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Comparing values for a private environmental good, xeriscape: Hedonic price method versus contingent valuation method

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COMPARING VALUES FOR A PRIVATE ENVIRONMENTAL GOOD, XERISCAPE: HEDONIC PRICE METHOD VERSUS CONTINGENT VALUATION METHOD

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ABSTRACT

Comparing Values for a Private Environmental Good, Xeriscape: Hedonic price method versus contingent valuation method

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The hedonic price method (HPM) and the contingent valuation method (CVM) are two valuation techniques used to estimate and report benefits of public and private environmental goods. Both methods are used in comparison studies for public goods, but not for private goods. The purpose of this study is to extend the knowledge of economic valuation for a private good by comparing a reported value from a contingent valuation survey with an estimate from the HPM using the application of xeriscape landscaping in residential settings. Market data were collected from 500 residential locations in Clark County, Nevada; of this sample, 250 homes had xeriscape landscaping, and the remaining 250 homes did not. Surveys were mailed to these locations, and a copy of the survey was also made available on the internet. A total of 49 respondents was obtained. The key findings are that (a) market participants value xeriscape landscaping; (b) survey respondents value xeriscape landscaping; and (c) a benefit estimate for the private environmental good using the HPM is greater than a benefit reported using the CVM,

confirming results from past studies of public goods. This study contributes to the literature by exploring the literature gap in welfare measurement when using two methods and making comparisons and helps to further identify the advantages and limitations of the HPM and CVM valuation techniques.

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CHAPTER 1

INTRODUCTION

This research compared benefits of a private environmental good, xeriscape, a water-conserving type of landscape, using two methods, the *hedonic price method* (HPM) and the *contingent valuation method* (CVM) to determine any differences. The HPM estimates benefits of environmental amenities indirectly through real estate markets. The CVM uses surveys to directly report a participant's benefits for an environmental good.

In this study, the HPM indirectly revealed market participants' valuations of xeriscape benefits. The CVM elicited reported valuation benefits for xeriscape from survey participants' responses. The benefits from each method were compared in an effort to extend the knowledge of economic valuations for a private good. Hurley, Otto, and Holtkamp (1999) suggested that such comparisons may help with further identification of the advantages and limitations of each method.

The goal of this chapter is to present the scope of the study, describe its significance, and provide an overview of the methodology. The following section provides a brief evaluation of the literature concerning the HPM and CVM and the formulation of the research questions of this study.

Summary of the Literature Review

This dissertation identified four main areas of literature: (a) studies of the HPM, (b) studies of the CVM, (c) comparison studies using the HPM and the CVM, and (d) landscaping/xeriscape application studies. A description of the HPM and the CVM, their major limitations, and research studies using each method are presented next, in addition to an overview of comparison studies using both the HPM and the CVM and landscaping/xeriscape landscaping application studies.

The first area of literature identified comprised studies of the HPM, estimating benefits of environmental amenities indirectly through real estate markets (Hansen, 2006; Qiu, Prato & Boehm, 2006). While the HPM is one of the most widely used indirect methods to measure benefits of environmental public goods, its dependence on large data sets in specific locations creates difficulties in empirical research applications (Belhaj, 2003; Ready, Berger, & Blomquist, 1997; Tyrvainen & Miettinen, 2000). The major advantage of the HPM is that it is based on actual observed behavior in the marketplace, more accurately indicating consumer preferences than the CVM, which is based on consumer responses to hypothetical scenarios (Tisdell, 2005; Tyrvainen, 1997). The HPM estimated the impact of landscaping characteristics on house sale prices in several studies (see, e.g., Des Rosiers, Theriault, Kestens, & Villeneuve, 2002; Henry, 1999, 1994; Netusil, 2005; Theriault, Kestens, & Des Rosiers, 2002).

Studies of the CVM made up the second area of literature identified, using surveys to directly determine a participant's willingness to pay[1] (WTP) for changes in quantity or quality for some environmental good (Carson, 1999; Hanemann, 1999; Smith,

[1] The CVM also uses willingness-to-accept (WTA) to determine changes in quantities or qualities for some environmental good, but these studies are not included since they are outside the scope of this research.

1993). The CVM is one of the most popular approaches for assessing values of aesthetic resources (Schaeffer, 2007). The reliance on consumer responses to hypothetical situations for CVM valuation is the major criticism of the method since these responses often differ from real market responses to the same situations (Earnhart, Knetsch, & Brown, 2001; Green & Tunstall, 1999; Oglethorpe & Miliadou, 2000). Thus HPM results are often used to validate CVM results (e.g., Qiu et al., 2006[2]; Shabman & Stephenson, 1996; Tisdell, 2005;). Some studies value environmental goods using the CVM (see, e.g., Loueiro, McCluskey, & Mittelhammer, 2003; Mbata, 2006; Veisten & Navrud, 2006). There were no CVM studies in the literature reporting xeriscape benefits.

Studies using both the HPM and CVM comprised the third area of literature identified. Given the advantages and limitations of each method, researchers are constantly debating the merits of these valuation techniques. For example, Shabman and Stephenson (1996) ask which "particular technique generates an 'unbiased,' 'reliable,' or 'accurate estimate'?" (p. 440). Veisten and Navrud (2006) report that the credibility of CVM has to a large extent been dependent on external validation from a revealed preference technique. Most studies in the literature using the HPM, a revealed preference method, and the CVM, a stated preference method, for comparison measured benefits of public goods.[3] Ready, Berger, and Blomquist (1997) used a comparison of CVM and HPM estimates to check for the consistency of both methods. Tyrvainen (1997) found

---

[2] Qiu et al. (2006) did not specify whether the environmental goods, riparian buffers and open space, were public or private. In previous studies of the same subject matter, though, the same or similar goods were considered public (see, e.g., Schipper, Rietveld, & Nijkamp, 2001; Zelmer, 2003). So this unspecified study is considered to be a valuation of public goods, for the purpose of this study.

[3] There were several studies worthy of mention, but not included because they did not exactly fit the HPM-CVM comparison format used in this research (see, e.g., Earnhart, 2006; Hofler & List, 2004; Ruijgrok, 2006; Smith, Van Houvtven, & Pattanayak, 2003). A study compared HPM and CVM benefits, but was published in a foreign journal and no translations were available, so it was not included in this study (Kluvankova, 1998).

HPM estimates to be similar to CVM reported values for the same amenity (Tyrvainen & Vaananen, 1998). Belhaj (2003) used the HPM and the CVM to compare the two techniques using the same respondents. Nijland, Van Kempen, Wee, and Jabben (2003) used HPM estimates and CVM reported values in a cost–benefit analysis. Qiu et al. (2006) used HPM estimate results to justify CVM reported results. There were no HPM-CVM studies comparing benefits for a private environmental good such as xeriscape.

The fourth area of literature identified concerned the application of landscaping/xeriscape. Valuation studies elicited benefit estimates for landscaping using the HPM (see, e.g., Henry, 1999; Netusil, 2005; Theriault et al., 2002). The studies by Larsen and Harlan (2006) and Spinti, St. Hilarie, and VanLeeuwen (2004) elicited consumer preferences for xeriscape landscaping using surveys but did not ask consumers their WTP, as in CVM studies. Other studies used two types of method for valuation of landscaping: the HPM and nonvaluation preference surveys (e.g., Des Rosiers et al., 2002; Henry, 1994). Kirkpatrick, Daniels, and Zagorski (2007) used a field survey to inspect garden types, including native gardens, a form of xeriscape. The studies by Hurd (2006) and Sovocool, Morgan, and Bennett (2006) used market data to estimate water savings for xeriscape on both individual and community levels, but no studies estimated the benefits of xeriscape as reflected in home sales prices.

In summary, several gaps in the literature can be seen: absent in the literature are (a) xeriscape valuation studies using the HPM, (b) xeriscape valuation studies using the CVM, (c) studies comparing benefits from the HPM and CVM for private goods, such as xeriscape landscaping, and (d) xeriscape application studies comparing estimates from the HPM and reported WTP values from the CVM. This scarcity of research gave rise to the following question: How does a value estimate from the HPM and a reported WTP value from the CVM compare for a private good such as xeriscape landscaping?

To answer this question, this research (a) used the HPM to estimate if market participants valued a private good such as xeriscape and (b) used the CVM to report if survey participants valued a private good such as xeriscape landscaping.

The purpose of this study was to compare benefits of a private environmental good, xeriscape, using the HPM and CVM techniques to determine any differences. An overview of the methods used in this study to answer the research questions is presented hereafter.

Summary of the Research Methods

This study used the HPM to estimate if market participants valued a private good such as xeriscape. The HPM was used to examine real estate market data and socioeconomic data. A total of 500 homes were used in this study for the HPM analysis. Two hundred fifty homes had xeriscape landscaping, and 250 homes had nonxeriscape landscaping. HPM regression analysis used four models in this study.

This research used the CVM to report if survey participants valued a private good such as xeriscape. Survey data were examined using the CVM. A questionnaire was sent to 500 homeowners, asking respondents to make a choice between a hypothetical xeriscape-landscaped home and a status quo non-xeriscape-landscaped home and to place a dollar value on their preferred landscape type.

The value estimates from the HPM and the reported WTP values from the CVM were compared for analysis of the primary research question: How does a valuation estimate from the HPM and a reported WTP value from the CVM compare for a private good such as xeriscape landscaping?

This study contributes to the knowledge of economic valuation by extending the existing knowledge of research methodologies when using two methods for comparison. This study also provides a greater depth of understanding about private good valuation. Since the valuation of public goods when using HPM depends on the indirect valuation of a marketed private good, more knowledge obtained about the valuation of private goods will provide a stronger foundation for public good valuations. This study also contributes to the literature by (a) providing policy makers with information about xeriscape landscaping, indicating that it does have a positive effect on property values, and (b) providing researchers with information about the HPM and the CVM used in comparison studies for valuing a private environmental good.

This dissertation is organized as follows: Chapter 2 reviews the theoretical and empirical studies in the environmental valuation literature; chapter 3 explains the methods used to answer the research questions; chapter 4 presents the results of the hypothesis testing; and chapter 5 provides a discussion of the results in comparison with previous studies and presents recommendations and conclusions.

CHAPTER 2

LITERATURE REVIEW

The environmental valuation literature focusing on the HPM and the CVM provides the basis for the present study. This chapter will examine both the theoretical literature and the empirical research in the field. The literature review is organized into the following six sections: (a) definitions, (b) theoretical background, (c) applied environmental valuation literature, (d) applied environmental valuation literature for landscaping, (e) summary, and (f) hypotheses.

Definitions

This section presents definitions of public, quasi-public, private, and quasi-private goods to give preciseness to environmental valuation terms used in this study. Two examples of a public nonmarket good and a private nonmarket good are also presented.

Economists distinguish between two types of goods, *public* and *private*. The definitions for public and private goods each contain two parts. Private goods are those for which (a) when the owner of the good can exclude others from using or consuming (Sanders, 1985, p. 1145) and (b) the marginal cost of providing an additional unit of the good to another person is greater than zero. Examples of private goods are homes or cars. A pure public good is one that is nonexcludable and nondepletable (Freeman, 2003).

According to Freeman (2003), *nonexcludable* means that "once the good has been provided to one individual, others cannot be prevented from making use of the good" (p. 3). Freeman goes on to define the *nondepletable* good by stating that "one person's use does not diminish the use that others can make of the good" (p. 3). An example of a pure public good is national defense (Carson, 1999).

Scholars recognize intermediate categories between pure public and private goods by including definitions for quasi-public and quasi-private goods. *Quasi-public* goods are those goods "provided by the government but for which it is possible to exclude members of the public from its use...Common examples include government campgrounds and houses located near public lakes" (Carson & Groves, 2007, p. 187). *Quasi-private* goods are those (a) with individual property rights, (b) with the ability to exclude potential consumers, and (c) that are not freely traded in competitive markets (Mitchell & Carson, 1989). According to Mitchell and Carson (1989, p. 57), TV frequencies are an example of a quasi-private good.

Environmental goods are classified as public, quasi-public,[4] or private goods in the environmental literature. Natural resources, such as forests, and environmental attributes, such as air quality, are considered to be public or quasi-public goods. An environmental attribute such as landscaping can be considered to be a private good. Many of these goods are part of environmental systems or services that link them to markets (Freeman, 2003). If environmental goods are linked directly to markets, they are considered to be *market goods*. Environmental goods are considered to be *nonmarket goods* when they are indirectly linked to markets. To illustrate the difference between

[4] There were no studies found in the environmental literature valuing a quasi-private environmental good.

nonmarket and market goods, two examples are described subsequently.

Air pollution in residential locations can be considered to be a nonmarket public environmental good valued indirectly through residential home sales prices, a market good. Air pollution meets the criteria of a public good because others cannot be prevented from using the good and because one person's use does not diminish others' use of the good. If there are two identical homes for sale, Home A, located in an area with air pollution selling for less money than Home B, located in an area without air pollution, then the difference in sales price would be the nonmarket value of air pollution. The home located in the area without air pollution having a higher sales price means the buyer values the location of Home B, without air pollution more than the location of Home A, with air pollution. Since air pollution does not specifically affect only one home, it is considered to be a public good affecting many.

Residential landscaping is an example of a nonmarket private environmental good. It is considered a private good because the owner of the good can exclude others from using it and because the marginal cost of providing an additional unit of the good to another person is greater than zero. Even though residential landscaping is not directly valued, bought, and sold in the marketplace, it can be valued indirectly through house sales price, a market good. For an example, imagine a person has a choice between two identical homes, except for the type of landscaping: Home A has a higher sales price, with xeriscape landscaping, and Home B has a lower price with turf landscaping, a type of non-xeriscape landscaping. The buyer chooses Home A at the higher price. In so doing, the buyer has indirectly placed a value on the xeriscape type of landscaping as being the difference in sales price between Home A and Home B. Residential landscaping in this example is considered to be a nonmarket private environmental good.

Theoretical Background

This section presents the theoretical background of economic valuation using the HPM and the CVM for environmental goods. Measurements of preferences and benefits, behavioral methods, and nonmarket valuation are presented.

Measurements of Preferences and Benefits

Measurements of individual preferences and changes of those preferences are the basis for economic valuation of environmental goods[5] (Haab & McConnell, 2002). The economic value of such goods is measured by the net change in income that compensates for or is equivalent to the changes in quality or quantity of the goods (Haab & McConnell, 2002). Benefits can be measured by observing people's behavior in a real-world situation or by collecting responses to hypothetical questions to determine an individual's WTP more or less for a particular good in question (Freeman, 2003).

Behavioral Methods

Researchers use behavioral methods to describe money welfare measures of change (Haab & McConnell, 2002). Behavioral methods examine (a) how much of the behavior was influenced by a public (or private) good and/or (b) how much of the behavior was influenced by welfare considerations (Haab & McConnell, 2002).

Price changes and quality (quantity) changes can lead to measurements of welfare. Haab and McConnell (2002) reported that WTP or willingness-to accept (WTA) are ways of describing changes in quantity (quality) or price. Compensating or equivalent

[5] The term *environmental goods* in this study will refer to environmental goods, services and/or resources.

variation can also provide welfare measurements of individual changes in quantities of goods as price and income levels change.

Haab and McConnell (2002) further define WTP and WTA in more detail: (a) WTP is the amount of money an individual will pay to acquire a good or service, or an improvement in a good or service; (b) WTP also represents the amount of income an individual will pay to avoid a decrease in a good or service; (c) WTA is the amount of income an individual will accept for a decline in a good or service; (d) WTA could also be the amount an individual will accept to forego an improvement.

Nonmarket Valuation

Valuation of nonmarket environmental goods and services is measured by individual preferences for goods or services through stated preference (SP) and revealed preference (RP) methods. Revealed preferences are estimated by indirect methods of valuation such as the HPM. Stated preferences are reported directly by asking a consumer how much he or she values the goods or services through a survey or interview, using direct methods of valuation such as the CVM and contingent behavior.

Smith (1997) denoted a public good as q and a private good as x in a description of nonmarket valuation. Using the previous air pollution example and Smith's denotation, air pollution, a public nonmarket good, would be denoted by q, and sales price of a residential home, a private market good, would be denoted by x. Preference for the home or sales price of the home x would be affected by the amount and quality of air pollution q present where the home was located. Preferences or sales price (x) are indirectly related to air pollution (q). If more homes are demanded in locations without air pollution, the sales price in those locations may increase.

Thus q (either designated as quantity or quality) and price are parameters that affect choices (Smith 1997). Those choices can be used to elicit an individual's values for q. How much an individual values q should be reflected in the prices he or she is willing to pay to acquire the private market good (x) affected by q. Most studies have focused on q as a public nonmarket good, but q can also be a nonmarket private good, which cannot be directly purchased. The value of q in this case can also be revealed through another private good x, which is a market good.

Smith (1997) reported on some assumptions about how q, a public or private nonmarket good, relates to the private market good for estimating WTP. Linkages between q and the private good x are based on some form of substitution or (weak) complementarity between the nonmarket environmental good or service and the private good(s), thus providing the basis for nonmarket valuation (Smith, 1997). According to Haab and McConnell (2001), "weak complementarity offers a way of measuring willingness to pay for changes in public goods by estimating the demand for private goods" (p. 14). The WTP for changes in a public good equal the WTP for access to a private good (Haab & McConnell).

Compensating Variation and Equivalent Variation

Freeman (2003) Freeman III (2003) described *compensating variation* and *equivalent variation* as measures that allow an individual to make changes to consumption of quantities of goods as price and income levels change. Haab and McConnell (2002) further described *compensating variation* as "the amount of income paid or received that leaves the person at the initial level of well-being" and *equivalent* *variation* as "the amount of income paid or received that leaves the person at the final level of well-being" (p. 6).

Haab and McConnell (2002) described a preference function for an individual as u(x,q), where x= $x_1 \ldots x_m$ is the vector of private (market) goods, q = $q_1 \ldots q_m$ is the vector of public nonmarket goods (which may also be characteristics of private goods), and u represents utility level. It is assumed that x are available at prices represented by p = $p_1 \ldots p_m$ and that an individual's utility is subject to his or her income y. The preference function provides the basis for indirect utility functions and expenditure functions needed for environmental valuation (Haab & McConnell, 2002).

Indirect Utility Function (Marshallian Ordinary Demand Curve)

According to Haab and McConnell (2002) welfare estimation of individual preferences is based on the theoretical structure provided by the indirect utility function. V(p,q,y) represents the indirect utility function of an individual's preferences and demands, where p = $p_1 \ldots p_m$ is a vector of the prices, q = $q_1 \ldots q_n$ is the vector of public goods (which may also be characteristics of private goods), and y represents income (Haab & McConnell, 2002). Derivations of the indirect utility function with respect to price and income give the *Marshallian* or *ordinary*, *demand curve* (Haab & McConnell, 2002).

Derivations of the Indirect Utility Function

According to Azevedo et al. (2003) an ordinary (Marshallian) demand equation can be used to represent an individual's (*i's*) preferences:

$$"q_i = f(p_i, y_i\text{: } \beta) + \varepsilon_i \qquad (1)$$

where q_i denotes the quantity consumed by individual *i*, p_i denotes the associate price, y_i is the individual's income, and β is the vector of unknown parameters. The additive stochastic term is used to capture heterogeneity in individual preferences within the population." It is assumed that an analyst would have the following data available: (a) the actual price and quantity for the environmental good in question, (b) the quality attributes for that good, and (c) the individual sociodemographic characteristics (Azevedo, 2003). This demand equation can be used for both SP and RP valuations of q, either directly or indirectly.

Expenditure Function (Hicksian Demand Curve)

Welfare estimation of individual preferences is also based on the theoretical structure provided by the expenditure function Haab and McConnell (2002). The minimum expenditure function is represented by m (p,q,u), where p = $p_1 \ldots p_m$ is a vector of the prices, q = $q_1 \ldots q_n$ is the vector of public goods (which may also be characteristics of private goods), and u represents level of utility (Haab & McConnell, 2002).

Derivations of the expenditure function with respect to price gives the *Hicksian demand curve* (Haab & McConnell, 2002).

An Expenditure Function for the Increase of a Good

An expenditure function can be written for a Hicksian (compensating variation) WTP for an increase in an environmental good q:

$$\text{WTP} = e\ (p, q_0, u_0) - e\ (p, q_1, u_0) \quad (2)$$

where e represents minimum expenditures[6], p represents the vector of prices for the

[6] Note that the minimum expenditure is represented by m in the Haab and McConnell (2003) definition and by e in the Smith (1997) definition.

marketed good, q represents quasi-fixed commodities (environmental goods or services), and u represents utility level (Smith, 1997).

The Hedonic Price Method

The HPM is a revealed preference technique that can estimate the value of an unobservable nonmarket environmental good or service through indirect measurements of demand for an observable marketed private good (Smith, 1993). The HPM is based on capitalization theory, where the cost or value of an amenity is captured in the price of the good (Hidano, 2002). Callan and Thomas (2004) further described this technique in relation to attributes (variables) such as environmental quality (quantity or goods). Any environmental variable's implicit price can be determined through regression analysis used by HPM (Callan & Thomas, 2004). An explicit price, such as house price, can be decomposed into implicit price components, such as environmental quality (q) (Callan & Thomas, 2004). A demand for environmental quality can be estimated after the determination of the implicit price of q and used to measure changes in consumer surplus (Callan & Thomas, 2004).

Formally, Haab and McConnell (2002) describe an hedonic price function as:

"$p = h(\mathrm{z})$, (3)

where p is the price of a house, for example, and z is a vector of attributes" (p. 247). WTP for a change in quality (or quantity) of an environmental good or service can be represented by the basic expression (Haab & McConnell, 2002, p. 250):

$$WTP = h\,(\mathrm{z}^*) - h\,(\mathrm{z}), \quad (4)$$

where z* represents the new vector of attributes, z is the original vector, and "h (z) is the deterministic part of the hedonic price function" (Haab & McConnell, 2002, p. 266).

According to Haab and McConnell (2002) these welfare estimates can be calculated at the mean price. A semi-log function can give an approximate percent change in housing prices from changes in levels of an attribute (Haab & McConnell, 2002).

Rosen (1974) provided a basic regression model of HPM when there is a single characteristic (cited in Haab & McConnell, 2002):

$$P = f[S, N, SE, Q] \tag{5}$$

where P represents price, S represents site and structural characteristics, N represents neighborhood characteristics, SE represents socio-economic characteristics, and Q represents environmental characteristics.

WTP using Rosen's (1974) basic model would then be represented as

$$WTP = f[S, N, SE, Q^*] - f[S, N, SE, Q] \tag{6}$$

HPM is often used for comparison of residential properties, with and without an environmental amenity (McFadden, 2002). HPM reveals the value of environmental attributes through "a statistical calculation procedure that results in a percentage of property-values" (Ruijgrok, 2006, p. 208). The results from this procedure suggest a consumer's WTP for those attributes (Mathis, Fawcett, & Konda, 2003).

The Contingent Valuation Method (CVM)

The CVM is a stated preference technique using WTP (or WTA) to report benefit values (Azevedo, Herriges, & Kling, 2003; Carson, 1999; Schechter, 1999). A survey is often used in CVM studies to describe hypothetical markets (Carson, 1999). The survey elicits consumer valuation responses to changes in quantities or qualities of some environmental good (Carson, 1999; Hanemann, 1999; Smith, 1993). The survey usually consists of three parts: (a) descriptions of the good being valued and the hypothetical situation, (b) questions concerning the consumers WTP for the good (or WTA a compensation for an increase or decrease of the good), and (c) general attitude questions about the good and socio-economic questions (Tryvainen & Vaananen, 1998).

The contingent valuation method can obtain measures that represent the difference between two expenditure functions (Mitchell & Carson, 1989). Respondents estimate what changes in income and simultaneous changes in the level of a good will leave their utility levels unchanged. The basic expenditure function equation for this difference is as follows:

$$WTP = m\ (p,q,u) - m\ (p,q^{*},u) \text{ when } u = V(\mathrm{p,q,}y) \qquad (7)$$

where income (m) is expressed as a function of prices (p), a good (q), a good increased (q^*), and utility (u) (Haab & McConnell, 2003). According to Haab and McConnell (2003) "willingness to pay is the amount of income an individual would give up to make him indifferent between the original state: income at y and the public (or private) good at q and the revised state: income reduced to y - WTP and the public (or private) good increased to q*" (pp. 7-8). WTP is the positive part of equivalent variation and corresponds to the positive parts of the Hicksian measures.

Again, using an adaptation of Rosen's (1974) model for purpose of comparison, a basic WTP model for CVM could also be written as

$$WTP = f\,[PREF,\ SE,\ Q] \qquad (8)$$

where WTP represents willingness-to-pay, $PREF$ represents preferences, SE represents socio-economic characteristics, and Q represents environmental characteristics. Equation 8 could then be written as

$$WTP = f\,[PREF,\ SE,\ Q^{*}]\ -\ f\,[PREF,\ SE,\ Q] \qquad (9)$$

The value of changing the amount of the good can thus be reported.

HPM Estimates Compared with CVM Values

Hanemann (1994) reported that it is possible to compare direct use values reported by the CVM with estimates obtained through indirect methods, such as the HPM. This literature review identified 16 previous HPM-CVM comparison studies for environmental goods (e.g., Carson et al., 1996; Qiu et al., 2006; Ready et al., 1997; Shabman & Stephenson, 1996).

As previously reported in this literature review, the value of an environmental good can be measured indirectly through an HPM regression analysis by estimating the percentage change in sale price between those homes with and without the environmental good (Qiu et al., 2003). The CVM value for an environmental good can be reported directly from the dollar values that respondents state they are willing to pay for the environmental good. The percentage change in sales price from the HPM is multiplied by the sales price of each home in the study and then averaged to transform the benefit of the environmental good into dollar values, which can then be compared to dollar value estimates from the CVM (Blomquist, 1988; Qiu et al., 2003). The mean or median reported CVM values can then be compared with the mean or median estimated HPM values.

Qiu et al. (2003) converted the HPM coefficients to dollar values at the sample mean and then compared the estimated values to the mean reported CVM WTP values. Ready et al. (1997) compared median benefit estimates of HPM, coefficients converted to dollar values, to median reported CVM WTP values. Shabman and Stephenson (1996) compared the mean benefit estimates of HPM to the mean reported CVM WTP values.

