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Public Support for Land Preservation

Measuring Relative Preferences in In Delaware

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Public Support for Land Preservation: Measuring Relative Preferences in Delaware. By Joshua M. Duke, Thomas W. Ilvento, and Rhonda A. Hyde, Department of Food and Resource Economics, University of Delaware. FREC Research Report No. 02-01.

Abstract

Public preferences for nonmarket services of preserved land in Delaware are measured using two survey techniques. The results of a conjoint experiment, using a sample of 199 Delawareans, suggest that the environmental and agricultural attributes of preserved land are most important to the residents. The conjoint results also suggest that these services are of substantial value to Delawareans; at the margin, at least, agricultural and environmental preserved land provide net benefits to the public. The analytic hierarchy process is used to assess separate survey results from 129 Delawareans. The results provide specific weights on the relative importance of attributes and qualities of preserved land, which in large part replicate and reinforce the results of the conjoint experiment. Overall, Delawareans seem to be most concerned with keeping farming as a way of life, having access to locally grown agricultural commodities, protecting water quality, and preserving rural character.

Keywords: Purchase of development rights, purchase of agricultural conservation easements, nonmarket values, analytic hierarchy process, conjoint analysis

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Summary

Public preferences for the nonmarket services of preserved land in Delaware are measured using two survey techniques. A conjoint experiment assesses data from a sample of 199 Delawareans and the analytic hierarchy process interprets a separate survey of 129 Delawareans. The results of the conjoint analysis and the AHP reinforce each other and provide specific weights on the relative importance of attributes and qualities of preserved land.

Overall, Delawareans are:

- Very concerned about land preservation;
- Very supportive of the land-preservation activities of the Delaware Agricultural Lands Preservation Program;
- Most concerned with keeping farming as a way of life, having access to locally grown agricultural commodities, protecting water quality, and preserving rural character; and
- Somewhat less concerned with open space, with protecting agriculture because it is an important industry, and with "habitat" types of environmental protection.

Other findings suggest:

- The value of the public's goodwill to the continuing activities of the program is estimated to be between $1,209,216 and $4,685,162;
- The most important attributes of preserved land are those that provide agricultural (rural amenities) and environmental (human regarding) services;
- The net benefits of many of the parcels preserved in 2000 were likely positive;
- For some recently preserved parcels—especially agricultural or environmental parcels—the net benefits of preservation exceeded $1,000,000;
- The public seems to prefer growth control that promotes rural character rather than growth control that preserves land at immediate risk of development; and
- The results reflect the support for the first farm preserved. Net benefits diminish as more farms are enrolled.

Public Support for Land Preservation

Measuring Relative Preferences in Delaware[1]

Joshua M. Duke, Thomas W. Ilvento, and Rhonda A. Hyde[2]

1. INTRODUCTION

Contemporary land-use control offers many tools for the conservation of undeveloped lands. Private conservation efforts, such as land trusts, complement a pervading set of overlapping government-based tools, including purchase of development rights programs, transfer of development rights programs, conservation easements, and zoning for open space. Many states, counties, and local governments are using these approaches to preserve agricultural lands, wetlands, and other open space (American Farmland Trust 1997). Support for these programs is usually inferred through bond referenda, donations, and general opinion surveys. Direct measures of public support through targeted surveys are often lacking in the policy debate. Furthermore, in studies that attempt to measure public support for the preservation of agricultural and other lands, there is often a lack of clarification as to what types of land are supported and why. Mainly, a survey of preference for multiattribute, nonmarket goods is extremely complex, though experimental design and statistical inference can simplify the process for the respondent.

This report seeks to improve our understanding of public support for preservation of land. Questions addressed include:

- What attributes and qualities of land explain the public's support for preservation?
- Is the public demanding protected open space or growth control?
- Is the preservation of agricultural land more or less important than ensuring environmental quality?
- How would the public prefer to trade off the attributes and qualities of preserved land?
- Do the nonmarket benefits of preserving land outweigh the costs?

This report measures public support for land preservation in Delaware through the use of two complementary but distinct analytical strategies for eliciting preferences via surveys. The methodologies include conjoint analysis—an experimental survey method—and the analytic hierarchy process (AHP)—a nonstatistical survey technique. Both approaches distinguish sources and intensities of support for various attributes of preserved land. The results provide a picture of the public's support for land preservation, explaining why the public supports preservation and for what types of land. The conjoint approach also offers insight into the public's willingness to pay for preservation services and provides an estimate of the value of different types of preserved parcels.

1.1 The Delaware Agricultural Lands Preservation Program

Intense growth pressures are increasingly challenging Delaware's system of land-use control (Duke, Mackenzie, and Ilvento 2002). In 1991, the state adopted the Delaware Agricultural Lands Preservation Program, which authorizes agricultural districting and conservation easement programs. By 2001, 53,783 acres had been enrolled in the conservation easement program.

1.2 Definitions

Purchase of agricultural conservation easements. Conservation easements are contracts in which landowners voluntarily agree to not convert their land to developed uses in exchange for a payment and/or tax reduction. Often, state programs to purchase conservation easements are referred to as purchase of development rights programs, though technically, development rights differ from conservation easements. Also, although there are many techniques to achieve land preservation goals, conservation easements as used by Delaware are the focus of this report.

Parcel. The term parcel is used to refer to actual undeveloped land in the State, which is or can be enrolled in a preservation program. Parcel should not be confused with **"farm"**, which this report uses to identify the hypothetical parcels used in the conjoint analysis.

Attribute. This report assumes that undeveloped land can be characterized by its nonmarket attributes. Attributes are then distinguished by their **qualities**. These are specified in section 2.1.

This report is organized as follows. The second section discusses the state-of-the-art research on the public support for land preservation, focusing on new survey techniques for eliciting preference. The current report is associated with related literature in the field. Section 3 describes the conjoint experiment, survey, and results. The AHP method and results are in section 4. Section 5 draws policy conclusions from the results.

2. PUBLIC SUPPORT FOR LAND PRESERVATION

Land preservation programs are not only popular, but are also well positioned to increase social welfare. The efficiency of public land preservation programs requires that support be generated solely by the nonmarket services of land. Gardner (1977) issued an early criticism of purchase of agricultural conservation easement programs, noting that such programs ought to be justified by something other than market-based agricultural objectives, such as soil quality or land suitability for agriculture, which are traded efficiently in markets. Social welfare is only enhanced when the external benefits provided by farmers and other owners of undeveloped land are internalized. The money paid from the public to landowners for these services encourages the optimal provision of undeveloped land. Though it has not been analyzed formally, policy makers also point out that land preservation funds do not "go away" but instead stay in the target rural communities and may help to accomplish other policy goals.

2.1 Attributes and Qualities of Preserved Land

Our perspective of public support for land preservation identifies four general sources, corresponding to the nonmarket attributes of preserved land. These attributes and

qualities are presented visually in figure 5 on page 20. One attribute of preserved land arises from its nonmarket **agricultural** services, defined by such qualities as keeping farming as a way of life, providing locally grown food, and promoting an important industry. Preserved land also provides the nonmarket **environmental** services of preserving natural places, protecting ground and surface water quality, and protecting wildlife habitat. Preserving breaks in the built environment and scenic quality describe the nonmarket services of the **open space** attribute. Finally, preserved lands provide nonmarket **growth control** services, such as preserving rural character and slowing development. These attributes correspond to lands that are actually preserved by Delaware's program and are mainly in line with the attributes assessed by researchers in other states.

2.2 Selected Studies on the Nonmarket Services of Preserved Land

Previous studies sought initially to identify, and later measure and compare, the sources of support for PDR programs. Prior to the 1980s, research in this area classified the various types of services provided by preserved farmland and open space and assessed the coherence of public intervention in the market for these services. In a study of open space, Berry (1976) discusses six highly interdependent sources of value: utility, functional, contemplative, aesthetic, recreational, and ecological. Berry's (1976) work, in effect, distinguishes active use values (recreational) from passive use values (aesthetic) and nonuse values (contemplative). Effort is also made to distinguish ecological value that is readily valuable to humans (functional) from that which is not (ecological). Gardner (1977) offered a classification for protected farmland services that was divided into four interdependent characteristics: food sufficiency, local effects of agricultural industry, open space and environmental amenities, and more efficient urban development. Gardner (1977) argued that markets efficiently provide all these services, except perhaps open space and environmental amenities. This argument may highlight an important disconnect between that which characterizes efficient policy and that which is actually being implemented by program managers. Indeed, a survey of planners in the metropolitan Northeast by Pfeffer and Lapping (1994) found that one half of respondents believe that the primary objective of farmland preservation is growth management. Nevertheless, empirical evidence exists of a suboptimal allocation of agricultural land, in terms of amenity benefits, in urban-influenced regions (Lopez, Shah, and Altobello 1994).

A growing body of literature has emerged either to measure or compare the nonmarket services of farmland, thereby assuming that the marketable services of farmland are correctly valued by markets. Measurement studies have used contingent valuation to value the nonmarket services provided by farmland or other protected open space, though the bundle of nonmarket services is somewhat unique to each study (Halstead 1984; Bergstrom, Dillman, and Stoll 1985; Beasley, Workman, and Williams 1986; Bowker and Didychuk 1994).

