designing image simulation for research: the selection of elements in a composition (Shafer & Richards, 1974). The ability of a respondent to recognize the simulation as the place which it is intended to simulate is important. Nassauer (1983) found that when simulations are recognized as the places they simulate, the chances for high correlation between field and photographic responses is good. Some studies have shown that by altering the biophysical elements in the images, respondents' preference scores can objectively measure the impact each element has on the overall score (Shafer et al., 1969; Daniel 1990; Rudell et al., 1989). Thayer et al. (1976) found that cropping photographs to improve landscape "beauty" by eliminating undesirable elements and exhibiting factors consistent with landscape "beauty" resulted in increased perceived "beauty."

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Interestingly, the researchers found that cropping photographs to increase landscape "ugliness," or exhibiting undesirable elements, did not result in reduced perceived landscape "beauty" (Thayer et al., 1976).

However, both the contents and the organizational patterns play an important role in people's preference for natural settings (Kaplan & Kaplan, 1989). Photographic composition is often broken down into what photographers refer to as the "Rule of Thirds" (Mai et al., 2011). The Rule of Thirds describes the division of a photograph into nine equal panes, three vertical sections and three horizontal sections, by using two vertical and two horizontal division-lines (Smith, 1797). The points at where the horizontal and vertical division-lines intersect create four points of optimal focus within a composition (Greenzweig, 2001). It has been shown that when viewing images, people usually look at one of the these intersection points rather than the center of the image (Luo & Tang, 2008). Svobodoba et al. (2014) showed a significant influence on visual preferences of the composition of landscape scenes according to the Rule of Thirds. They found that the two intersection-points on the left, along with the lower-right intersection-point, had a significant influence on the visual preference of the respondents assessing landscape photographs (Svobodoba et al., 2014). They also found that trees and shrubs, appearing both solitary and in groups, were the most positively assessed landscape elements at these intersection-points (Svobodoba et al., 2014). Placement of the horizon in a photograph according to the Rule of Thirds has proven to have a significant influence on the visual preference of respondents (Svobodoba et al., 2014). In their 2014 study, Svobodoba et al. found that the perceived beauty of landscape scenes with the horizon

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placed in the center and upper third of an image was significantly higher than images where the horizon was placed in the lower third.

The selection of media for presentation must also be considered in image design for research. Historically, options were limited to either photographic prints or projector slides, with slides found to predict substantially more variation in field responses (Shaffer & Richards, 1974). Recently, the Internet has also been used in image-survey data collection, which allows for a greater variation in respondents to the survey (Wherrett, 2000).

2.5   Aeolian Sand Deposits and the Human-Environment Conflict

Part of this thesis deals with the nuisance of aeolian (wind-blown) sand deposits along U.S. Highway 90 in Harrison County that results from the human-environment conflict of urbanization adjacent to a sand-shore ecosystem. The subsequent section will review the existing literature on problems stemming from and current countermeasures against aeolian sand on beaches as well as other sand-dominated terrains around the world.

One of the important problems in beach stabilization is how to control aeolian sand (Hotta & Horikawa, 1996). Most of the problems associated with coastal sand drift tend to be chronic rather than acute and a nuisance rather than a danger (Sherman & Nordstrom, 1994). Wind-blown sand is capable of invading forests; burying roads, railways and other infrastructure; blocking drainage facilities; inundating cemeteries, houses and recreation facilities on and behind the beach; causing personal discomfort or abrading of park and garden fixtures, vegetation, housing, and motor vehicles; blowing sand away from foundations and undermining structures; causing lateral and vertical

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loading on ceilings, walls, and gutters, and reducing visibility (Sherman & Nordstrom, 1994). Blowing sand is also capable of damaging property by abrasion. This damage most commonly occurs in the pitting of windshields, but in regions with high frequency of blowing sand, telephone poles and fence posts must be armored against blowing sand (Sherman & Nordstrom, 1994).

Countermeasures against aeolian sand serve one or both of two functions: the restrain function is to stop the generation of blown sand, and the trap and fixation function is to trap the blown sand at the upwind side and to store the blown sand at a given location so to prevent its further transportation downwind (Hotta & Horikawa, 1996). The restrain function can further be divided into those that work by increasing the resistance force of the sand, such as spraying the sand with water or a coagulant, or replacing the surface sand; and those that work by decreasing the shearing force that acts on the sand surface, such as fences, planting sand grasses and shrubs, covering with nets, straw-mats, and hay, or a conservation forest (Hotta & Horikawa, 1996). The trap and fixation function can be further divided into those that work by the forced trapping and resting of aeolian sand, like trenches and fences with high porosity; and those that work by trapping and reducing wind speed and resting, like fences, foredunes, planting shrubs, artificial large-scale sand ripples, movable porous fences, and conservation forests (Hotta & Horikawa, 1996).

Aeolian sand is a nuisance throughout sand dominated areas of the globe. The Qinghai-Tibet Railway in China experiences aeolian sand nuisances like accumulation, erosion, and abrasion in the Cuonahu Lake area (Yang et al., 2012). Sand burial due to accumulation is the most damaging and dangerous effect of aeolian sand to the Qinghai-

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Tibet Railway (Yang et al., 2012). Small quantities of sand can fill the railway ballast and cover the slope surface, while large accumulations can bury the rails, damage the track, halt the operation of trains, and even cause traffic accidents on the nearby highway (Yang et al., 2012). Wind force causes intense vegetation denudation and transportation of fine sand on the ground surface (Yang et al., 2012). Fine sand frequently moves on the mobile dune surfaces and the blown-sand flow caused by strong wind enhances wind erosion (Yang et al., 2012). Wind-blown sand has a high hardness because it has many quartz grains, which can impact the locomotives, rolling stock, and communications signal equipment (Yang et al., 2012). Sand filling the ballast bed can cause many railway problems, can increase maintenance workload, and can shorten the time between major overhauls (Yang et al., 2012). Sand on the railway also seriously impairs flexibility and drainage (Yang et al., 2012).

2.6   Knowledge of the Ecological Benefits of Saltwater Marshes and Sand Shore Ecosystems

The final part of this thesis deals with the knowledge of respondents on the ecological functions of saltwater marshes and sand dunes. Saltwater marshes and sand beaches and dunes provide many crucial ecological benefits to the estuarine and coastal ecosystem. Therefore, it is important for the public to not only be aware of these benefits, but to understand how these ecosystems function to provide the benefits. Knowledge of the public's understanding of the ecological benefits of saltwater marshes and sand dunes, in addition to attractiveness, is important for designers and policy makers in order to ensure that future plans and designs are accepted and embraced by the public. The

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following section will review many of the ecological benefits of saltwater marshes and sand dunes as well as some of the existing literature on public environmental knowledge.

Saltwater marshes are intertidal grasslands that form in low-energy, wave-protected shorelines along continental margins and extensively behind barrier-island systems (Barbier et al., 2011). Saltwater marshes provide a high number of valuable ecological benefits, including raw materials and food, coastline protection, erosion control, water purification, maintenance of fisheries, and carbon sequestration (Barbier et al., 2011).

For thousands of years, saltwater marshes have provided coastal protection from waves and storm surge, as well as from coastal erosion (Davy et al., 2009). Saltwater marshes reduce the velocity, height, and duration of incoming waves by stabilizing sediment, increasing the intertidal height, and providing baffling vertical structures like grass (Morgan et al., 2009). Marshes are also likely to reduce storm surge duration and height by providing extra water uptake and holding capacity in comparison to the sediments of un-vegetated mudflats and beaches (Barbier et al. 2011).

Saltwater marshes also act as natural filters that purify water entering estuaries (Mitsch & Gosselink, 2008). Water from rivers, terrestrial runoff, groundwater, or rain slows as it passes through marshes due to the baffling and friction effect of upright grasses (Morgan et al. 2009). Sediments which are suspended in the water are then deposited on the marsh surface, which facilitates nutrient uptake by saltwater marsh grasses (Barbier et al., 2011). This water filtration service benefits both human health as well as adjacent ecosystems which may be degraded by nutrients and pollutants (Barbeir et al. 2011).

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Saltwater marsh ecosystems also serve to maintain fisheries by boosting production of both ecologically and economically important fishery species such as shrimp, oysters, clams, and fishes (Boesch & Turner, 1984). In the Gulf of Mexico, saltwater marshes may account for as high as 66% of the shrimp and 25% of the blue crab production (Zimmerman et al. 2002). Due to their complex and tightly packed plant structure, saltwater marshes provide habitats that are mostly inaccessible to larger fishes, and therefore provide protection and shelter for the increased growth and survival of young fishes, shrimp, and shellfish (Boesch & Turner, 1984).

Saltwater marshes also sequester millions of tons of carbon annually (Mitsch & Gosselink, 2008). The anoxic nature of marsh soils causes carbon sequestered by saltwater marsh plants during photosynthesis to often be shifted from the short-term carbon cycle of 10-100 years, to the long-term carbon cycle of 1000 years as buried, slowly decaying biomass in the form of peat (Mitsch & Gosselink, 2008). This cycle-shifting capability is unique among many of the world's ecosystems, where carbon is mostly turned over quickly and does not often move into the long-term carbon cycle (Barbier et al., 2011).

Coastal beaches and sand dunes form at low-lying coastal margins where sand transported by oceanic waves and wind combine with vegetation to produce geomorphic structures (Barbier et al. 2011). This sandy-shore ecosystem includes both marine and terrestrial components and, depending on the sand supply, vary in the extent to which the beach versus the dune dominates (Short & Hesp, 1982). Sandy beaches and dunes exist at all latitudes of the Earth and cover approximately 34% of the world's ice-free coastlines (Hardisty, 1994). Like saltwater marshes, sandy beaches and dunes provide many

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valuable ecological benefits, such as coastal protection, erosion control, water catchment and purification, maintenance of wildlife, and carbon sequestration (Carter, 1990).

Coastal protection is one of the most valuable services provided by a sand shore ecosystem, especially during events such as extreme storms, tsunamis, and sea level rise (Barbier et al., 2011). As waves reach the shoreline, they are diminished in strength by the beach slope and, at times of high tide, also by the foredune, which is a structure immediately behind the beach where sand accumulates in hills or ridges parallel to the shoreline (Barbier et al., 2011). Foredunes vary in height and width depending on the presence of vegetation and sand supply from the beach, and therefore also vary in their ability to attenuate waves (Hesp, 1989).

Beaches and sand dunes provide sediment stabilization and soil retention in vegetation root structure, thus controlling erosion and protecting recreational beaches, tourist-related business, ocean front properties, land for aquaculture and agriculture, and wildlife habitat (Barbier et al., 2011). The use of sand dunes as an erosion control program can be substituted for the building of seawalls and groins, which can inadvertently accelerate the degradation of the coastal environment (Landry et al., 2003). However, erosion-control programs such as sand dunes can also have negative effects on the surrounding environment, such as affecting recreational beach use and views, displacing coastal erosion elsewhere, and disturbing natural wildlife habitat (Barbier et al., 2011).

Another ecological benefit of sand shore ecosystems is water catchment (Barbier et al., 2011). Sand dunes, in particular are able to store significant amounts of water that can serve as aquifers for coastal populations (Carter, 1990). For example, the Meijendel

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dune aquifers in the Netherlands have been used as a source for drinking water for centuries and to this day supplies enough water for 1.5 million people in surrounding cities (van der Meulen et al., 2004).

Coastal sand dunes can also provide maintenance of wildlife in the form of habitat for fish, shellfish, birds, rodents, and ungulates, which have been captured or cultivated for food since humans first colonized the coast (Carter, 1990). In some regions of the world, sand dunes have been used for agricultural purposes (Pye & Tsoar, 1990).

Sand dunes that encourage vegetation growth and productivity will also assist in carbon sequestration, although the process is likely to vary with the type of vegetation, sediment deposition and subsidence, and coastal geomorphology (Barbier et al., 2011).

Many of the ecological services provided by saltwater marshes and sandy beaches and dunes have become threatened by human use. Saltwater marshes are at risk from biological invasions, eutrophication, climate change and sea level rise, increasing air and sea surface temperatures, increasing CO_2 concentrations, altered hydrologic regimes, marsh reclamation, vegetation disturbance, and pollution (Sillman et al., 2009). The destruction of this habitat has caused many of the ecological services it provides to be lost. Approximately 50% of the original saltwater marsh ecosystems have been degraded or destroyed globally, and in some areas, such as the West Coast of the United States, the loss is greater than 90% (Gedan & Silliman, 2009). Sand beaches and dunes are at risk from human use, species invasion, and climate change (Brown & McLachlan, 2002). Many of the services this ecosystem provides, especially coastal protection and coastal freshwater catchment, are threatened by the removal or disruption of sand and vegetation coupled with increased storm intensity and sea level rise (Ruggiero et al., 2010).

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Environmental literacy is defined as an understanding of natural systems combined with how they interact with human social systems (Mancl et al., 1999). The basic principles of ecology such as energetics, cycling, growth and competition are the common denominators in developing environmental literacy (Odum, 1993). Knowledge regarding beneficial and harmful environmental behaviors is a prerequisite for environmentally conscious action (Pelletier et al., 1998).

