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Article

Factors Influencing Landowners' Decisions for Income-Generating Activities on Private Coastal Wetland in Louisiana

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Abstract: The coastal zone of Louisiana contains more than 3 million wetland acres and has the highest acreage of salt marsh of any state. However, Louisiana accounts for 80 percent of the nation's coastal land loss. The loss of Louisiana's coastal wetlands results in changes in economic and ecological benefits on local communities. The purpose of the study is to investigate the factors that motivate private coastal landowners to participate in income-generating activities and the level of income derived from their coastal wetland parcels and to gauge their opinion of potential policy instruments for coastal wetlands stewardship. A double-hurdle model was applied to econometrically identify the determinants on the participation and level of participation in income-generating activities using data collected from a sample of coastal wetland owners. The results based on the estimated parameters and marginal effects revealed that decisions to participate and the level of participation are related to physical characteristics of the wetland and socioeconomic characteristics of the landowner. For example, the type of wetland is the primary factor influencing the decision to participate and the level of participation. In addition, understanding the landowner's attitude toward wetland restoration program provides the opportunity for policymakers to better evaluate current and potential policies for coastal management in Louisiana.

Keywords: coastal management; double-hurdle model; income-generating activity; marginal effect; wetland

1. Introduction

1.1. Coastal Wetland Loss in Louisiana

Louisiana's coastal wetlands provide a variety of economic, ecological, cultural, and recreational values and are some of the most productive ecosystems in the United States. Benefits of coastal wetlands include flood control, shoreline protection, carbon storage, provision of biological diversity, and support for many fishery and ecotourism industries [1]. The Louisiana Coastal Zone (LCZ) includes more than 3 million wetland acres. While this area is vast, the state has experienced a net loss of over 1900 square miles (1,216,000 acres) of coastal wetlands since the 1930s. Barras et al. [2] estimated a current annual average land loss rate of 24 square miles (15,360 acres) per year. The total land loss at this rate in Louisiana represents approximately 80% of the coastal wetland loss occurring in the continental United States. Several factors have contributed to this loss, including hydrologic modification, navigation canals, nutrient and sediment starvation, sea level rise, and subsidence [3–5]. Currently at risk are the remaining coastal wetlands, most of which are under private ownership.

At the present rate and without substantial increases in restoration spending, another 600–1000 square miles are expected to be lost by the year 2050.

1.2. Traditional Program Approaches

More than 2 billion in state and federal dollars have already been directed toward this crisis, with an additional 50 billion called for by an ambitious, 50-year state master plan [5]. These investments are predicated on the need for protection and restoration of a wide range of market and non-market benefits, including: storm surge attenuation, protection of coastal communities and commercial infrastructure, maintenance of water quality and quantity, and the provision of critical habitat for numerous species of birds, fish, wildlife, and plants. To date, the vast majority of this spending has come through large-scale hydrologic, vegetative, and structural projects funded via federal–state partnerships. This public-works approach to restoration has been the hallmark of major project sponsors for the past three decades, including the Coastal Wetland Planning, Protection, and Restoration Act (CWPPRA), the Water Resources Development Act (WRDA), and the Coastal Impact Assistance Program (CIAP). Other federal laws and programs, however, have acknowledged the potential for smaller-scale projects and landowner incentives in maximizing the return on limited program dollars. The livelihoods of coastal landowners are often closely linked to the sustainability and productivity of their property. Thus, restoration programming that capitalizes on the economic incentives of private landowners could help to maximize the return on limited funding. Such approaches are common in the programmatic approaches utilized in the Conservation Title of the US Farm Bill. Caffey et al. [6] pointed to the apparent advantage of this landowner-based model, noting that conservation programs had contracted 600% more wetland acreage in Louisiana than the acreage benefited by CWPPRA projects, and had done so at 40% of the cost.

1.3. Existing and Potential Policy Instruments in Louisiana

Not all policy options are equally effective in achieving desired social goals given the alternative enterprises and the influence of different property characteristics and socioeconomic characteristics on the income-generating potential of coastal property. As differentiation in a landowners' resources, opportunities, and attitudes increases, the complexity of the response to a given policy will also increase. This may require that policy instruments be tailored to specific landowner and property characteristics. In practice, the effectiveness of public goals to encourage private coastal restoration efforts may depend upon more than just a simple method of making transfer payments. The reason for this is that private landowners with different situations are likely to exhibit heterogeneous preferences over a range of relevant land use alternatives. A wide range of management approaches has been proposed for the general problems of land and water conservation and ecosystem restoration in the United States. General categories of these approaches, with some specific examples relevant to coastal Louisiana, include:

- Public land purchases—Federal programs such as the CWPPRA and the Land and Water Conservation Fund (LWCF) have enabled the purchase and restoration of a small percentage of the coastal wetlands in Louisiana. Many private landowners, however, may be reluctant to sell their properties, preferring other means of achieving restoration goals.
- Public purchase of permanent or temporary conservation easements—Federal programs located in the Departments of Agriculture, Interior, and Commerce provide small levels of funding for the purchase of conservation easements on private coastal wetland properties.
- Establishing new markets for land—One existing but underutilized approach is the establishment of wetland mitigation banks through which credits for wetland restoration can be bought and sold. Another potential approach is the establishment of a market for carbon credits; brackish marshes such as those in the Louisiana coastal zone are believed to have good potential for carbon sequestration.

- Implementing innovative tax incentive programs—One potential incentive scheme involves severing, where needed, surface and subsurface property rights so that oil and gas producers may continue to exploit subsurface minerals but also may take advantage of reduced taxes for undertaking surface restoration efforts. The second example in this category would be shifting towards the taxing of land activities and not property. This latter approach is a landowner-specific approach that could be developed and refined using the results of this research.
- Subsidies for plant, fish, and wildlife management—Examples include bounties on the eradication of nuisance species, such as nutria (*Myocastor coypus*), an herbivorous rodent whose behavior is extremely destructive of wetlands. Another example includes programs to compensate landowners for conserving protected species, such as the US Fish and Wildlife Service's Private Stewardship Grants Program.

Specific programs for stewardship of privately-owned wetlands in the LCZ have primarily taken the form of easements and incentives. In the 1970s and 1980s, many landowners participated in the Water Bank Program (WBP), which provided \$30 million annually for wetland preservation easements. In the past 20 years, wetland stewardship funding has been primarily available to coastal landowners through programs administered through the Conservation Title of the U.S. Farm Bill. Such programs are administered by the Natural Resource Conservation Service (NRCS) and have included the Coastal Wetlands Reserve Program (CWRP), the Wetland Reserve Easement (WRE), and coastal habitat subsidies provided under the Environmental Quality Incentives Program (EQIP). Additionally, landowners in the LCZ interested in waterfowl habitat improvement projects have had access to U.S. Fish and Wildlife Service (USFWS) funding under the North American Wetlands Conservation Act (NAWCA). The NAWCA was established in 1989 to provide small grants and cost-share partnerships for wetlands conservation projects. Finally, the National Oceanic and Atmospheric Administration (NOAA) administers a Coastal and Estuarine Land Conservation Program (CELCP). This acquisition program has provided state and local governments with funding to protect more than 100,000 acres of threatened coastal estuarine lands.