The comparison studies have used several methods to measure the sources of public support for PDR programs. Furuseth (1987) reports ordinal measures of support for various statements, which capture the main objectives of farmland preservation programs. Although Furuseth (1987) found support arising from agricultural, environmental, and open space objectives, the survey approach did not reveal the relative importance of each objective. Kline and Wichelns (1994) used an indirect

approach to measuring the sources of support, employing referenda data in Rhode Island and Pennsylvania to associate town-level support for PDR programs with town-level characteristics. Kline and Wichelns (1994) distinguished three attributes of preserved land, including environmental, agricultural, and growth control (open space was included in the environmental attribute). Kline and Wichelns (1994) argued that environmental and growth-control objectives are important and warn against considering only agricultural attributes when designing PDR program guidelines.

In a study most directly motivating the research presented in this paper, Kline and Wichelns (1996) used focus groups to develop a list of nine qualities of preserved farmland or open space. Kline and Wichelns (1996) then surveyed 515 respondents in Rhode Island to establish mean ratings of these qualities on a scale from 1 (not important) to 10 (most important). Eight of these qualities and their mean ratings are listed for comparison with our results in table 9. A factor analysis of the ratings data led Kline and Wichelns (1996) to place each quality into an attribute.

The empirical evidence suggests that PDR programs consistently garner a majority of public support (see Furuseth 1987 and Kline and Wichelns 1994, 1996). In another paper, Kline and Wichelns (1998) extended their results in two important ways. First, they argued that public access may not be necessary to deliver the services the public demands from preserved open space. Second, Kline and Wichelns (1998) used a binary choice conjoint analysis to identify the types of land uses the public wants preserved. Importantly, cropland and land adjacent to water were desired, while no preference could be identified for forestland and wetland. Rosenberger (1998) substantially replicates Kline and Wichelns' (1996) work, using data from Colorado, and extended the discussion of the cost-effective delivery of land preservation services to include private programs.

AHP offers a method for aggregating preferences in multiattribute utility theory (MAUT) problems where, prior to being surveyed, respondents may not have considered carefully the subtle trade-offs associated with environmental management. The MAUT basis is increasingly being employed in nonmarket valuation studies and other contexts as researchers seek to ask ever-more complex questions of the public (Gregory and Wellman 2001). As with other models of choice, MAUT has shortcomings (van den Bergh, Ferrer-i-Carbonell, Munda 2000; Gowdy and Mayumi 2001). Recently, Russell et al. (2001) found mixed empirical evidence about whether or not MAUT techniques improved the internal consistency of preference surveys.

There exist relatively few applications of AHP to environmental or natural resource problems, although the MAUT utility basis for AHP is well developed (Zahedi 1987). AHP studies of these problems tend to survey a relatively small number of experts or professional resource managers: 5 respondents in Peterson, Silsbee, and Schmoldt (1994); 12 respondents in Alho and Kangas (1997); and a small, unspecified number in Stagg and Imber (1990). Other studies used stakeholders (18 respondents in Mawapanga and Debertin 1996) or participants in an interest-group role-playing exercise (20 respondents in Willett and Sharda 1995). The main extension of this report is to apply AHP to a comparatively large sample of the public to investigate their preferences. AHP reveals the relative weights the public places on the environmental, agricultural, growth control, and open-space attributes. AHP is also used to identify the relative weights the public places on qualities within each of these four

attributes. The results of the AHP methodology are then compared to the results of the conjoint analysis and those of Kline and Wichelns (1996).

3. MEASURING SUPPORT USING CONJOINT ANALYSIS

A conjoint design asks respondents to make trade-offs by evaluating different bundles of attributes for a particular good. By comparing these bundles, an analyst can decompose overall responses into measures of the relative importance for each attribute in the bundle. The logic behind conjoint analysis is that consumers do not make decisions about a product by evaluating one feature at a time. Rather, they tend to evaluate the entire bundle of attributes of a particular product. For example, when purchasing an automobile, the attributes of make, model, color, price, reliability, and style are important considerations, among other things. When shopping, the consumer attempts to balance these considerations when viewing cars on the lot. A person may say that he or she wants a white car, but may trade the color off for other factors such as price or availability. Traditional survey methods often ask consumers to evaluate attributes one at a time. While these methodologies yield useful information, they fail to identify the relative importance of various attributes and the trade-offs that are made when a bundle of attributes is presented. The conjoint design attempts to disentangle the importance of attributes through an experimental design and statistical analysis.

Conjoint analysis was developed within psychology (Luce and Tukey 1960) and is heavily used within the field of marketing research. Increasingly, conjoint analysis is being used within the discipline of applied economics. A typical conjoint survey asks the respondent to evaluate a bundle of attributes (a profile) of a particular good. By comparing various bundles, the analysis teases out the relative importance of each attribute when compared to the other attributes over different attribute levels.

3.1 Conjoint Experimental Design

This study analyzes public preferences for preserving undeveloped land, using the following attributes: **price**, **acreage**, **forest cover**, **natural open space**, **cropland**, and **rate of growth**. Each attribute is measured at various levels (table 1). The levels provide a range for each attribute that is consistent with the design, previous research, and actual preserved parcels in Delaware. The quantitative measures of cropland, forestland, and wetland/open space acres proxy for the agricultural, environmental, and open space attributes, respectively, discussed in section 2.1. The connection between attributes and their proxies was reinforced though a script read to the respondents and interaction with the enumerator.

Table 1
Conjoint Survey Farm Attribute Levels

Cost per Acre	Acreage	Cropland	Forest Cover	Natural Open Space	Rate of Growth
$400	40	100% Farmland	0% Forested	0% Open Space	Low
$1,000	120	50% Farmland	25% Forested	25% Open Space	Moderate
$1,500	200	0% Farmland	50% Forested	50% Open Space	High
$4,000	280				
$20,000	500				

This design does not include a full profile of all attribute levels for each respondent due to the length and complexity of such a survey. Rather, an orthogonal, main-effects design is used to enable us to ask each respondent to analyze a limited number of profiles for comparison. This approach allows us to examine stated choice across all respondents in order to assess the relative importance of all the attribute levels. The orthogonal design used in this project was performed using the "Conjoint Designer" package (Bretton-Clark 1996). The hypothetical "farms" created for this analysis have six independent attributes, with three attributes having five levels and four attributes having three levels. A five-block design is thought of as an additional control attribute (see Horner 2001). The design reduced the 10,125 unique profiles—or "farms"—to a more simplified format of 25 "farms", arranged into five blocks of five "farms" each. Each respondent examined five "farms" in one of the blocks.

3.2 Conjoint Survey Procedures

The conjoint survey was administered via face-to-face, intercept interviews at Department of Motor Vehicle (DMV) locations throughout Delaware. The DMV-intercept approach was used in Kline and Wichelns (1998) and provides a relatively inexpensive mechanism for meeting an approximately random cross section of Delaware residents. Respondents were approached in the drivers license renewal areas. This minimizes a potential bias with intercepting persons using the automobile registration area; owners of new cars are prescreened from the DMV registration process. Each participant was asked to review a block of "farms", presented as visual cards. The visual approach was used to emphasize the attributes, to provide visual reference for the unfamiliar and complex decision, and to aid the respondent in comparing "farms". Two examples of visual cards are included in this report (figures 1 and 2). The respondents were chosen at random at each of the four DMV locations in the state, and their participation was voluntary (see table 2). We were pleased with the overall response rate, given that the respondents were approached prior to their DMV business. However, the response rate at the Georgetown location was the lowest, at 30 percent.

The interview began with a brief description of the project. The respondent was then shown the five "farms" selected for them and asked to:

1. **Rank** the "farms" in order of their personal preference;

2. **Rate** each "farm" on a scale of –5 to +5 on willingness to pay the stated price; and

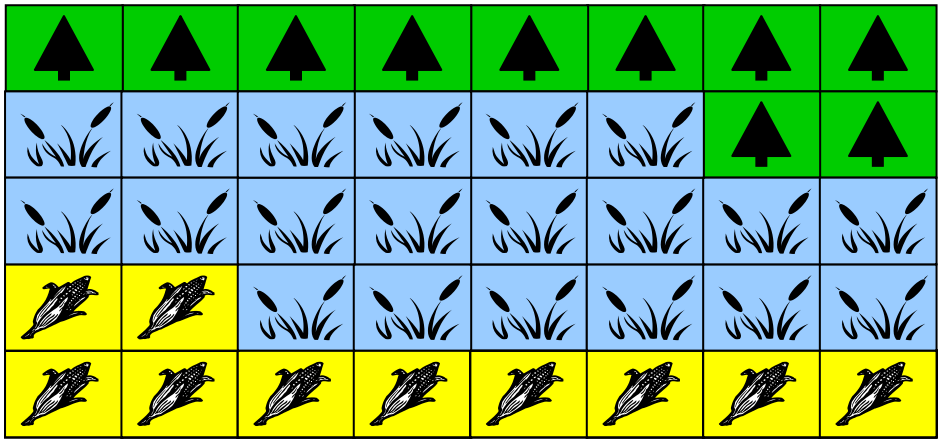
3. Answer seven demographic questions privately using a clipboard.

