Ecosystem Services on Forest and Agricultural Lands of Maryland:

A Survey of Maryland Tree Farmers and Agricultural Landowners

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This study was modeled after two similar research studies: "A Survey on Conservation Payments on California Rangelands" by Molly Cheatum[1] and "Ecosystem Services and Markets Associated with Red Wolf Habitat in North Carolina" by Randall Kramer and Aaron Jenkins.[2]

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[1] Cheatum, M., F. Casey, P. Alvarez, & B. Parkhurst. 2011. *Payments for Ecosystem Services: A California Rancher Perspective.* Conservation Economics White Paper. Conservation Economics and Finance Program. Washington, D.C.: Defenders of Wildlife. 65pp.

[2] Kramer, R., & A. Jenkins. 2009. *Ecosystem Services, Markets, and Red Wolf Habitat: Results from a Farm Operator Survey.* Ecosystem Service Series NI-R-09-01. Nicholas Institute for Environmental Policy Solutions, Duke University. 38 pp

INTRODUCTION

Maryland contains 2.4 million acres of forestland; 75 percent, or 1.8 million acres, is family owned. These private forest landowners, numbering 130,800, own 78 percent of the forestland, with an average size holding of 17 acres; 75 percent of these landowners, however, own less than 10 acres. These private forestlands protect and supply more than two-thirds of Maryland's drinking water.

There are 12,834 agricultural farms in Maryland, covering 2.1 million acres; 1.5 million acres are devoted to crops, with over 62,700 people employed in agriculture. Maryland farms are typically small and farmland is expensive. The average size is 169 acres, making Maryland the state with the 10th smallest average farm acreage. However, the average estimated market value of land and buildings per acre is $2,911, making Maryland the fifth most expensive state in this category. Maryland farmers are aging, reflecting a national trend. The average age of Maryland farmers is 55.8 years, compared to the U.S. average of 53.3 years. Maryland's farms hold the key to many ecosystem services.

Maryland's forests and farms provide valuable ecosystem services to the State and the Chesapeake Bay region. Ecosystem services produce many natural resources: clean water, clean air, timber, habitat for fisheries, flood control, and the pollination of agricultural plants. These environmental functions are essential to sustaining all life on earth.

The vast majority of Maryland's forest and agricultural lands are privately owned. Improved management of these lands will increase the quality and quantity of the ecosystem services they produce. It is therefore important that the proper incentives are put in place to promote sustainable land management practices. These incentives, both public and private, will encourage landowners to manage their lands in a way that best enhances ecosystem services.

Despite their essential nature, ecosystem services, which are for the most part too sophisticated to reproduce, are often poorly understood. While first-world societies have reproduced some of these services, for instance, by building water and sewage treatment facilities, many natural services cannot be replaced by technology. Human civilization depends on the continuation of ecosystem services. Our efforts to recognize, maintain, and enhance ecosystem services will benefit mankind today and in the future. A healthy ecosystem serves not only mankind but all living things.

Maryland's private landowners will need help to manage and sustain ecosystem services. They will need educational programs put in place to help them understand the value of these services and to learn how best to enhance and protect them. They will need markets to be established to assist and encourage them to manage their land in a way that best maintains the ecosystem services their land provides. Most of these services are public goods, which offer little to no incentive both to landowners for investing in ecosystem services and to the public for funding public goods that are privately produced on agricultural and forested lands. This results in a huge challenge.

Until recently, few studies have explored landowners' knowledge and understanding of the term ecosystem services and whether or not landowners would agree to participate in a payment-for-ecosystem-service (PES) program. The socioeconomic study we propose here explores the extent to which agricultural landowners and Tree Farmers understand what ecosystem services are. Moreover, we attempt to determine what specific attributes would affect farmer participation in PES programs in Maryland, such as monetary incentives, financial entry points that would draw farmers into a program, who farmers would trust entering into a program contract with, and contract lengths.

In developing the framework for this survey instrument, we have relied on two similar studies: "Payments For Ecosystem Services: A California Rancher Perspective" (Cheatum et al., 2011) and "Ecosystem Services, Markets, and Red Wolf Habitat: Results from a Farm Operator Survey" (Kramer & Jenkins, 2009). These studies will help develop a baseline of information for future PES programs.

This report describes the survey methodology, presents results, and makes policy recommendations relevant to the design of future ecosystem service programs and markets.

RESEARCH OBJECTIVES

To Determine:

1) Whether Tree Farmers and agricultural landowners are knowledgeable about ecosystem services.

2) What Tree Farmers and agricultural landowners think about participation in a PES program.

3) How demographics and geographic characteristics affect willingness to participate in a PES program.

4) How financial payments, contract length, and the agency administering a PES program affect participation.

5) Whether there are significant differences in the survey responses of Tree Farmers and agricultural landowners.

PREVIOUS RESEARCH

Over the course of the past 20 years, the focus of many research projects has been to determine the landowner characteristics that drive adoption of conservation programs. This array of research can help shed light on the characteristics of landowners that correlate to program participation. Nowak (1987) examined how the diffusion of information, as well as economic and ecological factors, affects the adoption of agricultural conservation technologies. The diffusion of information appears to play an important role in the adoption of both conservation and agricultural technologies. Access to information tends to be increasingly important as the complexity of the innovation increases. Access to information becomes less important when the risks associated with adoption are reduced through cost-sharing or other institutional support. Nowak noted that the benefits of adoption vary among farmers. Consequently, it is important to control for farmer-specific characteristics when modeling technology adoption or program participation.

Beedell and Rehman (1999) used the structural social-psychology model, which is often referred to as the theory of planned behavior, to explain farmers' conservation-related behavior. They concluded that farmers with high environmental awareness and farmers who are members of farming and wildlife advisory groups tend to be more influenced by conservation-related concerns and less influenced by farm-management concerns than other farmers. However, they also found that less environmentally aware farmers were more easily influenced by farming and conservation referent groups, grants, and conservation advice than more environmentally aware farmers. This suggests that it's important to control for farmers' attitudes about the environment when assessing the efficacy of environmental education or when analyzing farmers' participation decisions in conservation programs.

Ervin and Ervin (1982) examined the adoption of voluntary erosion control practices and developed a theoretical model based on institutional, personal, physical, and economic characteristics for the land and landowner. They found that education and the awareness of the degree of erosion play the most important role in determining a farmer's decision to invest in soil conservation practices. Thus, they concluded younger farmers might be more apt to adopt conservation practices than older farmers.

Konyar and Osborn's (1990) analysis of the first three USDA Conservation Reserve Program (CRP) sign-up periods indicated that farm tenure, farm size, land value, farmer age, erosion rate, and expected net returns influenced the probability of CRP participation. McLean-Meyinsse et al. (1994) concluded that Louisiana farmers do not participate in the CRP if revenues from cropland are an important source of income or if the farmers are tenants; awareness of CRP is significantly related to education, income, race, and average return per acre; willingness to participate is positively influenced by payment per acre, age, and farm status.

Hagan (1996) examined participation in the Maryland Buffer Incentive Program. Generally speaking, he found that owners who generate their income from farming tend not to participate in existing forest buffer programs. He also found that program participants are younger, have more

years of formal education, and fewer years of experience working on and managing farms than nonparticipants.

Tjaden (2002) examined Maryland farmers' adoption of riparian buffers. The analysis revealed that farm as well as farmer characteristics impacted the adoption of riparian buffer technology. Important determinants of adoption included: farm size, being located on the Lower Eastern Shore, owner age, prior participation in government conservation programs, and having heard about riparian buffers.

While many other research projects have focused on landowner adoption of conservation practices and programs, very few have researched the adoption of ecosystem services programs. The two projects that were used as a framework for this project are the most relevant to the topic of participation in PES programs.

Kramer and Jenkins (2009) attempted to determine whether ecosystem service markets can be used to achieve biodiversity conservation goals on private lands. In particular, they analyzed possible sources of revenue from conserved red wolf habitats in North Carolina. Kramer and Jenkins' findings suggested that there is an overall lack of familiarity with ecosystem services terminology in North Carolina. Nonetheless, many farmers are interested in participating in future PES programs, particularly if the programs emphasize wildlife conservation or water quality. Payment levels, contract length, and program administration type are found to be important factors in farmers' decisions to enroll. The authors also found farm operators appear to be willing to take less payment on average if the contract length for the PES program is shorter. Farm operators also prefer a program managed by a state agency, perhaps reflecting their past positive experience with the North Carolina Cost Share Program. Kramer and Jenkins also found that carbon storage is the least well-understood and least attractive ecosystem service for respondents. The lack of information with and interest in carbon offsets underscores the need for information campaigns. They further found that a PES program that is specific to red wolf conservation is not widely supported. A targeted marketing and information campaign could be used to address a lack of familiarity with ecosystem services and markets.

Cheatum et al. (2011) examined the California ranching community's interest in a payment-for-ecosystem-service program intended to promote habitat conservation on California rangelands. Their findings suggested that ranchers are ready and willing to participate in a PES program that preserves wildlife habitats. Moreover, they found that emphasizing the extent to which other ecosystem services (such as water quality and carbon sequestration) benefit wildlife may encourage higher participation PES programs. Unfortunately, Cheatum et al. also found that most ranchers were not familiar with the terms used when talking about ecosystem services, carbon sequestration, or payment for these services. They suggested that the language used when discussing these services should be reframed, or that substantial educational outreach programs should be undertaken. Additionally, ranchers responded somewhat favorably and equally to the concept of stacking and bundling payments. As in previous work, Cheatum et al. found that ranchers are more likely to participate in programs with shorter contract lengths and higher

payment levels. Unlike in Kramer and Jenkins (2009), Cheatum et al. found that California ranchers prefer nonprofit organizations as program administrator; state agencies were by far the least-preferred administrator.

This study builds on current literature and attempts to address the current knowledge gaps and factors that influence participation in a PES program. It examines the attributes of program participants and desirable PES program features.

METHODS

Survey Design

This survey was modeled after two surveys developed by researchers at Duke University and Defenders of Wildlife: "Ecosystem Services and Markets Associated with Red Wolf Habitat in North Carolina" by Randall Kramer and Aaron Jenkins (2009) and "A Survey on Conservation Payments on California Rangelands" by Molly Cheatum et al. (2011). Modifications were made based on Maryland-specific scenarios, organizations, and pricing. For possible future studies, the format of the contingent valuation and conjoint choice questions were maintained so comparisons could be made among the earlier studies and our own.

The revised survey was shared with numerous organizations for feedback prior to pretesting. These organizations are: Maryland Association of Soil Conservation Districts, Maryland Department of Natural Resources (Maryland Forest Service and Office for a Sustainable Future), Maryland Farm Bureau, Maryland Department of Agriculture, Chesapeake Bay Program Office, Pinchot Institute, Biophilia Foundation, Sustainable Solutions, U.S. Geological Survey, American Forest Foundation, Defenders of Wildlife, U.S. Forest Service, University of Maryland's Agricultural Resource Economics Department, University of Maryland Extension, Maryland Forest Association, Maryland Tree Farm Committee, Maryland Agro-Ecology Center, and Duke University's Nicholas School of the Environment. The survey instrument was refined based on feedback from these institutions in preparation for submission to the Institutional Review Board (IRB) at the University of Maryland.

Pre-testing

Once IRB approval was obtained from the University of Maryland, appointments[3] were made with five Maryland landowners to pretest the survey instrument. Of these five participants, four owned farmland and one owned a tree farm. Of the five, two were female and three were male. All participants were between the ages of 40 and 78. Of the four owning farmland, two rented all of their farmland and two were part-time farmers. In all cases, Bob Tjaden, the principal investigator (PI) for the project, was present to answer any questions and time each participant's completion of the survey.

Pre-tests indicated that the survey was too long, that some of the questions were confusing, and that the questions dealing with climate change and carbon sequestration were too politically sensitive. This pretest allowed us to reword several questions, to modify the survey format, and to shorten the survey by deleting unnecessary questions. The survey was re-administered to the original pretest participants after the modifications were made.

The second pretest survey took participants between 10 and 15 minutes to complete, compared to 20 to 25 minutes for the first pretest survey. Minor modifications were made before a final draft of the survey was sent to participating organizations for feedback and suggestions. All comments

[3] Pre-testing took place during the first 2 weeks of February, 2012.

were considered and final changes were made before a final version of the survey was sent to TKM Marketing for editing and layout. The final version of the survey instrument is in Appendix C.

Survey Implementation

Our original intent was to perform a telephone survey; however, with the challenges of some families disconnecting home phones in favor of using individual cell phones, our inability to acquire cell phone numbers, and advice from experts in survey methodology, we decided to perform a mail survey.

We obtained the Maryland Tree Farm's mailing list from the American Forest Foundation[4] with the understanding that the list would be used one time, for this research project only. We obtained addresses for over 1,000 Maryland Tree Farmers. Filters were put in place to identify duplicate names on the same tree farm and multiple tree farms for the same person. Only one owner per tree farm was sent a survey. After eliminating redundant respondents, we selected 878 Tree Farmers to receive the survey.

Insofar as agricultural landowners are concerned, the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) reports there are 12,834 farms in Maryland. We obtained the names and addresses of agricultural landowners (with farms larger than 100 acres) from the Maryland Department of Planning's property view database. This database of agricultural landowners who own 100 acres or more was filtered to delete farms that also contained forestland. This was done so there would be little or no potential of a landowner receiving a survey as a Tree Farmer and an agricultural landowner. The filtered database was stratified by percentage of farmland by county for a total of 1,108 farms. The table for the stratified distribution of farms per county is provided in Appendix A.,Table A.1.

We contracted with Larry Harris of Mason-Dixon Polling and Research Group in Washington, DC, to print and post initial notification letters, survey mailings, and follow-up postcards. Mason-Dixon Polling and Research also collected the survey data, digitized it, and produced basic statistical results. Dillman's tailored design method was followed.

