A CONJOINT ANALYSIS OF CONSUMER PREFERENCES FOR WETLANDS MITIGATION IN GEORGIA

by

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(Under the Direction of John C. Bergstrom)

ABSTRACT

Wetlands provide important economic benefits to man. These include the provision of habitat for economically important species, recharging of ground water aquifers, provision of amenities for outdoor recreation, and the protection of coastal areas from storm surges. Since the time of European settlement however, the quantity of wetlands in the continental United States has been declining due to the conduct of economic activities in wetlands, as well as the expansion of built development. Although several pieces of legislation have been enacted to minimize wetlands loss, coastal Georgia continues to experience such losses. This research seeks to assess consumer's willingness to pay (WTP) for a mitigation policy for the preservation of Georgia's wetlands. By applying a conjoint analysis method, a one time WTP was estimated at $77.29 per Georgia household. Subsequent analysis yielded a benefit cost ratio of 7.41, suggesting that wetlands mitigation is economically feasible in Georgia.

INDEX WORDS: Wetlands, Mitigation, Conjoint Analysis, Coastal Georgia, Attributes, Willingness to Pay, Valuation

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DEDICATION

Dedicated to my sons Koya and Osei, who have continually shown me the virtues of endurance, and determination, and to my wife Earlene, for her unwavering belief in me.

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INTRODUCTION

Since the time of European settlement, the quantity of wetlands in the area that is now the United States has declined by more than 50% (Dahl, 2000). Estimated at 221 million acres then, total wetlands decreased to an estimated 105 million acres in 1997. Such significant loss of wetlands has become a major policy issue especially as wetlands have been proven to be vital resources in the sustenance of important economic and recreational species, provision of recreational opportunities, maintenance of ground water sources for both human consumption and industry, and provision of habitat for wildlife.

The need to sustain growing human populations through increased urban and rural development, as well as industrial, agricultural and sivilculture activities has led to increased incidences of dredging, draining, filling in, leveling and flooding, all of which are major causes of wetlands loss.

The continued loss of wetlands prompted the enactment of the Emergency Wetlands Resources Act in 1986, with the objective of conserving the remaining wetlands in the United States. This Act, along with several related federal, state and local initiatives, has resulted in a notable reduction in the rate of wetlands loss in the US since the decade of the eighties. For instance, surveys by the US Fish and Wildlife Service assessed the mean annual rate of wetlands loss from the mid-1950's to mid-1970's to be 458,000 acres. A subsequent survey by Dahl and Johnson for the period mid-1970's to mid-1980's revealed that the average rate of wetlands loss had declined to roughly 290,000 acres per year. In the following decade, this rate of wetlands loss had declined even further to a net wetlands loss of 644,000 acres, representing an annual loss rate of 58,500 acres from 1986 to 1997. These figures represent an overall reduction in the average annual rate of wetlands loss of 80% from the mid-1970's to the mid-1990's.

These achievements notwithstanding, wetlands decline continues to be a major environmental challenge for many regions in the United States. This is because of the peculiar nature and function of different types of wetlands in supporting a range of economic and social activities.

1.1 A Profile of Wetlands Degradation in the US

Dahl (2000) identifies two broad wetland types in the US, these being freshwater lakes and reservoirs, and estuarine marine wetlands. Of the current stock of wetlands, 95% is of fresh water type, while the remaining 5% is estuarine.

Freshwater wetlands are mainly inland fresh water bodies, which support a wide variety of fish and wildlife species either as deep water habitats, or as stop-over locations for migratory birds. They also provide diverse aesthetic spaces thereby contributing to environmental quality, and afford valuable recreational experiences such as hunting, fishing, bird-watching, hiking camping and other outdoor activities. Fresh water wetlands can be found in every state in the US. In 1997, this stock was estimated at 100.2 million acres, of which 50.7 million acres were regarded as forested wetlands, 25.2 million acres were classified as freshwater emergents, 18.4 million were freshwater shrub and 5.5 million were fresh water ponds. The majority (98%) of all wetlands losses recorded in the US is fresh water wetlands, and is estimated at 633,500 acres for the period 1986 – 1997. As noted by Dahl (2000), these wetland losses are attributable to urban development, which caused losses of 30%, agriculture (26%), silviculture (23%), and rural development (21%).

Considering estuarine wetlands, three sub-categories have been identified in the US. These are inter-tidal salt and brackish marshlands, estuarine shrubs such as mangroves, and inter-tidal non-vegetated wetlands. The 5% of estuarine wetlands comprises 5.3 million acres, of which vegetated estuarine lands make up roughly 87%, with the remainder being classified as non-vegetated marine wetlands. Although these types of wetlands are of considerably less acreage in the US, they provide coastal protection from storm surge damage, and serve the vital and important role as nursery, feeding and breeding, and staging areas for a number of economically important species. These include commercial and recreational fish species, shellfishes such as blue crabs and shrimp, migratory birds and mammals.

Dahl (2000) notes that estuarine wetlands account for only 10,400 acres or 2% of overall wetlands losses between 1986 and 1997. Apart from the many land-based threats to wetlands in general, estuarine wetlands also face threats and stresses from nature including storms, wind and wave erosion, land subsidence and sea-level rise. Given the pivotal role of these wetlands in sustaining economically important species, as well as recreational and tourist activities, the loss of estuarine wetlands is considerably more consequential for US gulf coast and Atlantic states compared to other states. The State of Georgia is one such state, for which its coastal wetlands are a crucial base for the sustenance of the coastal economy.

1.2 Wetlands Degradation in the State of Georgia

Georgia possesses over 2,300 linear miles of coastline which is bordered by roughly 700,000 acres of a rich and diverse coastal estuarine ecosystem. This ecosystem evolved from the confluence of six major watersheds which mix fresh water from rivers with saltwater from the ocean to generate a highly productive food chain in which several species thrive. This coastal estuary is complemented by a broad band of coastal marshlands as well as barrier islands. Estimated at 378,000 acres, Georgia's coastal marshlands constitute approximately 33% of all remaining salt marshes on the US Atlantic coast (National Oceanic and Atmospheric Administration – NOAA and Georgia Department of Natural Resources - GADNR, 2003).

As noted by the NOAA and GADNR, up to 75% of all commercially harvested fish and shellfish depend on estuarine areas to support critical stages of their life cycles. In the case of Georgia, this aquatic ecosystem forms a critical component of the life cycles of recreational fish species such as red drum and spotted-sea trout, as well as blue crabs, shrimp and oysters. Additionally, endangered species such as manatees and short nose sturgeon also find protective habitats within these estuarine areas. This natural resource generates some $1 billion annually in nature-based businesses for Georgia's coastal economy, and supports approximately 40,000 jobs (NOAA, GADNR, 2003).

Over the past two decades however, major economic development accompanied by rapid population growth has resulted in a significant reduction of wetlands, estimated to be more than 23% by the early 1990's (NOAA, 2005). For the eleven county coastal region, Glynn and Chatam counties have sustained the greatest losses largely because these have been subjected to the most intense economic development.

1.3 The Research Problem

The decline in wetland areas has resulted in direct and indirect impacts on at least four broad groups in coastal Georgia. These include the blue crab sector, which has experienced dramatic decline in crab stocks over the past four years (Geer and Robertson, 2003). Additionally, shrimpers, recreationists, and general consumers have either been affected, or risk medium to long term negative effects from the reduction of wetland areas on the coast.

Considering blue crabs, the total value of harvests for coastal Georgia was estimated at $1.9 millions in 2002 (Geer and Robertson, 2003). These earnings were generated from 2 million pounds of crabs harvested by 159 commercial crabbers, and represent a significant decline in blue crab harvests over the past four years. Although the Georgia Department of Natural Resources cites the effects of drought and diseases as the principal causes of this decline, other observers point to the decline in wetlands acres as a major factor in the reduced abundance of blue crabs (Wall, 2003).

Related to the impacts on the blue crab, recent evidence also point to a decline in production of selected shrimp species, particularly the white shrimp. As noted by Geer and Robertson (2003), catch figures for this specie for the past three years have generally been below the long term average obtained from assessment trawls under taken by the GA-DNR.

In the case of recreationists, the *Red Drum, Spotted Sea trout,* and *Striped Bass* are the most important species engaged by Georgia's anglers. And while populations of these species have recovered and remained fairly stable over recent years, challenges to other recreational species have resulted in reduced access by recreational fishers to fishing areas. Additionally, Wall (2003) observes that even for passive recreational users such as wildlife watchers, declines in wetland areas have resulted in reduced sightings of particular bird species, as well as the Georgia black bear in recent years. This raises the possibility of reducing the value of the recreational experience to outdoor enthusiasts in coastal areas of Georgia.

Yet another impact of wetlands loss relates to the increase in salinity of ground water sources used by consumers in coastal Georgia. Alber and Sheldon (1999), while noting the limitations of available data, suggest that there has in fact been a significant increase in the downstream salinities of the Savannah and Satilla Rivers between 1974 and 1992. Most importantly, they indicate that flushing times have also increased for at least four estuaries during the period. These developments are compounded by evidence of increased salt water intrusion into the upper Floridian Aquifer, the main source of drinking water for thousands of consumers on the coast. Increased extraction coupled with decreased wetlands have been cited as the cause for increased salinity of ground water sources since the capacity to recharge ground water sources is reduced with the loss of wetland areas.

Not withstanding these manifest effects, there exists several regulatory and policy measures for the protection of the natural and environmental resources of the coast. The State's legislative framework draws from the Federal Coastal Zone Management Act of 1972, which created a voluntary program for State level administration of coastal management activities. On this basis, Georgia formalized a network of coastal management regulations under the Georgia Coastal Management Program, the goal of which is to balance economic development with preservation of the natural, environmental, historic and recreational resources of the Georgia coast for present and future generations. This program takes its legislative mandate from the Georgia Coastal Management Act, which was promulgated in 1987. Under this act, protection of coastal resources has been accorded special priority in the national interest, and relates specifically to policies and actions for the protection of the following coastal resources:

- fish species and habitat
- threatened wildlife habitats

- public recreational facilities
- freshwater aquifers
- historic, cultural and archeological sites
- barrier islands
- wetlands

This act allows for the setting of policy goals for the protection of Georgia's coastal resources. The scope of the problem along with this enabling policy framework justifies the pursuit of this research, the objectives of which are elaborated below.

1.4 Thesis Objectives

This thesis has two broad objectives. These are:

1. To apply a conjoint analysis method in obtaining a measure of consumer's willingness to pay for wetlands mitigation policies for the Georgia coast as a means of securing the future of important nature-based industries in the state.
2. To estimate a benefit cost ratio for the implementation of a wetlands mitigation policy for the Georgia coast.

With respect to the estimation of willingness-to-pay (WTP) measures, there have been few applications of WTP estimation methods to elicit values for wetlands mitigation in the US. For instance, in a comprehensive review undertaken by Boyer and Polasky (2004) none of the several urban wetland valuation studies cited were in support of the development of wetland mitigation policies. Similarly, a meta analysis conducted by Woodward and Wui (2001) revised

39 studies which valued wetland services, and none of these focused on the elicitation of consumer values for wetland mitigation policy. Another meta analysis by Brouwer et al (1997) identified two studies which supported wetland protection strategies. Once again, these did not specifically focus on wetland mitigation as a resource protection strategy. A possible explanation for this situation is that the mitigation approach to the preservation of natural resources is still relatively new, and has therefore not been subjected to extensive investigations and analysis.

Considering conjoint analysis, while the method has been well developed and applied in the field of market research and transportation studies, it has so far found limited application in the assessment of natural resources. Ozdemir (2003) notes that the use of the method in this field is still quite new. This thesis therefore aims to contribute to the body of knowledge in this specific area.

1.5 Methods

The objectives for this study were achieved by administering a mail survey to 600 respondents in the State of Georgia. The design of the questionnaire required the partitioning of respondents into four blocks representing the four geographic regions of North, South, East and West Georgia. A fractional factorial experimental design was used to obtain an efficient design for two wetland mitigation programs each comprising six attributes these being:

1. Protection of Blue Crabs stocks
2. Protection of White Shrimp stocks
3. Protection of Red Trout stocks
4. Prevention of Saltwater Intrusion into ground water supplies

5. Acreage of Wetlands preserved
6. One time cost to be paid for the mitigation program

The first four of these attributes were evaluated at two levels vis. 'Yes' and 'No', while the remainder were assessed at four levels each. The resulting sixteen designs were then partitioned into the four blocks above.

In order to elicit consumer's values for wetland migration programs, respondents were presented with four choice-sets each containing two alternative mitigation programs, and asked to indicate their preference by voting for either one or none of the proposed programs. Consumer choices were then analyzed under a multinomial logistic framework to ultimately derive willingness-to-pay (WTP) estimates of consumer preferences for wetlands protection on the Georgia coast. These WTP estimates were then applied, using certain assumptions, and cost estimates to derive a benefit cost ratio for the implementation of wetland mitigation policies for coastal Georgia.

Finally, additional demographic and perceptions data were also gathered and used to develop a profile of consumers who responded to the proposals for implementing wetland mitigation policies in Georgia.

1.6 Thesis Organization

Subsequent to the thesis introduction in Chapter 1, Chapter 2 reviews the current literature on wetlands and wetlands mitigation programs in the US, as well previous valuation studies on wetlands mitigation programs. Chapter 3 discusses the methodological approach to deriving consumer estimates by reviewing conjoint analysis, and elaborating the theoretical model to be estimated. In Chapter 4, the data and empirical model are discussed, while survey results, results of model estimation, and estimation of benefit cost ratios are presented in Chapter 5. Finally, Chapter 6 draws conclusions from the research by examining policy and methodological implications, and also identifies areas for future research.

CHAPTER 2

LITERATURE REVIEW

Wetlands mitigation is a relatively new strategy for the preservation of wetland areas, and came to prominence in the early 1990's (Fennessy S., 2006). Hence, in order to apply conjoint analysis to the evaluation of mitigation policy, it is first necessary to have a good appreciation of the importance of wetlands as well as wetlands mitigation as a preservation approach. This is the objective of this chapter. The benefits of wetlands are first discussed, after which the evolution of wetlands mitigation as a preservation strategy is reviewed. The chapter also reviews previous valuation studies on wetland mitigation, and surmises on insights for the current research.

2.1 The Benefits of Wetlands

The benefits of wetlands may be broadly categorized into physical, ecological and social services. These services have been identified by Bergstrom et al (1990) to include support to commercial fishing and trapping, waste assimilation, flood control, storm protection and outdoor recreation.

Considering physical services three main functions are flood control, ground water recharge and maintenance of water quality. Wetlands provide flood control by serving as natural repositories for storm water. This is especially important for large cities where built development reduces the rate of soil water percolation (US Environmental Protection Agency - EPA, 1993). By accumulating excess water from storm and non-storm sources, wetlands also play a critical hydrological role in recharging ground water aquifers, which often serve as drinking water sources for many large human populations as well as water sources for several industrial and agricultural applications. Choi and Harvey (2000) in a study to quantify the ground-water discharge and recharge in the wetlands of the Northern Florida Everglades estimated the average quantum of ground-water recharge over a four-year period to be 13.4 hectare-meter per day. This represented roughly 31% of the total surface water pumped daily into this system for treatment.

Another function of wetlands, particularly in coastal areas, is physical mitigation of structural damage occasioned by the passage of hurricanes and similar storm conditions across coastal areas. In this case, the dense coastal wetland vegetation serves as an invaluable physical barrier for the absorption of the immense energy of a storm-surge.

In the process of storage and recharge, wetlands also play a vital role in the natural enhancement of water quality through processes such as sedimentation, filtration, adsorption, ion exchange, precipitation, and biodegradation (US EPA, 1993). Through sedimentation, suspended solids are removed from the water, and the rate of removal depends on particulate size as well as the rate of stream flow through the wetland. Filtration takes place where vegetation and other biota trap suspended pollutants as these are transported through the wetland area, while adsorption occurs with the adhesion of dissolved pollutants to other physical elements in the water. According to the US-EPA, adsorption is a key process in the removal of heavy-metals from polluted waters as they flow through wetland areas.

Wetlands also support important biological and chemical activities which result in changes in biochemical properties such as pH, soil nutrient content, and variation of microbe populations such as bacteria and other micro-organisms. In this regard, wetlands play a key role in nitrogen and phosphorus speciation which are two of the most important chemical transformations which occur in wetlands (EPA, 1993).

Considering ecological services, the unique physical environment formed by wetlands provides a valuable source of food and habitant for a diverse range of plant and animal species. According to Mitsch and Gosselink (1986), wetlands may be extensively used by both terrestrial and purely aquatic animals, and some animals utilize wetlands at various critical stages of the life cycle. Among such animals are fishes, shrimp and crabs, and many bird species find wetland conditions suitable for nesting and protecting their young. Moreover, wetlands provide habitats for a large number of endangered and threatened plant and animal species, including reptiles, amphibians, fishes and birds. The periodic variation of water characteristics such as levels, turbidity and salinity also favor the proliferation of amphibians, reptiles and other invertebrates which require changes in aquatic phases to facilitate breeding, egg development, and larval growth (Mitsch and Gosselink, 1986). All of these wetland functions are intimately related, and hence any physical, biological or chemical alterations can severely impact the well-being of human and wild- life populations which depend on them for sustenance.

Wetlands are also important in rendering economic and social services. In terms of economics, wetlands are a source of important hardwoods such as mangroves as well as peat which are harvested for use by man. They also serve as spawning grounds for commercial fish species such as shrimp and crabs. Wetlands also provide valuable amenity services and are therefore important in supporting recreation and tourism activities such as boating, sport fishing, hunting, hiking and camping. In this context, wetlands provide both economic and social benefits.

In the case of Georgia, Geer (2003) estimated that State's value for all commercially harvested seafood products to be $14.8 million in 2002. These earnings were directly attributed to the presence of extensive marine wetlands and related marshlands on the Georgia coast.

2.2 Wetlands Mitigation Banking

Given the recognized importance of wetlands to overall social and economic well-being as well as the fact that significant wetlands losses have been occasioned by industrial, urban and agricultural development activities, several federal and state regulatory mechanisms have been invoked in order to limit the impact of these developments on the stock of wetland in the United States. In this regard, the principal legislation employed is Section 404 of the Federal Clean Water Act, which was proclaimed in 1972[1] and is administered both by the US Environmental Protection Agency (EPA), and the US Army Corps of Engineers (USACE). The Clean Water Act provides for wetlands protection through a permitting system for the discharge of dredged or fill-in materials into waters in the US (Fennessy,2006). Over time the regulatory framework was amended and embellished ultimately resulting in the Water Resources Development Act of 1990, in which the federal government established the national goal of no net loss of wetlands. This objective motivated regulators to seek new approaches towards protecting wetlands, while meeting the increasing demands by developers for regulatory clearance to encroach upon wetland areas. Among the approaches to emerge was the concept of wetlands mitigation banking.