Table 2
Conjoint Survey Location, Date, and Response Rates

Location	Date	Interviews	Response Rate
Georgetown DMV	2/26/01 to 2/27/01	50	30%
Dover DMV	3/1/01 to 3/02/01	50	60%
Wilmington DMV	3/5/01 to 3/6/01	49	40%
New Castle DMV	3/8/01 to 3/9/01	50	70%

In this approach, respondents were reminded that zero represented indifference. The purpose of the graphical representations was to impress upon the respondent the difference in size between "farms" and to illustrate the land-use composition of each "farm". The respondents were told that the cards were hypothetical "farms" that could be found in Delaware, but were not suggestive of any actual farm in the state. Each "farm" was printed on 8.5" by 11" high quality paper and placed in a plastic sheet protector. Directly under each graphical representation was a text box indicating the "farm's" total acreage, a onetime household cost for preservation, and the risk of development in the surrounding area of the "farm". The amount of acreage in agriculture, forest, and wetlands/open space was represented in graphical boxes, where each block represented five acres. The onetime household cost for preservation was derived based on a cost of preservation per acre multiplied by the number of acres in the "farm" and then divided by the number of households in Delaware. This figure gave the respondent the average cost per household to preserve that particular "farm".

All potential respondents were read a brief phrase concerning the purpose of the survey and were given instructions as to what they would be asked to evaluate. A poster board was used during the preliminary contact, which included pictures of different kinds of agricultural and undeveloped lands with keys to the symbols in the "farms". All the pictures were taken in January 2001, shortly before the survey was administered.
The respondent was first asked to rank the five hypothetical "farms" in order of preference for preservation. An additional poster board enabled the interviewer to



Costs a one-time household tax of **$0.32** to preserve
Low risk of development in area
200 total acres

Figure 1
Conjoint Survey Sample Card for a Small, Mixed-Use "Farm"

position the "farms" in order of preference to allow the respondent to further evaluate the "farms". Once the preference order was established, respondents rated each "farm" on the scale of –5 to +5 based on their hypothetical willingness to pay the stated price for each "farm". In this scale, negative numbers corresponded with no willingness to pay and positive numbers with willingness to pay, while zero was designated as the point of indifference. The scale was explained to respondents by indicating that if they were willing to pay the onetime tax associated with the "farm" they should give the "farm" a positive rating or, conversely, if they were not willing to pay they should give the "farm" and negative rating. After the rankings and ratings were recorded, respondents were asked to complete seven additional questions which dealt with their demographic attributes, whether they had visited a farm in the past three years, and an overall level of concern about land preservation in Delaware.

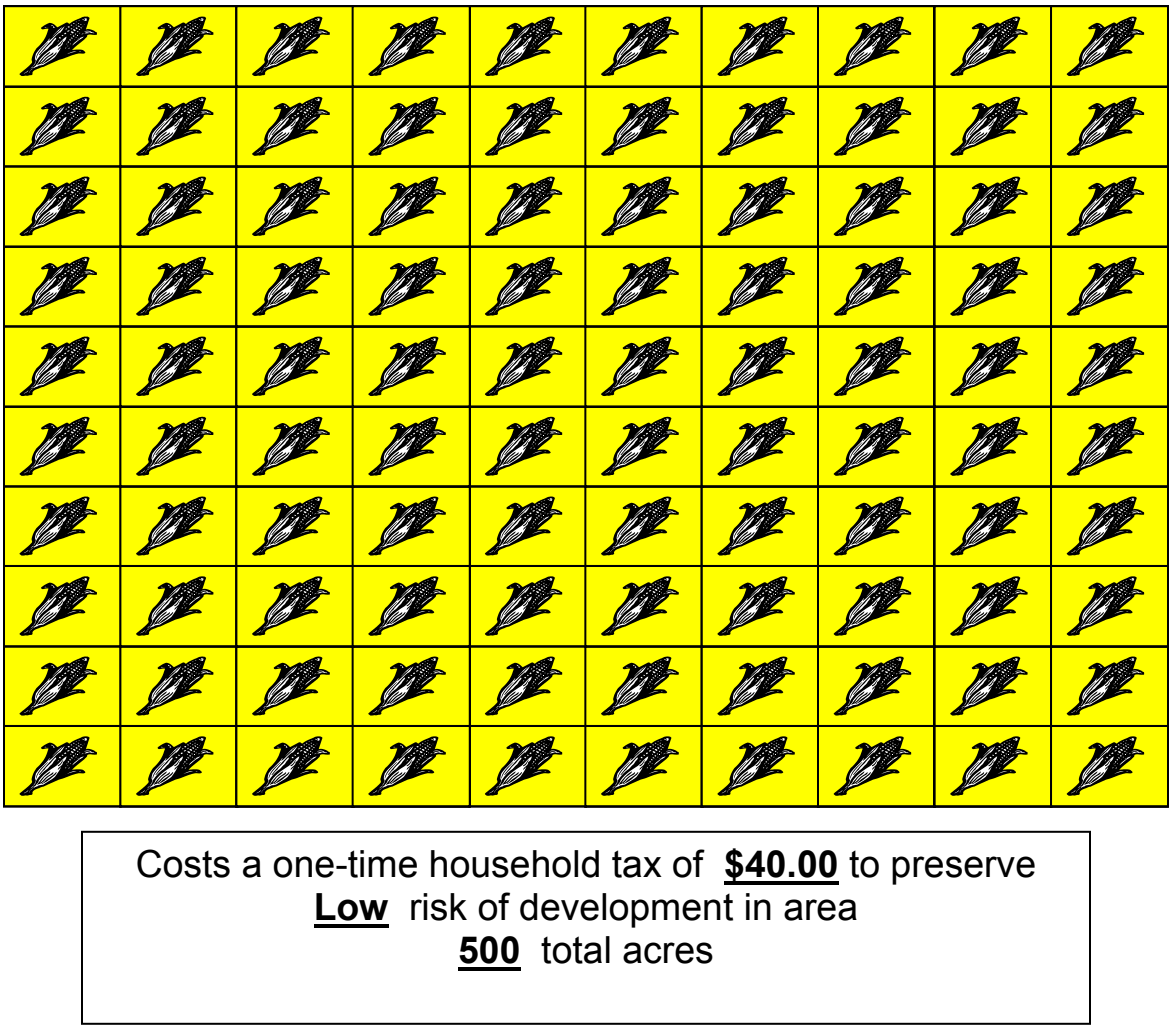


Figure 2
Conjoint Survey Sample Card for a Large, Agricultural-Use "Farm"

3.3 The Conjoint Sample

In total, 199 Delaware residents responded to the conjoint survey for an overall response rate of 44.8 percent. Nonresponse occurs when a person refuses to participate after being asked. The survey instrument is presented in figure 4. The highest response rate was found in the New Castle County DMV and the lowest was in the Sussex County facility (see table 2). The Sussex County location was least conducive to interviews due to space constraints and set-up limitations and, as a result, more people refused to participate at this location. The interviews took place between February and March of 2001.

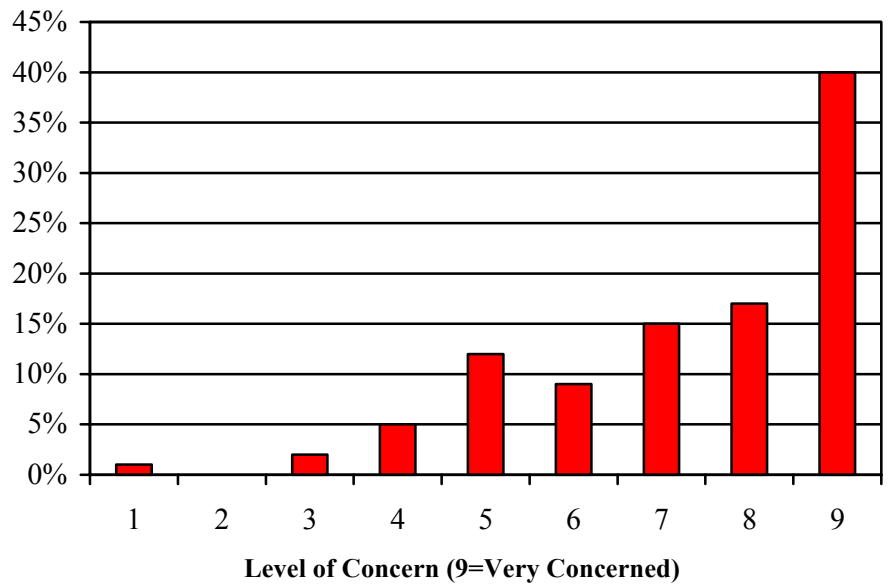


Figure 3
Conjoint Survey Respondent Concern About Land Preservation in Delaware

While the sample reflects different locations within the state, it is not weighted in proportion to the residents within Delaware. In essence, the survey oversampled residents of Kent and Sussex County relative to their populations in the state. To assess this bias, two dummy variables representing county of residence are included in the models. Subsequent statistical tests indicate that there are no statistical differences among respondents' ratings by county of residence.

Of the 199 respondents to the survey, 41 percent were female and the average age was 46 years. The majority of the respondents indicated that they owned their own home (73 percent) and most indicated that they had visited a farm in the last three years. The respondents were also asked about their level of concern about land preservation in Delaware. The scale used ranged from of 1 to 9, where 1 represented "Not Concerned" and 9 represented "Very Concerned". The average rating was 7.9, and 40 percent of the respondents chose the highest level of concern (see figure 3). The high level of concern of this group is consistent with other Delaware studies of land use.

On a scale of –5 to 5, the average rating across all of the "farms" was 3.2 indicating high support for preservation. This also indicates high levels of support and that on average the respondents were willing to pay to preserve the "farms". This average is surprising given the relatively high level of funding required to preserve some of the "farms".