On April 2, 2012, Bob Tjaden, project PI, sent an introductory letter to 1,108 agricultural landowners and 878 Tree Farmers. On March 26, one week prior to the survey mailing, Len Wrabel, chairman of the Maryland Tree Program, also sent a validation letter to Tree Farmers. We were not able to obtain a validation letter from the Maryland Farm Bureau (due to time restrictions); however, the Farm Bureau did include a notice in their monthly newsletter encouraging their members to participate in the survey.

The surveys were mailed April 2 along with a letter from Larry Harris, explaining the survey process and providing respondents with an opportunity to complete the survey by hand or online. All

[4] The American Forest Foundation is located in Washington, DC, and manages the Tree Farm system nationwide and maintains an active database of all Tree Farmers.

respondents received a prepaid, self-addressed envelope for returning the paper version of the survey to the Mason-Dixon Polling and Research Group. We mailed follow-up postcards to all possible respondents on April 5 and then again on April 9. Surveys were to be completed by April 15.

A total of 33 surveys were returned to Mason-Dixon because the addresses were wrong, mislabeled, or nonexistent. One survey was returned with a letter of refusal to participate. Of these 34 uncompleted surveys, 19 had been sent to Tree Farmers and 15 to agricultural landowners.[5]

Of the 1,986 surveys mailed, there were 536 responses; 516 of these responses were fully completed. This is a response rate of 28 percent (536/1952). Only 47 (9%) of respondents completed the survey on-line. The distribution of returned completed surveys reasonably approximated the original stratified survey mailings by counties. Thus, we believe that the responses represent a reasonable approximation of Maryland's agricultural landowners and Tree Farmers.

[5] It is important to note, the letter of refusal was a well thought out handwritten letter stating that, "based on the University of Maryland Law Clinic assisting the Water Keepers Alliance in prosecuting a farm family on the Eastern Shore reference to poultry litter runoff, we no longer trust the University of Maryland and are not interested in cooperating with you on this research project."

RESULTS

Descriptive Statistics

Summary information from the 516 completed surveys is reported in Table 1. The majority of respondents are male (81%) and the average age is 66.8 years. Over 50% of respondents have a college education. Notably, 41% report an annual household income of more than $100,000. However, only 15% claimed that the majority of their income comes from their land. Tree Farmers represented 56% of the completed surveys.

Table 1. Demographics

	Tree Farmer	Acres Owned	% Income from Land	Gender	Age	Education	Ownership Structure	Household Income
Question #	2	3	7	29	30	31	32	33
Statistic	56%	204	15%	81% Male	66.8	51% College +	81% Private	41% > $100K

Summary statistics related to land ownership, decision-making, and participation in conservation programs are provided in Table 2. The average land tenure is 30 years, with 35% of respondents leasing land to others, while 10% of respondents rent land from others. Only 43% of respondents report prior participation in conservation programs. Perhaps not surprisingly, 81% of landowners indicate that renters have no influence on decisions to participate in conservation programs. Eighteen percent of respondents who rent land report they have some influence on whether or not land is placed into a conservation program.

Table 2. Land Management & Decision Making

	Farms or Manages Land	Leases Land to Others	Rents Land from Others	Participated in Conservation Programs	Landowner Influenced by Renters	Renters' Influence on Conservation Programs
Question #	1	4	5	8	9	10
Statistic	30 years	35% (146 average acres)	10% (197 average acres)	43%	19% (some to total influence)	18% (some influence)

When asked, "Have you heard the term ecosystem services before this survey?" 57% responded they had not, while 43% indicated they had (see Figure 1). Of those respondents who had heard the term ecosystem services, 56% were Tree Farmers and 44% were agricultural landowners (see Figure 2).

Two questions (Questions 11 and 13) were used to test respondents' knowledge about ecosystem services. In Question 11, respondents were asked to rate their familiarity with numerous terms on a scale of 1 to 5 (see Figure 3).[6] The average degree of familiarity with the term ecosystem services was rather low, 2.09. Respondents were even less familiar with the term payment-for-ecosystem-services (their average degree of familiarity was 1.62 out of 5). A difference in means test was used to determine whether the results of Question 11 were different for Tree Farmers and agricultural landowners. Responses indicated 73% of the agricultural landowners and 63% of the Tree Farmers were not familiar with the "ecosystem service" term (Figure 4). Difference in means tests indicated that these means were statistically different from one another.

Question 13 asked respondents who had heard the term ecosystem services to describe what the term meant to them. Respondents indicated that the term was most frequently associated with the preservation of wildlife habitat and the purification of air and water (see Figure 5).

Figure 1

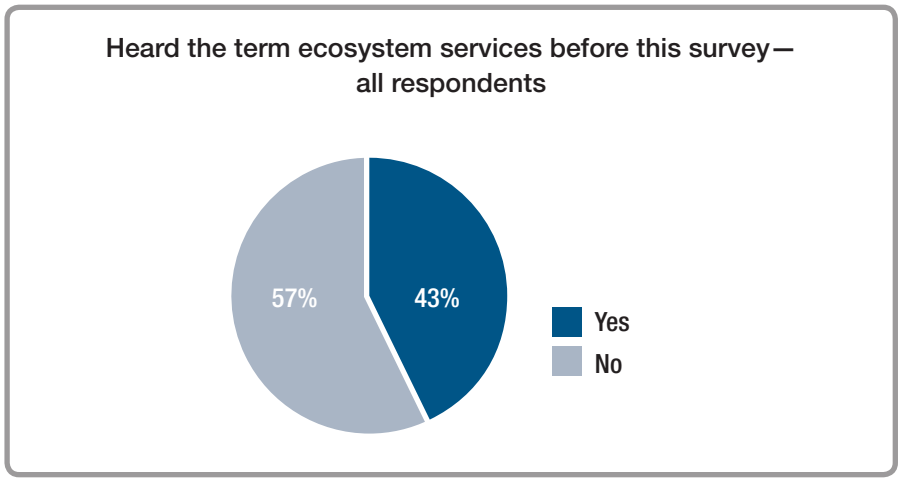
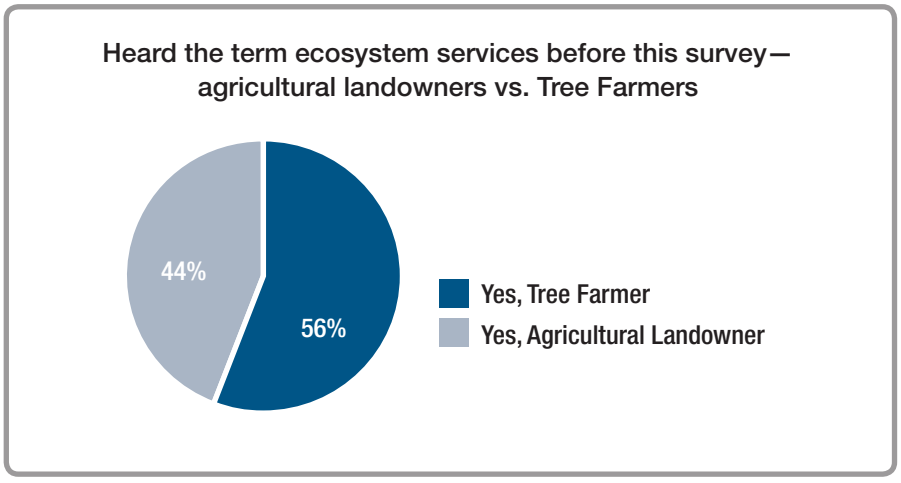


Figure 2



[6] 1 indicates a lack of familiarity, 5 indicates a high degree of familiarity.

Figure 3

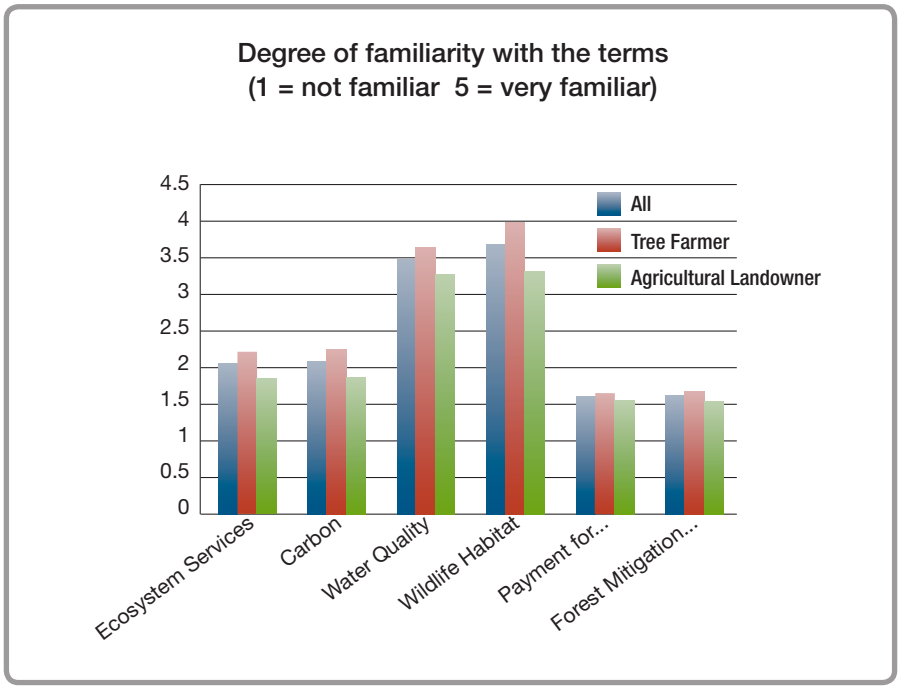


Figure 4

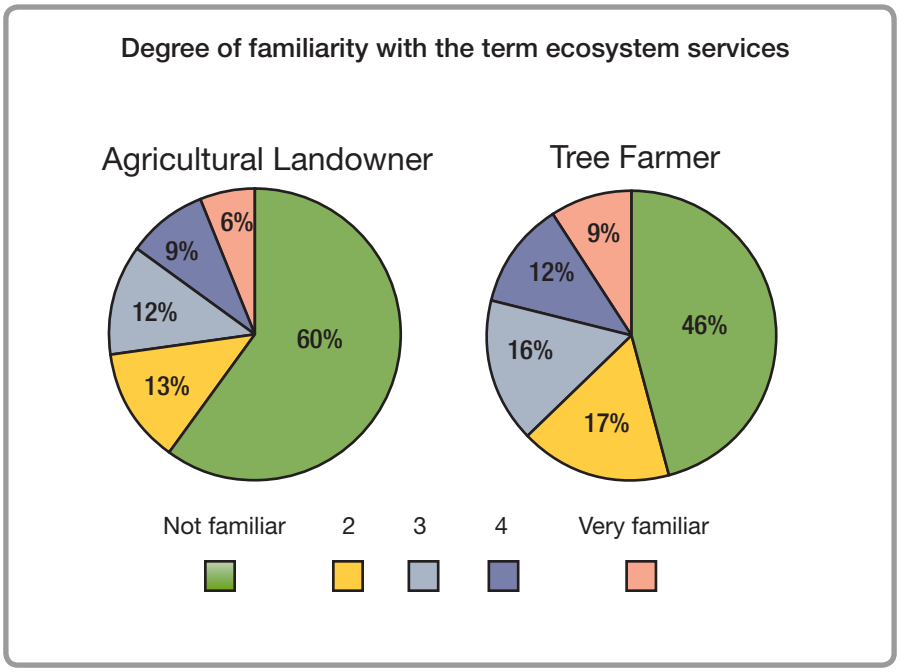
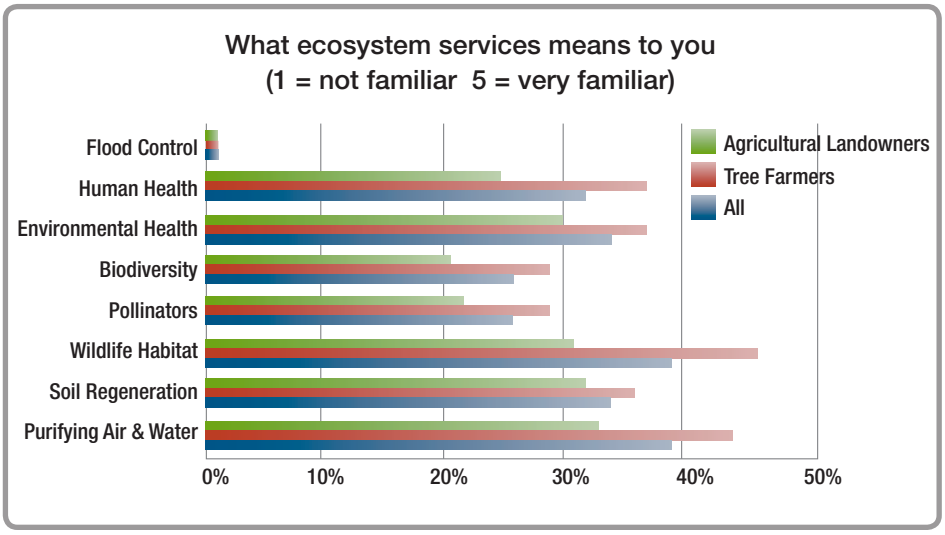


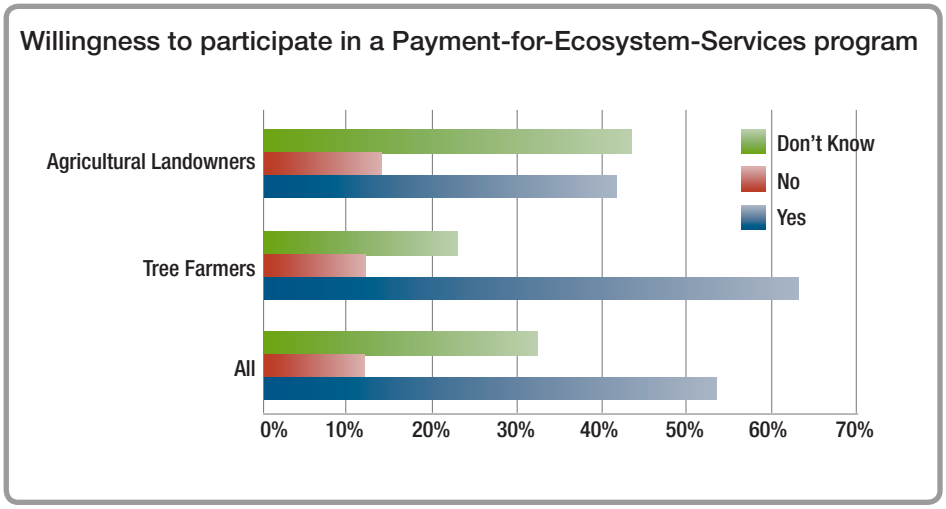
Figure 5



Question 14 asked whether respondents would consider participating in a PES program. Generally speaking, respondents seemed willing to consider participation. The majority of respondents would consider participation (54%), while only 13% would not (Figure 6). Approximately, one-third of respondents were unsure what they thought about participating in PES programs.