According to Reppert (1992), wetlands mitigation banking is a natural resource management concept which provides for the advanced compensation of unavoidable wetlands

[1] Note that a previous rendition of this Act was known as the Federal Water Pollution Control Act Amendments of 1972.

loss due to development activities. A bank is normally regarded as a large preserved block of wetland, the tangible and intangible benefits of which have been estimated as banking credits. Mitigation banks are established either through a direct process of creation, restoration, enhancement or preservation of previously existing wetlands. Moreover, these wetland areas may even exist outside the immediate development area, and developers who are forced to encroach on wetland areas, can then facilitate their project development by buying 'rights of encroachment' in the form of credits equivalent to the quantity of wetlands loss called debits. The long term objective of this mechanism is to realize a stable quantity of wetlands within a defined geographic region, while at the same time facilitating land development.

Fennessy (2006) describes a wetland mitigation banking system as a 'regulated pseudo-market' which allows for the trade in wetlands losses and gains. While credits and debits are typically measured in acres of wetlands, other criteria related to specific and unique ecological attributes such as ecosystem functionality, peculiar species habitats, or even particular economic benefits may be used to assess credit and debit values.

Since one of the goals of the Water Resources Act was to attain no net loss in wetlands, developers under the act would be required to 'create' an equivalent quantity of wetlands, for each acre 'consumed' in the development process. In practice therefore, a wetland mitigation bank works by providing a stock of wetlands, from which a developer could purchase *a priori* wetland stocks in order to offset those wetlands used up in development. Hence assuming a development requires one (1) acre of wetland, the developer can purchase the credits to one (1) acre of wetland from a bank as compensation for the one acre to be used up in the development. This credit may be purchased at a location other than the development site, thereby obviating the need to create the corresponding quantum of wetlands adjacent to the development.

Fennessy (2006) also notes that over time, wetlands mitigation banking has evolved as one of the key tools employed in the regulatory domain for the use of natural resources, as it provides a market clearing tool for the myriad stakeholder interests in both the preservation and efficient utilization of wetlands. Among the notable advantages of wetlands mitigation banking is its flexibility and economy of scale, as it allows developers to compensate for wetlands uses from diverse locations, and frees them from the obligation of engaging in wetlands development and restoration activities. At the same time, economy of scale is attained by concentrating wetlands restoration or creation activities into fewer but larger projects, resulting in more ecologically significant wetlands areas at lower unit costs. Since larger wetlands are also more ecologically robust in terms of stability, diversity and ecosystem relationships, the stimulation of single large wetlands projects to offset many smaller wetland loss acreages also results in scale effects in ecological terms.

2.2.1 Key Banking Functions of Wetland Mitigation Banks

In practice, the implementation of a wetland mitigation banking project involves undertaking six (6) key banking functions. These are described by the Environmental Law Institute -ELI (1994) to be:

- Client
- Permitting
- Credit Production
- Long-term Property Ownership
- Credit Evaluation
- Bank Management

The client refers to those agents who, by their development activities, impact on a wetland area for which mitigation would be required. Clients may be private developers, or other local, municipal, state or federal agencies which may be forced to impact wetlands in order to provide public goods and services. The client may play several roles in the mitigation banking process, but typically represents market demand for compensatory mitigation, and may not be directly involved in the actual mitigation activities such as creation, restoration, enhancement or preservation of wetlands. As the representative of the market demand for mitigation credits however, it is the client who makes the market operability of the mitigation bank feasible.

The permitting function represents the range of legal and administrative mechanisms which give authorization to the client to access credits in a mitigation bank. Permitting may be carried out by a number of federal, state, and local agencies which exercise regulatory oversight over a targeted wetland, and the process is undertaken so as to guarantee consonance with regulatory and other policy guidelines for the use of the natural resources in a specified location. Effectively, the permitting process guarantees that the development project meets requirements related to sequencing of activities, proximity restrictions, and acceptable technical standards for mitigation, and therefore serves to craft the appropriate market climate which would ensure success of the mitigation bank.

Credit production is another key function which must be undertaken in the process of establishing a mitigation bank. This involves the acquisition of the relevant land titles to the areas targeted for mitigation, and the actual conduct of the mitigation work. Subsequent to the establishment of the bank, credit production activities are usually extended to site monitoring and maintenance.

Another key banking function is that of long-term-ownership. As discussed subsequently, this is a critical factor related to the long term preservation of mitigated areas. As noted ELI (1994), private owners of mitigation banks tend to have less incentives to engage in maintenance and monitoring activities once all bankable credits are exhausted. Prudent management of a bank therefore requires initiatives to 'transfer' land titles from the private to the public domain so that the public interests in the wetland areas can be used to guarantee long term preservation of the bank. Mechanisms for effecting long-term property ownership of mitigation banks include seeking the involvement of non-governmental or other public agents in purchasing related conservation easements thereby obviating prospects for long term future impacts on mitigated wetlands.

Since mitigation banks sell credits to offset development impacts, credit valuation is another critical function to be undertaken in the mitigation banking process. Several valuation methods are applicable in this process, with the ultimate goal being to assess wetland ecosystem function and service parameters in order establish the total quantum of benefits that can be obtained from a mitigation bank. Because the client and the banker as principal market intermediaries in the banking process may have directly conflicting interests in the setting of credit values, credit valuation is usually done by the permitting agent or by an independent consultant.

The final key function to be undertaken in mitigation banking is bank management. According to the ELI (1994), "…bank management is the process of determining whether produced credits and proposed debiting projects meet the conditions established for use of the mitigation bank and recording resulting transactions". Essentially this is an accounting and documentation function, in which transactions such as credit withdrawals are recorded, and balances updated. This function becomes more critical in banks where several clients and producers may be continually interacting to generate and withdraw credits. Accurate transaction records are therefore critical to ensuring no net loss of wetlands, as contemplated under the overarching national wetlands policy. Additionally, the permitting process will normally require documentation which could provide evidence of compliance with technical and other policy standards agreed to at the permitting stage of the banking project. It is the bank management function that will ensure that such standards are achieved.

2.2.2 Issues in Wetlands Mitigation Banking

Naturally, given the relative newness of wetlands mitigation as a regulatory approach, several contentious issues have arisen in the practice of wetlands mitigation banking. Fennessy (2006) notes the more common of these concerns to be the timing of the mitigation, function and value, and issues related to risk responsibility and perpetuity. Reppert (1992) also identifies concerns related to the methods used to evaluate wetlands credits as a basis for determining the amount of bankable credits which might be obtained from a wetlands bank.

2.2.2.1 Timing of the Mitigation

Considering the question of timing, differences of opinion exist between environmentalists, developers and mitigation bankers with respect to the optimal timing for effecting credit sales in a development project. At issue is the optimal trade-off between economic and ecological risks, with the former being related to the need for developers to bring projects to fruition in the minimum possible time so as minimize the time horizon over which no returns are generated on their investments. Environmentalists, on the other hand recognize the need for a sufficiency of time to elapse in order to guarantee positive results from a compensatory wetlands establishment or restoration project. Fennessy (2006) observes that… "ideally, credit sales should be permitted only when the constructed wetland is judged to be fully functional and relatively self-sufficient". This ecological requirement is deemed to be necessary in order to prevent temporal loss of wetlands, as well as to safeguard against possible high risks of wetlands failure arising out of the relative newness of both the science and art of wetlands construction.

2.2.2.2 Function and Value

In the case of wetland function and value, there is also debate about the relative importance of each of these dimensions in the wetland mitigation process. At the core of the issue is the observation that given the ecological complexities of a wetland, there is no clear and direct relationship between wetland acreage and functions. Hence the functional value of a small wetland in processes such as flood control, water quality enhancement, and the provision of species habitat may be higher depending on the economic and human interaction occasioned in this wetland, compared to a larger and more remote wetland area. At the same time the reverse may also be true depending on the mix of geographic, ecological and economic variables. As noted by Fennessy (2006), the measure of economic externalities arising from development impacts on a wetland is not to be determined only in terms of affected acreage, but also from the ecological functions that may be impaired in the process. Such functions are thought to be related to several additional factors, and not only wetland size.

2.2.2.3 Risk Responsibility and Perpetuity

The issue of risk relates principally to the responsibility for assuming such risks, as well as the prospect that the presence of significant risks could ultimately impair perpetuity concerns (Fennessy, 2006). This is especially the case where the assumption of such risks is associated with long term wetland maintenance costs.

Since the land acquisition, and subsequent maintenance costs are the most significant inputs in any wetlands mitigation banking project, a mitigation banker driven by the profit-maximization motive, might therefore be inclined to prematurely terminate wetlands mitigation programs, after the establishment of a bank, thereby shifting the responsibility to some other agency, and in the process increasing risks of failure of the bank. Furthermore, mitigation banking as an industry is still in the embryonic stages of its development, and therefore requires substantial research in landscape modeling of previously drained or created wetlands in order to determine reliable establishment and maintenance protocols which could ultimately minimize risks of wetlands loss over the medium to long term. Fennessy (2006) advocates that such modeling should be done by an alliance which includes state and local government agencies, environmental researchers, developers and mitigation bankers, so as to guarantee the application of a minimum level of scientific robustness which could lead to minimum-risk wetland mitigation standards.

2.2.2.4 Quantifying Wetland Credits

A further difficulty in the application of the wetland mitigation approach is that of quantifying the value of wetland functions. Since, as noted by Reppert (1992), the ultimate objective of wetlands mitigation banking is to "…replace the physical and biological functions and human-use values of the wetlands which are unavoidably lost due to development...", pragmatic assessment of wetlands loss should also include the value of functionality forgone as part of the measure of credit value.

Several approaches, both analytical and non-analytical have been applied in the estimation of wetlands debits and credits. Reppert (1992) broadly classifies these approaches in terms of scope of ecological comprehensiveness to include:

- Simple indices which are derived from easily observed wetland characteristics and are used as surrogate indicators of single or multiple ecological functions;
- Narrowly tailored systems which seek to directly measure a limited range of wetland services
- Broadly tailored systems which assess a wider range of wetland functions based on observable characteristics
- Other approaches which involve the application of best professional judgments, combinations of approaches, and/or economic valuation.

Developers are inclined to apply simple indices for evaluating wetland credits, since these methods, afford speed, and clarity, and involve little field work, thereby making them relatively inexpensive to implement. Among the main parameters assessed under this method are size of wetland area and number of species. However several site specific parameters have also been employed. One such example is the Seaworld Eelgrass Mitigation Bank, which uses eelgrass density as a measure of wetland quality. The simply index approach however does not address any ecological function or service concerns, and its application requires careful consideration of the trade-off between simplicity and cost effectiveness so as to prevent unacceptable levels of wetlands losses in the implementation of the mitigation banking project.

Narrowly tailored assessment methods offer some improvement over simple indices by taking at least a few wetland functions into account in arriving at wetland credit values. Hence these methods tend to provide more accurate measures of wetland values. The potential drawback however, is in choosing which wetland function to evaluate, as well as the need for more information. With respect to function choice, this approach runs the risk of focusing exclusively on only a narrow range of functions which may be potentially less important compared to excluded wetland functions. Possibly one of the most widely applied of these methods is the Habitat Evaluation Procedure (HEP) developed jointly by the U.S. Fish and Wildlife Service and other Federal Agencies, which attempts to measure wildlife species compatibility with wetland habitats. Such compatibility may be measured in terms of optimum habitat for a specific species, biological productivity, flood-flow retention or other pre-determined wetland values, and these criteria are used to generate a Habitat Suitability Index (HSI) for an indicator species. The HSI is defined as the optimum habitat support which the wetland cover provides. By multiplying this index by the acreage of wetlands to be affected by development, an estimate of the value of wetland credits can be obtained[2]. HEP methods are the most widely used to determine the value of wetland credits in the U.S.

In acknowledging the limitations of the approaches outlined above, the broadly tailored assessment methodologies seek to more comprehensively evaluate wetlands complexity by taking into account a much broader spectrum of wetland functions. Increased analytical scope however results in greater complexity and higher expense in their implementation in mitigation

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[2] Note that the HSI is calculated for selected indicator species, and is rated in *Habitat Units* on a scale of 0.0 to 1.0. The HSI compares ecological information gathered from a targeted wetland with the optimum habitat for the indicator species.

banking. Moreover, the administrative requirement of a single quantitative value for banking purposes has led to elaborate data analytical processes which ultimately yield "dimensionless wetland values of little or no ecological meaning" (Reppert, 1992). One of the most broadly tailored evaluation methods is the Wetland Evaluation Technique (WET) which was developed by the Federal Highway Administration, Corps of Engineers, and the Environmental Protection Agency (EPA).

Finally another generic approach to wetland function evaluation is the Hydro-geomorphic Method (HGM). This approach ascribes a category to wetlands by applying the three broad criteria. The first of these is geomorphic setting, which describes the physical landscape upon which the wetland is found, with appropriate examples being depressional, slope-flat, peat land, riverine and fringe. The second criterion is water source, and refers to categories such as precipitation, ground water discharge, and surface or near-surface inflow. Lastly, hydrodynamics alludes to the relative directional flow of water within the water-table of the wetland system, with important categories being vertical fluctuation, unidirectional flow and bi-directional flow. The challenge in applying the HGM approach is having available functionally evaluated reference wetland sites against which the potentially impact wetland could be assessed. The result of this comparison is the Functional Capacity Index which is derived as a ratio of the estimated Functional Capacity of the target wetlands against the functional capacity of the reference sites. This ratio is then used as a proxy for the quantum of credits that are created through the restoration or creation of wetlands in a mitigation process.

Although function value estimation has been attempted using the Hydrogeomorphic (HGM) method, Fennessy (2006) notes that this approach assesses primarily self-sustaining ecosystem functions, unlike the other methods above, which focus on valuable wetland functions provided to society. Furthermore, the emphasis on measurability may still preclude a complete assessment of ecological functions particularly those that are hard to observe.

2.3 Wetland Mitigation Banking in the U.S.

Having outlined the mechanics and challenges in the development of wetland mitigation banks, the extent to which such projects have been implemented in the U.S. is examined. The first comprehensive assessment of wetland mitigation banking in the U.S. was undertaken by the Environmental Law Institute (ELI) in 1992[3]. At that time, the U.S. Army Corps of Engineers identified some forty-four (44) mitigation banks in existence in seventeen states, and estimated another seventy (70) to be in the planning stages in 1992. Most of the banks in operation then were single client entities sponsored principally by the department of transportation, and with the objective of compensating for unavoidable wetland losses.

In terms of performance, many banks at that time were judged to have several deficiencies, including improper implementation and poor long-term maintenance (Blumbaugh and Reppert, 1993). Additionally, as an emerging industry, banking operations of this nature were seen to be evolving in the absence of clear national policy guidelines, an inadequacy that seemed to explain the deficiencies at that time.

The ELI in an updated study in 2002, noted substantial changes in wetland mitigation banking practices in the U.S. over the ensuing decade. By this time some 219 banks were approved, with another 95 banks awaiting approval. Moreover, there was evidence of a significant shift in state participation in such banks from the early 1990's with 63% of them being private commercial operations in 2002, compared to a mere 2% of banks in 1992.

[3] This study was conducted by ELI on behalf of the UA Army Corps of Engineers' Institute for Water Resources. Findings form this study were also reported by Brumbaugh and Reppert in the First Phase Report of the National Wetland Mitigation Study,

Additionally, there has been some clarification of procedures associated with the establishment of wetland mitigation banks through the issuance of new guidelines, federal and state legislation and state policies. For example, while Section 404 of the Federal Clean Water Act provides guidelines for wetland protection, this is more the case for coastal rather than inland wetlands protection. Since the U.S. Army Core of Engineers and the EPA are key partners in implementing 404 requirements, both agents signed a federal mitigation memorandum of agreement in 1990, which sought to clarify the protocol for determining both the type and level of mitigation that would be required under the 404 guidelines. Possibly a more significant federal legislative mechanism however was the 1995 Federal Banking Guidance, which established the overall legitimacy of wetlands mitigation banking as a regulatory mechanism for controlling the impact of development on wetland areas. A significant aspect of this guidance document was an attempt to officially define the concept of mitigation banking, as well as to promote the methods as an acceptable approach policy approach towards the protection of national wetlands (Votteler and Muir, 1996). Still further federal regulatory mechanisms for wetlands mitigation over the past decade were evidenced with the issuance of the U.S. Army Corps' Regulatory Guidance Letter on compensatory mitigation in 2001. The aim of this letter was to achieve "mores stringent standards for mitigating impacts to the aquatic eco-system, including wetlands" (Votteler and Muir, 1996).

During this period too, there were also improvements in the state regulatory framework for wetlands mitigation. Since 1993, as many as twenty-nine (29) states had implemented wetlands related legislation in order to effect further protection at State level. More specifically, by 2002, twenty-three (23) states had passed statues and other regulations authorizing the use of wetland mitigation banks (U.S. Geological Survey, 2005). The states of California, Georgia, Alabama, Minnesota, New Jersey, Florida, Massachusetts, New York, Rhode Island, Illinois, Oregon and Connecticut are deemed to have implemented the most comprehensive programs of wetlands protection over the past decade.

Apart from the geographic distribution, the current distribution of wetland mitigation banks in the U.S. is also reflected in these legislative initiatives. The majority of banks are found on the Southern and South Eastern states, with a smaller concentration on the west coast states of Oregon, and California. As at 2002, Florida, California, Illinois, and Alabama had the largest number of registered banks, with at least 30 in each of these states. The next highest concentration of banks occurred on the south-east coast where North Carolina held 13 approved banks, South Carolina held 10, and Virginia held 21. Other states with significant numbers of mitigation banks at that time included Texas with 15, Ohio with 13, and Oregon with 14 banks[4].

Considering the distribution of banks for the state of Georgia, the majority of mitigation banks are located on the Georgia coast in the U.S. Army Corps' district of Savannah. A profile of the 30 banks in operation in Georgia in 2002 is summarized in Table 2.1 below.