FARMLAND PRESERVATION SURVEY

"The University of Delaware is surveying residents in the state to see what kinds of farms, if any, the public would like to see preserved. Being preserved means a farm could not be sold for future development and would remain "as is." If you have 5 minutes to spare, this survey asks you to rank a series of five farms and then rate them according to your preference. Each card that you will be given depicts a hypothetical farm. These farms all differ in size, a one-time household tax to preserve the farm, and the general rate of development in the area where the farm happens to occur. Each farm also differs in percentage of forested area, natural open space, and agricultural cropland. The green blocks represent forested land, the blue blocks represent a natural open space area, and the yellow blocks represent agricultural cropland. The hypothetical cost to preserve a farm is a one-time household tax. This hypothetical tax would be in addition to your present state taxes and would go to the state's purchase of development rights program. There are no right or wrong answers and all information is confidential and anonymous. Would you like to participate?"

How likely are you to preserve a farm? If you are willing to pay the given cost to preserve a farm, give it a positive rate (**+5 being the highest**). If you are not likely to pay the given cost to preserve a farm, give it a negative rate (**-5 being the lowest**). If you are indifferent in preserving a farm, give it a rating of **zero (0)**.

BLOCK #_____

MOST PREFERRED FARM	#_____	SCORE _____
2nd RANKED FARM	#_____	SCORE _____
3rd RANKED FARM	#_____	SCORE _____
4th RANKED FARM	#_____	SCORE _____
LEAST PREFERRED FARM	#_____	SCORE _____

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

6) Please mark the appropriate DMV location:

1 □ GEORGETOWN 2 □ DOVER 3 □ NEW CASTLE 4 □ WILMINGTON

7) Sex: 1 □ MALE 2 □ FEMALE

8) Do you own or rent your home? 1 □ OWN 2 □ RENT

9) What year were you born? _____

10) Which range best describes your household income level?

1 □ under $25,000 3 □ $50,000 to $74,999 5 □ $100,000 or over

2 □ $25,000 to $49,999 4 □ $75,000 to $99,999

11) How often have you visited or been on a farm in the past 3 years?

1 □ never 3 □ seldom (2-3 times) 5 □ often (6 or more times)

2 □ once 4 □ occasionally (4-5 times) 6 □ live on a farm

12) Are you concerned with the issue of land preservation in Delaware? (Circle one)

1 2 3 4 5 6 7 8 9
(not concerned) (concerned) (very concerned)

All information is kept confidential. Thank you for participating in this survey!

Figure 4—Conjoint Survey Instrument

3.4 Conjoint Statistical Modeling

The data are analyzed using several different models with different assumptions about the ratings. Alternative models provide a check on the validity of each approach and provide more confidence in the overall approach. The models include a two-tailed tobit, an ordered probit model, and a grouped regression. All models are estimated using LIMDEP (version 7). Each approach is described below.

Two-Tailed Tobit Model. Ordinary Least Squares (OLS) assumes that the dependent variable is measured continuously. In practice, many times the dependent variable is measured on a scale that is less than continuous and may be censored on the upper end, lower end, or both ends. The rating is the dependent variable in the conjoint model and may be censored in both the upper and lower ends of the rating scale. Recall that the respondent was asked to respond to a rating index that went from –5 to +5. While this scale is reasonable in a survey question, it may pose problems in subsequent analysis. The respondent may have wanted to score a lower or higher rating, but was restricted by the form of the question. In this case, the OLS model will yield biased results, with the bias towards one or both of the censored values. The two-tailed tobit (tobit) model yields results that can be interpreted similarly to OLS, but estimates the effects of independent variables on a dependent variable while conditioning some parameters on the estimated probability associated with censoring on either end.

Grouped Data Regression Model. An alternative approach to the tobit model is the grouped data regression (grouped) model. Grouped models are "used when the range of the dependent variable is completely censored" (Greene 1998, p. 703). This is the case when the data are ordered categories and the limits are known. In our model, integers are used for ratings, though the intervals between the integers are censored. The grouped model uses the additional information of the threshold values of the ordered categories to help with estimation and thus provides better estimates of the respondent preferences between the ordered categories. The coefficients for the grouped and tobit models are directly comparable.

Ordered Probit Model. The ordered probit model is based on the standard normal distribution and is estimated via a maximum likelihood function. The ordered probit model is appropriate when the data are ordered categories, as is the case with the rating scale used in the conjoint survey. The ordered probit model assumes that the coefficients for the independent variables are the same across all levels of the dependent variable, and that the only differences are due to differences in the intercepts. As a result, the ordered probit model includes additional intercept terms in the model.

Each of these models assumes cardinal utility, which is not recognized as theoretically valid by most economists. Nevertheless, the relative differences among the attributes ought to be indicative of general trends and effects. There are more acceptable ways to estimate these data in accordance with the ordinal properties of utility theory. Mackenzie (1993) showed that the statistical results varied little between the cardinal and ordinal measures, though the cardinal measures were more precise. Accordingly, we estimate ratings data as if they are cardinal measures.

It is important to note that the unit of analysis in all the models in the conjoint

study is the parcel that was evaluated. Although the survey was administered to 199 people, each person was asked to evaluate five parcels in a single block. The five assessments yielded 995 useable data points for the subsequent analysis. In a real sense, the data are similar to a repeated measures design, with five measurements for each subject. To control for possible bias of the design, we include dummy variables that represent the block of "farms" (five blocks represented by four dummy variables). Furthermore, to control for subject evaluation bias, we include a mean rating variable that reflects the mean rating the subject gave for the other four "farms" in the block. This variable reflects the tendency for some subjects to be an "easy" or "tough" evaluator.

Variables in the model. The variables in the model are described below. The dependent variable in both models is the respondent rating for a particular "farm", which has a range of –5 to +5.

HHCOST – The household cost associated with a particular "farm". The cost is calculated as the total cost to preserve the "farm" divided by the number of households in Delaware.

AGACRE – The number of acres in the parcel that are in agricultural production. This variable is calculated as the total number of acres in the "farm" multiplied by the percentage of cropland (either 0 percent, 50 percent, or 100 percent).

FORACRE – The number of acres in the parcel that are forestry. This variable is calculated as the total number of acres in the "farm" multiplied by the percentage of forestland identified in the "farm" (either 0 percent, 25 percent, or 50 percent).

OPENACRE – The number of acres in the parcel that are open space. This variable is calculated as the total number of acres in the "farm" multiplied by the percentage of land in natural open space identified in the "farm" (either 0 percent, 25 percent, or 50 percent).

BLOCK – The set of indicator variables representing the block from which each "farm" is drawn. To check to see if there is any influence due to the block of "farms" a respondent received, we included Block dummy variables into the model – BLOCK1, BLOCK2, BLOCK3, and BLOCK5. The fourth block became the reference category.

GROWTH2 – One of the attributes of each "farm" was the rate of growth (i.e., residential and commercial development) around the parcel – low, moderate, and high). This variable is an indicator variable coded one if the growth was moderate and zero otherwise. The reference category is low growth.

GROWTH3 – This variable is an indicator variable coded one if the growth was high and zero otherwise. The reference category is low growth.

SUSSEX and NEW CASTLE – Two indicator variables are included to represent the respondent's county of residence. SUSSEX stands for Sussex County and NEW CASTLE represents New Castle County. The reference county is Kent County. The county variables are included to control for any bias due to the sampling procedure, which included an equal amount from each county.

RMEANOBS – An additional variable is included in the analysis that reflects the respondent's tendency for rating "farms".

RMEANOBS is the average rating of the respondent for all other "farms" in the block (excluding the "farm" for the particular observation). The inclusion of RMEANOBS in the model provides for a measure of the respondent's consistency in rating parcels and his or her tendency to differentiate between parcels. We also interpret this coefficient as a measure of the overall good will of the program. Our use of this variable is similar to Mackenzie (1993) with the enhancement that the mean measure excludes the current "farm" under consideration.

3.5 Conjoint Statistical Results

Results for the three models are given in table 3. Although the coefficients cannot be directly compared due to the type of model, there is considerable consistency in statistical significance across all three models. All show a significant overall fit of the model. The coefficients all agree in sign, and each model indicates the same level of significance for the coefficients, with a few exceptions (significant at the $p < 0.10$ rather than $p < 0.05$ level). All the models show that HHCOST, AGACRE, FORACRE, and RMEANOBS are significant at the $p < 0.01$ level, while GROWTH2 is significant at the $p < 0.05$ level. In terms of the control variables, only BLOCK2 is significant at the $p < 0.05$ level. The coefficients for the county variables show that there is no significant difference by county and reflect a lack of bias with the sampling procedure.

The coefficient for HHCOST is negative, which indicates that parcel rating is inversely sensitive to price. The coefficients for AGACRE and FORACRE show that respondents reacted positively to preservation of land for agriculture and forest. However, the lack of significance for OPENACRE does not allow us to conclude that there is support for preservation of wetlands/open space. The RMEANOBS variable was significant and positive, indicating strong overall good will for land preservation by respondents from Delaware.

3.6 Willingness to Pay Estimates

Although these results do not reveal the entire demand curve for these nonmarket services—and thus the public's willingness to pay for all undeveloped parcels in Delaware—the results do offer insight into the public's value for preservation programs, in general, and the next few parcels that may be preserved. Following Mackenzie (1993), we calculate the willingness to pay (WTP) for a particular parcel as the marginal rate of substitution between HHCOST and other variables in the model. WTP is expressed as the ratio of the model coefficients:

$$WTP_i = -\frac{b_i}{b_{HHCOST}}$$

where b_i is the model coefficient for the ith variable and b_{HHCOST} is the coefficient for HHCOST.