Notably, there seemed to be major differences between Tree Farmer and agricultural landowners. Sixty-four percent of Tree Farmers were willing to consider participation in PES programs, while only 42% of agricultural landowners were willing to consider participation (see Figure 6). This suggests that there may be fundamental differences between Tree Farmers and agricultural landowners. These differences may be ideological or stem from misinformation. Further work is needed to determine whether educating agricultural landowners about ecosystem services could increase their willingness to consider participation in PES programs.

Figure 6



Question 15 explored the extent to which respondents valued the following ecosystem services: carbon storage, water quality, wildlife habitat, pollinators, endangered species, and biodiversity. Respondents were asked to rate their interest in participating in a program to conserve each ecosytem on a scale from 1 to 5.[7] Respondents were generally in favor of enrolling in all types of programs, with the most interest in water quality (3.89) and wildlife habitat (3.84). Figure 7 presents average responses to Question 15. Figure 8 depicts the percentage of respondents that would be willing to enroll in a conservation program for each ecosystem service.[8]

Figure 7

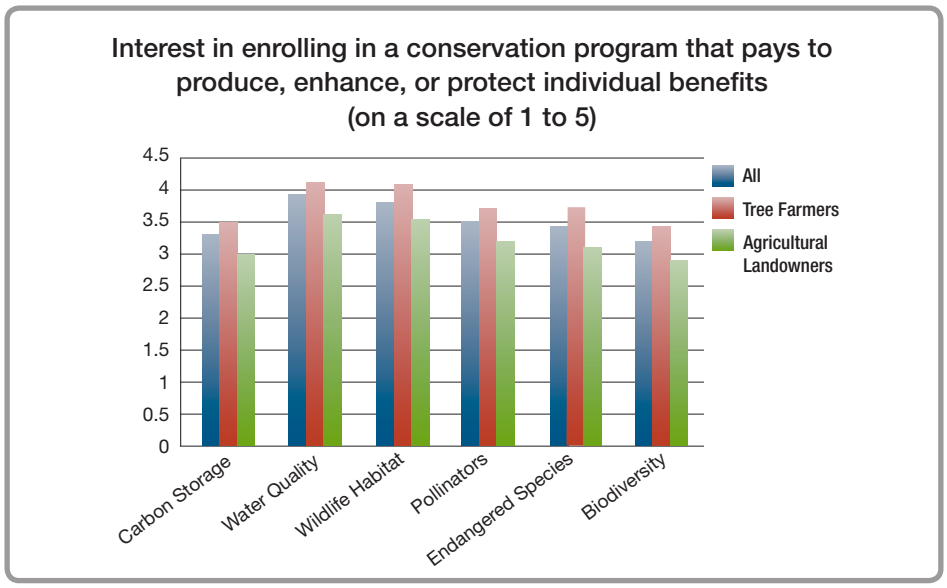
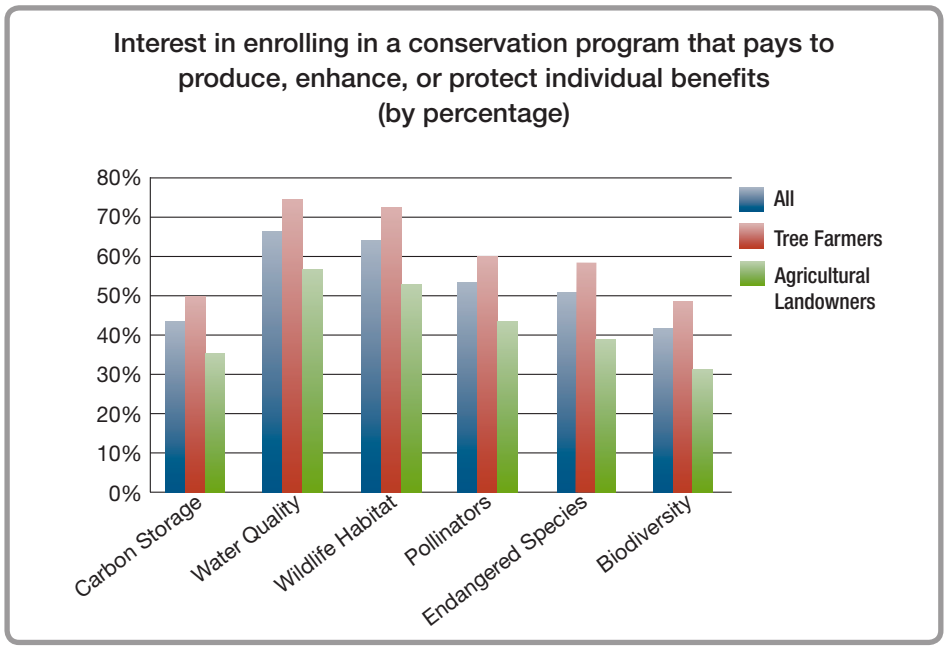


Figure 8



[7] 1 indicates low interest, 5 indicates a high degree of interest.

[8] It was assumed that a response of 3 or higher indicated a willingness to participate.

Econometric Models

Contingent Valuation

Several survey questions were used to gauge interest in a PES program (see Questions 14, 24, 25, and 26). Questions posed at the beginning of the survey tended to be rather general. As the survey progressed the questions became more specific and required the respondent to make increasingly difficult choices. For instance, while Question 14 was intentionally vague, Question 24 provided specific details about a PES program to preserve several types of rare, threatened, or endangered species (see text box below).

In parts of the Mid-Atlantic, animals such as bear, quail, turtles, squirrels, and eagles are part of the natural environment. Increasingly, habitat is being lost for a variety of reasons.

There are organizations and private businesses interested in ensuring many of these wildlife species survive and are considering how to enlist the help of landowners and managers; in particular rare, threatened, or endangered species, such as the Bald Eagle, Delmarva Fox Squirrel, or Bog Turtle. Some organizations recognize the important role that private landowners play in wildlife conservation and are considering the creation of voluntary programs in which landowners could receive payments to apply conservation practices that improve habitat for many of the endangered or threatened species.

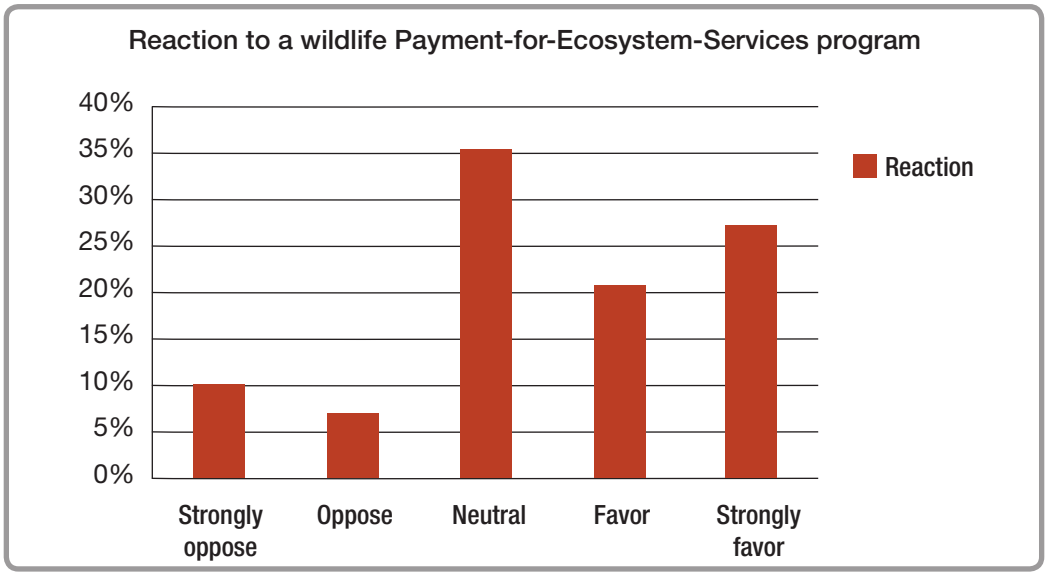
24. What is your initial reaction to such a program?

(Please circle the number that most closely matches your response)

Strongly Oppose		Neutral		Strongly Favor
1	2	3	4	5

As indicated by the results summarized in Figure 9, respondents seemed receptive to the program described above.

Figure 9



We further asked two more specific questions (Questions 25 and 26) based on payment rates with different program scenarios; one scenario dealt with endangered/threatened wildlife species administered by a nongovernmental organization and a second dealt with planting trees for clean air and water administered by a state agency. Payment rates varied among $40, $75, $150, and $250 per acre per year. These payment rates were randomly distributed among respondents, but consistent across questions.[9] Questions 25 and 26 are listed below:

25. **Suppose there was a program that consisted of establishing or preserving habitat for wildlife species such as Bald Eagles, Delmarva Fox Squirrels, or Bog Turtles. The hypothetical program would be administered by a private business or non-governmental organization, have a contract length of 10 years, and involve a small percentage of your land. If this program paid you $X per acre per year for 10 years, would you be willing to participate?**

    ___Yes ___ No ___Don't know

26. **Suppose there was a program that established new forests to help clean our air and water. This hypothetical program would be administered by a state agency such as MD DNR, have a contract length of 10 years, and involve planting trees on crop, pasture, or fallow land. If this program paid you $X per acre per year for 10 years would you be willing to participate?**

    ___Yes ___ No ___Don't know

Responses to Question 14, "would you participate in a PES program," were analyzed using a probit regression. The results of this regression are provided in Table 3. Responses to Questions 25 and 26 were jointly analyzed using a bivariate probit regression. The results of this regression are shown in Table 4.

Generally speaking, Tree Farmers appear more likely to participate in conservation programs than agricultural landowners. Both Tree Farmers and agricultural landowners that earn a large percentage of their income from farming are less likely to participate.

Having heard the term ecosystem services had a positive and significant impact on Tree Farmer and agricultural landowner participation when the program details were provided (Questions 25 and 26), but an insignificant impact when the program was briefly and generally described (Question 14). Payment levels had a positive and significant impact on participation in conservation programs intended to protect wildlife, but not in conservation programs intended to clean the air and water. Being located in the Upper Shore region also appeared to increase participation rates (especially for agricultural landowners).

[9] 25% of the surveys distributed had a payment level of $40, 25% had a payment level of $75, etc.

Table 3

Are farmers willing to consider participation in a PES program (Q14)?
Regression Results, Probit Regression (with and without Tree Farmer Interactions)

Variable	Label	All	Consider (Q.14) Tree Farmers (Restricted Sample)	Farmers (Restricted Sample)
Heard	Indicator for whether the respondent has heard of Ecoystem Services	0.25	0.19	0.41
Income	Indicates that the respondent earned more than $80k a year	0.04	-0.07	0.12
Advanced Degree	Indicates that the respondent has an advanced degree	-0.05	0.08	-0.26
Female	Indicates that the respondent is Female	0.10	-0.01	0.42
Acres Owned	Acres of Ag Land Owned	0.0002	0.0001	0.001
Years Owned	Number of Years Land has been Owned	-0.01	-0.01	-0.003
Agricultural Producer	Indicates that the respondent's land is used for agricultural production	0.05	-0.10	0.23
Animal Producer	Indicates that the respondent's land is used for animal production	0.44 *	0.39	0.56
Recreational Use	Indicates that the respondent's land is used for recreational purposes	0.34	0.37	0.39
Percent Income	Percent of the respondent's income that is earned from the land	-0.01 **	-0.002	-0.01 **
Central Region	Indicator for whether the operation is located in the "Central" Region	-0.36	-0.47	-0.11
Lower Shore Region	Indicator for whether the operation is located in the "Lower Shore" Region	0.52 **	0.14	1.69 ***
Southern	Indicator for whether the operation is located in the "Southern" Region	-0.23	-0.41	-0.04
Upper Shore	Indicator for whether the operation is located in the "Upper Shore" Region	0.46 *	-0.02	0.97 **
Tree Farmer	Indicates that the respondent is a tree farmer	0.37 **		
Constant	-	-0.02	0.56 *	-0.70
Observations	-	310	170	140
Psuedo R2	-	0.12	0.05	0.20