1.4. Tapping into Private Incentives

The literature examining participation in federal/state wetland-restoration sponsored programs is limited; however, several studies have looked specifically at conservation program participation at the individual level in the United States as well as in other countries [7–13]. Aside from literature focused on wetlands, a number of studies have been conducted examining those factors leading to participation in various land conservation programs [10,14–25]. In general, previous studies indicate that a landowners' decision to participate in land-related activities (such as ecosystem conservation and wetland restoration) is affected by a wide range of economic, geographic, and sociological factors [9,11,13,26,27]. While the technology necessary for wetland conservation and restoration varies in complexity and cost, in many cases these solutions will either impact or be implemented on private lands. This situation is especially true in Louisiana, where more than 80% of coastal wetlands are privately owned [5].

Incentivizing environmental stewardship of privately-held tracts requires an understanding of the economic linkages between landowners and natural resources. Roberts et al. [28] described a partitioning of Louisiana's coastal wetland revenues into 'surface' and 'subsurface' categories. Subsurface revenues are those emanating from the production of oil and natural gas-based energy. Energy revenues have historically accounted for the majority of income to private coastal landowners in the state—although these sources have been on a long-term decline due to resource depletion, falling prices, and the offshore migration of the petroleum sector. The authors describe surface-based revenues for various wetland types (freshwater, brackish, and salt) and indicate that two types of enterprises—waterfowl hunting and alligator harvesting (egg and adult) comprise the vast majority of surface-based revenues. While other wetland-based commercial activities have emerged in recent years (e.g., ecotourism, fishing leases), the majority of surface revenues from Louisiana's coastal wetlands

continue to be dominated by waterfowl- and alligator-based enterprises. According to 2017 Louisiana Summary [29], total Louisiana gross farm value of all alligator harvest (wild and farm-raised) and waterfowl hunting leases during 2017 were \$83.6 million and \$55.21 million, respectively. The total gross farm value of all alligator harvest and waterfowl hunting from the 20 coastal parishes during 2017 accounted for 64 percent and 68 percent of the state total for these two enterprises, respectively.

These surface values are driven to a great extent by habitat quality and the extent to which landowners maintain or enhance that habitat through investments in environmental stewardship. Dedah [7] found, however, that almost three-quarters of coastal wetland owners in Louisiana exhibited risk-averse behavior regarding wetland stewardship expenditures, likely due to the relatively low income derived from surface-use activities versus subsurface revenues from oil and natural gas. The author suggests that landowners would be reluctant to support publicly funded wetland conservation and restoration projects simply on the prospect that such projects would provide substantial public benefits. If the private benefits to landowners for preserving their wetlands were higher, however, there might be greater incentive to participate in stewardship programming.

1.5. Approach and Rationale

The goal of this study is to employ an empirical model to examine the factors that motivate landowner participation and intensity of surface-based income generating activities and to gauge their opinion of potential policy instruments for coastal wetlands stewardship. Specific objectives include: (a) Determining landowner characteristics, including attitudes and use of their wetland property for surface income-generating activities, knowledge and opinions regarding cost-sharing programs, and their general socioeconomic information; (b) Identifying physical characteristics of the associated property parcels, including the type of wetland, the total acreage of different marsh types, and presence of a hunting lodge/camp, etc.; (c) Estimating the importance of specific property and landowner characteristics on participation rates and the intensity of participation (i.e., the level of income-generating activities) in the two primary enterprises conducted on coastal Louisiana wetland properties (i.e., alligator and waterfowl hunting enterprises); and, (d) Exploring the general constraints and opportunities for participation in wetland stewardship programs based on the findings above.

The remainder of this paper is presented in four parts. The methods section outlines the case study and sample frame, the econometric approach, and model variables. The results section includes a discussion of maximum likelihood estimates, marginal effects, and program participation. The conclusion section summarizes the findings. The last section discusses limitations and additional research and implications for public policy.

2. Methods

2.1. Case Study and Sample

The study area is located in the Louisiana Coastal Zone (LCZ); the State of Louisiana is divided into 64 parishes, of which 20 parishes are located in Louisiana's tidally-influenced coastal zone. This region contains a range of wetland habitats, ranging from freshwater to saline marsh. Figure 1 shows the water/wetland interface for five coastal parishes (Cameron, Lafourche, Plaquemines, Terrebonne, and Vermilion parishes), which were chosen in this study (Figure 1). The total gross farm value of all wild alligator harvest and waterfowl hunting from these parishes in 2017 was \$64.66 million and \$35.27 million, which account for 75 percent and 64 percent of the state total and account for 99 percent and 94 percent of the 20 coastal parishes total for these two enterprises, respectively [29]. For this study, a questionnaire was implemented using Dillman's [30] tailored design method for mail surveys. This survey was designed to determine how the characteristics of individual landowners and their properties influence their participation and intensity in revenue-generating activities. Additional questions were used to gauge participation in wetland restoration programming, and respondent perceptions of opportunities and constraints by program type. A draft version of the questionnaire

was developed in early 2015 and tested amongst extension agents of the Louisiana Sea Grant College program. The survey instrument contained two sections with a total of 23 questions that allowed for quick answers selected from several categories. The last question was open-ended and solicited additional topics that might not have been adequately covered in this survey. The final version of the questionnaire is provided in Appendix A.

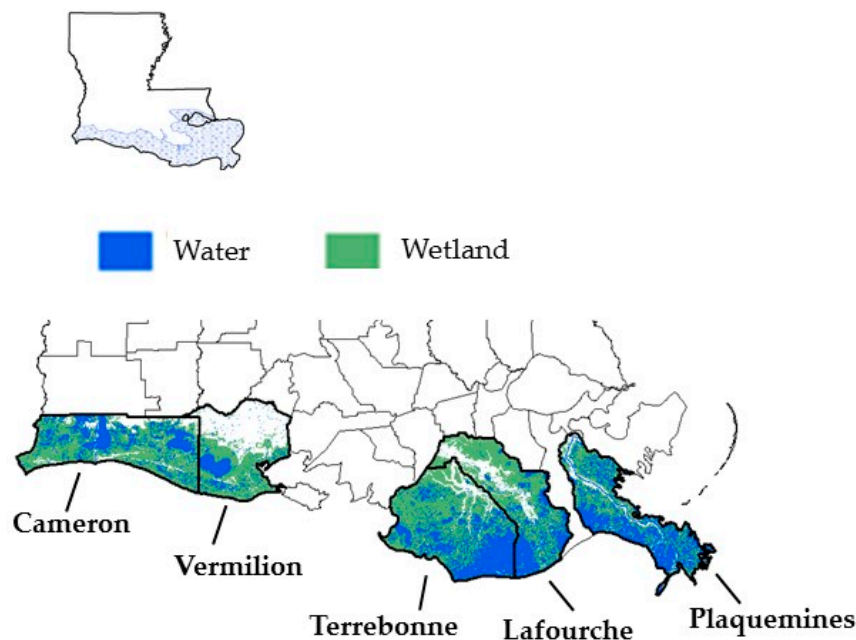


Figure 1. Study area: Parishes of coastal Louisiana in which landowners were surveyed (Source: U.S. Geological Survey).