The coefficients from the tobit model are used for WTP estimates. Following Mackenzie (1993), we constructed 95 percent confidence intervals around these estimates of WTP. We also convert household WTP to state-level WTP by multiplying household WTP by the number of households in Delaware that was used in the original cost per acre conversions (250,000 households). These estimates are for the sample parcels and their marginal values to the public and account for their external benefits.

It is important to note that the figures are estimates and that the conjoint method does not fully account for how these values decline as more and more acres are enrolled.

Table 3
Conjoint Survey Statistical Results

Variable	Tobit Model Coefficient (Standard Error)	Grouped Regression Coefficient (Standard Error)		Ordered Probit Coefficient (Standard Error)
Constant	0.7997	0.8207*		1.3883***
	(0.4943)	(0.4502)		(0.1757)
HHCOST	-0.1921***	-0.1766***		-0.0549***
	(0.0210)	(0.0191)		(0.0063)
AGACRE	0.0058***	0.0054***		0.0017***
	(0.0016)	(0.0014)		(0.0005)
FORACRE	0.0090***	0.0083***		0.0025***
	(0.0019)	(0.0018)		(0.0006)
OPENACRE	-0.0010	-0.0009		-0.0002
	(0.0019)	(0.0018)		(0.0006)
BLOCK1	0.7312*	0.6479*		0.1829
	(0.4251)	(0.3877)		(0.1199)
BLOCK2	-0.8851**	-0.7777**		-0.2804**
	(0.4046)	(0.3690)		(0.1311)
BLOCK3	-0.8316*	-0.7935**		-0.2539**
	(0.4356)	(0.3970)		(0.1255)
BLOCK5	-0.2275	-0.2130		-0.0722
	(0.4278)	(0.3902)		(0.1234)
GROWTH2	-0.8163**	-0.7535**		-0.2438**
	(0.3691)	(0.3366)		(0.1182)
GROWTH3	-0.3423	-0.3326		-0.0881
	(0.2891)	(0.2636)		(0.0818)
SUSSEX	-0.2055	-0.1746		-0.0778
	(0.3551)	(0.3237)		(0.1024)
NEWCASTLE	0.0928	0.0805		0.0166
	(0.3146)	(0.2869)		(0.0912)
RMEANOBS	1.3659***	1.2465***		0.3881***
	(0.0758)	(0.0690)		(0.0231)
Sigma	3.5126	3.1818	Mu1	0.3124***
	(0.1267)	(0.1142)		(0.0808)
Log Likelihood	-1566.959	-1513.5980	Mu2	0.5504***
				(0.0964)
			Mu3	0.6777***
				(0.1007)
			Mu4	0.8357***
				(0.1053)
			Mu5	1.1318***
				(0.1124)
			Mu6	1.4088***
				(0.1161)
			Mu7	1.7431***
				(0.1186)
			Mu8	2.1746***
				(0.1213)
			Mu9	2.5717***
				(.1233)

n=995
* p < .10 for two-tailed test, ** p < .05 for two-tailed test, *** p < .01 for two-tailed test

The most precise interpretation is that the estimates are only relevant for the **first** "farm" enrolled after the survey occurred. Subsequent "farms" should have a lower value, according to the law of demand. The results of these estimates are in table 4.

3.7 Interpretation of Willingness to Pay Results

Great care is needed to interpret these figures. Several qualifications are in order:

The results are most accurate for a small number of new parcels enrolled in the program.

Thus, for the next several parcels preserved by the Delaware Agricultural Lands Preservation Program, the WTP results ought to be relatively similar to actual, unobserved values among residents. For large numbers of parcels added under the program, the results may or may not be representative, though we do know from the law of demand that they should be lower than the WTP estimates for the next several parcels enrolled.

The results only suggest Delawareans' values—not those of residents of other states—and thus constitute a lower bound on value.

If residents from other states value the preservation services in Delaware, then these values are likely to be higher. For instance, Delaware is an important stop for migratory birds. If bird watching activities by residents in other states are enhanced by Delaware's land preservation activities, then the welfare of out-of-state residents could be added to the figures presented here.

These results may be overstated due to the hypothetical nature of the choice.

Efforts were made during enumeration to impress upon respondents the opportunity cost of their choice. Nevertheless, it is impossible to remove fully incentives for respondents to answer hypothetical questions strategically.

Table 4
Conjoint Survey Willingness-to-Pay Results (Using the Tobit Results)

	Household Willingness to Pay			State Aggregate Willingness to Pay		
VARIABLE	**95% Lower**	**Mean WTP**	**95% Upper**	**95% Lower**	**Mean WTP**	**95% Upper**
Constant	($0.88)	$4.16	$9.59	($221,214)	$1,040,642	$2,398,330
AGACRE	$0.02	$0.03	$0.05	$3,827	$7,586	$11,451
FORACRE	$0.03	$0.05	$0.07	$6,596	$11,728	$17,934
OPENACRE	($0.03)	($0.01)	$0.02	($6,259)	($1,287)	$3,756
BLOCK1	($0.54)	$3.81	$8.33	($136,030)	$951,443	$2,083,219
BLOCK2	($9.05)	($4.61)	($0.49)	($2,261,423)	($1,151,753)	($121,323)
BLOCK3	($9.10)	($4.33)	$0.12	($2,273,806)	($1,082,135)	$29,151
BLOCK5	($5.71)	($1.18)	$3.24	($1,428,259)	($295,980)	$809,264
GROWTH2	($8.15)	($4.25)	($0.50)	($2,036,901)	($1,062,210)	($124,564)
GROWTH3	($4.87)	($1.78)	$1.19	($1,217,930)	($445,471)	$297,034
SUSSEX	($4.83)	($1.07)	$2.60	($1,207,791)	($267,347)	$649,821
NEWCASTLE	($2.78)	$0.48	$3.79	($695,199)	$120,788	$948,539
RMEANOBS	$5.72	$7.11	$9.15	$1,430,430	$1,777,387	$2,286,832

Keeping the qualifications in mind, the results suggest that Delawareans place a high value on the program for land preservation.

First, there is an important "goodwill" value associated with an ongoing program for land preservation. The constant and RMEANOBS measure these goodwill benefits because they capture, respectively, the unexplained support and the average support in the model.

> *The present value of having and sustaining an active farmland preservation program is likely between $1,209,216 and $4,685,162, assuming low growth parcels are enrolled.*

The public prefers that parcels preserved be in low growth areas. This goodwill value is lowered as the proportion of high and moderate growth risk parcels are enrolled.

One could also infer the net value of parcels that entered the program immediately following the survey in 2000. For example,

> *A 1,000-acre farm may provide net benefits between $1,327,000 and $8,951,000.*

This range assumes it costs $2,500,000 to buy the development rights to this parcel, which provides between $3,827,000 and $11,451,000 in benefits. Other similar calculations can be made, as long as they represent the initial parcels enrolled following enumeration.

4. MEASURING SUPPORT USING AHP

Saaty (1980) developed AHP as a flexible, yet structured methodology, which enables an individual (or a group of individuals) to define a specific problem and derive a solution based on the individual's (or the group's) own experience of that problem. This study uses AHP for two major reasons. First, it allows for the simultaneous consideration of four farmland attributes and ten qualities to prioritize reasons for support of land preservation. Second, the "decision maker" may be a sample of Delawareans, which allows for the inference of public preference. This section describes the AHP theory, survey of 129 randomly selected Delawareans, and the results.

4.1 AHP Theoretical Background

Zahedi (1987) proposed the existence of an underlying utility foundation in AHP. Zahedi (1987) showed that the process of selecting alternatives is consistent with maximizing a respondent's uni-attribute utility function or a respondent's multi-attribute utility function (MAUT). His results implied an ability to synthesize AHP and utility theory's utility maximization criterion to solve decision problems. The uni-attribute theory can provide results consistent with AHP, but it is only concerned with finding the best alternative with no ability to rank all alternatives. MAUT provides weightings and relative rankings of alternatives; however, these relative rankings are based on probabilistic outcomes of alternatives. For the problem at hand, the alternatives are not probabilistic in nature. That is, the four farmland attributes do not randomly occur according to any a priori probability distribution. Rather, all four farmland attributes are important, but to varying degrees, as reasons for Delaware residents to support land preservation. The relative degree of importance of the four farmland attributes is quantified through AHP methodologies.

The first step in utilizing AHP to assess quantitatively the relative degree of importance of the four-farmland attributes is

to form a hierarchy of farmland attributes and qualities. The hierarchy accounts for all four general farmland attributes as well as specific qualities within each general attribute. Survey respondents make two types of pairwise comparisons: (1) pairwise comparisons of the specific qualities within each general attribute and (2) pairwise comparisons of the general attributes. The survey group's pairwise comparisons are synthesized into five comparison matrices (one comparison matrix for qualities within each of the four general attributes and one comparison matrix of the general attributes). Each of the five matrices assumes the following form:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad (1)$$

where a_{ij} represents the pairwise comparison rating for attribute i and attribute j. Four main axioms underlie the theoretical validity of the comparison matrix A (Saaty 1986):

1. *Reciprocal Comparison:* If $a_{ij} = x$, then $a_{ji} = 1/x$ where $x \neq 0$.