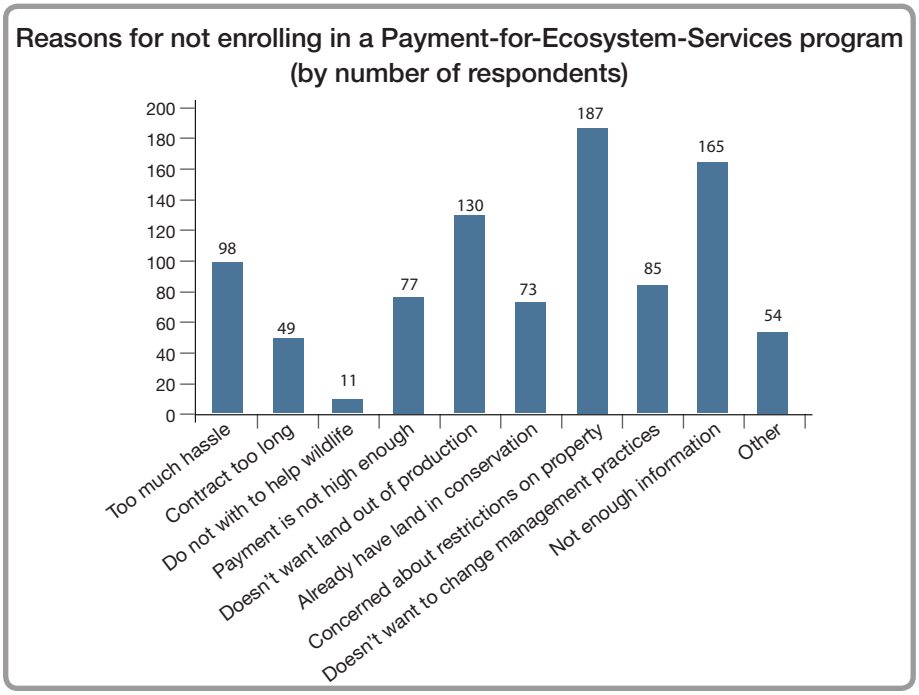
Table 4

Are farmers willing to participate in conservation programs intended to preserve wildlife and/or air quality? Regression Results, Probit Regression (with and without Tree Farmer Interactions)

	Wildlife Prog. (Q25)			Air Quality Prog. (Q26)		
Variable	**All**	**Tree Farmers**	**Non Tree Farmers**	**All**	**Tree Farmers**	**Non Tree Farmers**
Bid	0.003 ***	0.004	0.003 *	0.001	0.0001	0.001
Heard	0.32 **	0.50	0.18	0.39 **	0.61	0.22
Income	0.01	0.13	-0.13	0.25	0.44	0.11
Advanced Degree	0.26	0.28	0.32	0.14	-0.36 ***	0.73 ***
Female	-0.34 *	-0.58	-0.12	-0.14	-0.39	0.02
Acres Owned	0.0002	0.0001	0.0004	0.0001	0.0001	-0.0002
Years Owned	-0.01	-0.00004	-0.01	-0.003	-0.005	0.0004
Agricultural Producer	-0.09	-0.07	0.03	0.10	0.59	-0.06
Animal Producer	-0.01	-0.04	0.06	0.07	0.17	0.15
Recreational Use	-0.13	-0.21	0.01	-0.08	-0.10	0.05
Percent Income	-0.003	-0.005	-0.003	-0.007 **	-0.005	-0.01 **
Central Region	0.09	0.10	0.17	0.30	0.05	0.46
Lower Shore Region	-0.15	-0.45 *	0.48	-0.35	-0.68	-0.23
Southern Region	-0.05	-0.21	0.12	-0.13	-0.36	0.07
Upper Shore Region	0.56 **	0.53	0.65 *	-0.12	-0.23	-0.07
Tree Farmer	0.48 ***			0.66 ***		
Constant	-0.69 **	-0.46	-0.81	-1.12 ***	-0.32	-1.32 **
	All	**Tree Interactions**				
Rho	0.93 ***	1.06 ***				
Observations	326	326				
Psuedo R2	0.40	0.43				

Question 27 explores why tree farmers and agricultural landowners choose not to participate in PES programs (see Figure 10). One-hundred-eighty-seven respondents indicated that they were concerned about government restriction on property,165 responded they did not have enough information, and 130 do not want to take land out of production.

Figure 10



Conjoint Analysis

The conjoint choice experiment entailed asking respondents to choose one of three hypothetical programs (A, B, or Neither) in five different scenarios. These scenarios forced respondents to make tradeoffs by selecting their most preferred option. Each scenario varied over three attributes: payment amount (in dollars per acre per year), contract length (in years), and administrative agency (federal, state, or NGO). A sample scenario is presented below.

Program Features	Program A	Program B	Neither
Contract Length	30 years	15 years	
Program Administration	Non-governmental Organization	State Agency	
Payment Level (per acre per year)	$100	$30	
Please check only one program: A, B, or Neither			

We estimated two specifications. The first specification contains our primary variables of interest (differences in payment levels, contract length, and indicators for the administrative agency). The second specification includes interaction terms that allow the effects of these variables to differ by location, age, sex, and among Tree Farmers/agricultural producers.

Both specifications reported in Table 5 include an intercept, a variable that captures an individual's inherent tendency to prefer the status quo. Notice that the intercept is negative and significant in both specifications, which strongly suggests respondents have an inherent preference for nonparticipation in PES programs.

Table 5

Which Attributes of Conservation Programs Do Farmers Prefer (Conjoint Analysis, Questions 16-20) Regression Results, Conditional Logit Model

Variable	Label	Specification 1	Specification 2
Intercept	-	-0.63 ***	-0.46 **
Bid	Payment for Participation (per acre, per year)	0.01 ***	-0.001
Contract length (years)	Length of the Conservation Program	-0.02 **	0.003
State	Program is administered by a State Agency	0.27 *	-0.68
Federal	Program is administered by a Federal Agency	-0.12	-1.41 *
Tree cross State	Interaction of Tree Farmer Ind. and State		0.70 **
Tree cross Federal	Interaction of Tree Farmer Ind. and Federal		0.51 *
Central cross Federal	Interaction of Central Region Ind. and Federal		0.75 *
Upper Shore cross Bid	Interaction of Upper Shore Region Ind. and Federal		0.01 *
Full Time Farmer cross Contract	Interaction of Full Time Farmer Ind. and Contract		0.03 *
Full Time Farmer cross State	Interaction of Full Time Farmer Ind. And State		0.55 **
Consider cross Bid	Interaction of Willingness to Consider Participation Ind. and Bid		0.01 ***
Consider cross State	Interaction of Willingness to Consider Participation Ind. and State		0.86 ***
Consider cross Federal	Interaction of Willingness to Consider Participation Ind. and Federal		0.95 ***
Female cross State	Interaction of Female Ind. and State		0.71 **
Age cross Contract Length	Interaction of Age and Contract Length		-0.001 *
Observations	-	3720	3720
Pseudo R2	-	0.04	0.15

The parameter estimate for Bid is positive and significant in Specification 1. The interaction terms for Bid (Upper Shore cross Bid and Consider cross Bid) are also both positive and significant. This implies that higher payments encourage participation in PES programs, especially for those agricultural landowners who tend to consider participation in conservation programs and for agricultural landowners with operations in the Upper Shore region.

Contract length appears to have a negative and significant impact on participation in conservation programs. The magnitude of this estimate appears to be driven by older farmers, who have shorter planning horizons and may be more risk averse than their younger counterparts.

Insofar as agency preference is concerned, Tree Farmers prefer state agencies to NGOs, especially if they are predisposed to consider participation in conservation programs. Tree Farmers also tend to prefer federal agencies to NGOs if their operations are located in the Central region or if they are predisposed to consider participation in conservation programs. However, generally speaking, agricultural landowners prefer NGOs to both state and federal agencies.

Table 6 presents the marginal effects of these variables. As in the probit/bivariate probit models, there is a difference between regression results and marginal effects. The regression results indicate the extent to which the variables of interest affect choice; however, the results are hard to interpret accurately. It's easier to interpret the marginal effects, which indicate the extent to which a change in a variable affects the probability that agricultural landowners will choose a given alternative.

Table 6

Which Attributes of Conservation Programs Do Farmers Prefer (Conjoint Analysis, Questions 16-20)
Marginal Effects, Conditional Logit Model

Variable	Label	Specification 1	Specification 2
Intercept	-	-0.15 ***	-0.10 ***
Bid	Payment for Participation (per acre, per year)	0.002 ***	-0.0002
Contract length (years)	Length of the Conservation Program	-0.01 ***	-0.01 ***
State	Program is administered by a State Agency	0.06 *	-0.21 ***
Federal	Program is administered by a Federal Agency	-0.03	-0.31 ***
Tree cross State	Interaction of Tree Farmer Ind. and State		0.69 ***
Tree cross Federal	Interaction of Tree Farmer Ind. and Federal		0.50 ***
Central cross Federal	Interaction of Central Region Ind. and Federal		0.75 **
Upper Shore cross Bid	Interaction of Upper Shore Region Ind. and Federal		0.01 **
Full Time Farmer cross Contract	Interaction of Full Time Farmer Ind. and Contract		0.03 **
Full Time Farmer cross State	Interaction of Full Time Farmer Ind. And State		0.57 ***
Consider cross Bid	Interaction of Willingness to Consider Participation		0.01 ***
Consider cross State	Interaction of Willingness to Consider Participation Ind. and State		0.86 ***
Consider cross Federal	Interaction of Willingness to Consider Participation		0.94 ***
Female cross State	Interaction of Female Ind. and State		0.72 ***

When asked about the relative importance of program attributes when making their decisions in the conjoint choice type questions, contract length scored highest (3.77 on a 5-point scale), followed by payment levels (3.65) and program administration (3.53). See Figure 11.

Figure 11

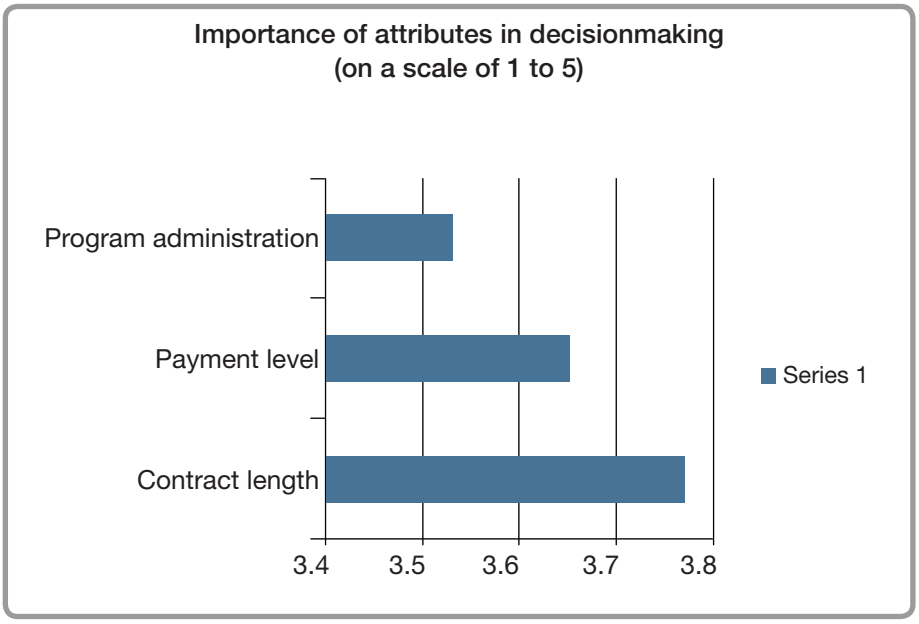


Table 7 demonstrates the effects for our primary variables of interest, program administration, payment level, and contract length. The marginal value of contract length is $2. This indicates that, on average, a respondent would need an additional $2 per acre per year for each additional year of the contract.

The marginal value for program administration indicates that, on average, respondents would require an additional payment of $27 per acre per year if a PES program is administered by a private corporation rather than a state/federal agency. Marginal value for a program managed by a federal institution is $12. However, this number is not significantly different from zero, which means that we cannot really say that $12 is a good estimate; thus the marginal value of a program administered by a federal agency is zero.

Table 7

Which Attributes of Conservation Programs Do Farmers Prefer (Conjoint Analysis, Questions 16-20) Regression Results, Conditional Logit Model

Variable	Label	Specification 1		Specification 2		Marginal Values
Intercept	-	-0.63	***	-0.46	**	
Bid	Payment for Participation (per acre, per year)	0.01	***	-0.001		
Contract length (years)	Length of the Conservation Program	-0.02	**	0.003		$2.00
State	Program is administered by a State Agency	0.27	*	-0.68		$27.00
Federal	Program is administered by a Federal Agency	-0.12		-1.41	*	$ 0

CONCLUSIONS

1) Less than 50% of respondents are familiar with the term ecosystem services.

2) The most important reason to reject participation in a PES program is lack of information. This suggests that educational programs could increase knowledge about ecosystem services and acceptance of PES programs.

3) Tree Farmers appear more willing than agricultural farmers to participate in PES programs.

4) Tree Farmers with a higher percentage of off-farm income are more likely than other respondents to participate in PES programs.

5) There is not strong support for the hypothesis that location influences participation in PES programs (despite limited evidence suggesting that agricultural landowners in the Upper Shore region are slightly more willing to participa te).

6) Respondents prefer shorter contract lengths (possibly because respondents are risk averse).

7) Payments appear to increase participation in PES programs.

8) Agricultural landowners prefer PES programs administered by NGOs, while Tree Farmers prefer programs administered by the state or federal government.

9) Evidence suggests that having “heard” or being “familiar with” the term ecosystem services increases the probability of participation in PES programs. This suggests that education about the topic may increase the probability of participation.

DISCUSSION & RECOMMENDATIONS

Results from both the contingent valuation and conjoint choice experiments demonstrate that respondents react to monetary incentives when deciding whether or not to participate in conservation programs. Because of its careful design and the large number of observations elicited, the conjoint choice experiment provides stronger evidence of this effect.[10]

While there is limited evidence of regional differences among Maryland's agricultural landowners, neither the contingent valuation nor the conjoint choice analysis suggests that these differences strongly affect the participation decision.

The results of the conjoint choice experiment provide strong evidence that longer contracts negatively impact participation in conservation programs. Insofar as the administrative agency is concerned, evidence suggests that respondents prefer state governments to NGOs. Agricultural producers seem to prefer NGOs over federal agencies.

Our results indicate that those who are willing to consider participation respond to monetary incentives and prefer state/federal agencies to NGOs. By contrast, those who have an inherent bias against conservation programs (those who would not consider participation) are not responsive to changes in monetary incentives, contract lengths, or the administrative agency. This suggests that respondents who are willing to consider participation should be offered appropriate incentives. It will be difficult to induce participation by agricultural landowners with a strong bias against conservation programs.