The level of ecological literacy among the general population in the U.S. is not known (Jordan, 2009). It has been shown that fewer than 20% of Americans are sufficiently literate to read a science article in a major newspaper, understand a science-based television program, or comprehend a popular science book (Miller, 2002). A 1999 study by Mancl et al., however, shows that on average, Ohio adults appeared to greatly understand four principles of ecology: biogeography, the Earth as a biosphere, ecological energetics, and carrying capacity. Biogeography looks at the protection of endangered species and their access to their habitat (Mancl et al., 1999). Ecological energetics recognizes the sun as the primary energy source on earth and the finite nature of fossil fuels (Mancl et al., 1999). It also considers how energy is expressed in natural systems, such as through the food supply and the forces of flowing water and blowing wind (Mancl et al., 1999). The Earth as a biosphere includes climate change, distant air-pollution impacts, and the interdependence of rural and urban communities in the production of food and the recycling of wastes (Mancl et al., 1999). Their study showed lower levels of understanding of ecological succession, biotic interaction, and the importance of diversity (Mancl et al., 1999). Ecosystem succession involves the impact of modifying landscapes by natural forces like flooding and human activities such as

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clearing woodlands, modifying waterways, and draining land (Mancl et al., 1999). Biotic interaction examines predator/prey relationships, natural selection, and the impact of exotic species on native communities (Mancl et al., 1999). Importance of diversity stresses the risks associated with monocultures to catastrophic disease in crops and livestock, as well as illustrates the benefits of crop rotation to maintain diversity and productivity (Mancl et al., 1999).

This literature review has provided a brief synopsis of previous studies of public perception of landscape design, landscape quality assessment methods, aeolian sand deposits and human-environment conflict, and knowledge of the ecological benefits of saltwater marshes and sand dunes. These studies will be used in a comparative capacity in the subsequent chapters which cover this thesis's methodology as well as results and discussion.

CHAPTER III

METHODOLOGY

3.1   Introduction

In order to understand public perception of the attractiveness of vegetated beaches versus the attractiveness of non-vegetated beaches, a modified Visual Perception Survey™ (Nelessen, 1994), or VPS™, was created and administered to 100 respondents that were recruited at various locations along the 42-kilometer Harrison County Beach between Henderson Point and Biloxi over the course of four days in September of 2011. The following chapter will describe, in detail, the methodology employed in conducting the research for this thesis. First, the method of data collection used in the survey will be discussed. Second, a detailed description of the various images, both original and digitally altered, will be presented. Third, an overview of the topics which were utilized in the accompanying questionnaire to the VPS™ will be described. Fourth, there will be a detailed description of the site where the survey was administered. Last, the hypotheses which will be tested in this thesis will be listed and described in detail.

3.2   Data Collection

The data used in this thesis was collected through a survey which utilized both images and questions designed to gauge respondents' opinions on the attractiveness of the existing beach conditions as well as digitally-manipulated images which altered existing beach conditions by either adding or subtracting vegetation. Respondents were asked to

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rate the attractiveness of the image presented to them by circling one of the numbers 1, 2, 3, 4, or 5 printed below each image (Figure 3-1). A rating of "1" was considered "least attractive" and a rating of 5 was considered "most attractive." A rating of "3" would be considered neutral. However, it should be noted that since negative ratings were not made available, respondents could not rate the image as "unattractive." Respondents were not made aware of the intended purpose of the survey and were only asked to rate the attractiveness of the images in the survey and evaluate 10 statements concerning the design of Harrison County Beach. No incentive was offered to potential respondents for their participation.

Figure 3.1   Example of The Modified VPS Used in This Thesis

Respondents were asked to rate the attractiveness of the scenes depicted in each image by circling one of numbers 1-5, with 1 representing "least attractive" and 5 representing "most attractive

3.3   Images

The images used in the survey fall into one of three categories: image-pairs, images depicting existing beach conditions along U.S. Highway 90, and images depicting wind-blown sand covering U.S. Highway 90. The Image-Pairs are included in order to gauge respondents' opinions on the attractiveness of vegetation and other specific beach design features. The images depicting existing beach conditions along U.S. Highway 90 were included in order to attempt to quantify respondents' opinions on the attractiveness of emergent grasses in a designed beach environment. Images depicting wind-blown sand along U.S. Highway 90 were shown in order to gauge respondents' opinions on the current beachside conditions of wind-blown sand covered streets, parking lots, and sidewalks that are a result of current unsustainable, non-biological, erosion-control techniques. However, the images used in this survey were presented to respondents in a random manner, which would mean that an unaltered image and its corresponding digitally altered counterpart were not presented to respondents consecutively in the survey. Respondents were not made aware of the categorization of the images to which they were responding.

Image-Pairs are two photographs, one featuring an unaltered, existing beach scene and the other having been manipulated to either remove or add vegetation or other beach design features. The images were not presented to respondents in pairs and respondents were not made aware of which images were altered or unaltered, or which beach design features were added or removed. Images were presented in full color. Full color photographs have been shown have a higher correlation with in-field data than black and white photographs (Buhyoff et al., 1978). Images were presented at "eye-level," or the

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views that a person would have were they actually in the field at the images' locations. Photographs taken from this vertical angle of view have been shown to most closely approximate field experiences (Nassauer, 1983). The Image-Pairs were all framed in a "wide-angle" format, as this format has also been shown to most closely represent in-field experiences (Zube et al., 1974).

Image-Pair 1 (Figure 3-2) consist of images titled Image 1 and Image 2. Image 1 depicts existing beach conditions of an expansive sand beach dotted with artificial sand fences used in an attempt at erosion control. Conditions in this image allow for maximum occupancy by beachgoers, but is also unsustainable, due to the failure of the sand fences to control wind-blown sand erosion. Image 2 has Queen Palms (*Syagrus romanzoffiana*) in place of the existing sand-fences as well as the addition of Sabal Palmettos in the background. Palmettos will provide shade with their leaves and reinforce the sand with their root systems.

Image 1

Image 2

Figure 3.2   Image-Pair 1

Image 1 depicts existing beach conditions of an expansive sand beach dotted with
artificial sand fences used in an attempt at erosion control. Image 2 has been digitally
altered to show Queen Palms (*Syagrus romanzoffiana*) in place of the existing sand-
fences as well as the addition of Sabal Palmettos in the background.

Image-Pair 2 (Figure 3-3) consist of images titled Image 3 and Image 4. Image 3

depicts existing beach conditions at a recreational sunbathing area in front of a group of

erosion-control sand fences. Image 4 has been digitally altered to include Queen Palms

(*Syagrus romanzoffiana*) near the existing lounge chairs and dunes vegetated with Sea

Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) in place of existing

sand fences. The palmettos will provide shade to the beachgoers as well as reinforce the

sand with their root systems. The beach grasses will naturally help control erosion by

providing further reinforcement to the sand with their root systems as well as accumulate

wind-blown sand with their leaves, helping to naturally form dunes.

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Image 3

Image 4

Figure 3.3   Image-Pair 2

Image 3 depicts existing beach conditions at a recreational sunbathing area in front of a group of erosion-control sand fences. Image 4 has been digitally altered to include Queen Palms (*Syagrus romanzoffiana*) near the existing lounge chairs and dunes vegetated with Sea Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) in place of existing sand fences.

Image-Pair 3 (Figure 3-4) consist of images titles Image 5 and Image 6. Image 5

depicts existing beach conditions of an expansive, non-vegetated sand beach with a

culvert drain protruding into the water, a common drainage practice along the Mississippi

Gulf Coast. Image 6 has been digitally altered to include beach plantings of Sea Rocket

(*Cakile edentula*), Bitter Panic Grass (*Panicum amarum*), Sea Oats (*Uniola paniculata*),

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which will reinforce the sand beach with their root systems, and Queen Palms (*Syagrus romanzoffiana*) and Sabal Palmettos (*Sabal palmettos*); which will provide shade with their leaves as well as reinforce the sand beach with their root systems. The existing culvert drain has been replaced with a rock-jetty planted with Saw Palmettos (*Seronoa repens*), Dwarf Wax Myrtles (*Myrica pusilla*), and Sea Rocket (*Cakile edentula*).

Image 5

Image 6

Figure 3.4   Image-Pair 3

Image 5 depicts existing beach conditions of an expansive, non-vegetated sand beach with a culvert drain protruding into the water. Image 6 has been digitally altered to include beach plantings and to replace the existing culvert drain pipe that protrudes into the Mississippi Sound with a vegetated rock jetty.

Image-Pair 4 (Figure 3-5) consist of the images titled Image 7 and Image 8. It is the only Image-Pair in which the digital manipulation was done in order to remove beach vegetation instead of adding beach vegetation. Image 7 depicts existing conditions of a

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heavily vegetated sand beach that is part of an existing upper beach restoration project located in Biloxi at Miramar Road. This image includes Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), Sea Rocket (*Cakile edentula*), and a Queen Palm (*Syagrus romanzoffiana*). Image 8 has been digitally manipulated to remove all vegetation, which would allow for the highest beach occupancy but would also increase the frequency of wind-driven sand erosion events.

Image 7

Image 8

Figure 3.5   Image-Pair 4

Image 7 depicts part of an existing upper beach restoration project in Biloxi at Miramar Road which has been planted with Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), Sea Rocket (*Cakile edentula*), and a Queen Palm (*Syagrus romanzoffiana*). Image 8 has been digitally altered to remove all vegetation.

Many of the images used in this survey include drainage culverts, sand fences, and rock jetties. In some cases, it may be possible that some respondents saw an image as

being more attractive or less attractive because of these non-vegetation beach elements. Therefore, images of these non-vegetation elements were included in the survey so that the attractiveness rating of that image may be compared to the attractiveness rating of any image which also contains that element. In the survey, there were three images which show these elements, Image 16, Image 17, and Image 18. Image 16 (Figure 3-6) is of a rock jetty, planted with Saw Palmettos (*Seronoa repens*), Dwarf Wax Myrtles (*Myrica pusilla*), and Sea Rocket (*Cakile edentula*), located on the beach directly across U.S. Highway 90 from Treasure Bay Casino in Biloxi. Image 17 (Figure 3-7) shows one of the many storm water drainage culverts which protrude into the Sound along the entire 42-kilometer length of the Mississippi Gulf Coast. Image 18 (Figure 3-8) shows a close up view of a double row section of erosion control sand fences that are common along the entire 42-kilometer length of the Mississippi Gulf Coast.

Figure 3.6   Image 16

Image 16 features a rock jetty planted with Saw Palmettos *(Seronoa repens)*, Dwarf Wax Myrtles *(Myrica pusilla)*, and Sea Rocket (*Cakile edentula*), located on the beach directly across U.S. Highway 90 from Treasure Bay Casino in Biloxi.

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Figure 3.7   Image 17

Image 17 shows one of the many storm water drainage culverts that protrude into the Sound along the entire 42-kilometer length of the Mississippi Gulf Coast Beach.

Figure 3.8   Image 18

Image 18 shows a close up view of a double row section of erosion control sand fences.

The images that depict various existing vegetated beach conditions along U.S. Highway 90 are titled Image 9, Image 10 and Image 11. These photographs were included in the survey in an attempt to gauge respondents' opinions on the attractiveness

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of emergent sea grasses in a designed beach environment. Respondents were not made aware that this was the intent behind including these images in the survey. The images which depict existing vegetated beach conditions along the Mississippi Gulf Coast can be viewed in Appendix D.

Image 9 (Figure 3-9) depicts a view from the center of an existing upper beach re-nourishment project in Biloxi at Miramar Road and includes the florae Sea Oats (*Uniola panicula*), Longleaf Pine (*Pinus palustrus*), Bitter Panic Grass (*Panicum amarum*), Salt Hay (*Spartina patens*), and Sea Rocket (*Cakile edentula*). Image 10 (Figure 3-10) and Image 11 (Figure 3-11) both depict the existing conditions of a manmade beach located on the east side of Biloxi Bay in Ocean Springs, Mississippi that is populated with the florae Bitter Panic Grass (*Panicum amarum*) and Saltgrass (*Distichlis spicata*) growing at the shoreline, and also includes an existing corrugated-plastic drainage pipe that protrudes into the water. This area of beach is located directly across Beach Front Drive from Fort Maurepas State Park. Here, the beach is incorporated into an existing recreation area.

Figure 3.9   Image 9

Image 9 depicts a view from the center of an existing upper beach re-nourishment project in Biloxi at Miramar Road and includes the florae Sea Oats (*Uniola panicula*), Longleaf Pine (*Pinus palustrus*), Bitter Panic Grass (*Panicum amarum*), Salt Hay (*Spartina patens*), and Sea Rocket (*Cakile edentula*).

Figure 3.10   Image 10

Image 10 depicts a view of an upper beach recreation area across Biloxi Bay in Ocean Springs, Mississippi.

Figure 3.11   Image 11

Image 11 depicts another view from the center of an existing upper beach recreation area across Biloxi Bay in Ocean Springs, Mississippi.

Images depicting existing conditions of wind-blown sand covering U.S. Highway 90 are titled Image 12, Image 13, Image 14 and Image 15 (Figure 3-11). These images were included in the survey to gauge respondents' opinions on the attractiveness of the results of current wind-erosion-control techniques. Image 12 depicts wind-blown sand covering a beachside parking lot, a typical scene along U.S. Highway 90 in Harrison County. Image 13 shows a view of a wind-blown sand covered sidewalk and parking lot located on the north side of U.S. Highway 90. Image 14 is a view of another wind-blown sand covered sidewalk located on the north side of U.S. Highway 90. Image 15 depicts another wind-blown sand covered sidewalk and parking lot located on the north side of U.S. Highway 90.

www.manaraa.com

IMAGE 12

IMAGE 13

IMAGE 14

IMAGE 15

Figure 3.12   Image 12, Image 13, Image 14 and Image 15

Image 12, Image 13, Image 14 and Image 15 all depict existing conditions of wind-blown sand covering U.S. Highway 90 and its surrounding sidewalks and parking lots.

