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**Factors Influencing Private Landowner
Restoration Investment Decisions in Coastal Louisiana**

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Abstract

Coastal wetland loss has been a major problem in Louisiana, exceeding 1.2 million acres over the last century alone. Although federal, state, and local efforts have attempted to combat this loss from a public perspective, little has been done to encourage private landowners to maintain and protect their coastal lands. This paper investigates the factors that influence private landowners to invest in coastal wetland restoration and maintenance activities in Louisiana. We surveyed private coastal landowners to determine their general socioeconomic characteristics, attitudes toward risks, attitudes toward wetland conservation, current uses of landholdings, and previous investments in wetland restoration and maintenance projects. Using this survey data, an econometric model was estimated to determine how various factors could influence the probability and the level of investment in coastal restoration. Preliminary results show that property size, attitudes toward wetland restoration and maintenance, land use, and degree of risk aversion are important factors in a landowner's decisions to invest in wetland restoration and maintenance.

Introduction

The coast of Louisiana, with more than three million wetland acres, accounts for about 40 percent of the nation's total salt marshes and about 15 percent of the nation's total freshwater wetlands. In the last century alone, however, Louisiana is estimated to have lost more than 1.2 million acres (1,875 square miles) of coastal wetland (CWPPRA 2006). A number of factors have contributed to wetland losses in Louisiana. Topping the list of these factors is the construction of flood-control levees along the Mississippi river that prevent wetlands from receiving most of the fresh water inputs and nutrients that are necessary to their survival (Boesch *et al.* 1994). In

addition, the dredging of access canals and navigation channels has led to the redirection of alluvial sediments away from the coast and exacerbated erosion and saltwater intrusion. As a result of this dredging, it is estimated that about 160-200 million metric tons per year of sediments that once supplied the coastal wetlands are now delivered directly onto the outer continental shelf (Caffey and Shexnayder 2003; Caffey 2005).

Although human induced factors, wetland losses are caused by natural factors such as hurricanes, sea level rise, subsidence, and nutria herbivory activities. For example, the U.S Geological survey estimates that 217 square miles of Louisiana coastal wetlands were destroyed as a result of hurricanes Katrina and Rita alone (USGS 2006). If the current wetland loss rate continues, Louisiana is projected to lose an additional 431,000 acres (673 square miles) by the year 2050 (CWPPRA 2006). The economic implication of this projected loss is tremendous, with the state and the nation potentially losing billions of dollars that are directly or indirectly derived from activities occurring on these wetlands. According to some estimates, the economic costs of this projected wetland loss under no action scenarios is estimated to be in a range of \$27-100 billion (LADNR 1999).

Regardless of the scope of federal and state public funding allocated to wetlands, any long-term solution requires the engagement of private landowners directly in restoration and protection activities. Encouraging landowners to undertake private restoration and maintenance activities can be a very difficult task for several reasons. First, the majority of the benefits associated with wetland restoration and maintenance activities are public rather than private. Second, the decisions to undertake wetland restorations and maintenance are subject to several sources of uncertainty, including climate change, changes in wetland restoration technology, and changes in wetland regulation policies. In addition, there are substantial sunk costs associated

with the permitting, processing, and construction of wetland restoration projects that might prove fruitless in the face of climate change and sea-level rise. Therefore, any analysis of the decision to privately invest in wetland restoration and maintenance should be grounded in a theoretical model that accounts for the effects of risk and uncertainty on the decision making process. The uncertainty associated with the investment decision introduces an additional hurdle to the landowner's investment decision such that positive investments in wetland restoration and maintenance should be observed only when the expected present value of the revenue of the investment exceeds the expected present value of the investment costs by a large premium. This premium is equal to the option value of waiting (opportunity cost of investment) (Fisher *et al.* 1972; Arrow and Fisher 1974; and Dixit and Pindyck, 1994). Therefore, applying a simple net present value (NPV) rule results in open-loop management that can lead to earlier or overinvestment compared to what would occur when the decision process takes into account future uncertainty and irreversibility of the investment.