The mailing list of private coastal landowners was obtained from coastal parish assessor's offices. Following Dedah [7], this study initially stratified landowners of 1159 parcels into three groups based on the number of wetland parcels owned. Landowners having ownership of three or more parcels were excluded from the study given the large scale of land under management, the complexity and divergent management objectives across multiple tracts, and difficulties in identifying the correct spokesperson within larger, corporately-owned operations. This refined the research focus to landowners having only one or two parcels.

After eliminating large landowners, duplicates, parcels without mailing addresses, and publicly owned properties, the sample frame was reduced to a total of 866 landowners for the study area. An initial wave of survey packages was sent out in the spring of 2016 and included a cover letter, questionnaire, a geographic information system (GIS) parcel map of the owned parcel(s), and a self-addressed postage-paid return envelope. Approximately two weeks later, a postcard was sent out reminding landowners to fill out the survey if they had not already done so. The final number of useful returns from this process was 122, or an effective response rate of 14%. These respondents owned a total of 99,425 acres with an average holding of 814 acres. In terms of the total wetland area controlled by the survey respondents, these individuals controlled approximately 3% of the total wetland acreage in the LCZ [5].

2.2. Econometric Approach

Conventionally, three main econometric methodologies, the standard Tobit model, the Heckit model, and double-hurdle model, could be utilized to investigate landowners' decisions concerning participation in income-generating activities and the level of income derived from these activities. The Tobit model, however, is very restrictive in its parameterization and considers only the dependent

variable to be censored at the corner and ignores the source of zero observations [31–34]. Although the Heckit model uses a two-stage estimation procedure to deal with the problem associated with the zero observations generated by the non-participation decision, it assumes no zero observation in the second stage [21]. The double-hurdle model generalizes the Tobit model by introducing an additional hurdle which must be passed before observing any positive values and permits potential zero values in the second stage [35]. By using a Probit estimator to model the participation decision, zero observations on the dependent variable can be either attributed to corner solutions or nonparticipation [31,35]. This model also allows the two stages to be treated separately. Thus, a separate stochastic process can be used to model the probability of participation and the level of participation [36].

In this study, private landowners' decisions can be divided into a two-stage decision-making process. In the first stage, the wetland owner must decide whether to participate in income-generating activities. It is expected to reflect the individual's perceptions and attitudes toward those factors influencing income-generating activities. Conditional on the outcome of the first stage, the second stage considers the level of income to be forthcoming from these activities. The decision process suggests that the double-hurdle model is appropriate for the current study.

Double-Hurdle Model

Following Jones [24], the specification of the DH model can be expressed as

Stage 1: Participation decision equation

$$y_{1i}^* = x_{1i}\beta_1 + \epsilon_{1i}; \epsilon_{1i} \sim N(0, 1) \quad (1)$$

$$y_{1i} = \begin{cases} 1 & \text{if } y_{1i}^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

Stage 2: Level of income equation

$$y_{2i}^* = x_{2i}\beta_2 + \epsilon_{2i}; \epsilon_{2i} \sim N(0, \sigma^2) \quad (3)$$

$$y_{2i} = \begin{cases} y_{2i}^* & \text{if } y_{1i} = 1 \text{ and } y_{2i}^* > 0 \\ 0 & \text{if } y_{1i} = 0 \end{cases} \quad (4)$$

Finally, the observed level of income is determined as

$$y_i = y_{1i} \cdot y_{2i} = x_{2i}\beta_2 + \epsilon_{2i} \text{ if } y_{1i}^* > 0 \text{ and } y_{2i}^* > 0 \quad (5)$$

In this specification, a positive level of income y_i is observed if $y_{1i}^* > 0$ and $y_{2i}^* > 0$. This illustrates the DH element to the model. y_{1i}^* is a latent endogenous variable representing the decision to participate in income-generating activities for landowner i , y_{2i}^* is a latent variable representing the level of income for landowner i , y_i is the observed level of income for a landowner i . x_{1i} is a set of landowner characteristics and beliefs that influence the landowner's decision to participate in income-generating activities, x_{2i} is a vector of physical characteristics of the property (e.g., total acres and percent in different wetland types and open water) that affect the landowner's level of income. β_1 and β_2 are vectors of estimable parameter. In this formulation, $(x_{1i}; x_{2i})$ may contain the same common explanatory variables, although their corresponding effects on the two hurdle equations might be quite different. ϵ_{1i} is normalized to 1 since the outcome of the first hurdle is binary. Both error terms, ϵ_{1i} and ϵ_{2i} , are assumed to be normal and independently distributed and can be written as

$$\begin{pmatrix} \epsilon_{1i} \\ \epsilon_{2i} \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right] \quad (6)$$

The independent DH model is estimated using maximum likelihood technique and the log likelihood function is given as

$$\ln L = \sum_0 \ln \left[1 - \Phi(x_{1i}\beta_1) \Phi\left(\frac{x_{2i}\beta_2}{\sigma}\right) \right] + \sum_+ \ln \left[\Phi(x_{1i}\beta_1) \frac{1}{\sigma} \varphi\left(\frac{y_i - x_{2i}\beta_2}{\sigma}\right) \right] \quad (7)$$

where '0' under the summation sign denotes the summation over the zero observations in the sample (level of income $y_i\beta_1\beta_1$ is zero) and '+' indicates summation over the positive observations (level of income $y_i\beta_1\beta_1$ is positive); $\Phi(\cdot)$, $\Phi x_{1i}\beta_1$ and $\varphi(\cdot)$ denote standard normal cumulative distribution function and standard normal probability density function (*cdf* and *pdf*), respectively.