Table 2.1: Profile of Wetland Mitigation Banks in the State of Georgia - 2002

Name of Mitigation Bank	County	Watershed	Corps' District	Year Established	Status	Bank Type
Banks County DOT			Savannah		Pending	
Bazemore	Screven		Savannah	1998	Approved /Active	Single Client Bank
Bowen Mill Pond	Brooks	Suwannee River	Savannah	1997	Approved /Active	Single Client Bank
Burke County	Burke	Savannah River	Savannah	1998	Approved /Active	Single Client Bank
Callaway Farms	Harris	Chattahoochee River	Savannah	1998	Approved /Active	Private Commercial Bank

[4] All figures from Environmental Law Institute's Wetland Mitigation Bank Database

Name of Mitigation Bank	County	Watershed	Corps' District	Year Established	Status	Bank Type
Cecil Bay /Heart Pine Pond	Cecil (City)		Savannah	1999	Approved /Active	Private Commercial Bank
Chattahoochee	Fulton	Chattahoochee River	Savannah	2002	Approved /Active	Private Commercial Bank
Cherry Creek	Lowndes		Savannah	2000	Approved /Active	Private Commercial Bank
Etowah River Mitigation Preserve	Dawson	Alabama, Coosa, Tallapoosa (ACT)	Savannah	2000	Approved /Active	Public Commercial Bank
Etowah River Stream	Forsyth	Coosa River	Savannah	2001	Approved /Active	Private Commercial Bank
Flint River Basin			Savannah		Pending	
Fort Stewart	Fort Stewart (City)		Savannah	2000	Approved /Active	Public
GA-DOT Black Creek Stream			Savannah		Pending	
Hartsfield Atlanta Airport	Fayetteville (City)	Flint River	Savannah	1999	Approved /Active	Single Client Bank
Holy Ghost	Rockdale		Savannah	1996	Approved /Active	Private Commercial Bank
Indian Creek	Colquitt	Suwannee River	Savannah	2000	Approved /Active	Single Client Bank
Marshlands Plantation Inc.	Camden	Satilla	Savannah	1996	Approved /Active	Private Commercial Bank
Millhaven			Savannah	1992	Approved /Active	Private Commercial Bank
Montezuma Mitigation Site	Macon		Savannah	1998	Approved /Active	Single Client Bank
Moreland Place Bottom	Terrell		Savannah	2000	Approved /Active	Private Commercial Bank
Mulberry River	Barrow	Upper Oconee River	Savannah	2000	Approved /Active	Private Commercial Bank
Ogeechee River	Bryan, Richmond Hill (City)	Ogeechee River	Savannah	1999	Approved /Active	Private Commercial Bank
Old Thorn Pond	Bulloch, Stilson (City)	Ogeechee River	Savannah	1998	Approved /Active	Private Commercial Bank

Name of Mitigation Bank	County	Watershed	Corps' District	Year Established	Status	Bank Type
Phinizy Swamp (Merry Land Brickyard)	Augusta (City)	Savannah	Savannah	2000	Approved /Active	Private Commercial Bank
Pine South	Jefferson	Ogeechee River	Savannah	2000	Approved /Active	Private Commercial Bank
Prater Island	Whitfield, Dalton (City)		Savannah	2001	Approved /Active	Single Client Bank
Pritchett			Savannah		Pending	
Raleigh Joyce Tract	Mont-gomery	Altamaha River	Savannah	1998	Approved /Active	Single Client Bank
Satilla River	Camden	Satilla	Savannah	1996	Approved /Active	Private Commercial Bank
Wrayswood Bank			Savannah		Pending	

Source: ELI Wetlands Database – www2.eli.org, 2006

2.4 Previous Studies on Wetlands Valuation

Since public and private development decisions often impact wetlands, it is necessary to have good estimates of changes in social welfare occasioned by such impacts in order to design efficient polices for the preservation and wise use of wetlands. Boyer and Polasky (2004) observe that the extent of the impacts of decisions made is not usually clear to decision-makers, thus often resulting in inferior decisions being made with respect to the use of wetlands. And even where such impacts are taken into account, debates continue over whether some wetlands areas are being put to their maximum economic use (Woodward and Wui, 2001). In order to overcome these deficiencies, policy makers rely on value estimates of the social and economic benefits which are provided to society. According to Boyer and Polasky (2004), possibly the earliest wetland valuation study was undertaken by fisheries biologist Percy Viosca Jr, in 1926 in an attempt to estimate the value of fishing. Several valuations were later attempted towards the end of the 1960's (Brander, Florax and Vermaat, 2003), and have since provided the basis for improved policy decisions on the use of wetlands. More recently, several hundred of these valuation studies have been summarized in meta analyses. Among the most renown of these are analyses undertaken by Brander, Florax and Vermaat (2003); Warwood and Wui (2000); Boyer and Polasky (2004); Brouwer et al, (1997) and Smith and Osborne, (1996).

In the analysis by Brander, Florax and Vermaat (2003), 191 studies covering twenty-five countries on all five continents were reviewed. These studies were broadly categorized into three categories thus:

1. Studies which simply estimated values for specific wetland sites. Examples of these include Acharya, 2000; Barbier and Strand, 1998; and Cooper and Loomis, 1991.
2. Studies which review or compare already existing wetland valuations. These cases include Barbier et al, 1997; Bardeki, 1998; Dixon and Lal 1997;
3. Studies which focus on methodological development or validation of the non-market valuation application to wetlands. These examples include Bateman and Langford, 1997; Barbier 1991; Dalecki, Whitehead and Blomquist, 1993.

Additionally, most of the studies in this review focused on freshwater wetlands as well as the valuation of specific wetland ecological functions, the most common of which were flood and flow control; storm buffering; sediment retention; ground water recharge/discharge; and habitat and nursery provision for plant and animal species (Brander, Florax and Vermaat, 2003).

Considering valuation methods, the review by Brander, Florax and Vermaat, 2003 showed all of the commonly applied methodologies[5] to be in use for the range of studies. Although valuation methodologies tended to vary by wetland functions, the most commonly used methodology was the Market Price approach which was employed in ninety-one (91) studies. The Contingent Valuation method was also widely applied, being used in thirty-eight (38) studies, while the Replacement Cost Method was used in twenty-eight (28) studies.

Finally, in terms of value estimates, given the diverse range of measurement metrics[6] in the literature, standardization of valuation results was necessary in order to compare results. Standardization based on a U.S.$ per hectare by Brander, Florax and Vermaat (2003) yielded an average annual wetland value of $2,800 U.S.$ per hectare for these studies. The distribution of values was however skewed, with the median value being U.S.$150 per hectare per year. In summarizing wetland values by continent, Brander, Florax and Vermaat (2003) also found the highest wetland values were yielded for studies in Europe, North America and Australasia, while lower values were obtained for Africa, Asia, and South America.

A second meta analysis was undertaken by Woodward and Wui, (2000). In this study, forty-six (46) valuation studies were reviewed, from which thirty-nine (39) were used to conduct a meta analysis. Although most valuations were conducted in the United States, from sites such as California, Florida, Louisiana, Minnesota, North and South Carolina, the Great Lakes region, this analysis also included studies from wetlands in Nigeria, Mexico, the Baltic's, Canada and

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[5] These methods include Opportunity Cost; Market Prices; Production Function; Net Factor Income; Replacement Cost; Travel Cost Method; Hedonic Pricing; and Contingent Valuation. A notable absence among these studies was the use of the Conjoint or Stated Choice Methodologies in the assessment of wetland ecosystem attribute values.
[6] The Brander, Florax and Vermaat, study reviewed measurements in terms of WTP per household; Capitalized Values; Marginal Values per Acre. Further complications arise when incorporating differenced in currencies, as well as average values.

Sweden. These studies also assessed both urban and rural wetland regions, and applied the full range of widely used valuation methods.

Some specific studies reviewed included Amacher et al (1989) application of the Net Factor Income (NFI) method to value 6000 acres of coastal wetlands on Lake St. Clair in the Great Lakes region in the state of Michigan. This analysis yielded a value range of $737 - $2,212 per acre of wetland.

A second study used in the analysis was conducted by Breaux, Farber and Day (1995), in which theses researchers conducted an economic benefit analysis of using natural coastal wetlands systems for wastewater treatment. This study employed a Cost Savings approach to determine wetlands values for 2,680 acres of coastal wetlands in Dulac, Louisiana, resulting in estimates of $42.29 – $65.39 per acre per year.

Among the non-U.S. studies included in the analysis was a study of wetlands undertaken by Folke C. (1991) in the Martebomire on Sweden's Gotland Island in the Baltic Sea. This 8,401 acres site yielded per acre value estimates ranging from $51.39 to $141.32, using a Replacement Value methodology.

Further reviews of wetland valuation studies were carried out by Boyer and Polasky (2004). These studies focused on urban wetlands, and the application of several methodologies to value these resources in an urban context. Among the valuations studies cited were Doss and Taff, 1996; Lupi et al, 1991; and Mahan et al, 2000, all of which utilized the Hedonic Price method to assess the impact of wetlands on property values. The Mahan study revealed that property values increased by roughly $24 with a one acre increase in the size of nearby wetland areas in metropolitan Portland in the State of Oregon, while Lupi et al found increases of $47 in house values with per acre increases in wetlands in Ramsey County, Minnesota (Boyer and Polasky, 2004).

Studies applying other valuation methods were also reviewed and included valuations by Kamierczak (2001) in Louisiana, using the Replacement Cost Method; and Barbier (2000) using the Production Methods to value wetland services in Thailand.

Finally, a meta analysis conducted by Brouwer et al (1997) provides yet another set of wetland studies, all of which were conducted using the Contingent Valuation methodology (CVM), and were drawn from Crowards and Turner (1996). This analysis reviewed fifty-nine (59) studies which included Bateman, Langford and Willis, 1995; Carson and Mitchell, 1993; Cooper and Loomis, 1991; and Phillips, Hanley and Adamowicz, 1993.

2.5 Insights for the Current Research

The review of literature generated at least two key insights for the current research. The first is that the literature revealed very little application of the conjoint valuation methodology to the assessment of wetland areas.

Additionally, the review made very apparent the newness of wetlands mitigation as a social policy for the conservation of wetlands. It is anticipated that this research could enhance the body of knowledge towards future enhanced application of wetlands mitigation as a natural resource preservation policy measure.

CHAPTER 3

METHODOLOGICAL APPROACH AND THEORETICAL MODEL

This chapter discusses the methodological approach to deriving consumer estimates by reviewing conjoint analysis, and elaborating on the theoretical model to be estimated. The chapter first explores the mechanics of conjoint analysis as a means of assessing natural resource values, and then briefly discusses the theoretical framework for eliciting consumer values. Finally, the theoretical model for consumer valuation is developed.

3.1 Conjoint Analysis – A Theoretical Framework

A survey of the contemporary literature on stated preference methods for environmental resource valuation shows that conjoint analysis has had relatively limited application in economics (Griner and Faber 2000), and its use in the assessment of natural and environmental resources is relatively new (Adamowicz, Louviere, and Swait, 1998). The approach derives from the theoretical foundations of attribute based consumer choice as promulgated by Lancaster (1966), as well as random utility theory which forms the basis for models of consumer judgment and decision making (McFadden, 1986 Manski, 1977). In its earliest applications, conjoint analysis was used in transportation economics and market research, and its extension to environmental resource valuation has been pioneered by Adamowicz, Louviere, and Swait (1998, Adamowicz et al, 1998) since the early 1990's.

Specifically, conjoint analysis has been undertaken by Adamowicz et al (1999) to measure passive use values for woodland caribou habitant enhancement programs in West

Central Alberta, and by Griner and Farber (1999) to value water quality improvements for acid mine degraded watersheds in Western Pennsylvania. Mathews et al (1995) also elaborated on the application of conjoint analysis in the measurement of inter-temporal and habitat trade-offs to consumers as a method of arriving at economic damage assessments for the degradation of natural resources.

Conjoint analysis is an attribute-based valuation methodology which affords a partial valuation analysis of a natural resource. Unlike other valuation methods[7] which assess resource values as a wholly integrated entity, this method allows for the valuation of various natural resource attributes, and as such provides a framework for tradeoff analysis of attribute combinations or choice sets. The data, gathered through a consumer survey, are elicited from this analysis as consumer responses to these choice sets, and are offered as ratings or rankings of preferences for paired comparisons (Huang, Haab, and Whitehead, 1997). Huang, Haab, and Whitehead also note that a further advantage of conjoint analysis is provision of a more market like setting in which consumers face a series of choice options, varying characteristics, and prices. This is purported to improve the validity of stated preferences.

At the same time, a notable drawback of the method is that scenarios may be cognitively challenging to respondents where it is applied to a resource with many characteristics, and multiple scenarios. This represents a major limitation to the applicability of conjoint methods in the valuation of natural resources. Given this constraint, the actual implementation of conjoint analysis involves an elaborate process of experimental design in order to develop statistically efficient choice sets of resource attributes from which consumers are asked to choose.

It also requires extensive preliminary analyses of relevant consumers in order to identify the appropriate attributes for valuation as well as the feasibility of the valuation context

[7] These include *contingent valuation, hedonic pricing, production function analysis* and *travel cost methods.*

contemplated for the analysis. Adamowicz, Louvierre, and Swait (1998) summarize the application of conjoint analysis to involve the following seven tasks[8]:

1. Characterization of the decision problem
2. Attribute level selection
3. Experimental design development
4. Questionnaire development
5. Sample sizing and data collection
6. Model Estimation
7. Decision support system

Characterization of the decision problem is the most important stage of the valuation process since it frames the analysis and provides the basis for contriving the economic context in which consumer choices may be made. This task involves the conduct of focus group discussions, cognitive interviews with experts, and literature searches. Ultimately, the aim of this stage of the research is to understand how consumers may likely arrive at a decision question, define the dimensions of the resource to be evaluated, search out possible alternatives and attributes, construct choice sets, and eventually make choice decisions. This stage of the analysis also explores relevant consumer demographics which might be important in informing the sampling plan to be used in subsequent stages of the research.

Attribute selection involves defining the number and nature of each attribute to be used in the research. Although this process draws heavily from the analysis above, attribute identification is also defined based on the researcher's previous experience, as well as secondary

[8] Adamowicz et al use the term *Stated Choice Analysis* to define the evolution of conjoint analysis as an attribute-based application to the valuation of natural resources.

and/or primary exploratory research. Along with each identified attribute it is also necessary to specify the levels which would be applied in the analysis. Levels are typically specified as numbers or words, but may also be represented as charts, or graphics. Adamowicz, Louviere, and Swait (1998) note that levels should be chosen so as to adequately reflect the relevant range of variation in the evaluated resource. Considering an example, a choice design may be developed to evaluate consumer's preferences for different types of vehicles. For this design, the four (4) attributes may be identified for each vehicle to be 1) vehicle type, 2) price, 3) engine capacity, and 4) transmission type. For each attribute, *levels* may be further specified with vehicle type being 'sub-compacts', 'trucks', 'minivans', and 'sport utility vehicles-SUV)' while price may have levels of '$10,000 or less', and 'Over $10,000'. Engine capacity could also be specified at 3 levels – '1600cc or less', '1800cc', or 'Over 1800cc'. Finally transmission type may be either 'Automatic' or 'Manual'. This design is summarized in Table 3.1, and is shown to have four attributes, two of which have 2 levels each, one attribute has 3 levels, and one has 4 levels. This results in a $\mathbf{2^2 * 3^1 * 4^1}$ choice design with 48 treatment combinations or choice sets over which car purchasers would have to choose.

Table 3.1: Example of Choice Experiment Design for Vehicle Purchase

Attribute	**Number of Levels**	**Level Labels**
Vehicle Type	4	1= 'Sub-compact' : 2='Truck' 3= 'Minivan : 4='SUV'
Price	2	1= '$10,000 or less' : 2='Over $10,000'
Engine Capacity	3	1= '1600cc or less': 2='1800cc' 3='Over 1800cc'
Transmission Type	2	1= 'Manual' : 2='Automatic'

Having determined the attributes and levels to be used, some form of orthogonal experimental design is applied to generate relevant attribute profiles for the analysis. Adamowicz, Louviere, and Swait (1998) define an attribute profile as a "single attribute combination in a complete factorial combination of attribute levels". These designs are usually main-effects designs, which under the assumption of no interaction effects, are sufficient for capturing consumer preferences within a conjoint analysis framework[9]. Kurfeld (2000) observes that typical factorial designs can rapidly generate a very large sample of profiles, and therefore recommends the extraction of statistically significant fractions of these designs for use in empirical research. The criterion for extracting these fractions is to maximize the level o *independence or orthogonality* among the attributes, so that each attribute becomes a clear basis for consumer choice. Where orthogonality is maximized, the design is said to be efficient. Optimal fractional factorial designs are usually extracted using sophisticated computer algorithms.

Questionnaire development is largely a roll out of the optimal choice sets onto paper in a manner that facilitates efficient and unbiased administration in a survey. In practice, it is recommended that each respondent should be subjected to no more than eight choice sets (Adamowicz, Louviere, and Swait, 2000). Where the optimal design exceeds this optimal number of sets the questionnaire should be designed to be administered to various sample blocks. Besides the choice scenarios, additional sections may be included in the questionnaire to capture data such as respondent demographics, psychographic profiles, and respondent behavior in terms of use or other forms of engagement of the natural resource to be assessed. Finally, an essential element of the questionnaire development process is its pre-testing, which would serve to

[9] Louviere notes that this is a key assumption; if it is violated, the use of main effects experimental design models could lead to potentially large biases in estimated utility parameters.

validate respondents understanding of the choice scenario, as well as to clarify any unanticipated aspects in sampling and administration of the survey instrument.

Sample sizing and data collection considerations involve decisions about desired levels of accuracy and data collection costs. This trade-off is often further complicated by estimations which might involve sub-group or individual differences, such as sample blocks, as well as the total number of choice sets, and the number of choice sets, and the number of choice alternatives in a given scenario.

The data gathered for this type of model are classically categorized as limited dependent data, where respondents express choice as a discrete binary variable. Such data are most commonly estimated as a Multinomial Logit Model (MNL), using the maximum likelihood estimation criterion (Griner and Farber, 1999). This is discussed further below.

Finally, Adamowicz, Louviere and Swait (1998) identify the need for a decision support system which gives transparency to the process of choice model estimation, and allows for the results to be made easily accessible to non-technical parties. This was considered to be especially important where the results of analysis are to be used for direct policy decisions, or in environmental damage assessments procedures, where increased access might be critical for building confidence, and fostering acceptance of the results.