Using mail survey data, this study employs a discrete choice model to determine the factors that influence the landowners' decisions to invest in wetland restoration and maintenance in coastal Louisiana. The landowners are assumed to maximize the expected present value of future cash flow subject to the uncertainty associated with wetland restoration technology, climate change, and government policy. The first section of the paper provides a brief literature review. Next, a theoretical model of wetland restoration decisions is presented, followed by a description of the survey data and the estimation procedures used with the econometric model. The results of the econometric model are then presented, and the paper concludes with a discussion of the model results and policy implication.

Literature Review

Although not previously examined in the Louisiana wetland system, a number of studies have looked at the factors that determine various types of resource restoration and/or protection activities. Ervin and Ervin (1982) investigated the factors that determine the use of soil conservation practices using a random sample of Missouri farmers. The study found that education, perception of erosion problem, the susceptibility of soil to erosions, and cost sharing subsidies play important roles in the farmer's decision to invest in soil conservation. Norris and Batie (1987) used a tobit model to investigate soil conservation decisions in Virginia. Using total conservation expenditure as a dependent variable, the study found that financial factors, including debt and income, were the most important determinants for the farmers' conservation decision. In addition, other factors, including perceptions of erosions, education, off-farm income, and land tenure arrangements, were statistically significant in the model. Featherstone and Goodwin (1993) used a Tobit model to analyze the factors that influenced a farmer's decision to invest in long-term conservation improvements in Kansas. The study found that farm size, incomes, type of farm, ownership structure, and age were all important in decisions to invest in conservation improvements. The study could not, however, find evidence that participation in government programs influenced the farmer's conservation decisions. Soule et al. (2000) investigated the impact of land tenure on the adoption of conservation practices using a sample of 941 U.S. corn producers. They found that the form of land tenure had a significant effect on the adoption of conservation-related practices. Hagos and Holden (2006) studied the effect of land tenure, public programs, and resource poverty on the household's investment in soil conservation in northern Ethiopia. The study found that public conservation programs have positive effects on private investment. The study also found that risk aversion plays a critical role

in the household's decision to intensify soil conservation measures, but not in the household's initial decision to use soil conservation measures. Additionally, other factors, including land characteristics and perception of returns on conservation investments, were found to be important in the household's decision to invest and intensify soil conservation activities.

With respect to forestry plantation investment, Romm et al. (1987) used a logit regression to determine the factors that influence private forestry investment in northern California. They found that income, residency, and age were the most important predictors of the private landowner's forestry investment. The property size was found to be the most important factor affecting the landowner's decision to invest in timber harvesting. Nagubadi *et al.* (1996) used a probit model to analyze the participation of nonindustrial forest landowners in government forestry assistance programs. The study revealed that property size, ownership reason, governmental sources of information, forestry membership, age, fear of loss of property rights, and time span of the ownership were all important determinants in the landowners' program participation.

With respect to wetlands, Jones *et al.* (1995) surveyed private wetland landowners in New Zealand to determine their attitudes toward wetland protection and potential conservation mechanisms. The result of the study showed that the incentives method is the most preferred mechanisms to encourage the landowners' protection of wetlands. The study suggested the use of a range of planning mechanisms including the ones based on economic incentives and financial compensation. Soderqvist (2003) analyzes factors that motivate farmers' participation in the wetland creation program in Sweden. The study concluded that not only financial factors such as subsidies determine farmers' willingness to participate in the program, but also various private

and public environmental benefits of the program are also important determinants for the farmers' participation decisions.

Analytic Framework

Assume that a risk neutral landowner owns a property size A_t at time t . Part of this property is wetland denoted by w_t and the rest $(A_t - w_t)$ is upland. Following Zhao and Zilberman (1999) and Parks (1993) models specification, the private net benefit derived from wetland use on the land at time t can be written as:

$$B^t(w_t) = R^t(w_t) - C^t(w_t) \quad (1)$$

where $R^t(w_t)$ is the total revenue and $C^t(w_t)$ is the total cost associated with revenue producing activities on the wetlands. Further assume that there is wetland loss α_t at time t . For a risk neutral landowner, the decision problem is to choose the optimal level of restoration I_t that maximizes the present value of the expected net private benefits from wetland use:

$$V_1 = \int_{t=0}^{\infty} e^{-\delta t} E[B^t(w_t - \alpha_t + I_t) - C_t(I_t) - C_0] dt$$

subject to $I_t \leq \alpha_t$ (2)

where E is the expectations operator, δ is the discount rate, $C_t(I_t)$ and C_0 are the variable and fixed costs (respectively) associated with restoration level I_t , and the constraint requires that the level of wetland restoration does not exceed the level of wetland losses at time t . The variable cost of restoration is assumed increasing and convex, so $C'(I_t) > 0$ and $C''(I_t) > 0$ for $I_t \geq 0$.