It should be mentioned that respondents willing to consider participation tend to have heard of, or are familiar with, the term ecosystem services. This is one justification for educating respondents who are unfamiliar with the concept.

In both the contingent valuation and conjoint choice experiments, other specifications were tested. For various statistical reasons (such as concerns about endogeneity and collinearity), it was decided not to include these specifications in the results. Some of the explanatory variables we tested, but chose not to include, are indicators for: whether land is privately owned, number of acres of land in the operation, an income above $80,000,[11] and operators with advanced degrees.[12]

As previously mentioned, Tree Farmers and agricultural producers tend to have slightly different preferences. Tree Farmers tend to prefer having state agencies administer PES programs, while agricultural landowners prefer having NGOs administer these programs. One explanation of this difference is that Maryland's Tree Farmers have access to many state-run programs that were

[10] The "suggestions" section provides a brief discussion of the differences between the two analyses.

[11] Which was collinear in the conditional logit model, but not the probit or bivariate probit model.

[12] See footnote 6.

designed to facilitate planting and forest management. By contrast, agricultural landowners have had a tenuous relationship with both state and federal agencies over the course of the past several years. Our results demonstrate that PES programs should be tailored to specific audiences. In short, one size does not fit all.

Suggestions for Improving the Survey

Although we are confident in our results, no survey is perfect and improvements could be made in future studies. In general, the parameter estimates from the conjoint choice experiments demonstrate the expected results and numerical signs. However, certain results from the contingent valuation regressions are not intuitive. In part, this may be because of the sample size. However, the survey design may be a contributing factor. We suggest the following modifications to the survey:

- When asking questions that will be analyzed using a probit or bivariate probit model (for instance, Questions 25 and 26), randomly vary the order in which these questions are asked.[13]

- When writing contingent valuation questions, keep in mind that the results are only applicable to the good/service described. For instance, the coefficients estimated from an analysis of Question 25 can be used to infer how the explanatory variables affect participation in an NGO-administered program to preserve wildlife species. The parameter estimates will not provide much insight into how the respondent reacts to changes in the agency administering the program.

- Endogeneity is a serious concern. For instance, Question 22 allows respondents to specify which administrative agencies they trust. This variable is likely to be correlated with unobserved, farmer-specific variables, as well as participation decisions. Including this variable in a regression is likely to bias the parameter estimates.

[13] Notice that few of the explanatory variables have explanatory power in the analysis of Question 25. It is possible that respondents did not think carefully about their responses to this question because it was similar to (and preceded) Question 26.

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APPENDIX A: Survey Statistics and Tables

Table A.1

Survey Distribution to Farm Population by County

County	# Farms*	% Farms of Statewide Total	# Surveys Distributed/County**
Allegany	302	2%	26
Anne Arundel	377	3%	34
Baltimore	751	6%	66
Calvert	274	2%	23
Caroline	574	4%	49
Carroll	1148	9%	98
Cecil	583	5%	51
Charles	418	3%	36
Dorchester	424	3%	36
Frederick	1442	11%	123
Garrett	677	5%	59
Harford	704	5%	60
Howard	335	3%	29
Kent	377	3%	33
Montgomery	561	5%	49
Prince George's	375	3%	32
Queen Anne's	521	4%	46
St. Mary's	621	5%	53
Somerset	329	3%	29
Talbot	305	2%	26
Washington	844	7%	73
Wicomico	508	4%	44
Worcester	384	3%	33
Total	12,834	100%	1,108

*NASS 2011
**Total farm survey population (1,108) X % farms of statewide total per county

Table A.2

Select Summary Statistics

Variable	Label	Mean	Std Dev	Obs
Consider	Indicates that the respondent would consider participation in a conservation program to improve the quantity of ecosystem services	0.54	0.50	476
Participate in a Wildlife Program	Indicates that the respondent would enroll in a 10 year program to protect endangered wild life programs	0.45	0.50	505
Participate in a Clean Air Program	Indicates that the respondent would enroll in a 10 year program to create new forests (and clean air/water)	0.31	0.46	505
Heard of Ecosystem Services	Indicates that the respondent has heard the term ecosystem services	0.44	0.50	509
Pure Air	Indicates that the respondent associates ecosystem services with "purifying the air and water"	0.38	0.49	517
Soil Regeneration	Indicates that the respondent associates ecosystem services with "soil regeneration"	0.33	0.47	517
Wildlife Habitat	Indicates that the respondent associates ecosystem services with "wildlife habitats"	0.38	0.49	517
Pollinators	Indicates that the respondent associates ecosystem services with "pollinators"	0.25	0.43	517
Biodiversity	Indicates that the respondent associates ecosystem services with "biodiversity"	0.25	0.43	517
Environmental Health	Indicates that the respondent associates ecosystem services with "environmental health"	0.33	0.47	517
Human Health	Indicates that the respondent associates ecosystem services with "human health"	0.31	0.46	517
Advanced Degree	Indicates that the respondent has an advanced degree	0.30	0.46	496
Female Indicator	Indicates that the respondent is female	0.19	0.39	504
Acres Owned	Acres owned by the respondent	204.28	436.05	480
Tree Farmer	Indicates that the respondent is a tree farmer	0.56	0.50	507
Agricultural Crop Producer	Indicates that the respondent is an agricultural crop producer	0.38	0.49	497
Animal Producer	Indicates that the respondent is an animal producer	0.23	0.42	497
Forestry	Indicates that the respondent is a forester	0.16	0.37	497
Horse Farmer	Indicates that the respondent is a horse farmer	0.07	0.26	497
Recreational Land	Indicates that the respondent's primary land use is recreational	0.09	0.28	497
Income less than 20k	Indicates that the respondent earns less than 20k	0.05	0.22	426
Income between 20k and 40k	Indicates that the respondent earns between 20k and 40k	0.16	0.36	426
Income between 40k and 60k	Indicates that the respondent earns between 40k and 60k	0.10	0.30	426
Income between 60k and 80k	Indicates that the respondent earns between 60k and 80k	0.16	0.37	426
Income between 80k and 100k	Indicates that the respondent earns between 80k and 100k	0.13	0.34	426
Income between 100k and 150k	Indicates that the respondent earns between 100k and 150k	0.17	0.38	426
Income between 150k and 200k	Indicates that the respondent earns between 150k and 200k	0.11	0.31	426
Income over 200k	Indicates that the respondent earns over 200k	0.12	0.33	426
Percent Income from Farming	Percent of income earned from agricultural activities	15.25	28.05	477
Central	Indicates that the respondent's operation is located in the Central Region	0.19	0.39	506
Lower Shore	Indicates that the respondent's operation is located in the Lower Shore Region	0.13	0.34	506
Southern	Indicates that the respondent's operation is located in the Southern Region	0.16	0.37	506
Upper Shore	Indicates that the respondent's operation is located in the Upper Shore Region	0.14	0.35	506
Western	Indicates that the respondent's operation is located in the Western Region	0.38	0.49	506

Table A.3

Select Summary Statistics

Variable	Label	Mean	Std Dev	Obs
Participate	Indicates that the respondent would consider participation in a conservation program to improve the quantity of ecosystem services	0.54	0.50	476
Participate in a Wildlife Program	Indicates that the respondent would enroll in a 10 year program to protect endangered wild life programs	0.45	0.50	505
Participate in a Clean Air Program	Indicates that the respondent would enroll in a 10 year program to create new forests (and clean air/water)	0.31	0.46	505
Heard of Ecosystem Services	Indicates that the respondent has heard the term ecosystem services	0.44	0.50	509
Pure Air	Indicates that the respondent associates ecosystem services with "purifying the air and water"	0.38	0.49	517
Soil Regeneration	Indicates that the respondent associates ecosystem services with "soil regeneration"	0.33	0.47	517
Wildlife Habitat	Indicates that the respondent associates ecosystem services with "wildlife habitats"	0.38	0.49	517
Pollinators	Indicates that the respondent associates ecosystem services with "pollinators"	0.25	0.43	517
Biodiversity	Indicates that the respondent associates ecosystem services with "biodiversity"	0.25	0.43	517
Environmental Health	Indicates that the respondent associates ecosystem services with "environmental health"	0.33	0.47	517
Human Health	Indicates that the respondent associates ecosystem services with "human health"	0.31	0.46	517
Advanced Degree	Indicates that the respondent has an advanced degree	0.30	0.46	496
Female Indicator	Indicates that the respondent is female	0.19	0.39	504
Acres Owned	Acres owned by the respondent	204.28	436.05	480
Tree Farmer	Indicates that the respondent is a tree farmer	0.56	0.50	507
Agricultural Crop Producer	Indicates that the respondent is an agricultural crop producer	0.38	0.49	497
Animal Producer	Indicates that the respondent is an animal producer	0.23	0.42	497
Forestry	Indicates that the respondent is a forester	0.16	0.37	497
Horse Farmer	Indicates that the respondent is a horse farmer	0.07	0.26	497
Recreational Land	Indicates that the respondent's primary land use is recreational	0.09	0.28	497
Income less than 20k	Indicates that the respondent earns less than 20k	0.05	0.22	426
Income between 20k and 40k	Indicates that the respondent earns between 20k and 40k	0.16	0.36	426
Income between 40k and 60k	Indicates that the respondent earns between 40k and 60k	0.10	0.30	426
Income between 60k and 80k	Indicates that the respondent earns between 60k and 80k	0.16	0.37	426
Income between 80k and 100k	Indicates that the respondent earns between 80k and 100k	0.13	0.34	426
Income between 100k and 150k	Indicates that the respondent earns between 100k and 150k	0.17	0.38	426
Income between 150k and 200k	Indicates that the respondent earns between 150k and 200k	0.11	0.31	426
Income over 200k	Indicates that the respondent earns over 200k	0.12	0.33	426
Percent Income from Farming	Percent of income earned from agricultural activities	15.25	28.05	477
Central	Indicates that the respondent's operation is located in the Central Region	0.19	0.39	506
Lower Shore	Indicates that the respondent's operation is located in the Lower Shore Region	0.13	0.34	506
Southern	Indicates that the respondent's operation is located in the Southern Region	0.16	0.37	506
Upper Shore	Indicates that the respondent's operation is located in the Upper Shore Region	0.14	0.35	506
Western	Indicates that the respondent's operation is located in the Western Region	0.38	0.49	506

Table A.4

Select Summary Statistics, by Willingness to Consider Participation in a Conservation Project

Variable	Would Consider Participation			Would Not Consider Participation			Significant Difference
	Mean	Std Dev	Obs	Mean	Std Dev	Obs	
Participate in a Wildlife Program	0.64	0.48	258	0.23	0.42	213	No
Participate in a Clean Air Program	0.44	0.50	256	0.15	0.36	214	No
Heard of Ecosystem Services	0.49	0.50	257	0.39	0.49	216	No
Pure Air	0.45	0.50	259	0.33	0.47	217	No
Soil Regeneration	0.40	0.49	259	0.28	0.45	217	No
Wildlife Habitat	0.46	0.50	259	0.31	0.46	217	No
Pollinators	0.32	0.47	259	0.18	0.38	217	No
Biodiversity	0.32	0.47	259	0.18	0.38	217	No
Environmental Health	0.41	0.49	259	0.27	0.45	217	No
Human Health	0.38	0.49	259	0.25	0.43	217	No
Advanced Degree	0.33	0.47	254	0.25	0.43	207	No
Female Indicator	0.16	0.37	255	0.22	0.41	213	Yes
Acres Owned	226.37	557.30	240	173.42	173.78	203	No
Tree Farmer	0.66	0.48	255	0.44	0.50	214	No
Agricultural Crop Producer	0.34	0.47	250	0.45	0.50	210	Yes
Animal Producer	0.27	0.45	250	0.19	0.39	210	No
Forestry	0.15	0.36	250	0.17	0.38	210	No
Horse Farmer	0.08	0.27	250	0.06	0.24	210	No
Recreational Land	0.09	0.28	250	0.07	0.26	210	No
Income less than 20k	0.04	0.19	232	0.07	0.26	162	Yes
Income between 20k and 40k	0.13	0.33	232	0.20	0.40	162	Yes
Income between 40k and 60k	0.10	0.30	232	0.10	0.31	162	No
Income between 60k and 80k	0.20	0.40	232	0.11	0.32	162	No
Income between 80k and 100k	0.12	0.33	232	0.11	0.32	162	No
Income between 100k and 150k	0.17	0.37	232	0.18	0.38	162	No
Income between 150k and 200k	0.11	0.31	232	0.11	0.32	162	No
Income over 200k	0.14	0.35	232	0.11	0.32	162	No
Percent Income from Farming	10.66	21.20	244	21.06	33.90	196	Yes
Central	0.13	0.33	252	0.25	0.43	214	Yes
Lower Shore	0.18	0.39	252	0.09	0.29	214	Yes
Southern	0.14	0.35	252	0.18	0.39	214	No
Upper Shore	0.15	0.36	252	0.11	0.32	214	No
Western	0.40	0.49	252	0.36	0.48	214	No

Table A.5

Select Summary Statistics, by Tree Farmer Indicator

Variable	Tree Farmers			Non Tree Farmers			Significant
	Mean	Std Dev	Obs	Mean	Std Dev	Obs	Difference
Consider	0.64	0.48	263	0.42	0.50	206	No
Participate in a Wildlife Program	0.52	0.50	280	0.36	0.48	216	No
Participate in a Clean Air Program	0.40	0.49	278	0.20	0.40	218	No
Heard of Ecosystem Services	0.48	0.50	281	0.38	0.49	219	No
Pure Air	0.43	0.50	285	0.32	0.47	222	No
Soil Regeneration	0.35	0.48	285	0.31	0.46	222	No
Wildlife Habitat	0.45	0.50	285	0.30	0.46	222	No
Pollinators	0.28	0.45	285	0.21	0.41	222	No
Biodiversity	0.28	0.45	285	0.20	0.40	222	No
Environmental Health	0.36	0.48	285	0.29	0.45	222	No
Human Health	0.36	0.48	285	0.24	0.43	222	No
Advanced Degree	0.32	0.47	270	0.28	0.45	217	No
Female Indicator	0.15	0.36	278	0.24	0.42	217	Yes
Acres Owned	213.66	477.35	265	195.20	385.71	208	No
Agricultural Crop Producer	0.21	0.41	277	0.61	0.49	211	Yes
Animal Producer	0.33	0.47	277	0.08	0.27	211	No
Forestry	0.23	0.42	277	0.08	0.27	211	No
Horse Farmer	0.07	0.26	277	0.07	0.26	211	No
Recreational Land	0.09	0.29	277	0.09	0.28	211	No
Income less than 20k	0.04	0.20	239	0.06	0.24	179	No
Income between 20k and 40k	0.15	0.36	239	0.15	0.36	179	No
Income between 40k and 60k	0.11	0.31	239	0.08	0.28	179	No
Income between 60k and 80k	0.21	0.41	239	0.09	0.29	179	No
Income between 80k and 100k	0.12	0.33	239	0.15	0.35	179	No
Income between 100k and 150k	0.16	0.37	239	0.20	0.40	179	No
Income between 150k and 200k	0.09	0.29	239	0.12	0.33	179	No
Income over 200k	0.11	0.32	239	0.14	0.35	179	No
Percent Income from Farming	9.54	20.69	264	22.88	34.08	204	Yes
Central	0.14	0.34	278	0.25	0.44	220	Yes
Lower Shore	0.17	0.37	278	0.09	0.28	220	No
Southern	0.16	0.37	278	0.15	0.36	220	No
Upper Shore	0.09	0.28	278	0.21	0.41	220	Yes
Western	0.45	0.50	278	0.30	0.46	220	No

Table A.6

Percent of Respondents Familiar With the Term...