3.2 Economic Theory Underlying Consumer Choice

In order to make rational choices among many policy options, economic theory appeals to the notion of welfare maximization as the appropriate criterion for guiding choice (Freeman M. A., 1999). The fundamentals of this theory are based on consumers maximizing utility given their budget constraint, while firms as producers of goods and services, maximize their profit subject to the available production technology. In the context of the broader society, resources are considered to be efficiently allocated among competing interests when it is not possible to enhance the well-being of one group without reducing that of the others. Policy proposals which achieve this allocative condition, given the total available resources are said to be Pareto Optimal. Because it is difficult to achieve this ideal in practice, the challenge in efficient policy design, is to propose social and economic changes which maximize social welfare at minimum costs. Economic theory specifies the appropriate measure of individual welfare change as the *Hicksian Surplus* which measures the amount of compensation to be given or received by a consumer in order to maintain the same level of utility for any policy change. The relevant welfare measure used in applied policy analysis depends on the nature of the proposed policy change, as well as assumptions made about the *consumer's rights* in respect of the proposed change. Hence, policies which result in changes in relative prices faced by the consumer are measured as *equivalent* or *compensating variations*, while policies which change the quantities[10] of a good available to the consumer are measured as *equivalent* or *compensating surplus*. Considering rights, if it is assumed that the consumer has a right to the initial or pre-policy utility level, then compensating variation and compensating surplus are the appropriate welfare measures for the policy change. Similarly, if the assumed consumer right is for the subsequent level of utility arising from the policy, then equivalent variation and equivalent surplus are the relevant welfare measures. Judgments about the specific rights of the consumer are normative, and depend on the overall system of ethics and values adopted by consensus in the society in which the policy is to be implemented. Because Hicksian welfare measures are based on unobserved consumer utility, the *Marshallian surplus* is used in practice, since this is based on

[10] Note that these measures are for restricted or rationed quantity changes where optimizing adjustments are not allowed.

observed market prices and consumer incomes. Depending on the direction of the policy change[11], these measures estimate the above Hicksian welfare changes as *willingness-to-pay (WTP)* or *willingness to accept compensation (WTAC)* estimates.

Since consumers derive utility from the use of private and public goods as well as natural resources, policies which bring about changes either in the quantities or prices of these goods will cause changes in the Hicksian welfare measures discussed above. Natural resources include environmental goods such as wetlands, clean air and water, as well as amenities, such as scenic views and wildlife. In order to make efficient policy choices related to public, non-marketed goods such as natural resources, WTP/WTAC estimates are used to assess consumer's value for these resources. Because of the particular public nature of most natural resources, economic theory recognizes a range of components of total economic value which may be obtained as a part of overall welfare benefits gained by consumers in the use of natural resources. Freeman (1999) identifies these components broadly to include active use values, which measure consumer's values from actively using the resource, as well as passive use values which measure the consumer's satisfaction from the existence of the resource.

The analysis of a policy proposal to change the quantity of wetlands through wetlands mitigation banking in coastal Georgia is based on the theoretical framework discussed above. The key assumptions and methodological approach to the analysis are discussed in the sections which follow.

[11] That is an increase or decrease in quantities or prices.

3.3 Specification of Analytical Models

The conjoint analysis model structure falls into the category of discrete choice models in which the data for analysis are dichotomous (Yes/No) type responses to a number of available alternative wetland mitigation packages from which consumers make choices.

This data structure allows for analysis under the Random Utility Framework, in which consumers make choices so as to maximize utility. The utility (Ui) associated with each chosen alternative is hypothesized to be given by the indirect utility function:

$$U_i = V_i + \varepsilon_I \qquad (1)$$

where

V_i = a systematic component or predictable portion of utility,

and

ε_i = an error component.

V_i in-turn is given by:

$$V_i = \Sigma_k \beta_{ik} X_{ikn} \qquad (2)$$

where:

$X_i k_n$ represents the value for the wetland mitigation attribute, k for consumer n and choice option i

β_{ik} is the coefficient associated with this attribute.

According to Adamowicz, Louviere, and Swait (1998) the presence of the random component in the random utility function permits the analyst to make probabilistic statements about consumer choice. Hence, a logit model which estimates the probability of such choices may be derived from equation (1) thus:

$$\mathbf{Pr}\ \{i\} = e^{s\mathbf{V}_i} \Big/ \Sigma_{\,i}\, e^{s\mathbf{V}_j} \qquad (3)$$

In a probabilistic framework, a consumer chooses a wetland mitigation package i over package j, if the utility of i is greater than the utility of j. That is, where:

$$V_i + \boldsymbol{\varepsilon_i} > V_j + \boldsymbol{\varepsilon_i} \qquad (4)$$

On the assumption of the distribution of the error component of the utility function, as being IIA (Independent of Irrelevant Alternatives) across alternatives and individuals, and Gumbel-Shaped, a Multinomial Logit Model (MNL) may be specified to estimate the choice probabilities (Adamowicz, Louviere, and Swait , 1998). Typically these models are estimated by the method of Maximum Likelihood.

Model estimation yields choice probabilities for a range of prices or bids used in the conjoint model. These data are used to estimate a bid curve, the area under which represents the estimated marginal consumer willingness to pay for the proposed environmental change. Hanemann (1984) and Cameron (1988) document two approaches to estimating WTP based on the derived bid curves. Because the model estimation takes place under a random utility framework, the derived WTP measures are actually mean or expected WTP estimates.

The Hanemann approach was developed based on the work of Bishop, Heberlein and Kealy (1983) who tested one each of a hypothetical and simulated market model in a valuation of WTP for hunting permits in East Central Wisconsin. It is based on the assumption that the consumer holds the right to the status quo in terms of environmental resources, and yields an estimated Hicksian compensating surplus measure as the change in consumer welfare resulting from a policy change.

While the Hanemann approach is the more widely utilized, it has been challenged by Cameron (1988) who proposed a simpler and more direct method for extracting the utility-theoretic inverse Hicksian demand functions. Cameron proposed that this approach was less restrictive than Hanemann's, and that it utilized more efficiently the information captured under utility specifications of the MNL model. Based on the Cameron approach, an estimate of consumer WTP for natural resource changes is given by the equation:

$$\text{Mean WTP}_i = E[CS_i] = |\alpha + \sum(\beta_i Y_i)/ \beta_1|$$

where:

$E[CS_i]$	=	Mean Compensating Surplus per Consumer *i*
α	=	Estimated MNL Regression Constant
β_i	=	Estimated MNL Regression Coefficients for Attributes *i* $(i > 1)$
β_1	=	Estimated MNL Regression Coefficients for the Bid Price Variable
Y_i	=	Mean Environmental Attribute *i*

Figure 3.1 below shows the Cameron approach estimated area of compensating surplus as the region under the bid curve.

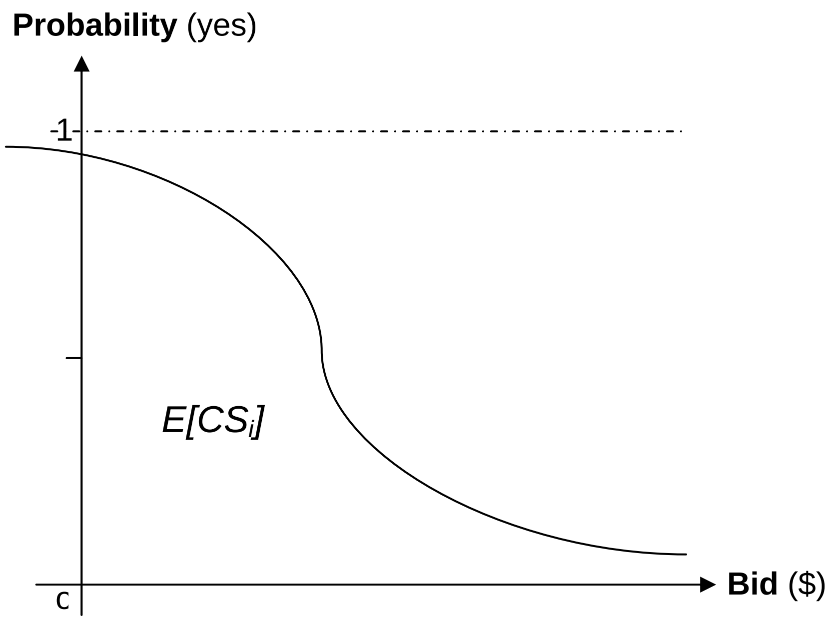

Figure 3.1: Estimate of Welfare Measure as Area under Bid Curve

In this analysis, the estimated bid curve was derived from the MNL regression, and the coefficients were applied in the Cameron method to derived consumer's willingness to pay for mitigation policies for wetlands in Georgia.

CHAPTER 4

DATA AND EMPIRICAL MODEL

This chapter discusses the empirical model, as well as decisions and tasks undertaken to achieve the research objectives. It outlines the practical issues related to the survey and experimental design, the specification of the empirical model, and the development of the sample plan. The chapter also discusses the implementation of the field survey as well as the approach to model estimation.

4.1 Survey Design

The data for this research were collected using a mail survey, and include consumer willingness to pay for wetland protection policies for the Georgia coast, consumer ratings on a number of psychographic statements, and respondent demographics. The survey design drew heavily from past studies in which the conjoint methodology was applied in the assessment of a natural resource. Among these was a study by Bergstrom and Volinskiy (2004) which examined public preferences and values for the purchase of agricultural conservation easement programs in Georgia, and another by Ozdemir (2003) in which the convergent validity of conjoint values for farmland conservation easements was assessed. Additionally, reviews of the status of wetlands and fishery resources in coastal Georgia (Wall, 2003; Geer, 2003) were used to inform the technical profile of the survey design. Although budgetary limitations precluded the conduct of focus group sessions for the survey design, extensive literature reviews as well as two elaborate survey pre-tests were undertaken in order to given confidence to the final survey design.

The survey package comprised of a cover letter, an information booklet, the final questionnaire, and an addressed return mailing envelope. The cover letter introduced the research, and solicited the respondent's cooperation in competing and returning the enclosed questionnaire, while at the same time providing all necessary re-assurances of respondent confidentiality. The information booklet provided respondents with details on the current status of wetlands in the US in general and in coastal Georgia in particular. It also offered a brief profile on the benefits and uses of wetlands, and summarized the salient elements of wetland mitigation banking as a policy approach towards the preservation of wetlands. A map of the relevant counties to be targeted for policy intervention on the Georgia coast was also included in order to better focus respondents to the specific geographic region for which the policy intervention is contemplated.

The final questionnaire comprised of six (6) sections. Section one contained a set of True/False questions, which were provided to assess whether respondents had in fact reviewed the information booklet provided. This was done so as to ensure that respondents were informed of the policy issue under consideration in the research. Section two, provided respondent validation questions in order to minimize respondent bias by excluding respondents whose background might involve direct and routine interaction with wetlands and wetlands issues. The third section asked respondents to indicate what level of priority they felt should be placed on preserving different attributes of wetlands, as well as how the results of wetland mitigation programmes should be prioritized. Section four of the questionnaire presented the conjoint questions for four (4) wetland mitigation policy programs sets in Georgia. Each program set asked two questions about consumer's choice between two alternatives, and whether they would choose either of the policy alternatives proposed for each wetland mitigation program.

In Section five respondents were asked to rate a number of psychographic statements which assessed either the level of importance which they ascribed to wetland issues, or their level of agreement or disagreement with relevant statements about wetlands. Finally section six gathered general demographic data which were used to validate the consumer choices reflected in the conjoint analysis.

4.1.1 Survey Attributes and Levels

A key aspect of the survey design was the determination of the relevant conjoint attributes and levels. Since the research objective was to determine consumer willingness to pay for a wetlands mitigation policy in coastal Georgia, six (6) attributes were identified. Four of these were specified as likely policy actions, either in terms of species preservation or protection of wetland functions. Because it was possible for any broad-based policy measure to simultaneously benefit several species, policy options were identified as wetland preservation or protection actions which would *uniquely* benefit the specific target species. These actions included control measures such as manipulation of species harvest seasons, or protection of vulnerable stages of the species' life cycle. This specification was critical in order to control for colinearity effects which might exist between different protection strategies, since a single wetland protection strategy could impact several wetland species simultaneously. To overcome this weakness, wetland mitigation policy attributes identified to include a species specific technical strategy for protecting wetlands. The strategies identified were those which were widely utilized by the Georgia Department of Natural Resources for species protection on the Georgia coast (Geer and Robertson, 2003).

Two additional attributes were also defined, the first of which served as a scale factor for measuring the relative scope of each mitigation program. The second was a price variable which served as the monetary stimulus on which respondents would base their willingness to pay.

The six attribute variables used in the conjoint design are as follows:

1. Protection of blue crabs by limiting harvests of mature females
2. Protection of white shrimp by imposing shorter harvest season
3. Prevention of saltwater intrusion onto ground water for drinking
4. Protection of recreational Red-Drum by banning commercial harvests during the brooding season
5. Total acres of wetland preserved over the next five years
6. One-time cost to your household in 2005

In terms of levels, the first four attributes were specified at two levels each, while the final two were specified at four levels each. In the case of wetland acreage levels, several factors were used to specify the level of wetlands to be preserved under any wetlands mitigation policy in Georgia. Firstly, current estimates of coastal wetlands/marshlands in Georgia are estimated at 378,000 acres (NOAA, 2000), while the total quantity of marshland & coastal estuarine areas was assessed at 700,000 acres (EPA, 2004). Note that this excludes inland wetlands, which together with all coastal wetlands are estimated at 5 million acres for the state of Georgia. The US-EPA also estimates the total decline in wetlands in the state of Georgia over past three decades to be approximately 23% of the total or roughly 87,000 acres. This figure implies that annual decline in wetland was 2,900 acres per year. This estimate was rounded off to 3,000 acres per year, and was used as the minimum amount of land to be protected under any mitigation program, in order to achieve a no net loss of wetlands by any policy proposed. Since

3,000 acres represents approx 0.8% of the current total wetlands on the GA coast, levels were set using increments of protected wetland acreages by a factor of 5. On this basis, the following levels were derived for the amounts of wetlands preserved over a five year period:

Amount of Land Preserved by Policy (Over a five year Period)

1. 15,000 acres
2. 75,000 acres
3. 150,000 acres
4. 225,000 acres

It was assumed that these levels of wetlands changes should have significant impacts on the species identified for protection under the policies proposed in the research.

The monetary stimulus or price level was fixed for the study based on the pretests undertaken for the survey. The first of two pre-tests was administered in the City of Athens, Georgia in mid-November, 2004 to a sample of 25 respondents which comprised a significant share of students of the University of Georgia, as well as residents. The pre-test price level had a range of $10 to $75, with intermediate values being $25, and $50. The analysis of choice by income demographics indicated that more than 64% of respondents chose programs within the upper price ranges. This was even the case for low-income respondents[12] and suggested that the proposed price range was too low. The range was therefore increased by roughly 100%, resulting in new price levels of $25, $60, $100, and $150. This range was tested in the second pre-test conducted in Athens, Georgia in March- April, 2005, and yielded a more even distribution of responses among the various income groups. This price range was therefore retained for the final survey instrument. The final matrix of attributes and levels which was used to generate the choice sets is presented in Table 4.1 below.

[12] Because of the significant number of students in the pre-test, it was assumed that those reporting annual incomes of $15,000 or less were students.

Table 4.1: Matrix of Attributes and Levels for Conjoint Design

Attribute	Variable Name	Number of Levels	Level Labels
Protection of Blue Crabs by Limiting Harvests of Mature Females	X1	2	1= 'Yes' : 2='No'
Protection of White Shrimp by Imposing a Shorter Harvest Season	X2	2	1= 'Yes' : 2='No'
Prevention of Salt Water Intrusion into Ground Water for Drinking	X3	2	1= 'Yes' : 2='No'
Protection of Recreational Red Drum by Banning Commercial Harvests During the Brooding Season	X4	2	1= 'Yes' : 2='No'
Total Acres of Wetlands Preserved over the Next Five Years	X5	4	1= '15,000': 2='75,000' 3= '150,000': 4='225,000'
One Time Cost to Your Household in 2005	X6	4	1=$25; 2=$60; 3=$100; 4=$150;

4.1.2 Experimental Design

The findings of the previous stage of the research were used to develop a choice model design for the conjoint analysis. The choice design is necessary in order to evaluate consumer utility preferences for the various wetland preservation elements identified above, and forms the basis for examining substitutability for various elements of wetland preservation policies among consumers in coastal Georgia.

These elements are presented as different choice combinations or *choice sets*, which contain various levels of each attribute. Each package was also presented at various price levels which represent consumer's willingness to pay for wetland mitigation policies. According to experimental design theory[13], the above matrix should result in a $2^4 * 4^2$ experimental design which will require 256 runs (or treatment combinations) for a *full factorial* examination of the design.

[13] Montgomery Douglas C. *'Design and Analysis of Experiments – 3rd Ed'* , Wiley, 1994

Recognizing that consumers would not be able to feasibly evaluate all 256 treatment combinations, the literature recommends a *Fractional Factorial Design* where only a sub-set of the treatment combinations are presented for evaluation. While a number of computer algorithms are available for this purpose, the ***mktruns*** and ***mktdes*** macros developed by Kuhfeld (2000) of the SAS Institute were applied to generate an optimal Fractional Factorial Design based on the attribute matrix in Table 4.1.

This algorithm first generates the full factorial design (or candidate set) from which, by an iterative process, it then extracts the optimal fraction for examination based on the criterion of maximum choice design efficiency[14].

Kuhfeld (2000) notes that design efficiency depends on the size of the covariance matrix associated with the distribution of weights of the attributes which influence consumer choice. Maximum efficiency is attained where the size of the covariance matrix is *minimized* – that is, the weights tend to become more stable over a number of consumers. The efficiency measure is designated according to how the size of the covariance matrix is measured.

A-efficiency for instance, is based on the *average variance* around the estimated parameters of a model, while *D-efficiency* is based on the *determinant* of the covariance matrix. A third index – *G-efficiency*, is based on the maximum standard error for prediction over all elements in a full design or candidate set. D-efficiency, is regarded as being more robust than A- or G-efficiency, and was therefore employed as the efficiency criterion for this choice design. The resulting optimal fraction from the SAS analysis is presented in Table 4.2 below.

[14] See Kuhfeld et al *'A General Method for Constructing Efficient Choice Designs'*, SAS Institute, 1996.

Table 4.2: Optimal Design Fractions for Choice Design

Wetlands Block Design Summary.lst - Optimal Fractions

Some Reasonable Design Sizes (Saturated=11)	Violations	Cannot Be Divided By
16	0	
32	0	
24	1	16
12	9	8 16
20	9	8 16
28	9	8 16
14	17	4 8 16
18	17	4 8 16
22	17	4 8 16
26	17	4 8 16

Table 4.3: Optimal Choice Design

Wetlands Block Design Summary.lst- Design Optimization - Optex 15

Block	x1	x2	x3	x4	x5	x6
1	2	1	2	2	4	1
1	1	1	1	1	3	2
1	1	2	1	2	1	4
1	2	2	2	1	3	3
2	1	2	1	2	4	3
2	2	1	2	2	1	2
2	1	1	1	1	2	1
2	2	2	2	1	2	4
3	2	1	1	2	3	4
3	1	2	2	2	2	2
3	1	1	2	1	1	3
3	2	2	1	1	1	1
4	1	2	2	2	3	1
4	2	1	1	2	2	3
4	1	1	2	1	4	4
4	2	2	1	1	4	2

Note: In table 4.3, each column (X1..X6) represents the 6 attributes specified in the choice design. Each row represents the combination of levels of each attribute which result in an individual choice set. Hence this matrix represents the 16 combinations of attribute levels, which optimize the choice design. See Table 4.1.