The parameter estimates of the DH model, however, provide little direct information and the economic interpretation frequently focuses on the analysis of the marginal effects of regressors on the expected value of y_i for limited dependent variable models [37]. By using the McDonald and Moffitt [38] decomposition, the unconditional expected value of the DH model can be expressed as [37]

$$E(y_i) = P(y_i > 0) * E(y_i | y_i > 0) \quad (8)$$

where $P(y_i > 0)$ is the probability of participation and $E(y_i | y_i > 0)$ is the conditional expected level of income. Following Burke's [31] notation, the probability of participation is given as

$$P(y_i > 0/x_{1i}) = 1 - P(y_i = 0/x_{1i}) = \Phi(x_{1i}\beta_1) \quad (9)$$

The expected value of y , conditional on $y > 0$ is given as

$$E(y_i/x_{2i}, y_i > 0) = x_{2i}\beta_2 + \sigma\lambda\left(\frac{x_{2i}\beta_2}{\sigma}\right) \quad (10)$$

where $\lambda(\cdot)$ is the inverse Mills ratio (IMR) $\lambda(\cdot) = \frac{\varphi(\cdot)}{\Phi(\cdot)}$. After substituting Equations (9) and (10) into Equation (8), the unconditional expected value of y can be expressed as

$$E(y_i/x_{1i}, x_{2i}) = \Phi(x_{1i}\beta_1) \left\{ x_{2i}\beta_2 + \sigma\lambda\left(\frac{x_{2i}\beta_2}{\sigma}\right) \right\} \quad (11)$$

Marginal effects can be obtained by taking the first derivative of Equations (9)–(11) with respect to the explanatory variable x_j . For continuous explanatory variables, the marginal effects are calculated at the sample mean. While the marginal effects are used to measure percentage changes in the probability of participation and the absolute changes in the conditional and unconditional level of income when the value of variable shifts from zero to one [37].

2.3. Variables

In the econometrical model, the response variable of participation in income-generating activities in the first stage represents a binary variable equal to 1 if the landowner i reports that he/she participated in income-generating activities (i.e., alligator and/or waterfowl hunting) in 2015 and 0 otherwise. From the full sample, about 41% of landowners participated in these income-generating activities. The variable of level of income from income-generating activities denotes the income derived from alligator and/or waterfowl hunting in the second stage, which is represented by a continuous variable equal to annual income in dollars for landowner i . The average income among landowners who participated in these income-generating activities equaled \$12,204 with a standard deviation of \$13,657 (Table 1). The respondent variables are assumed to be expressible as a linear combination of a vector of explanatory variables. Previous researchers have provided insight on landowners' and other stakeholders' perceptions towards decisions on whether to participate in a given conservation program and have found that a suite of socioeconomic and property characteristic factors are important [10–13,26–28]. The various studies give an overall picture of the factors associated with landowners' participation.

Table 1. Variable definitions and descriptive statistics.

Variable	Description	Mean	Std.Dev
Response Variables			
Participation in income-generating activities	=1 if landowners participated in leasing land for alligator/waterfowl hunting and 0 otherwise	0.41	0.49
Level of income from income-generating activities	income received from these activities (\$/year)	12,204	13,657
Explanatory Variables			
Socio-economic Characteristics			
Aged 54 or younger	=1 if a landowner was 54 years old or younger and 0 otherwise	0.15	0.36
College degree	=1 if a landowner had a college degree or higher and 0 otherwise	0.72	0.45
Land ownership	=1 if the landowner is a sole owner and 0 otherwise	0.31	0.47
Years of ownership	the number of years that the property in question was in family possession.	70.87	38.73
Participating in government program	=1 if the landowner participated in any state or federal wetland restoration program and 0 otherwise.	0.10	0.30
Participating in other commercial-based activities	=1 if the landowner participated in any other commercial-based activities and 0 otherwise	0.14	0.35
An active outdoor enthusiast	=1 if the landowner considers himself/herself to be an outdoor enthusiast and 0 otherwise	0.65	0.48
Property Characteristics			
Southeast parish	=1 if the wetland parcels located in the southeast coastal parishes (i.e., Terrebonne, Lafourche, and Plaquemines) and 0 for those in the Southwest (i.e., Cameron and Vermilion)	0.66	0.48
Hunting lodge/camp	=1 if hunting lodge/camp is available on the parcel and 0 otherwise	0.11	0.32
Active management	=1 if the landowner actively managed his/her wetland property for waterfowl habitat and 0 otherwise	0.13	0.34
Land type			
One land type	=1 if the property containing only one land type (i.e., freshwater marsh, brackish marsh, salt marsh, or 'other' land type) and 0 otherwise	0.75	0.43
Two land type	=1 if the property with two types of land combination (i.e., property comprised of freshwater marsh and brackish marsh or property comprised of salt marsh and brackish marsh) and 0 otherwise	0.18	0.39
Three land type	=1 if the property containing three types of land and 0 otherwise	0.07	0.35
Total acreage of freshwater marsh	total acreage of freshwater marsh on the parcel	734	1409
Total acreage of brackish marsh	total acreage of brackish marsh on the parcel	510	1344
Total acreage of salt marsh	total acreage of salt marsh on the parcel	62	205
Total acreage of other type of land	the total non-wetland acres on the parcel	341	1167

From the survey, landowners were asked if they participate in any state or federal wetland restoration program on the property specified in the questionnaire, e.g., CWPPRA, WBP, Wetlands Reserve Program (WRP), and Coastal Protection and Restoration Authority (CPRA). While enrollment in a government program is hypothesized to impact the decision to participate in income-generating activities, the expected relationship is unknown. According to responding landowners, other commercial-based activities include farming, shrimping, crabbing, grazing, pasture, cattle production, and commercial/industrial land rental for the non-wetland portion of the parcel.

Enrollment in other commercial-based activities is hypothesized to influence the decision to participate in income-generating activities, and the expected relationship is unknown. While a variable of outdoor enthusiast was not included in any of the studies reviewed in this study, one might hypothesize that there is a relationship between participation/income and whether the landowner considers himself to be an outdoor enthusiast. Based on landowner's responses, their favorite outdoor activities include fishing, hunting, hiking, biking, walking, and gardening. The wetlands located in southwest Louisiana are generally higher quality. To investigate the spatial heterogeneity, the parish location variable was included in this study. The presence of a hunting lodge/camp was hypothesized to relate to the probability of participation and level of income from the participation. Active management involves water control, vegetation management through burning, cutting, herbicides, etc. on the property. It was hypothesized that active management would impact the decision of participation in income-generating activities and the level of income from participation. Based on

theoretical consideration and literature review, the explanatory variables in this study were categorized by various socio-economic characteristics of the landowner and physical characteristics associated with the individual properties. The explanatory variables selected, together with the sample descriptive statistics, are presented and fully described in Table 1. The socio-economic characteristics of Landowner included both socioeconomic and demographic variables as well as variables representing opinions held by the respective landowners. Specifically, socio-economic characteristics variables include aged 54 or younger, college degree, land ownership, years of ownership, participating in government program, participating in other commercial-based activities, and an active outdoor enthusiast. The property characteristics variables include southeast parish, hunting lodge/camp, active management, land type, total acreage of freshwater marsh, total acreage of brackish marsh, total acreage of salt marsh, and total acreage of 'other' land.