	Ecosystem Services	Carbon Storage	Water Quality	Wildlife Habitat	Markets for Ecosystem Services	Forest Mitigation Banking
All	19%	21%	55%	64%	8%	10%
Non Tree Farmers	15%	16%	48%	51%	7%	8%
Tree Farmers	22%	24%	60%	74%	9%	11%

Table A.7

Average Degree of Familiarity with the Terms...
(1=Not Familiar, 5=Very Familiar):

	All	Tree Farmers	Non-Tree Farmers
Ecosystem Services	2.09	2.23	1.89
Carbon Storage	2.11	2.27	1.88
Water Quality	3.53	3.69	3.32
Wildlife Habitat	3.72	3.99	3.36
Markets for Ecosystem Services	1.62	1.66	1.56
Forest Mitigation Banking	1.64	1.69	1.57

Table A.8

Percent of Respondents Associating Ecosystem Services with...

	All	Tree Farmers	Non-Tree Farmers
Purifying Air and Water	0.38	0.43	0.32
Soil Regeneration	0.33	0.35	0.31
Wildlife Habitat	0.38	0.45	0.30
Pollinators	0.25	0.28	0.21
Biodiversity	0.25	0.28	0.20
Environmental Health	0.33	0.36	0.29
Human Health/Wellbeing	0.31	0.36	0.24
Flood Control	0.01	0.01	0.01

Table A.9

Percent of Respondents Interested in Participating in a Conservation Program for...

	Carbon Storage	Water Quality	Wildlife Habitat	Pollinators	Endangered Species	Biodiversity
All	44%	67%	65%	54%	51%	42%
Non Tree Farmers	36%	57%	53%	44%	39%	32%
Tree Farmers	50%	75%	73%	60%	59%	49%

Table A.10

Average Interest in Enrolling in a Conservation Program that Pays to Produce or Enhance...
(1=Not Interested, 5=Very Interested)

	All	Tree Farmers	Non-Tree Farmers
Carbon Storage	3.29	3.48	3.03
Water Quality	3.89	4.09	3.61
Wildlife Habitat	3.84	4.10	3.45
Pollinators	3.52	3.72	3.22
Endangered Species	3.44	3.67	3.10
Biodiversity	3.20	3.39	2.93

Table A.11

Reasons that Non Respondents* Chose Not to Participate in Conservation Programs

	All	Tree Farmers	Non-Tree Farmers	Significant Difference
Too much paperwork/hassle	28%	29%	27%	No
Contract length is too long	14%	13%	15%	No
Do not wish to help wildlife	3%	4%	3%	No
Payment not high enough	22%	17%	27%	Yes
Do not wish to take land out of production	37%	25%	49%	Yes
Already have land in conservation uses	20%	24%	17%	No
Concerns about government restriction	54%	54%	54%	No
Do not want to change land management	24%	26%	24%	No
Not enough information	47%	51%	44%	No

* Percentage of respondents that chose not to participate in a conservation program intended to purify air and water by establishing new forests.

Table A.12

Full-time farmer, and would you consider participation in a Payment-for Ecosystem-Services program?

	Inherent propensity for nonparticipation (Full sample) (2)	Inherent propensity for nonparticipation (excluding missing values) (4)	Tree farmer effect (5)	Regional effects (Western is used as reference category) (6)	Female effect (15)	Private land effect (18)
Intercept	–0.66 ***	–0.63 ***	–0.62 ***	–0.62 ***	–0.46 **	–0.46 **
Alternative's attributes						
Payment (US $)	0.01 ***	0.01 ***	0.01 ***	0.01 **	-0.001	-0.001
Contract length (years)	-0.03 ***	-0.02 **	-0.03 **	-0.02	-0.05 **	0.003
Administered by state agency	0.21 *	0.27 *	-0.07	-0.04	-1.00 **	-0.68
Administered by federal agency	-0.25 **	-0.12	-0.37 *	-0.57 *	-1.48 ***	-1.41 *
Tree farmer, interacted with						
Administered by state agency			0.62 ***	0.67 ***	0.69 **	0.70 **
Administered by federal agency			0.45 *	0.54 *	0.50 *	0.51 *
Central region, interacted with						
Administered by federal agency				0.58 *	0.75 *	0.75 *
Upper Shore region, interacted with						
Payment (US $)				0.01 *	0.01 *	0.01 *
Full-time farmer, interacted with						
Contract length (years)					0.03 *	0.03 *
Administered by state agency					0.57 **	0.55 **
Would you consider participation in a PES program, interacted with						
Payment (US $)					0.01 ***	0.01 ***
Administered by state agency					0.86 ***	0.86 ***
Administered by federal agency					0.94 ***	0.95 ***
Female, interacted with						
Administered by state agency					0.72 **	0.71 **
Age, interacted with						
Contract length (years)						-0.001 *
N	6240	3720	3720	3720	3720	3720
Pseudo R-sq	0.045	0.036	0.043	0.057	0.148	0.153
Log-likelihood	-2183.2	-1313.7	-1303.2	-1285.1	-1160.0	-1153.3

Table A.13

	Chi-square test of association (p-value)						
	Tree farmer	*Full-time farmer*	*Income >80k*	*Female*	*Advance degree*	*Would consider PES*	*Heard ES*
Tree farmer							
Central region	**0.004**	**0.213**	**0.510**	**0.003**	**0.017**	**0.004**	**0.010**
Lower Shore region	**0.047**	**0.679**	**0.493**	**0.599**	**0.925**	**0.010**	**0.493**
Southern region	**0.422**	**0.584**	**0.214**	**0.999**	**0.108**	**0.032**	**0.879**
Upper shore region	**0.018**	**0.672**	**0.905**	**0.093**	**0.048**	**0.027**	**0.905**
Western region	**0.053**	**0.545**	**0.394**	**0.423**	**0.025**	**0.674**	**0.172**
Full-time farmer	**0.010**						
Income >80k	**0.000**	**0.533**					
Female	**0.344**	**0.165**	**0.118**				
Advance degree	**0.268**	**0.070**	**0.006**	**0.191**			
Would consider PESP	**0.003**	**0.002**	**0.420**	**0.213**	**0.208**		
Heard ES	**0.274**	**0.220**	**0.476**	**0.705**	**0.903**	**0.039**	
Private land	**0.115**	**0.330**	**0.132**	**0.839**	**0.695**	**0.294**	**0.113**

APPENDIX B: Econometric Models

Contingent Valuation Econometric Model

This section describes the econometric model and its rationale. Three survey questions were used to directly gauge farmer* interest in conservation programs:

Question 14: If there were a conservation program that offered you a payment for improving the quantity and/or quality of ecosystem services your land provides, would you consider participating in such a program?

Question 25: Suppose there was a program that consisted of establishing or preserving habitat for wildlife species such as Bald Eagles, Delmarva Fox Squirrels, or Bog Turtles. The hypothetical program would be administered by a private business or nongovernmental organization, have a contract length of 10 years, and involve a small percentage of your land. If this program paid you "x" dollars[14] per acre per year for 10 years, would you be willing to participate?

Question 26: Suppose there was a program that established new forests to help clean our air and water. This hypothetical program would be administered by a state agency such as MD DNR, have a contract length of 10 years, and involve planting trees on crop, pasture, or fallow land. If this program paid you "x" dollars per acre per year for 10 years, would you be willing to participate?

Responses to Question 14 were analyzed using a probit regression (see Tables B.1 & B.2). Because of their similarity, Questions 25 and 26 were jointly analyzed using a bivariate probit regression (see Tables B.3 & B.4).

Estimating Probit Models

All farmers have an (unobserved) inclination, or propensity, to participate in payment-for-ecosystem-service (PES) programs. Denote this propensity y^* and assume that $y^* = X'\beta + \varepsilon$, where the matrix X represents a set of exogenous variables, the matrix β represents a set of unknown parameters, and the matrix ε represents disturbances that are randomly distributed. Because we don't observe y^*, it is necessary to infer how exogenous variables affect farmers' willingness to participate from their (observable) actions. In this case, farmers answered survey questions about participation in PES programs. These survey questions were framed such that responses to the questions were binary. Let the variable y be coded such that $y \epsilon [0,1]$ where 1 indicates willingness to participate in PES programs, and 0 indicates unwillingness to participate. Furthermore, assume that:

$$y = 1 \; if \; y^* > 0$$

$$y = 0 \; if \; y^* \leq 0$$

*In Appendix B, the word "farmer" indicates Tree Farmer and agricultural landowner together.

[14] Survey respondents were randomly offered $40, $75, $150, or $250 per acre to participate in the programs described in questions 25 and 26.

Then the probability that $y = 1$ is
$Prob(y > 0 \mid x) = Prob(X'\beta + \varepsilon > 0 \mid x) = Prob(\varepsilon > -X'\beta \mid x) = F(X'\beta)$, where F is the cumulative distribution function of the random variable ε. More simply:

$$Prob(y = 1) = F(X'\beta)$$
$$Prob(y = 0) = 1 - F(X'\beta)$$

If we assume that F is the standard normal distribution, then the model can be estimated using Maximum Likelihood. The Likelihood Function for a sample of *n* observations can be written as:

$$L = \prod_{i=1}^{n} [F(X_i'\beta)]^{y_i} [1 - F(X_i'\beta)]^{1-y_i}$$

in which *n* represents the number of observations in the dataset. The estimation problem is to maximize L given X by choosing β.

Estimating Bivariate Probit Models

The bivariate probit model is very similar to the probit model. Assume that farmers have a choice between two PES programs. Let y_1^* represent a farmer's propensity to participate in program 1, and y_2^* represent a farmer's propensity to participate in program 2. Assume that:

$$y_1^* = X_1'\beta_1 + \varepsilon_1$$
$$y_2^* = X_2'\beta_2 + \varepsilon_2$$

Furthermore, assume that ε_1 and ε_2 are correlated and that their distribution can be represented using the standard bivariate normal probability density function. Because y_1^* and y_2^* are not observed, it is necessary to infer how the variables in X affect y^* using farmers' responses to survey questions. Let y_1 represent the farmer's reported willingness to participate in program 1, and y_2 represent the farmer's reported willingness to participate in program 2. As in the previous example, willingness to participate is coded 1, unwillingness to participate is coded 0. So:

$$y_1 = 1 \; if \; y_1^* > 0, 0 \text{ otherwise}$$
$$y_2 = 1 \; if \; y_2^* > 0, 0 \text{ otherwise}$$

The estimation problem is to find the $Prob(Y_1 = y_{i1}, Y_2 = y_{i2}) = F(X_1'\beta_1, X_2'\beta_2)$. Technical details aside, this problem can also be solved via Maximum Likelihood Estimation.

Specifications Analyzed

We assume that a farmer's (unobservable) willingness (or propensity) to consider participation in a PES program (see Question 14) is a function of: whether he/she has heard the term ecosystem services; whether he/she earns more than $80k a year; whether he/she has an advanced degree; whether he/she is female; the number of acres of agricultural land owned; the number of years that the agricultural land has been owned; whether he/she is an agricultural producer; whether he/she is an animal producer; whether he/she uses their land for recreational purposes; the percentage of income that is earned on the farm; as well as whether he/she is located in the central, lower shore, southern, or upper region of Maryland. Less generally:

$$\begin{aligned} &Willingness\ to\ Consider\ Participation\ in\ a\ PES\ program \\ &\quad = \alpha + Heard'B_1 + Income'B_2 + Advanced\_DegreeB_3 + FemaleB_4 + Acres\_OwnedB_5 \\ &\quad + Years\_OwnedB_6 + AgProducerB_7 + Animal\_ProducerB_8 + Rec\_UserB_9 + Perc\_IncB_{10} \\ &\quad + CentralB_{11} + Lower\_ShoreB_{12} + SouthernB_{13} + Upper\_ShoreB_{14} + \varepsilon \end{aligned}$$

where the ε_i are identically, independently normally distributed.