Table 4.4: Efficiency Measures for Optimal Choice Design

Wetlands Block Design Summary.lst - Design Optimization 14

The OPTEX Procedure

Design Number	D-Efficiency	A-Efficiency	G-Efficiency	Average Prediction Standard Error
1	100.0000	100.0000	100.000	0.8292
2	100.0000	100.0000	100.000	0.8292
3	98.7934	97.4684	93.5414	0.8399
4	98.7934	97.4684	93.5414	0.8399
5	97.0304	93.9788	86.1838	0.8553

From the table, two efficient designs were obtained at 16 and 32 choice sets respectively. Efficiency is gauged by the number of violations (column 2) to the orthogonality condition on which the design algorithm is implemented in order to yield choice sets. These violations are further confirmed by tests of divisibility by factors of the design matrix, and are shown under the column heading "Cannot Be Divided By" in Table 4.2. Based on these results the design size was limited to 16 runs (1/16 fraction). This optimal design output and its associated efficiency measures from SAS are shown in Tables, 4.3 and 4.4 respectively.

The design optimization results suggest that an efficient fractional design of 16 choice sets (Table 4.3) would adequately elicit consumer's utility preferences for wetland mitigation policies which lead to preservation of coastal wetlands in Georgia. It was however considered that given the complexity of the resource to be evaluated, 16 choice sets would still be too many for consumers to reliably and consistently exercise their preferences through choice of an

Table 4.5: The Conjoint Question – Wetland Mitigation Policies

In this section, four (4) sets of wetland mitigation programs are presented. Suppose you had to vote between two wetland mitigation programs, Program A and Program B. These programs differ in terms of attributes of the wetlands that would receive priority in the bidding process, the number of acres in the program and the cost to you. Assuming also that there are limited funds to implement the program, in which case each program would be implemented *only in those locations in coastal Georgia* for which the program has priority. For each of these four set of programs, please tell us which of the two bidding programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or do nothing.

Program Set 1:

Attributes	Wetland Mitigation Program A	Wetland Mitigation Program B
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	No	Yes
Protection of White Shrimp by Imposing a Shorter Harvest Season	Yes	Yes
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	No	Yes
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	No	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	225,000	150,000
One time Cost to your Household in 2005	$25	$60

1. Which program do you prefer?
   (PLEASE CIRCLE ONE NUMBER)

   1 Program A
   2 Program B

2. Now suppose you could vote between Program A, Program B and doing nothing. How would you vote? (PLEASE CIRCLE ONE NUMBER)

   1 I would vote for Program A
   2 I would vote for Program B
   3 I would not vote for either program

optimal mitigation policy. These choice sets were therefore randomized and then allocated into four blocks representing the four regions of North, South, East and West Georgia. This randomized block design was then used in the development of the conjoint questionnaire for data collection. The mechanics of transferring the experimental design into the conjoint questionnaire are presented in the Appendix. Table 4.5 provides an example of one of the 16 resulting conjoint questions used in the final questionnaire.

4.2 The Sample Plan

Sampling for this research was conducted by Survey Sampling International (SSI), a global research sample provider. SSI applied an area sampling methodology using counties from Designated Market Areas in the state of Georgia as the primary sampling unit. Sampling units were drawn from the four geographic regions used as blocks, and individual respondents were sub-sampled by ZIP codes from each block.

Overall, a sample of six hundred (600) respondents was drawn from four blocks, each of which contained 12 randomly selected counties. Hence, sampling was done on 48 counties, and 150 respondents were drawn from each block. The sample containing respondent's name, address, telephone number and 9-digit ZIP code was supplied to the researcher as an electronic file in order to facilitate mail-merge of envelopes for a mail survey. Table 4.6 below lists the counties by block sampled for the research.

Table 4.6: Counties by Block – Wetlands Survey

BLOCK 1: NORTH	BLOCK 2: WEST	BLOCK 3: EAST	BLOCK 4: SOUTH
- Dade	- Haralson	- Morgan	- Terrell
- Walker	- Coweta	- Taliaferro	- Decatur
- Gordon	- Meriwether	- Hancock	- Colquitt
- Hall	- Chattahoochee	- Baldwin	- Lanier
- Franklin	- Taylor	- Richmond	- Wayne
- Cobb	- Schley	- Emanuel	- Glynn
- Walton	- Newton	- Putnam	- Dooly
- Barrow	- Pike	- Warren	- Coffee
- Catoosa	- Monroe	- Columbia	- Cook
- Forsyth	- Harris	- Washington	- Long
- Oconee	- Peach	- Jefferson	- Ware
- Wilkes	- Macon	- Johnson	- Camden

4.3 The Empirical Model

Based on the utility maximization framework discussed in the previous chapter, the conjoint choice format provides the opportunity for the consumer to maximize his or her utility by choosing the appropriate wetlands mitigation policy which yields the highest benefits. The empirical model to be tested in this framework therefore includes four (4) ecological variables, the preservation of which might be expected to yield consumer benefits, as well as a scale[15] and price variable. The following six (6) attributes were specified as empirical variables in the conjoint model:

- Protection of Blue Crabs by Limiting Harvests of Mature Females
- Protection of White Shrimp by Imposing a Shorter Harvest Season
- Prevention of Salt Water Intrusion into Ground Water for Drinking
- Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season
- Total Acres of Wetlands Preserved Over the Next Five Years
- One time Cost to your Household in 2005

[15] Acreage of land preserved was used as a scale variable in the model.

Since the proposed policies in the conjoint model give varying priorities to different ecological attributes, the four ecological attributes are entered as dummy variables in the model. A summary of the model variables is presented in Table 4.7.

Table 4.7: Variables in the Conjoint Model:

Variable	Description	Code
Protection of Blue Crabs by Limiting Harvests of Mature Females	1 = 'Yes' 0 = 'No'	BLUCRAB
Protection of White Shrimp by Imposing a Shorter Harvest Season	1 = 'Yes' 0 = 'No'	WSHRIMP
Prevention of Salt Water Intrusion into Ground Water for Drinking	1 = 'Yes' 0 = 'No'	SLTWATR
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	1 = 'Yes' 0 = 'No'	RDTROUT
Total Acres of Wetlands Preserved Over the Next Five Years	15,000 acres 75,000 acres 150,000 acres 225,000 acres	TOTACRE
One time Cost to your Household in 2005	\$25 \$60 \$100 \$150	ONECOST

Recalling the random utility framework discussed in chapter 3, we note that individuals make choices over various policy options depending on their expected utility to be derived from various combinations of policy attributes. The empirical model can therefore be defined as a function which relates consumer choice to wetland policy attributes. In this case, policy attributes are the ecological species and services which are to be protected under each proposed wetland mitigation program, and consumers are assumed to make policy choices so as to maximize their expected utility.

The empirical model is therefore defined as follows:

$$CHOICE = CONSTANT + \beta_1 BLUCRAB + \beta_2 WSHRIMP + \beta_3 SLTWATR + \beta_4 RDTROUT + \beta_5 TOTACRE + \beta_6 ONECOST$$

Of the seven right-hand-side variables in the model, BLUCRAB, WSHRIMP, SLTWATR and RDTROUT were dummy variables representing either a priority or no priority for protection under each proposed wetlands mitigation policy.

Hence the data for these variables were read as '1', where protection of the relevant attribute was a priority in the policy, and '0' where it was not a priority. TOTACRE and ONECOST were continuous variables, reflecting the scale factor in terms of acreage of land protected in each proposal, and the relative cost to households in supporting each mitigation proposal. CONSTANT represents the constant of regression required for feasible estimation of the model. Finally, the discrete dichotomous choice of each wetlands mitigation programme which is dependent on the combination of right-hand side variables is represented in the model by the CHOICE variable.

Economic theory suggests that the expected signs of the estimated parameters in this model should all be positive, except for ONECOST, which should be negative to reflect the classical price quantity demand function relationship. The choice scenario imposed by the conjoint analysis of the wetlands policy results in a probabilistic or random utility framework for consumer choice. And since consumers express their preferences under a dichotomous (Yes/No) choice scenario, the resulting choices generate multiple data points for a limited dependent stochastic model. According to McFadden (1986), this type of model is usually estimated as a multinomial logit (MNL) model. MNL model estimation was therefore undertaken to yield choice probabilities for the alternative wetlands mitigation programmes proposed in the study. These probabilities were used subsequently to calculate the consumer's willingness to pay for various combinations of policy attributes in each proposed wetlands mitigation program.

4.4 The Field Survey

The data for this study were gathered using a mail survey. The survey was administered in accordance with the sample plan outlined above and was implemented in two mailings. The first mailing of 600 questionnaires was done during the early summer period of June to Mid-July, 2005. Each mailed envelope contained an information booklet, the questionnaire, a self addressed return envelope, and a letter of introduction which sought the consumer's cooperation in completing the survey.

Six weeks later, a follow-up mailing was made to the non-responding sub-sample with a reminder card further encouraging them to complete the survey. Respondents were given a further six weeks to complete the survey, and the data collection exercise was deemed to be complete by mid-September, 2005. While ideally responses to these types of surveys are significantly enhanced with incentives, budgetary limitations precluded the offering of such incentives in this research.

4.5 Data Analysis and Model Estimation

The model was estimated using the CLOGIT procedure in LIMDEP®. For this procedure, the data were set up as two rows of choice sets for each wetland program as well as a choice variable to capture consumer choice. Two rows were required in order to allow for consumers' follow-up choice when they made a choice between the wetland program and the status quo position. Hence each program set resulted in five (5) rows of data. Given that each questionnaire asked respondents to choose over four sets of wetland programs, each questionnaire resulted in twenty (20) rows of choice data per respondent. A final variable – *nij* - was included to enable LIMDEP to interpret the structure in which respondents made choices for each wetland program in the data set.

Initially, one model each was estimated for each of the sample blocks, after which a single model was estimated for the full data set. In the estimation, choice probability, elasticity and cross-tabulation options were specified so as to be able to generate the appropriate bid curve, as well as to conduct partial and trade-off analysis of marginal changes in wetland policy attributes on consumer choice. Psychographic and demographic data were analyzed using the Frequencies, Cross Tabulations and Descriptive Statistics procedures in SPSS®. Model estimation results and welfare measure calculations are discussed in the next chapter.

CHAPTER 5

RESEARCH RESULTS

The results of the analysis are presented in this chapter. These include firstly, an analysis of the survey response, followed by demographic and psychographic profiles of the respondents. The model results are also presented, and the estimates of consumer willingness to pay for wetland mitigation policies in Georgia are summarized. The chapter concludes with a benefit-cost analysis of proposed policies for preserving Georgia's wetlands.

5.1 Response to the Survey

The survey response was extremely low. Despite a follow-up to an initial mailing of 600 hundred questionnaires, only 76 responses were received after a total survey period of 16 weeks. This amounted to an overall response of 12.7%. Of the questionnaires returned, two were incomplete not having addressed the conjoint section of the questionnaire, and therefore could not be used in the estimation of the conjoint model. In terms of responses by sample block, both the North and East blocks generated the highest percentage of respondents, while the lowest response rate was obtained from the West block. It was also notable that the North and East block generated a higher number of respondents compared with counties in the South block where Georgia's wetlands are located (Table 5.1). The low response rate has implications for non-response bias in the sample, since it is possible that systematic factors may have either predisposed respondents to favorably respond, or prevent the non-respondents from responding to the survey.

Table 5.1: Response by Sample Block

	Block			
	1: North	**2: West**	**3: East**	**4: South**
No. of Respondents	23	12	23	16
Percentage	31	16	31	22

The analysis therefore compared sample and population parameters in order to assess the impact of this non-response on the results. Because of the overall low response, the social and demographic analyses were not partitioned by blocks.

5.2 Respondent Demographics

In terms of demographics, 67% of respondents were male, while 33% were female. This compares with a state population percentage of 49.2% for male and 50.8% for female (US Census Bureau, 2000), and clearly indicates a disproportionate number of male respondents in the sample. The largest share of respondents (28%) was within the 51 – 65 age category, with another 27% being in the 41 -50 age group. Twenty-one (21%) of respondents were between the ages of 31 – 40 years, while only 10 percent of respondents were within the 21 – 30 age group. These figures are again inconsistent with the state population estimates of 9% for the 55-64 year age group, and 13.2% for the 45-54 years age group (US Census Bureau, 2000). There was no response from persons under twenty one years (Table 5.2).

Table 5.2: Age Category of Respondents

		Frequency	**Percent**
Category	21 - 30	7	9.9
	31 - 40	15	21.1
	41 - 50	19	26.8
	51 - 65	20	28.2
	Over 65	10	14.1
	Total	**71**	**100.0**

The sample was generally well-educated with 53% having attained at least a college degree. A further 29% attended some college or technical school, while at least 15% of respondents were high school graduates. Less than 2% of the sample achieved eight years or less of education (Table 5.3). Once again, however, these figures generally exceed the state population estimates which show percentage of high school graduates approaching 28.7%, but the number of college graduates being lower at 16% (US Census Bureau, 2000).

Table 5.3: Years of Schooling Completed

		Frequency	Percent
Category	Eight Years or Less	1	1.4
	Some High School	1	1.4
	High School Graduate	11	15.1
	Some College or Technical School	16	21.9
	Technical School Graduate	5	6.8
	College Graduate	23	31.5
	Post Graduate Work	16	21.9
	Total	**73**	**100.0**

This education profile is reflected in the total annual household income for the sample in 2004. Up to 19% of respondents reported income of over $100,000 for that year, with another 15% falling within the $60,000 – 69,999 annual income categories. Ten percent (10%) earned between $45,000 to $49,000 in 2004, while 13% gained between $25,000 and $29,999. Overall, only 3% of respondents received less than $10,000 in total household earnings in 2004 (Table 5.4).

Table 5.4: Total 2004 Household Income

		Frequency	Percent
Category	Less than $10,000	2	3.0
	$10,000 - $14,999	1	1.5
	$20,000 - $24,999	3	4.5
	$25,000 - $29,999	3	4.5
	$30,000 - $34,999	4	6.0
	$35,000 - $39,999	3	4.5
	$40,000 - $44,999	2	3.0
	$45,000 - $49,999	7	10.4
	$50,000 - $59,999	6	9.0
	$60,000 - $69,999	10	14.9
	$70,000 - $79,999	2	3.0
	$80,000 - $89,999	7	10.4
	$90,000 - $99,999	4	6.0
	Over $100,000	13	19.4
	Total	**74**	**100**

Considering size of households, the majority of respondents (40%) were from two-person households. Twenty-five percent of respondents were from households with four persons, while 14% and 13% were from households with 1 and 3 persons respectively. Only 8% of respondents were from households, with 5 or more persons. These figures are largely consistent with the state average household size which was estimated at 2.65 persons for the year 2000 (US Census Bureau, 2000).

Respondents were also profiled for their experience and engagement with wetlands. Eighty-one percent (81%) had visited wetlands in the past, and 85% had friends and/or relatives who had visited wetlands in the past. At the same time only 15% of respondents held jobs which involved working with wetlands. Table 5.5 summarizes these responses.

Table 5.5: Respondents Experience with Wetlands

Experience	Yes		No	
	Frequency	Percent	Frequency	Percent
Ever visited wetlands	59	81%	14	19%
Relatives/Friends ever visited wetlands	62	85%	11	15%
Job involves work with wetlands	11	15%	62	85%

5.3 Ranking of Priorities for Attribute Preservation under Wetlands Mitigation

Consumers were also asked to assign priorities to wetland mitigation programmes based on the preservation of specific wetland attributes, such as selected species, wetland services, acreage of wetlands preserved, and economic impacts of mitigation. Ratings were assigned using a scale of 1 for 'No Priority' to 6 for 'High Priority. For most attributes, consumers ascribed high priority ratings for preservation under a wetland mitigation program. Preservation of ground water received the highest mean rating of 5.81, followed by reduction of salt water intrusion which obtained a mean rating of 5.41.

Table 5.6: Mean Priority Ratings for Preservation of Wetland Attributes

Attribute Protected Under Wetland Mitigation	Mean Priority Rating	Standard Error
Wetland Mitigation for Protection of Blue crabs	5.28	0.108
Wetland Mitigation for Protection of White shrimp	5.39	0.105
Wetland Mitigation for Protection of Red Drum	5.19	0.120
Wetland Mitigation for Protection of Black Bear	4.70	0.532
Wetland Mitigation for Protection of Wetland Forests	5.26	0.135
Wetland Mitigation for Protection of Ground Water	5.81	0.079
Wetland Mitigation for Reduction of Salt Water Intrusion	5.41	0.130
Wetland Mitigation for Preserve Large Amount of Wetlands	5.30	0.101
Wetland Mitigation for Preserve Small Amount of Wetlands	3.73	0.212
Wetland Mitigation for Preventing Investments in wetlands	4.26	0.199

Among the targeted wetland species, mean priority rating for preservation ranged from a high of 5.39 for white shrimp; 5.28 for blue crabs; 5.26 for wetland forests; to the lowest of 4.70 for black bear. Consumers also regarded the preservation of a high amount of wetlands to be a priority, with a rating of 5.30. This position was reinforced by the lowest priority rating among all wetland mitigation attributes to be 3.73 for the preservation of a *small amount* of wetlands (Table 5.6).

5.4 Consumer Ratings for Choice among Different Land Types

The relative importance to consumers of preserving wetlands compared to other types of land was also investigated in the survey. This level of importance was rated on a scale of 1 to 6, where 1 represents 'Not Important' and 6 represents 'Very Important'. The results of consumer ratings of wetlands against other land types are presented in Table 5.7.

Table 5.7: Mean Importance Ratings for Alternative Land Types

Alternative Land Type	Mean Level of Importance	Standard Error
Choosing between Wetlands and Forest lands	4.92	0.699
Choosing between Wetlands and Lake front	4.19	0.173
Choosing between Wetlands and River Front Land	4.40	0.193
Choosing between Wetlands and Ocean Front Lands	4.53	0.195
Choosing between Wetlands and Farmlands	4.71	0.165
Choosing between Wetlands and Prairie	3.92	0.193
Choosing between Wetlands and Mountain	4.34	0.193
Choosing between Wetlands and Undeveloped City Lands	3.81	0.222

This table shows the alternative land types of highest importance for preservation to be forests and farmlands, which consumers rated at 4.92, and 4.71 respectively. The lesser important alternatives were prairie lands (3.92) and undeveloped city lands (3.81). Both river front lands (4.40) and ocean front lands (4.53) were also considered to be important although not rated as high as forest and farm lands.