3. Results

3.1. Maximum Likelihood Estimates

The maximum-likelihood (ML) estimates of the double-hurdle model are presented in Table 2 with associated robust standard errors reported in parentheses. The parameter estimates of the double hurdle model provided direct information and indicated the significance of the explanatory variable and the direction of its influence on the dependent variable.

Table 2. Maximum likelihood estimation of the DH model.

	Participation Decision	Level of Income
Socioeconomic/Demographic Characteristics		
Aged 54 or younger	1.90 *** (0.69)	−11,116.43 (11,273.45)
College degree	0.16 (0.44)	39,682.90 *** (13,434.68)
Land ownership	−0.72 (0.55)	−47,152.33 *** (17,517.98)
Years of ownership	−	−253.39 * (135.19)
Participating in government program	−	−12,153.41 (11,946.38)
Participating in other commercial-based activities	−5.48 *** (0.87)	−
An active outdoor enthusiast	−0.76 (0.51)	−
Property Characteristics		
Southeast parish	0.34 (0.52)	−7344.74 (8531.55)
Hunting lodge/camp	−1.91 *** (0.62)	13,738.71 (10,933.94)
Active management	10.15 *** (1.11)	1059.18 (18,018.51)
One land type	1.93 ** (0.99)	6649.30 (11,481.36)
Two land type	0.32 (0.87)	18,771.96 (13,105.26)
Three land type	Reference group	Reference group
Total acreage of fresh water marsh	0.0046 *** (0.0015)	11.85 ** (5.45)
Total acreage of brackish marsh	0.0011 *** (0.0002)	5.82 * (3.46)
Total acreage of salt marsh	−0.0009 (0.0010)	2.75 (17.11)
Total acreage of other type of land	0.0003 (0.0002)	13.65 *** (4.74)
Constant	−3.38 *** (0.99)	−24,962.73 (22,400.95)
Sigma	9260.94 *** (2007.28)	
Wald χ^2 statistic	1083.74 ***	
Log-Likelihood	−342.19	
Number of observations	122	

Notes: Robust standard errors are in parentheses. Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10.

The coefficients of aged 54 or younger and hunting lodge/camp on participation and level of income exhibited different signs. The results suggest that landowners who are 54 years old or younger were more likely to participate in income-generating activities. Landowners who had a hunting lodge/camp on his/her wetland parcel were less likely to participate in income-generating activities but received more income than other landowners if they did. The results supported the assumption of the double-hurdle model that a factor might have different effects on the probability of participation and the level of participation. Meanwhile, the variables, active management and one land type, were found to positively related to the participation decision but was not significantly associated with the level of participation. The opposite is true for the variables college degree, land ownership, years of ownership, and total acreage of other type of land; these variables were found to be significant in the level of participation but did not significantly associated with the participation decision. In addition, the variables, total acreage of freshwater marsh and total acreage of brackish marsh were found to be significant in both the participation equation and the level of income equation. Specifically, with an increase in acreage of freshwater/brackish marsh, the empirical results showed an increase in participation rate as well as the level of participation.

3.2. Marginal Effects Estimates

Table 3 presented the marginal effects (ME) of probability of participation, conditional, and unconditional level of participation with corresponding standard errors, which are evaluated at the sample mean of all variables. The discussion focuses specifically on the most interesting variables and their interpretation.

The marginal effects with respect to land ownership had a significant and negative effect on the level of income but not on the probability. The results indicated that sole-owners were found to receive \$11,830 and \$6150 less income than landowners who own the wetland parcel through joint ownership or 'other' ownership structure for the conditional and unconditional level of income, respectively. One might hypothesize that the negative effect of sole ownership on income reflects time constraints among sole owners. Specifically, leasing of property for waterfowl and/or alligator hunting may require monitoring and other activities to ensure that lessees are abiding by the agreed upon rules of use. Time constraints for a sole owner may exceed those in a 'partnership' where the various owners can 'split' monitoring and other activities.

Concerning participating in government programs, the result indicated that whether to participate in government-sponsored wetland restoration programs plays a negative and significant role in the level of participation. This finding may reflect commercial restrictions placed on acreage upon enrollment in government programs. This is the case, for example, with acreage enrolled in easement-based programs such as the Wetlands Reserve Program and Conservation Reserve Program. The marginal effect with respect to participating in other commercial-based activities indicated that landowners who participated in other commercial-based activities have a 55% lower probability of participating in income-generating activities from alligator and waterfowl uses.

The location variable (southeast parish) plays a negative and significant role on the conditional level of income but not on the probability of participation and unconditional level of income derived from participation. In particular, the conditional marginal effect indicated that landowners who own wetland parcel in the southeast of Louisiana were found to receive \$1842 less income. The results suggest that location was an important factor associated with the level of income but did not impact the decision of whether or not to participate in income-generating activities. The 'poorer' quality associated with wetlands in the Southeast vis-à-vis Southwest may explain this finding. Since the quality of the wetlands in southwest parishes are generally recognized to be of higher quality and this quality is not considered in the analysis, one can expect that income generated from this participation is higher in the southwest parishes than in the southeast parishes.

Table 3. Marginal effects with respect to continuous and discrete variables.

	Participation	Conditional Income	Unconditional Income
Socioeconomic Characteristics			
Aged 54 or younger	0.20 (0.26)	−2789.06 ** (1338.70)	−453.75 (1034.56)
College degree	0.02 (0.17)	9955.55 *** (2071.69)	4972.20 *** (1002.94)
Land ownership	−0.07 (0.21)	−11,829.46 *** (2829.42)	−6149.73 *** (1523.96)
Years of ownership		−63.57 *** (17.88)	−31.29 *** (6.70)
Participating in government program		−3049.02 ** (1339.61)	−1500.69 *** (502.35)
Participating in other commercial activities	−0.54 * (0.33)		−2507.17 (2683.96)
An active outdoor enthusiast	−0.07 (0.19)		−349.24 (723.34)
Property Characteristics			
Southeast parish	0.033 (0.19)	−1842.63 ** (915.68)	−751.50 (710.00)
Hunting lodge/camp	−0.19 (0.24)	3446.73 *** (1044.77)	825.24 (1227.68)
Active management	0.99 ** (0.42)	265.72 (1844.72)	4769.78 (4736.45)
One land type	0.19 (0.38)	1668.16 (1206.63)	1705.00 (1681.33)
Two land type	0.03 (0.33)	4709.46 *** (1548.57)	2462.05 ** (1195.07)
Total acreage of fresh water marsh	0.0004 (0.0006)	2.97 *** (0.80)	3.85 (3.02)
Total acreage of brackish marsh	0.0001 (0.0001)	1.46 *** (0.47)	1.22 * (0.69)
Total acreage of salt marsh	−0.0001 (0.0004)	0.69 (1.73)	−0.09 (1.47)
Total acreage of other type of land	0.00003 (0.00009)	3.42 *** (0.75)	1.80 *** (0.48)

Notes: Delta-method standard errors are in parentheses. Asterisks indicate levels of significance: *** = 0.01, ** = 0.05, and * = 0.10.