Blomquist in 1988 compared both the mean and median reported contingent market values (CVM) to the implicit market estimated values (HPM)

On the basis of the theory of implicit markets for HPM, Blomquist (1988) reported that the contingent values for an environmental good do not necessarily equal the value for an environmental good implicit in the housing market. Theoretically, implicit values, from HPM for example, were predicted to be greater than contingent WTP values, from CVM for example[7]. Blomquist used values for lake views and dwelling unit heights as environmental goods in his study. Figure 1 is a graph that Blomquist (1988) used to demonstrate his theory.

In Figure 1, V represents a view-related amenity. V* represents the quantity chosen by those residents who have a lake view, R_V represents the marginal implicit (hedonic) price curve, D_1 represents the demand curve for a resident who has no lake view, and D_2 represents the demand curve for lake view for a resident who chooses the quantity V* and who has a lake view.

Blomquist (1988) provides further descriptions for the Figure 1. Let CMV represent contingent market values obtained from a interview and CMVLP represent the maximum amount residents are WTP through increased housing costs to obtain an identical apartment with a view. Let CMVLA represent the minimum amount residents are WTA through reduced housing costs to give up their view. Let IMVLA represents the implicit market value for the same lake view. Let CMVH represent the maximum amount residents are WTP through increased housing costs to obtain an identical apartment but with a view 10 floors higher.

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[7] Theory predicted that reported WTA values from CVM were greater than estimated values from HPM (Blomquist, 1988). This is noted here, but does not apply to this study that is only using WTP reported values from the CVM.

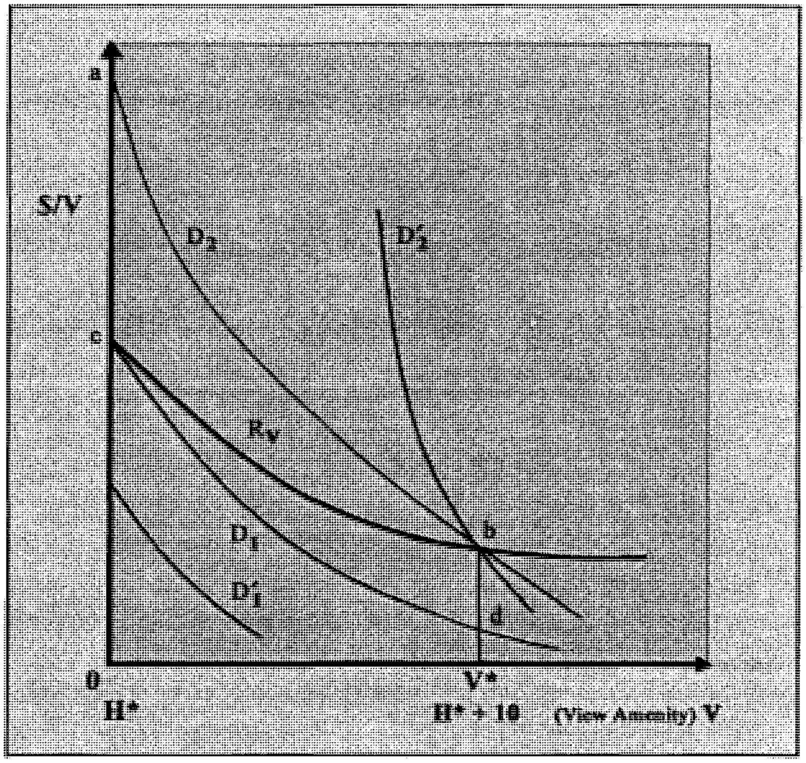

Figure 1. View -- Residents' Implicit Demand Curves and the Marginal Hedonic Price Curve. Adapted from "Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets," by G. Blomquist, 1988, *Urban Studies, 25,* Page 335.

Blomquist (1988) described the implicit market for a view-related amenity (V) in Figure 1. The marginal implicit (HPM) price curve (R_v) in Figure 1 is assumed to slope downward to the right, then D_2 can represent the demand (marginal bid) curve for lake view for a resident who already has a lake view and who choose quantity V*. The shaded area abV*0 in Figure 2 represents such a utility-maximizing resident CMVLA. This was the minimum amount a resident with a view was willing to accept through reduced housing costs to give up their view.

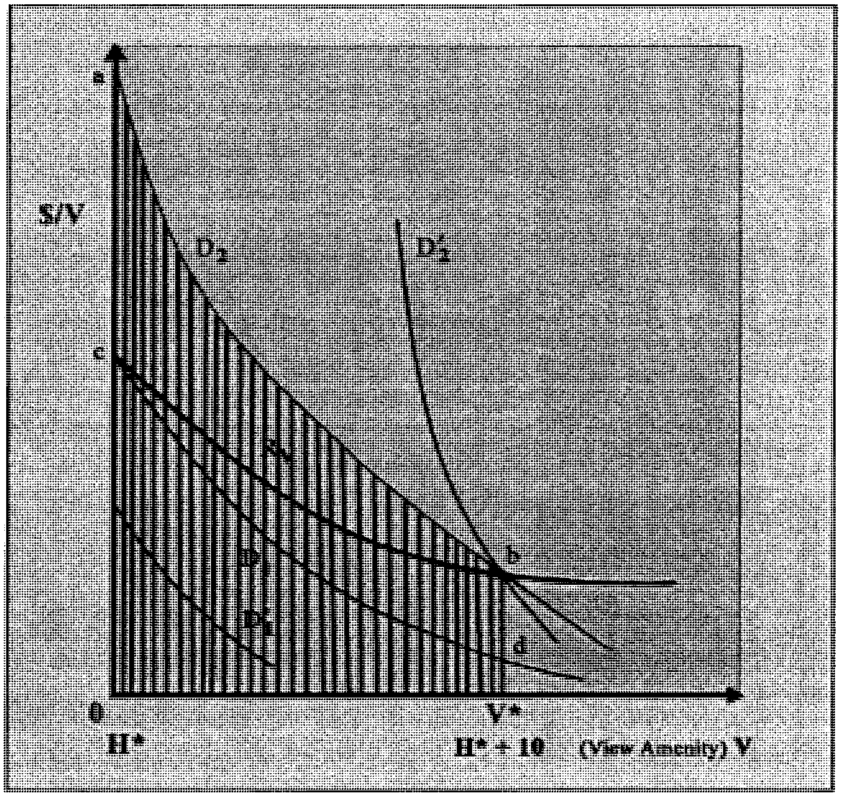

Figure 2. The utility-maximizing resident (CMVLA). Adapted from "Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets," by G. Blomquist, 1988, *Urban Studies, 25,* Page 335.

The shaded area cbV*0 in Figure 3 represents the implicit market value (IMVLA) for the same lake view as represented by utility-maximizing resident CMVLA. CVMLA is greater than or equal to IMVLA because "the resident who chooses V* will have a demand curve which lies everywhere above R_v for quantities less than V* or is coincident with R_v" (Blomquist, 1988, p. 335).

The shaded area in Figure 4 represents the resident CMVLP who has no lake view and is given by cdV*0 which is less than or equal to the implicit market value given by cbV*0 (the shaded area in Figure 4). This shaded area is the maximum amount a resident is WTP to get a view of an identical apartment. The residents are sorted by the market for lake views implicit in the housing market so that CMVLA ≥IMVLA ≥CMVLP. D_2 may be much lower than other individual's demand curves for those with a view such as D'_2 . Individual's demand curves for those without a view, such as D'_1, and are bounded from below by zero. Blomquist (1988) suggests that IMVLA and CMVLP may be much smaller than CMVLA.

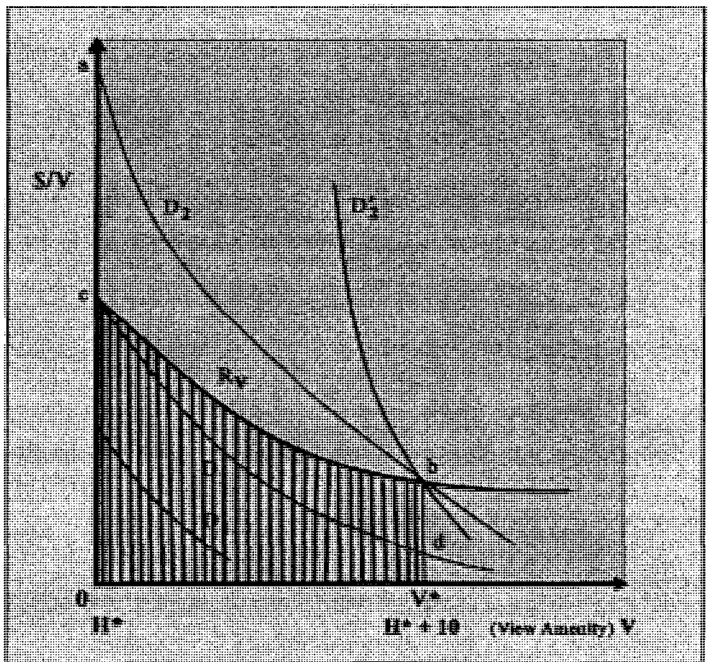

Figure 3. The implicit market value with lake view (IMVLA). Adapted from "Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets," by G. Blomquist, 1988, *Urban Studies, 25,* Page 335.

Blomquist (1988) further provides the same reasoning for the view-related amenity height as for that of lake view without a view. Let H* be the maximizing dwelling unit height and H* + 10 be the choice of an apartment with a view, which is 10 floors higher than H*. CMVH is given by the area cd(H* + 10)H* if D_1 is an individual's demand curve for height. The area cb(H* + 10)H* gives the IMVH, the implicit market value for height, and is greater than or equal to CMVH.

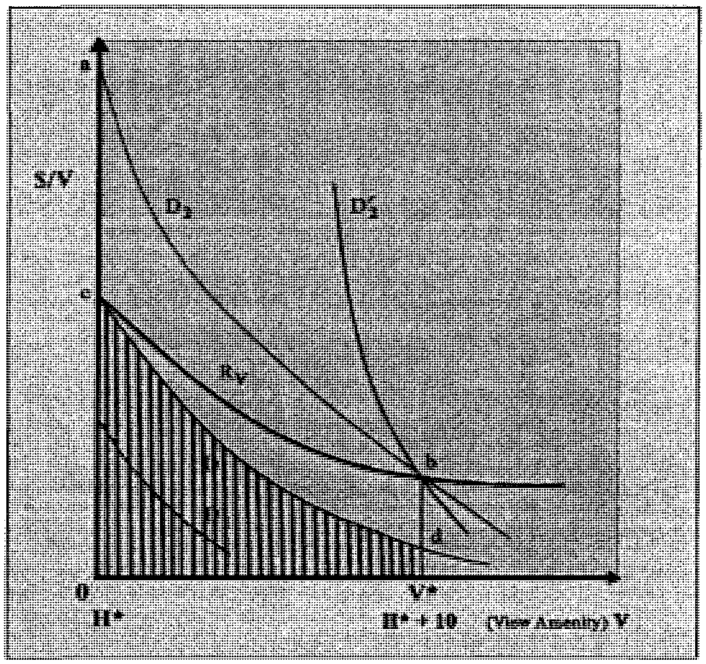

Figure 4. The resident CMVLP with no lake view. Adapted from "Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets," by G. Blomquist, 1988, *Urban Studies, 25,* Page 335.

Blomquist (1988) demonstrated in these figures based on the theory of implicit markets that the contingent values for lake view and height do not necessarily equal the value for lake view (or height) implicit in the housing market. According to Blomquist this implies "that the contingent value can be expected to differ from the implicit value for the same good" (p. 335). These findings predict that reported WTP values from CVM are expected to be less than estimated valued from HPM.

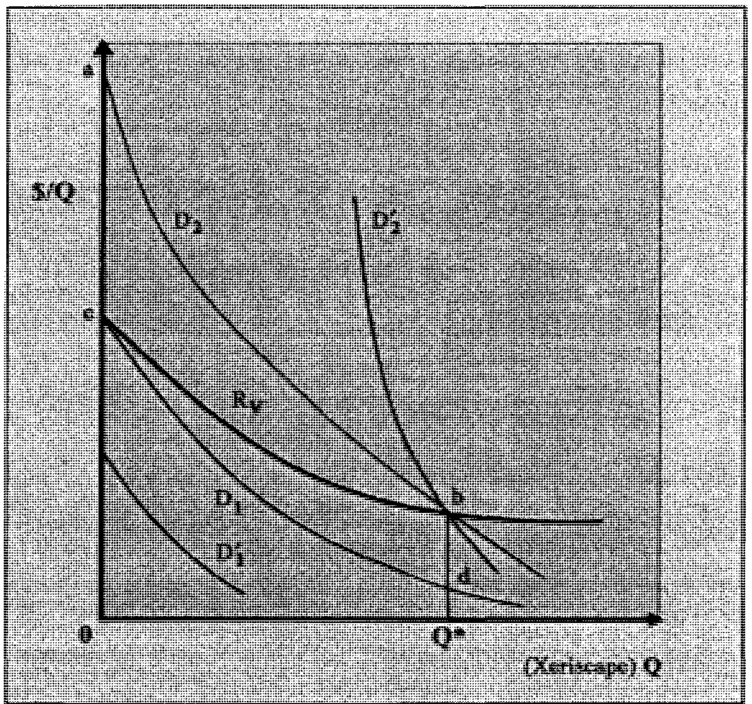

Figure 5. Xeriscape -- Residents' Implicit Demand Curves and the Marginal Hedonic Price Curve. Adapted from "Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets," by G. Blomquist, 1988, *Urban Studies, 25,* Page 335.

Figure 5 is an adaptation of Figure 1 for this study, where now Q represents xeriscape, an environmental amenity. Q* represents the quantity chosen by those residents who have xeriscape, R_V represents the marginal implicit (hedonic) price curve, D_1 represents the demand curve for a resident who has no xeriscape, and D_2 represents the demand curve for xeriscape for a resident who chooses the quantity Q* and who has a xeriscape. D_2 represents the minimum amount residents are WTA through reduced housing costs to give up xeriscape.

So as Blomquist (1988) demonstrated in figure 1-4 for lake view and height it is anticipated that in Figure 5 for xeriscape, that the contingent WTP values for xeriscape reported will also be less than the estimated value for xeriscape implicit in the housing market.

HPM Criticisms Within Economics

The following are criticisms of HPM consistently reported in the literature: (a) the necessity of large data sets, (b) difficulty with variable selection, (c) choice of functional form is critical, and (d) inability to evaluate non-use-related motives. Each of these criticisms is described in order subsequently.

The first criticism concerns the large data sets required for HPM studies. According to Tyrvainen and Miettinen (2000), large data sets are required for comprehensive HPM studies and are laborious to collect. Large data sets may be useful for explanatory purposes, but problems with multicollinearity, autocorrelation, and heteroskedasticity may occur when these large sets are integrated into linear regression models (Theriault et al., 2002; Tyrvainen & Miettinen, 2000).

The second criticism of HPM concerns the selection of variables to be used as independent variables. According to Dale, Murdoch, Thayer, & Waddell (1999), the research of Atkinson and Crocker (1987) and Graves, Murdoch, Thayer, & Waldman (1988) indicated that hedonic price estimates could be significantly affected by variable selection. Dale et al. (1999) further suggested that there are no concrete guidelines provided by hedonic price theory concerning selection of variables to include in the set of independent variables. There is a possibility that collinearity may exist among variables (attributes) when an indirect method is used, and this is cause for concern (Henry, 1999;

McCluskey & Rausser, 2001). If some explanatory variables are multicollinear, then there may be difficulty in estimating accurate and stable regression coefficients (Tryvainen & Miettinen, 2000). When there are more parameters in a model, there will be larger variance around each parameter, reducing precision around each parameter (Tryvainen & Miettinen, 2000). Vanslembrouck, Van Huylenbroeck, and Meensel (2004) suggested that omission of important characteristics is a weakness of HPM that can cause analytical problems. Sturm and Haan (2005) indicated that "several different models may all seem reasonable given the data, but yield different conclusions about the parameters of interest" (p. 598). Variable selection is an important consideration in HPM studies and may cause problems with the resulting parameter estimates, yet few theoretical guidelines are provided.

The third criticism of HPM concerns the selection of the functional form to be used for analysis of the data. Not determining the correct mathematical specification of the model can cause analytical problems (Garrod, 1994). According to Tyrvainen and Miettinen (2000) "the functional form of the hedonic price equation cannot be specified purely on theoretical grounds" (p. 208). When choosing a function type in hedonic price models, there are no definite rules (Lee, Park, & Kim, 2003).

The fourth criticism of HPM concerns the nonability of HPM to estimate nonuse and some direct-use environmental values. Market prices rarely reflect nonuse values (Bishop, 1998). Revealed preference methods, indirect methods of measurement, are most likely not able to measure nonuse values (Freeman, 2003). Earnhart et al. (2001) suggested that preferences for uncommon attributes, like restored wetlands (a nonuse environmental amenity), are not effectively captured through hedonic analysis.

CVM Criticisms Within Economics

There are also many criticisms of the methodology employed in the CVM. Eight criticisms of the methodology are consistently reported in the literature: (a) hypothetical bias, (b) inconsistencies between WTP and WTA, (c) strategic bias, (d) information bias, (e) validity and reliability, (f) framing issues, (g) wording issues, and (h) monetary valuation issues.

The first criticism involves hypothetical bias. Green and Tunstall (1999) offered a definition of *hypothetical bias* as the differences between what people say they would do in a hypothetical situation and what they do after an actual event. Green and Tunstall (1999) further suggested that respondents over report their valuations in a hypothetical situation and then underpay when faced with the same situation in the real marketplace. Bateman and Willis (1999) further indicated that these hypothetical bias problems may be attributed to poorly designed or inadequate surveys and can be eliminated through better quality survey designs and execution. Oglethorpe and Miliadou (2000) suggested that hypothetical bias refers to the hypothetical nature of a survey and the fact that real transactions are not being made. Earnhart et al. (2001) further explained that the hypothetical nature of choices and questions is a common criticism of any stated preference method.

The second criticism of the CVM reflects concerns about inconsistencies between WTP and WTA responses. In a 30-year review from 1970 to 2000 with a wide variety of goods, Horowitz and McConnell (2003) reported that WTP was usually substantially lower than WTA. They further added that the ratio was highest for nonmarket goods, followed by ordinary private goods, and then experiments involving money. They also reported that when differences in survey designs were accounted for, the ratios were still highest for nonmarket goods. Plott and Zeiler (2006) found that WTP–WTA gaps were not reliably observed across experimental designs in a meta-literature review.

The third criticism of the CVM concerns strategic bias. According to Oglethorpe and Miliadou (2000) and Tomohara (2005), strategic thinking[8] can cause respondents to refuse to reveal their true WTP/valuations, resulting in strategic bias. When respondents intentionally manipulate their responses to make the results favorable to themselves, this could, theoretically, be thought of as strategic bias (Yasunaga, Ide, Imamura et al., 2006).

The fourth criticism of CVM involves information content and how it is presented as a source of bias. An essential part of a survey in the CVM is a description of the hypothetical scenario. Information contained in the description could bias respondents' answers (Noonan, 2003). Noonan (2003) reported meta-regression analyses of 129 different WTP estimates from 65 studies. Noonan discovered a form of information bias in these studies. In the Noonan analysis, when respondents were informed about costs, the WTP values were reported to be substantially lower than when they were not informed about costs.

The fifth criticism of the CVM concerns the validity and reliability of the results. Wierstra et al. (2001) found that WTP answers were clearly less valid in relation to construct and scope validity in their experiments with mainly nonuse values. These nonuse value experiments had complex information concerning environmental goods. Noonan (2003) found that many people respond with low WTP, and only a few people report very high values. These types of responses commonly skew the distribution of

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[8] An example of strategic thinking is that a respondent may be able to enjoy an environmental good in question, while others are paying (Oglethorpe & Miliadou, 2000).

WTP values in empirical work. Biases in the survey instrument may be the cause of inflated WTP values reported by respondents, causing differences to occur between the mean and median WTP (Noonan, 2003).

A sixth area of concern with CVM involves framing issues. Rolfe, Bennett, and Louviere (2001) suggested that if respondents have difficulties in framing some choices, it may be because they are dependent on the pool of substitutes and choice options offered. These framing effects in relation to substitutes may be more widespread than commonly assumed (Rolfe et al., 2001). Framing effects may also be caused by any changes in the range of substitutes that respondents may consider. According to Rolfe and colleagues, when respondents view the number and types of choices as being realistic, then the evidence suggests that common attributes between similar studies are valued in much the same way. When respondents do not view choices as being realistic, then small changes in presentation appear to drive value changes. (p. 18)

A seventh issue of concern with CVM involves survey design and concerns the order of wording used in a survey questionnaire. A study by Holbrook, Krosnick, Carson, and Mitchell (2000) proposed that the quality of data can be compromised when there are departures from conventional ways of offering response alternatives. The ordering of response words may change the quality of data. Holbrook and colleagues assert that "when writing questions using sets of words governed by . . . conventions, researchers should conform to them, because violating them may reduce data quality" (p. 491).

The eighth criticism of CVM studies involves monetary valuation. Two issues concerning monetary valuation of a nonmarket environmental good were posed by Loomis (2005) and Shabman and Stephenson (1996), concerning (a) the quantification of economic values for providing people with clean and natural environments when no explicit market prices exist and (b) the fact that people may not be accustomed to thinking in dollar terms about nonmarket commodities, even though they may have strong positive feeling about them. According to Pearce (1998), even though there are no direct markets to measure environmental goods, there are related markets (housing and transportation) that attempt to reveal consumer preferences for these goods through indirect valuation techniques. Consumer preferences may also be revealed by directly asking people to value environmental goods. Consumers can state their preferences and how much they are willing to pay for the goods in question.

Applied Environmental Valuation Literature

HPM and CVM Comparison Studies for Public Goods

Table 1 summarizes some current examples of environmental valuation studies comparing benefit estimates for public goods using the HPM and the CVM. The first study reported in Table 1 was to value flood risk reduction from construction of a flood control project (Shabman & Stephenson, 1996). The methods used in the study were HPM, CVM, and the property damages avoided (PDA) valuation technique. Voter referendum, using actual past voting records, was also used to further interpret the results for comparison with the CVM results. The methods were used for testing the validity and accuracy of nonmarket valuation techniques. Substantial differences were found between the values from all methods. The hedonic mean estimates were more than 4 times larger than the CVM reported values and twice as large as PDA. Azevedo et al. (2003) suggests though that "discrepancies between the individual parameter estimates obtained using RP and SP estimates are not necessarily indicative of a failure of either method, but instead suggestive that the two sources are working in correcting the limitations inherent in each method" (p. 527).

Table 1

Previous Applied Valuation Studies: Nonlandscaping

Author(s)	Year of article	Environmental good	Valuation method
Shabman and Stephenson	1996	Flood risk reduction	CVM, HPM, PDA[9]
Ready et al.	1997	Farmland	CVM, HPM
Tyrvainen	1997	Urban forest	HPM
Tyrvainen and Vaananen	1998	Urban forest	CVM
Belhaj	2003	Air Pollution	CVM, HPM
Nijland	2003	Noise abatement	CVM, HPM
Qiu et al.	2006	Riparian buffer and open space	CVM, HPM

Ready et al. (1997) conducted the second study reported in Table 1.The CVM and HPM were used to compare the benefits of the amenity value of horse farmland to Kentucky residents. Differences were reported between the values from both methods, with the CV reported WTP values being 20% lower than the HPM estimated values. Ready et al. concluded that these results were not statistically significant and could have been due to random error. Ready et al. also suggested that the CVM and HPM values, being close in magnitude, increased their confidence in both estimates. Ready et al. found

[9] The study by Shabman and Stephenson (1996) also used the property damages avoided (PDA) valuation technique in addition to the HPM and the CVM.

that income,[10] age, education, and sex were not individually significantly related to WTP. The researchers concluded that their results "demonstrate that both contingent valuation and hedonic pricing can be useful tools for evaluating external impacts that accompany regional changes in land use" (p. 454).

The third comparison in Table 1 involves two separate studies: Tyrvainen (1997), which used the HPM, and Tyrvainen and Vaananen (1998), which used the CVM. Both studies measured the amenity values of urban forests and wooded recreation areas (reported to be positive environmental amenities) related to housing prices in the same city in Finland.

In the HPM study by Tyrvainen (1997), the benefit of urban forests was reflected in the property prices of nearby apartment housing. Linear and semi-log models were used for regression analysis. The R^2 for the linear model was 0.664, and it was 0.659 for the semi-log model. In the linear model, the age, number of rooms, presence of a sauna, and roof type were significant coefficients. Additional rooms decreased the apartment price, and a sauna increased the apartment price. Age and distance to the center of town were reported as the strongest explanatory variables related to apartment price. All environmental variables were significant at the 5% and 10% levels, with most having a positive influence on apartment price. The implicit prices were used to evaluate the changes in the environmental assets. The presence of forest parks had a negative effect on house prices. On the other hand, increasing the amount of forested area in the housing

[10] Ready et al. (1997) suggested that income not being significantly related to WTP was "not that uncommon in CV studies, due to a combination of difficulties in measuring income . . . and the fact that dichotomous choice data [which was used by Ready et al.] contains relatively less information than continuous data" (pp. 455–456).

district had a positive effect on prices. Nearness to a watercourse and recreation areas was also reported as having a positive effect on house prices.

In the CVM study by Tyrvainen and Vaananen (1998), visitors to the wooded recreation areas reported WTP for the use of wooded recreation areas. This WTP, the researchers reported, contributed to the quality of the housing environment. There was a 68% response rate to the questionnaire. Forest views from an apartment and the use of the wooded recreation areas were positive significant explanatory variables for WTP. The level of income did not have an effect on WTP. Sex, family type or size, education level, and housing type were not statistically significant.

The fourth study in Table 1 by Belhaj (2003) estimated WTP for reduction of air pollution caused by road traffic in Morocco using the HPM and CVM. The mean WTP estimated by the HPM was quite similar to the WTP values reported using the CVM where distance to the town center was used as a proxy for environmental factors. Several variables had a positive impact on WTP in the Belhaj study including; younger age, higher income, some education, environmental awareness.

The fifth study in Table 1 was conducted by Nijland et al. (2003) and valued the external environmental effect of traffic noise to be used in a cost–benefit analysis of possible noise abatement measures. Variables included structural, neighborhood, and environmental characteristics. The structural characteristics were the number of rooms and the heating system. The neighborhood characteristics were proximity to schools and shops. The environmental variables were noise levels. Benefits were calculated according to consumer preferences for dwellings based on values estimated from HPM and reported from the CVM. Costs were surpassed by benefits. HPM was used to yield a price for noise reduction derived from the difference in house prices. The results revealed that richer people tended to live in more expensive houses in quieter areas, while poorer people tended to live in less expensive houses in noisy areas.