5.5 Psychographic Profiles of Respondents

The survey also examined consumers' psychographic profiles by assessing their responses to a number of attitude, interests and opinion statements. These statements assessed consumers' attitudes in respect of the following wetland related dimensions:

- Wetland services
- Development and industrial activities in wetlands
- Commercial fisheries value from wetlands
- Social benefits of wetlands
- The role of government in protecting wetlands,

A Likert Summated Ratings Scale with a range of 1 for 'Strongly Disagree' to 5 for 'Strongly Agree' was used to capture these responses. Mean ratings for each statement are presented in Table 5.8 below.

Based on the scale, indifference to a statement (neither agree nor dis-agree) is implied by a mean rating of 3. Considering wetland services, there was overall agreement by the sample that wetlands provided useful services to society. For instance, the statement *"Wetlands help to protect fish and wildlife"* received a mean rating of 4.85, while a related statement *"Wetlands help to protect well-water quality for people"* received a mean rating of 4.49. Mean ratings of 4.25 and 4.38 indicating agreement were also obtained for the statements *"Wetlands protect*

Table 5.8: Ratings for Psychographic Statements

Statement	Mean Rating	Standard Error
Wetlands help to protect fish & wildlife	4.85	0.053
Wetlands help to protect well-water quality for people	4.49	0.126
Industrial activities…cause major environmental problems in wetlands	4.18	0.136
Waste disposed from industry is *not* a major problem for wetlands	1.58	0.139
Soil erosion from farms cause major problems in wetlands	3.49	0.187
Wetlands protect coastal comm. from flooding	4.25	0.140
Wetlands do *not* contribute to beautiful scenery	1.43	0.093
I like to view wetlands scenery	4.17	0.145
People should not do commercial activities in wetlands	3.35	0.159
Wetlands provide good wildlife habitat	4.77	0.059
Protection of wetlands will reduce sprawl	3.76	0.165
Wetlands are important part of coastal/rural communities	4.60	0.077
Most persons in crabbing/shrimping are not wealthy	3.41	0.178
Government spends too much to bail out fishermen	1.99	0.159
Fishing more satisfying occupation than others	2.71	0.179
Small family fishing business must be preserved	3.89	0.136
Commercial fishing more efficient than family enterprises	2.95	0.194
Comm. fishing get too many government benefits	2.52	0.207
Small fishing enterprises are better wetland stewards than larger ones	3.19	0.198
Government should treat fish like any other business	3.40	0.181
Government should *not* protect wetlands for future generations	1.40	0.119
Today's seafood safer than it ever has been	2.51	0.191
Today's seafood is *not* as fresh as it has been	2.20	0.178
Our country is likely to suffer seafood shortages in the near future	2.99	0.199
Wetlands help to insure nations food and drinking water supply	4.38	0.126

coastal communities from flooding", and *"Wetlands help insure the nation's food and drinking water supply"*, respectively.

In terms of development and industrial activities in wetland areas, there was also consensus that these activities could have a negative impact on wetlands. The mean rating for the statement *"Industrial activities such as mining cause major environmental problems in wetlands"* was 4.18. A low mean rating of 1.58 for the contrasting statement *"Waste disposal from industry is <u>not</u> a major problem for wetlands"* further endorsed consumers' position with respect to the impact of industrial development on wetlands. However there appeared to be some ambivalence among consumers concerning the conduct of commercial activities in wetlands with only a slight agreement rating of 3.35 for the statement *"People should not do commercial activities in wetlands"*.

Consumers' opinions about the commercial fishing value from wetlands were also assessed from the statements *"Commercial fishing is more efficient than family enterprises"* and *"Commercial fishing gets too many government benefits"*. Respondents generally disagreed with these statements by offering mean ratings of 2.95 and 2.52 respectively. In the case of the first statement the rating suggests a belief among consumers that family fishing businesses could be important in efficiently harvesting fish stocks from fisheries supported by wetlands. However, response to the second statement hints at an appreciation of the role of commercial fishers in the extraction of fish stocks and the need for some public sector support to sustain them.

The statements, *"Fishing is a more satisfying occupation than others"* and *"Small family businesses should be preserved"* were among some other statements used to profile the social dimension among respondents. The first statement received general disagreement with a mean rating of 2.71. There was however general agreement with the second statement (mean rating – 3.89). Other statements such as *"Most Persons in crabbing/shrimping are not wealthy"*, and *"Government spends too much to bail out fishermen"* also received a mean rating of 3.41 and 1.99 respectively. This suggests an expectation among respondents of more public policy support to secure the well-being of persons whose livelihood depends on wetlands.

Finally, the psychographic profile explored consumers' expectations with respect to the role of government in the protection of wetland areas. There was clear disagreement among respondents with the statement *"Government should not protect wetlands for future generations"* (mean rating – 1.40), indicating a clear expectation of a significant role for government in protecting wetlands into the future.

5.6 Conjoint Model Results

The conjoint model was estimated in order to obtain choice probabilities for attribute mixes defined for various wetland mitigation policy proposals. The results of model estimation are used to generate WTP estimates and then to finally estimate a benefit cost ratio.

5.6.1 Results of Model Estimation

Estimation of five models was attempted, these being one for each of the four sample blocks, and one for the total data set. Estimation for each of the block models failed due to matrix errors[16] resulting from the small sub-sample for each block. It was therefore not possible to derive comparable model coefficients for each block sampled.

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[16] For each of these models, Limdep reported *non-positive* definite Hessian matrices; standard errors and t-statistics could not be computed for most variables.

Given the limitations of the block models, a single model for the total sample was estimated. Although the overall significance of the model was low (adjusted R^2 = 0.382) this model produced much improved results, with all wetland attributes showing significance at the 1% level[17]. Moreover, the price variable ONECOST was negative and therefore consistent with economic theory.

Among the attributes, the SLTWATR variable (Prevention of Saltwater Intrusion into Ground Water for Drinking), contributed most to consumer choice of wetland mitigation policy with a coefficient of 1.35 (se=0.148). BLUCRAB (Protection of Blue crabs by Limiting Harvests of Mature Females) and TOTACRE (Total Acres of Wetlands Preserved over the Next Five Years) were the other major variables influencing consumer choice with coefficients of 0.83 (se=0.154) and 0.80 (se=0.113) respectively. WSHRIMP (Protection of White Shrimp by Imposing a Shorter Harvest Season) generated a coefficient of 0.72 (se=0.176) while the coefficient for RDDRUM (Protection of Recreational Red Drum by Banning Commercial Harvests during Brooding Season) was estimated at 0.49 (se=0.232). The price variable had the smallest influence on consumer choice of wetland mitigation program for coastal Georgia with a coefficient of -0.01 (se=0.002). These results are summarized in Table 5.9 below.

5.6.2 Elasticities and Trade-Off Analysis

Trade-off analysis was undertaken in order to examine the effect of a change in model attributes on the probability of choosing a particular policy alternative. This effect was estimated for each alternative mitigation program (Program A, Program B, or the Status Quo) and was measured by its elasticity.

[17] The only exception here was RDDRUM which was significant at the 5% level.

Table 5.9: Estimation Results for CLOGIT Model – Full Sample:

Variable	Parameter Estimates (Standard Error)
BLUCRAB	0.829** (0.154)
WSHRIMP	0.722** (0.176)
SLTWATR	1.347** (0.148)
RDDRUM	0.487* (0.232)
TOTACRE	0.796** (0.113)
ONECOST	-0.010** (0.002)
CONSTANT_1[18]	-1.313** (0.279)
CONSTANT_2	-1.762** (0.310)

** - *Significant at 1% level*
* - *Significant at 5% level*

In the case of the scale attributes ONECOST (One time Cost to Household in 2005), and TOTACRE (Total Acres of Wetlands Preserved over the Next Five Years), ONECOST yielded an elasticity of -0.396 for Program A, and -0.654 for Program B. This suggests that a one unit increase in one-time costs would result in a *decrease* in choice probability of 0.396 for Program A, and 0.654 for Program B respectively, with Program B having a higher likelihood of *not* being chosen.

Positive elasticities were also obtained in the case of the TOTACRE attribute, with Program A yielding 0.433 and Program B yielding 0.448, indicating that increases in the quantum of wetlands targeted for mitigation under any wetlands program would have a positive

[18] The two regression constants in the model are for each of the Programs (A, and B) over which consumers made choices in the survey.

effect on the likelihood of program choice. Because of the dichotomous nature[19] of the other model attributes, no elasticities could be estimated for these dummy effects.

Note that in all cases, the probability of choosing the status quo by voting for neither Program A nor Program B was unaffected by any marginal effects on the policy attributes, since for all cases, the elasticity estimates for this option were zero. The elasticities for attribute changes for Programs A and B are summarized in Table 5.10.

Table 5.10: Elasticities for Attribute Changes in Mitigation Programs

Attribute	Elasticity	
	Program A	**Program B**
Total Acres of Wetland Preserved over Next Five Years	0.433	0.448
One Time Cost to Households in 2005	-0.396	-0.654

5.7 Estimated Consumer Willingness to Pay

Based on the estimated coefficients of the total model (Table 5.9), the approach used by Cameron (1988) was employed in generating mean household WTP for the implementation of wetlands mitigation policies in Georgia. A number of key assumptions are important in applying this approach. Firstly, as noted by Cameron (1988), while the Logistic model is non-linear, it can be assumed to be linear for this purpose. Secondly, given that the anticipated policy is for a change in the quantity of wetlands resource, the appropriate welfare measure is a Hicksian surplus (Freeman, 1999). Moreover, the consumer is assumed to have a right to the *initial or pre-policy* stock of wetland resources, thus making the relevant Hicksian measure a Compensating Surplus (Freeman, 1999). Related to this is the further assumption that the

[19] Recall that these attributes were entered into the conjoint model with levels specified as '1=Yes' or '0=No'

welfare change that is being measured is a restricted or rationed quantity change where optimizing adjustments by the consumer are not allowed. Finally, for the purpose of this research, it is assumed that the coastal wetlands benefit consumers only in coastal Georgia, and that the stream of benefits from wetlands mitigation would be obtained five years after investment in the policy. The Cameron approach is applied using the following equation:

$$[CS] = | \alpha + \Sigma [\beta_i(Mean\ Y_i)]/ \beta_1| \quad (5.1)$$

where $[CS]$ = *Measure of Compensating Surplus*

α = *regression constant*

β_1 = *Coefficient of Bid Amount (One Cost)*

β_i = *Coefficient of All other Regressors*

Y_i = *All other regressors*

In order to apply equation 5.1, the TOTACRE variable was normalized by dividing by 100,000, in order to achieve standardized orders of magnitude relative to the other variables. Substituting coefficients from Table 5.9 yielded a mean household WTP for wetlands mitigation in coastal Georgia of $77.29, or approximately $77. Table 5.11 details the application of the Cameron equation to yield the total WTP estimate.

While it was quite difficult to identify standardized estimates from previous studies, the Brander, Florax and Vermaat (2003) meta analysis provides a framework for comparison. For instance, this research obtained a mean annual wetland value of just over $2,800 per *hectare (or $1,166 per acre) for* a study which reviewed 111 valuation exercises in the US. Considering median values however, this study also found an annual mean WTP measure for wetland preservation per *hectare* of $150, or $62.50 per acre. Given that none of these studies employed the conjoint valuation methodology, this figure compares favorably with the findings of this study, and provides a reasonable convergent validity test of the conjoint analysis results.

Table 5:11: Application of the Cameron Equation to Derive WTP Estimates

Attribute(Y_i)	α	β_i	Mean Y_i	Attribute Weight[20]	β_1 (Onecost)	WTP ($77.30* Attribute Weight)
BLUCRAB	-1.317	0.829	0.40	0.16	-0.01	$12.27
WSHRIMP	-1.317	0.722	0.40	0.14	-0.01	$10.70
SLTWATR	-1.317	1.347	0.40	0.26	-0.01	$19.94
RDDRUM	-1.317	0.487	0.43	0.10	-0.01	$7.78
TOTACRE	-1.317	0.796	90324.36	0.34*	-0.01	$26.61
Total WTP	**-1.317**			**2.09**	**-0.01**	**$77.30**

* Figure normalized by dividing by 100,000.

5.7.1 Willingness to Pay for Wetland Attributes

WTP measures for specific attributes were also partitioned out based on the proportional weight of each attribute coefficient in equation 5.1. On this basis, Georgia households showed their highest WTP to be for TOTACRE (the total acres of wetlands preserved over the next five years), with an estimate of $26.60 per household. This was followed by SLTWATR (prevention of salt water intrusion into drinking water from ground sources) $19.94, and then BLUCRAB (Protection of Blue Crabs by Limiting Harvests of Mature Females) $12.27. With respect to WSHRIMP (Protection of White Shrimp by Imposing a Shorter Harvest Season), consumers manifested an estimated WTP of $10.70. Significantly, the protection of the red drum recreational species – RDDRUM, yielded the lowest mean WTP of $7.78. These estimates are summarized in Table 5.11.

[20] The attribute weight for WTP is calculated as [βiY/ Σ [βi(Mean Yi)] and represents an attribute's proportional share of total WTP. For example, the attribute weight for BLUCRAB was estimated as (0.33/2.09)=0.16.

5.7.2 Confidence Interval of the WTP Estimate

In considering the calculation of confidence intervals for maximum likelihood WTP estimates, Cooper (1994) points out that ideally, reliable estimates are best obtained from numeric or 'bootstrapping' methods, especially when the sample size is small. However, the Cameron approach to estimating WTP approximates a linear transformation of the regression coefficients, which allows for the construction of confidence intervals using the variance-covariance matrix of the regression model. For this application, Cooper (1994) offers the following equation of the Cameron analog to confidence interval estimation:

$$CI = WTP +/- t(1-\theta/2) * \sqrt{(X_i \sum \beta_i X_i)} \quad 5.2$$

where

CI = *Confidence Interval*

Θ = *Required level of precision*

β_i = *Coefficients in the MNL Model*

X_i = *Mean of the Model Attributes*

t = *Desired level of confidence (%)*

Applying equation 5.2 yields a 95% confidence interval for the overall WTP of the sample of \$77.30 +/- 0.71 = \$76.59 - \$78.01.

5.8 Benefit Cost Analysis

According to Freeman (1999), benefit cost analysis is essentially a set of rules and definitions for the measurement of benefits and cost, and is applied on the assumption that the management goal is to maximize the net economic values associated with the use of environmental and natural resources. Underlying this assertion is the notion of economic efficiency which guides the formulation of economic policy. Given, the objective of this research, a natural extension of the derivation of consumer WTP estimates is to assess relative benefits and costs in a benefit cost analytical framework. This requires an estimation of the total benefits of a policy change as well as the total costs of implementing the policy. It further requires judgments about an appropriate discount framework as well as clear decision-making criteria given the calculation of benefit cost ratios.

The public nature of wetland resources allows for the aggregation of individual benefits, measured as mean WTP, across a relevant population in order to determine total benefits. For this research, two likely populations which would benefit from a wetlands mitigation policy in Georgia were assumed to be 1) *All* households in the state of Georgia, and 2) *Only* households on the Georgia coast or policy target area. Additionally, given the low sample response rate of 13% for this study, it was further assumed that non-respondents had a zero WTP for wetland mitigation policies, and therefore did not expect any benefits from the implementation of such policies. This assumption allowed for the further disaggregation of the relevant population to 3) *Only respondents* from *all* Georgia households, as well as 4) *Only respondents* from coastal Georgia[21].

Benefit cost ratios were therefore estimated for four (4) scenarios represented by the partitioning of the relevant population as outlined above. This approach allowed for the assessment of the extent to which sample non-response resulted in significant differences in estimated benefits and costs.

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[21] On this basis, the number of *respondents* for all of the state of Georgia was estimated at 13% of all Georgia households, while the number of respondents for coastal Georgia was estimated at 13% of the total number of households in the policy target area.

5.8.1 Estimation of Total Benefits - All Georgia Households

Given the assumption that the benefits of any wetlands mitigation policy will redound to all Georgia *households*, the number of Georgia households for 2002 was estimated at 3,006,369 (US Census Bureau, 2006) and used to aggregate the total benefits of wetlands mitigation in the state. Using the estimated mean household WTP of $77.30, the total *annual* benefits to *all* households of a wetland mitigation policy for the state of Georgia is estimated at $232,392,323.7 or $232.4 million.

Noting that the survey had a non-response rate of 87%, the effect of this statewide non-response reduced the estimated number of households by 87%, and benefits to respondent households[22] were therefore assessed at $30,211,002.

5.8.2 Estimation of Total Benefits – Coastal Georgia Households

Assuming that only households on the Georgia coast would benefit from the policy, the relevant policy population was identified as the following 10 coastal counties:

- Brantley
- Bryan
- Camden
- Chatam
- Charlton
- Effingham
- Glynn
- Liberty
- Long
- Mc Intosh

This policy target area is shown in Figure 5.1 below. Together these counties had a total number of households of 255,413 in 2005[23] (FedStats, 2006). The total *annual* benefit for a wetland mitigation policy to households in the target area is therefore estimated at $19,743,425.

[22] Given by (1-0.87) * 3,006,369 * $77.30

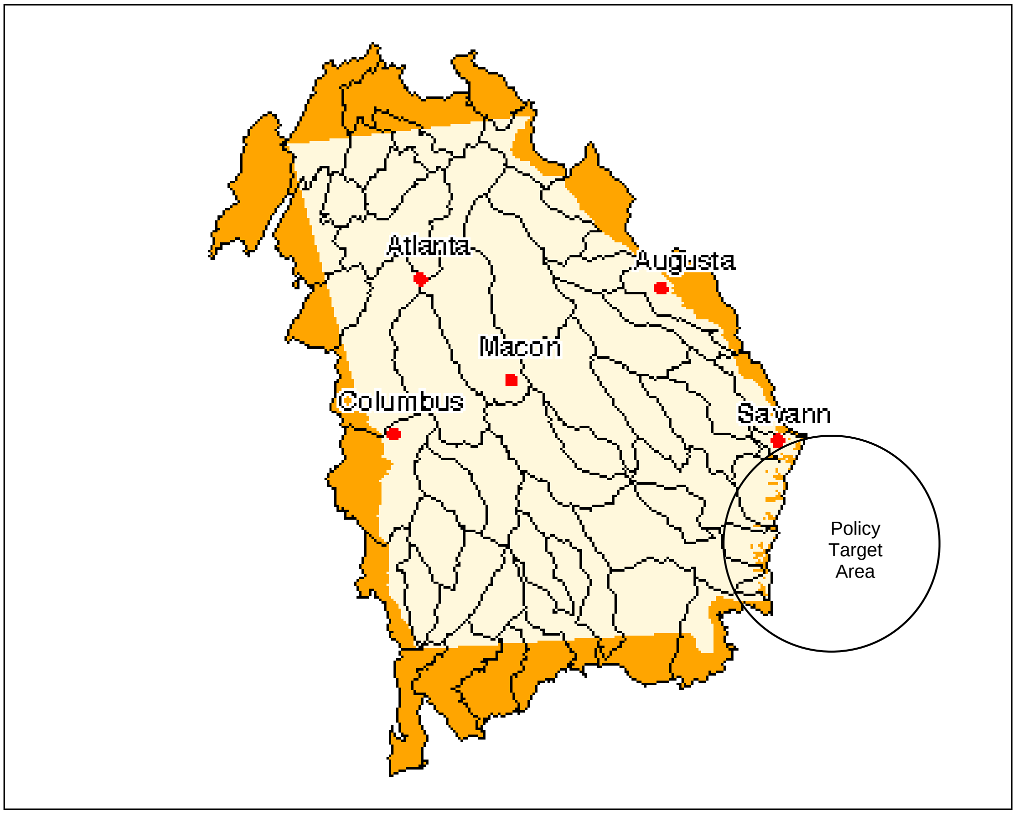

Figure 5.1: Policy Target Area – Coastal Georgia
Source: *EPA*

In the case of respondents from coastal Georgia, the number of households in the target area was also reduced by 87% so that the benefits to *only* responding households were also estimated at $2,566,645, on the assumption that non-respondents here also had a zero WTP for any wetlands mitigation policy.