3.4   Questionnaire Topics

In addition to asking respondents to rate the attractiveness of various images, they were also asked to evaluate 10 statements about the beach and its design elements by circling "agree," "disagree," or "not sure" printed beneath each statement. The statements utilized in this questionnaire fall into one of three topics: those intended to gauge respondents' opinions on the attractiveness of the beach and its design elements, one intended to gauge respondents' opinions on the possibility of allowing parts of the beach to return to natural conditions, and those intended to gauge respondents' opinions on the erosion control benefits of saltwater marshes and sand dunes.

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Statements intended to gauge respondents' opinions on the attractiveness of various beach designs are titled Statement 1, Statement 2, and Statement 9. Statement 1 is "Saltwater marshes make the beach environment appear dirty" and was included to gauge respondents' opinions on the attractiveness of sea grasses growing at the shoreline in the beach environment. Statement 2, "It is a better view to see the Gulf of Mexico across a saltwater marsh than across a sand beach" was included to gauge whether respondents preferred to view the Gulf across a sand beach or a saltwater marsh. Statement 9, "Saltwater marshes make the beach more attractive" was included in order to gauge respondents' opinions on the attractiveness of a saltwater marsh in the beach environment by utilizing a statement that is essentially the opposite of Statement 1.

Statement 4, "The 26 miles of Harrison County Beach should have some areas that are allowed to return to natural beach conditions, including saltwater marshes, sand dunes, beach grasses and beach trees" is intended to gauge respondents' opinions on the possibility of allowing parts of the beach to return to natural conditions as opposed to the current, expansive, groomed sand beach. This statement is included in order for its quantified mean response to be compared to the quantified mean response of the Image-Pair comparisons to see what, if any, correlations exist.

Statements intended to gauge respondents' opinions on the erosion control benefit of saltwater marshes and sand dunes are titled Statement 6, Statement 7, and Statement 10. Statement 6, "Saltwater marshes help control beach erosion," and Statement 7, "Saltwater marshes gather sand from waves and make the beach wider" were included to gauge respondents' opinions on the ecological function and benefit of saltwater marshes in the beach environment. Statement 10, "Beach sand dunes help keep blowing sand off

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the highway" was included in order to gauge respondents' opinions on the ecological function and benefit of vegetated sand dunes in the beach environment.

3.5   Site Description

Responses to the survey were collected manually along various locations of the entire 42-kilometer Harrison County Beach. This includes the cities of Pass Christian, Long Beach, Gulfport, and Biloxi. Respondents were recruited from various locations along the beach including fishing piers, marinas, open beach, and recreational nodes in order to include several users of the Mississippi Sound as well as diversify the demographic response to the survey. Also, it was believed by the researcher that by administering the survey on or around the Harrison County Beach, the images included in the survey would be more likely to be recognized by respondents as being representative of the Harrison County Beach. Which, as mentioned earlier, was shown by Nassauer (1983) to provide for more accurate responses from photograph-based surveys. Prospective respondents were approached by the researcher and each asked if they would be willing to fill out a survey concerning the overall design of the beach in Harrison County. Respondents were not made aware of the intention of the survey and were only asked to rate the attractiveness of the images in the survey and evaluate the statements.

3.6   Hypotheses Tested

For the purposes of this thesis, three hypotheses concerning the overall design of the beach were developed. The first hypothesis tested, "there is no difference between peoples' perception of the attractiveness of vegetated and non-vegetated beaches" is

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intended to test whether respondents will find the images in the survey that include vegetation more attractive than those which do not include vegetation.

In order to test this hypothesis, the overall attractiveness ratings of the images that make up the aforementioned four Image-Pairs were compared. In addition, the overall attractiveness score of Image 9, Image 10, and Image 11; or images included in the survey in an attempt to quantify the public's opinion on the attractiveness of emergent beach grasses, was analyzed. Statements in the questionnaire concerning the attractiveness of various beach design alternatives, Statement 1 (Saltwater marshes make the beach environment appear dirty), Statement 2 (It is a better view to see the Gulf of Mexico across a saltwater marsh than across a sand beach), and Statement 9 (Saltwater marshes make the beach more attractive), were compared and analyzed as well. The results of these images were analyzed by making a comparison of the mean rating (the sum of all ratings divided by the total number of respondents, denoted: $\bar{x}$) of images 1-8 was made using a t-test with an alpha-level (α) of 0.01. These eight images consist of four Image-Pairs, with each consisting of one image depicting an existing beach scene and one image depicting a digitally-altered beach which either adds or subtracts native beach vegetation.

The second hypothesis tested in this thesis, "the public has no opinion on the attractiveness of wind-blown sand-covered roads and sidewalks" is intended to gauge respondents' opinions on the attractiveness of wind-blown sand-covered roads and sidewalks that are common along U.S. Highway 90 in Harrison County. In order to test this hypothesis, the images depicting U.S. Highway 90 and its surrounding sidewalks covered in wind-blown sand: Image 12, Image 13, Image 14, and Image 15; were

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compared and analyzed. These images were analyzed by comparing the mean statistic for each image to a possible high score of 5 and low score of 1. A rating of 1 was equal to "least attractive" and a rating of 5 represented "most attractive." Therefore, for the purposes of this hypothesis, a mean score of 3 represents "not definitive," less than 2 determines "unattractive," and more than 4 determines an image to be "attractive."

Hypothesis 3, " there is no difference between the number people who have an understanding of the ecological benefits of saltwater marshes and sand dunes and the number of people who do not have an understanding of the ecological benefit of saltwater marshes and sand dunes" is intended to gauge respondents' knowledge on the erosion control benefits of saltwater marshes and sand dunes. In order to test this hypothesis, the statements concerning the erosion control benefits of saltwater marshes and sand dunes, Statement 6 (Saltwater marshes help control beach erosion), Statement 7 (Saltwater marshes gather sand from waves and make the beach wider), and Statement 10 (Beach sand dunes help keep blowing sand off the highway); were compared and analyzed. All three statements were analyzed by using the mean statistic and Statement 6 and Statement 7 were compared using a t-test to see if respondents understand how saltwater marshes help control water-driven erosion.

CHAPTER IV

RESULTS AND DISCUSSION

4.1   Introduction

After collecting 100 responses to the survey, the data was entered into a Microsoft

Excel™ spreadsheet for calculation and analysis. The subsequent chapter will present the

results of the survey and questionnaire, as well as discuss and analyze possible

interpretations. The results and discussion will be presented by hypothesis. First,

Hypothesis 1, "There is no difference between beach users' perception of the

attractiveness of vegetated and non-vegetated beaches" will be discussed by presenting

the findings of the results of the attractiveness ratings of the aforementioned Image-Pair

comparisons, the images that depict non-vegetation beach elements such as drainage

culverts and rock jetties, the individual images depicting existing vegetated beach

conditions on the Harrison County Beach, and all relative statements from the

accompanying questionnaire. Second, Hypothesis 2, " Beach users have no opinion on

the attractiveness of wind-blown sand-covered roads and sidewalks" will be discussed by

presenting the results of the attractiveness scores of the four images that depict wind-

blown sand covering parts of U.S. Highway 90 and its surrounding sidewalks and parking

lots. Third, Hypothesis 3, "There is no difference between the number of respondent who

have an understanding of the ecological benefits of saltwater marshes and sand dunes and

the number of respondents who do not have an understanding of the ecological benefit of

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saltwater marshes and sand dunes" will be discussed by presenting the results of the statements from the accompanying questionnaire that pertain to the ecological function of sand dunes and saltwater marshes.

4.2   Demographics

Of the 100 responses, 40% (n=40) were collected in Biloxi, 25% (n=25) were collected in Gulfport, 18% (n=18) were collected in Pass Christian, and 17% (n=17) were collected in Long Beach. Males made up 56% (n=56) of the respondents and females made up 44% (n=44) of the respondents. Ages of the respondents ranged from 18 to 67. Twenty-six percent (n=26) of the respondents were between ages 18 and 24, 26% (n=26) of the respondents were between ages 25 and 34, 21% (n=21) of the respondents were between ages 35 and 44, 19% (n=19) of respondents were between ages 45 and 54, and 8% (n=8) were 55 or above. Thirty-six percent (n=36) of the respondents reported a highest level of education as being a 4 year college, 39% (n=39) reported a 2 year college as being the highest level of education completed, and 25% (n=25) reported high school being the highest level of education completed. A complete breakdown of the demographics of the survey respondents is shown in Table 4-1.

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Table 4.1   Summary Demographics Table.

Location	Gender
40% from Biloxi 25% from Gulfport 18% from Pass Christian 17% from Long Beach	56% Male 44% Female
Age	**Education**
26% between ages 18 and 24 26% between ages 25 and 34 21% between ages 35 and 44 19% between ages 45 and 54 8% ages 55 and above	36% reported a 4 year college as being the highest level of education completed 39% reported a 2 year college as being the highest level of education completed 25% reported high school being the highest level of education completed

This table shows a breakdown of respondents demographics. Survey location, gender, age, and highest level of education completed are listed.

4.3   Hypothesis 1: There is no difference between beach users' perception of the attractiveness of vegetated and non-vegetated beaches.

The first hypothesis to be tested in this thesis, "There is no difference between beach users' perception of the attractiveness of vegetated and non-vegetated beaches," is intended to gauge respondents' opinions on the attractiveness of vegetation in the beach environment. This hypothesis was tested by comparing the overall mean responses of the individual images that make up the Image-Pairs described in the previous chapter, the images that depict current vegetated beach conditions, and the images that depict non-vegetation elements of the Mississippi Gulf Coast Sand Beach that are included in other photos used in the survey. The overall mean response of the two images in each Image-

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Pair were compared to each other using a standard t-test with an alpha level of 0.01, which allows for a 99% confidence interval (Table 4-2).

4.3.1   Image-Pair 1

The first Image-Pair to be compared in order to test Hypothesis 1 is Image-Pair 1, which consists of the images titled Image 1 and Image 2 (Figure 4-1). For Image 1, which depicts existing beach conditions of an expansive sand beach dotted with artificial sand fences used in an attempt to control erosion, 0% (n=0) chose "1," 6% (n=6) chose "2," 28% (n=28) chose "3," 43% (n=43) chose "4," and 23% (n=23) chose "5;" with a response of "1" meaning "least attractive" and "5" meaning "most attractive." These responses resulted in an overall mean response of 3.83 for Image 1.

Table 4.2   Summary Table for Hypothesis 1

IMAGE-PAIR 1	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 1	3.83	0.275	ACCEPT
Image 2	3.95		
IMAGE-PAIR 2	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 3	3.25	9.48E-8	REJECT
Image 4	3.83		
IMAGE-PAIR 3	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 5	3.36	0.0016	REJECT
Image 6	3.78		
IMAGE-PAIR 4	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 7	3.43	0.011	ACCEPT
Image 8	3.77		
IMAGE	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 9	3.47	0.002	REJECT
Image 10	3.12		
Image 11	3.12		
IMAGE	MEAN RESPONSE	P-VALUE	ACCEPT/REJECT
Image 16	3.6	n/a	n/a
Image 17	2.23	n/a	n/a
Image 18	3.19	n/a	n/a

This table show the mean response rating for each Image used in testing Hypothesis 1, as well as the comparative p-values for each Image-Pair and whether the p-values allow to reject or accept the null hypothesis.

Figure 4.1   Image-Pair 1 Results

Image 1, which shows an existing non-vegetated beach, received a mean response score of 3.83. Image 2, which has been digitally altered to include beach vegetation, received a mean response score of 3.95.

In the case of Image 2, which has been digitally altered to show Queen Palms (*Syagrus romanzoffiana*) in place of the existing sand-fences as well as the addition of Sabal Palmettos in the background, 1% (n=1) chose "1," 10% (n=10) chose "2," 18% (n=18) chose "3," 35% (n=35) chose "4," and 36% rated the image with a score of "5;" with a response of "1" meaning "least attractive" and "5" meaning "most attractive." This resulted in an overall mean response of 3.95 for Image 2. Using a t-test, the comparative p-value of 0.275 indicates that the difference in the mean ratings within the image-pair were consistent with the null hypothesis. Therefore, for this Image-Pair, the respondents did not perceive any difference in the attractiveness of the image depicting an non-

vegetated beach and the corresponding image which had been digitally altered to include vegetation.

It is possible that the small difference in the mean ratings of each scene in Image-Pair 1 can be attributed to the types of digital alterations utilized. Because the sole alteration of the original (Image 1) was the substitution of four palmettos for man-made sand fences in Image 2, many respondents may not have seen enough of a difference between each image for them to rate one image more or less attractive than the other. Or, in accordance with Ode et al. (2009), respondents may not have perceived a significant difference in the "naturalness" between the two images. This could be attributed to the fact that the edges of the landscape depicted in the scene were unchanged, as the shape index of edges was found to be a significant factor in preference scores in Ode et al. (2009). This could also mean that the substitution of two Queen Palms for the existing sand fences and the addition of two Sabal Palms in the background may not have been a sufficient amount of succession to make Image 2 appear more "natural" than Image 1, as level of succession was also found to influence preference scores (Ode et al., 2009) It is also possible that respondents did not see the substitution of four palmettos for the existing sand fences as enough of an improvement in "beauty," in accordance with Thayer et al. (1976), who found that by adding elements associated with beauty to an image, respondents would, in turn, rate those images as being more beautiful; to see Image 2 and a more "beautiful" scene compared to Image 1.

It is worth noting that the results of Image-Pair 1 are not consistent with Svobodoba et al. (2014) and their findings that the inclusion of specific landscape elements at specific intersection-points, in relation to the Rule of Thirds, in a photograph

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will influence preference scores. According to Svobodoba et al. (2014), the inclusion of a solitary tree or a group of trees, in the left-two intersection-points, according to the Rule of Thirds, should have had a positive influence on respondents' preference scores. However, in this case, the group of Queen Palms and Sabal Palmettos were placed at the upper-left intersection, in relation to the Rule of Thirds, but the difference in the two images' preference scores was not found to be statistically significant (Figure 4-2). They also found that the inclusion of man-made elements in these two left-most focal-points, according to the Rule of Thirds, would have a negative influence on respondent's preference scores; which was not the case in Image-Pair 1, either (Svobodoba et al., 2014).