2. *Homogeneity:* If characteristics i and j are judged to be of equal relative importance then, $a_{ij} = a_{ji} = 1$ with $a_{ii} = 1$ for all i.

3. *Independence:* When expressing preferences under each criterion, each criterion is assumed to be independent of the properties of the decision alternatives.

4. *Expectations:* When proposing a hierarchical structure for a decision problem, the structure is assumed to be complete.

Table 5 shows a hypothetical comparison of three qualities within the environmental attribute. For example, the pairwise comparison of wildlife habitat versus water quality represents a survey respondent's opinion that wildlife habitat is slightly more important than water quality as a reason for supporting land preservation through Delaware's PDR program. Similarly, the comparison matrix indicates a rating of 1/3 on the pairwise comparison of water quality versus wildlife habitat to reflect the reciprocal comparison axiom stated above. Given this reciprocal property, only $n(n\text{-}1)/2$ actual pairwise comparisons are needed for an n x n comparison matrix.

In an ideal case, perfect consistency of individual or aggregate preference would exist when

$$a_{ik}\, a_{kj} = a_{ij} \quad \text{for all i, j, k} \qquad (2)$$

meaning that weights w_i and the numerical ratings a_{ij} satisfy

$$w_i / w_j = a_{ij} \text{ for all i, j .} \qquad (3)$$

Table 5
AHP Hypothetical Comparison Matrix for the Environmental Attribute

	Water Quality	Wildlife Habitat	Natural Places
Water Quality	1	3	7
Wildlife Habitat	1/3	1	2
Natural Places	1/7	1/2	1

Thus

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ . & . & \cdots & . \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix}. \qquad (4)$$

However, complete consistency in rating alternatives is rarely the case when subjectivity is involved. Saaty (1977, 1980) proposed the right eigenvector method that constructs the vector of priority weights and facilitates testing for inconsistency. For a case of perfect consistency,

$$A\mathrm{W} = \mathrm{nW} \qquad (5)$$

where A is the n x n comparison matrix and $\mathrm{W} = (w_1, w_2, \ldots w_n)^T$. In reality, a certain degree of inconsistency exists among subjective pairwise comparisons of items. Therefore, Saaty (1977, 1980) proposed the following redefinition of

$$A\mathrm{W} = \lambda_{\max}\mathrm{W} \qquad (6)$$

where $\lambda_{\max}$ is the maximum eigenvalue (Perron root) of matrix *A*. Saaty (1977, 1980) proposed that the principle right eigenvector W be computed by raising the matrix *A* to increasing powers of k and normalizing the resulting system:

$$W = \lim_{k \to \infty} \frac{A^k e}{e^T A^k e} \qquad (7)$$

where e = (1, 1, ... , 1). If the weighted values converge on the kth iteration, then the final weight vector W is defined as

$$W = \frac{A^k e}{e^T A^k e} \qquad (8)$$

The maximum eigenvalue, $\lambda_{\max}$, can now be determined by

$$\lambda_{\max} = \sum_i \sum_j a_{ij} w_i . \qquad (9)$$

Saaty (1977, 1980) proved that $\lambda_{\max} \geq n$, which enables AHP to test the degree of inconsistency in a respondent's ratings. The quantity $\lambda_{\max} - n$ measures the degree of inconsistency within the *n* x *n* matrix *A*. The consistency index for an *n* x *n* comparison matrix with largest eigenvalue, $\lambda_{\max}$, is

$$CI = \frac{\lambda_{\max} - n}{n - 1}. \qquad (10)$$

Denote the consistency index for a randomly generated *n* x *n* matrix as *RI*. Using the *CI* and *RI* indexes, Saaty (1980) defined the consistency ratio as $CR = CI / RI$. Values of $CR \leq 0.1$ are desired. Higher CR values imply an unacceptable level of inconsistency and respondents would be asked to revise their pairwise comparison ratings.

The a_{ij} values are quantitative measures of each respondent's judgment concerning the relative degree of importance of quality/attribute i over quality/attribute j. In this study, the "decision maker" is actually a group of 129 randomly selected survey respondents (all Delaware residents). In a case of group decision making, Golden et al. (1989) suggest the geometric mean as a method of calculating the overall average comparison rating across all respondents. Aczel and Saaty (1983) proved that the geometric mean is consistent and upholds the four axioms underlying the AHP process. Given *m* survey respondents, a composite judgment of their a_{ij} values, is the geometric mean of the a_{ij} values which is defined as

$$a_{ij}^{*} = \sqrt[m]{\prod_{k=1}^{m} a_{ij}^{k}} \qquad (11)$$

Using the geometrically averaged a_{ij}* values, a set of numerical weights w_1, w_2, ..., w_n are computed to represent the relative degree of importance of the qualities within each general attribute. These numerical weights represent a vector of relative importance weights with $\Sigma\, w_i = 1$. Also, a set of numerical weights v_1, v_2, ..., v_n are computed to represent the relative degree of importance of the attributes. These weights represent a vector of relative-importance weights for the attributes with $\Sigma\, v_i = 1$. The AHP is processed using EXCEL and is checked for inconsistent preferences at the aggregate level.

4.2 AHP Survey Procedures

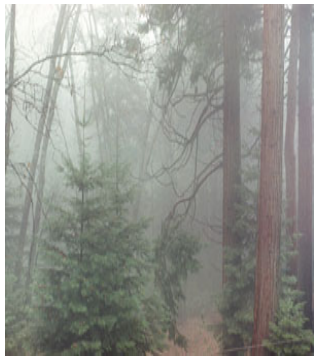
One hundred-twenty nine Delaware residents were interviewed to reveal their collective preference for land preservation. The enumerators intercepted and solicited the participation of respondents and then offered a short statement for respondents to read describing in general terms the existing PDR program in Delaware. Two graphical aids were used to help respondents conceptualize the various services provided by protected land. First, enumerators showed respondents an 8 ½-by-11-inch sheet (figure 6) that used icons and a picture to show how protected agricultural land in Delaware may contain forestland, farmland, or wetlands. Then, the enumerators described the comparisons to be made by using a large poster (40 x 30 inches) with the qualities grouped with each attribute. This poster is reproduced in a scaled-down version in figure 5. Each quality was represented with words and a pictorial representation. All materials were available to respondents to read at their own pace and for later reference. At all times, the enumerators attended to the respondent and answered any questions. When respondents were comfortable with the context, the enumerators asked them to make pairwise comparisons and rank the intensity of their preference: the four attributes and then ten total qualities of each attribute. The survey concluded with several demographic and opinion questions.

As a result of pretesting the survey instrument, two additional qualities were added for the final survey to the eight from Kline and Wichlens (1996): "important industry" as a quality of the agricultural attribute and "breaks in the built environment" as a quality of the open space attribute. Although the attributes are presented generically—with little descriptive material—enumerators reported that respondents seemed to understand the choices. Minimal descriptive material allows the respondents to bring their own experience and perspective to the choice. Empirical studies explaining landscape perceptions are available elsewhere (for instance, Zube and Simcox 1989).

Despite their apparent understanding of the choice to be made, enumerators reported that many respondents objected to the difficulties in trading off these attributes and qualities. One suspects that the source of these objections may arise from the subtlety of the trade off to be made. Moreover, because the "goods" are not exchanged on markets, respondents were likely unfamiliar with the trade-off. These problems were mitigated by two factors. First, the survey instrument allows respondents to express indifference between two attributes or qualities. Second, the analysis using AHP did not find inconsistency of preference in aggregate. All of the geometrically averaged comparison matrices passed the test for inconsistency. Thus, the aggregated comparison matrices will not demonstrate inconsistency.

Survey on Support for Delaware's Purchase of Development Rights Program

Environmental



Preserving

NATURAL PLACES

Source: Yahoo Picture Gallery
http://search.gallery.yahoo.com

Protecting ground and surface

WATER QUALITY

Source: The USGS
http://www.gsa.usgs.gov/ada/picturesmw.html

Protecting

WILDLIFE HABITAT

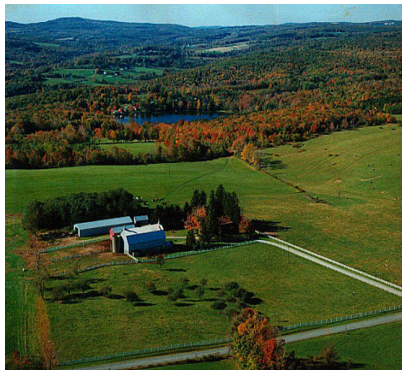
Source: Picture.com
http://www.thephotosite.com

Growth Control

Preserving

RURAL CHARACTER

Source: Picture.com
http://thephotosite.com



SLOWING DEVELOPMENT

Source: Yahoo Picture Gallery
http://search.gallery.yahoo.com

Agriculture

Keeping

FARMING AS A WAY OF LIFE

Source: Farmpicture.com
http://farmpictures.com

Providing

LOCALLY GROWN FOOD

Source: City of Waltham, Massachusetts
http://waltham-community.org

Promoting an

IMPORTANT INDUSTRY

Source: Farmpictures.com
http://farmpictures.com

Open Space

Preserving

BREAKS IN THE BUILT ENVIRONMENT

Source: Yahoo Picture Gallery
http://search.gallery.yahoo.com

Preserving

SCENIC QUALITY

Source: Farmpictures.com
http://farmpictures.com

Survey on Support for Delaware's
Purchase of Development Rights Program

Context

Since 1991 the Delaware Agricultural Lands Preservation Society has been combating sprawl by purchasing the development rights to farmland. The State pays farmers to keep farming as they always have, but allows the State to prevent the farmland, forestland, and wetlands on the farm parcel from being sold for nonagricultural uses—like housing developments. Participation in the program is entirely voluntary for farmers.