5.8.3 Estimation of Total Costs

In considering costs, Freeman (1999) disputes the conventional wisdom of assessing costs as merely the expenses associated with acquiring, implementing and maintaining environmental abatement equipment. Instead he identifies costs as including the losses in utility

[23] Compiled from individual county statistics, and adjusted for 2005.

faced by consumers for having to forego various quantities of marketed and non-marketed goods and services. In this regard, the analysis of costs for the evaluation of this policy takes into account both commensurable and incommensurable costs. With respect to a wetlands mitigation program, expenditures related to land acquisition, physical restoration, utilities and maintenance are all classified as commensurate costs. Non-commensurate costs include costs related to non-measurables such as opportunity costs, and other intangibles associated with the establishment and use of wetland mitigation banks.

Although there is little detailed information on the actual costs of operating mitigation banks, Reppert (1992) cites annual per acre establishment and maintenance costs ranging from $223 to $20,000, with averages of $3,630 for projects in Southern Virginia. Using an average annual inflation rate[24] of 2.9% (Federal Reserve Bank of Minnesota, 2006) this figure was adjusted to a 2005 cost estimate of $5,264. And assuming a target for conservation under wetland mitigation of 30,240 acres[25] over a five year period, the total estimated cost of the policy is $159,183,360. This amounts to roughly $31,336,672 of mitigation costs per year.

5.8.4 Benefit Cost Ratios

Having obtained estimates of benefits and costs, several decision-making criteria are available to the policy-maker, in order to determine whether or not the proposed policy should be implemented. The over-arching philosophy which informs the policy choice is often based on criteria such as pareto or economic efficiency, social welfare maximization, or pareto optimality. Within the domain of such decision-making further considerations may include accounting and administrative issues, legislative and court decisions, the results of social impact analysis, as well

[24] This inflation rate was estimated for the period 1990 – 2003. The years 2004 – 2005, were excluded from the average because of the high energy prices for these years.
[25] This figure represents 8% of the current stock of 378,000 acres of coastal wetlands in Georgia.

Table 5.12: Benefit Cost Ratios – Wetlands Mitigation Program, Coastal Georgia

Items	**Totals**
Interest Rate	**2.4%**
Benefit/Cost Ratio - All Georgia Households	
Total Benefits ($M)	232.4
Total Costs($M)	31.34
Discounted Total Benefits (PV)	206.4
Discounted Total Costs (PV)	27.84
Benefit/Cost Ratio	**7.41**
Benefit/Cost Ratio - % of Respondents From All Georgia Households Only	
Total Benefits ($M)	30.20
Total Costs($M)	31.34
Discounted Total Benefits (PV)	26.82
Discounted Total Costs (PV)	27.84
Benefit/Cost Ratio	**0.96**
Benefit/Cost Ratio - All Coastal Georgia Households Only	
Total Benefits ($M)	19.70
Total Costs($M)	31.34
Discounted Total Benefits (PV)	17.50
Discounted Total Costs (PV)	27.84
Benefit/Cost Ratio	**0.63**
Benefit/Cost Ratio - % of Respondents From Coastal Georgia Households Only	
Total Benefits ($M)	2.60
Total Costs($M)	31.34
Discounted Total Benefits (PV)	2.31
Discounted Total Costs (PV)	27.84
Benefit/Cost Ratio	**0.08**

as the requirements for maintaining safe minimum standards, particularly in the context of insufficient information on policy impacts. In practice however, policy decision making often begins by examining *economic* considerations, in which case *Net Present Value (NPV)*, and *Benefit Cost Ratio (BC)*, are the most commonly used decision criteria. For policies which yield a stream of benefits and costs over time, an appropriate *social discount rate* is another decision variable which the policy-maker has to resolve. In this case, the analyst can apply either the *market interest rate, marginal productivity of investment (MPI), corporate discount rate (CDR), own personal discount rate* or the *own social discount rate*.

Taking the above issues into account, the Benefit Cost ratio was applied as the decision criterion for pursuing a wetlands mitigation program in coastal Georgia. Since the program is being evaluated over a five-year period, a market interest rate of 2.4% was applied to discount the stream of benefits and costs. This is an estimate of the real interest rate, based on 2005 discount rate for low risk US government 10 year treasury bills. This discount rate was used since it represents low risk, and has been adjusted to account for the decline in purchasing power occasioned by inflationary effects over time. The 10-year Treasury bill interest rate was 5.15% in 2005 (Federal Reserve Bank, 2006), while the 2005 inflation rate was estimated at 2.75% (US Bureau of Labor Statistics, 2006). Based on these parameters, the discounted benefits, costs and estimated BC ratios for the four scenarios outlined above are presented in Table 5.12 above. These results show that a positive and significant benefit cost ratio of 7.41 was obtained only for the case where it was assumed that the benefits of wetland mitigation would accrue to *all* Georgia households.

In all other scenarios, the ratios were less than one, indicating that mitigation costs exceeded benefits where benefits were not assessed statewide. These findings suggest that at least *on economic grounds,* a *statewide* policy for wetlands mitigation in Georgia is feasible, since net discounted benefits exceed net discounted costs. Ultimately however, the optimal decision should be made based on additional ecological, ethical, political and social/cultural considerations.

CHAPTER 6

CONCLUSION

This chapter summarizes the study, and discusses policy and management implications. It also identifies limitations of the research.

6.1 Summary of the Research

The objective of this research was to assess consumer's willingness to pay for a wetlands mitigation policy for the preservation of wetland areas in coastal Georgia. The rationale for this research was based on the fact of continued wetlands loss on the Georgia coast, and its implications for reduced social and economic benefits to consumers over time. Such benefits are related to Georgia's strong nature-based economy which includes the coastal shrimping and crabbing industry, recreational fishing, and tourist activities on its coastal wetlands.

The study applied the conjoint analysis method to evaluate a wetlands mitigation approach to preserving these wetlands, and designed a conjoint model in a discrete choice framework, which asked consumers to exercise choice over four wetland mitigation programs. Each program was constructed based on six attributes, four of which were wetland protection elements for blue crabs, white shrimp, red drum – a recreational fish specie- and ground water for drinking. The other two attributes were scale variables representing the size of the wetland area to be preserved, and a price variable or one time bid to be paid by the consumer in 2005.

By applying an optimization experimental design algorithm, 16 choice sets were identified based on these attributes, and were apportioned into four blocks for field data collection. The data for this research were collected using a mail survey which was administered statewide with one follow-up mailing over a period of sixteen (16) weeks. The survey instrument which was classified into the four blocks also gathered data on consumer's attitudes, interests and opinions related to wetlands, as well as relevant demographics. Prior to field data collection, the final questionnaire was field tested in two pre-tests so as to ensure the viability of the survey to address the research objectives. Sampling for the survey was done using the services of Survey Sample International (SSI)®, an international sampling consultancy which drew the survey based on demographic management areas in the State of Georgia.

The response to the survey was quite low as only 13% out of a target sample of 600 provided responses. While this low response rate precluded the analysis of the data by blocks, the full data set was used to estimate a Multinomial Logit Model using LIMDEP®. This model showed all the attributes to be significant in influencing consumer's choice of wetland mitigation policy for coastal Georgia, and the derived coefficients yielded a mean *household* WTP for wetland mitigation of $77.30. Considering demographics, such payments were offered by a generally well-educated and mature market, with moderate to high annual household incomes.

Based on this estimated WTP, and using a proxy for wetland mitigation costs from related studies in coastal Virginia, a benefit cost ratio of 7.41 was estimated for all Georgia households, indicating that at least on economic grounds, a policy for wetlands mitigation would be feasible for the state of Georgia.

6.2 Policy and Management Implications

At least three key management implications are apparent from this research. Firstly, from a policy management perspective, the findings suggest that wetlands mitigation is a feasible policy for conserving and minimizing the impact of development of wetlands in Georgia's coastal areas. This is significant since the approach remains relatively new, and still requires ongoing validation to encourage its use as a policy measure.

The second implication – a methodological one – relates to the apparent robustness of the conjoint method in eliciting consumer preferences for complex resources such as wetlands. This is especially the case given the relatively low survey response, notwithstanding which, the model yielded the expected signs of the attribute variables. Moreover, the results indicate consumers' ability to undertake the notional tradeoffs among many variables in order to arrive at a utility maximizing choice for wetland preservation.

Finally, the findings also indicate that preferences for wetland preservation can be formed by consumers who might reside somewhat remotely from the actual wetland site, but who may still harbor specific preferences for their preservation. This is especially important for economic planning for the state, as the results showed, North Georgia residents having relatively strong preferences for preserving White Shrimp, while coastal residents were not as inclined to attach significant welfare benefits to either the preservation of recreational species, or the preservation of blue crab. It is therefore possible that given the experience of the failure of the blue crab fishery in coastal Georgia over the past 2 – 3 years, consumers have begun to adjust their expectations of the role of this resource in securing their economic well-being in the future.

6.3 Limitations of the Research

The inadequacy of the survey response remains the most notable limitation of this research, since this precluded the full examination of consumer preferences in a spatial context. While contemporary survey methodology advocates the use of incentives to secure higher mail survey response rates, budgetary limitations prevented the offering of incentives in order to secure consumer response. The implementation of similar research with adequate resources to guarantee enhanced response remains a good option for further examination of consumer preferences for the implementation of wetland mitigation polices in Georgia.

A second limitation which is related to the first is that the demographic profile is not balanced, as it shows a large share of respondents to be well-educated, over 40 year, and earning generally high incomes. This therefore undermines the universality of the WTP estimates as it suggests a significant level of sample bias.

A third limitation is the unavailability of wetlands mitigation cost data for informing the calculation of benefit costs ratios. This constraint derives largely from the relative newness of the approach. Moreover, full establishment and functioning of mitigation banks is only achieved over a significant time span, and the institutional framework for supporting documentation and costing of this approach is still in its infancy. Future research is required to address this deficiency.

These limitations notwithstanding, the study has demonstrated the feasibility of applying the conjoint method to assess a fairly new policy approach – wetland mitigation. The results indicate that the apparent limitations are likely to be feasibly addressed by a significantly enhanced sample size.

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APPENDIX

Sample Block: ***1***
Questionnaire No: ___________

Public Opinion Survey

Source: EPA

Wetlands Mitigation for the Protection of Wetlands in Coastal Georgia

WHAT DO YOU THINK?

Section A: We presented a lot of material in the Information Booklet. In this section, we will ask a few questions to make sure we presented the information clearly. Please **feel free** to refer back to the ***Background Information Booklet*** when answering the questions on this page and other questions in the survey.

1. For each statement below, please circle "T" if you think the statement is true and "F" if you think the statement is false.
(CIRCLE ONE LETTER FOR EACH STATEMENT)

	True	**False**
Most of the US coastal wetlands can be found on the coast of the Gulf of Mexico	**T**	**F**
Commercial and recreational fishing are not very important industries in coastal Georgia	**T**	**F**
Wetlands Mitigation Banking will prevent development of industries	**T**	**F**
Wetlands are important in maintaining the quality of drinking water sources	**T**	**F**
Wetlands serve as nursery and spawning grounds for commercial fisheries such as shrimp and blue crab in coastal Georgia	**T**	**F**

Section B: In this section, we are interested in learning about your experience with wetlands.

2. Does your job involve working with wetlands?

   1 YES
   2 NO

3. Have you ever visited any wetland area?

   1 YES
   2 NO

4. Have any of your relatives or friends ever visited a wetland area?

   1 YES
   2 NO

5. Please tell us how frequently you engage in any of the following activities:
   (CIRCLE ONE NUMBER FOR EACH ITEM)

	Regularly	**Sometimes**	**Rarely**	**Never**
Engage in recreational activities (fishing, wildlife hunting and viewing) in wetland areas	1	2	3	4
Purchase blue-crabs, shrimp and other sea foods	1	2	3	4
Read news, magazines and other information related to wetlands	1	2	3	4
Attend meetings, seminars and other activities related to wetlands	1	2	3	4

Section C: In this section we will ask you to rate how much priority you think should be given to certain benefits to be derived from preserving wetland areas. Please feel free to use the Information Booklet if you need it.

6. How much priority do you think should be given to wetlands mitigation if it results in the preservation of the following?
(CIRCLE ONE NUMBER FOR EACH ITEM)

	High Priority ←				→	**No Priority**	**Don't Know/ Don't Care**
Protection of: - Blue Crabs	6	5	4	3	2	1	0
- White Shrimp	6	5	4	3	2	1	0
- Red Trout Sport Fish	6	5	4	3	2	1	0
- Black Bear	6	5	4	3	2	1	0
- Wetland Forests	6	5	4	3	2	1	0
- Ground water supply for drinking	6	5	4	3	2	1	0

7. Please tell us how much priority you think should be given to wetlands mitigation if it results in:
(CIRCLE ONE NUMBER FOR EACH ITEM)

	High Priority ←				→	**No Priority**	**Don't Know/ Don't Care**
Reduction of salt water intruding into ground water sources used for drinking	6	5	4	3	2	1	0
Preservation of a large amount of wetlands over time	6	5	4	3	2	1	0
Preservation of only a small amount of wetlands	6	5	4	3	2	1	0
Prevention of investments in areas which have increased preserved wetlands	6	5	4	3	2	1	0

Section D: In this section we ask what you think about a number of wetland mitigation programs

- The Wetland Mitigation Programs we wish you to consider will be the same as described in the Information Booklet.

- Please feel free to refer back to the Information Booklet.

- Only consumers in the State of Georgia will be eligible for the program.

- In this section we will ask you to choose between two Wetland Mitigation Programs that give priority to preserving different species, and other benefits provided by wetlands.

- The programs differ in terms of the emphasis that will be given to protecting different species or other benefits of wetlands

- Programs also differ by the amount of wetlands which will be preserved under a Mitigation program over a period of five years.

- After you tell us which of the two programs you prefer, we will ask you if you would vote to have one of these programs or to have no Wetlands Mitigation program at all.

- There are **four (4) sets** of these questions.

In this section, four (4) sets of wetland mitigation programs are presented. Suppose you had to vote between two wetland mitigation programs, Program A and Program B. These programs differ in terms of attributes of the wetlands that would receive priority in the bidding process, the number of acres in the program and the cost to you. Assuming also that there are limited funds to implement the program, in which case each program would be implemented *only in those locations in coastal Georgia* for which the program has priority. For each of these four set of programs, please tell us which of the two bidding programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or do nothing.

Program Set 1:

Attributes	**Wetland Mitigation Program A**	**Wetland Mitigation Program B**
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	No	Yes
Protection of White Shrimp by Imposing a Shorter Harvest Season	Yes	Yes
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	No	Yes
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	No	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	225,000	150,000
One time Cost to your Household in 2005	$25	$60

8. Which program do you prefer?
(PLEASE CIRCLE ONE NUMBER)

1 Program A
2 Program B

9. Now suppose you could vote between Program A, Program B and doing nothing. How would you vote? (PLEASE CIRCLE ONE NUMBER)

1 I would vote for Program A
2 I would vote for Program B
3 I would not vote for either program

Program Set 2:

	Wetland Mitigation Program A	Wetland Mitigation Program B
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	Yes	No
Protection of White Shrimp by Imposing a Shorter Harvest Season	No	No
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	Yes	No
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	No	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	15,000	150,000
One time Cost to your Household in 2005	$150	$100

10. Which program do you prefer?
(PLEASE CIRCLE ONE NUMBER)

1 Program A
2 Program B

11. Now suppose you could vote between Program A, Program B and doing nothing. How would you vote? (PLEASE CIRCLE ONE NUMBER)

1 I would vote for Program A
2 I would vote for Program B
3 I would not vote for either program

Program Set 3:

	Wetland Mitigation Program A	**Wetland Mitigation Program B**
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	Yes	Yes
Protection of White Shrimp by Imposing a Shorter Harvest Season	Yes	No
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	Yes	Yes
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	Yes	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	150,000	15,000
One time Cost to your Household in 2005	$60	$150

12. Which program do you prefer?
(PLEASE CIRCLE ONE NUMBER)

1 Program A
2 Program B

13. Now suppose you could vote between Program A, Program B and doing nothing. How would you vote? (PLEASE CIRCLE ONE NUMBER)

1 I would vote for Program A
2 I would vote for Program B
3 I would not vote for either program

Program Set 4

	Wetland Mitigation Program A	**Wetland Mitigation Program B**
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	No	No
Protection of White Shrimp by Imposing a Shorter Harvest Season	Yes	No
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	No	No
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	No	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	225,000	150,000
One time Cost to your Household in 2005	$25	$100

14. Which program do you prefer?
(PLEASE CIRCLE ONE NUMBER)

1 Program A
2 Program B

15. Now suppose you could vote between Program A, Program B and doing nothing. How would you vote? (PLEASE CIRCLE ONE NUMBER)

1 I would vote for Program A
2 I would vote for Program B
3 I would not vote for either program

Section E: In this section we will ask you a few questions about your opinions on some aspects of wetlands

16. If you had to choose between preserving wetlands to different types of land, how would you rate each of these alternatives?
(CIRCLE ONE NUMBER FOR EACH ALTERNATIVE)

	Very Important ↔					**Not Important**	**Don't Know/ Don't Care**
Wetlands	6	5	4	3	2	1	0
Forestland	6	5	4	3	2	1	0
Lake Frontage	6	5	4	3	2	1	0
River Frontage	6	5	4	3	2	1	0
Ocean Frontage	6	5	4	3	2	1	0
Farmland	6	5	4	3	2	1	0
Prairie	6	5	4	3	2	1	0
Mountains	6	5	4	3	2	1	0
Undeveloped Land in Cities	6	5	4	3	2	1	0

17. Please tell us how strongly you agree or disagree with each of the following statements (CIRCLE ONE NUMBER FOR EACH STATEMENT)

	Agree ⟷				**Dis-agree**	**Don't Know/ Don't Care**
Wetlands help to protect fish and wildlife	5	4	3	2	1	0
Wetlands help to protect the quality of well water people use for drinking	5	4	3	2	1	0
Industrial activities such as mining cause major environ-mental problems in wetlands	5	4	3	2	1	0
Disposal of wastes from industry is not a major problem for wetlands	5	4	3	2	1	0
Soil erosion from farms cause major problems in wetlands	5	4	3	2	1	0
Wetlands protect coastal and rural communities from flooding	5	4	3	2	1	0
Wetlands do not contribute to beautiful scenery	5	4	3	2	1	0
I like to view wetlands scenery	5	4	3	2	1	0
People should not be allowed to do commercial activities in wetlands	5	4	3	2	1	0
Wetlands provide good wildlife habitat	5	4	3	2	1	0
Protection of wetlands will reduce residential and commercial sprawl.	5	4	3	2	1	0
Wetlands are an important part of coastal and rural communities	5	4	3	2	1	0

18. Please share your views about wetlands by indicating your level of agreement with the following statements. (CIRCLE ONE NUMBER FOR EACH STATEMENT)

	Strongly Agree	←	**Neither**	→	**Strongly Disagree**	**Don't Know/ Don't Care**
Most persons involved in shrimping/crabbing are not wealthy	5	4	3	2	1	0
The government spends too much to bail out fishermen	5	4	3	2	1	0
Fishing is a more satisfying occupation than most others	5	4	3	2	1	0
Small family fishing businesses must be preserved	5	4	3	2	1	0
Commercial fishing businesses are more efficient that smaller family-owned ones	5	4	3	2	1	0
Commercial fishing enterprises get too many government benefits	5	4	3	2	1	0
Small fishing businesses are better stewards of wetlands than larger enterprises	5	4	3	2	1	0
Government should treat fishing businesses just like any other business	5	4	3	2	1	0
Government should not protect wetlands for future generations	5	4	3	2	1	0
Today's seafood is safer than it ever has been	5	4	3	2	1	0
Today's sea food is not as fresh as it has been	5	4	3	2	1	0
Our country is likely to suffer seafood shortages in the near future	5	4	3	2	1	0
Wetlands help to insure our nation's food & drinking water supply	5	4	3	2	1	0

Section F: In this last section, we would like to ask you some questions about your background that will help us compare your answers with those of other people. Please be assured that all of your responses are strictly confidential.