With a positive and significant sign, the conditional marginal effect for hunting lodge/camp indicated that landowners who had a hunting lodge/camp on his/her wetland parcel were found to receive \$3447 more income. The positive relationship between the presence of a hunting lodge/camp and the level of income could be the fact that a hunting lodge/camp provides more comfortable ways to enjoy the outdoor activities, which attract more visitors and therefore increased revenue.

Considering wetland types, the marginal effect results indicated that higher surface revenue from fresh marshes than for brackish and saline marshes about surface revenues from alligator and waterfowl. In particular, a one-acre increases in the freshwater marsh and brackish marsh translate into an increase in income of \$2.97 and \$1.46 more income, respectively. The findings are consistent with ecological research on the gradient estuarine productivity being generally lower for saline versus fresher marshes [39].

The results from marginal effect estimation revealed that the longer the landowner owned the wetland tract, the less income the landowner received from surface income-generating activities, on average. It also appeared that the small portion of landowners (10%) who indicated that they participated in government-sponsored wetland restoration programs were found to have less income from surface activities, on average.

3.3. Participation in Wetland Programs

As previously stated, only 10% of respondents indicated that they had ever participated in a state or federal wetland restoration program (Table 1). Those who had never participated were

asked to respond to a range of potential obstacles to their involvement. Figure 2 depicts responses to a three-point Likert scale of potential constraints to program involvement. Combining responses identified as somewhat to very important, 60% of respondents indicated that their land was needed for other purposes, 64% identified complications in the application, and 72% indicated concerns over long-term commitment. The largest single obstacle, however, pertained to the lack of financial compensation—with nearly 80% of respondents indicating that a lack of adequate funding to incentivize their participation was a somewhat to very important constraint to participation. Additional obstacles to participation reported as ‘other’ included lack of knowledge about restoration programming, out-of-state residents, applied but rejected; and property owned by too many heirs. While the survey did not gauge the monetary range of offers accepted (or rejected) for program involvement, marginal effects are estimated for changes in surface revenue (Table 3). These estimates can be partially interpreted as reservation prices—or the minimum dollars per acre that would need to be offered by a given program to offset existing surface revenues from alligator and waterfowl harvesting on various tract sizes and wetland types. Additional information, however, is required to understand landowner preferences for specific policy mechanisms and the extent to which surface revenue generating activities would be allowed. Surface-revenue generating activities are allowed to varying extents under different easement programs offered under the Conservation title of the U.S. Farm Bill.

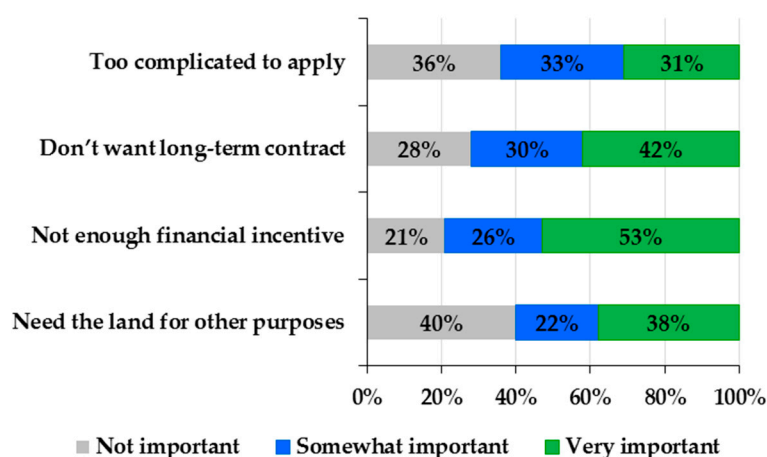


Figure 2. Landowners' attitudes concerning various constraints to participation in wetland restoration programs.

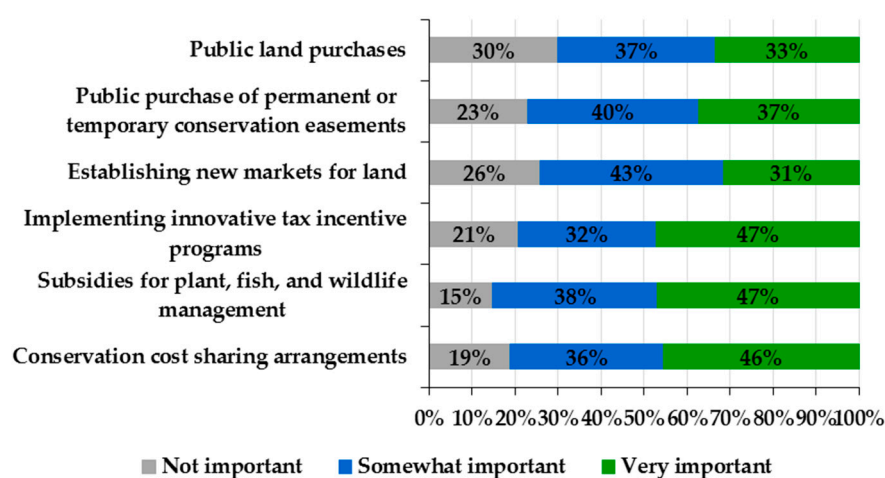


Figure 3. Landowners' preferences for various policy instruments for wetland restoration in coastal Louisiana.

Landowners were asked to indicate the importance of various policy instruments in regards to their preference for wetland restoration in coastal Louisiana (Figure 3). Combining those policy instruments identified as somewhat to very important, it is evident that respondents generally supported most program options (>70%) such as public land acquisition, establishment of new markets for coastal land, and permanent or temporary conservation easements. The most important options, however, included: innovative tax incentive programs (80%), conservation cost-share agreements (82%), and direct subsidies for plant, fish, and wildlife management (85%). (Direct subsidies for wildlife and fisheries management may take the form of payments for control of invasive species or protection of threatened or endangered species habitat).