To date, Delaware has spent $55 million to buy the development rights to 54,000 acres of farmland, forestland, and wetlands on 152 farms.

We need your help. We want to know more about how you value these services and amenities provided by farmland, forestland, and wetlands. These land characteristics are of the following types:

(1) Environmental
(2) Growth control
(3) Open Space
(4) Agricultural

Please answer the survey—it should only take 10 minutes.

Figure 6
AHP Context

Survey on Support for Delaware's
Purchase of Development Rights Program

Typical Farm Parcel

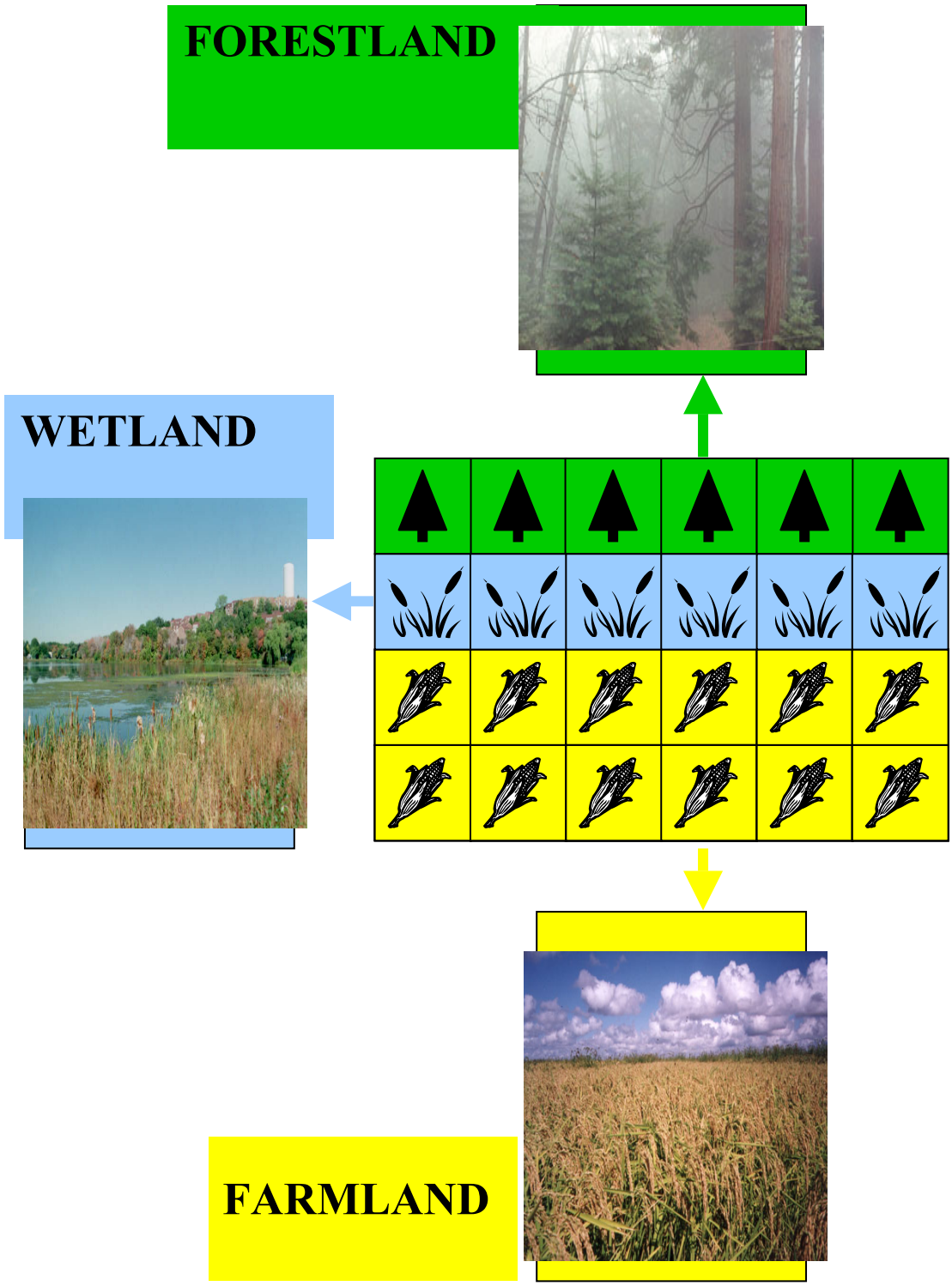


Figure 7
AHP Typical Farm Parcel

Survey on Support for Delaware's Purchase of Development Rights Program

Comparison Scale

Rating	Explanation of Relative Importance
1	Two characteristics are equally important
2	Between 1 and 3
3	Circled characteristic is slightly more important
4	Between 3 and 5
5	Circled characteristic is moderately more important
6	Between 5 and 7
7	Circled characteristic is much more important
8	Between 7 and 9
9	Highest possible degree of importance for the circled characteristic over the other

Figure 8
AHP Comparison Scale

Survey on Support for Delaware's Purchase of Development Rights Program

Directions: Please compare the following farmland parcel characteristics.

(1) **Circle the characteristic that is more important to you.**

(2) **Assign a rating (1-9) that reflects the degree of the importance of the circled characteristic over the other characteristic.**

				Rating
Environmental	Water quality	vs.	Wildlife habitat	1 – 9
	Water quality	vs.	Natural places	1 – 9
	Wildlife habitat	vs.	Natural places	1 – 9

				Rating
Growth Control	Rural character	vs.	Slowing development	1 – 9

				Rating
Open Space	Scenic quality	vs.	Breaks in the built environment	1 – 9

				Rating
Agricultural	Important industry	vs.	Locally grown food	1 – 9
	Important industry	vs.	Farming as a way of life	1 – 9
	Locally grown food	vs.	Farming as a way of life	1 – 9

				Rating
Parcel Characteristics	Environmental	vs.	Growth Control	1 – 9
	Environmental	vs.	Open Space	1 – 9
	Environmental	vs.	Agricultural	1 – 9
	Growth Control	vs.	Open Space	1 – 9
	Growth Control	vs.	Agricultural	1 – 9
	Open Space	vs.	Agricultural	1 – 9

	Please circle one choice				
Sex	Male	Female			
Do you own or rent your home?	Own	Rent	Other		
In what County do you live?	New Castle	Kent	Sussex		
How many times have you visited a farm in the last five years?	0	1 – 4	5 – 10	11 – 15	15+
Please rate your concern with the issue of farmland retention in Delaware?	1 2 3	4 5 6	7 8 9 10		
	Not concerned	Concerned	Very concerned		
Which category best describes your household income?	Under $25,000	$25,000 - $49,999	$50,000 - $74,999	Over $75,000	
In what year were you born?					

All information is kept confidential. Thank you for participating in this survey!

Figure 9—AHP Survey Instrument

4.3 The AHP Sample

A sample of 129 respondents, resulting in 1806 pairwise comparisons, was obtained in the spring of 2001 by intercept interview at one of four Delaware Department of Motor Vehicles locations. Enumerators intercepted respondents using the license-renewal services in an effort to achieve the broadest cross-section of the Delaware population. As with any sample, the critical benchmarks of quality center on determining whether nonresponse was a significant problem and whether the sample was representative of the decision-making population. These two issues are even more important in AHP because the nonstatistical analysis does not include an error term and thus the results have no uncertainty attached to them.

It is very difficult to determine if nonresponse—defined as a respondent who was asked to participate but refused—was a critical problem. The response rate was 54 percent, which is acceptable given that respondents were asked to participate before, after, or while waiting to finish their DMV business. As table 6 shows, males participated more frequently than females. Other than this, there is no way to know whether respondents differed in meaningful ways from nonrespondents. However, descriptive statistics of the sample at least offer insight as to whether nonresponse is likely to be a problem. The sample was not proportional to Delaware's population by county, though the final results are adjusted according to county population (table 8). New Castle County comprises 63.8 percent of the population but only 43.8 percent of the sample—a 20 percent under-representation. Sussex County was over-represented in the sample by 17.2 percent.

Table 6
AHP Sample Selection Statistics

	Female			Male			Total			
DMV Location	NR	R	Total	NR	R	Total	NR	R	Total	Response Rate (percent)
Wilmington, NCC	9	12	21	5	15	20	14	27	41	66
New Castle, NCC	12	9	21	7	17	24	19	26	45	58
Dover, KC	33	17	48	25	8	33	58	25	83	30
Georgetown, SC	9	24	32	10	27	37	19	51	70	73
Total	63	62	122	47	67	114	110	129	239	54
County of Residence										County Population (2000)
New Castle		23			33			56 (43.4%)		500,265 (63.8%)
Kent		16			9			25 (19.4%)		126,697 (16.2%)
Sussex		23			25			48 (37.2%)		156,638 (20.0%)
Total		62			67			129		783,600

NR=Nonrespondent, R=Respondent, NCC=New Castle County, KC=Kent County, SC=Sussex County

Table 7
AHP Demographics and Opinions by County of Residence

County	Home Owners (percent)	Age	Number of Visits to a Farm (last 5 years) 0 Visits (percent)	1 – 4 Visits (percent)	5 - 10 Visits (percent)	11 - 15 Visits (percent)	15 + Visits (percent)	Concern**
NCC	55.4	37.7*	9.3*	61.1*	14.8*	3.7*	11.1*	6.60*
KC	66.7*	42.2*	16.0	44.0	8.0	4.0	28.0	7.82
SC	83.3	47.6*	10.4	25.0	8.3	4.2	52.1	7.67
Sample Mean	68.0*	42.3*	11.0*	44.1*	11.0*	3.9*	29.9*	7.24*

NCC=New Castle County, KC=Kent County, SC=Sussex County
*Excludes missing values.
** Measures level of concern from 1-10.