The sixth study in Table 1 was by Qiu et al. (2006), evaluating riparian buffers and open space in a suburban watershed through two nonmarket valuation methods. They evaluated residents' perceptions of and their WTP for adopting riparian buffers and preserving farmland in real estate markets. HPM variables included lot size, number of bathrooms, bedrooms, total rooms, base area, total area, property age, land value, lot area, garage size, sale price, school zoning, and size. WTP values were consistent with the economic values of open space and proximity to streams embedded in existing home prices. HP functions using full samples had the following results: (a) R^2 was 0.5235 and (b) the F value was 380.55. The researchers found that property with open space sold for 4% more than similar property without open space. They also reported that sales prices decreased about $12 for each meter away from a stream at the sample mean. If properties were within a flood zone, the sales prices would drop by 5%.

Comparison Studies for Private Goods

Some studies have compared nonmarket values for private environmental goods. Many of the comparison studies of private goods have involved responses from contingent valuation surveys and collection of market data to value consumer items such as food items, automobiles, paintings, or lottery tickets (e.g., Bhatia & Fox-Rusby, 2003; Blumenschien, Johannesson, Yokoyama, & Freeman, 2001; Cummings, Harrison, & Rutstrom, 1995; Johannesson, Blomquist, Blumenschein, Johansson et al., 1999; Loomis, Brown, Lucero, & Peterson, 1996; Neill, Cummings, Ganderton, Harrison, et al., 1994; Willis & Powe, 1998). These studies are summarized in Appendix A.

Only a few studies have used private goods for valuing the effects of environmental amenities on house prices using two types of valuation methods for comparison, one method being the HPM. In housing bundles, the homeowner has control over the quality or quantity of private goods, such as landscaping, an environmental characteristic. Some studies have measured the benefits of landscaping or trees on house prices using two or more types of valuation methods (see, e.g., Anderson & Cordell, 1988; Des Rosiers, Theriault, Kestens, & Villeneuve, 2002; Henry, 1994, 1999; Morales, 1983; Morales, Micha, & Weber, 1983; Theriault, Kestens, & Des Rosiers, 2002).[11]

Applied Environmental Valuation Literature for Landscaping

Noneconomic Research

This research examines a private environmental good, xeriscape landscaping, associated with residential housing. Residential landscaping is a private good, and water conservation is a public good. For the purpose of this study, residential xeriscape landscaping will be defined as a private environmental good[12] with public policy dimensions of reduced water consumption. This section reviews the landscaping literature that summarizes preferences and valuation issues related to xeriscape. The first section reviews positive and negative factors impacting preferences. The second section reviews the landscaping literature and summarizes the environmental and structural

[11] These studies are listed in Table 2.

[12] While xeriscaping can be enjoyed by more than just the homeowner, in the literature, landscaping type is treated as a private good and does not meet the definition of quasi-private good or quasi-public good (Carson, 1999; Mitchell & Carson, 1989). So to be consistent with the literature, xeriscape is defined herein as an environmental private good.

characteristics impacting house prices.

Positive Factors

Four surveys reported preferences for xeriscape or native gardens due to attractiveness, ease of maintenance, and the variety of desirable plants provided. In a preference survey by Cotter and Croft (1974)[13] in New Mexico, xeriscape was considered attractive and easier to maintain than non-xeriscape landscaping. Respondents to a second survey by Thayer (1982) in California reported that xeriscape was as attractive as turf. In a third preference survey by Spinti et al. (2004) in Arizona, xeriscape was again considered attractive. Respondents to the Spinti et al. (2004) survey also indicated (a) a willingness to use desert plants and xeriscape and (b) that desert plants provided the variety of plants they desired. The most popular garden type in the Kirkpatrick et al. (2007) study was the simple native garden.

Studies conducted in several southwestern states also reported water usage, shortage, and savings as reasons for preferring xeriscape. Participants in three separate studies in New Mexico, California, and Arizona indicated preferences for xeriscape landscaping because it uses less water (Cotter & Croft, 1974; Kennedy & Zube, 1991; Thayer, 1982). In a fourth Texas survey, participants said they would use native plants in their landscaping if the plants conserved water (Lockett, Montague, McKenney, & Auld, 2002). Water shortages were listed as a reason New Mexico homeowners would reduce water usage on landscapes (Spinti et al., 2004). Additionally, water price, water scarcity, and drought conditions affected landscape choices in a second New Mexico preference survey by Hurd (2006). Water savings was also a reason affecting xeriscape landscape

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[13] This study was the only non-peer reviewed article, but it is included for its perspective on preference survey formation and results from one of the first studies on xeriscape.

choices specifically (Hurd, 2006). After a conversion of turf to xeriscape in southern Nevada, there was a 33% average reduction of household water consumption reported in a 5-year study (Sovocool, Morgan, & Bennett, 2006).[14] Kirkpatrick, et al. (2007) reported the expense of using water appeared to encourage garden types that did not require heavy watering.

A link was reported between preferences for xeriscape and monetary savings (Hurd, 2006; Sovocool et al., 2006). Yearly labor costs for xeriscape maintenance were reported to be $206 lower than yearly labor costs for turf-dominated landscape maintenance in a southern Nevada study (Sovocool, 2005). There was also an additional $240 savings in water costs reported in the same southern Nevada study (Sovocool,

In the landscaping literature, education and residency were two socioeconomic factors linked with preferences for xeriscape. An Arizona study by Kennedy and Zube (1991) found that the longer residents lived in the area, the more they reported an appreciation for xeriscape. Results from a 2002 study by Lockett et al. indicated that the more education participants had, the more time they spent in horticultural activities. Lockett et al.'s (2002) results also suggested that more education and more time in horticultural activities were linked to a greater preference for xeriscape. Spinti et al. (2004) found that the less time residents had lived in the area, the more willing they were to use desert plants in their backyards, regardless of the impact on property value (Spinti et al., 2004).

[14] These savings were based on the conversion of 2,160 square feet from turf to xeriscape, with 2004 pricing information (Sovocool, 2005).

Negative Factors

Several surveys found in the literature reported respondents' reasons for not preferring xeriscape. Some people in Texas considered xeriscape not aesthetically pleasing and too expensive to maintain (Lockett et al., 2002). In an Arizona study by Martin, Peterson, and Stabler (2003), the longer residents lived in the area, the more they preferred nonxeriscape. In a second Arizona study, Spinti et al. (2004) found that there was no correlation between years spent in the Southwest or years spent in rural areas and willingness to use desert landscaping in participants' front yards. In the same study by Spinti et al. (2004), a lower percentage of survey respondents reported that they actually had desert landscaping compared to those who said they were willing to use desert plant materials. In a New Mexico study, respondents did not prefer xeriscape in two out of three cities (Hurd, 2006). In the Australian study (Kirkpatrick, et al., 2007) it appeared that people over age 65, renters, and people living in homes in higher altitudes did not prefer native gardens.

Summary of Noneconomic Research

Table 2 provides a summary overview of the previous xeriscape landscaping studies reported in the literature review using field surveys, consumer surveys, homeowner surveys, and workshops to elicit preferences for xeriscape[15] landscaping.

Two additional studies used homeowner surveys and market data to estimate the impact of xeriscape on water costs (Hurd, 2006; Hurd & Smith, 2005). One other additional study used homeowner data and market data to estimate the impact of xeriscape on water costs (Sovocool et al., 2006). A total of 13 studies are represented in

[15] Studies referring to native garden landscaping are also included in this table even though they were not referred to as xeriscape landscapes in the original studies.

Table 2: (a) five studies used homeowner surveys, (b) two studies used consumer surveys, (c) two studies used a combination of consumer surveys and workshops, (d) two studies used a combination of homeowner surveys and market data,[16] (e) one study used homeowner data and market data, and (f) one study used a field survey.

Table 2

Previous Applied Valuation Studies: Xeriscape Landscaping

Author	Year of Article	Type of Survey	Landscaping Characteristic	Study Site
Cotter & Croft	1974	Homeowner survey	Xeriscape	New Mexico
Thayer	1982	Homeowner survey	Xeriscape	California
Kennedy and Zube	1991	Consumer survey	Xeriscape	Arizona
Lohr and Bummer	1992	Consumer survey, workshop	Xeriscape	Washington
McKenney and Terry	1995	Consumer survey workshop	Xeriscape	Texas
Lockett et al.	2002	Consumer survey	Xeriscape	Texas
Martin et al.	2003	Homeowner survey	Xeriscape	Arizona
Spinti et al.	2004	Homeowner survey	Xeriscape	New Mexico
Hurd and Smith	2005	Homeowner survey market data	Xeriscape	New Mexico
Hurd	2006	Homeowner survey market data	Xeriscape	New Mexico
Larsen and Harlan	2006	Homeowner survey	Xeriscape	Arizona
Sovocool et al.	2006	Homeowner data market data	Xeriscape	Nevada
Kirkpatrick et al.	2007	Field survey	Native Gardens	Australia

[16] Table 3 will be presenting landscaping valuation studies later in this chapter, which provided landscaping values as a percentage of house value. Three studies (Hurd, 2006; Hurd & Smith, 2005; Orland, Vining, & Ebero, 1992) did not provide a percentage of house value in their results, so they are not listed in Table 3, but are included in Table 2.

Economic Research

This section reviews the environmental and structural characteristics impacting house prices in the applied economic environmental valuation literature for landscaping. The structural characteristics associated with housing reviewed in this section include type of house; square footage; lot size; and numbers of bedrooms, bathrooms, garages, and patios. The environmental characteristics reviewed in this section include trees and landscaping.

In the literature review, landscaping is an environmental characteristic that can impact house values positively or negatively. In a study by Orland, Vining, & Ebero (1992), attractive landscaping was associated with high house values, while little or poor landscaping contributed to low house values. In two studies by Henry (1994, 1999), property values increased by 7% and 6%, respectively, with better landscaping. According to Des Rosiers et al. (2002), other landscaping characteristics can also positively impact property values, including (a) a high percentage of lawn cover and (b) features such as flower arrangements, rock plants, the presence of a hedge, and so on. Although when an above average density of vegetation was visible from the property, Des Rosiers et al. (2002) added, there was a negative impact on house prices. Good landscaping, Behe, Hardy, Barton, et al. (2005) reported, could increase the perceived value of a home. Behe, et al. (2005) further added that the size of plants and the sophistication of landscape design[17] were found to contribute positively to house values.

The literature review also revealed that trees, specifically in landscaping, can impact house values positively or negatively. In a 1973 study in Amherst, Massachusetts,

[17] Behe et al. (2005) defined *sophisticated design* as landscapes with curved beds, island beds, and peninsulas with more plant materials.

Payne found that the presence of mature trees[18] positively impacted property value.[19] The impact was positive as the number of trees increased up to 30. There was a decline in the property value, though, after the number of mature trees exceeded 30 (Payne, 1973). In a 1980 study in Manchester, Connecticut, Morales found that a substantial amount[20] of mature tree cover on a property could increase sales price by 6%. In a 1983 study by Morales et al., there was an increase of a range of 11% or 17% in property value with trees present, depending on the evaluation method. In another study by Anderson and Cordell (1988) in Georgia, a lower, estimated 4% increase in sales price was associated with trees in the landscape. In the same Georgia study, it was found that as lot and sale characteristics[21] increased, so did the number of trees (Anderson & Cordell, 1988). In a study in Champaign-Urbana, Illinois, Orland et al. (1992) found that "for more expensive properties there was a slight increase in value for the addition of smaller trees, but a decrease associated with large trees. For less expensive properties there was no significant effect of tree presence or size" (p. 298). In a study by Dombrow, Rodriquez, and Sirmans (2000) in Louisiana, it was estimated that trees added approximately 2% to home values.

Table 3 summarizes the studies comparing or validating benefit estimates from two methods, previously reviewed, linking house price valuation with trees or landscaping. These studies used HPM and/or field surveys and/or homeowner surveys or consumer surveys for comparison or validation of benefits related to residential

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[18] Trees only added value when they were 6 in. or more in diameter.
[19] The study was conducted on simulated half-acre lots.
[20] *Substantial amount* was defined as between 50% and 60% of the lot in mature tree cover (Morales, 1980).
[21] Lot and sales characteristics can include factors such as house size, number of amenities, and number of bathrooms (Anderson & Cordell, 1988).

landscaping. These studies were selected because they also provided a percentage added to house sales price for landscaping or trees.[22] Four of these studies used the HPM and field surveys to estimate the benefits of trees or landscaping (Anderson & Cordell, 1988; Des Rosiers et al., 2002; Morales, 1980; Theriault et al., 2002). Two of the studies used consumer surveys to measure the benefits of landscaping (Behe et al., 2005; Hardy, Behe, Barton et al., 2000). Two of the studies used field surveys, homeowner surveys, and HPM to measure the value of trees (Morales et al., 1983; Theriault et al., 2002). One study used HPM to estimate the value of trees (Dombrow et al., 2000). Each study is summarized individually in the next sect

Table 3

Previous Applied Economic Environmental Valuation Studies: Landscaping

Author	Year of article	Environmental good	Valuation method	Percentage added to house sales price	Dollar value added to house sales price
Morales	1980	Trees	Field survey, HPM	0.06	2,686
Morales et al.	1983	Trees	Field survey, homeowner survey, HPM	0.17 and 0.11	9,500 and 6,000
Anderson and Cordell	1988	Trees	Field survey, HPM	0.04	1,613
Henry	1994	Landscaping	Field survey, HPM	0.07	6,936
Henry	1999	Landscaping	Field survey, HPM	0.06	5,444
Hardy et al.	2000	Landscaping	Consumer survey	0.13	23,147
Dombrow et al.	2000	Trees	HPM	0.02	1,800
Des Rosiers et al.	2002	Landscaping	Field survey, HPM	0.08	8,624
Theriault et al.	2002	Trees	Field survey, homeowner survey, HPM	0.03	3,422
Netusil	2005	Trees & Stream Slope & Stream	HPM	0.13 -0.16	$33,014 -$40,334
Behe et al.	2005	Landscaping	Consumer survey	0.08	3,012

[22] Hurd and Smith (2005), Hurd (2006), Payne (1973), and Orland et al. (1992), although valuation studies, did not provide percentages added to house sales price for landscaping or trees.

The earliest study reported in Table 3 was by Morales in 1980 to determine whether or not trees contributed to residential property value and the extent of that contribution using data from homes within two different areas in Manchester, Connecticut. Through a field survey, tree cover was observed and reported. Market data were obtained for square footage of home, number of bathrooms, square footage of lot, number of fireplaces, number of garages, date of sale, tree cover, and location and used in the multiple linear regression analysis. The field survey and market data indicated a 6% to 9% increase in sales price for homes with tree cover, dependent on location.

The second study reported in Table 3 was in 1983 by Morales et al., reporting results from a similar study from the city of Greece, New York. The comparison houses (trees and no trees) were located in the same neighborhoods. Morales et al. used four sources of information to value the contribution of trees to home value: (a) homeowner survey responses, (b) general appraisers' observations, (c) an arborist appraiser's guide, and (d) market data. Market data included the following factors: square footage of home, number of rooms, square footage of lot, number of fireplaces, number of garages, date of sale, house age, and tree cover. Regression analysis was used. The results showed that tree cover does contribute to the value of residential property in Rochester, New York. Tree cover attributed an estimated range of 11% to 17% increase in home value. The value estimates were dependent on the method used. The method using the appraiser's guide provided the lowest value estimates.

The third study in Table 3, conducted in 1988 by Anderson and Cordell, evaluated the effect of lot and tree variables on house price. A field survey and market data were used in this study. Housing structural factors provided the market data for regression analysis. The housing structural factors included house size, house age, number of trees in front yard, number of fireplaces, lot size, capacity of carports and garages, presence of central air conditioning, and total number of rooms. The results were as follows: (a) R^2 was estimated in the range of 77% to 79%; (b) all coefficients were statistically significant for the $p < .05$ level; and (c) the presence of trees added an estimated 4% to 5% premium to the house sales price.

The fourth and fifth studies in Table 3 were by Henry in 1994 and 1999 in Greenville, South Carolina. The studies estimated the impact of landscaping on house value. Two hundred and eighty-eight homes were used in the 1994 study and 218 homes in the 1996 study. In both studies, the regression models were similarly structured so results could be compared. Landscape and design professionals conducted a survey to evaluate individual home landscaping and neighborhoods. Housing and tax data were also used from the County Assessors Office. Housing characteristics, location, and landscape quality were the types of data used in both studies. The survey and market data were combined for analysis. A logged form of regression was used in the 1994 analysis due to heteroscedasticity problems in the linear form. The logged form improved the fit of the model. Linear and log linear regressions were used in the 1999 study. The quality of landscaping on nearby lots added an estimated 10% to property value in the 1994 study and 19% in the 1999 study. Traffic was negatively associated with sales price in the 1994 study, lowering house value by an estimated 5% when near a heavily traveled road. Traffic was not a significant contributor to sales price in the 1999 study. Each of the Henry studies is summarized in the following paragraphs.

The results from the Henry (1994) study indicated that house value estimates positively increased from 4% to 10% with improved landscaping. The 4% to 10% range is summarized as follows: (a) a 4% to 5% estimated increase for upgrades from good to excellent landscaping; (b) an 8% to 10% increase for upgrades from average/poor to good landscaping; (c) a 4% to 5% increase for upgrades to the highest level of landscaping, if neighboring lots were excellent; and (d) an 8% to 10% negative impact on sales price if landscapes on neighboring lots were less appealing. Additional results reported were as follows: (a) the coefficient of variation was 1.96, (b) R^2 accounted for 63.6% of the variation in home sales price, (c) R^2 adjusted was 61.9%, (d) the F value was 37.91, and (e) the RMSE was 0.224.

The results from the Henry (1999) study indicated that house values would positively increase from (a) 4% to 10% with improved landscaping, (b) 6% to 7% with upgrades from good to excellent landscaping, and (c) 4% to 5% with upgrades from average/poor to good landscaping. Additional results reported for the Henry (1999) study were as follows: (a) the coefficients of variation were 3.18–3.23, (b) the R^2 accounted for 74% to 75% of the variation in home sales prices, (c) the R^2 adjusted was 73% to 74%, (d) the F values were 61–73, and (e) the RMSE was 0.364–0.370.

The sixth study reported in Table 3 is Hardy et al. (2000). A consumer survey of 158 people was conducted at a flower show in Detroit, Michigan, to determine the value of landscaping on home value. Participants were asked to evaluate landscaping through a series of photographs of one home with different landscape designs. Participants were also asked a series of questions about gardening involvement, plant knowledge, and demographic information about themselves. Conjoint analysis was used for evaluation of the data. There was an estimated 13% increase in home value when homes had the most valued landscape.

The seventh study in Table 3, by Dombrow et al. (2000), related to tree valuation in Baton Rouge, Louisiana. An arborist's guide from the same appraisers association as in the Morales et al. (1983) study was used in this study. Multiple regression analysis was used to estimate the market value of homes with mature trees. A semi-log form of regression controlled for physical and neighborhood characteristics, time trends, and unusual conditions of sale. Multicollinearity was controlled, but heteroskedasticity was evident. The independent variables explained 85% of variance in the model. Coefficients were all significant, except for fireplace and below market financing. The results indicated that mature trees contributed to an estimated 2% of home values.

The eighth study in Table 3 is Des Rosiers et al. (2002) and was conducted in the territory of the Quebec Urban Community. The researchers performed a field survey of home sites and collected market data. The study investigated the effect of landscaping on house values. The researchers used three different models using linear and semi-log linear function forms. The semi-log forms yielded better results with higher *t* values. Results indicated that visible surrounding tree cover had a positive impact on property prices. The overall results estimated a 3% to 12 % increase in property value with the presence of various types of landscaping, including (a) hedges (4%), (b) landscaped curbs (4%), and (c) landscaped patios (12%).

Theriault et al. (2002) conducted the ninth study in Table 3 in Quebec City. There were several different sources of data used in this study: (a) an opinion poll of home buyers, (b) a summary of the homeowner's home sales price, (c) an on-site survey of properties to assess vegetation, (d) socioeconomic attributes of families, (e) census data,

(f) accessibility to services, and (g) a description of transacted homes. A two-step approach was used, combining hedonic and binary logistic models. A semi-logged hedonic model was used to assess the specific contribution of mature trees to house value. Binary logistic regression was used to model the likeliness of choosing a property with mature trees. Multicollinearity was limited in the hedonic model, with variance inflation factors less than 5. Heteroskedasticity in the hedonic model was minimal due to the use of the semi-log form. Results indicated that (a) values increased with increased proximity to services and (b) socioeconomic factors impacted values. The mean estimation of impact of mature trees on house values varied between 9% and 15%, depending on the socioeconomic status of the neighborhood. This study provided a different approach by "combining economic and behavioural modeling to enhance understanding of landscaping in urban regions" (Theriault et al., 2002, p. 478).

Netusil (2005) reported the tenth study reported in Table 3.The HPM was used to examine how sales price of homes were related to environmental zoning and amenities. The on-site interactive amenities of trees/stream and slope/stream are the two specifically related to this dissertation research. The sales price of houses sold between 1999 and 2001 in Portland, Oregon were used in the Netusil study. The HPM estimated that properties steeply sloped with a stream sold for an estimated 16% less than properties without those environmental characteristics. There was an estimated 13% increase in sales price for properties with a stream and trees present. The effect of the stream variables on sales price did not vary across the five quadrants of the study area.

The most current study reported in Table 3, the 11th study, is by Behe et al. (2005). A survey was conducted in seven states in the eastern and central United States.

Voluntary participants viewed photographs that depicted landscaping in a home's front yard. Participants were asked to determine which landscaping attributes they valued the most. Design sophistication was most valued, followed by plant size; least important was plant material type. The results from participants in all seven states indicated that home values increased from an estimated 5% to 11% with good landscaping.

Summary

What Is Known About Studies Using HPM and CVM

A wide variety of studies were found that used HPM and CVM in different approaches. Studies were reported in the environmental literature that used hedonic pricing and contingent valuation to value the effects of public or quasi-public environmental goods on house prices. Other studies used one method to validate the results of the other method[23] (Shabman & Stephenson, 1996; Qiu et al., 2006). Studies comparing benefits from two methods[24] were also present (Nijland, 2003; Ready et al., 1997; Tyrvainen, 1997; Tyrvainen & Vaananen, 1998). Four studies compared results or combined data with hedonic pricing and stated preference methods to value the effects of private environmental goods on house prices (Henry, 1994, 1999; Morales et al., 1983; Theriault et al., 2002). One comparison study measured the benefits of xeriscape landscaping on water costs, but not its effect on house prices (Larsen & Harlan, 2006).

[23] Studies prior to 1996 are summarized in Carson et al. (1996) and are not reported here.

[24] Smith, Van Houtven, and Pattanayak (2002) also used HPM, CVM, and travel cost method in a complementary approach, but combined the data. The Smith study is not applicable to this study and is thus only mentioned for completeness.

What Is Known About Xeriscape

This section summarizes what is known about xeriscape with respect to its advantages and disadvantages for individuals and the community.

Advantages for Individual Homeowners and the Community

The literature revealed several advantages for individual homeowners using xeriscape landscaping, including the following: (a) maintenance can be easier, (b) less water is used, (c) money is saved on water costs, (d) labor maintenance costs are lower, and (e) xeriscape is considered attractive and aesthetically pleasing and provides the variety of plants desired by homeowners.

Disadvantages for Individual Homeowners and the Community

The literature also reported disadvantages of using xeriscape landscaping for individual homeowners and the community: (a) xeriscape was not considered to be aesthetically pleasing by some people and was therefore not always preferred and (b) xeriscape was considered too expensive to maintain.

What Is Not Known

Currently, there are no studies comparing the value estimates of private environmental goods using the HPM and the CVM. Furthermore, there are no studies comparing the value estimates of xeriscape landscaping.

In summary, several gaps in the literature can be seen: absent in the literature are (a) xeriscape valuation studies using the HPM, (b) xeriscape valuation studies using the CVM, (c) studies comparing benefits estimated from the HPM and reported WTP values from the CVM for private goods, and (d) xeriscape application studies comparing benefits estimated from the HPM and reported WTP values from the CVM. This scarcity of research gave rise to the following question: How does a value estimate from the HPM and a reported WTP value from the CVM compare for a private good such as xeriscape landscaping? To answer this question, this research (a) used the HPM to estimate if market participants valued a private good such as xeriscape and (b) used the CVM to report if survey participants valued a private good such as xeriscape landscaping.

Research Questions

The following three research questions guide the remainder of this study:

Research Question 1: Do market participants value xeriscape landscaping?

Research Question 2: Do survey participants report a positive WTP value for xeriscape landscaping?

Research Question 3: How does a value estimate from the HPM and a reported WTP value from the CVM compare for xeriscape landscaping?

Hypothesis Tests

There are three hypothesis tests in this study. The first research question is: Do market participants value xeriscape landscaping? The null and alternative hypotheses based on this first research question are, respectively, that the mean HPM estimate is equal to zero and that it is greater than zero. Before the first hypothesis test could be performed a coefficient needed to be estimated. A preliminary test, Test 1a, provided this necessary information.