The traditional net present value (NPV) models predicts that landowners will invest in wetland restoration when the net present value of the expected discounted cash flow of wetland restoration exceeds the cost of restoration. If $V_1 > 0$, then the landowner will invest in wetland restoration and maintenance. If the expected present value of the net benefit of wetland

restoration V is negative, then the landowner will not invest in wetland restoration and maintenance. A landowner with high fixed cost of restoration might choose to delay investment in wetland restoration and maintenance until the return from investment is sufficiently larger than the cost of investment. Given that fixed costs associated with permit requirement and land-use management plans might be high under the current wetland regulatory constraints, it is expected that the majority of landowners will choose not invest in wetland restoration and maintenance.

Even though the investment decision model described above is very appealing, it departs from the actual private decision process that wetland landowners face because it ignores the role of risk and uncertainty in the decision process. Faced with the uncertainty associated with future global climate change (i.e., sea level rise), performance of wetland restoration technology, and changes in wetland regulation policy, an analysis of the landowner's decision to invest in wetland restoration and maintenance should account for the perceived risk of the investment decision. If, after accounting for risk, landowners will invest in wetland restoration and maintenance only when the benefit of wetland restoration exceeds the restoration cost by a large hurdle, then the traditional NPV rule underestimates the costs of wetland restoration and maintenance by ignoring the downside risk of the investment decision.

To account for the effects of risk aversion and uncertainty on the landowner's investment decision, the landowner's objective function described in equation 2 was adjusted to incorporate the von Neumann-Morgenstern utility function (u). The landowner's decision problem is to choose the optimal level of restoration I_t that maximizes the present value of the expected utility of the net benefits from the wetland:

$$V_2 = \int_{t=0}^{\infty} e^{-\delta t} E u [B^t(w_t - \alpha_t + I_t) - C_t(I_t) - C_0] dt$$

subject to $I_t \leq \alpha_t$ (3)

where $u(\cdot)$ is a continuous and twice differentiable von Neumann-Morgenstern utility function with positive first derivatives (u'). The sign of the second derivative (u'') is negative for a risk-averse landowner and positive for risk-seeking landowner.

Based on the model specification above, investments in wetland restoration and maintenance occurs only if the expected discounted utility of the benefits of wetland restoration exceed the discounted utility of the restoration costs ($v_2 > 0$). A risk-averse landowner with high fixed cost of restoration may choose to delay investment until the return from investment is sufficiently larger than the cost of investment in order to offset the downside risk of wetland restoration. On the other hand, a risk-averse landowner might consider investing in wetland restoration and maintenance in order to reduce the economic risks associated with lower property value and returns. Hence, the effect of risk aversion on the landowner's decision to invest in coastal wetland restoration is ambiguous and subject to empirical estimation.

Data and Methods

Data used in the analysis were obtained by mail survey of private wetland landowners in coastal Louisiana during the fall of 2009. The sampling frame was obtained from the State of Louisiana's Department of Natural Resources and consisted of all mapped wetland properties in the Coastal Management Zone of Louisiana. Collectively, more than 80 percent of Louisiana's privately-held coastal wetlands were covered by the sampling frame. The survey questionnaire was designed using Dillman's (1978) total design method for mail surveys. An initial version of the survey was mailed to a random sample of 30 landowners to pre-test the survey questionnaire. Based on the result of this pre-test, some changes were made to the survey questionnaires and a final version of the survey was mailed out 372 landowners who owned fewer than 3 property

tracts.¹ The landowners were contacted a total of six times; notification letter of the impending survey, a first mailing followed by a reminder post card, a second mailing followed by a second reminder post card, and a third mailing. Of the 372 potential respondents, 48 were either deceased, no longer owned the property, or could not be contacted (i.e., the questionnaires were returned as undeliverable). A total of 74 completed questionnaires were returned for a modified response rate of 22.8 percent.