Figure 4.2   Image-Pair 1 Marked for the Rule of Thirds

This shows Image-Pair 1 marked to show the intersection points created by the Rule of Thirds. The addition of the group of Queen Palms and Sabal Palmettos in Image 2 was made at the upper-left intersection point, which has been shown to influence preference scores (Svobodoba et al., 2014).

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4.3.2   Image-Pair 2

The second Image-Pair to be compared in order to test Hypothesis 1 is Image-Pair 2, which consists of the images titled Image 3 and Image 4 (Figure 4-3). For Image 3, which depicts existing beach conditions at a recreational sunbathing area in front of a group of erosion-control sand fences, 2% (n=2) chose a rating of "1," 17% (n=17) chose a rating of "2," 40% (n=40) chose a rating of "3," 36% (n=36) chose a rating of "4," and 5% (n=5) scored the image with a rating of "5;" with a response of "1" meaning "least attractive" and "5" meaning "most attractive." This resulted in Image 3 receiving an overall mean rating of 3.25.

Figure 4.3   Image-Pair 2 Results

Image 3 depicts existing beach conditions at a recreational sunbathing area in front of a group of erosion-control sand fences. Image 4 has been digitally altered to include Queen Palms (*Syagrus romanzoffiana*) near the existing lounge chairs and dunes vegetated with Sea Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) in place of existing sand fences.

In the case of Image 4, which has been digitally altered to include Queen Palms (*Syagrus romanzoffiana*) near the existing lounge chairs and dunes vegetated with Sea Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) in place of existing sand fences, 1% (n=1) chose a rating of "1," 2% (n=2) chose a rating of "2," 31% (n=31) rated the image with a "3," 45% (n=45) chose to rate the image with a "4," and 21% (n=21) gave the image a rating of "5;" with a response of "1" meaning "least attractive"

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and "5" meaning "most attractive." This resulted in Image 4 scoring an overall mean rating of 3.83. A comparison of the two mean rating scores, using a t-test, resulted in a p-value of less than 0.001 (9.48E-8), which indicated that there is a significant amount of evidence, in this case, to reject the null hypothesis and conclude that for Image-Pair 2, respondents perceived a difference in the attractiveness of an image depicting an non-vegetated beach and its corresponding image which has been digitally altered to add vegetation. In this case, respondents found Image 4, which had been digitally altered to include Queen Palms (*Syagrus romanzoffiana*) near the existing lounge chairs and sand dunes vegetated with Sea Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) in place of existing sand fences, to be significantly more attractive than Image 3 which depicts existing beach conditions at a recreational sunbathing area in front of a group of man-made sand fences used to control erosion.

In this Image-Pair, the addition of the Queen Palmettos within the existing recreation and sunbathing area on the beach in image 3 was seen, overall, as enough of an improvement in beauty to see Image 4 as being significantly more beautiful than Image 3, which is absent of any vegetation within the existing recreation and sunbathing area. Therefore, the results are consistent with Thayer et al. (1976), who found that by adding elements associated with beauty to an image, respondents would, in turn rate the image as being more beautiful; and it may be possible that people find the addition of vegetation to the beach recreation and sunbathing areas as being more beautiful than current, non-vegetated areas.

It is also possible that the addition of the sand dunes vegetated with Sea Oats and Bitter Panic Grass was seen as more attractive than the existing sand fences which are

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located between the roadway and the recreation and sunbathing area. The addition of the sand dunes in Image 4 blocks the view of the roadway; and may have caused respondents to see Image 4, which was digitally altered to include the sand dunes on the left side of the image, as having a more varied edge and a more complex shape index than did Image 3; as more complex shape indexes of edges has been shown to have a positive influence on respondents' preference scores (Ode et al., 2009).

The results of Image-Pair 2 are consistent with the findings of Svobodoba et al. (2014), in that the vegetation that was digitally added to Image 4, in this case Queen Palms (*Syagrus romanzoffiana*) near the existing lounge chairs as well as sand dunes vegetated with Sea Oats (*Uniola paniculata*) and Bitter Panic Grass (*Panicum amarum*) replacing existing sand fences, were placed in the image near the left points of interest, in relation to the Rule of Thirds, and their findings that landscape elements located at these points in a photograph have a significant influence on the visual preference for the entire landscape scene (Figure 4-4).

Figure 4.4   Image-Pair 2 Marked for the Rule of Thirds

Image-Pair 2 marked to show the intersection points created by the Rule of Thirds. The vegetation added in Image 4 was placed near the left intersection points, which have been shown to influence preference scores (Svobodoba et al., 2014).

4.3.3   Image-Pair 3

The third Image-Pair to be compared in order to test Hypothesis 1 is Image-Pair 4, which includes the images titled Image 5 and Image 6 (Figure 4-5). For Image 5, which depicts existing beach conditions of an expansive, non-vegetated sand beach with a culvert drain protruding into the water, 4% (n=4) of respondents rated the image with a score of "1," 17% (n=17) rated the image with a score of "2," 32% (n=32) of respondents rated the image with a score of "3," 33% of respondents rated the image with a score of

"4," and 14% (n=14) rated the image with a score of "5." This resulted in Image 5

receiving a mean attractiveness rating of 3.36.

Figure 4.5   Image-Pair 3 Results

Image 5 depicts existing beach conditions of an expansive, non-vegetated sand beach
with a culvert drain protruding into the water. Image 6 has been digitally been altered to
include beach plantings and to replace the existing culvert drain pipe that protrudes into
the Mississippi Sound with a vegetated rock jetty.

For Image 6, which has been digitally altered to include beach plantings of Sea

Rocket (*Cakile edentula*), Bitter Panic Grass (*Panicum amarum*), Sea Oats (*Uniola*

paniculata), Queen Palms (*Syagrus romanzoffiana*), and Sabal Palmettos (*Sabal*

palmettos); and also has been digitally altered in order to replace the existing culvert

drain pipe that protrudes into the Mississippi Sound with a rock jetty which has been

planted with Saw Palmettos (*Seronoa repens*), Dwarf Wax Myrtles (*Myrica pusilla*), and

Sea Rocket (*Cakile edentula*); 3% (n=3) of respondents rated the image with a score of "1," 9% (n=9) of respondents rated the image with a score of "2," 20% (n=20) of respondents rated the image with a score of "3," 43% (n=43) of respondents rated the image with a score of "4," and 25% (n=25) of respondents rated the image with a score of "5." By these numbers, Image 6 received a mean attractiveness rating of 3.78. A comparison of the mean attractiveness score for Image 5 and Image 6 resulted in a p-value of 0.0016, which provides enough evidence that respondents found Image 6, which was altered to include beach vegetation and a planted rock jetty, significantly more attractive than Image 5 which depicts current non-vegetated conditions; and therefore, in this case, we can reject the hypothesis that there is no difference between beach users' perception of the attractiveness of vegetated and non-vegetated beaches.

This result could be interpreted as being that some respondents may have perceived Image 5, which depicts an existing non-vegetated beach, as less attractive based solely on the unattractiveness associated with the culvert drain that protrudes into the Mississippi Sound. As previously noted, Balling and Faulk (1982) found that the presence of man-made constructions caused a decrease in a landscape's perceived "naturalness." It is very likely that a drainage culvert extending from the beach area into the water would be considered by most to be an example of a man-made construction and therefore would likely lead to a decrease in perceived "naturalness," which would then, in accordance with Thayer et al.'s (1976) findings that humans prefer a natural environment to a built one; lead to decreased perceived attractiveness. However, the location of the drainage culvert in the upper right side of Image 5, in relation to the Rule of Thirds, is at an intersection point that has been previously shown to not have any significant influence

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on preference scores (Svobodoba et al., 2014). Conversely, according to Svobodoba et al. (2014), due to the vegetated rock jetty in Image 6 being located in the same upper right intersection, in accordance with the Rule of Thirds, as the exposed drainage culvert in Image 5; it also should not have had any significant influence on respondents' preference scores.

It could also be interpreted that the seemingly large amount of beach vegetation which was added to Image 6 altered the framing of the scene depicted in the image enough that it caused respondents to view the image as more attractive. As previously mentioned, Thayer et al. (1974) discovered that the framing and composition of elements in a photograph could be altered or cropped to improve "beauty" and would thus be perceived as being more "beautiful." In this case, the placement of the beach plantings, specifically the trees, may have been enough of a difference in the spatial composition of the overall image that it caused respondents to perceive the digitally altered "photograph" as a whole as being more attractive; and may not have necessarily been the actual elements of vegetation in the scene that respondents found to be more attractive.

The location of the groups of beach vegetation in Image 6 could have had an influence on respondents' preference scores. The clusters of Sea Rocket (*Cakile edentula*), Bitter Panic Grass (*Panicum amarum*), Sea Oats (*Uniola paniculata*), Queen Palms (*Syagrus romanzoffiana*), and Sabal Palmettos (*Sabal palmettos*) are located in the upper left intersection (Figure 4-6), in relation to the Rule of Thirds, which has been shown to have significant influence on respondents' preference scores (Svobodoba et al., 2014). Small scale landscape elements, such as groups of trees and shrubs, have been

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shown to have the greatest amount of influence on respondents' preference scores
(Svobodoba et al., 2014).

Figure 4.6   Image-Pair 3 Marked for the Rule of Thirds

Image-Pair 3 marked to show intersection points created by the Rule of Thirds. The
groups of beach vegetation placed near the left-two intersection points are located near
intersection points which have been shown to influence preference scores (Svobodoba et
al., 2014).

4.3.4   Image-Pair 4

The fourth Image-Pair to be compared in order to test the hypothesis that beach

users find non-vegetated beaches more attractive than vegetated beaches is Image-Pair 4,

which includes the images titled Image 7 and Image 8 (Figure 4-7). In the case of Image

7, which depicts part of an existing upper beach restoration project in Biloxi at Miramar

Road which has been planted with Sea Oats (*Uniola paniculata*), Bitter Panic Grass

(*Panicum amarum*), Sea Rocket (*Cakile edentula*), and a Queen Palm (*Syagrus romanzoffiana*), 2% (n=2) of respondents rated the image with a score of "1," 14% (n=14) of respondents rated the image with a score of "2," 38% (n=38) of respondents rated the image with a score of "3," 31% (n=31) of respondents rated the image with a score of "4," and 15% (n=14) of respondents rated the image with a score of "5." This resulted in Image 7 receiving an overall mean rating of 3.43. For Image 8, which was digitally altered to remove all vegetation from the upper beach restoration project and depicts an expansive sand beach, 2% (n=2) of respondents rated the image with a score of "1," 5% (n=5) of respondents rated the image with a score of "2," 30% (n=30) of respondents rated the image with a score of "3," 40% (n=40) of respondents rated the image with a score of "4," and 23% (n=23) of respondents rated the image with a score of "5." Image 8 received an overall mean rating 3.77. A comparison of Image 7 and Image 8 using a t-test resulted in a p-value of 0.011, which provides sufficient evidence, in this case, to accept the hypothesis that there is no difference between beach users' perception of the attractiveness of vegetated and non-vegetated beaches.

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IMAGE 7
$\bar{x} = 3.43$

IMAGE 8
$\bar{x} = 3.77$

Figure 4.7   Image-Pair 4 Results

Image 7 depicts part of an existing upper beach restoration project in Biloxi at Miramar Road which has been planted with Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), Sea Rocket (*Cakile edentula*), and a Queen Palm (*Syagrus romanzoffiana*). Image 8 has been digitally altered to remove all vegetation.

The results of this Image-Pair could be attributed to the location of the vegetation on the two intersection points on the left, in relation to the Rule of Thirds (Figure 4-8), has been previously found to have significant influence on respondents' preference scores (Svodoboda et al., 2014). This was not the case with the vegetation in Image 7. This could be due to the vegetation in Image 7 being primarily beach grasses like Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), and Sea Rocket (*Cakile edentula*). In Svobodoba et al. (2014), landscape vegetation utilized in the study was primarily trees and shrubs. The sole tree in Image 7, a small Queen Palm (*Syagrus romanzoffiana*), was located on the left edge of the Image and may not have been noticed by some respondents.

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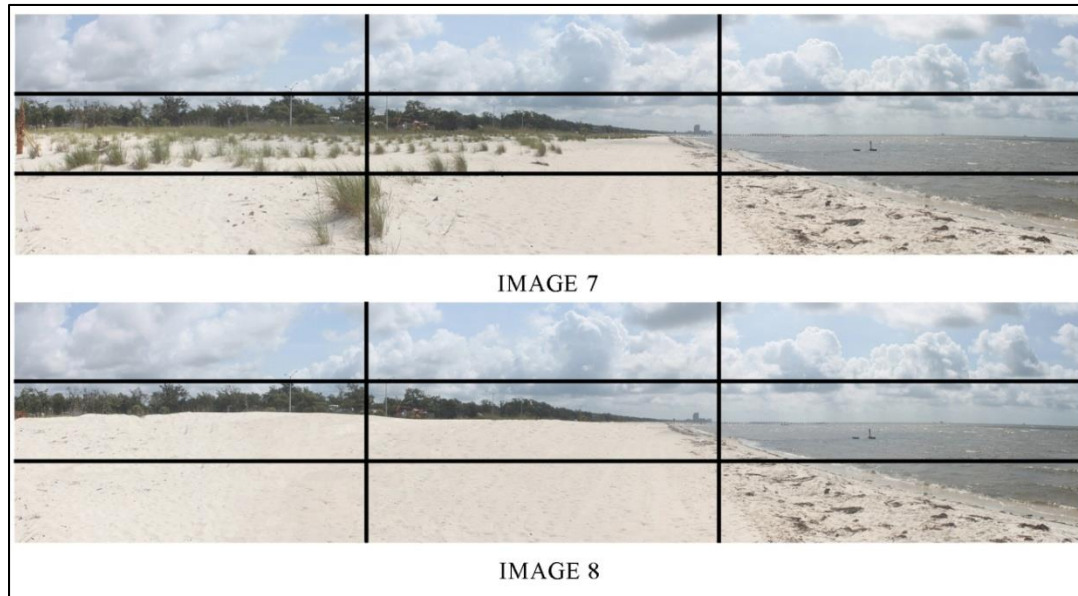
Figure 4.8   Image-Pair 4 Marked for the Rule of Thirds

Image-Pair 4 marked to show the intersection points created by the Rule of Thirds. The beach vegetation in Image 7 is located near the lower-left intersection point.