Test 1a

The null hypothesis is that the coefficient from the HPM regression analysis for xeriscape is equal to zero, while the alternative is that it is greater than zero. β is the coefficient for the private environmental good from the HPM regression analysis. Most previous studies have suggested that β will be greater than zero for landscaping at residential locations (e.g., Behe et al., 2005; Hardy et al., 2000; Morales et al., 1983; Theriault et al., 2002).

$$H1a_0 : \beta_{HPM} = 0$$
$$H1a_A : \beta_{HPM} > 0$$

Test 1

Do market participants value xeriscape landscaping? The null hypothesis is that the mean HPM estimate is equal to zero, while the alternative is that it is greater than zero. $\overline{X}_{HPM}$ is the mean estimate of the xeriscape. $\overline{X}_{HPM}$ is estimated by multiplying the mean house price from the sample by the coefficient from the HPM regression analysis to estimate a percentage of house price attributed to xeriscape. The hypothesis test 1 was adapted from Dale et al. (1999)[25].

$$H1_0 : \overline{X}_{HPM} = 0$$
$$H1_A : \overline{X}_{HPM} > 0.$$

Test 2

The second research question is: Do survey participants report a positive WTP value for xeriscape landscaping? The null and alternative hypotheses based on this research question are, respectively, that the mean reported WTP value through a CVM study is zero dollars and that they are greater than zero dollars. The majority of previous

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[25] Dale et al. (1999) tests issues dealing with time, distance, and location.

studies report a positive WTP for a private good, such as trees and landscaping, in a housing market (e.g., Anderson & Cordell, 1988; Des Rosiers et al., 2000; Dombrow et al., 2000; Henry, 1994, 1999; Morales, 1980; Morales et al., 1983; Theriault et al., 2002). $\overline{X}_{\text{CVM}}$ is the mean WTP for a private good reported by survey participants:

$$H2_0 : \overline{X}_{\text{CVM}} = 0$$
$$H2_A : \overline{X}_{\text{CVM}} > 0.$$

Test 3

Research question 3 is: How does a value estimate from the HPM and a reported WTP value from the CVM compare for xeriscape landscaping? The null and alternative hypotheses based on this research question are, respectively, that the mean HPM estimate is equal to the mean reported WTP value through a CVM study and that they are not equal. For public and quasi-public goods, theory and the majority of previous empirical studies suggest that the HPM estimate will be greater than reported WTP value from the CVM (Blomquist, 1988; Carson et al., 1996). So in this study the findings are expected to concur with the findings of the previous studies and theoretical expectations. $\overline{X}_{\text{HPM}}$ is the mean estimate of a private good for HPM. $\overline{X}_{\text{CVM}}$ is the mean WTP reported for a private good using the CVM. This third test is based on the Blomquist (1988) theoretical expectations:

$$H3_0 : \overline{X}_{\text{HPM}} = \overline{X}_{\text{CVM}}$$
$$H3_A : \overline{X}_{\text{HPM}} > \overline{X}_{\text{CVM}}$$

The next chapter discusses the methods and presents the data for this study.

CHAPTER 3

STUDY SITE, METHODS, AND DATA

This chapter describes the study site, explains the methods used in the data analysis, and presents the HPM and CVM data for a private good and is divided into four sections: (a) description of study site, (b) methods to test hypotheses, (c) real estate market data and neighborhood data, and (d) survey design and data.

Description of Study Site

The study area chosen for this research project was Clark County in southern Nevada. This area is a highly populated, arid region, with less than 4.5 inches of rainfall annually (Sovocool et al., 2006). The water supply for southern Nevada comes primarily from the Colorado River basin (Sovocool, 2005). The Southern Nevada Water Authority (SNWA) was formed in 1991 to manage these water resources.

Drought conditions began in southern Nevada in 1999 and continued through 2004. SNWA implemented a Drought Plan in 2003 as the drought became more severe. The Drought Plan put forth that "the biggest potential for water savings comes from reduction in consumptive water demand, primarily, in the form of outdoor water-uses, such as landscape irrigation" (SNWA-WRP, 2006, p. 18). One of the suggestions in the plan included the reduction of turf grass in landscapes, which could reduce water usage and costs. Installation of xeriscape landscapes was another action that could reduce water usage and costs. Thus a tiered water-rate structure[26] was implemented to promote the reduction of turf and use of xeriscape as a conservation tactic (Sovocool, 2005). This tiered water-rate structure was employed to discourage water use; as water use would increase, costs would also increase simultaneously. Even after the severe drought conditions subsided in 2005, an SNWA committee recommended even "more aggressive promotion of water conservation and regulation of water use through methods such as the reduction of turf" (SNWA-IWPAC, 2005, p. 8). It is expected that this continued aggressive promotion will help alleviate any problems in the future.

As part of their promotion of water conservation and regulation, the SNWA started a program called Water Smart Landscapes in 1999 to promote xeriscape. Rebates were offered as an incentive to convert turf areas. In 2004–2005, the time frame of this study, the converted areas needed to be covered with at least 50% living plant materials, when fully grown, and the remaining area with mulch. One dollar per square foot was offered for the first 1,500 ft^2 converted. Fifty cents per square foot was offered for any additional areas over 1,500 ft^2. At least 400 ft^2 total needed to be converted. Drip irrigation water systems with filter pressure regulators had to be used. Also drip-emitter rates needed to be set at less than 20 gallons per hour. If sprinklers were used, they had to be modified so they would not spray the converted area. The converted area had to remain in compliance for at least 10 years. There were no specific plants required as replacements for the turf, but property owners were encouraged to use drought-tolerant plants.

As a result of this initiative, more than 26.8 million ft^2 of turf was converted in

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[26] The tiered water-rate structure is an increasing block rate structure that is set up "such that the more a user consumes on an average daily basis within a cycle, the more expensive, per unit (i.e., per gallon), water becomes" (Sovocool, 2005, p. 52).

2004. Since the program began in 1999, over 64 million ft^2 of turf have been replaced. Since 1999, an estimated 3.5 billion gallons of water has been saved annually (SNWA-WRP, 2006, p. 18).

Clark County, Henderson, the city of Las Vegas, North Las Vegas, and Boulder City all limit, restrict, or prohibit the amount of turf planted on new properties and old properties. Different types of restrictions apply, based on the drought stage at the time building permits are issued. The three drought stages are (a) no drought; (b) drought watch; and (c) drought alert. For new single-family homes built during no drought or drought watch stages, all of the cities limit the front yard to 50% turf, except for Boulder City, which limits both front and backyard areas to 50% turf. During a drought alert stage, no new turf is allowed in front yards in any city, except for Boulder City, which allows 50% of the amount of turf that is allowed under nondrought conditions (SNWA-Turf, 2007).

The SNWA recognized that public outreach was a necessary part of establishing support for its plan. Thus public education programs became an important part of the SNWA policies. The goal of these programs is to help the public understand that responsible water use is a critical part of living in a desert environment. Understanding about water use is necessary before people will accept regulation and pricing mandates or participate in incentive programs (SNWA, 2006, p. 19).

Because xeriscape landscaping is actively encouraged in the desert region of southern Nevada, this area provides an optimal location to examine (a) the impact of xeriscape landscaping on home values and (b) whether xeriscape can be considered an amenity or disamenity.

Table 4

Definitions for HPM and CVM Data and Sources for Clark County

Variable	Variable definition	Variable category	Type of data	Data source
lsize	Lot size (ft^2)	Structural characteristics	CVM data	Assessor's
hsize	The square footage of my home is _____.	Structural characteristics	CVM data HPM data	Assessor's and perspective
hardscape	Hardscape (ft^2)	Structural characteristics	HPM data	Assessor's
landscape	Landscaped area (ft^2)	Structural characteristics	HPM data	Assessor's
garage	Garage (ft^2; 1 = present, 0 = absent)	Structural characteristics	HPM data	Assessor's
pool	I have a swimming pool. Presence of pool (1 = present, 0 = absent)	Structural characteristics	CVM data HPM data	Assessor's
patio	Patios (ft^2; 1 = present, 0 = absent)	Structural characteristics	HPM data	Assessor's
parcel	Parcel number	Neighborhood characteristics	HPM data	Assessor's
address	Home address	Neighborhood characteristics	HPM data	Assessor's
zip code	My zip code is _____. Property zip code	Neighborhood characteristics	CVM data HPM data	Assessor's and perspective
sales date	Date house sold	Property value, time frame	HPM data	Assessor's
hprice	My property value is _____. House price (USD)	House price Property value	CVM data HPM data	Assessor's
construction date	The age of my home is _____. Age (years)	Time frame	CVM data HPM data	Assessor's
occupied units	How many homes occupied	Neighborhood characteristics	Neighborhood characteristics	Perspective
number of units	Number of homes	Neighborhood characteristics	Neighborhood characteristics	Perspective
population	Number of people	Neighborhood characteristics	Neighborhood characteristics	Perspective
age	What is your age? Age of adults (years)	Neighborhood characteristics	Neighborhood characteristics	Survey
grad	What is the highest education level you have completed? Education of adults	Neighborhood characteristics	Neighborhood characteristics	Survey and perspective

Variable	Variable definition	Variable category	Type of data	Data source
children	Presence of children	Neighborhood characteristics	Neighborhood characteristics	Perspective
mobile home	Housing type	Neighborhood characteristics	Neighborhood characteristics	Perspective
single family	Housing type	Neighborhood characteristics	Neighborhood characteristics	Perspective
household income	The annual income bracket for my family is ______.	Neighborhood characteristics	Neighborhood characteristics	Survey
medinc	Median income (USD)	Neighborhood characteristics	Neighborhood characteristics	Perspective
How long have you lived in southern Nevada?	Years in southern Nevada	Neighborhood characteristics	Neighborhood characteristics	Survey and perspective
actual_xeri	I have at least 51% southwestern desert-type landscape "Xeriscape" in my front and backyard. (strongly agree to strongly disagree)	Environmental characteristics	CVM data HPM data	Survey and assessor's
actual_nonxeri	I have at least 51% turf-dominated-type landscape in my front and backyard. (strongly agree to strongly disagree)	Environmental characteristics	CVM data HPM data	Survey and assessor's
wtp (nonxeri) 5E, 5G	What is the maximum extra dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping if you were buying the house?	Preferences, willingness-to-pay	CVM data	Survey
wtp (xeri) 5F, 5H	What is the maximum extra dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping if you were buying the house?	Preferences, willingness-to-pay	CVM data	Survey
chose_nonxeri 5E, 5G	Given these two landscapes (of the identical house), which one do you prefer?	Preferences	CVM data	Survey
chose_xeri 5F, 5H	Given these two landscapes (of the identical house), which one do you prefer?	Preferences	CVM data	Survey

Variable	Variable definition	Variable category	Type of data	Data source
like_non-xeri 1A, 1C	Xeriscape landscape (most favorite to least favorite comparison with three other photos)	Preferences	CVM data	Survey
like_xeri 1B, 1D	Non-xeriscape-dominated landscape (most favorite to least favorite comparison with three other photos)	Preferences	CVM data	Survey
xeri_pleasing	Water-conserving landscapes called "xeriscapes" are aesthetically pleasing (strongly agree to strongly disagree)	Preferences	CVM data	Survey
gender	What is your gender? (male, female)	Neighborhood characteristics	CVM data	Survey

Methods to Test Hypotheses

Two methods were used to value benefits of a private good, xeriscaping, for homeowners in Clark County, Nevada: HPM and CVM. The benefits from the two methods are then compared. HPM and CVM data sources are presented in Table 4. The analytical results of the HPM and CVM data are presented in chapter 4.

There are different ways of reporting statistical values in the literature: using either point estimates with one or more significant figures and/or a range of values. Hassenzahl (2006) suggested presenting "no more than one significant figure in tables" (p. 274) when "available evidence does not warrant precise quantification" (p. 273). Hassenzahl also advocated "listing a range of plausible values [that] allows us to distinguish between robust and nonrobust estimates" (p. 273). The previous studies used for HPM-CVM comparisons with the current study presented point estimates and more than one significant figure in their tables (Belhaj, 2003; Nijland, 2003; Qiu et al., 2006;

Ready et al., 1997; Shabman & Stephenson, 1996; Tyrvainen, 1997; Tyrvainen & Vaananen, 1998). Thus, for purposes of comparison, this study will present estimates and report values in the same way as the previous HPM-CVM comparison studies cited in this study.

Real Estate Market Data and Neighborhood Data

Real estate market data and socioeconomic data were used for the analysis of Research Question 1: Using the HPM, do market participants value xeriscape landscaping? A total of 500 homes were used in this study. Two hundred fifty homes had xeriscape landscaping, and 250 homes had nonxeriscape landscaping. Each xeriscape landscaped home was paired with a nonxeriscape landscaped home, and each pair was located within the same subdivision. The SNWA and Clark County Assessors Office provided structural characteristics of homes and environmental information for this real estate market data selection. The Las Vegas Chamber of Commerce (LVCC, 2004, 2005) also provided neighborhood data through the zip code profiles.

Three hundred ten homes completed the SNWA turf reduction program from 1999 to 2004 and were sold between January 2004 and June 2005. These homes were known to have xeriscape landscaping. Of the 310 homes, 60 homes were eliminated in the process of determining the 250 nonxeriscape landscaped homes for comparison. This elimination process will be described in the following paragraphs.

Data about these 310 xeriscape landscaped homes were compiled from the Clark County Assessors Office database. Data included parcel number, subdivision name, dwelling owner(s), dwelling address, construction year, sales date, dwelling square footage, lot square footage, first floor square footage, pool square footage, garage square footage, and patio square footage. Factors related to most of these variables, or the variables themselves, had been identified from previous HPM studies of landscaping associated with housing (Anderson & Cordell, 1988; Des Rosiers et al., 2002; Dombrow et al., 2000; Henry, 1994, 1999; Morales, 1980; Morales et al., 1983; Theriault et al., 2002). There was one exception, which was first floor square footage, used specifically for this study to calculate the square footage of the landscapable area.[27]

Lot sizes, dwelling sizes, sales dates, and subdivision names of the 310 xeriscape homes were limiting statistics used to determine the selection of the 250 nonxeriscape homes for the comparisons. These limiting factors determined the amount of landscapable area. The average lot size of the xeriscape homes was 6,389 ft^2. The maximum lot square footage value was 10,890, and the minimum value was 2,614. These maximum and minimum values were used to determine the three standard deviations of 1,616 ft^2 to set the upper boundary of 11,237 ft^2 and the lower boundary of 1,541 ft^2. Of this xeriscape group, the maximum lot square footage value was within the upper boundary set, and the minimum lot square footage value was within the lower boundary set. The average dwelling square footage of the xeriscape homes was 1,815. The maximum dwelling square footage value was 3,222, and the minimum value was 991. These maximum and minimum values were used to determine the setting of three standard deviations of 480 ft^2 to set the upper boundary of 3,256 ft^2 and the lower boundary of 375 ft^2. Of this xeriscape group, the maximum dwelling square footage value

[27] The landscape area represented the lot square footage minus the hardscape area (which included the square footage of first floor of the dwelling, garages, and patios).

was within the upper boundary set, and the minimum dwelling square footage value was within the lower boundary set.

The average lot size of the 310 xeriscape homes was 6,389 ft^2. The average hardscape[28] area of the xeriscape homes was 2,783 ft^2. Thus the average landscapable area of the 310 xeriscape homes was the average lot size, 6,389 ft^2, minus the average hardscape area, 2,783 ft^2, which equaled an average of 3,606 ft^2.

The following procedure was used for determining the 250 nonxeriscape comparison homes and limiting the xeriscape homes from 310 to 250, thus eliminating 60 xeriscape homes. The Clark County Assessors Office database was the source of information to obtain additional information about the 310 homes. The database was also used to obtain the matching set of nonxeriscape homes for comparison. The landscape area and hardscape area of the nonxeriscape homes were calculated from the information provided by the Assessors Office, as described previously for the xeriscape homes. The market data (after conversions) included the following structural characteristics: (a) lot square footage, (b) dwelling square footage, (c) hardscaped area square footage, (d) landscaped area square footage, (e) garage square footage, (f) pool square footage, and (g) patio square footage. The data also included parcel number, address, zip code, sales price, sales date, and construction year for each home.

To select the 250 nonxeriscape homes, several restrictions were applied when accessing the public data from the Clark County Assessors Office. Those homes that had already converted to xeriscape were eliminated. Homes were limited to Las Vegas Valley Water District customers, in case water usage data are needed for further analysis. Homes

[28] The hardscape area represented the combined total square footage of the first floor of the dwelling, patios, and garages.

that were constructed after 2003 were eliminated so that the age of newer homes would not be a factor in comparison with older homes. There were 34,745 potential matches that met the minimum qualifications. Then, further restrictions were applied to limit these potential matches. Home selections were restricted to subdivisions where the xeriscape homes were located. Also, pool square footage, dwelling square footage, and lot square footage were used to further limit selections. Only homes that were sold between January 2004 and June 2005 were included. The sales dates of the nonxeriscape homes were subtracted from the sales dates of the xeriscape homes to determine the two sets of homes with the most closely matched sales dates; 2,328 potential nonxeriscape matches were identified.

These 2,328 potential nonxeriscape matches were then entered into one spreadsheet, prioritized by parcel number, and matched with a xeriscape property in the same subdivision. From 1 to 93 potential nonxeriscape matches were identified for each xeriscape property. Each matched set, the xeriscaped home and the group of nonxeriscape potential matches, was prioritized by the percentage of how much the dwelling square footage of the potential nonxeriscape homes matched the square footage of the xeriscape home. The following information was also included to determine the most reasonable matches: (a) the percentage of how much the lot square footage of the potential nonxeriscape homes matched the lot square footage of the xeriscape home, (b) how much the actual dwelling and lot square footage of each xeriscape and potential nonxeriscape home matched; and (c) limiting selections to the least difference between the sales dates of the potential nonxeriscape home and the xeriscape home.

Aerial photographs of the potential nonxeriscape homes were then examined through the Clark County Assessors Web site. These photographs were examined to determine if they had turf or trees present on the property. If turf or trees were present, then the potential nonxeriscape homes were evaluated on how well their dwelling and lot sizes and sales dates matched the xeriscape comparison home. Two hundred fifty of the most closely matched pairs were chosen for the real estate market data set for this study.

The average lot size of the 250 xeriscape homes was 6,274 ft^2. The average hardscape area of the xeriscape homes was 2,739 ft^2. Thus the average landscapable area of the 250 xeriscape homes was the average lot size, 6,274 ft^2, minus the average hardscape area, 2,739 ft^2, which equaled an average of 3,535 ft^2.

The average lot size of the 250 nonxeriscape homes was 6,288 ft^2. The average hardscape area of the nonxeriscape homes was 2,732 ft^2. Thus the average landscapable area of the 250 nonxeriscape homes was the average lot size, 6,288 ft^2, minus the average hardscape area, 2,732 ft^2, which equaled an average of 3,556 ft^2.

Additional neighborhood variables were obtained from the Las Vegas Chamber of Commerce (2004, 2004) zip code profiles. The neighborhood variables selected were (a) number of occupied housing units, (b) number of housing units, (c) population, (d) presence of children, (e) mobile home, (f) single-family home, (g) median household income, (h) living in Clark County for less than 1 year, and (i) living in Clark County for more than 20 years. These variables were chosen, based on previous HPM valuation studies, to determine any influence on sales price and subsequent xeriscape values (Des Rosiers et al., 2002; Henry 1994, 1999; Theriault et al., 2002). Some of the other factors were chosen because of their possible influence on sales price and subsequent xeriscape values, as indicated in previous HPM housing studies estimating the influence of environmental externalities, other than landscaping, on sales price (Azevedo et al., 2003; Ethier, Poe, Schulze, & Clark, 2000; Loureiro, McCluskey et al., 2003; Mohamed, 2006; Neill, Hassenzahl, & Assane, 2007; Ready et al., 1997; Ruijgrok, 2006). The descriptive statistics for use with the HPM are presented hereafter.

HPM Descriptive Statistics

Table 5 contains the descriptive statistics for the real estate market data and the location data. The real estate market data are contained in the first three sections of Table 5, dependent variable, structural characteristics, and environmental characteristics, while the neighborhood data are located in the fourth section of Table 5, neighborhood variables.

Dependent Variable

The first section of Table 5 contains data concerning the dependent variable, house sale price (A-1), containing information about the sales price of the 500 homes comprising the real estate market data. The mean house value of the combined sales price of the nonxeriscape and xeriscape homes was $317,090. The mean sales price of the nonxeriscape homes was $306,851, and the mean sales price of the xeriscape homes was $327,329. The mean sales prices of the xeriscape and nonxeriscape homes were within an estimated 6% of one another, indicating that selling prices were very similar.

Structural Characteristics

The second section of Table 5 contains the structural characteristics. The first characteristic, house size (B-1), contains the sales price of the 500 homes comprising the real estate market data. The mean dwelling square footage of all groups within this

Table 5

Descriptive Statistics for Hedonic Data

No.	Variable	Units	*n*	Mean	Median	*SD*	*SE*	Min	Max
				A: Dependent variable					
A-1	House sale price	Log (USD)							
	hprice all		500	317089.97	300000.00	91590.11	4096.03	70000.00	780000.00
	hprice nonxeri		250	306851.09	295500.00	90201.73	5704.86	79863.00	710000.00
	hprice xeri		250	327328.85	311000.00	92001.76	5818.70	70000.00	780000.00
				B: Structural characteristics					
B-1	House size	ft^2							
	hsize all		500	1801.18	1737.50	467.93	20.93	991.00	3206.00
	hsize nonxeri		250	1800.99	1755.50	459.73	29.08	998.00	3206.00
	hsize xeri		250	1801.36	1728.00	476.91	30.16	991.00	3206.00
B-2	House age	years							
	hage all		500	8.52	8.50	3.28	0.15	1.50	14.50
	hage nonxeri		250	8.50	8.50	3.22	0.20	1.50	14.50
	hage xeri		250	8.54	8.50	3.34	0.21	2.50	14.50
B-3	Pool	percent							
	pool all		500	0.13	0.00	0.34	0.02	0.00	1.00
	pool nonxeri		250	0.13	0.00	0.34	0.02	0.00	1.00
	pool xeri		250	0.13	0.00	0.34	0.02	0.00	1.00
B-4	Lot size	ft^2							
	lotsize all		500	6284.81	6098.00	1450.96	64.89	3049.00	10454.00
	lotsize nonxeri		250	6290.01	6098.00	1455.40	92.05	3049.00	10019.00
	lotsize xeri		250	6279.60	6098.00	1449.41	91.67	3049.00	10454.00
B-5	Hardscape	ft^2							
	hard all		500	2735.86	2604.50	737.43	32.98	1270.00	6054.00
	hard nonxeri		250	2731.54	2617.00	708.46	44.81	1401.00	5565.00
	hard xeri		250	2740.17	2595.50	766.70	48.49	1270.00	6054.00
B-6	Landscape	ft^2							
	land all		500	3542.41	3469.50	1152.52	51.54	1177.00	8244.00
	land nonxeri		250	3549.63	3496.00	1136.05	71.85	1177.00	6937.00
	land xeri		250	3535.19	3446.00	1171.00	74.06	1433.00	8244.00

No.	Variable	Units	*n*	Mean	Median	*SD*	*SE*	Min	Max
B-7	Garage	percent							
	garage all		500	1.00	1.00	0.06	0.00	0.00	1.00
	garage nonxeri		250	1.00	1.00	0.06	0.00	0.00	1.00
	garage xeri		250	1.00	1.00	0.06	0.00	0.00	1.00
B-8	Patio	percent							
	patio all		500	0.98	1.00	0.13	0.01	0.00	1.00
	patio nonxeri		250	0.98	1.00	0.13	0.00	0.00	1.00
	patio xeri		250	0.98	1.00	0.13	0.01	0.00	1.00
				C: Environmental characteristics					
C-1	Landscape type	percent							
	landtype all		500	1.00	1.00	0.00	0.00	1.00	1.00
	landtype nonxeri		250	0.50	0.50	0.50	0.02	0.00	1.00
	landtype xeri		250	0.50	0.50	0.50	0.02	0.00	1.00
				D: Neighborhood variables					
D-1	Child	percent							
	child all		500	0.33	0.33	0.06	0.00	0.18	0.49
	child nonxeri		250	0.33	0.33	0.06	0.00	0.18	0.49
	child xeri		250	0.34	0.33	0.06	0.00	0.18	0.49
D-2	Mobile home	percent							
	mobile all		500	0.02	0.00	0.05	0.00	0.00	0.23
	mobile nonxeri		250	0.02	0.00	0.05	0.00	0.00	0.23
	mobile xeri		250	0.02	0.00	0.04	0.00	0.00	0.23
D-3	Single family	percent							
	single family all		500	0.73	0.75	0.16	0.01	0.12	1.00
	single family nonxeri		250	0.72	0.73	0.17	0.01	0.12	1.00
	single family xeri		250	0.74	0.75	0.16	0.01	0.18	1.00
D-4	College graduate	percent							
	grad all		500	0.21	0.19	0.09	0.00	0.09	0.85
	grad nonxeri		250	0.21	0.19	0.09	0.01	0.09	0.85

No.	Variable	Units	*n*	Mean	Median	*SD*	*SE*	Min	Max
	grad xeri		250	0.21	0.19	0.09	0.01	0.09	0.85
D-5	Median income	USD							
	medinc all		500	57854.11	58137.50	10427.75	466.34	22264.00	86451.50
	medinc nonxeri		250	57053.84	58137.50	11092.04	701.52	22264.00	86451.50
	medinc xeri		250	58654.37	58904.00	9674.37	611.86	32518.50	86451.50
D-6	Live less 1 year	percent							
	liveless all		500	0.07	0.06	0.03	0.00	0.00	0.15
	liveless nonxeri		250	0.07	0.06	0.03	0.00	0.00	0.15
	liveless xeri		250	0.07	0.06	0.03	0.00	0.00	0.15
D-7	Live more 20 years	percent							
	livemore all		500	0.24	0.23	0.07	0.00	0.10	0.43
	livemore nonxeri		250	0.25	0.23	0.07	0.00	0.10	0.43
	livemore xeri		250	0.24	0.23	0.07	0.00	0.10	0.43
D-8	Vacant	percent							
	vacant all		500	0.05	0.05	0.03	0.00	0.00	0.17
	vacant nonxeri		250	0.05	0.05	0.03	0.00	0.00	0.17
	vacant xeri		250	0.05	0.05	0.03	0.00	0.00	0.17
D-9	Population change[a]	rate of change							
	popch all		500	12.32	7.50	25.93	1.16	–28.90	118.20
	popch nonxeri		250	11.96	5.40	25.54	1.62	–28.90	118.20
	popch xeri		250	12.67	7.50	26.36	1.67	–28.90	118.20
D-10	Housing change[b]	rate of change							
	houch all		500	6.33	3.70	11.87	0.53	–31.20	47.80
	houch nonxeri		250	5.96	2.30	11.65	0.74	–31.20	47.80
	houch xeri		250	6.69	4.70	12.09	0.76	–31.20	47.80

Note: Neighborhood demographics from *Las Vegas Perspective 2004–2005*.
[a]Rate of population change by zip code = [(pop05 – pop04)/pop04] × 100 (Neill et al., 2007).
[b]Rate of housing change by zip code = [(hou05 – hou04)/hou04) × 100 (Neill et al., 2007).

subsection was 1,801. The house square footage estimates were within less than 1% of one another, indicating that all groups of homes had almost identical square footages.