4. Conclusions

The private landowner engagement model for wetland conservation has not been widely utilized in coastal regions of the United States, particularly in the LCZ. While a variety of state and federal program options have been in place during the past two decades, participation in the coastal regions has been relatively small compared to inland programming. The primary purpose of this study was to understand why people participate in commercial activities on their land and future participation in coastal restoration/maintenance programs might be improved. This survey focused on two primary sources of surface income for the LCZ, alligator and waterfowl harvesting. Income generating decisions were found to be driven by a number of factors, including expected net returns from engaging in these activities, uncertainty as to the outcome of the engagement, and an array of socioeconomic/demographic characteristics of the wetland owner and the physical characteristics of the property. The general decision process of private landowners can be divided into a two-stage decision-making process. Landowners initially decide whether to participate in income-generating activities and then consider the level of income derived from these activities.

The Cragg's DH model was applied to identify the determinants on the participation and level of participation in income-generating activities using the household survey data. In general, the study shows that the majority of the variables under investigation related to both the probability of participation and the level of income. This implies that both landowners' socioeconomic characteristics and physical wetland characteristics are important to investigate the surface income from their coastal wetland property and likelihood of participation. Our results, based on the estimated parameters and marginal effects, revealed that decisions to participate in income-generating activities and the level of income are related to physical characteristics of the property and socioeconomic/demographic characteristics of the landowner. Descriptive statistics indicate that a lack of sufficient financial incentive is the most important reason why landowners have not participated in state or federal programming for wetland restoration and conservation. Nevertheless, respondents did indicate preferences for specific forms of programming, indicating a wide degree of support for most options (>70%) with the highest preferences (>80%) for programs that provided tax incentives, direct costs share agreements, and subsidies for wildlife and fisheries management.

As mentioned earlier, 80 percent of coastal wetland is under private ownership in Louisiana, the acceptance of private wetland owners to wetland-related programs and their participation in these programs are critical if future coastal management efforts are to be successful. Encouraging private investment, however, can be difficult because of the uncertainty as to the impact of any project, the spatially complex nature of expected wetland losses, and the fact that the benefits of wetland restoration tend to accrue to the general public rather than to individual landowners.

5. Discussion

5.1. Limitations and Further Research

The sample of data was drawn from five parishes (Cameron, Vermilion, Terrebonne Lafourche, and Plaquemine parishes) among 20 coastal parishes in Louisiana. Although every effort was made

to obtain all available data for econometric investigation in this study, the amount of data used for descriptive and empirical statistical analysis is limited. As information from other parishes becomes available, the analysis could be expanded and yield a larger database from which to conduct the analysis. The empirical model of Cragg's double-hurdle in which the first hurdle uses a Probit model and a truncated normal model in the second hurdle was employed in this study. Since Cragg's double-hurdle model assumes independence for error distribution, there is an implication that the results could be sensitive to model misspecification. Thus, it would be desirable to explore dependent double-hurdle model and Box-Cox double-hurdle models for further research.

This study stratified landowners of 866 parcels into two groups based on the number of wetland parcels they owned. An alternative, more comprehensive estimation of landowner participation in income-generating activities would include all landowners. While the empirical analysis combined both alligator harvest and/or waterfowl hunting enterprises, separate double-hurdle models could be used to estimate participation effects for these and other surface revenue activities individually. Moreover, the authors acknowledge the possibility of unobserved variables as drivers of participation and surface income, however, these factors were not the focus of the study and are captured on the error term.

5.2. Policy Implications

The results from this study suggest that only a few of Louisiana's small-scale landowners choose to participate in state or federal wetland restoration programs. Understanding the various attitudes among landowners toward these programs provides the opportunity for policymakers to better evaluate current and potential approaches to program implementation. Despite limited findings from this research, the descriptive and empirical results have potential implications with respect to crafting wetland restoration policy and data collection in coastal Louisiana.

First, policymakers may consider establishing additional outreach programs geared toward the 'smaller' (i.e., non-corporation) coastal wetland owners. Unlike corporations with large coastal tracts, the costs of remaining abreast of restoration programs and policy are likely large relative to expected benefits for owners of smaller coastal parcels. Thus, any education program would need to be developed with this understanding in mind and tailored accordingly.

Second, as recommended by Coreil [40], policymakers should consider 'speeding up' and simplifying the application process and modifying restoration contract terms. Many of the concerns listed in the comment section of the survey pertained to time constraints, both in terms of the long time required for application processing and the long term of contracts. Policy adjustments in this regard might prove useful.

Third, policymakers need to ascertain the types of incentives (financial and others) to entice private landowners to accept wetland restoration projects on their property. Gaining the cooperation of coastal landowners, however, is complicated by the fact that while the public benefits accruing from these projects are likely to be large, private benefits are likely to be small and, potentially, negative. If coastal restoration and management needs are to be met in Louisiana, public funds must be leveraged to private investment. Therefore, financial incentives are likely to play an essential role in the decision-making process among coastal landowners considering whether or not to engage in specific types of wetland restoration and management activities. Moreover, results from this study indicate that coastal landowners who participated in a state or federal restoration program receive less surface income than landowners who did not participate. To the extent that these results are valid, an obvious question arises regarding the opportunity costs of participation. In designing policy instruments that might impede surface income activity (e.g., easements) policy-makers should consider the marginal costs and benefits to landowners. Program participation would likely be higher for instruments designed to compensate for losses in surface revenue. Compensation requirements, however, will vary with differences in socioeconomic factors and individuals are likely to exhibit heterogeneous

preferences over a range of relevant land use alternatives. Thus, policymakers need to consider a portfolio of policy instruments to increase the range of options available for private coastal landowners.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A Wetland Economic Survey

2015 Wetland Economic Survey INTRODUCTION

Dear Landowner,

I am writing on behalf of LSU AgCenter and the Louisiana Sea Grant to request your help with an important project. As part of a larger program, we are conducting a survey to understand why people participate in commercial activities (alligator harvest and waterfowl hunting) on their land and how we can improve future coastal restoration/maintenance programs in Coastal Louisiana.

The following questionnaire will take approximately 10 min to complete. The information you provide us will be extremely valuable regarding potential policy instruments aimed at encouraging private participation in coastal wetland maintenance and restoration.

Participation is strictly voluntary and you may refuse to participate at any time. WE ASSURE YOU THAT YOUR ANSWERS WILL BE COMPLETELY CONFIDENTIAL. Moreover, the results of the survey will be only reported in a summary format, so again no one will link you to your responses. Please complete the attached questionnaire and return it in the self-addressed postage-paid envelope to us within the next TWO WEEKS.

Thank you in advance for your cooperation. If you have any questions or need help with this survey, please feel free to contact us at:

Phone number: 225-578-6296

Email: walterk@lsu.edu or hwang23@lsu.edu

Note: If you prefer to complete this questionnaire online, please provide your email address and parcel ID to Hua Wang at hwang23@lsu.edu and we will send the appropriate linkage to the questionnaire.