We assume that a farmer's (unobservable) willingness (or propensity) to consider participation in a PES program that protects endangered wildlife (see Question 25), and a farmer's (unobservable) willingness (or propensity) to consider participation in a PES program that cleans the air and water (Question 26) is a function of: the payment offered for participation; whether he/she has heard the term Ecosystem Services; whether he/she earns more than $80K a year; whether he/she has an advanced degree; whether he/she is female; the number of acres of agricultural land owned; the number of years that the agricultural land has been owned; whether he/she is an agricultural producer; whether he/she is an animal producer; whether he/she uses their land for recreational purposes; the percentage of income that is earned on the farm; as well as whether he/she is located in the central, lower shore, southern, or upper region of Maryland. Less generally:

$$\begin{aligned} &Willingness\ to\ Consider\ Participation\ in\ a\ PES\ program\ to\ protect\ Wildlife \\ &\quad = \gamma_1 + Bid'\beta_{1,1} + Heard'\beta_{1,2} + Income'\beta_{1,3} + Advanced\_Degree\beta_{1,4} + Female\beta_{1,5} \\ &\quad + Acres\_Owned\beta_{1,6} + Years\_Owned\beta_{1,7} + AgProducer\beta_{1,8} + Animal\_Producer\beta_{1,9} \\ &\quad + Rec\_User\beta_{1,10} + Perc\_Inc\beta_{1,11} + Central\beta_{1,12} + Lower\_Shore\beta_{1,13} + Southern\beta_{1,14} \\ &\quad + Upper\_Shore\beta_{1,15} + \nu_1 \end{aligned}$$

$$\begin{aligned} &Willingness\ to\ Consider\ Participation\ in\ a\ PES\ program\ to\ Clean\ Air\ and\ Water \\ &\quad = \gamma_2 + Bid'\beta_{2,1} + Heard'\beta_{2,2} + Income'\beta_{2,3} + Advanced\_Degree\beta_{2,4} + Female\beta_{2,5} \\ &\quad + Acres\_Owned\beta_{2,6} + Years\_Owned\beta_{2,7} + AgProducer\beta_{2,8} + Animal\_Producer\beta_{2,9} \\ &\quad + Rec\_User\beta_{2,10} + Perc\_Inc\beta_{2,11} + Central\beta_{2,12} + Lower\_Shore\beta_{2,13} + Southern\beta_{2,14} \\ &\quad + Upper\_Shore\beta_{2,15} + \nu_2 \end{aligned}$$

Interpreting the Regression Results and the Marginal Effects

Notice that the parameter estimates in the specifications above indicate how the variables of interest affect farmers' (unobservable) willingness to participate. However, we are not necessarily interested in farmers' latent willingness to participate, we are interested in their probability of participation. To see how the variables in X affect the probability of participation we must calculate:

$$\frac{dProb(y=1)}{dX} = \frac{dF(X'\beta)}{dX'\beta} = \frac{dF(X'\beta)}{dX'\beta} * \frac{dX'\beta}{dX} = f(X'\beta) * \beta$$

Notice that the marginal effects depend on X. We have calculated the marginal effects at the variable means.

Examples

Consider Table B.1. Notice that the parameter estimate for the variable "Lower Shore Region" is 0.52. This indicates that having heard the term ecosystem services increases a farmer's willingness to consider a participation program by 0.52 "propensity units." While this result is qualitatively useful (it indicates that having heard the term ecosystem services makes farmers more likely to consider participation in a PES program), it is hard to interpret (because we don't know what propensity units are).

Now, consider Table B.2. Notice that the parameter estimate for the marginal effect of the "Lower Shore Region" is 0.18. This estimate provides information that is easier to interpret; it indicates that having heard the term ecosystem services increases the probability of participation by 18 percent.

Next consider Tables B.3 and B.4. Notice that the variable "Heard" increases the willingness to participate in wilderness programs by 0.32 "propensity units" and the willingness to participate in clean air programs by 0.39 "propensity units." However, the marginal effect of "Heard" is 0.12. This indicates that having heard of ecosystem services increases the joint probability of accepting Wilderness AND Air Quality PES programs by 0.12.

Table B.1

Are farmers willing to consider participation in a conservation program (Q14)?
Regression Results, Probit Regression (with and without Tree Farmer Interactions)

Variable	Label	Consider (Q14) All	Consider (Q14) Tree Farmers (Restricted Sample)	Consider (Q14) Farmers (Restricted Sample)
Heard	Indicator for whether the respondent has heard of Ecoystem Services	0.25	0.19	0.41
Income	Indicates that the respondent earned more than $80k a year	0.04	-0.07	0.12
Advanced Degree	Indicates that the respondent has an advanced degree	-0.05	0.08	-0.26
Female	Indicates that the respondent is Female	0.10	-0.01	0.42
Acres Owned	Acres of Ag Land Owned	0.0002	0.0001	0.001
Years Owned	Number of Years Land has been Owned	-0.01	-0.01	-0.003
Agricultural Producer	Indicates that the respondent's land is used for agricultural production	0.05	-0.10	0.23
Animal Producer	Indicates that the respondent's land is used for animal production	0.44 *	0.39	0.56
Recreational Use	Indicates that the respondent's land is used for recreational purposes	0.34	0.37	0.39
Percent Income	Percent of the respondent's income that is earned from the land	-0.01 **	-0.002	-0.01 **
Central Region	Indicator for whether the operation is located in the "Central" Region	-0.36	-0.47	-0.11
Lower Shore Region	Indicator for whether the operation is located in the "Lower Shore" Region	0.52 **	0.14	1.69 ***
Southern	Indicator for whether the operation is located in the "Southern" Region	-0.23	-0.41	-0.04
Upper Shore	Indicator for whether the operation is located in the "Upper Shore" Region	0.46 *	-0.02	0.97 **
Tree Farmer	Indicates that the respondent is a tree farmer	0.37 **		
Constant	-	-0.02	0.56 *	-0.70
Observations	-	310	170	140
Psuedo R2	-	0.12	0.05	0.20

Table B.2

Are farmers willing to consider participation in a conservation program (Q14)?
Marginal Effects, Probit Regression (with and without Tree Farmer Interactions)

Variable	Label	Consider (Q14) All	Consider (Q14) Tree Farmers (Restricted Sample)	Consider (Q14) Farmers (Restricted Sample)
Heard	Indicator for whether the respondent has heard of Ecoystem Services	0.08	0.06	0.13
Income	Indicates that the respondent earned more than $80k a year	0.02	-0.03	0.04
Advanced Degree	Indicates that the respondent has an advanced degree	-0.02	0.03	-0.08
Female	Indicates that the respondent is Female	0.04	-0.002	0.13
Acres Owned	Acres of Ag Land Owned	0.0001	0.00003	0.0003
Years Owned	Number of Years Land has been Owned	0.00	-0.002	-0.001
Agricultural Producer	Indicates that the respondent's land is used for agricultural production	0.02	-0.03	0.07
Animal Producer	Indicates that the respondent's land is used for animal production	0.15 *	0.13	0.17
Recreational Use	Indicates that the respondent's land is used for recreational purposes	0.12	0.12	0.12
Percent Income	Percent of the respondent's income that is earned from the land	-0.003 **	-0.001	-0.004 **
Central Region	Indicator for whether the operation is located in the "Central" Region	-0.12	-0.16	-0.03
Lower Shore Region	Indicator for whether the operation is located in the "Lower Shore" Region	0.18 **	0.05	0.53 ***
Southern	Indicator for whether the operation is located in the "Southern" Region	-0.08	-0.14	-0.01
Upper Shore	Indicator for whether the operation is located in the "Upper Shore" Region	0.16 *	-0.01	0.30 ***
Tree Farmer	Indicates that the respondent is a tree farmer	0.12 **		

Table B.3

Are farmers willing to participate in conservation programs intended to preserve wildlife and/or air quality? Regression Results, Bivariate Probit Regression (with and without Tree Farmer interactions)

Variable	Wildlife Prog. (Q25) All	Wildlife Prog. (Q25) Tree Farmers (restricted sample)	Wildlife Prog. (Q25) Farmers (restricted sample)	Air Quality Prog. (Q26) All	Air Quality Prog. (Q26) Tree Farmers (restricted sample)	Air Quality Prog. (Q26) Non Tree Farmers (restricted sample)
Bid	0.003 ***	0.004 ***	0.003 *	0.001	0.0001	0.001
Heard	0.32 **	0.50 **	0.18	0.39 **	0.61 ***	0.22
Income	0.01	0.13	-0.13	0.25	0.44 **	0.11
Advanced Degree	0.26	0.28	0.32	0.14	-0.36	0.73 ***
Female	-0.34 *	-0.58 **	-0.12	-0.14	-0.39	0.02
Acres Owned	0.0002	0.0001	0.0004	0.0001	0.0001	-0.0002
Years Owned	-0.01	-0.00003	-0.01	-0.003	-0.00520	0.00
Agricultural Producer	-0.09	-0.07	0.03	0.10	0.59 *	-0.06
Animal Producer	-0.01	-0.04	0.06	0.07	0.17	0.15
Recreational Use	-0.13	-0.21	0.01	-0.08	-0.10	0.05
Percent Income	-0.003	-0.005	-0.003	-0.007 **	-0.005	-0.012 **
Central Region	0.09	0.10	0.17	0.30	0.05	0.46
Lower Shore Region	-0.15	-0.45	0.48	-0.35	-0.68 **	-0.23
Southern Region	-0.05	-0.21	0.12	-0.13	-0.36	0.07
Upper Shore Region	0.56 **	0.53	0.65 *	-0.12	-0.23	-0.07
Tree Farmer	0.48 ***			0.66 ***		
Constant	-0.69 **	-0.46	-0.81	-1.12 ***	-0.32	-1.32 **
	All	Tree Farmers	Farmers			
Rho	0.93 ***	1.07 ***	1.06 ***			
Observations	326	180	146			
Psuedo R2	0.40	0.11	0.13			

Table B.4

Are farmers willing to participate in conservation programs intended to preserve wildlife and/or air quality? Marginal Effects, Bivariate Probit Regression (with and without Tree Farmer Interactions)

Variable	Wildlife Prog. (Q25) and Air Quality Prog. (Q26) All	Tree Farmers (restricted sample)	Non Tree Farmers (restricted sample)
Bid	0.0005 *	0.0004	0.0004
Heard	0.12 ***	0.20 ***	0.05
Income	0.05	0.12 *	0.01
Advanced Degree	0.06	-0.06	0.14 **
Female	-0.06	-0.16 *	-0.005
Acres Owned	0.00003	0.00004	-0.0000004
Years Owned	0.00	-0.001	-0.0004
Agricultural Producer	0.01	0.13	-0.01
Animal Producer	0.01	0.04	0.03
Recreational Use	-0.03	-0.05	0.01
Percent Income	-0.002 **	-0.002	-0.002 **
Central Region	0.07	0.02	0.08
Lower Shore Region	-0.09	-0.21 **	-0.004
Southern Region	-0.03	-0.11	0.02
Upper Shore Region	0.03	0.01	0.03
Tree Farmer	0.19 ***	NA	NA

Conjoint Choice Econometric Model

Estimating Conditional Logit Models

Conjoint choice experiments are characterized by situations in which an individual is given a choice among two or more alternatives. These experiments are often modeled using a type of random utility model, the conditional logit model.

Assume that individual *i* receives utility, u_{ij} , from choice *j*. Then u_{ij} can be represented by:

$$u_{ij} = z'_{ij}\theta + \varepsilon_{ij}$$

where z_{ij} is a set of exogenous, choice, and individual specific variables and ε_{ij} are randomly distributed error terms. Assume that individual *i* choses alternative *j* if and only if $u_{ij} \geq u_{ik} \; \forall \, j \neq k$. If this is the case, and if the residuals, ε_{ij} , are extreme value distributed (and independent across alternatives), then the probability that individual *i* chooses alternative *j* is:

$$Prob(u_{ij} \geq u_{ij}) = \frac{\exp\,(z'_{ij}\theta)}{\sum_{j=1}^{J} \exp\,(z'_{ij}\theta)}$$

The Log Likelihood Function of the conditional logit model is:

$$lnL = \sum_{j}\sum_{i} y_{ij} * Pro\square(individual\ i\ chooses\ alternative\ j)$$

where $y_{ij} = 1$ if individual *i* chooses alternative *j*. This likelihood function can be maximized iteratively using Newton's Method (or a comparable iterative search algorithm).

Specifications Analyzed

We hypothesized that farmer *i's* utility from choosing alternative *j* depended on a number of factors: the payment offered for participation, the contract length, the administrative agency, and whether or not the farmer was a Tree Farmer. Less generally, it was assumed that:

$$u_{ij} = \beta_p P_{ij} + \beta_c C_{ij} + \beta_s S_{ij} + \beta_f F_{ij} + \beta_{st}(S_{ij} * T_i) + \beta_{st}(F_{ij} * T_i) + \varepsilon_{ij}$$

where P is the payment in dollars; C is the contract length in years; S is a dichotomous variable that takes value one if administered by state agency and zero otherwise; F is a dichotomous variable that takes value one if administered by a federal agency and zero otherwise; T is a dichotomous variable that takes value one if respondent is a Tree Farmer and zero otherwise; β_k is the corresponding coefficient for each variable included in the specification; and ε_{ij} are identically, independently, extreme value distributed residuals.

Interpreting the Regression Results and the Marginal Effects

As in the probit/bivariate probit models, there is a difference between the regression results and the marginal effects. The regression results indicate the extent to which the variables of interest affect farmer *i's* utility from choice *j*. However, because utility is an abstract concept (and nobody knows exactly what a "util" is) these results are hard to interpret. It's easier to interpret the marginal effects, which indicate the extent to which a change in a variable affects the probability that a farmer will choose a given alternative.

Examples

Consider Table B.5. Notice that the parameter estimate for "Bid" is 0.01. This indicates that increasing the bid by 1 dollar/acre, increases the utility from an alternative by 0.01 utils. This result indicates that increasing payment makes participation in PES programs more likely, but because utils are abstract units of measurement, it is hard to interpret how much more likely. Next, consider Table B.6. The parameter estimate for the marginal effect of "Bid" is 0.002. This suggests that increasing the payment for a PES program will increase the probability of selecting an alternative by 0.2 percent.