The second structural characteristic, house age (B-2), concerns the age of the 500 homes comprising the real estate market data. The mean house age of the combined nonxeriscape and xeriscape homes was 8.52 years. The mean house age of the nonxeriscape homes was 8.50 years, and the mean house age of the xeriscape homes was 8.54 years. The estimates were within less than 1% of one another, indicating that all groups of homes were of similar age.

The third structural characteristic, pool (B-3), concerns the presence and size of pools as part of the 500 homes comprising the real estate market data. The mean presence of pools of the combined nonxeriscape and xeriscape homes was 13%. The mean estimates were within 7% of one another, indicating a similar number of pools present in all groups of homes.

The fourth structural characteristic, lot size (B-4), concerns the lot square footage of the 500 homes comprising the real estate market data. The mean lot size of the combined lot square footages of the nonxeriscape and xeriscape homes was 6,285. The mean lot size of the nonxeriscape homes was 6,290 ft^2, and the mean lot size of the xeriscape homes was 6,280 ft^2. The mean estimates were within less than 1.0% of one another, indicating that all groups of homes had almost identical lot square footage.

The fifth structural characteristic, hardscape (B-5), concerns the square footage of the hardscaped area of the 500 homes comprising the real estate market data. The mean hardscaped area of the combined hardscaped square footages of the nonxeriscape and xeriscape homes was 2,736 ft^2. The mean hardscaped area of the nonxeriscape homes was 2,732 ft^2, and the mean hardscaped area of the xeriscape homes was 2,740 ft^2. The mean estimates of all groups were within less than 1% of one another, indicating that all groups of homes had almost identical hardscaped areas in square footage.

The sixth structural characteristic, landscape (B-6), concerns the square footage of the landscaped area of the 500 homes comprising the market data. The mean landscaped area of the combined landscaped square footages of the nonxeriscape and xeriscape homes was 3,542 ft^2. The mean landscaped area of the nonxeriscape homes was 3,549 ft^2, and the mean landscaped area of the xeriscape homes was 3,535 ft^2, slightly larger than the nonxeriscape landscaped area.

The seventh structural characteristic, garage (B-7), concerns the percentage of homes with a garage. Almost all homes reported having a garage, as indicated by the mean of 1.0.

The eighth structural characteristic, patio (B-8), concerns the percentage of homes with a patio. A mean of 98% of the homes in all groups in this subsection had a patio.

Environmental Characteristics

Landscape type (C-1) concerns the percentage of homes with xeriscape or nonxeriscape landscaping. The mean percentage of homes with nonxeriscape landscaping was 50, and for homes with xeriscape landscaping, the mean was 50%. The mean estimates were within 1% of one another, indicating that all groups of homes had almost identical square footages of landscaped areas.

Neighborhood Variables

The next section of Table 5 contains neighborhood data about the 500 homes from the Las Vegas Chamber of Commerce (LVCC, 2004, 2005). All estimates were obtained from homes in the same zip code areas as the 500 homes.

The first neighborhood variable, children (D-1), reports that the mean percentage of homes that had children was 33 for all homes and for the nonxeriscape home categories; the mean percentage was 34 for xeriscape homes, a slightly higher percentage than for nonxeriscape homes.

The second neighborhood variable, mobile home (D-2), reports the mean percentage of those homes that were mobile homes as 2, the same for all groups within this subsection.

The third neighborhood variable, single family (D-3), reports the mean percentage of homes that were single-family dwellings to be in the range of 72 to 74: 73% for all homes, 72% for nonxeriscape homes, and 74% for xeriscape homes, all very similar percentages.

The fourth neighborhood variable, college graduate (D-4), reports that 21% of the people living in the zip code areas graduated from college, regardless of landscape type.

The fifth neighborhood variable, median income (D-5), reports the median income of all households as $57,854, with nonxeriscape homes at $57,054 and xeriscape homes at $58,654, with a range of 2% from each other, showing very similar incomes.

The sixth neighborhood variable, live less 1 year (D-6), reports that 7% of the residents had lived in the area less than 1 year, regardless of landscape type.

The seventh neighborhood variable, live more 20 years (D-7), reports that 24% to 25% of the residents had lived in the area for more than 20 years.

The eighth neighborhood variable, vacant (D-8), reports that 5% of the homes on average were reported to be vacant between 2004 and 2005, regardless of the landscape type.[29]

The ninth neighborhood variable, population (D-9), reports the rate of population change by zip code area between 2004 and 2005 (Neill et al., 2007). The rate of change for all homes was 12.32; for nonxeriscape homes, 11.96; and for xeriscape homes, 12.67, all very similar.

The final neighborhood variable, housing change (D-10), reports the rate of change of homes by zip code. The rate of change ranged from 5.96 to 6.69 for all three categories. The rate of change for all homes was 6.33; for nonxeriscape homes, 5.96; and for xeriscape homes, 6.69, all within 11% of one another.

HPM Models

The value added to xeriscape homes relative to nonxeriscape homes can be estimated by ordinary least squares regressions, where the dependent variable is the sales price of the homes (Mohamed, 2006). There are four models used for regression analysis in this study. Three of the models are based on variables used in previous HPM studies reported in the literature (Des Rosiers et al, 2000; Henry, 1994, 1999; Thierault, 2002). The fourth model contains variables from the previous studies plus the additional variables reported in Table 2. The regression model of HPM follows equation 5 previously presented in Chapter 2: $P = f[S, N, SE, Q]$ (Rosen, 1974).

[29] The total number of units in the area for 2005 was subtracted from the number of occupied units to get the number of unoccupied units. Then this number of unoccupied units was divided by the total number of units in the area to get the percentage of vacant homes in the zip code areas.

Three groups of variables[30] are used in the hedonic models in this study: (a) structural variables (*S*); (b) neighborhood variables (*N*); and (c) environmental characteristics (*Q*). The following structural variables (*S*) represent the following attributes associated with the site, size, and quality of the home: (a) square footage of house (*house size* and *hsize*), (b) age of house (*house age* and *hage*), (c) presence of pool (*pool*), (d) square footage of hardscape (*hardscape*), (e) square footage of landscape (*landscape*), (f) presence of garage (*garage*), and (g) presence of patio (*patio*). On the basis of previous studies, the researcher hypothesized that house size (*hsize*), lot size (*lot size*), pool (*pool*), and garage (*garage*) will positively affect home value, while house age (*hage*) will negatively affect home value (Des Rosiers et al. 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al. 2002).

The following neighborhood characteristics (*N*) represent the location and character of the neighborhood and market factors: (a) dwelling is a single-family home (*single family*), (b) dwelling is a mobile home (*mobile home*), (c) presence of children (*child*), (d) graduated college (*edugrad*), (e) median household income (*incmed*), (f) percentage of people living in the zip code areas where the homes were located for less than 1 year (*live less*), (g) percentage of people living in the zip code areas where the homes were located for more than 20 years (*live more*), (h) rate of change of population in the zip code areas where the homes were located (*popch05*), and (i) rate of new homes in the zip code areas where the homes were located (*houch05*). On the basis of previous studies, the researcher hypothesized that median household income (*incmed*), college graduates (*edugrad*), and change in population (*popch05*) will positively affect home

[30] These three groups are adapted from a previous study by Neill et al. (2007).

value, while the rate of new homes (*houch05*) will negatively impact home value, and the presence of children (*child*) may affect home value positively or negatively (Des Rosiers et al. 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al. 2002).

The environmental characteristic (*Q*) includes xeriscape landscaping (*xeri*), which the researcher hypothesized to positively affect home value.

The basic regression is as follows:

$$lhprice = \beta_0 + \beta_1 (hsize) + \beta_2 (hage) + \beta_3 (pool) + \beta_4 (lot\ size) + \beta_5 (hardscape)$$
$$+ \beta_6 (landscape) + \beta_7 (garage) + \beta_8 (patio) + \beta_9 (child) + \beta_{10} (mobile\ home)$$
$$+ \beta_{11} (single\ family) + \beta_{12} (edugrad) + \beta_{13} (incmed) + \beta_{14} (live\ less) + \beta_{15} (live\ more)$$
$$+ \beta_{16} (vacant) + \beta_{17} (popch05) + \beta_{18} (houch05) + \beta_{19} (xeri) + u,$$

where

lhprice = the natural log of the selling price

β_0 = the intercept in the regression

β_i = the regression coefficients, $i = 1, 2, \ldots 19$

hsize = house size in square feet

hage = house age in years

pool = presence of pool

lotsize = lot size in square feet

hardscape = size of hardscaped area in square feet

landscape = size of landscaped area in square feet

garage = presence of garage

patio = presence of patio

child = presence of children in zip code areas where homes are located

mobile home = percentage of dwellings that are mobile homes in zip code areas where homes are located

single family = percentage of dwellings that are single-family homes in zip code areas where homes are located

edugrad = percentage of college graduates in zip code areas where homes are located

incmed = median income of households in zip code areas where homes are located

live less = percentage of people living in the area less than 1 year in zip code areas where homes are located

live more = percentage of people living in the area more than 20 years in zip code areas where homes are located

vacant = percentage of homes that are vacant in zip code areas where homes are located

popch05 = rate of change of population in zip code areas where homes are located

houch05 = rate of new homes in zip code areas where homes are located

xeri = a dummy variable equal to 1 for homes with xeriscape landscaping and 0 for homes with nonxeriscape landscaping

u = the error term.

Model 1

Model 1 was based on a study by Theriault et al. (2002), in which the effect of mature trees on home value was estimated. Theriault et al. used the following variables common to this study: (a) structural characteristics *hprice, hage, pool,* and *garage* and (b) neighborhood characteristics *child, edugrad,* and *incmed.* This researcher also included the environmental characteristic *xeri.* On the basis of previous studies, this researcher hypothesized that house size, income, and the presence of pools would have a positive effect on house value, while the presence of children might have a positive or negative impact (Des Rosiers et al., 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al., 2002).

Model 2

Model 2 is based on a study by Des Rosiers et al. (2002), in which the authors estimated the effect of landscaping on home value. Des Rosiers et al. used the following variables, which were common to this study: (a) structural characteristics *hsize, lotsize, pool, garage,* and *patio* and (b) neighborhood characteristics *single family, child, edugrad,* and *incmed.* This researcher also used the environmental characteristic *xeri* and hypothesized that house size (*hsize*) and college graduates (*edugrad*) will have a positive effect on house value (Des Rosiers et al., 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al., 2002).

Model 3

Henry (1994, 1999) estimated the effect of landscaping on home value in two studies used for Model 3.Henry used the following variables, which were common to this study: structural characteristics *hsize, lotsize,* and *garage*. The environmental characteristic *xeri* was also included in this study. The researcher hypothesized that house size (*hsize*) will have a positive effect on the presence of xeriscape (Des Rosiers et al., 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al., 2002).

Model 4

Model 4 was based on the studies by Theriault et al. (2002), Des Rosiers et al. (2002), and Henry (1994, 1999), who estimated the effects of trees and landscaping on home value; additional variables were added from data available through the Las Vegas County Assessors Office and the Las Vegas Chamber of Commerce. The following variables were used: (a) structural characteristics *hsize, hage, pool, lotsize, hardscape, landscape, garage,* and *patio*; (b) neighborhood characteristics *child, mobile home, single family, edugrad, incmed, liveless, livemore, vacant, popch05,* and *houch05*; and (c) environmental characteristic *xeri*. It was hypothesized, based on previous study results, that house size (*hsize*), pools (*pool*), median household income (*incmed*), college graduates (*edugrad*), and change in population (*popch05*) will have a positive effect on house value, while the rate of new homes (*houch05*) will negatively impact home value, and the presence of children (*child*) may have a positive or negative impact (Des Rosiers et al., 2002; Henry, 1994, 1999; Neill et al., 2007; Theriault et al., 2002).

The regression results were used for Hypothesis Test 1a. The null hypothesis is that the coefficient from the HPM regression analysis is equal to zero, while the alternative is that it is greater than zero:

$$H1a_0 : \beta_{HPM} = 0$$
$$H1a_A : \beta_{HPM} > 0$$

The results from test 1a are used in Hypothesis Test 1:

$$H1_0 : \overline{X}_{HPM} = 0$$
$$H1_A : \overline{X}_{HPM} > 0,$$

where $\overline{X}_{HPM}$ is the estimate of the private good, xeriscape, which is the percentage of house sales price the homeowners were willing to pay to acquire a home with xeriscape landscaping. The null hypothesis is the mean HPM estimate is equal to zero, while the alternative is that it is greater than zero. The $\overline{X}_{\text{HPM}}$ is estimated by multiplying the mean house price from the sample by the coefficient from the HPM regression analysis to estimate a percentage of house price attributed to the environmental good: The following equation was used to calculate the mean xeriscape value for the four models and thus the WTP value estimated from the four hedonic models:

$$\overline{X}_{\text{HPM}} = \overline{\text{WTP}}_{\text{HPM}}$$
$$= \frac{(\overline{hprice}_{xeri})(\beta_{xeri\ 1}) + (\overline{hprice}_{xeri})(\beta_{xeri\ 2}) + (\overline{hprice}_{xeri})(\beta_{xeri\ 3}) + (\overline{hprice}_{xeri})(\beta_{xeri\ 4})}{4} \quad (10)$$

where $\overline{hprice}_{xeri}$ equals the average house value (sales price) of the 250 xeriscape homes included in the market data, $\beta_{xeri\,1}$ is the xeriscsape coefficient for Model 1, $\beta_{xeri\,2}$ is the xeriscape coefficient for Model 2, $\beta_{xeri\,3}$ is the xeriscape coefficient for Model 3, and β_{xeri4} is the xeriscape coefficient for Model 4. This xeriscape value for the HPM ($\overline{X}_{\text{HPM}}$) can then be compared with the xeriscape WTP value ($\overline{X}_{\text{CVM}}$) reported by respondents to the CVM survey.

Survey Design and Data

Survey data were used for the contingent valuation method of analysis for Research Question 2: Using the CVM, do survey participants value a private good such as xeriscape landscaping?

Homeowners of the 500 homes selected from the Clark County Assessors Office and the SNWA database were sent a survey questionnaire (Appendix B). The survey

Table 6

Variable Characteristics and Descriptions for CVM

Variable	Variable category	Variable description
hprice	House price, property value	My property value is _____.
hsize	Structural characteristics	The square footage of my home is _____.
hage	Structural characteristics	The age of my home is _____.
pool	Structural characteristics	I have a swimming pool.
actual_xeri	Environmental characteristics	I have at least 51% southwestern desert–type landscape "Xeriscape" in my front and backyard. (strongly agree to strongly disagree)
actual_nonxeri	Environmental characteristics	I have at least 51% turf-dominated-type landscape in my front and backyard. (strongly agree to strongly disagree)
wtp (nonxeri) 5E, 5G	Knowledge and preferences, willingness-to-pay	Nonxeriscape landscape (photo) chosen. What is the maximum extra dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping if you were buying the house?
wtp (xeri) 5F, 5H	Knowledge and preferences, willingness-to-pay	Xeriscape landscape (photo) chosen. What is the maximum extra dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping if you were buying the house?
like_nonxeri 1A, 1C	Knowledge and preferences	Nonxeriscape landscape (photo). I like this landscape. (strongly agree to strongly disagree)
like_xeri 1B, 1D	Knowledge and preferences	Xeriscape landscape (photo). I like this landscape. (strongly agree to strongly disagree)
chose_nonxeri 5E, 5G	Knowledge and preferences	Nonxeriscape landscape (photo) chosen. Given these two landscapes (of the identical house), which one do you prefer?
chose_xeri 5F, 5H	Knowledge and preferences	Xeriscape landscape (photo) chosen. Given these two landscapes (of the identical house), which one do you prefer?

Variable	Variable category	Variable description
xeri_desire	Knowledge and preferences	Feelings about using desert plants. They provide the landscape I desire. (strongly agree to strongly disagree)
look_attractive	Knowledge and preferences	Feelings about using desert plants. They look attractive. (strongly agree to strongly disagree)
xeri_pleasing	Knowledge and preferences	Water-conserving landscapes, called "xeriscapes," are aesthetically pleasing. (strongly agree to strongly disagree)
age_person	Neighborhood characteristics	What is your age? (20 or less, 21–24, 25–30, 31–40, 41–50, 51–64, 65+ years)
gender	Neighborhood characteristics	What is your gender? (male, female)
income	Neighborhood characteristics	The annual income bracket for my family is ____.
education	Neighborhood characteristics	What is the highest education level you have completed?

asked respondents to make a choice between a hypothetical xeriscape-landscaped home and a status quo non-xeriscape-landscaped home.

Table 6 lists variables and data sources used for this CVM analysis. On the basis of previous CVM studies, four sets of independent variables were chosen to be included in the survey: (a) structural characteristics, (b) environmental characteristics, (c) knowledge and preferences, and (d) neighborhood characteristics (Brookshire, Thayer, Schulze, & d' Arge, 1982; Chattopadhyay, Braden, & Patunru 2005; Neill et al., 2007; Ready et al., 1997; Schlapfer, Roschewitz, & Hanley, 2004; Tyrvainen & Vaananen, 1998).

The Human Subjects review group approved the experimental design survey protocol on March 7, 2005, and a copy is in Appendix C. A supplementary protocol was also approved to be posted on the World Wide Web on January 20, 2006. The Human

Subjects review group did not allow any matching of the CVM responses directly with the HPM data due to privacy issues and human subjects regulations.

In addition to questions about the respondents' WTP, the survey provided a description of xeriscape and nonxeriscape landscaping and an overview of water conservation issues in Clark County, Nevada. Recipients were asked to report several neighborhood characteristics: house age, number of bedrooms, house size, presence of pool, zip code, residential area type, property value, amount of time living in the area, household income, gender, education, and household size.

The respondents were also asked to report their homes' landscaping type, type of grass, type of irrigation system, influence of landscaping on purchasing decision, and type of landscape conversion. The questionnaire also asked respondents to express their opinions about water conservation and landscaping preferences. The framework and content of several of the questions about landscaping and irrigation included in this survey were based on previous landscaping preference surveys (see, e.g., Behe et al., 2005; Hardy et al., 2000; Theriault et al., 2002), and some were based specifically on previous xeriscape landscaping preference surveys (see, e.g., Hurd, 2006; Hurd & Smith, 2005; Larsen & Harlan, 2006).

CVM Descriptive Statistics

Table 7 presents the descriptive statistic results for the CVM analysis based on the responses to the questionnaire. A total of 91 questionnaires were undeliverable and returned unopened. Forty-one respondents completed the survey and returned their answers by mail. An additional 500 postcards were sent 3 months after the initial survey, inviting potential participants to complete the survey via the Internet. An additional eight surveys were completed online. Out of the 500 postcard reminders, the Internet survey invitations, and the 49 delivered questionnaires, a total of 49 questionnaires were completed either online or through the mail, with a 12% response rate.

Since these were anonymously returned there was no way of knowing if those that completed the survey online had also completed a hard copy of the survey and mailed it in. Calculations were performed on the 41 mailed in survey participants WTP responses to see if they differed from the total 49 participants WTP responses. The results were within 8% from both groups. The results from the total respondents are reported in this study.

The descriptive statistics data of Table 7 are divided into three sections: (a) single variables, (b) double variable combinations, and (c) multiple variable combinations. The first section (Section A), containing single variables, is divided into five subsections: A-1 (preferences [text]), A-2 (preferences [photos]), A-3 (house [text]), A-4 (neighborhood [text]), and A-5 (WTP [text and photos]). The second section (Section B), containing double variables combined, is divided into three subsections: B-1 (preferences and personal), B-2 (preferences/WTP and personal information), and B-3 (preferences and WTP). The third section (Section C), containing multiple variables combined, is divided into three subsections: C-1 (preferences and WTP), C-2 (preferences, WTP, and neighborhood), and C-3 (preferences, WTP, and house). Charts are included for reference within the text with information from Table 7. Percentages and N values were approximated from the reported information when not available from the descriptive statistics directly. The terms *yes* and *no* were used to approximate responses from the likert scale questions. A summary of each of these sections and subsections follows.

Table 7

Descriptive Statistics for Contingent Valuation Data

No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
				A: Single variables					
A-1	Preferences (text)								
	xeri_pleasing	xeri	49	0.80	0.75	0.16	0.02	0.50	1.00
	look_attractive	xeri	49	0.76	0.75	0.18	0.03	0.00	1.00
	xeri_desire	xeri	49	0.71	0.75	0.22	0.03	0.00	1.00
	actual_nonxeri	nonxeri	49	0.42	0.25	0.38	0.05	0.00	1.00
	actual_xeri	xeri	49	0.64	0.75	0.41	0.06	0.00	1.00
A-2	Preferences (photos)								
	like_nonxeri 1A	nonxeri	48	0.52	0.50	0.30	0.04	0.00	1.00
	like_xeri 1B	xeri	49	0.45	0.25	0.27	0.04	0.00	1.00
	like_nonxeri 1C	nonxeri	49	0.79	0.75	0.25	0.04	0.25	1.00
	like_xeri 1D	xeri	49	0.57	0.75	0.38	0.05	0.00	1.00
	chose_nonxeri 5E	nonxeri	46	0.02	0.00	0.15	0.02	0.00	1.00
	chose_xeri 5F	xeri	46	0.98	1.00	0.15	0.02	0.00	1.00
	chose_nonxeri 5G	nonxeri	49	0.29	0.00	0.46	0.07	0.00	1.00
	chose_xeri 5H	xeri	49	0.71	1.00	0.46	0.07	0.00	1.00
A-3	House (text)								
	hprice	USD	41	406,390	395,000	129,493	20,223	120,000	700,000
	hsize	ft^2	49	2,046	1,750	618	88	1750	4000
	hage	years	49	9.37	8.00	4.60	0.66	2.00	20.00
	pool	percent	49	0.33	0.00	0.47	0.07	0.00	1.00
A-4	Neighborhood (text)								
	age_person	years	49	47.03	45.00	12.56	1.79	22.50	70.00
	gender	m = 1, f = 0	47	0.45	0.00	0.50	0.07	0.00	1.00
	income	USD	45	90,778	102,500	29,149	4,345	37,500	125,000
	education	more = 1, less = 0	49	0.57	1.00	0.50	0.07	0.00	1.00

No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
A-5	WTP (text and photos)								
	wtp 5E +5G	USD nonxeri	14	1,982	500	3,506	937	0.00	10,000
	wtp 5F + 5H	USD xeri	55	3,622	2,000	7,256	978	0.00	50,000
	wtp 5E + 5F	USD nonxeri + xeri	36	3,890	1,750	8,433	1,406	0.00	50,000
	wtp 5G + 5H	USD nonxeri + xeri	33	2,634	1,000	4,018	699	0.00	20,000
				B: Double variables					
B-1	Preferences and neighborhood								
B-1a	*actual_nonxeri +inc*	USD nonxeri	15	89,833	102,500	31,275	8,075	37,500	125,000
	actual_xeri+inc	USD xeri	28	87,500	102,500	28,260	5,341	37,500	125,000
	actual_nonxeri +more ed	more nonxeri	17	0.41	0.00	0.51	0.12	0.00	1.00
	actual_xeri +more ed	more xeri	31	0.65	1.00	0.49	0.09	0.00	1.00
	actual_nonxeri +less ed	less nonxeri	10	1.00	1.00	0.00	0.00	1.00	1.00
	actual_xeri +less ed	less xeri	11	1.00	1.00	0.00	0.00	0.00	1.00
B-1b	*like_nonxeri 1A + inc*	USD	22	88,523	102,500	30,352	6,471	37,500	125,000
	like_xeri 1B +inc	USD	13	100,769	102,500	22,739	6,307	65,000	125,000
	like_nonxeri 1C +inc	USD	36	92,569	102,500	28,862	4,810	37,500	125,000
	like_xeri 1D+inc	USD	23	87,500	102,500	30,057	6,267	37,500	125,000
B-1c	*like_nonxeri 1A +more ed*	nonxeri	23	0.61	1.00	0.50	0.10	0.00	1.00
	like_xeri 1B +more ed	xeri	15	0.60	1.00	0.51	0.13	0.00	1.00
	like_nonxeri 1C +more ed	nonxeri	38	0.53	1.00	0.51	0.08	0.00	1.00
	like_xeri 1D +more ed	xeri	27	0.48	0.00	0.51	0.10	0.00	1.00
	like_nonxeri 1A +less ed	nonxeri	9	1.00	1.00	0.00	0.00	1.00	1.00
	like_xeri 1B +less ed	xeri	6	1.00	1.00	0.00	0.00	1.00	1.00

No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
	like_nonxeri 1C+less ed	nonxeri	18	1.00	1.00	0.00	0.00	1.00	1.00
	like_xeri 1D +less ed	xeri	14	1.00	1.00	0.00	0.10	0.00	1.00
B-2	Preferences, WTP, and neighborhood								
B-2a	*chose_nonxeri 5E +wtp+inc*	USD	1	37,500	37,500	-	-	37,500	37,500
	chose_xeri 5F +wtp+inc	USD	39	92,949	102,500	28,590	4,578	37,500	125,000
	chose_nonxeri 5G +wtp+inc	USD	11	97,955	102,500	29,724	8,962	37,500	125,000
	chose_xeri 5H +wtp+inc	USD	20	91,125	102,500	28,021	6,266	37,500	125,000
B-2b	*chose_nonxeri 5E +more ed*	nonxeri	1	0.00	0.00	–	–	0.00	0.00
	chose_xeri 5F +more ed	xeri	42	0.59	1.00	0.50	0.08	0.00	1.00
	chose_nonxeri 5G +more ed	nonxeri	12	0.50	0.50	0.52	0.15	0.00	1.00
	chose_xeri 5H +more ed	xeri	22	0.68	1.00	0.48	0.10	0.00	1.00
	chose_nonxeri 5E +less ed	nonxeri	1	0.00	0.00	–	–	1.00	1.00
	chose_xeri 5F +less ed	xeri	17	1.00	1.00	0.00	0.00	1.00	1.00
	chose_nonxeri 5G+less ed	nonxeri	6	1.00	1.00	0.00	0.00	1.00	1.00
	chose_xeri 5H +less ed	xeri	7	1.00	1.00	0.00	0.00	1.00	1.00
B-3	Preferences and WTP								
	chose_nonxeri 5E +wtp	USD	1	10,000	10,000	0.00	0.00	10,000	10,000
	chose_xeri 5F +wtp	USD	42	3,367	1,375	7,805	1,204	0.00	50,000
	chose_nonxeri 5G +wtp	USD	12	1,479	500	2,837	819	0.00	10,000
	chose_xeri 5H +wtp	USD	23	3,388	2,000	4,258	888	0.00	20,000