Sincerely,

Walter R. Keithly, Jr.

Survey Project Leader

Louisiana Sea Grant

Louisiana State University

Hua Wang

Survey Project Assistant

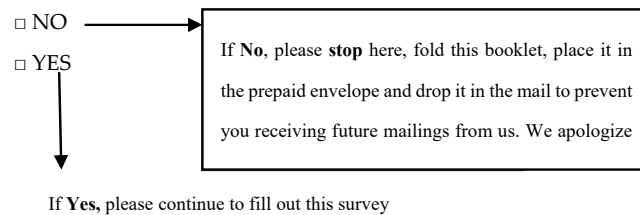
Louisiana Sea Grant

Louisiana State University

Enclosed with this questionnaire is a wetland GIS map which according to parish records is identified as a parcel you own in the coastal zone. Later in this questionnaire we are going to ask you to focus on commercial activities associated with this parcel (alligator harvest or waterfowl hunting). And all of your answers will be kept strictly confidential and never associated with your name.

Section 1: General Information

1. Do you own the parcel on the map enclosed with this questionnaire?



2. How do you own the specific parcel?
 - ☐ Sole ownership
 - ☐ Joint ownership through an undivided heirship
 - ☐ Joint ownership through a corporation or trust
 - ☐ Other (please explain) _____
3. If you maintain joint ownership of the parcel, what is your ownership percentage?
 _____ %
4. Based on the enclosed GIS map, is the stated acreage correct?
 - ☐ NO
 - ☐ YES
 If no, what is your estimated of the correct acreage?
 _____ acres
5. Approximately how long has this parcel been in family possession?
 _____ years
6. Referring to the enclosed GIS map, what types of wetland do you own on this parcel? (Check the answer to all that apply)
 - ☐ Salt marsh
 - ☐ Brackish marsh
 - ☐ Freshwater marsh
 - ☐ There is no wetland on this parcel
7. Do you use this property for any commercial-based activities?
 - ☐ NO—If NO, please skip to **question 14**
 - ☐ YES—If YES, please proceed to **question 8**
8. Please indicate the commercial activity (activities) on this property? (Check the answer to all that apply)
 - ☐ Alligator harvest (including egg collection)
 - ☐ Waterfowl hunting
 - ☐ Other (please specify) _____
9. What is the total number of acres of parcel you use for the following commercial activities? Please **outline** the area on the GIS map enclosed and select the type of wetland (check all boxes that apply)
 - ☐ Alligator harvest: _____ acres
 (☐ Salt marsh; ☐ Brackish marsh; ☐ Freshwater marsh ☐ Other)
 - ☐ Waterfowl hunting: _____ acres
 (☐ Salt marsh; ☐ Brackish marsh; ☐ Freshwater marsh ☐ Other)
 - ☐ Other: _____ acres
 (☐ Salt marsh; ☐ Brackish marsh; ☐ Freshwater marsh ☐ Other)
10. Is there any hunting lodge/camp on the parcel?
 - ☐ NO
 - ☐ YES
11. Do you actively manage your property for waterfowl habitat (e.g., water control, vegetation management through burning, cutting, herbicides ...)?
 - ☐ NO
 - ☐ YES

12. What was the revenue derived from the parcel in question from the following commercial activities in 2015? (Again, this information will be confidential)
- ☐ \$ _____ Alligator harvest (including egg collection)
- ☐ \$ _____ Waterfowl hunting
- ☐ \$ _____ Other
13. Do you receive any sub-surface (oil & gas) revenue from this parcel?
- ☐ NO
- ☐ YES
14. Do you participate in any state or federal wetland restoration programs?
- ☐ NO
- ☐ YES
- 14a. If YES, which program(s) do you participate in?
- ☐ Former Wetlands Reserve Program (WRP) (Merged into Agricultural Conservation Easement Program in 2014 Farm Bill).
- ☐ Water Bank Program (WBP)
- ☐ Coastal Protection and Restoration Authority (CPRA)
- ☐ Coastal Wetlands Planning, Preservation & Restoration Act (CWPPRA)
- ☐ Other (please specify) _____
- 14b. If NO, why do you not participate? How important were the following reasons for doing so? Check the appropriate box for each statement.

Reasons for not participation (check all that apply)	Not Important	Somewhat Important	Very Important
Too complicated to apply	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Don't want long-term contract	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Not enough financial incentive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Need the land for other purposes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (explain): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

CONTINUE TO NEXT PAGE

15. How would you rate the following current or pending policy instruments in regards to wetland restoration in coastal Louisiana? Please indicate (by checking a box) the level of importance for each current or pending approach below.

Policy instruments	Not Important	Somewhat Important	Very Important
Public land purchases	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public purchase of permanent or temporary conservation easements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Establishing new markets for land	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implementing innovative tax incentive programs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Subsidies for plant, fish, and wildlife management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Conservation cost sharing arrangements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section 2: Demographics

16. Which range includes your age?
- ☐ Under 25
- ☐ 25–34
- ☐ 35–44
- ☐ 45–54
- ☐ 55–64
- ☐ 65 or older

17. What is your gender?
- ☐ Male
 - ☐ Female
18. What is your race?
- ☐ White
 - ☐ Asian
 - ☐ Native American
 - ☐ Black/African American
 - ☐ Latino/Hispanic
 - ☐ Other (please specify) _____
19. Which of the following best describes your total household pre-tax 2015 income?
- ☐ Under \$20,000
 - ☐ \$20,000–\$39,999
 - ☐ \$40,000–\$59,999
 - ☐ \$60,000–\$79,999
 - ☐ \$80,000–\$99,999
 - ☐ \$100,000–\$150,000
 - ☐ Over \$150,000
20. What is the highest level of education you have completed?
- ☐ Less than High School
 - ☐ High School Degree or equivalent
 - ☐ Some College
 - ☐ College Degree
 - ☐ Bachelor Degree
 - ☐ Master Degree
 - ☐ Doctorate
21. Do you consider yourself an active outdoor enthusiast?
- ☐ NO
 - ☐ YES
- If YES, what are your favorite outdoor activities?
- _____
22. Do you consider yourself an environmentalist?
- ☐ NO
 - ☐ YES
- If YES, how would you rate your effort in environmental protection? Please circle the appropriate number
(1 with no effort ... 5 with great effort).
- 1_____2_____3_____4_____5
23. Finally, we welcome your opinion on any topics that might not have been adequately covered in this survey, please use the space below. Also, if you would like a copy of the final report, please provide an email address and we will send you an electronic version of the report.

I want to thank you for your time and candid answers. You have been very helpful. Please return the survey within the next TWO WEEKS in the self-addressed postage-paid envelope provided.

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