Interpreting the variable interactions requires slightly more work. Consider Table B.5. The parameter estimate for "Tree cross State" is 0.69. This indicates that Tree Farmers receive 0.69 utils more than nontree farmers when a PES program is administered by the state government. It is necessary to add the parameter estimate for "State" (-0.99), which represents the utils that nontree farmers receive when a PES program is administered by the state government, to the parameter estimate for "Tree cross State" (0.69), to determine the total amount of utils that Tree Farmers receive from a PES program when it is administered by the state government (0.02 utils).

Table B.5

Which Attributes of Conservation Programs Do Farmers Prefer (Conjoint Analysis, Questions 16-20) Regression Results, Conditional Logit Model

Variable	Label	Specification 1	Specification 2
Intercept	-	-0.63 ***	-0.46 **
Bid	Payment for Participation (per acre, per year)	0.01 ***	-0.001
Contract length (years)	Length of the Conservation Program	-0.02 **	-0.051 **
State	Program is administered by a State Agency	0.27 *	-0.99 **
Federal	Program is administered by a Federal Agency	-0.12	-1.48 ***
Tree cross State	Interaction of Tree Farmer Ind. and State		0.69 **
Tree cross Federal	Interaction of Tree Farmer Ind. and Federal		0.50 *
Central cross Federal	Interaction of Central Region Ind. and Federal		0.75 *
Upper Shore cross Bid	Interaction of Upper Shore Region Ind. and Federal		0.008 *
Full Time Farmer cross Contract	Interaction of Full Time Farmer Ind. and Contract		0.03 *
Full Time Farmer cross State	Interaction of Full Time Farmer Ind. And State		0.56 **
Consider cross Bid	Interaction of Willingness to Consider Participation Ind. and Bid		0.01 ***
Consider cross State	Interaction of Willingness to Consider Participation Ind. and State		0.86 ***
Consider cross Federal	Interaction of Willingness to Consider Participation Ind. and Federal		0.93 ***
Female cross State	Interaction of Female Ind. and State		0.71 **
Observations	-	3720	3720
Pseudo R2	-	0.04	0.15

Table B.6

Which Attributes of Conservation Programs Do Farmers Prefer (Conjoint Analysis, Questions 16-20)
Marginal Effects, Conditional Logit Model

Variable	Label	Specification 1	Specification 2
Intercept	-	-0.15 ***	-0.10 ***
Bid	Payment for Participation (per acre, per year)	0.002 ***	-0.0002
Contract length (years)	Length of the Conservation Program	-0.01 ***	-0.01 ***
State	Program is administered by a State Agency	0.06 *	-0.21 ***
Federal	Program is administered by a Federal Agency	-0.03	-0.31 ***
Tree cross State	Interaction of Tree Farmer Ind. and State		0.69 ***
Tree cross Federal	Interaction of Tree Farmer Ind. and Federal		0.50 ***
Central cross Federal	Interaction of Central Region Ind. and Federal		0.75 **
Upper Shore cross Bid	Interaction of Upper Shore Region Ind. and Federal		0.01 **
Full Time Farmer cross Contract	Interaction of Full Time Farmer Ind. and Contract		0.03 **
Full Time Farmer cross State	Interaction of Full Time Farmer Ind. And State		0.57 ***
Consider cross Bid	Interaction of Willingness to Consider Participation		0.01 ***
Consider cross State	Interaction of Willingness to Consider Participation Ind. and State		0.86 ***
Consider cross Federal	Interaction of Willingness to Consider Participation		0.94 ***
Female cross State	Interaction of Female Ind. and State		0.72 ***

APPENDIX C: Survey Instrument

Ecosystem Services on Forest and Agricultural Lands of Maryland:
A Survey of Maryland Tree Farmers
and
Agricultural Landowners

University of Maryland
College of Agriculture and Natural Resources
College Park, Maryland
April, 2012

Section 1: Land Use Background

1. **How many years have you personally farmed or managed land (agricultural or forest) in Maryland?** _____Years

2. **Are you a Maryland Tree Farmer?** ☐ Yes ☐ No

3. **Do you own the land?** ☐ Yes ☐ No
   If yes, what county or counties? _____How many acres? _____

4. **Do you lease out land to others?** ☐ Yes ☐ No
   If yes, what county or counties? _____How many acres? _____

5. **Do you rent land from others?** ☐ Yes ☐ No
   If yes, what county or counties? _____How many acres? _____

6. **What is the primary use of your owned and/or rented land?** (Check one)
   ☐ Agricultural crop production ☐ Forestry activities ☐ Horse grazing
   ☐ Animal production (poultry/dairy/sheep) ☐ Recreation ☐ Other (specify)_____

7. **Approximately what percentage of your annual income comes from your owned and/or rented land?** _____%

8. **Have you participated or do you currently participate in a conservation payment, rental, or easement program?** ☐ Yes ☐ No ☐ Don't know

9. **If you identify yourself as a landowner who leases out land, how much influence do your renters have on which land conservation programs you participate in?**
   (Please circle one number that most closely matches your response, from 1= No Influence to 5=Total Influence)

No Influence		Neutral		Total Influence	Don't Know	Not Applicable
1	2	3	4	5		

10. **If you identify yourself as a renter of land, how much influence or control do you have over whether the land you rent can be placed into a conservation program?**
    (Please circle one number that most closely matches your response, from 1= No Influence to 5=Total Influence)

No Influence		Neutral		Total Influence	Don't Know	Not Applicable
1	2	3	4	5		

11. We would like to find out what you know about the following terms. **Please indicate your degree of familiarity by circling the number that most closely matches your response**, (from 1=Not Familiar to 5=Very Familiar).

	Not Familiar		Somewhat Familiar		Very Familiar
Ecosystem services	1	2	3	4	5
Carbon storage	1	2	3	4	5
Water quality	1	2	3	4	5
Wildlife habitat	1	2	3	4	5
Payments or markets for ecosystem services	1	2	3	4	5
Forest mitigation banking	1	2	3	4	5

Section 2: Ecosystem Services

There is a growing awareness that forests and some farmland provide many environmental benefits to society, such as purifying air and water, renewing soils, providing habitat for wildlife, and helping to stabilize the climate. The term ecosystem service is used to refer to these benefits.

12. Have you heard the term *ecosystem services* before this survey? ..... ☐ Yes ☐ No

13. If yes, please check all that apply or consider what ecosystem services mean to you?

☐ Purifying air and water ☐ Soil regeneration ☐ Wildlife habitat
☐ Pollinators ☐ Biodiversity ☐ Environmental health
☐ Human health/wellbeing ☐ Flood control ☐ Other (please specify)_____

14. If there were a conservation program that offered you a payment for improving the quantity and/or quality of ecosystem services your land provides, would you consider participating in such a program?..... ☐ Yes ☐ No ☐ Don't know

15. Please indicate your level of agreement with the following statement:
"I would be interested in enrolling in a conservation program that pays to produce, enhance, or protect benefits such as..." (Circle one number that most closely matches your response)

	Completely Disagree		Neutral		Completely Agree
Carbon storage	1	2	3	4	5
Water quality	1	2	3	4	5
Wildlife habitat	1	2	3	4	5
Pollinators	1	2	3	4	5
Endangered Species	1	2	3	4	5
Biodiversity	1	2	3	4	5

Hypothetical Situation

A conservation program is being developed that takes a first step towards encouraging landowner and operator participation in emerging markets for ecosystem services. Guidelines are being developed to provide payments for ecosystem services. These include voluntary programs that would give landowners the opportunity to receive payments for applying conservation practices on their property. The potential programs are described by the following three features:

Contract Length — Programs offer landowners several different options for the length of time that land can be enrolled in them. Contract length options are 5, 15, and 30 years.

Program Administration — The organization administering the program enrolls the land, works with the landowners and distributes the payments to participating landowners. Organization options are Federal agency (e.g., USDA, US Fish & Wildlife Service), State agency (e.g., MD Department of Natural Resources or MD Department of Agriculture), or Non-Governmental Organizations (NGO's).

Program Payment — Landowners receive a guaranteed rental payment for enrolling land in a program. Payment level options are $30, $70, $100, and $200 per acre per year.

Directions: In each of the following five examples, we ask you to select your preferred option from the programs presented. Please assume that these programs would apply to your owned and/or rented land. ***Look at each example individually and make your choice by placing an X in the blank box for Program A, Program B, or Neither. You should only make one choice for each example. Do not compare examples.***

16. Example #1

Program Features	Program A	Program B	Neither
Contract length	30 years	15 years	
Program administration	Non-governmental organization	State agency	
Payment level (per acre per year)	$100	$30	
Please check only one program: A, B, or Neither			

17. Example #2

Program Features	Program A	Program B	Neither
Contract length	15 years	5 years	
Program administration	Federal agency	Non-governmental organization	
Payment level (per acre per year)	$70	$30	
Please check only one program: A, B, or Neither			

18. Example #3

Program Features	Program A	Program B	Neither
Contract length	15 years	5 years	
Program administration	Non-governmental organization	Federal agency	
Payment level (per acre per year)	$30	$70	
Please check only one program: A, B, or Neither			

19. Example #4

Program Features	Program A	Program B	Neither
Contract length	5 years	5 years	
Program administration	State agency	Federal agency	
Payment level (per acre per year)	$100	$30	
Please check only one program: A, B, or Neither			

20. Example #5

Program Features	Program A	Program B	Neither
Contract length	15 years	5 years	
Program administration	Federal agency	State agency	
Payment level (per acre per year)	$200	$100	
Please check only one program: A, B, or Neither			

21. When you were making your choices between alternative programs in examples 1-5, how important were each of the program features to your decisions? (Circle one number that most closely matches your response, with 1=Not Very Important to 5=Very Important)

Program Features	Not Very Important		Neutral		Very Important
Contract length	1	2	3	4	5
Program administration	1	2	3	4	5
Payment level (per acre per year)	1	2	3	4	5

22. Who would you prefer to work with when entering into a payment agreement for an ecosystem service program? In other words, who would you trust entering into an agreement? (Check one)

☐ Federal agency ☐ State agency ☐ Non-governmental organization ☐ Private company

23. How frequently do you consult with the following people about land management decisions such as enrolling in conservation programs? (Circle your response with 1=Never to 5=Very Frequently)

	Never		Sometimes		Very Frequently
University of MD Extension	1	2	3	4	5
Other operators/landowners	1	2	3	4	5
Family members	1	2	3	4	5
USDA-NRCS/Soil Conservation District	1	2	3	4	5
DNR-forester	1	2	3	4	5
DNR-wildlife biologist	1	2	3	4	5
Consulting forester	1	2	3	4	5
Conservation organization specialist	1	2	3	4	5

In parts of the Mid-Atlantic, animals such as bear, quail, turtles, squirrels, and eagles are part of the natural environment. Increasingly, habitat is being lost for a variety of reasons.

There are organizations and private businesses interested in ensuring many of these wildlife species survive and are considering how to enlist the help of landowners and managers; in particular rare, threatened or endangered species, such as the Bald Eagle, Delmarva Fox Squirrel or Bog Turtle. Some organizations recognize the important role that private landowners play in wildlife conservation and are considering the creation of voluntary programs in which landowners could receive payments to apply conservation practices that improve habitat for many of the endangered or threatened species.

24. What is your initial reaction to such a program?
(Please circle the number that most closely matches your response.)

Strongly Oppose		Neutral		Strongly Favor
1	2	3	4	5

25. Suppose there was a program that consisted of establishing or preserving habitat for wildlife species such as Bald Eagles, Delmarva Fox Squirrels, or Bog Turtles. The hypothetical program would be administered by a private business or non-governmental organization, have a contract length of 10 years, and involve a small percentage of your land. If this program paid you $40 per acre per year for 10 years, would you be willing to participate?

☐ Yes ☐ No ☐ Don't know

26. Suppose there was a program that established new forests to help clean our air and water. This hypothetical program would be administered by a state agency such as MD DNR, have a contract length of 10 years, and involve planting trees on crop, pasture, or fallow land. If this program paid you $40 per acre per year for 10 years would you be willing to participate?

☐ Yes ☐ No ☐ Don't know

27. If you responded NO or DON'T KNOW to the previous question, what are the reasons you would choose not to enroll in a conservation payment program like this?
(Please check all that apply.)

- ☐ Too much paperwork/general hassle
- ☐ Do not wish to help wildlife population
- ☐ Do not wish to take any land out of agricultural crop production
- ☐ Already have enough of my land in conservation uses
- ☐ Payment not high enough
- ☐ Contract length is too long
- ☐ Concern about government restriction on private property
- ☐ Do not want to change the way I manage my land
- ☐ No enough information
- ☐ Other (Please specify) _____

28. Do you agree or disagree with the following statement: "Having more management choices that allow landowners to diversify production and income options would help manage risks."

Strongly Agree		Neutral		Strongly Disagree
1	2	3	4	5

Section 3: Personal Background

29. Are you ☐ Male ☐ Female

30. How old are you? _____ Years Old

31. What is the highest level of education that you have achieved? (Check ONE)

☐ Less than high school diploma
☐ High School diploma or GED
☐ Technical/vocational degree
☐ Some college at a 4-year institution
☐ 4-year college degree
☐ Advanced degree beyond 4-year degree

32. If you own land, what is the ownership structure of that land? (Check ONE)

☐ Private individual
☐ Corporation
☐ Partnership (e.g., LLC)
☐ Other (please specify) _____

33. What was your approximate annual household income before taxes last year? (Check ONE)

☐ Less than $20,000
☐ $20,000 to $39,999
☐ $40,000 to $59,999
☐ $60,000 to $79,999
☐ $80,000 to $99,999
☐ $100,000 to $149,999
☐ $150,000 to $199,999
☐ Over $200,000

Thank you very much!
Please place the survey in the postage-paid envelope provided, and drop it in the mail.
This survey builds upon similar research in California and North Carolina.