C: Multiple variables									
No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
C-1	Preferences and WTP								
C-1a	*actual_nonxeri +wtp_nonxeri 5G*	USD	6	667	500	753	307	0.00	20,000
	actual_xeri +wtp_xeri 5H	USD	23	3,388	2,000	4,258	888	0.00	20,000
C-1b	*like_nonxeri A1 +wtp_nonxeri 5G*	USD	9	1,861	500	3,214	1,071	0.00	10,000
	like_nonxeri C1 +wtp_nonxeri 5G	USD	12	1,479	500	2,837	819	0.00	10,000
	like_xeri B1 + wtp_xeri 5H	USD	8	2,084	1,750	1,784	631	0.00	5,000
	like_xeri D1 +wtp_xeri 5H	USD	15	3,528	2,000	4,834	1,248	375	20,000
C-2	Preferences, WTP, and neighborhood								
	wtp_nonxeri 5E +more ed	USD	0	–	–	–	–	–	–
	wtp_xeri 5F +more ed	USD	25	2,208	1,000	2,938	588	0.00	10,000
	wtp_nonxeri 5G +more ed	USD	6	2,417	750	3,878	1,583	0.00	10,000
	wtp_xeri 5H +more ed	USD	15	2,478	1,500	2,606	673	0.00	10,000
	wtp_xeri 5F +less ed	USD	17	5,071	2,000	11,746	2,849	0.00	50,000
	wtp_nonxeri 5G +less ed	USD	6	542	375	749	306	0.00	2,000
	wtp_xeri 5H +less ed	USD	8	5,094	3,250	6,187	2,188	1,000	20,000
C-3	Preferences, WTP, and house								
C-3a	House sale price								
	chose_nonxeri +chose_xeri +hprice	USD	65	421,754	400,000	130,103	16,137	240,000	700,000
	chose_nonxeri +hprice	USD	11	409,545	400,000	140,258	42,289	240,000	700,000
	chose_xeri +hprice	USD	54	424,241	400,000	129.193	17,581	240,000	700,000

No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
	chose_nonxeri (5E) + chose_xeri (5F) + hprice	USD	38	418,079	400,000	123,744	20,074	240,000	700,000
	chose_nonxeri (5G) + chose_xeri (5H) + hprice	USD	37	417,216	400,000	125,335	20,605	240,000	700,000
	chose_nonxeri (5E) +hprice	USD	1	450,000	450,000	-	-	450,000	450,000
	chose_xeri (5F) +hprice	USD	36	417,833	400,000	127,056	21,276	240,000	700,000
	chose_nonxeri (5G) +hprice	USD	10	405,500	380,000	147,167	46,538	240,000	700,000
	chose_xeri 5H) +hprice	USD	18	437,056	417,500	136,159	32,093	260,000	700,000
C-3b	House size								
	chose_nonxeri +chose_xeri+hsize	ft^2	77	2,094	1,750	659	75	1,750	4,000
	chose_non-xeri +hsize	ft^2	13	2,019	1,750	688	190	1,750	4,000
	chose_xeri +hsize	ft^2	64	2,109	1,750	657	82	1,750	4,000
	chose_nonxeri (5E) + chose_xeri (5F) + hsize	ft^2	44	2,080	1,750	644	97	1,750	4,000
	chose_nonxeri (5G) + chose_xeri (5H) + hsize	ft^2	43	2,087	1,750	650	99	1,750	4,000
	chose_non-xeri (5E) +hsize	ft^2	1	1,750	1,750	-	-	1,750	1,750
	chose_xeri (5F) +hsize	ft^2	42	2095	1,750	656	101	1,750	4,000
	chose_non-xeri (5G) +hsize	ft^2	12	2,042	1,750	714	206	1,750	4,000
	chose_xeri (5H) +hsize	ft^2	22	2,136	1,750	676	144	1,750	4,000
C-3c	House age								
	chose_nonxeri +chose_xeri+hage	years	77	9.06	8.00	4.64	0.53	2.00	20.00
	chose_nonxeri +hage	years	13	11.19	8.00	5.94	1.65	2.00	20.00

No.	Variable	Label	*n*	Mean	Median	*SD*	*SE*	Min	Max
	chose_xeri +hage	years	64	8.63	8.00	4.26	0.53	2.00	20.00
	chose_nonxeri (5E) + chose_xeri (5F) + hage	years	44	9.02	8.00	4.49	0.68	2.00	20.00
	chose_nonxeri (5G) + chose_xeri (5H) + hage	years	43	8.93	8.00	4.50	0.69	2.00	20.00
	chose_nonxeri (5E) +hage	years	1	20.00	20.00	-	-	20.00	20.00
	chose_xeri (5F) +hage	years	42	8.79	8.00	4.26	0.66	2.00	20.00
	chose_nonxeri (5G) +hage	years	12	10.46	8.00	5.55	1.60	2.00	20.00
	chose_xeri (5H) +hage	years	22	8.34	8.00	4.36	0.93	2.00	20.00
C-3d	Pool								
	chose_nonxeri +chose_xeri +pool	percent	77	0.36	0.00	0.48	0.06	0.00	1.00
	chose_nonxeri +pool	percent	13	0.31	0.00	0.48	0.13	0.00	1.00
	chose_xeri +pool	percent	70	0.39	0.00	0.49	0.06	0.00	1.00
	chose_nonxeri (5E) + chose_xeri (5F) + pool	percent	44	0.36	0.00	0.49	0.07	0.00	1.00
	chose_nonxeri (5G) + chose_xeri (5H) + pool	percent	43	0.37	0.00	0.49	0.07	0.00	1.00
	chose_nonxeri (5E) +pool	percent	1	0.00	0.00	-	-	0.00	0.00
	chose_xeri (5F) +pool	percent	42	0.36	0.00	0.48	0.07	0.00	1.00
	chose_nonxeri (5G) +pool	percent	12	0.33	0.00	0.49	0.14	0.00	1.00
	chose_xeri (5H) +pool	percent	22	0.41	0.00	0.50	0.11	0.00	1.00
C-4	WTP								
	wtp_nonxeri 5E +5G +wtp_xeri 5F +5H	USD	69	3,290	1,000	6,679	804	0.00	50,000
	wtp_nonxeri 5E +5G	USD	14	1,982	500	3,506	937	0.00	10,000
	wtp_xeri 5F +5H	USD	55	3,622	2,000	7,256	978	0.00	50,000

Note: For preferences, two different scales were used: (a) 1 = strongly agree, 0.75 = agree, 0.50 = undecided, 0.25 = disagree, 0.00 = strongly disagree and (b) 1 = yes a lot, 0.75 = yes a little, 0.50 = undecided, 0.25 = not very much, 0.00 = not at all. The following abbreviations are used: *xeri,* mean xeriscape landscaping; *nonxeri,* mean nonxeriscape landscaping; *cvm 1,* participants' responses to the first set of questions of the willingness-to-pay section of the survey (Questions 5d and 5e; variables *choose_nonxeri (5E)* and/or *choose_xeri (5F)* and wtp_max_xeri and/or wtp_max_nonxeri); *cvm 2,* participants' responses to the second set of questions of the willingness-to-pay section of the survey (Questions 5f and 5g; variables *choose_nonxeri (5G)* and/or *choose_xeri (5H)*; *wtp,* mean willingness-to-pay; *cvm,* contingent valuation method; *ed,* mean education; *inc,* mean income; *h,* mean house; and *1A, 1B, 1C, 1D, 5E, 5F, 5G, 5H,* photos on the survey.

Section A: Single Variables

The first section (A) of Table 7 contains single variables and is divided into five sub-sections: A-1 (preferences [text]), A-2 (preferences [photos]), A-3 (house [text]), A-4 (neighborhood [text]), and A-5 (WTP [text and photos]).

A-1	xeri_pleasing		look_attractive		xeri_desire	
	N	Mean	N	Mean	N	Mean
yes	39	0.80	37	0.76	35	0.71
no	10	0.20	12	0.24	14	0.29

A-1	actual_nonxeri		actual_xeri	
	N	Mean	N	Mean
yes	21	0.42	31	0.64
no	28	0.48	18	0.26

The first subsection of Table 7 (A-1), preferences (text), contains data reported from the survey participants' responses to questions asking whether they preferred xeriscape landscaping. Questions asked whether the participant thought xeriscape (a) was pleasing, (b) was attractive, and (c) was the type of landscaping the participant desired, and whether (d) the participant had xeriscape or nonxeriscape in his or her yard. It was reported that 71% to 80% of the respondents (35-39 out of 49) reported that xeriscape was pleasing, looked attractive and they desired it. Forty-two to sixty-four percent reported they had xeriscape in their yards. Twenty-six to forty-eight percent of the respondents (18-28 out of 49) indicated that they had nonxeriscape in their yards.

A-2	like_nonxeri 1A		like_xeri 1B		like_nonxeri 1C		like_xeri 1D	
	N	Mean	N	Mean	N	Mean	N	Mean
yes	25	0.52	22	0.45	39	0.79	28	0.57
no	23	0.48	27	0.55	9	0.21	21	0.43

A-2	chose_nonxeri 5E + wtp		chose_xeri 5 + wtp		chose_nonxeri 5G+ wtp		chose_xeri 5H + wtp	
	N	Mean	N	Mean	N	Mean	N	Mean
yes	1	0.02	45	0.98	14	0.29	35	0.71
no	45	0.98	1	0.02	35	0.71	14	0.29

The second subsection of Table 7 (A-2), preferences (photos), contains participants' responses to questions asking whether they preferred xeriscape landscaping when presented with photos. The photos contained the same home, with xeriscaping in one photo and nonxeriscaping in another photo. The responses of participants indicated how much they liked the landscaping in the photos of (a) a home with xeriscape landscaping and (b) the same home with nonxeriscape landscaping. There were a total of four sets of photos in the questionnaire. The mean of all the nonxeriscape preferences was reported as 41% for nonxeriscape and 68% for xeriscape. More participants reported they preferred xeriscape more than nonxeriscape landscaping, as displayed in the photos.

A-3	hprice (USD)		hsize (sf^2)		hage (years)		pool (percent)	
	N	Mean	N	Mean	N	Mean	N	Mean
	41	406,390	49	2,046	49	9.37	49	0.33

The third subsection of Table 7 (A-3), house (text), contains participants' responses about their homes: (a) sale price, (b) house size, (c) house age, and (d) presence of a pool. The following mean values were reported: (a) the mean home sale price, $406,390, (b) the mean house size, 2,046 ft^2, (c) the mean house age, 9.4 years, and (d) the mean pool presence, 33%.

A-4	age_person (years)	
	N	Mean
	49	47.03
A-4	**gender**	
	N	Mean
male	21	0.45
female	26	0.55
A-4	**income (USD)**	
	N	Mean
	45	90,778
A-4	**education**	
	N	Mean
more	28	0.57
less	21	0.43

The fourth subsection of Table 7 (A-4), neighborhood, contains participants' reported responses about personal information: (a) age, (b) gender, (c) family annual income, and (d) level of education. The following mean values were reported: (a) the mean age of the respondents was 47 years old (49 out of 49 responding); (b) the mean gender was 0.55, indicating that slightly more women (26 out of 47) than men (21 out of 47) responded to the survey; (c) the mean annual household income was reported as $90,778 (45 out of 49 responding); and (d) the educational mean was 0.57, indicating that slightly more respondents (28 out of 49) had more education (graduate level or above). This data reported that there were 4% more women than men responding to the survey and 7% more participants overall, total men and women had more education than less education.

A-5	wtp 5E (nonxeri)		wtp 5F (xeri)		wtp 5G (nonxeri)		wtp 5H (xeri)	
	N	Mean	N	Mean				
wtp 5E (nonxeri)					14	1,982		
wtp 5F (xeri)	36	3,890						
wtp 5G (nonxeri)							33	2,634
wtp 5H (xeri)			55	2,622				

The fifth subsection of Table 7 (A-5), WTP, reports participants' responses to questions asking how much they would be willing to pay for the xeriscape and/or nonxeriscape landscaping in two separate photo sets. Two choices of landscaping were given in each of two photo sets (5E or 5F, and 5G or 5H). The same home was pictured in photos 5E and 5F. Photo 5E had nonxeriscape landscaping; photo 5F had xeriscape landscaping. A different home and different landscapes were pictured in photos 5G and 5H. Photo 5G had nonxeriscape landscaping, and photo 5H had xeriscape landscaping.

The mean WTP from both sets for either type of landscaping was reported as $2,782 above the price of the home. The first photo set, containing photos 5E and 5F, had a higher mean reported of $3,890 (36 out of 49 responding) than the second photo set, containing photos 5G and 5H with a mean reported of $2,634 (33 out of 49 responding). The data indicated that people were willing to pay more for either the nonxeriscape or xeriscape landscaping in the first photo set, containing photos 5E and 5F, than they were willing to pay for the either xeriscape or nonxeriscape landscaping in the second photo set, containing photos 5G and 5H. There were a combination of 55 total participants indicating they were willing to pay for xeriscape landscaping for both 5F and 5G added together. There were only 14 total participants reporting willingness to pay for nonxeriscape landscaping for both 5E and 5G added together (14 out of 55 responding).

Section B: Double Variables

The second section of Table 7 (Section B) contains double variable combinations and is divided into three subsections: B-1 (preferences and personal), B-2 (preferences/WTP and personal information), and B-3 (preferences and WTP). *A double variable refers* to two separate questions on the survey. Only those respondents who answered the first question and also answered the second question are included in each of these combinations. The first question is represented by the first variable in each combination, and the second question is represented by the second variable.

B-1a	actual_nonxeri		actual_xeri	
	N	Mean	N	Mean
inc (USD)	15	89,833	28	87,500
more ed (%)	17	0.41	31	0.65
less ed (%)	10	1	11	1

The first subsection of Table 7 (B-1), preferences and neighborhood, reports data from the survey participants' responses to questions concerning preferences for xeriscape or nonxeriscape landscaping and neighborhood information (education and income). Only responses from participants who answered the preference question and also the neighborhood question were used in this analysis. The first group (B-1a) contains data from survey responses to questions about the type of landscaping the participant has in his or her yard, xeriscape or nonxeriscape, and the participant's education and family annual income. The variable *actual_nonxeri* represented responses indicating that participants had nonxeriscape in their yards. The variable *actual_xeri* represented responses indicating that participants had xeriscape in their yards. The mean household annual income of those participants who had nonxeriscape in their yards was reported as $89,833 (15 out of 43); for those participants who had xeriscape in their yards, it was reported as $87,500 (28 out of 43). The data suggest that the mean household annual income was reported to be approximately 3% higher for those participants who had nonxeriscape versus those participants who had xeriscape. More participants (31 out of 48) indicated that they had xeriscape in their yards and more education (graduate school) than participants(17 out of 48) indicating that they had nonxeriscape in their yards and more education. Ten out of twenty-one participants indicated having nonxeriscape in their yards and less education while 11 out of 21 participants indicated that they had xeriscape in their yards and less education.

B-1b	like_nonxeri 1A		like_xeri 1B		like_nonxeri 1C		like_xeri 1D	
	N	Mean	N	Mean	N	Mean	N	Mean
inc (USD)	22	88,523	13	100,769	36	92,569	23	87,500

B-1c	like_nonxeri 1A		like_xeri 1B		like_nonxeri 1C		like_xeri 1D	
	N	Mean	N	Mean	N	Mean	N	Mean
more ed (%)	23	0.61	15	0.6	38	0.53	27	0.48
less ed (%)	9	1.00	6	1.00	18	1.00	14	1.00

The second group of Section B of Table 7 (B-1b and B-1c) reports data from survey responses to questions about the type of landscaping the participant preferred, xeriscape or nonxeriscape, and household annual income. Four photos were included in this group of questions: (a) photo 1A showed a house with nonxeriscape landscaping, and photo 1B showed the same house with xeriscape landscaping; (b) photo 1C showed a different house with nonxeriscape landscaping, and photo 1D showed the same house as in photo 1C, but with xeriscape landscaping. In subsection B-1b, the mean annual household income of those participants indicating that they liked nonxeriscape was $90,546 (58 out of 65), with the mean annual household income of those participants indicating they liked xeriscape being reported as $94,135 (36 out of 65). Section (B-1c) suggests that there of those people with more education (graduate school) there are more people that like nonxeriscape, a reported average of 57% (61 out of 108), than like xeriscape, a reported average of 54% (42 out of 108). Of those respondents with less education there is no difference between the responses from those liking xeriscape (or nonxeriscape

The second subsection of Table 7 (B-2), preferences, WTP, and neighborhood, reports participants' preferences for xeriscape or nonxeriscape landscaping, their WTP for the landscaping of their choice, and also neighborhood information (education and income). There were two choices of landscaping in each of two photo sets (5E or 5F, and 5G or 5H). The same home was pictured in photos 5E and 5F, but photo 5E had nonxeriscape landscaping, and photo 5F had xeriscape landscaping. A different home and different landscapes were pictured in photos 5G and 5H, but photo 5G had nonxeriscape landscaping, and photo 5H had xeriscape landscaping.

B-2a	chose_nonxeri 5E + wtp		chose_xeri 5F + wtp		chose_nonxeri 5G + wtp		chose_xeri 5H + wtp	
	N	Mean	N	Mean	N	Mean	N	Mean
inc (USD)	1	37,500	39	92,949	11	97,955	20	91,125

The first group (B-2a) reports data from participants who answered the preference question and reported their willingness-to-pay and who also provided income information. Those participants choosing xeriscape (59 out 84) had a higher mean annual household income of $92,037 than those participants choosing nonxeriscape (12 out of 84), with a mean annual household income of $67,728. This indicated that those participants choosing xeriscape had an approximately 27% higher mean annual household income than those participants choosing nonxeriscape. It should be noted that only one person chose nonxeriscape and reported willingness to pay for nonxeriscape and also reported a household income from the question pertaining to photo 5E.

B-2b	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
more ed (%)	1	0.00	42	0.59	12	0.50	22	0.68
less ed (%)	1	0.00	17	1.00	6	1.00	7	1.00

The second group (B-2b) reports data from participants who answered the preference questions and also provided neighborhood information regarding their education. Those participants (42 out of 77) indicating choosing xeriscape and also indicated that they had more education, a reported approximate average of 64% more were in graduate school than those participants (12 out of 77) indicating choosing nonxeriscape. An approximate equal percentage of participants chose xeriscape and had less than graduate school education than those participants choosing nonxeriscape and less than graduate school education.

B-3	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
wtp (USD)	1	10,000	41	3,449	12	1,479	23	3,388

The third group in Section B of Table 7 (B-3) reports data from participants who indicated which landscaping they preferred, xeriscape or nonxeriscape, and also provided a dollar amount they were willing to pay for the landscaping of their choice. Two choices of landscaping were given in each of two photo sets (5E or 5F, and 5G or 5H). The same home was pictured in photos 5E and 5F, but photo 5E had nonxeriscape landscaping, and photo 5F had xeriscape landscaping. A different home and different landscapes were pictured in photos 5G and 5H, but photo 5G had nonxeriscape landscaping, and photo 5H had xeriscape landscaping. The mean WTP of those participants choosing nonxeriscape from a combined mean of responses pertaining to nonxeriscape photos 5E and 5G was reported as $5,740 (13 out of 77). The mean WTP of those participants choosing xeriscape from a combined mean of responses pertaining to the xeriscape photos 5F and 5H was reported as $3,669 (64 out of 77). Twelve participants responding to the question pertaining to the nonxeriscape photo 5G and 1 participant responding to the question pertaining to the nonxeriscape photo 5E, for a combined total of 13 responses to the nonxeriscape photos, were also reporting a willingness to pay for their choice of landscaping. Forty-one participants responding to the question pertaining to the xeriscape photo 5F, and 23 participants responding to the question pertaining to the xeriscape photo 5H, for a combined total of 64 responses pertaining to xeriscape, also indicated an amount they were willing to pay for the landscaping of their choice.

Section C: Multiple Variables

The third section (Section C) of descriptive statistics of Table 7 contains multiple variable combinations and is divided into three subsections: C-1 (preferences and WTP), C-2 (preferences, WTP, and neighborhood), and C-3 (preferences, WTP, and house). *A multiple variable* refers to three or more separate questions on the survey. Only those respondents who answered all questions pertaining to a particular item are included in each of these combinations. The first question is indicated by the first variable in each combination, the second question is indicated by the second variable, the third question is indicated by the third variable, and so on. Respondents must have answered the initial question to be compared with responses from the second question. Only those participants who answered the first two questions were then compared with the third question, and so on, and were reported in this combination analysis.

C-1a	actual_nonxeri		actual_xeri	
	N	Mean	N	Mean
wtp_nonxeri 5G	6	667		
wtp_xeri 5H			23	3,388

C-1b	like_nonxeri A1		like_nonxeri C1		like_xeri B1		like_xeri D1	
	N	Mean	N	Mean	N	Mean	N	Mean
wtp_nonxeri 5G	9	1,861	12	1,479				
wtp_xeri 5H					8	2,084	15	3,528

The first subsection of Section C of Table 7 (C-1), preferences and WTP, contains multiple combinations of preferences and WTP. The first group (C-1a) reports data from survey responses to the following: (a) type of landscaping the participant had in his or her yard, xeriscape or nonxeriscape; (b) whether the participant chose nonxeriscape or xeriscape landscaping from the photo group 5G and 5H[31], respectively; and (c) whether the participant was willing to pay for the landscaping of his or her choice. The results indicated that those participants having xeriscape in their yards and also indicating that they preferred the xeriscape landscaping in photo 5H were also willing to pay $3,388

[31] The other photo group, 5E and 5F, was not used for this analysis because there were no data for the nonxeriscape part of the analysis: No participants chose nonxeriscape for the question relating to the photos 5E and 5F, were willing to pay, and also had nonxeriscape in their yards.

above the cost of the house to acquire the xeriscape landscaping (23 out of 29). Those participants having nonxeriscape in their yards and also indicating that they preferred the nonxeriscape landscaping in photo 5G were willing to pay only $667 above the cost of the house to acquire the xeriscape landscaping (6 out of 29). Twenty-three participants answered all the parts of the xeriscape information, and only 6 participants answered all the parts of the nonxeriscape information for this group.

The second group (C-1b) reports responses from participants indicating whether participants (a) preferred xeriscape or nonxeriscape as depicted in photos 1A, 1B, 1C, and 1D; (b) also chose nonxeriscape or xeriscape landscaping from the photo group 5G and 5H, respectively; and (c) also indicated that they were willing to pay for the landscape of their choice. Twenty-three participants out of 44 chose xeriscape in photos 1B, 1D, chose xeriscape in photo 5H, and also were willing to pay for the xeriscape. They reported a total mean xeriscape value of $2,806. Twenty-one participants out of 44 chose nonxeriscape in photos 1A and 1C, chose nonxeriscape in photo 5G, and were willing to pay for the nonxeriscape. They reported a total mean nonxeriscape value of $1,670. The results showed that more participants chose xeriscape and were willing to pay for it than participants who chose nonxeriscape and were willing to pay for it.

C-2	wtp_nonxeri 5E		wtp_xeri 5F		wtp_nonxeri 5G		wtp_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
more ed (USD)	0	-	25	2,208	6	2,417	15	2,478
less ed (USD)			17	5,071	6	542	8	5,094

The second subsection of Section C of Table 7 (C-2), preferences, WTP, and neighborhood, contains an analysis of the following reported data: (a) those participants choosing nonxeriscape or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants also indicating that they were willing to pay for the landscape of their choice; and (d) those participants also indicating a level of education attained (graduate school). Those participants who chose xeriscape, were willing to pay for xeriscape (wtp_xeri 5F + wtp_xeri 5H), and had the least education (less ed) reported a willingness to pay a mean of $5,083 for xeriscape landscaping (25 out of 71). Those participants who chose xeriscape, were willing to pay for xeriscape (wtp_xeri 5F + wtp_xeri 5H), and had more education (more ed) reported willingness to pay $2,343 for xeriscape landscaping (40 out of 71). Those participants who chose nonxeriscape landscaping, reported a willingness to pay for nonxeriscape (wtp_nonxeri 5G), and had more education (more ed) reported they were willing to pay $2,417 for nonxeriscape landscaping (6 out of 71). Those participants who chose nonxeriscape landscaping, reported they were willing to pay for nonxeriscape, and had less education (less ed) reported a willingness to pay $542 for nonxeriscape landscaping (6 out of 71). The group choosing xeriscape with the least education reported they were willing to pay the most for xeriscape. Those participants choosing nonxeriscape with the least education reported they were willing to pay the least for nonxeriscape.

The third subsection of Section C of Table 7 (C-3), preferences, WTP, and house, contains an analysis of the following data: (a) those participants choosing nonxeriscape or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants also indicating that they were willing to pay for the landscape of their choice; and (d) those participants indicating housing information. Three subsections of different housing information are reported in this section: (a) house sale price, (b) house size, (c) house age, and (d) presence of pool.

C-3a	chose_nonxeri + chose_xeri		chose_nonxeri		chose_xeri	
	N	Mean	N	Mean	N	Mean
hprice (USD)	65	421,754	11	409,545	54	424,241

C-3b	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
hprice ($)	1	450,000	36	417,833	10	405,500	18	437,056

The first subsection (C-3a), house sale price, contains an analysis of the following data: (a) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants also indicating that they were willing to pay for the landscape of their choice; and (d) those participants indicating house sale price. For this first group of combined responses, out of a possible 98 responses, 65 participants, or 66%, indicated either xeriscape or nonxeriscape, reported they were willing to pay for their landscaping choice, and indicated a house value. The mean house sale price from this first combined group of responses was reported as $421,754. Of those 65 responses, 11 responses were for nonxeriscape, or 17%, with a mean home sale price reported of $409,545, and 54 responses were for xeriscape, or 83%, with a mean home value reported of $424,241. The mean sale prices of the whole combined group and those of the nonxeriscape and xeriscape responses were very close in value, within a reported range of approximately 4%. The second part of C-3a reports the individual WTP responses. The combined mean value for house price for those choosing xeriscape and reporting a willingness to pay for it (chose_xeri 5F + chose_xeri 5H) was $427,445. The combined mean value for house price for those choosing nonxeriscape and willing to pay for it (chose_nonxeri 5E + chose_nonxeri 5G) was reported as $427,750, almost identical to those choosing xeriscape.