The survey questionnaire consisted of 37 questions divided among five sections. The first questioned landowners about attitudes toward various wetland restoration programs and their current and future participation in government-run wetland restoration programs. The second section included questions concerning property size, ownership and management type, the number of acres leased to others, when the property was first acquired, the current use of the property, the percentage of income derived from activities that took place on the wetlands, estimated wetland loss, and the expected market value of the property. The third section asked questions on the landowner's wetland investment decisions, including whether they had conducted any wetland restoration and maintenance projects, the time they started these projects, the type of restoration techniques used, how much they invested, motivation for the wetland restoration projects, perceptions about the source and level of uncertainty associated with wetland restoration and maintenance, and attitudes toward wetland restoration and maintenance. The fourth section collected demographic information such as age, education, income, gender, and place of residence. The final section of the survey asked landowners questions about their

¹ The sampling frame contained landowners of widely varying sizes, from those with less than 10 acres of wetlands up to those corporate entities holding hundreds of thousands of acres. Ultimately, this study will be incorporating property specific characteristics into the analysis, with these characteristics being drawn from GIS overlays of property boundaries on various coastal databases. Thus, the questionnaires were designed to query potential respondents about actions taken on specific property tracts. The results reported in this paper focus on the small landholders, as future surveying efforts will include personal interviews with the property managers for the large corporate landowners.

attitudes toward investment risk. Because of missing observations, 51 observations were used in the preliminary analysis reported below. Descriptive statistics for the variables used in the analysis are presented in Table 1.

For the econometric model, we assumed that there was a latent variable y^* that underlines the observable variable y , which represents the landowner's decision to invest in wetland restoration and maintenance. This latent variable y^* is equal to the present value of the expected utility of the net benefit of wetland restoration (v_2). The landowners will invest in wetland restoration and maintenance if present value of the expected utility of the net benefit is positive ($v_2 = y^* > 0$) and they will not invest in wetland restoration and maintenance if $v_2 = y^* < 0$. While this latent variable y^* is not observable, it is possible to observe (through the survey) whether the landowners make any investments in wetland restoration and maintenance. Hence, y^* will take a positive value if the landowners indicate that they have made investment in wetland restoration and maintenance ($y=1$) and the latent variable y^* will take a negative value if the landowners indicate that they did not make any investment in wetland restoration and maintenance ($y=0$).

For the j^{th} landowner, the decision problem in equation 3 can be expressed as:

$$y_j^* = \beta_j' X_j + \varepsilon_j \quad y_j = 1 \text{ if } y_j^* > 0 \quad y_j = 0 \text{ if } y_j^* < 0 \quad (4)$$

where X_j is a vector of regressors including the landowners' characteristics, landowners' attitudes toward risk, and wetland restoration and maintenance, and property characteristics. β_j is a vector of parameters to be estimated, and ε_j is a random error term. Based on the empirical studies we summarized before, the X_j vector of explanatory variables includes the following; the landowner' education level measured in years of schooling, landowner's age in number of years, a dummy variable indicating the landowner's income level, a measure of the landowner' risk

aversion, a measure of the landowner perception of the uncertainty associated with wetland restoration and maintenance activities, an index measure of the landowner attitude toward wetland restoration, a dummy variable indicating whether the landowner receives a government cost share subsidy, a tract size measured in number of acres, a dummy variable indicating the ownership type, a dummy variable indicating how the property is currently managed, a group of dummy variables to capture the current use of the landowner's wetland property, and a measure of the level of wetland loss on the property.

The probability that a landowner j will invest in wetland restoration and maintenance activities is given by the following probability model:

$$Pr\{y_j = 1\} = Pr\{y_j^* > 0\} = F(\beta_j' X_j)$$

where $F(\cdot)$ is the cumulative distribution function. In cases with discrete variable, the most commonly used function are either the logit or probit. Romm et al. (1983) use a logit model to analyze the factors that influence forest investment. Soule et al. (2000) use a logit model to determine how land tenure influences the adoption of conservation practices. Similar to these studies, the landowner's decision to invest in wetland restoration and maintenance is modeled using a logit model.