It could also be that the large patch of beach grasses in Image 7 may not have provided enough of a complex shape with a varied edge to be viewed by respondents' as being any different than the open, non-vegetated beach depicted in Image 8 (Ode et al., 2009). In Ode et al (2009), it was discovered that landscape scenes with edges which had a higher shape index with more complex shapes were found to result in higher preference scores from respondents. Additionally, Ode et al. (2009) found that the level of succession of a landscape had a significant influence on preference scores. Landscapes which had a low level of succession were least preferred while landscapes with medium to higher levels of succession were most preferred (Ode et al., 2009). Respondents may not have seen enough of a difference in the level of succession of the open, expansive sand beach in Image 8 and the large patch of beach grasses in Image 7 to prefer one image over the other.

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Interestingly, the results of this Image-Pair are not consistent with the findings of Shivlani et al. (2003) that showed that people preferred beaches with ample space for recreational activities. Image 7 depicts a beach that does not provide such space for recreational activities, as it is covered in vegetation except for a narrow strip near the shore while Image 8, with its expansive, open sand beach; does provide plenty of room for recreation.   This result could also be interpreted as being contradictory to Ode et al.'s (2009) finding that people prefer "natural" landscapes, but only if it is assumed that people view vegetated beaches as being "natural." It could also be possible that many respondents found the expansive, non-vegetated, sand beach as being more "natural" simply because it is the beach scene with which they have become the most familiar. Balling and Faulk (1982) found that familiarity has shown a correlation with preference scores and that people prefer landscapes with which they are familiar. In the case of the Harrison County Beach, this area of an upper beach restoration project which has been planted with native vegetation is not the normal beach environment and therefore would not be a familiar scene to many respondents.

4.3.5   Image 16, Image 17, and Image 18

Image 16, Image 17 and Image 18 all depict non-vegetation elements of the Mississippi Gulf Coast Sand Beach that are included in some of the other photos used in the survey (Figure 4-9). Images that showcase these non-vegetation elements were included in the survey so that the attractiveness rating of the image whose predominant feature is a non-vegetation element may be compared to the attractiveness rating of any other image which contains that element. Therefore, the researcher can use these images to attempt to understand how much, if at all, these various non-vegetation elements may

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have contributed or detracted from an image's attractiveness rating. Image 16, Image 17, and Image 18 are shown in Figure 4-9.

IMAGE 16
$\bar{x} = 3.6$

IMAGE 17
$\bar{x} = 2.23$

IMAGE 18
$\bar{x} = 3.19$
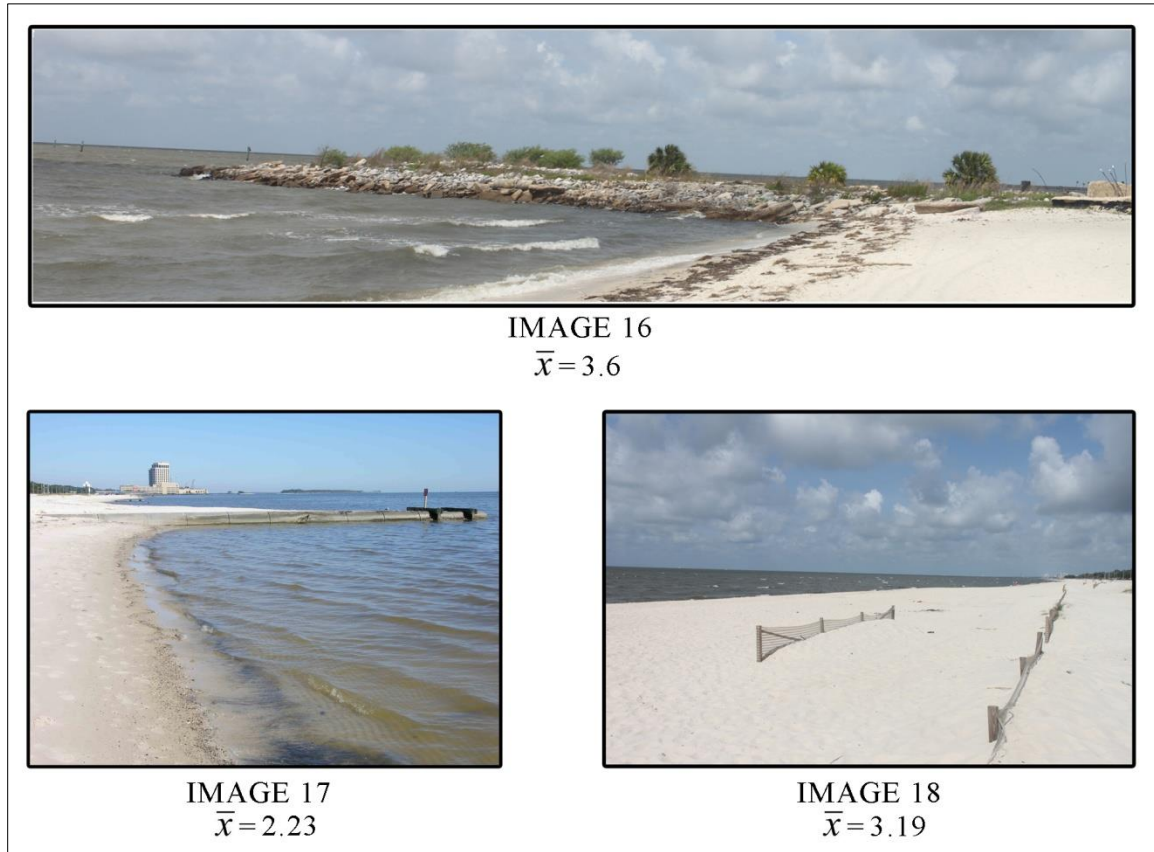
Figure 4.9   Images Depicting Non-Vegetation Elements of the Mississippi Gulf Coast Sand Beach Results

Images depicting non-vegetation elements of the Mississippi Gulf Coast Sand beach that are included in some of the other images used in the study. Image 16 shows a vegetated rock jetty. Image 17 depicts a storm water drainage culvert. Image 18 shows sand fences currently used for wind-blown sand erosion control.

For Image 16, which features a rock jetty planted with Saw Palmettos (*Seronoa repens*), Dwarf Wax Myrtles (*Myrica pusilla*), and Sea Rocket (*Cakile edentula*), located on the beach directly across U.S. Highway 90 from Treasure Bay Casino in Biloxi; 1% (n=1) of respondents rated the image with a score of "1," 11% (n=11) of respondents

rated the image with a score of "2," 31% (n=31) of respondents rated the image with a score of "3," 41% (n=41) of respondents rated the image with a score of "4," and 16% (n=16) of respondents rated the image with a score of "5." This resulted in Image 16 receiving an overall mean attractiveness rating of 3.6. This relatively high mean attractiveness score could be interpreted as meaning that overall, respondents found the vegetated rock jetty to be an attractive element of the beach. Therefore, the high attractiveness associated with the vegetated rock jetty could be a possible explanation for why, in Image-Pair 3, that Image 6, which had been digitally altered to replace an existing storm water drainage culvert with the vegetated rock jetty used in Image 16, was rated significantly higher than Image 5, which depicts the existing beach conditions of an exposed storm water outfall. This would be consistent with the findings of Thayer et al. (1976), who showed that altering images to add attractive elements or remove unattractive elements would raise or lower, respectively, the preference scores of those images.

For Image 17, which is a photograph of one of the many storm water drainage culverts that protrude into the Sound along the entire 42-kilometer length of the Mississippi Gulf Coast Beach, 38% (n=38) of respondents rated the image with a score of "1," 38% (n=38) of respondents rated the image with a score "2," 14% (n=14) of respondents rated the image with a score "3," 6% (n=6) of respondents rated the image with a score "4," and 4% (n=4) of respondents rated the image with a score "5." These numbers resulted in an overall attractiveness rating of 2.00. This relatively low mean attractiveness score could be interpreted to mean that overall, respondents did not find the exposed storm water drainage culvert to be very attractive. Therefore, the low

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attractiveness associated with the storm water drainage culvert could be a possible explanation for why, in the aforementioned Image-Pair 3, that Image 5, which features a similar storm-water drainage culvert, was rated significantly lower than Image 6, which had been digitally altered to replace the storm water drainage culvert with as vegetated rock jetty. The location of the drainage culvert in Image 17, in relation to the Rule of Thirds, would be near the upper, right intersection point. Unlike the other three intersection points in the Rule of Thirds, landscape elements placed at this point have not been shown to have significant influence on respondents' preference scores (Svobodoba et al. 2014). Additionally, the placement of the horizon in Image 17 is near the upper third of the image. Svobodoba et al. (2014) also found that the placement of the horizon in an image can significantly influence preference scores. Images in which the horizon is place near the center or the upper third of the image result in slightly higher overall perceived beauty; whereas images where the horizon is placed near the lower third of the image results in decreased perceived beauty (Svobodoba et al. 2014). Therefore, it is likely that it is the element depicted in Image 17, the drainage culvert, and not the placement of the element or the location of the horizon which respondents found to be relatively less attractive.

Image 18, which features a double row of erosion-control sand fences that are common along the entire 42-kilometer length of the Harrison County Sand Beach, 4% (n=4) of respondents rated the image with a score of "1," 24% (n=24) of respondents rated the image with a score of "2," 28% (n=28) of respondents rated the image with a score of"3," 37% (n=37) of respondents rated the image with a score of "4," and 7% (n=7) of respondents rated the image with a score of "5." This resulted in Image 18

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receiving an overall attractiveness rating of 3.19. This could be interpreted to mean that, overall, respondents found the existing sand fences to be relatively attractive, since 3.19 is closer to the "most attractive" score of 5 than it is to the "least attractive" score of 1. This may help to explain why, in Image-Pair 1, respondents did not see a significant difference in the attractiveness of Image 1, which featured the sand fences, and Image 2, which had been digitally altered to replace the sand fences with Queen Palms (*Syagrus romanzoffiana*).

4.3.6   Image 9, Image 10, and Image 11

Images 9, 10, and 11 all depict existing vegetated beach conditions at different locations along the Mississippi Gulf Coast (Figure 4-10). For Image 9, which shows a view from the center of an upper beach restoration project toward the Sound in Biloxi and includes the florae Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), Longleaf Pine (*Pinus palustrus)*, Salt Hay *(Spartina patens)*, and Sea Rocket *(Cakile edentula)*; 3% (n=3) of respondents rated the image with a score of "1," 12% (n=12) of respondents rated the image with a score of "2," 31% (n=31) of respondents rated the image with a score of "3," 43% (n=43) of respondents rated the image with a score of "4," and 11% (n=11) of respondents rated the image with a score of "5."Image 9 received an overall mean rating of 3.47.