C-3b	chose_nonxeri + chose_xeri		chose_nonxeri		chose_xeri	
	N	Mean	N	Mean	N	Mean
hsize (sf^2)	77	2,094	13	2,019	64	2,109

C-3b	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
hsize (ft^2)	1	1,750	42	2,095	12	2,042	22	2,136

The second subsection (C-3b), house size, contains an analysis of the following data: (a) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants indicating that they were willing to pay for the landscape of their choice; and (d) those participants indicating house size. For this first group of combined responses, out of a possible 98 responses, 77 respondents, or 78%, indicated either xeriscape or nonxeriscape, were willing to pay for their landscaping choice (chose_nonxeri + chose_xeri), and indicated a house size (hsize). The mean house size from this first combined group of responses was reported as 2,094 ft^2. Of those 77 responses, 13 responses were for nonxeriscape, or 17%, with a mean home size reported of 2,019 ft^2, and 64 responses were for xeriscape, or 83%, with a mean home size reported of 2,109 ft^2. The mean home sizes of the whole combined group and of the nonxeriscape and xeriscape responses were very close, within a range of approximately 5%. The second part of C-3b reports the individual WTP responses. The combined mean value for house size for those choosing xeriscape and willing to pay for it (chose_xeri 5F + chose_xeri 5H) was 2,116 square feet. The combined mean value for house size for those choosing nonxeriscape and willing to pay for it (chose_nonxeri 5E + chose_nonxeri 5G) was reported as 1,896 square feet, within an 11% range with those choosing xeriscape.

C-3c	chose_nonxeri + chose_xeri		chose_nonxeri		chose_xeri	
	N	Mean	N	Mean	N	Mean
hage (years	77	9.06	13	11.19	64	8.63

C-3c	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
hage (years)	1	20.00	42	8.79	12	210.46	22	8.35

The third subsection (C-3c), house age, contains an analysis of the following data: (a) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants indicating that they were willing to pay for the landscape of their choice; and (d) those participants indicating house age. For this first group of combined responses, out of a possible 98 responses, 77 participants, or 78%, indicated either xeriscape or nonxeriscape, were willing to pay for their landscaping choice, and indicated a house age. The mean house age from this first combined group of responses (chose_nonxeri + chose_xeri) was reported as 9.06 years. Of those 77 responses, 13 responses were for nonxeriscape (chose_nonxeri), or 17%, with a mean home age of 11.19 years, and 64 responses were for xeriscape (chose_xeri), or 83%, with a reported mean home age of 8.63 years. The reported mean ages of the whole combined group and of the nonxeriscape and xeriscape responses were not as close as the house sale prices and house size groups, but were within a range of 23%. The second part of C-3c reports the individual WTP responses. The combined mean value for house age for those choosing xeriscape and willing to pay for it (chose_xeri 5F + chose_xeri 5H) was 8.57 years. The combined mean value for house age for those choosing nonxeriscape and willing to pay for it (chose_nonxeri 5E + chose_nonxeri 5G) was reported as 15.23 years, with approximately a 44% range with those choosing xeriscape.

C-3d	chose_nonxeri + chose_xeri		chose_nonxeri		chose_xeri	
	N	Mean	N	Mean	N	Mean
pool (%)	77	0.36	13	0.31	64	0.38

C-3d	chose_nonxeri 5E		chose_xeri 5F		chose_nonxeri 5G		chose_xeri 5H	
	N	Mean	N	Mean	N	Mean	N	Mean
pool (%)	1	0.00	42	0.36	12	0.33	22	0.41

The fourth subsection (C-3d), presence of pool, contains an analysis of the following reported data: (a) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5E and 5F, respectively; (c) those participants indicating that they were willing to pay for the landscape of their choice; and (d) those participants indicating the presence or absence of a pool. For this first group of combined responses, out of a possible 98 responses, 77 participants, or 79%, indicated either xeriscape or nonxeriscape, were willing to pay for their landscaping choice (chose_xeri + chose_nonxeri), and indicated whether or not they had a pool (pool). The mean estimate from this first combined group of responses was reported as 36% of the participants indicating that they had a pool, chose either xeriscape or nonxeriscape, and were willing to pay for the landscape of their choice. Of those 77 responses, 13 responses were reported for nonxeriscape, or 17%, of which four respondents (31%) indicated they had a pool. Sixty-four responses were reported for xeriscape, or 90%, of which 24 respondents (38%) indicated they had a pool. The mean estimates of the whole combined group and of the nonxeriscape and xeriscape responses were not close at all. The second part of C-3d reports the individual WTP responses. The combined mean percentage of those respondents indicating they had a pool and choosing xeriscape and willing to pay for it (chose_xeri 5F + chose_xeri 5H) was reported as 39%. The combined mean percentage for pool for those choosing nonxeriscape and willing to pay for it (chose_nonxeri 5E + chose_nonxeri 5G) was 33%, with approximately a 16% range with those choosing xeriscape.

C-4	wtp_nonxeri 5E		wtp_xeri 5F		wtp__nonxeri 5E + 5G	
	N	Mean	N	Mean	N	Mean
wtp_nonxeri 5G	14	1,982				
wtp_xeri 5H			55	3,622		
wtp_xeri 5F + 5H					69	3,290

The final subsection of Section C of Table 7 (C-4), WTP, contains an analysis of the following reported data: (a) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5G and 5H, respectively; (b) those participants choosing nonxeriscape and/or xeriscape landscaping from the photo group 5E and 5F, respectively; and (c) those participants indicating that they were willing to pay for the landscape of their choice. For this final group of combined responses, out of a possible 98 responses, 69 participants, or 70%, indicated either xeriscape or nonxeriscape from both photo groups and were willing to pay for their landscaping choice ([wtp_nonxeri 5E + 5G] + [wtp_xeri 5f + 5h]). The combined mean of xeriscape and nonxeriscape values from this group of responses was reported as \$3,290. Of those 69 responses, 14 responses were for nonxeriscape, or 20%, with a mean nonxeriscape value reported of \$1,982, and 55 responses were for xeriscape, or 80%, with a mean xeriscape value reported of \$3,622. The mean values of the whole combined group and of the nonxeriscape and xeriscape responses were within a range of 55%.

CVM Valuation

The CVM values for a private environmental good are reported by averaging the values for the environmental good that survey respondents report they are willing to pay (Epstein, 2003). Thus the WTP values of all respondents to the CVM survey for the private environmental good xeriscape can be measured by the following equation:

$$\overline{X}_{CVM} = WTP_{CVM} = \frac{Q_1 + Q_2 + \ldots Q_n}{n}, \qquad (11)$$

where Q is the level of the private good, xeriscape, and n is the number of participants giving willingness-to-pay responses. This value was used for Hypothesis Test 2:

$$H2_0: \overline{X}_{CVM} = 0$$

$$H2_A: \overline{X}_{CVM} > 0.$$

The null hypothesis is that the mean reported WTP value through a CVM study is zero dollars, while the alternative is that it is greater than zero. This xeriscape WTP value for a private good reported by respondents to the CVM survey was then used to compare the xeriscape HPM value for a private good.

Comparison of HPM and CVM Xeriscape Values

How does a value estimate from the HPM and reported WTP value from the CVM compare for xeriscape landscaping? The WTP for HPM estimated by equation (15) was compared with the WTP value for CVM reported by equation (11) for analysis of Hypothesis Test 3:

$$H3_0: \overline{X}_{HPM} = \overline{X}_{CVM}$$

$$H3_A: \overline{X}_{HPM} \neq \overline{X}_{CVM}.$$

The null hypothesis is that the mean HPM estimate is equal to the mean WTP reported value, while the alternative is that they are not. $\overline{X}_{HPM}$ was the mean of WTP estimates of the private environmental good, xeriscape, for HPM. $\overline{X}_{CVM}$ was the mean reported WTP values of the private environmental good, xeriscape, for CVM.

Theory and the majority of empirical research suggest that HPM reported benefits will be greater than CVM reported benefits. In a meta-analysis by Carson et al., 1996 for quasi-public environmental goods revealed preference benefit estimates were on the average 30% greater than CVM reported benefits. It is therefore expected in this study that HPM benefit estimates will be greater than CVM reported benefits.

CHAPTER 4

RESULTS

This chapter presents the results of the hypotheses tests by examining in detail the effects of xeriscape on house values. The results of the three hypotheses tests will be presented in the first section. Multivariate and univariate statistical analyses are used in this chapter. Tables and figures accompany the text.

Tests of Hypotheses

This first section contains the results of the three hypotheses tests. The results of the test of Hypothesis 1 are presented first. This first test contains the hedonic price method results. The results of the test of Hypothesis 2 are presented next. This second test contains the contingent valuation method results. Finally, the results of the test of Hypothesis 3 are presented. This third test contains the comparisons of the results of both the hedonic price method and the contingent valuation method.

Test of Hypothesis 1

Do market participants value xeriscape landscaping? The null and alternative hypotheses based on this research question are, respectively, that the mean HPM estimate is equal to zero and that it is greater than zero. This section contains the hedonic price method results. Before the first hypothesis test could be performed a coefficient needed to be estimated. A preliminary test, Test 1a, provided this necessary information:

Test 1a

$$H1a_0 : \beta_{HPM} = 0$$

$$H1a_A : \beta_{HPM} > 0$$

The null hypothesis is that the coefficient from the HPM regression analysis for xeriscape is equal to zero, while the alternative is that it is greater than zero. β is the coefficient for xeriscape estimated from the HPM regression analysis using multivariate analysis. Regression analysis for the real estate market data and neighborhood data of 500 observations using the HPM are presented in Table 8. Model 1 contained predictor variables that were selected from a study by Theriault et al. (2002) and common to both studies, including house size (*hsize*), house age (*hage*), lot size (*lotsize*), pool (*pool*), presence of children (*child*), graduate school (*edugrad*), median household income (*incmed*), and presence of garage (*garage*). Model 2 contained a different set of predictor variables, which were selected from the Des Rosiers et al. (2002) study, including house size (*hsize*), lot size (*lotsize*), pool (*pool*), single family dwelling (*single family*), graduate school (*edugrad*), presence of garage (*garage*), and presence of patio (*patio*). Model 3 contained variables from a study by Henry (1994, 1999) with the following predictor variables: house size (*hsize*), lot size (*lotsize*), and presence of garage (*garage*). The predictor variables for Model 4 were selected from the real estate market data, the neighborhood data, and variables used in the first three models (Des Rosiers et al., 2002; Henry, 1994, 1999; Theriault, 2002). The following predictor variables are used in Model 4: house size (*hsize*), house age (*hage*), lot size (*lotsize*), pool (*pool*), size of hardscape area (*hardscape*), size of landscape area (*landscape*), single family dwelling (*single family*), mobile home (*mobile home*), presence of children (*child*), graduate school (*edugrad*), median household income (*incmed*), presence of garage (*garage*), presence of patio (*patio*), live in the area less than one year (*live less*), live in the area more than 20 years (*live more*), vacant dwellings (*vacant*), change of population (*popch05*), and rate of new homes (*houch05*).

The dependent variable was the log[32] of house price (*lhsprice*) for all four models. A semi-log functional form was used for the regression analysis. A dummy variable (*xeri*) was used to estimate the xeriscape landscaping effects on the house sales prices for all four models. The results from the regressions will be presented hereafter.

The variance inflation factor (VIF)[33] was below 3.9 for all coefficients for all four models. VIF values below 5–10 suggest that multicollinearity problems may be controlled and may not be problematic (Des Rosiers et al, 2002; Gujarati, as cited in Mohamed, 2006; Henry, 1994, 1999; Thierault, 2002). Pfaffenberger and Patterson (as cited in Henry, 1994) also suggested that the average VIF should be less than 2. The average VIF for all four models was less than 2.

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[32] The base-e natural logarithm was used (SPSS, 2006).

[33] VIF pertains to the collinearity for specific predictor variables in the context of a specific model.

Table 8

Regression Results for the HPM

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	12.592	12.591	12.592	12.591
	(0.012)**	(0.012)**	(0.013)**	(00.012)**
hsize	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
hage	-0.005	.	.	-0.005
	(0.003)***	(.)	(.)	(0.003)***
lotsize	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
pool	0.091	0.097	.	0.041
	(0.027)**	(0.028)**	(.)	(0.029)**
hardscape	.	.	.	0.000
	(.)	(.)	(.)	(0.000)***
landscape	.	.	.	0.000
	(.)	(.)	(.)	(0.000)***
single family	.	-0.060	.	-0.417
	(.)	(0.056)*	(.)	(0.093)*
mobile home	.	.	.	-0.754
	(.)	(.)	(.)	(0.325)
child	-0.796	.	.	-0.431
	(0.152)	(.)	(.)	(0.242)
edugrad	0.092	0.218	.	0.076
	(0.100)*	(0.103)	(.)	(0.123)
incmed	0.000	.	.	0.000
	(0.000)***	(.)	(.)	(0.000)***
garage	0.104	-0.001	0.141	0.006
	(0.135)	(0.161)	(0.143)	(0.155)
patio	.	0.160	.	0.134
	(.)	(0.082)*	(.)	(0.080)*
live less	.	.	.	-0.912
	(.)	(.)	(.)	(0.519)
live more	.	.	.	-0.158
	(.)	(.)	(.)	(0.236)
vacant	.	.	.	-0.144
	(.)	(.)	(.)	(0.388)
popch05	.	.	.	0.000
	(.)	(.)	(.)	(0.000)***
houch05	.	.	.	0.002
	(.)	(.)	(.)	(0.001)***
xeri	0.070	0.071	0.070	0.073
	(0.017)**	(0.018)**	(0.018)**	(0.016)**
xeri (H-P Adj.)	0.073	0.074	0.073	0.076
R - Sq[a]	0.580	0.543	0.523	0.612
Adj. R - Sq[b]	0.572	0.536	0.519	0.596
Root MSE[c]	0.189	0.196	0.200	0.183
Coeff Va[d]	17.37	16.81	16.50	17.84
F-Value	75.103	72.958	135.706	39.803
CI[e]	2.63	2.55	2.414	5.238

Variable	Model 1	Model 2	Model 3	Model 4
N	500	500	500	500

Note: *, **, *** indicate that parameters are significant at 10% (0.10), 5% (0.05), and 1% (0.01) level, respectively and standard errors are in parentheses.
[a]Correlation when squared and used to determine the percent of variation in house values that is explained by the regression model. [b]Adjusts for the artificial inflation of R^2 caused by R^2 always increasing, even though new regressors do not significantly help explain variation in house prices. The adjusted R^2 introduces a penalty to the equation for each new regressor added to the model to alleviate this problem. [c]Estimate of the variance of the residuals. [d]Coefficient of variation, which is the sample standard deviation divided by the sample mean and used as a relative measure of dispersion, which describes the amount of weight in the tails of a distribution. [e]Conditioning index (which is the square root of largest eigenvalue divided by the *i*th eigenvalue). If CI is greater than 30 and there is more than one variable that describes more than 50% of the variation, then multicollinearity is present, and adjustments should be made. *Source: SPSS, 2006.*

The average conditioning index (CI) for all four models was under 6. When CI values are greater than 15 it may indicate possible problems with collinearity, and when values are greater than 30 it may indicate possible serious problems (SPSS, 2006). The CI values were under 6 for all four models, suggesting that these estimates of the beta weights[34] for all variables were stable and reliable.[35]

The *F* test is used to estimate whether all coefficients are equal to zero. The test is used to provide an overall view to determine whether the model is good. The *F* values for all four models ranged from 39.803 to 135.706, indicating that the models were good (Des Rosiers et al., 2002; Henry, 1994, 1999; Thierault, 2002). For all four models together, there were 32 coefficients out of 44 that were significant at the 1%, 5%, and 10% levels, indicating that those 32 variables were contributing to the models, while 12 were not. The mean *xeri* coefficient of the four models in Table 7 was 0.071. The mean xeriscape (*xeri*) coefficients for all four models ranged from 0.70 to 0.73. When the

[34] The beta weights indicate the proportion increase or decrease in house price.

[35] According to SPSS (2006), "Condition indices are computed as the square roots of the ratios of the largest eigenvalue to each successive eigenvalue" (p. 1). The independent variables were centered to reduce collinearity problems. Centering for each variable was achieved by subtracting the mean of each variable from the 500 observations (SPSS, 2006).

Halvorsen–Palmquist adjustment[36] was applied to the xeriscape (*xeri*) coefficient, the mean xeriscape (*xeri*) coefficient of the four models was 0.074. The mean xeriscape (*xeri*) coefficients with the adjustment on all four models ranged from 0.73 to 0.76, slightly higher than the nonadjusted value estimates.

The mean of the adjusted R^2 of the four models was 0.56, ranging from 52% to 60%. This adjusted R^2 refers to the percentage of variation in house prices explained by the combined effect of the independent variables on the dependent variable. These results suggest that the independent variables explain 56% of the variation in the sales price.

There was a positive and significant coefficient at the 5% level on the xeriscape (*xeri*) dummy for all four models. The prices for homes with xeriscape landscaping were higher than for homes with nonxeriscape landscaping by 0.074. The positive sign of xeriscape suggests that xeriscape is a benefit to consumers and considered an amenity. For Model 1, the predictions that house size (*hsize*), income (*incmed*), and pools (*pool*) would have a positive effect on house value were verified. House size (*hsize*), house age (*hage*), lot size (*lotsize*), and income (*incmed*) were also highly significant at the 1% level. The presence of children (*child*) was predicted to be significant, with either a positive or negative impact. The presence of children (*child*) had a negative impact, but was not significant for Model 1, partly confirming the prediction. The presence of a pool (*pool*) and xeriscape (*xeri*) were also significant at the 5% level in Model 1. College

[36] An adjustment was recommended by Halvorsen and Palmquist (1980) based on a correction for misinterpretation of dummy variables as continuous variables in regressions specified as semilogarithmic, when in fact they are discontinuous: "Since a dummy variable enters the equation in dichotomous form, the derivative of the dependent variable with respect to the dummy variable does not exist. Instead, the coefficient of the dummy variable measures the discontinuous effect on [sales price] . . . of the presence of the factor represented by the dummy variable. The appropriate interpretation of the coefficient of a dummy variable can be shown directly by a transformation" (p. 474) of equations in which continuous variables are used to account for this misinterpretation. Without this Halvorsen–Palmquist correction, substantial errors could be reported (Halvorsen & Palmquist, 1980).

graduates (*edugrad*) was also significant at the 10% level in Model 1.

The predictions that house size (*hsize*) and college graduates (*edugrad*) would have a positive effect on house value were confirmed with the present study for Model 2. House size (*hsize*) was also highly significant at the 1% level, while college graduates (*edugrad*) was not significant. Lot size (*lotsize*) was highly significant at the 1% level. Pool (*pool*) and xeriscape (*xeri*) were significant at the 5% level. Single family dwelling (*single family*) and patio (*patio*) were significant at the 10% level.

For Model 3, the prediction that house size (*hsize*) would have a positive impact on house price was confirmed with a significant positive impact at the 5% level in the present study. Lot size (*lotsize*) was also significant at the 5% level in Model 3.

For Model 4, the predictions that house size (*hsize*), pools (*pool*), median household income (*incmed*), college graduates (*edugrad*), and change in population (*popch05*) would have a positive effect on house value were verified. Even though the predicted variables had a positive impact, house size (*hsize*) median household income (*incmed*), college graduates (*edugrad*), and change in population (*popch05*) were also highly significant at the 1% level. Pools (*pool*) and xeriscape (*xeri*) also had a positive impact and were significant at the 5% level. Single family dwellings (*single family*) was negatively significant at the 10% level. The presence of a patio (*patio*) was positively significant at the 10% level. The prediction for Model 4 of the rate of new homes (*houch05*) having a negative impact was not verified. The rate of new homes (*houch05*) was positive and highly significant at the 1% level. The presence of children (*child*) was also found to have a negatively impact in Model 4, but was not significant, thus confirming the prediction. House age (*hage*) had a negative impact and was highly significant at the 1% level. Lot size (*lotsize*), hardscape (*hardscape*), and landscape (*landscape*) were positive and highly significant at the 1% level. Garage also had a positive impact, but was not significant. Mobile home (*mobile home*), living less than one year (*live less*), living more than 20 years (*live more*), and vacant (*vacant*) all had a negative impact, but were not significant.

The models estimate the unique contribution of xeriscape after partialling out the contributions of the other variables. The test of xeriscape effects is actually conservative because all of the effects that are shared with other predictors are partialled out, so the fact that there are effects for xeriscape is all the more impressive. The null hypothesis for Test 1a was rejected because the xeriscape (*xeri*) coefficients in all four models were greater than zero.

This next section estimates the mean WTP value for the HPM data using the average of the xeriscape (*xeri*) coefficients from Models 1, 2, 3, and 4. The null and alternative hypotheses are, respectively, that the mean HPM estimate is equal to zero and that it is greater than zero.

Test 1

$$\mathrm{H1}_0\colon \overline{X}_{\mathrm{HPM}} = 0$$

$$\mathrm{H1}_A\colon \overline{X}_{\mathrm{HPM}} > 0$$

$\overline{X}_{\mathrm{HPM}}$ is the mean estimate of xeriscape. $\overline{X}_{\mathrm{HPM}}$ is estimated by multiplying the mean house price from the sample by the coefficient from the HPM regression analysis to estimate a percentage of house price attributed to xeriscape. The average sales price of the 250 xeriscaped homes from the HPM data, \$327,329, was multiplied by the average of the xeriscape (*xeri*) coefficients from the four models, (0.074), to determine whether the benefit estimate of xeriscape was greater than or equal to zero.[37] The resulting mean of the estimated benefits for xeriscape using the HPM was $24,222. The null hypothesis was rejected because the mean estimated value for xeriscape was greater than zero.

Discrete categorical data[38] are presented in Figure 6. Figure 6 shows the estimated percent of sales price attributed to xeriscape. This figure depicts the distribution of predicted xeriscape values (*xeri [H-P Adj.]*), which have been adjusted from Table 8. The estimates of the adjusted xeriscape (*xeri*) coefficients for (a) Models 1 and 3 are both 0.073 [*Model 1 & 3 adj. (7.3%)*]; (b) Model 2 is 0.074 [*Model 2 adj.* (7.4%)]; and (c) Model 4 is 0.76 [*Model 4 adj. (7.4%)*]. The sales price for the xeriscaped homes (*hsprice xeri*) from the HPM data set was used for these calculations. The sales price of each individual xeriscaped home was multiplied by the xeriscape (*xeri*) coefficient to determine the percentage of the home value being attributed to xeriscape.[39] The resulting xeriscape values were then binned into 11 categories, as shown on the *x*-axis in Figure 6, ranging from $5,000 to $59,999 in increments of $5,000. The percentage frequency distribution was then estimated for each of those categories. The percentage of observations is represented on the *y*-axis. The first dotted bar, labeled "Model 1 & 3," represents the mean xeriscape estimate, 0.073 applied to the xeriscaped homes' sales prices estimated in Models 1 and 3. The second open line, labeled "Model 2," represents

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[37] According to Dale et al. (1999), since the estimated functional form for the regression is semi-log, it makes "the equation quite amenable to interpretation since the coefficients can be interpreted as percent of average house price" (pp. 320–321).

[38] The distribution for this figure is a discrete probability distribution, not a normal distribution that is continuous (Nevill, Atkinson, Hughes, & Cooper, 2002).

[39] According to Dale et al. (1999), since the estimated functional form for the regression is semi-log, it makes "the equation quite amenable to interpretation since the coefficients can be interpreted as percent of average house price" (pp. 320–321).

the mean xeriscape estimate, 0.074 applied to the xeriscaped homes' sales prices estimated in Model 2. The third striped bar, labeled "Model 4," represents the mean xeriscape estimate, 0.076 applied to the xeriscaped homes' sales prices estimated in Model 4.

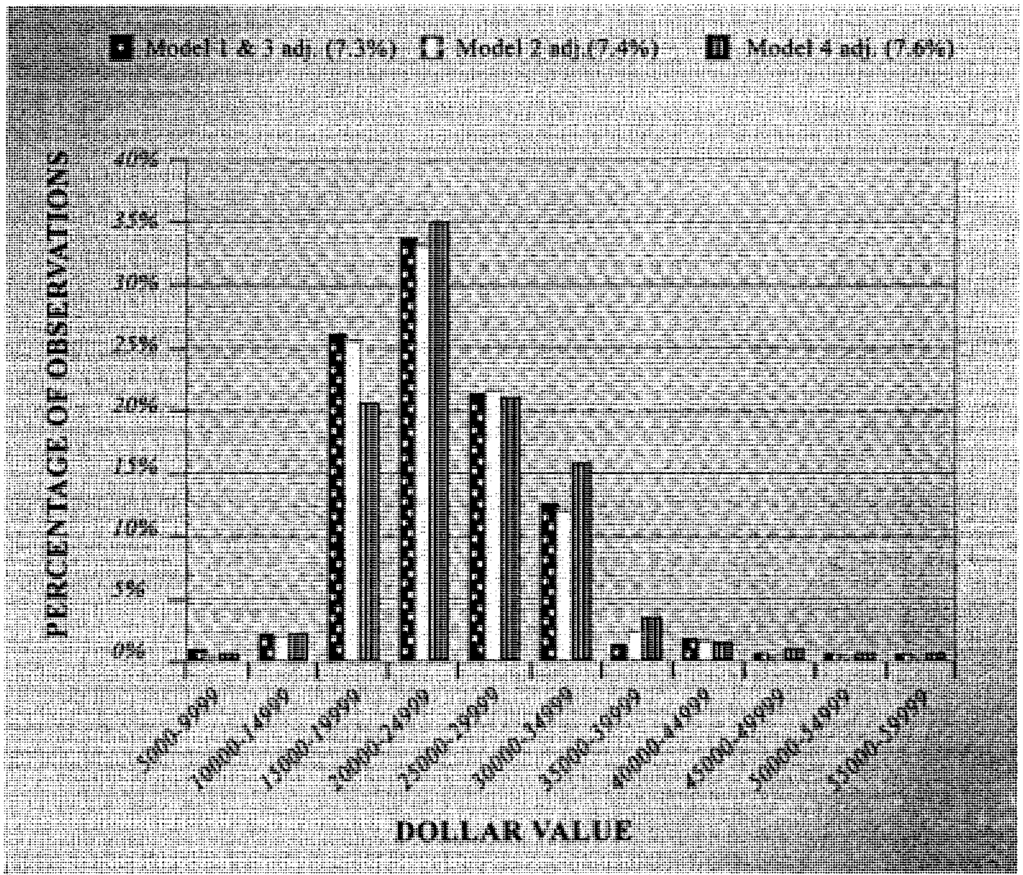

Figure 6. Percent Frequency Versus Dollar Value for Xeriscape for HPM.