19. Are you: (CIRCLE ONE NUMBER)

1 Male
2 Female

20. What year were you born? (FILL IN THE BLANK)

19____

21. How many years of schooling have you completed? (CIRCLE ONE NUMBER)

1 Eight years or less
2 Some high school
3 High school graduate
4 Some college or technical school
5 Technical school graduate
6 College graduate
7 Post graduate work

22. How many people live in your household? (FILL IN ALL BLANKS)

_______ People age 18 and older

_______ People under the age of 18

_______ Total number of people in your household

23. Which of the following categories comes closest to your 2004 household income? (CIRCLE ONE NUMBER)

1. Less than $10,000	9. $45,000 to $49,999
2. $10,000 to $14,999	10. $50,000 to $59,999
3. $15,000 to $19,999	11. $60,000 to $69,000
4. $20,000 to $24,999	12. $70,000 to $79,999
5. $25,000 to $29,999	13. $80,000 to $89,999
6. $30,000 to $34,999	14. $90,000 to $99,999
7. $35,000 to $39,999	15. Over $100,000
8. $40,000 to $44,999	

THANK YOU FOR YOUR HELP!

Please return this completed survey in the enclosed postage-paid envelope.

Please write in the space below if you have additional Comments about wetlands protection in Georgia

Background Information Booklet

Wetlands Mitigation for the Protection of Wetlands in Coastal Georgia

Please Read Before You Begin the Survey

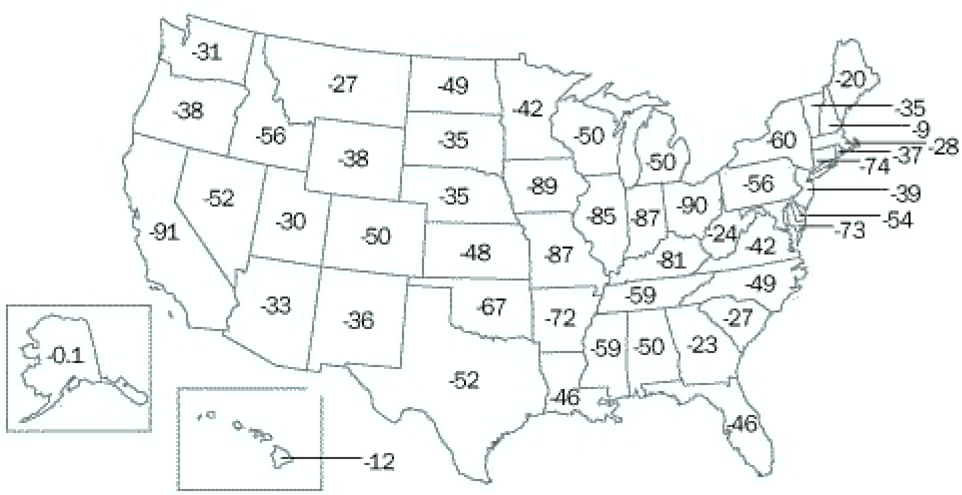
- In the 1600s, over 220 million acres of wetlands are thought to have existed in the lower 48 states. Since then, extensive losses have occurred, and over half of our original wetlands have been drained and converted to other uses.

- The lower 48 states contained an estimated 105.5 million acres of wetlands in 1997. This is an area about the size of California.

- Roughly 41% of the **coastal** wetlands in the continental United States are located along the Gulf of Mexico. (See Figure Below).

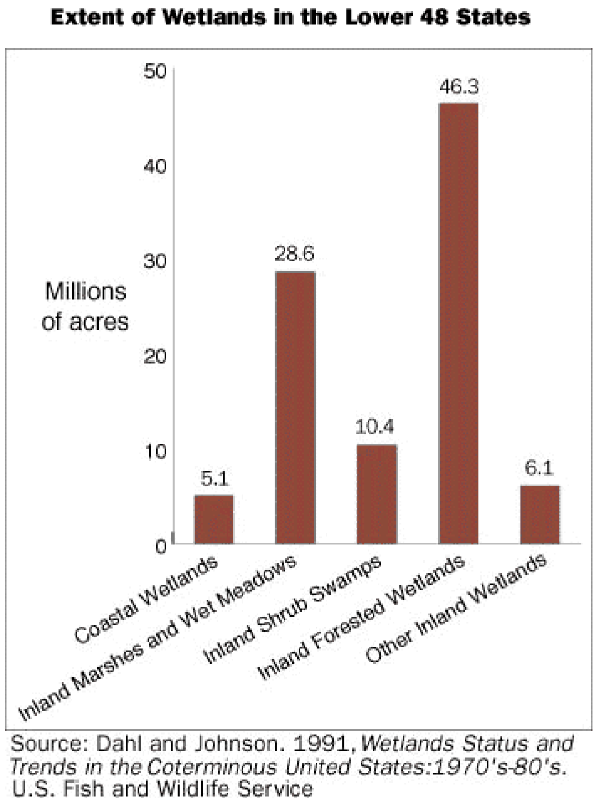
- Between 1986 and 1997, an estimated 58,500 acres of wetlands were lost each year in the continental United States (See Map Below).

Percentage of Wetlands Acreage Lost, 1780's-1980's



Twenty-two states have lost at least 50 percent of their original wetlands. Seven states—Indiana, Illinois, Missouri, Kentucky, Iowa, California, and Ohio—have lost over 80 percent of their original wetlands. Since the 1970's, the most extensive losses of wetlands have been in Louisiana, Mississippi, Arkansas, Florida, South Carolina, and North Carolina.

Source: Mitch and Gosselink. Wetlands. 2nd Edition, Van Nostrand Reinhold, 1993



- The main causes for loss of wet lands include:
  - Dredging
  - Building dykes and dams
  - Tilling for crop production
  - Levees
  - Logging
  - Mining
  - Construction
  - Runoff
  - Air and water pollutants
  - Changing nutrient levels
  - Hurricanes and other storms

- Many persons are concerned about the loss of wetlands in Georgia. They are especially concerned about the effects on crab and shrimp production, the loss of recreational spaces and wildlife, and the effects on ground water used by consumers for drinking.

- The purpose of this survey is to learn your own opinions about wetlands preservation in Georgia

Source: EPA (http://www.epa.gov/OWOW/wetlands/vital/status.html)

LOSS OF WETLANDS IN THE STATE OF GEORGIA

- **It is estimated that Georgia has approximately five million acres of wetlands. Of these, over 700,000 acres are coastal wetlands.**

- **Since 1970, Georgia has loss approximately 23% of its wetlands areas.**

- **Georgia's coastal marshlands amount to roughly one-third of all** salt marshes **on the US Atlantic coast.**

- **High population growth rate and intensive development on Georgia's coast is now affecting much of the coastal wetlands.**

- **These effects are now believed to be affecting important industries such as fishing, shrimping, and nature based tourism, as well as domestic drinking water supply.**

BENEFITS OF WETLANDS

Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs.

- Wetlands Yield Fish and other Sea-foods for the Nation
- Wetlands Provide Recreational Opportunities
- Wetlands Improve Water Quality
- Wetlands Help Control Floods

Source: EPA (http://www.epa.gov/OWOW/wetlands/vital/status.html)

USES OF WETLANDS IN GEORGIA

Wetlands sustain over one half of Georgia's protected species, provide breeding grounds for wildfowl, serve as nursery and spawning ground for commercial and recreational fisheries, and play a key role in water quality of both surface and ground water for consumers.

The presence of wetlands in coastal Georgia gives rise to the following important industries:

- Blue Crab Industry - $1.9 Million earned in 2002
- Shrimping industry – Generated more than 27 Million dollars in 1995
- Recreational fishing – Estimated expenditure more than $53M annually
- Tourism – Total tourism earnings in coastal Georgia approx. $1.39B in 1993.

WETLANDS MITIGATION – A PROGRAM TO REDUCE WETLANDS LOSS

A wetlands mitigation bank is a wetland area that has been restored, created, enhanced, or (in exceptional circumstances) preserved, which is then set aside to compensate for future conversions of wetlands for development activities. A wetland bank may be created when a government agency, a corporation, or a nonprofit organization undertakes such activities under a formal agreement with a regulatory agency. The value of a bank is determined by quantifying the wetland values restored or created in terms of "credits."

Benefits of Mitigation Banking

- Banking can provide more cost effective mitigation and reduce uncertainty and delays for qualified projects, especially when the project is associated with a comprehensive planning effort.
- Successful mitigation can be ensured since the wetlands can be functional in advance of project impacts.
- Banking eliminates the temporal losses of wetland values that typically occur when mitigation is initiated during or after the development impacts occur.
- Consolidation of numerous small, isolated or fragmented mitigation projects into a single large parcel may have greater ecological benefit.
- A mitigation bank can bring scientific and planning expertise and financial resources together, thereby increasing the likelihood of success in a way not practical for individual mitigation efforts.

Landowners needing to "mitigate" or compensate for authorized impacts to wetlands associated with development activities may have the option of purchasing credits from an approved mitigation bank rather than restoring or creating wetlands on or near the development site.

Wetland Mitigation Banking can result in restoration of previously destroyed wetlands or the preservation of current wetlands. Currently, state and local agencies fund the purchase of banks as offsets for future developments which may impact on local wetland areas.

Source: EPA - http://www.epa.gov/owow/wetlands/facts/fact16.html

LOCATION OF GEORGIA'S COASTALWETLANDS

Georgia's coastal wetlands form part of the eleven coastal counties of the State. These are:

- **Brantley**
- **Bryan**
- **Camden**
- **Charlton**
- **Chatham**
- **Effingham**
- **Glynn**
- **Liberty**
- **Long**
- **Macintosh**
- **Wayne**

See Map of Coastal Counties Below

Source: Georgia DNR

Research Survey
Wetlands Mitigation in Georgia

Dear Colleague:

You are invited to participate in a research study titled "*A Conjoint Analysis of Consumer Preferences for Wetlands Mitigation in Georgia*" conducted by Willard Phillips, Department of Agricultural and Applied Economics, University of Georgia, 542-0856 under the direction of Dr. John C. Bergstrom, Department of Agricultural and Applied Economics, University of Georgia, 208 Conner Hall, Athens, Georgia 30602.

The purpose of this research study is to determine how important it is to consumers to preserve wetland areas in Georgia, and to assess consumer's preferences for various policy options to preserve wetland areas.

If you should choose to participate in this study, your participation will involve the following:

- Completing the enclosed survey that includes questions about basic demographics, how much you value various policy options as well as your opinions on a number of statements. Please note that you may consider some of these statements inappropriate and may, therefore, wish to choose not to participate in this research.

Completion of the survey is expected to take a maximum of 20 minutes. All responses will be treated with strictest confidence and will be secured in a locked cabinet in my office, and any names and contact information will be destroyed by June, 2006. Any information that is obtained in connection with this study and that can be identified with you will remain confidential except as required by law. If you are not comfortable with the level of confidentiality proposed please feel free to mail me a copy of the survey at the address given below, with no return address on the envelope.

Your participation in this study is completely voluntary. You may withdraw at any time without penalty, or skip any questions you feel uncomfortable answering.

If you have any questions do not hesitate to contact Willard Phillips at **wphillip@uga.edu**. Please include a phone number in your email message to me if you would like for me to call you about your questions.

Thank you for the invaluable help that you are providing by participating in this research study.

Sincerely,

Willard Phillips
Department of Agricultural and Applied Economics,
University of Georgia
306 Conner Hall
Athens, Georgia 30602
wphillip@uga.edu
Phone: 706-542-0737

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu.

By completing the survey you are agreeing to participate in the research.

Research Survey

Wetlands Mitigation in Georgia

Dear Colleague:

About four weeks ago you received survey materials for a University of Georgia research study on wetlands protection conducted by Willard Phillips, Department of Agricultural and Applied Economics, University of Georgia, under the direction of Dr. John C. Bergstrom, Department of Agricultural and Applied Economics, University of Georgia, 208 Conner Hall, Athens, Georgia 30602.

The purpose of this research study is to determine how important it is to consumers to preserve wetland areas in Georgia, and to assess consumer's preferences for various policy options to preserve wetland areas.

So far we have not received your completed questionnaire. **Your response represents thousands of other Georgia citizens, so each returned questionnaire is very important to us in completing this research.** I have therefore enclosed another survey form which I would really appreciate your efforts in completing and returning to me at your earliest convenience.

The survey includes questions about basic demographics, how much you value various policy options as well as your opinions on a number of statements. Completion of the survey is expected to take a maximum of 20 minutes.

All responses will be treated with strictest confidence and will be secured in a locked cabinet in my office, and any names and contact information will be destroyed by June, 2006. Any information that is obtained in connection with this study and that can be identified with you will remain confidential except as required by law. If you are not comfortable with the level of confidentiality proposed please feel free to mail me a copy of the survey at the address given below, with no return address on the envelope.

Your participation in this study is completely voluntary. You may withdraw at any time without penalty, or skip any questions you feel uncomfortable answering.

If you have any questions do not hesitate to contact Willard Phillips at **wphillip@uga.edu**. Please include a phone number in your email message to me if you would like for me to call you about your questions.

Once again, thank you for the invaluable help that you are providing by participating in this research study.

Sincerely,

Willard Phillips
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306 Conner Hall
Athens, Georgia 30602
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By completing the survey you are agreeing to participate in the research.

GENERATING THE CONJOINT QUESTIONS FROM THE EXPERIMENTAL DESIGN

The optimal survey design contained 16 choice sets each with six (6) attributes. Since it was assumed that consumers could not efficiently make choices over 16 attributes, these choice sets were allocated across four (4) blocks, which represented the geographic regions Georgia as follows:

Block 1:	-	North Georgia
Block2:	-	West Georgia
Block 3:	-	East Georgia
Block 4:	-	South Georgia

As shown in Table 4.3, the first four choice sets were allocated to Block 1 (North), the second four to Block 2 (West), the third four to Block 3 (East), and the final four to Block 4 (South). Recall that each choice set contains a combination of attributes and levels. The four choice sets of each block were randomly distributed across four Program Sets in each questionnaire. Hence respondents of Block 1 would see only the choice sets allocated to Block1. Within each Program Set, consumers were provided with two Wetlands Mitigation Programs to compare and make a choice. This was achieved by sequentially distributing the choice sets within each block across the four program sets in each questionnaire. Within the questionnaire, the codes for attributes ands levels were replaced with the more readable labels. Based on this arrangement, the first two choice sets from the design would yield the following Program Set 1, with the following two vertically arranged programs (A,B) for Block 1:

Block 1 Design:

Block	x1	x2	x3	x4	x5	x6
1	2	1	2	2	4	1
1	1	1	1	1	3	2
1	1	2	1	2	1	4
1	2	2	2	1	3	3

Attribute Labels:
x1= Bluecrab
x2= White Shrimp
x3= Salt water
x4= Red drum
x5= Total acres
x6= One time Cost

Level Labels:

For x1..x4:	1= Yes	2=No		
For x5:	1=15,000;	2=75,000;	3=150,000;	4=225,000
For x6:	1=$25;	2=$60;	3=$100;	4=$150

Sample Conjoint Question developed from the experimental design

Program Set 1:

Attributes	Wetland Mitigation Program A	Wetland Mitigation Program B
Protection of Blue Crabs by Limiting Harvests of Mature Female Crabs	No	Yes
Protection of White Shrimp by Imposing a Shorter Harvest Season	Yes	Yes
Prevention of Salt Water Intrusion into Ground Water for Drinking Priority	No	Yes
Protection of Recreational Red Drum by Banning Commercial Harvests During Brooding Season	No	Yes
Total Acres of Wetlands Preserved Over the Next Five Years	225,000	150,000
One time Cost to your Household in 2005	$25	$60

The questionnaire also provided the respondent with the opportunity to vote for *neither* of Program A or B by asking them to indicate whether they would choose A, B or none of the programs in each program set. Figure A1 below outlines the context for the distribution of the experimental design in the questionnaire.

Figure A1: Context for Distribution of the Experimental Design