For Image 10, which shows a view of an upper beach recreation area located on the east side of Biloxi Bay in Ocean Springs, Mississippi, that is populated with the florae Bitter Panic Grass (*Panicum amarum)* and Saltgrass (*Distichlis spicata)* growing at the shoreline, and also includes an existing corrugated-plastic drainage pipe that protrudes into the water; 2% (n=2) of respondents rated the image with a score of "1," 24% (n=24)

of respondents rated the image with a score of "2," 40% (n=40) of respondents rated the

image with a score of "3," 28% (n=28) of respondents rated the image with a score of "4,"

and 6% (n=6) of respondents rated the image with a score of "5." Image 10 received an

overall mean rating of 3.12.
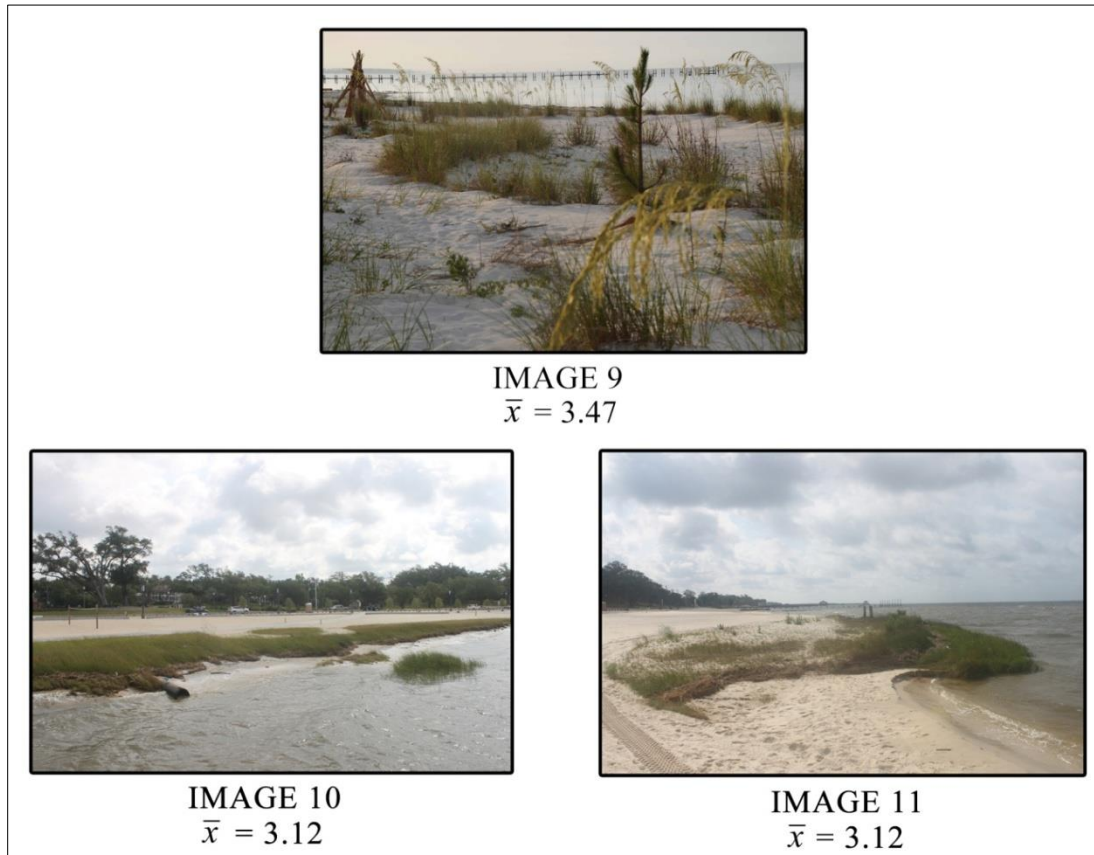
Figure 4.10   Image 9, Image 10, and Image 11 Results

Image 9, Image 10, and Image 11 depict vegetated beach conditions at different locations
along the Mississippi Gulf Coast.

Image 11 depicts a different view of the same upper beach recreation area located

on the east side of Biloxi Bay in Ocean Springs, Mississippi. For this image, 2% (n-2) of

respondents rated the image with a score of "1," 23% (n=23) of respondents rated the

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image with a score of "2," 41% (n=41) of respondents rated the image with a score of "3," 29% (n=29) of respondents rated the image with a score of "4," and 5% (n=5) of respondents rated the image with a score of "5." Image 11 interestingly received an overall mean rating of 3.12, which was identical to the overall mean rating of Image 10. Due to the fact that Images 10 and Image 11 received identical mean ratings of 3.12, we can conclude that respondents did not see any difference in the attractiveness of those two images. Therefore, it was only necessary to compare the identical mean rating of 3.12 for Image 10 and Image 11, with the mean rating of Image 9, which was 3.47. The subsequent t-test resulted in a p-value of 0.002, which indicates that most respondents found Image 9, which depicts the upper beach restoration project, significantly more attractive than Image 10 or Image 11, both of which depict Bitter Panic Grass (*Panicum amarum)* and Saltgrass (*Distichlis spicata)* growing at the shoreline and into the Mississippi Sound.

As previously noted, Image 9, Image 10, and Image 11 were included in the survey to gauge respondents' opinions on the attractiveness of various florae in a beach environment. In this case, respondents found Image 9, which does not feature vegetation growing at the shoreline, more attractive than Image 10 and Image 11, both of which depict Bitter Panic Grass (*Panicum amarum)* and Saltgrass (*Distichlis spicata)* growing at the water's edge. This result could be interpreted per the findings of Ode et al. (2009) that most people find the beach vegetation depicted in Image 9 to be more "natural" looking than the grasses depicted in Image 10 and Image 11. This increased perceived "naturalness" could be attributed to the framing of Image 9 versus the framing of Image 10 and 11. The vegetation in Image 9 encompasses the entirety of the frame as opposed

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to the vegetation which in Image 10 and Image 11 appears only in the immediate foreground of the image frame. This would be consistent with the findings of Thayer et al (1976), which showed that cropping an image to add desirable elements or subtract undesirable elements was shown to have an effect on preference scores. Which, in this case, Image 9 was framed to appear more "natural" than Image 10 or Image 11. The difference in preference scores could also be attributed to the fact that, while all three images were taken from "eye-level," Image 9 was taken from the beach towards the water and does not show the shoreline, while Image 10 and Image 11 were taken from the water towards the beach and show grasses growing at the water's edge. Therefore, it could be interpreted that respondents found the juxtaposition of vegetation and water at the shoreline depicted in Image 10 and Image 11 to be less attractive than the vegetation depicted in Image 9, which does not show the shoreline.

4.3.7   Statements Regarding the Attractiveness of Various Beach Designs and Their Elements

In order to test Hypothesis 1 "There is no difference between beach users' perception of the attractiveness of vegetated and non-vegetated beaches," three statements from the questionnaire which fall under the topic of those intended to gauge respondents' opinions on the attractiveness of the beach and its design elements will be analyzed. As previously mentioned, respondents were asked to respond to each question by circling either "Agree," "Not Sure," or "Disagree," which were located beneath each question. This allowed the researcher to apply a value of 1 for "Agree," 0 for "Not Sure," and -1 for "Disagree;" and then conduct a t-test to compare answers for each question. The three questions which will be analyzed in order to test Hypothesis 1 are titled

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Statement 1, Statement 9, and Statement 2. On Statement 1, "Saltwater marshes make the beach environment appear dirty," 55% (n=55) of respondents circled "disagree," 32% (n=32) circled "not sure," and 12% (n=12) circled "agree;" which resulted in a mean rating score of -0.42. For Statement 9, "Saltwater marshes make the beach environment more attractive," 38% (n=38) circled "disagree," 35% (n=35) circled "not sure," and 27% (n=27) circled "agree," which resulted in a mean rating score of -0.11. The negative results for both questions indicate that, overall, respondents disagreed with both questions. Comparison of the two results using a t-test yielded a p-value of 0.008, which indicates that respondents significantly disagreed more with Statement 1 than they did with Statement 9.

The majority (55%) of respondents disagreed with Statement 1, "Saltwater marshes make the beach environment appear dirty." This is more than the number of respondents who disagreed (32%) and who were not sure (12%) combined (44%). However, while more respondents (38%) disagreed with Statement 9, "Saltwater marshes make the beach environment more attractive," than did respondents who agreed (35%) or were not sure (12%), there was not a majority of respondents who felt the same way. It could be interpreted that while most people do not feel that saltwater marshes make the beach environment appear dirty, many do not find saltwater marshes to be attractive, either. It is possible that respondents do not equate "dirty" with "unattractive." Which could be interpreted as meaning that some respondents believe that the beach can be seen as being "unattractive" without being "dirty."

The results of these statements could help explain the results of Image 9, Image 10, and Image 11. The mean attractiveness rating of Image 10 and Image 11, both of

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which depicted an upper beach recreation area located on the east side of Biloxi Bay in Ocean Springs, Mississippi, populated with the florae Bitter Panic Grass (*Panicum amarum)* and Saltgrass (*Distichlis spicata)* growing at the shoreline were significantly less than Image 9, which shows a view from the center of an upper beach restoration project toward the Sound in Biloxi and includes the florae Sea Oats (*Uniola paniculata*), Bitter Panic Grass (*Panicum amarum*), Longleaf Pine (*Pinus palustrus)*, Salt Hay *(Spartina patens)*, and Sea Rocket *(Cakile edentula)*.It could be interpreted that the inclusion of the florae in Image 10 and Image 11 were seen by respondents as being "saltwater marsh-like" plants, and therefore, while not being seen as unattractive, were not viewed as being as attractive as the vegetation depicted in Image 9, which is more "terrestrial-like."

These results could also be considered to be consistent with the findings of Jedrzejczak (2004), who found that most people preferred more natural beach conditions described as "unguarded, empty, wild, beaches," and "dunes with sharp-edged grass." However, when it came to conditions underwater at the shoreline, it was found that most respondents preferred groomed conditions described as "non-covered, pure sand" as opposed to "tufts of sea grass" or "herds of colorful fish" (Jedrzejczak, 2004).

The third statement to be analyzed in order to test Hypothesis 1 is Statement 2, "It is a better view to see the Gulf of Mexico across a saltwater march than across a sand beach," was intended to quantify respondents' opinions on the different levels of potential attractiveness of the different possible views of the Gulf of Mexico. Of the 100 respondents, 32% (n=32) circled "disagree," 39% (n=39) circled "not sure," and 29% (n=29) circled "agree;" which resulted in a mean rating of -0.03.

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The results indicate that most respondents (39%) were not sure, or indifferent, to whether they thought that it was a better view to see the Gulf of Mexico across a saltwater marsh than across a sand beach. A higher number of respondents disagreed (32%) with the question than agreed (29%) with the question, which lead to the mean response score of -0.03. Therefore, it could be interpreted that more people believe that it is a better view to see the Gulf of Mexico across a sand beach than it is to view it across a saltwater marsh. However, due to most respondents being unsure of their preference, it cannot be determined that a majority of respondents prefer a view across a beach.

The results of Statement 2 are consistent with the results of the comparison of Image 9 and Image 10 with Image 11. Image 9 and Image 10, as previously noted, both depict a scene where beach grasses grow along the shoreline and into the water, which could be interpreted as being similar to a saltwater marsh. Image 10 shows a vegetated sand beach in the foreground with the Gulf of Mexico behind it in the distance. Image 9, which views the Gulf of Mexico across a sand beach was seen by respondents as being significantly more attractive than Image 10 or Image 11 which would be a view of the Gulf of Mexico across a saltwater marsh. The results of Statement 2 confirm this preference.

Finally, Statement 4 sums up the purpose of the study by asking respondents "the 26 miles of Harrison County Beach should have some areas that are allowed to return to natural beach conditions, including saltwater marshes, sand dunes, beach grasses and beach trees." For Statement 4, 6% (n=6) of respondents chose "disagree," 32% (n=32) of respondents chose "not sure," and 62% (n=62) of respondents chose "agree." The

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overwhelming majority of respondents believe that some area of Harrison County beach should have some areas that are allowed to return to natural beach conditions.

That such a large majority of respondents agreed with Statement 4 could be interpreted as not being consistent with the results of the Image-Pair analysis. The Image-Pair results were essentially split, with two which accepted the null hypothesis and two which rejected it. Therefore, it could be interpreted that although a majority of respondents believe that some areas of the beach should be allowed to return to natural beach conditions, perhaps they do not agree how attractive the beach would be if that were allowed to happen. This could be due to the types of plant material used in the Image-Pairs or their placement in the image. It could be that there was too much of one type of plant in an image or not enough variety of trees versus grasses in another image. It could also be that the location of certain components in some of the images caused respondents to view the image as being more or less attractive than they would if the component were placed in a slightly different location. Or, it could be that the framing of the scenes depicted in each image caused respondents to rate an image as more or less attractive than they would if the image were framed a different way.

4.4 Hypothesis 2: Beach users have no opinion on the attractiveness of wind-blown sand-covered roads and sidewalks.

The second hypothesis to be tested in this thesis, "Beach users have no opinion on the attractiveness of wind-blown sand-covered roads and sidewalks" is intended to gauge respondents' opinions on the attractiveness of the wind-blown sand-covered roads which result from the current erosion-control methods utilized on the Harrison County Beach. In order to test this hypothesis, the mean responses score for each image depicting wind-

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blown sand covering parts of U.S. Highway 90 and its surrounding sidewalks will be evaluated in comparison to the highest and lowest possible score. As previously mentioned, respondents were asked to rate how attractive they found each image by selecting one of numbers 1 through 5 which were printed below each image. A rating of 1 was equal to "least attractive" and a rating of 5 represented "most attractive." Therefore, for the purposes of this hypothesis, a mean score of 3 represents "not definitive," less than 2 determines "unattractive," and more than 4 determines an image to be "attractive."

4.4.1 Image 12, Image 13, Image 14, and Image 15

Image 12, Image 13, Image 14, and Image 15 all typify the results of coastal sand drift which are chronic rather than acute, but are both a nuisance and dangerous (Sherman & Nordstrom, 1994). The built-up sand is a nuisance because it must be removed and disposed of, which is both financially and energetically costly. In addition, the built-up sand which covers the road also presents a potential hazard to motorist in that it might cause vehicles to lose traction on the road surface and result in a wreck. The aeolian sand depicted in Image 12, Image 13, Image 14, and Image 15, on the surface, has buried parts of U.S. Highway 90, its surrounding sidewalks and grassy medians and right-of-ways. It has also built up on the structures adjacent to the right of way like the raised grassy area on the left of Image 13 and Image 14.

Image 12, Image 13, Image 14, and Image 15 all depict parts of U.S. Highway 90 and its surrounding sidewalks covered in wind-blown sand (Figure 4-11). For Image 12, which shows a view to the east from one of the many beachside parking areas located along the south side of U.S. Highway 90 in Biloxi covered in wind-blown sand, 10% (n=10) of respondents rated the image with a score of "1," 48% (n=48) of respondents

rated the image with a score of "2," 31% (n=31) of respondents rated the image with a score of "3," 8% (n=8) of respondents rated the image with a score of "4," and 3% (n=3) of respondents rated the image with a score of "5." This resulted in Image 12 receiving an overall mean rating of 2.46.

Figure 4.11   Image 12, Image 13, Image 14, and Image 15 Results

Image 12 depicts a view to the east of Highway 90 from one of the several beachside parking areas used by visitors. Image 13 and Image 14 both show a view to the east of a sand-covered Highway 90 West from a parking lot. Image 14 shows a view to the west from a parking lot along the north side of U.S. Highway 90.