Results

Table 2 reports results of the logit model. The coefficient of the wetland property size is positive and statistically significant indicating that the larger the wetland property size the higher the probability that an individual landowner will invest in wetland restoration and maintenance activities. The marginal effect value of this variable indicates that an increase in the property size by 10 acres leads to about 0.04 increase in the probability of investment in wetland restoration

and maintenance. This result is consistent with the finding of other studies that property size plays important role in the investment decisions for private landowners (Romm et al. 1987, Featherstone and Goodwin (1993)). None of the ownership variables are statistically significant at 10% level of significance. Therefore, ownership variables do not significantly influence the landowners' restoration decisions. The coefficient of the variable measuring the landowner attitudes toward wetland restoration and maintenance is positive and statistically significant at 10% level of significance. Hence, landowners who place importance on wetland restoration issues are more likely to invest in coastal wetland restoration.

The coefficient of the variable AGE was not statistically significant, indicating that the age of the landowner plays no role in determining whether to invest in wetland restoration and maintenance. Landowners who use part of their property for agriculture activities have less probability of investing in wetland restoration projects, with the coefficient of this variable being negative and significant at the 10% level of significance. The marginal effect value of this variable implies that landowners who use their properties for agriculture production have, on average, a 23% smaller chance of investing in wetland restoration and maintenance than other landowners, *ceteris paribus*. The coefficient of the variable that captures the risk preferences of the landowners was negative and statistically significant, although the marginal effect of risk on decisions was not statistically significant. This factor deserves more investigation. Finally, the estimation indicates that education has no impact on the probability of investment in wetland restoration and maintenance.

Conclusion

In summary, we found that wetland property size, attitudes toward wetland restoration and maintenance, land use, and the risk aversion characteristics of the landowner are all, to some degree, important factors influencing restoration and maintenance decisions. More specifically, landowners with large property size and have positive attitudes toward wetland restoration and maintenance, and do not use their properties for agriculture production are more likely to invest in wetland restoration and maintenance activities. The nonsignificance of other variables in the model such as age, education, and ownership type was somewhat surprising, but it might stem from the relatively small sample size in this preliminary estimation. The model is being refined and re-estimated as more data is collected, with a particular emphasis on investigation the nature of risk on decision making.

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Table1: Definitions and summary statistics of variables used in the analysis (Number of observations = 51)

Variable	Description	Mean	Std Dev
Invest	= 1 if the landowner invests in wetland restoration, 0 otherwise	0.35	0.48
Wetland_acres	Total wetland acres	2878.52	4926.16
Age	Age of the landowner	62.99	12.13
College	= 1 if the landowner has some college level, 0 otherwise	0.72	0.45
Soleowner	= 1 if the property is owned by one landowner, 0 otherwise	0.31	0.47
Joint_tenant	= 1 if the property is owned by joint tenants, 0 otherwise	0.23	0.42
Corporate	= 1 if the property is owned by corporate, 0 otherwise	0.28	0.45
Other_owner	= 1 if the property is owned by other owners, 0 otherwise	0.18	0.39
Attitudes	An index measure for the landowners attitudes	17.41	3.05
Agriculture	= 1 if the property used for agriculture production, 0 otherwise	0.22	0.42
Riskavr1	A measure for the risk aversion	4.88	2.53

Table 2: Results of the logit model for the landowners' wetland investment decisions

Variable	Parameter estimate	Std. Err.	Marginal effect	Std. Err.
Wetland_acres	0.00026**	0.00012	0.00004*	0.00002
Soleowner	2.37699	1.66155	0.44706	0.31660
Joint_tenant	1.49253	1.76144	0.27390	0.35587
Corporate	1.99126	1.70430	0.36243	0.33449
Attitudes	0.71286*	0.41154	0.10741**	0.03796
Age	-0.00775	0.03957	-0.00117	0.00587
Agriculture	-2.13135	1.28942	-0.22987*	0.12963
Riskavr1	-0.08291*	0.17219	-0.01249	0.02536
College	0.09506	1.08359	0.01410	0.15756
Constant	-14.89727	8.00780		