Kent County was over-represented by only 3.2 percent. Table 7 shows that the county-related demographic differences may be important and warrant the adjustment of the final results. Respondents from New Castle County visit farms less frequently and show less concern about the issue of farmland retention than other Delawareans. Sussex County is highly agricultural and, not surprisingly, 52.1 percent of Sussex County respondents visited a farm more than 15 times in the past five years. Only 11.1 percent of respondents in New Castle County had visited a farm with that frequency. Overall, the nonrepresentative response pattern may bias the results in favor of the agricultural attribute.[3]

4.4 AHP Results

Overall, Delawareans are demanding all the attributes of preserved land. Nonetheless, marked preferences exist for the agricultural and environmental attributes. The AHP results are presented by county, in table 8, and at the State level, in table 9.[4] Also, in table 9, results from Kline and Wichelns (1996) are offered for comparison. To reinforce a point in the modeling, the AHP derives results based on geometric means of respondents' survey data. Thus, the results can be interpreted as an expression of public preference in Delaware. As such, land preservation policy that meets public demand—at the least cost—would be efficient. An alternate approach to AHP, which is not pursued here, estimates multi-attribute preference across individuals and then aggregates using a majority-voting rule. The County results correspond to expectations, given the varying patterns of growth across the state. Sussex County is the geographically largest, least-densely populated, and most important agricultural county in Delaware. It is also the fastest growing county in the state with acres in residential land use increasing 158 percent from 1984 to 1997 (Duke, Mackenzie, and Ilvento 2002). Respondents living in Sussex County allocate 40 percent of their preference to the agricultural attribute. Growth control is also weighted highly, whereas environmental and open space attributes are less important. Almost on the scale of Sussex County, Kent County has been experiencing extensive residential growth in recent years. Kent County residents rank the agricultural attribute as the most important, followed by the environmental, open space, and growth control attributes. In contrast, New Castle County respondents most prefer the environmental attribute, followed closely by the agricultural attribute. This result also corresponds to expectations because New

Castle County is the most urban county. Although New Castle County's acres in residential use increased 99 percent from 1984 to 1997, only 15 percent of the growth occurred since 1992 (Duke, Mackenzie, and Ilvento 2002). Across the counties, the agricultural attribute seems to be the most important. Agriculture is approximately as important as environment to New Castle County residents and is 115 and 66 percent more important in Sussex and Kent Counties, respectively.

To derive state-level preferences for the attributes and qualities, county-level data are aggregated according to the distribution of population in the State. The sample suggests 33 percent of public support for Delaware's PDR program is associated with the agricultural attribute. Following in importance are the environmental (27 percent), growth control (21 percent), and open space (18 percent) attributes. The sharpness of the AHP results is pronounced; assuming one believes that the sample is sufficiently large and representative of Delawareans, then the results show, for instance, that the public is almost twice as interested in the agricultural services of protected land as the open space services. In general, the two results closely correspond to Kline and Wichelns' (1996) Rhode Island results, which attests to the similar realities of land use in both states. Significantly, agricultural and environmental motivations are preeminent in both surveys.

A fuller picture emerges, however, from the results on the relative importance of the various qualities of preserved land. By multiplying the quality weight by the attribute weight, an overall weight for each quality emerges. The sample places the most importance on providing locally grown food, keeping farming as a way of life, and protecting water quality. The sample expressed the least interest in protecting agriculture as an important industry, preserving natural places, and providing breaks in the built environment. The top three qualities contribute 41 percent of overall support, while the bottom three account for only 18 percent.

It is apparent from the results that the fullest picture of public support emerges at the quality level rather than the attribute level, although the four attributes are useful shorthand for discussing support. Indeed, one may aggregate the qualities into other ways to tell stories about support. For instance, the sample seems to be most interested in maintaining a rural character and the agricultural way of life. One possibly problematic conclusion is that the respondents seem to desire agricultural land uses and, at the same time, water quality. One may infer that preserved forestland and wetland probably deliver water quality services more effectively than preserved farmland. Yet the public is less interested in the other services of forestland and wetlands, including wildlife habitat and natural places. This result may suggest that cost-effective policy for land preservation in Delaware must include two separate approaches, one for farmland and one for other natural lands. Further work may be able to uncover the public's perceptions about the relationship between water quality and preserved land.

Table 8
AHP Results by County

		New Castle County Weights			Kent County Weights			Sussex County Weights		
Attribute	Quality	Attribute	Quality	Overall	Attribute	Quality	Overall	Attribute	Quality	Overall
Agriculture		0.295			0.399			0.404		
	Providing Locally Grown Food		0.386	0.114		0.447	0.178		0.485	0.196
	Keeping Farming as a Way of Life		0.431	0.127		0.428	0.171		0.387	0.156
	Important Industry		0.183	0.054		0.125	0.050		0.128	0.052
Environmental		0.303			0.240			0.188		
	Protecting Water Quality		0.509	0.154		0.433	0.104		0.440	0.083
	Protecting Wildlife Habitat		0.308	0.093		0.301	0.072		0.352	0.066
	Preserving Natural Places		0.183	0.056		0.267	0.064		0.207	0.039
Growth Control		0.214			0.171			0.241		
	Slowing Development		0.461	0.099		0.405	0.069		0.510	0.123
	Preserving Rural Character		0.539	0.115		0.595	0.102		0.490	0.118
Open Space		0.188			0.190			0.167		
	Preserving Scenic Quality		0.607	0.114		0.507	0.096		0.677	0.113
	Breaks in the Built Environment		0.393	0.074		0.493	0.094		0.324	0.054

NCC=New Castle County, KC=Kent County, SC=Sussex County

Table 9
AHP State-Level Results

			Quality Weight		Quality Rank		
Attribute	Quality	Attribute Weight	Within Attribute	Overall	AHP Rank	K&W* Rank	Rate (1-10)
Agriculture		0.334			**1**	**2**	
	Providing Locally Grown Food		0.416	0.141	1	4	8.23
	Keeping Farming as a Way of Life		0.422	0.140	2	5	7.78
	Important Industry		0.163	0.053	10	NR	NR
Environmental		0.270			**2**	**1**	
	Protecting Water Quality**		0.483	0.132	3	1	9.34
	Protecting Wildlife Habitat		0.316	0.084	7	2	9.04
	Preserving Natural Places		0.202	0.054	9	3	8.81
Growth Control		0.213			**3**	**4*** **	
	Slowing Development		0.462	0.099	6	8	7.19
	Preserving Rural Character		0.538	0.114	4	6	7.65
Open Space		0.184			**4**	**3*** **	
	Preserving Scenic Quality		0.605	0.111	5	7	7.65
	Breaks in the Built Environment		0.395	0.073	8	NR	NR

*Kline and Wichelns (1996). NR=not rated. **The AHP survey used the quality "protecting ground and surface water", while Kline and Wichelns (1996) only asked about groundwater. ***The growth control and open space attributes had different qualities in the two papers.

5. CONCLUSIONS

This report summarizes the results of two surveys investigating public support for preserved agricultural and undeveloped land in Delaware. The results suggest the following.

- Delawareans are very concerned about land preservation.
- Delawareans are very supportive of the land-preservation activities of the Delaware Agricultural Lands Preservation Program.
- The value of the goodwill to the continuing activities of the program is estimated to be between $1,209,216 and $4,685,162.
- The most important attributes of preserved land are those that provide agricultural (rural amenities) and environmental (human regarding) services.
- The net benefits of many of the parcels preserved in 2000 were likely positive.
- For some recently preserved parcels—especially agricultural or environmental parcels—the net benefits of preservation exceeded $1,000,000.
- The results reflect the support for the first farm preserved. Net benefits diminish as more farms are enrolled.
- The public seems to prefer growth control that promotes rural character rather than growth control that

preserves land at immediate risk of development.

- The public seems less concerned with open space and habitat types of environmental protection.

- The public's support for land preservation is weakest for protecting agriculture as an important industry.

- The results of the conjoint analysis and the AHP reinforce each other, thereby mitigating some of the shortcomings raised with the use of each method.

It turns out to be quite difficult and expensive for academics and policy makers to measure precisely the values of the nonmarket services of preserved land in the future. These results offer evidence that the public places high values on many of the agricultural and environmental lands that have recently been preserved by the state.

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[3] Correlations showed that respondents from Sussex County were more likely than those from New Castle County to visit farms frequently and express concern for agricultural land preservation. These respondents also differed in their preferences. For instance, when comparing environmental and agricultural attributes, respondents from Sussex County tended to favor agriculture whereas respondents from New Castle County tended to favor environment.

[4] In several cases of pairwise comparisons, one or two responses did not include rankings with the preference choice. These observations were eliminated from the calculations for the comparisons in which they were missing.

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