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For Image 13, which shows a view to the east from a parking lot of a business located on the north side of U.S. Highway 90 in Mississippi City covered in wind-blown sand, 16% (n=16) of respondents rated the image with a score of "1," 36% (n=36) of respondents rated the image with a score of "2," 39% (n=39) of respondents rated the image with a score of "3," 9% (n=9) of respondents rated the image with a score of "4," and no respondents rated the image with a score of "5." This resulted in Image 13 receiving an overall mean rating of 2.41.

For Image 14, which was taken at the same location as Image 13 and shows a view to the east from a parking lot of a business located on the north side of U.S. Highway 90 near Ken Combs Pier in Mississippi City covered in wind-blown sand, 14% (n=14) of respondents rated the image with a score of "1," 30% (n=30) of respondents rated the image with a score of "2," 41% (n=41) of respondents rated the image with a score of "3," 15% (n=15) of respondents rated the image with a score of "4," and no respondents rated the image with a score of "5." This resulted in Image 14 receiving an overall mean rating of 2.57.

Image 15 shows a view to the southwest of wind-blown sand covering a portion of U.S. Highway 90. This photograph was taken from the parking lot of a business located on the north side of U.S. Highway 90 near Ken Combs Pier in Mississippi City, which is at the same location as Image 13 and Image 14. For Image 15, 12% (n=12) of respondents rated the image with a score of "1," 34% (n=34) of respondents rated the image with a score of "2," 34% (n=34) of respondents rated the image with a score of "3," 16% (n=16) of respondents rated the image with a score of "4," and 4% (n=4) of

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respondents of respondents rated the image with a score of "5." This resulted in Image 15 receiving an overall mean rating of 2.66.

Image 12, Image 13, Image 14, and Image 15 all received overall mean ratings below 3, which means that most respondents believed that the images we closer to "least attractive" than "most attractive" when choosing a possible rating that was presented. However, due to the fact that none of the images received an average mean rating of less than 2, it cannot be determined that respondents found any of the images to be unattractive.

The built-up sand which is covering U.S. Highway 90 and it surrounding sidewalks in each picture is located at different intersection points, in relation to the Rule of Thirds, in each of the Images used to test Hypothesis 2 (Figure 4-12). In Image 12, the two most predominant patches of sand are located at the lower-right and near the upper-left intersection points.   Therefore, it can be determined that Hypothesis 2, "Beach users have no opinion on the attractiveness of wind-blown sand-covered roads and sidewalks," is accepted.
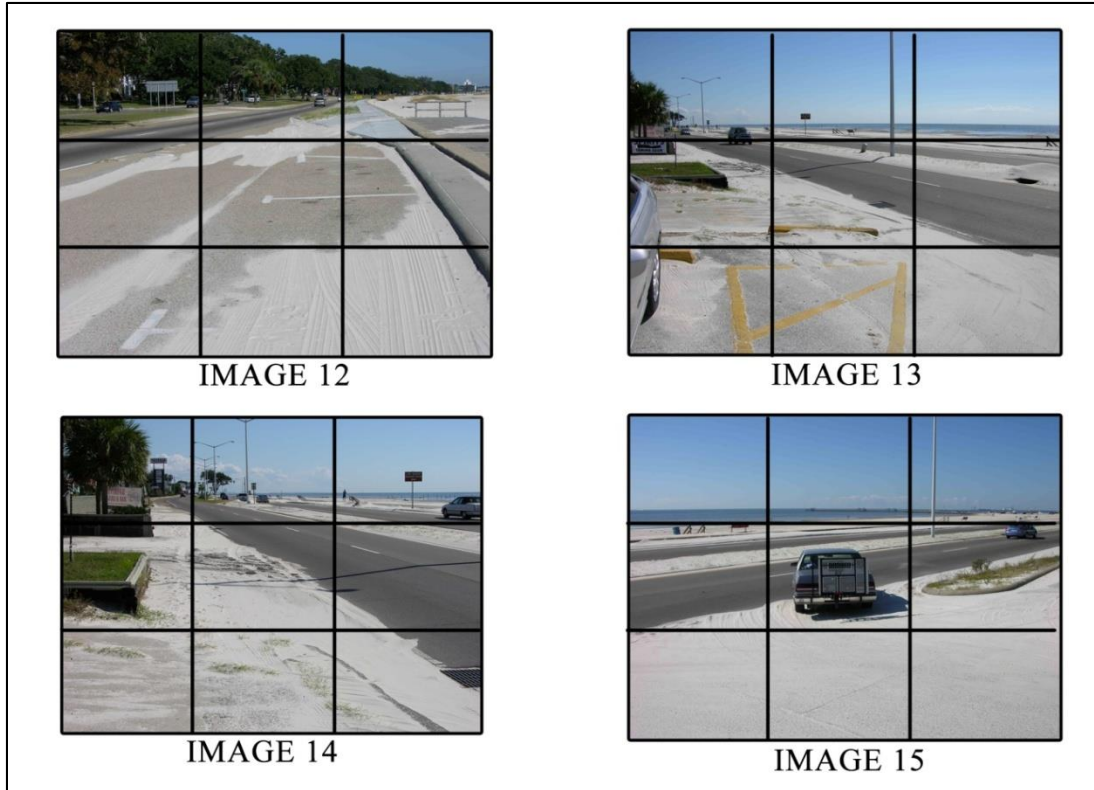
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Figure 4.12   Image 12, Image 13, Image 14, and Image 15 Marked for the Rule of
              Thirds.

Image 12, Image 13, Image 14, and Image 15 each marked to show the intersection points
created by the Rule of Thirds.

**4.5   Hypothesis 3: There is no difference between the number respondents who
        have an understanding of the ecological benefits of saltwater marshes and
        sand dunes and the number of respondents who do not have an
        understanding of the ecological benefit of saltwater marshes and sand dunes.**

The level of ecological literacy among the general population in the U.S. is not

known (Jordan et al., 2009). Therefore, in addition to understanding public perception of

the attractiveness of vegetated versus non-vegetated beaches, it is important to try to

understand if the general public has an understanding of the ecological benefits that

saltwater marshes and sand dunes provide to the coastal ecosystem. The third hypothesis

in this thesis is There is no difference between the number respondents who have an

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understanding of the ecological benefits of saltwater marshes and sand dunes and the number of respondents who do not have an understanding of the ecological benefit of saltwater marshes and sand dunes." It is included in this study in order to discover the general public's level of understanding of the ecological benefits of saltwater marshes and sand dunes.

In order to test Hypothesis 3, a set of three statements was utilized to determine respondents' opinions on the ecological function and possible benefits of saltwater marshes and sand dunes in the beach environment. The responses to these statements were the only data collected for this hypothesis because attractiveness is not necessarily a condition for ecological function. The responses to all three statements utilized for this hypothesis were analyzed by using the mean response statistic. However, Statement 6, which determines if respondents believe that saltwater marshes help control erosion, and Statement 7, which determines if respondents understand how saltwater marshes help control erosion, will be compared by using a t-test as well in order to see if there is a significant difference in the response.

4.5.1   Statement 6, Statement 7, and Statement 8

For Statement 6, "Saltwater marshes help control beach erosion," 5% (n=5) of respondents selected "disagree," 32% (n=32) of respondents selected "not sure," and 63% (n=63) of respondents selected "agree." This resulted in an overall mean response score of 0.58, which means that the majority of respondents believe that saltwater marshes help control beach erosion. Saltwater marshes, for thousands of years, have provided coastal protection from waves and storm surge, as well as helped control erosion (Davy et al., 2009). This overwhelming agreement from respondents corroborates the findings of

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Mancl et al. (1999), who found that adults in Ohio showed a great understanding of the principle of ecological energetics, which includes how energy is expressed in natural systems, including both flowing water and blowing wind. It is important to note that while most respondents agreed that saltwater marshes help control beach erosion, the statement made no mention as to why or how saltwater marshes help control beach erosion. Therefore, we cannot determine from these results that the majority of respondents understand how saltwater marshes function in an erosion control capacity.

Statement 7, "Saltwater marshes gather sand from waves and make the beach wider," 23% (n=23) of respondents selected "disagree," 44% (n=44) of respondents selected "not sure," and 33% (n=33) of respondents selected "agree." This resulted in an overall mean response score of 0.1, which means that most respondents were unsure if saltwater marshes gather sand from waves and make the beach wider. As previously mentioned, saltwater marshes reduce the velocity, height, and duration of incoming waves by stabilizing sediment, increasing the intertidal height, and providing baffling vertical structures like grass (Morgan et al., 2009). Due to most respondents not being sure whether they believed that saltwater marshes gather sand from waves and make the beach wider, this would seem to agree with Mancl et al. (1999), who found that adults in Ohio showed a lesser understanding of ecosystem succession, which includes the impact of modifying landscapes by natural forces like flooding

For Statement 10, "Beach sand dunes help keep blowing sand off the highway," 26% (n=26) of respondents selected "disagree," 35% (n=35) of respondents selected "not sure," and 38% (n=38) of respondents selected "agree." This resulted in an overall mean response score of 0.14, which means that most respondents believe that sand dunes help

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keep wind-blown sand off of the highway. Vegetated sand dunes provide sediment stabilization and soil retention in vegetation root structure, thus controlling erosion and protecting beaches, tourist-related businesses, and ocean-front properties including roadways (Barbier et al., 2011). The fact that there was not a clear majority of respondents who agreed that sand dunes helped to control aeolian sand, this result would seem to disagree with the results of Mancl et al. (1999), who found that adults in Ohio showed a great understanding of the principle of ecological energetics, which includes how energy is expresses in ecosystems through wind.

Therefore, the overall positive scores for Statement 6, Statement 7, and Statement 10 could be interpreted to mean that most respondents understand that sand dunes and saltwater marshes do provide some form of erosion control. However, the lack of a majority selecting similar responses for Statement 7 and Statement 10 could be interpreted than many respondents are unsure of the methods how saltwater marshes and sand dunes help control erosion.

4.6   Overall Results

Ultimately, this study has produced mixed results. Hypothesis 1, "There is no difference in beach users' opinions on the attractiveness of vegetated versus non-vegetated beaches," could be interpreted to be rejected, but only if the beach in question was vegetated with multiple types of florae. Hypothesis 2, "Beach users have no opinion on the attractiveness of wind-blown sand-covered roads and sidewalk," could be interpreted to be accepted, but only because the study did not include the ability for respondents to give images negative ratings. Hypothesis 3, "There is no difference between the number of respondents who have an understanding of the ecological benefits

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of saltwater marshes and sand dunes and the number of respondents who do not have an understanding of the ecological benefits of saltwater marshes and sand dunes," could be interpreted to be accepted, but only in that respondents did not show an understanding of the methods in which saltwater marshes provide ecological benefits. This will be discussed in greater length in the following chapter.

CHAPTER V

CONCLUSIONS

5.1 Introduction

This chapter presents the overall conclusions which may be drawn from this research, as well as discusses the limitations of the study. This section also discusses how the results of this study are relevant to the field of landscape architecture as well as any implications they may have on the field. Finally, possibilities of future areas of similar research are presented.

5.2 Conclusions

In conclusion, the results of this survey produced mixed results. In the Image-Pair analysis, the results of two of the Image-Pairs (Image-Pair 2, and Image-Pair 3) showed that respondents found the scene which depicted vegetated beach conditions to be significantly more attractive than the scene which depicted non-vegetated beach conditions. In the results of Image-Pair 1, respondents found the image which depicts vegetated beach conditions to be more attractive than the image which depicted non-vegetated beach conditions. In the results of Image-Pair 4, respondents found the image which depicted non-vegetated beach conditions to be significantly more attractive than the image which depicted vegetated beach conditions. Respondents also found all three of the images (Image 9, Image 10, and Image 11) which depict current vegetated beach conditions to be closer to a rating of "most attractive" than a rating of "least attractive."

Interestingly, the Image-Pairs in which the public found the vegetated scenes significantly more attractive than the un-vegetated scenes, Image-Pair 2 and Image-Pair 3, both had vegetated beach scenes in which there was a great amount of diversity of types of vegetation present. Conversely, the Image-Pairs in which the public did not perceive a significant difference in the vegetated scene and the un-vegetated scene, Image-Pair 1 and Imager-Pair 4, both had vegetated beach scenes in which there was one type of dominant vegetation. Therefore, we could conclude that, overall, respondents seemed to find vegetated beaches more attractive than non-vegetated beaches, but only if there is diversity of vegetation present.

According to this research, we can also conclude that most beach users agree that saltwater marshes and sand dunes help control beach erosion. This conclusion is reached due to Statement 6 of the survey, "Saltwater marshes help control beach erosion," receiving a mean response score of 0.58; and Statement 10 of the survey, "Beach sand dunes help keep blowing sand off the highway," receiving a mean response score of 0.14. The overall positive mean response scores for these Statements means that more survey respondents agreed with these two statements than disagreed or were unsure. However, we can also conclude that the majority of people do not understand how saltwater marshes help to control beach erosion. This conclusion is reached due to Statement 7 of the survey, "Saltwater marshes gather sand from waves and make the beach wider," receiving a mean response score of 0.1. Despite the overall positive mean response score, more respondents selected "not sure" than selected "agree" or "disagree."

We cannot draw a conclusion on whether beach users find wind-blown sand covering parts of U.S. Highway 90 attractive or unattractive. This is due to the survey not

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including both images that depict wind-blown sand covering U.S. Highway 90 and images that depict us Highway 90 not covered in wind-blown sand. Had the survey included both types of these images, it would have been possible to compare the two using a t-test and draw a conclusion. We also cannot draw a conclusion due to the survey images that depict wind-blown sand covering parts of U.S. Highway 90, Image 12, Image 13, Image 14, and Image 15 receiving overall mean response ratings of more than 2, which denotes "unattractive," and less than 4, which denotes "attractive."

5.3   Limitations

The main limitation of this study was the use of only positive numbers as a means of quantifying how attractive a respondent found a scene depicted in an image. Respondents were only given positive numbers 1 through 5, with one representing "least attractive" and 5 representing "most attractive." Therefore, it was not possible for a respondent to rate an image as unattractive by circling a negative number below an image.

Another limitation of the study was the way that the images were presented to the respondents in the survey. Some pages were populated with more than one image, which may have introduced bias by causing respondents to perceive an image to be more attractive simply because it appeared to be in relation to the accompanying image on the page.

Another limitation of this study was a lack of clear separation between vegetative elements and man-made elements of beach design in the images used in the survey. The inclusion of some common man-made elements of the Harrison County beach, such as exposed drainage culverts, dilapidated piers, etc., in the images could have had a negative

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influence on respondents' opinions; which make it difficult to determine if the respondents were judging the vegetation, lack of vegetation, or the common man-made elements in the images.

The lack of images which depict emergent sea grasses is another limitation of the study. There are only two images featured in this study which depict any emergent sea grasses, and none which had been digitally altered to remove them. All other images used in this study depict beach grasses, terrestrial shrubs and trees only. Therefore, it would be impossible to draw any conclusions on the attractiveness of beaches with emergent sea grasses versus beaches without emergent sea grasses.

The different sizes of the images used in the study was also a limitation. As previously stated, wide angle views have been shown to offer the highest correlation with field responses. In the case of the Image-Pairs, this wide angle format was utilized. However, in the case of the remaining images, those that depict current vegetated beach conditions and those that depict current man-made elements common to Harrison County Beach, a standard consumer photograph image aspect ratio of 4:3 was used.

Another limitation of the study is the times which the responses to the survey were collected. As previously noted, all responses to the survey were collected over the span of four days in September of 2011. This was done due to financial and time restraints. Therefore, the responses are limited to those of late-summer beachgoers only. A more robust and diverse response group would have been achieved if responses to the survey were collected over 4 days in Spring, 4 days in Fall, and 4 days in Winter, in addition to the 4 days in Summer. This was not possible due to the financial limitations of the study.

5.4   Relevance to the Field of Landscape Architecture

As briefly discussed in Chapter 1, this research could have implications for government officials and policy makers, coastal developers, and design professionals, such as landscape architects. In the case of landscape architects and other design professionals, by understanding that the general public seems to find vegetated beaches more attractive than non-vegetated beaches, these designers will be able to create beach environments that beachgoers will find more aesthetically pleasing and therefore will be more inclined to visit and use, which in turn will increase tourism to a given area. Also, since it was established in Fleming (1996) that vegetated beaches resist erosion more effectively than non-vegetated beaches, and it has now been shown that the public seems to prefer beaches vegetated with a variety of florae over non-vegetated beaches, landscape architects and engineers can be more inclined to incorporate the vegetated beaches as methods to erosion control into their designs. By increasing the use of beach vegetation as a method to control erosion, the cost of routine maintenance to the beach should be greatly decreased by reducing the frequency and scale of, or even eliminating the need for, beach re-nourishment projects. The increased use of sand dunes and vegetated beaches as methods to control erosion should also greatly reduce the frequency and scale of, or possibly eliminate the necessity for, sand removal projects on U.S. Highway 90.

5.5   Recommendations

Based on the results of this study, the researcher makes the following recommendations for the development of future studies of public preference of beach design. First, all of the images used in the study should have an opposite counterpart

which has been digitally altered to either add or remove a specific element of beach design. This will allow the researcher to specifically quantify an attractiveness rating for a given element of beach design, be it a specific type of plant, or a specific man-made structure. Additionally, one image may contain several elements of beach design. The researcher should use the same image, but with a different specific beach design element either added or removed. This would allow for greater accuracy in quantifying the attractiveness of that specific element of beach design.

Second, all images used in the study should be presented at the same wide-angle aspect ratio. This will allow for respondents to view all images, and therefore the elements in those images, from the same viewpoint. This should reduce the possibility for any bias to be possibly introduced by increasing or decreasing the viewable area of an image and causing a respondent to rate an image higher or lower simply because it was presented in a more or less attractive aspect ratio.

Third, all images should depict the same type of weather conditions. In this study, some of the images show cloudy skies and some show sunny skies. This likely introduced bias into the study. By depicting the same type of weather conditions in every image, the study should produce more reliable results.

Fourth, the use of Scantrons or some other computerized data collection software is recommended. This would greatly reduce the time involved in recording the respondents' data into a spreadsheet for analysis as well as reduce the possibility of a data input error.

Fifth, statements used in the accompanying questionnaire should be intended to address a very specific topic, and should have a counterpart statement that specifically

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addresses the opposite of the same topic. This will provide for better testing methods which will produce more reliable results.

Finally, the researcher recommends including both positive and negative numbers in the survey as possible attractiveness ratings. As previously noted, the use of both positive and negative numbers will allow for respondents to rate an image as "unattractive." This will allow for greater accuracy from the researcher when analyzing respondents' opinions on specific beach design elements.

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APPENDIX A

MODIFIED VISUAL PREFERENCE SURVEY USED IN THIS STUDY

99

Please circle the number below which best describes how attractive you find the scenes in the pictures.

Figure A.1   Survey VPS Page 1

This shows page 1 of the VPS portion of the survey as presented to respondents.
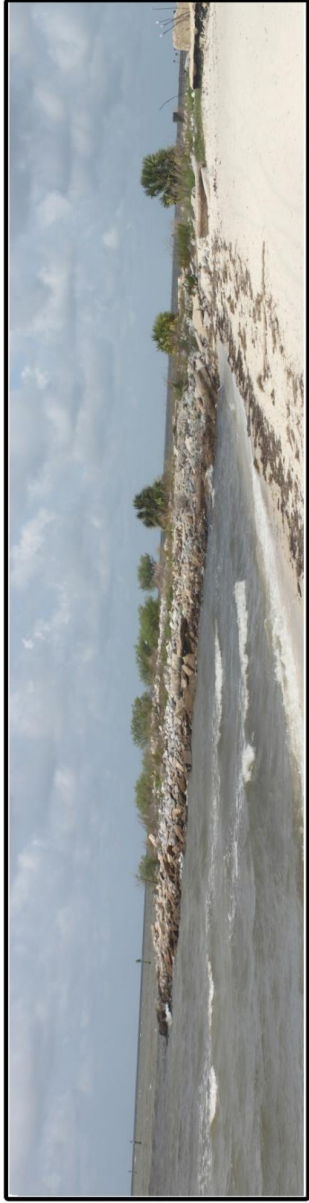
Please circle the number below which best describes how attractive you find the scenes in the pictures.

Figure A.2   Survey VPS Page 2

This shows page 2 of the VPS portion of the survey as presented to respondents.

101

Please circle the number below which best describes how attractive you find the scenes in the pictures.

1　2　3　4　5
Least　　　Most
Attractive　Attractive

1　2　3　4　5
Least　　　Most
Attractive　Attractive

Figure A.3　Survey VPS Page 3

This shows page 3 of the VPS portion of the survey as presented to respondents.

102

Please circle the number below which best describes how attractive you find the scenes in the pictures.

1 Least Attractive   2   3   4   5 Most Attractive

1 Least Attractive   2   3   4   5 Most Attractive

103

Figure A.4   Survey VPS Page 4

This shows page 4 of the VPS portion of the survey as presented to respondents.

Please circle the number which best describes how attractive
you find the scenes in the pictures below.

1	2	3	4	5
Least				Most
Attractive				Attractive

1	2	3	4	5
Least				Most
Attractive				Attractive

104

Figure A.5   Survey VPS Page 5

This shows page 5 of the VPS portion of the survey as presented to respondents.

Please circle the number which best describes how attractive
you find the scenes in the pictures below.

1   2   3   4   5
Least   Most
Attractive   Attractive

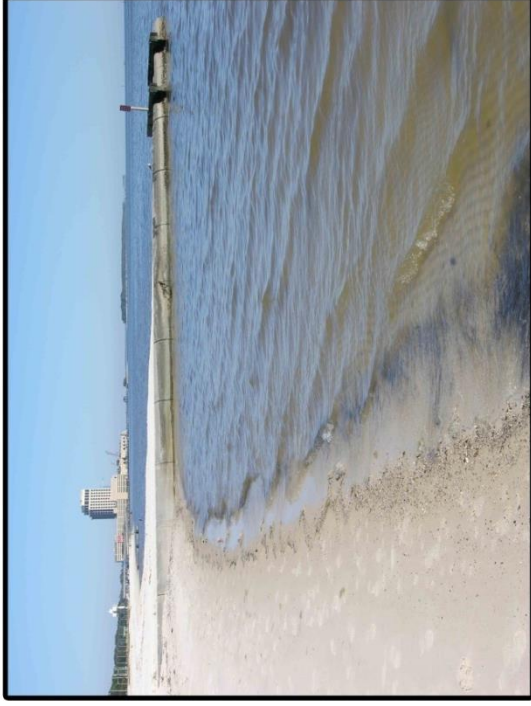1   2   3   4   5
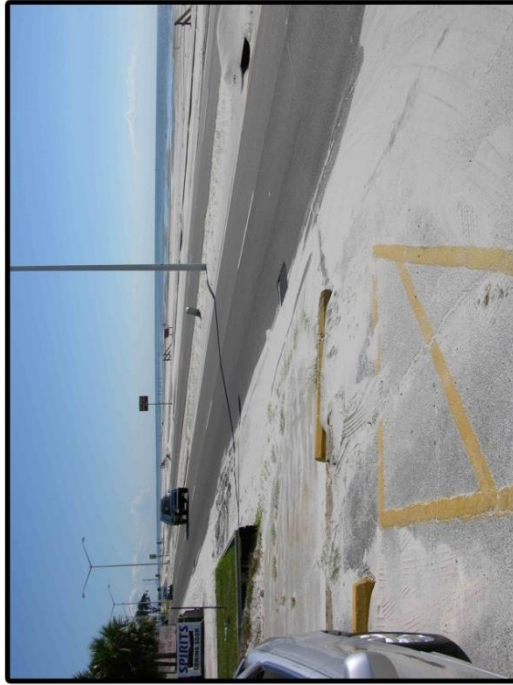Least   Most
Attractive   Attractive

105

Figure A.6   Survey VPS Page 6

This shows page 6 of the VPS portion of the survey as presented to respondents.

Please circle the number which best describes how attractive you find the scenes in the pictures below.

Figure A.7   Survey VPS Page 7

This shows page 7 of the VPS portion of the survey as presented to respondents.

106

Please circle the number which best describes how attractive
you find the scenes in the pictures below.

Least   Most
Attractive   Attractive
1   2   3   4   5

Least   Most
Attractive   Attractive
1   2   3   4   5

Figure A.8   Survey VPS Page 8

This shows page 8 of the VPS portion of the survey as presented to respondents.

107

Please circle the number which best describes how attractive you find the scenes in the pictures below.

1 2 3 4 5
Least Attractive   Most Attractive

1 2 3 4 5
Least Attractive   Most Attractive

Figure A.9   Survey VPS Page 9

This shows page 9 of the VPS portion of the survey as presented to respondents.

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APPENDIX B

QUESTIONNAIRE USED IN THIS STUDY

109

Name_____   Date:_____
Age_____   Survey Location:_____
Sex_____
Highest Level of Education Completed _____ High School   _____2 year college   _____4 year college
Are you a member of an Environmental Organization?_____
if yes, which one_____

Please evaluate the following statements by circling which answer best describes how you feel.

Saltwater marshes make the beach environment appear dirty.

           Disagree   Not Sure   Agree

It is a better view to see the Gulf of Mexico across a saltwater marsh than across a sand beach

           Disagree   Not Sure   Agree

It is a better beach experience to have a road beside the beach than to have shopping and restaurants beside the beach.

           Disagree   Not Sure   Agree

The 26 miles of Harrison County beach should have some areas that are allowed to return to natural beach conditions, including saltwater marshes, sand dunes, beach grasses, and beach trees.

           Disagree   Not Sure   Agree

Restaurants and shopping areas adjacent to the beach can be attractive.

           Disagree   Not Sure   Agree

Saltwater marshes help control beach erosion.

           Disagree   Not Sure   Agree

Saltwater marshes gather sand from waves and make the beach wider.

           Disagree   Not Sure   Agree

110

U.S. Highway 90 makes pedestrian access to the beach difficult.

               Disagree   Not Sure   Agree

Saltwater marshes make the beach environment more attractive.

               Disagree   Not Sure   Agree

Beach sand dunes help keep blowing sand off the highway.

               Disagree   Not Sure   Agree

APPENDIX C

SURVEY RESPONDENT COMMENTS

Table C.1   Respondent Comments Table

Respondent 16	The more natural the beaches are the more balanced they become. Between the traffic and the casinos, over manicured beaches tend to look too comercial (sic).
Respondent 18	First time visitor, so I'm not very familiar with MS Gulf Coast. I am familiar with the AL & FL Gulf Coasts.
Respondent 28	Sand dunes are important, and what is natural, cannot be unnatural. However, let's be honest, its (sic) not anything other than oil that is unnatural for the environment.
Respondent 30	Very nice, getting better all the time. Will visit it again in the future.
Respondent 35	I ultimately believe there should be a balance of marshes, dunes, and beaches. Nature is very important to coast culture, and the coast environment.

This shows any handwritten comments included by survey respondents.