The results indicated some consistency among the data sets, but slight differences were present. The xeriscape estimates for Model 4 were approximately 5% less than for Models 1, 2, and 3 in the $15,000–$19,999 range. The xeriscape estimates for Model 4 were approximately 4% higher than for Models 1, 2, and 3 in the $30,000–$34,999 range.

The xeriscape estimates from Model 4 had the greatest percentage, approximately 35%, overall in the \$20,000–\$24,999 group. The xeriscape estimates for Model 1 had the largest values reported in the \$15,000–\$19,999 range. The majority of xeriscape estimates were within the \$15,000–\$35,000 value range, with the largest group in the \$20,000–\$24,999 range. This means that the majority of people were willing to pay between \$15,000 and \$35,000 extra to have a home with xeriscape landscaping. This suggests that xeriscape is a positive environmental amenity.

Test of Hypothesis 2

Do survey participants report a positive WTP value for xeriscape landscaping? The null and alternative hypotheses based on this research question are, respectively, that the mean reported WTP value through a CVM study is zero dollars and that it is greater than zero dollars.

Test 2

$$H2_0: \overline{X}_{\mathrm{CVM}} = 0$$

$$H2_A: \overline{X}_{\mathrm{CVM}} > 0$$

The one-sample *t* test[40] was used, in two separate tests, to test if the mean willingness to pay for the private environmental good, xeriscape, in CVM 1 and CVM 2 was zero. Table 9 contains the *t*-statistics for the two WTP questions, CVM 1 (*chose_xeri 5F+wtp*) and CVM 2 (*chose_xeri 5H+wtp)*.

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[40] The *t*-statistic evaluates the difference between the sample mean and the hypothetical population mean in terms of the standard deviation of the sample means (SPSS, 2006).

CVM 1 and CVM 2 represent the values that respondents were willing to pay for xeriscape. The mean reported value for CVM 1 was $3,367 and for CVM 2 $3,388. The *t*-statistic for CVM 1 was 2.795, and it was 3.816 for CVM 2. The higher the *t*-statistic is in absolute value, the more significant the result will be (SPSS, 2006). The two-sided *p* value in Table 9 indicates that the WTP values were significantly different from zero.

Table 9

Willingness-to-Pay Questions CVM 1 and CVM 2: One-Sample T-Statistics

Variable	Sample size (n)	Sample Std. Deviation	Std. Error Mean	t Value	df	Two-sided p value[a]	Mean difference	95% CI of the difference	
								Lower	Upper
CVM 1	42	7,804.99	1,204.33	2.795	41	0.008	3366.71	934.51	5798.92
CVM 2	23	4,257.77	887.81	3.816	22	0.001	3388.04	1546.84	5229.24

Note: Test value = 0. CI = confidence interval.

The 95% confidence interval[41] was used. For CVM 1, this test yielded a *p* value[42] of 0.008, and for CVM 2, it yielded a *p* value of 0.001. Since the *p* values for both CVM 1 and CVM 2 are very small, both close to zero, this provides evidence against the null hypothesis. The null hypothesis for Test 2 is thus rejected at the 1% level of significance, with willingness-to-pay CVM 1 and CVM 2 values greater than zero.

[41] The very small value for alpha was used to minimize the chance of type-1 errors that sometimes incorrectly reject a null hypothesis that may actually be true (SPSS, 2006).

[42] The *p* value measures the probability that the results may have happened by chance. The smaller the *p* value, the more evidence there is against the null hypothesis. The farther out the test statistic is on the tails of the standard normal distribution, the smaller the *p* value will be, and the more evidence there will be against the null hypothesis (SPSS, 2006).

Figures 7 and 8 report discrete categorical data estimating preferences between xeriscape and nonxeriscape landscaping. Figure 7 depicts the percentage of observations versus dollar values for the first willingness-to-pay question (CVM 1 [*chose_xeri 5F+wtp*]). Figure 8 depicts the percentage of observations versus dollar values for the second WTP question (CVM 2 [*chose_xeri 5H+wtp*]). The dollar values are the survey participants' responses to how much above the house price they would be willing to pay for the landscaping of their choice. These dollar values represent the responses to the two WTP questions (CVM 1 and CVM 2) in the survey questionnaire. The percentage of observations represents the dollar value responses grouped together to indicate varying percentages of responses within each group. The survey contained two photos in each of two sets (CVM 1 and CVM 2). The photos in one set contained the same house, but one with a xeriscape front yard and the second with a nonxeriscape front yard. The photos in the second set were of a different house, one with a different xeriscape front yard and the second with a different nonxeriscape front yard. Two questions were asked about the photographs in each set. The first WTP question asked which landscaping the respondent preferred, the xeriscape or nonxeriscape. The second WTP question asked the respondent, for the preferred landscape the respondent chose in the first question, how much above the price of the house the respondent would be willing to pay to acquire that landscaping. Respondents who preferred xeriscape and also indicated a price value of zero or more are grouped and represented in Figures 7 and 8 by the dotted bars labeled "Choose Xeri WTP."

For both questions (*actual_xeri* and *actual_nonxeri*), the respondents indicated their choices on a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly* *disagree*), indicating the presence of xeriscape landscaping or nonxeriscape landscaping in their front yards, respectively. The responses were binned into two response categories. Responses of 1 (*strongly agree*) and 2 (*agree*) were binned as positive, and responses of 4 (*disagree*) or 5 (*strongly disagree*) were binned as negative. Neutral responses of 3 (*undecided*) were used in the descriptive statistics but were not used in the analysis for Figures 7 and 8 because their inclusion would provide no additional information. Nonresponses were excluded from this study. When participants did not answer a WTP question, their nonresponses were treated as missing data and were excluded from analysis (Blomquist, 1988). Those who responded to the WTP questions with a zero were not excluded from the analysis; rather, these responses were considered to be valid, indicating that the participants did not value xeriscape in that scenario.

Two separate questions, in another section of the survey, asked respondents to indicate if they had xeriscape or nonxeriscape landscaping in their front yards. For both questions (*actual_xeri* and *actual_nonxeri*), the respondents indicated their choices on a Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*) that they had xeriscape landscaping or nonxeriscape landscaping in their front yards, respectively. The responses were binned into two response categories. Strongly agree (1) and agree (2) were in the positive bin and those responding with a 4 (disagree) or 5 (strongly disagree) were binned as negative responses.

The open bars labeled "Choose Xeri WTP + Actual Xeri" represent those participants who (a) chose xeriscape from the first willingness-to-pay question; (b) indicated a value for xeriscape of zero or greater; and (c) indicated they had xeriscape landscaping in their front yards. The striped bars, labeled "Choose Xeri WTP + Actual

Non-Xeri," represent those respondents who (a) chose xeriscape from the first willingness-to-pay question; (b) indicated a value for the xeriscape of zero or greater; and (c) indicated they had nonxeriscape landscaping in their front yards. The percentage of observations is used instead of the number of observations because the number of people in the sample xeriscape and nonxeriscape groups is different. The number of observations does not provide a comparable scale across groups, while the percentage of each group with a particular WTP value does.

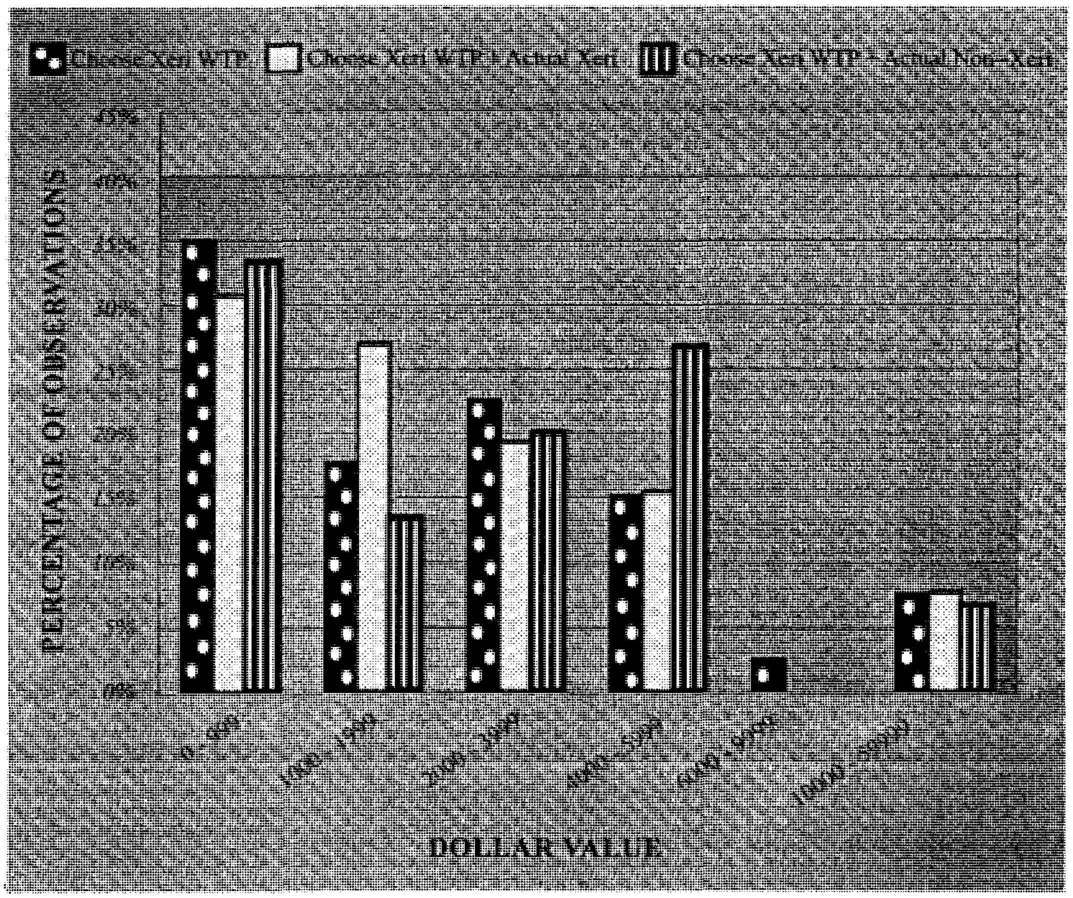

Figure 7. Percent Frequency of Dollar Value for Xeriscape for CVM 1.

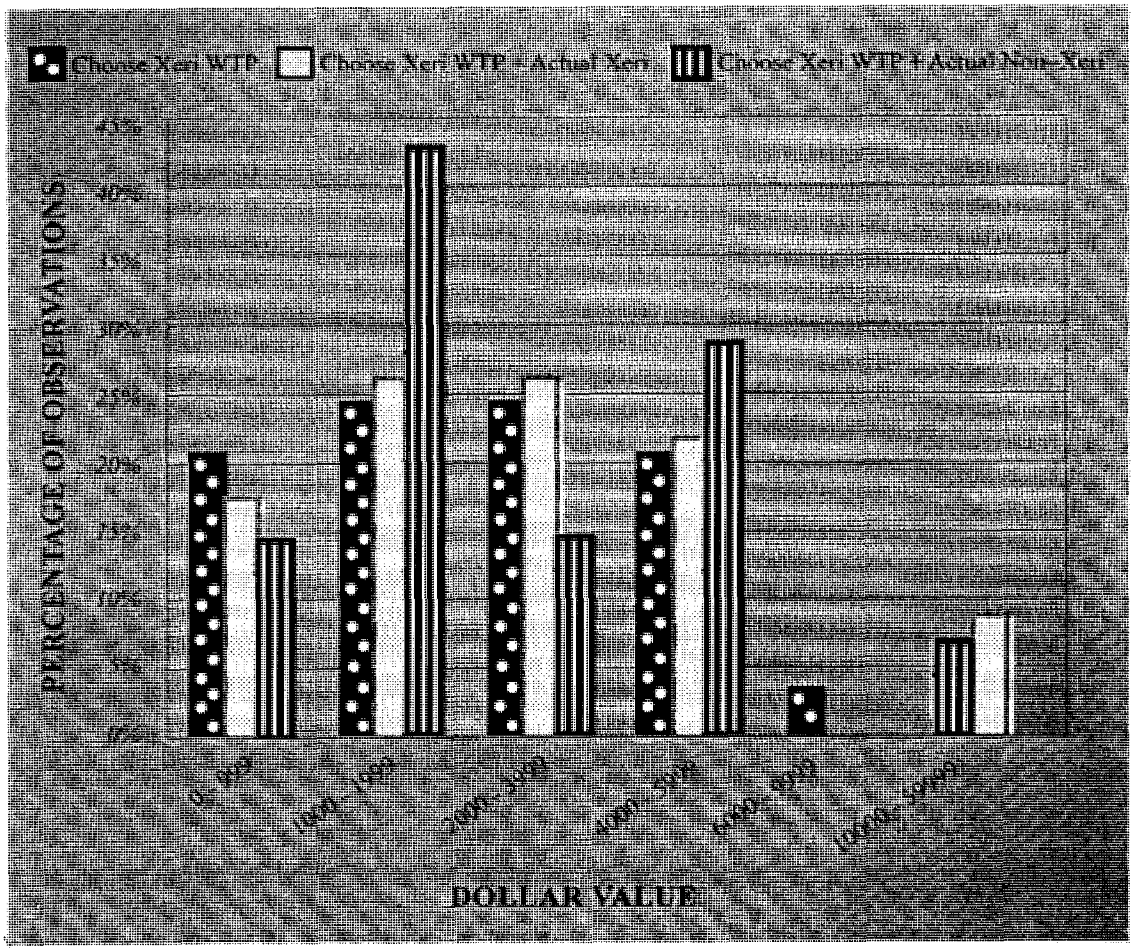

Figure 8. Percent Frequency of Dollar Value for Xeriscape for CVM 2.

Over 40% of the participants from the group labeled "Choose Xeri WTP + Actual Non-Xeri" who chose xeriscape were willing to pay $1,000 to $2,000 for the xeriscape yet had nonxeriscape in their front yards. This group is represented in Figure 7 by the tallest striped bar. It is also interesting to note that in both Figures 7 and 8, if respondents chose xeriscape and were willing to pay, the percentage of observations were evenly distributed in the price range below $6,000, regardless of whether they had xeriscape or nonxeriscape in their own yards. The results represented in both of these figures indicate a rejection of the second null hypothesis, because the mean reported WTP value through a CVM study is not equal to zero dollars. The WTP value for xeriscape was not only greater than zero dollars, it was significantly greater.

Test of Hypothesis 3

How does a value estimate from the HPM and a reported WTP value from the CVM compare for xeriscape landscaping? The null and alternative hypotheses based on this research question are, respectively, that the mean HPM estimate is equal to the mean reported WTP value through a CVM study and that they are not equal:

Test 3

$$H3_0: \overline{X}_{\text{HPM}} = \overline{X}_{\text{CVM}}$$

$$H3_A: \overline{X}_{\text{HPM}} \neq \overline{X}_{\text{CVM}}$$

Table's 10a and 10b contain results from the Kolmogorov–Smirnov (K–S)[43] test. The mean CVM WTP reported values for the private environmental good, xeriscape, are compared with the mean HPM xeriscape estimate in this test. The K–S test tries to determine if xeriscape values derived from two methods differ significantly.

The reported mean xeriscape CVM 1 (*chose_xeri 5F+wtp*) ($3,367) and CVM 2 (*chose_xeri 5H+wtp*)($3,388) values were used for comparison with the mean xeriscape HPM estimate ($24,222). The mean CVM 1 and CVM 2 never exceeds that of the HPM estimate. This is revealed by the zero values in the negative results of the most extreme

[43] According to SPSS (2006), "the [K–S] Z test statistic is a function of the combined sample size and the largest absolute difference between the two cumulative distribution functions."

Table 10a

Kolmogorov–Smirnov (K–S) Statistics for CVM Compared With HPM

	Value
HPM and CVM 1	
Most extreme differences	
Absolute	0.970
Positive	0.014
Negative	–0.970
K–S *Z*	6.039
Asymp. sig. (two-tailed)	0.000
HPM and CVM 2	
Most extreme differences	
Absolute	0.951
Positive	0.000
Negative	–0.951
K–S *Z*	4.457
Asymp. sig. (two-tailed)	0.000

Table 10b

CVM Versus HPM Comparisons

	Comparisons			
	n	K–S	Ksa	Pr > Ksa
		CVM 1		
CVM = 0	42	0.970	6.039	<.0001
HPM = 1	500	0.970	6.039	<.0001
		CVM 2		
CVM = 0	23	0.951	4.457	<.0001
HPM = 1	500	0.951	4.457	<.0001

differences.[44] This K–S test calculated the probability that differences as large or larger than –0.957 and –0.951 could occur if both samples actually came from the same distribution. This probability was for the HPM comparison with CVM 1 and CVM 2, respectively. The K–S test derived a value $p < .0001$, less than 1% for both tests of CVM 1 and CVM 2 with HPM. These results were clearly statistically significant. The probability of the K–S Z statistic is well below .05 for both of the comparisons. This indicates that the mean reported CVM 1 value and the estimated HPM value, and the mean reported CVM 2 value and the estimated HPM value, are significantly different at the 1% level.[45] Thus the third null hypothesis is rejected.

Table 11 presents the results of the parametric t test.[46] In both comparisons of the first WTP question (CVM 1 [*chose_xeri 5F+wtp*]) and the second WTP question (CVM 2 [*chose_xeri 5H+wtp*]) with the hedonic data (HPM), the probability value was close to zero ($p < .0001$). This indicated that the reported mean CVM 1 and CVM 2 values and the mean HPM estimate, in all probability, differed significantly. The dollar values of xeriscape obtained through the two methods are significantly different. The t statistics provide evidence for rejection of the third null hypothesis, that the HPM values of xeriscape are no different than the CVM values of xeriscape.

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[44] According to SPSS (2006), the most extreme differences refers to "the largest positive and negative points of divergence between the CDFs of the two sample distributions. . . . The absolute difference value labeled *absolute* is the absolute value of the larger of the two difference values reported directly below it. The *Positive* difference is the point at which the CDF for CVM1 or CVM2 exceeds the CDF for HPM by the greatest amount. The *Negative* difference is the point at which the CDF for CVM1 or CVM 2 exceeds the CDF for HPM by the greatest amount" (p. 1).

[45] It should be noted, though, that the K–S tests not only whether HPM and CVM 1 or CVM 2 differ in their mean level, but also whether they differ in other aspects of how they are distributed, such as standard deviation. One could obtain a significant K–S even when the means are equal, if one set of estimates is more variable than the other (SPSS, 2006).

[46] Even though one might expect xeriscape to have a positive impact, the proper way to test the null hypothesis is to use the more conservative nondirectional alternate hypothesis. The one-tailed directional tests could, perhaps, make it too easy to reject the null hypothesis, so two-tailed statistical tests are often used instead (SPSS, 2006).

Table 11

Comparison of HPM With CVM 1 and CVM 2: t Test (Parametric)

Variable	*n*	*df*	Method	*t* Value	Pr > |t|
			CVM 1		
CVM = 0	42	47.437	*t*-statistic	17.866	<.0001
HPM = 1	500	540	*t*-statistic	18.650	<.0001
			CVM 2		
CVM = 0	23	28.549	*t*-statistic	23.525	<.0001
HPM = 1	500	521	*t*-statistic	14.297	<.0001

Tables 12a, 12b, and 12c present the mean, median, and standard error for variables common from the CVM1, CVM2, and CVM1+CVM2[47] and HPM data. The ratios of CVM1/HPM, CVM2/HPM, and CVM1+CVM2/HPM are also reported. The common variables presented in all three tables are house price (*house price*), house size (*house size*), house age (*house age*), pool (*pool*), and xeriscape (*xeri*).

The estimated xeriscape value (*xeri value*) reflects the percentage of the sales prices of the 250 xeriscape homes calculated from the adjusted coefficient estimates reported for Models 1, 2, 3, and 4, as follows: (a) xeriscape value (*xeri value*) 7.3% reflects estimates from Models 1 and 3; (b) xeriscape value (*xeri value*) 7.4% reflects estimates from Model 2; and (c) xeriscape value (*xeri value*) 7.6% reflects estimates from Model 4.

[47] Socio-economic data relating to responses from both CVM 1 and CVM 2 were used for this table. For example: (a) 36 participants chose xeriscape for CVM 1 and also reported a house sales price; (2) 18 participants chose xeriscape for CVM 2 and also reported a house sales price; (3) 1 participant chose non-xeri for CVM 1 and also reported a house sales price; and (4) 10 participants chose non-xeri for CVM 2 and also reported a house sales price. The total of 36 + 18 + 1 + 10 participants equals 65 total participants answered CVM 1 and CVM 2. The house sales price they each reported was used in the calculations.

Table 12a

Comparisons for Common Variables of HPM and CVM (CVM1 + CVM 2) Data

		HPM				CVM1 + CVM2				CVM1+ CVM2/ HPM
Variable Name	Units	*n*	Mean	Median	*SE*	*n*	Mean	Median	*SE*	Ratio
house price all	dollars	500	317090	300000	4096.03	65	421754	400000	16137	1.33
house price nonxeri	dollars	250	306851	295500	5704.86	11	409545	400000	42289	1.33
house price xeri	dollars	250	327329	311000	5818.70	54	424241	400000	17581	1.30
house size all	ft^2	500	1801	1738	20.93	77	2094	1750	75	1.16
house size nonxeri	ft^2	250	1801	1756	29.08	13	2019	1750	190	1.12
house size xeri	ft^2	250	1801	1728	30.16	64	2109	1750	82	1.17
house age all	years	500	8.52	8.50	0.15	77	9.06	8.00	0.53	1.06
house age nonxeri	years	250	8.50	8.50	0.20	13	11.19	8.00	1.65	1.31
house age xeri	years	250	8.54	8.50	0.21	64	8.63	8.00	0.53	1.01
pool all	yes	500	0.13	0.00	0.02	77	0.36	0.00	0.06	2.77
pool nonxeri	yes	250	0.13	0.00	0.02	13	0.31	0.00	0.13	2.38
pool xeri	yes	250	0.13	0.00	0.02	70	0.39	0.00	0.06	3.00
xeri value 7.3%	dollars	250	23895	22703	424.77	55	3622	2000	978	0.15
xeri value 7.4%	dollars	250	24222	23014	430.58	55	3622	2000	978	0.15
xeri value 7.6%	dollars	250	24877	23636	442.22	55	3622	2000	978	0.15

*Note: **n*** is sample size; *SE* is standard error. Data are from Clark County, Nevada, Assessors Office and CVM survey.

Table 12a presents reported values from the two combined WTP questions (CVM1+CVM2) and the estimated values from HPM data. The ratios of CVM1+CVM2/HPM are also presented. CVM1+CVM2 respondents reported a 25% greater mean house sales price for all homes than estimated HPM prices. CVM1+CVM2 respondents reported a 14% larger house size than the HPM reported. The CVM1+CVM2 data set contained a greater number of older homes than the HPM data set by 6%. It is noted that the CVM1+CVM2 survey respondents reported higher sales prices, dwelling square footage, house age, and percentage of pools than were reflected in the HPM data.

The comparisons indicate that the xeriscape values from the HPM results were an average of 7 times greater than the xeriscape values (CVM1+CVM2) reported from the survey. Again, these results indicate rejection of the third null hypothesis, that there is no difference between CVM1+CVM2 and HPM value estimates. The ratio comparisons of CVM1+CVM2/HPM represent a range of ratios from 0.15 to 3.00, with xeriscape (*xeri*) having a 0.15 ratio and pool (*pool*) having the largest ratio at 3.00. The greatest difference between CVM1+CVM2 responses and HPM data were regarding the presence of pools. The second greatest difference between the CVM1+CVM2 and HPM data was regarding xeriscape value estimates.

Table 12b presents reported values from the first WTP question (CVM1) and the estimated values from HPM data. The ratios of CVM1/HPM are also presented. CVM1 respondents reported a 24% greater mean house sales price for all homes than estimated HPM prices. CVM1 respondents reported a 14% larger house size than the HPM reported. The CVM1 data set contained more older homes than the HPM data set by 6%. It is noted that the CVM1 survey respondents reported higher sales prices, dwelling square footage, house age, and percentage of pools than were reflected in the HPM data.

The comparisons in Table 12b indicate that the xeriscape values from the HPM results were an average of 7 times greater than the xeriscape values (CVM1) reported from the survey. Again, these results indicate rejection of the third null hypothesis, that there is no difference between CVM1 and HPM value estimates. The ratio comparisons of CVM1/HPM represent a range of ratios from 0.14 to 2.77, with xeriscape (*xeri*) having a ration of 0.14 and pool (*pool*) having the largest ratio at 2.77. The greatest difference between CVM1 responses and HPM data were regarding the presence of pools. The second greatest difference between the CVM1 and HPM data was regarding xeriscape values.

Table 12b

Comparisons for Common Variables of HPM and CVM1 Data

		HPM				CVM1				CVM1/ HPM
Variable Name	Units	*n*	Mean	Median	*SE*	*n*	Mean	Median	*SE*	Ratio
house price all	dollars	500	317090	300000	4096.03	38	418079	400000	20074	1.32
house price nonxeri	dollars	250	306851	295500	5704.86	1	450000	450000	-	1.47
house price xeri	dollars	250	327329	311000	5818.70	36	417833	400000	21276	1.28
house size all	ft^2	500	1801	1738	20.93	44	2080	1750	97	1.15
house size nonxeri	ft^2	250	1801	1756	29.08	1	1750	1750	-	0.97
house size xeri	ft^2	250	1801	1728	30.16	42	2095	1750	101	1.16
house age all	years	500	8.52	8.50	0.15	44	9.02	8.00	0.68	1.06
house age nonxeri	years	250	8.50	8.50	0.20	1	20.00	20.00	-	2.35
house age xeri	years	250	8.54	8.50	0.21	42	8.79	8.00	0.66	1.03
pool all	yes	500	0.13	0.00	0.02	44	0.36	0.00	0.07	2.77
pool nonxeri	yes	250	0.13	0.00	0.02	1	0.00	0.00	-	0.00
pool xeri	yes	250	0.13	0.00	0.02	42	0.36	0.00	0.07	2.77
xeri value 7.3%	dollars	250	23895	22703	424.77	42	3367	1375	1204	0.14
xeri value 7.4%	dollars	250	24222	23014	430.58	42	3367	1375	1204	0.14
xeri value 7.6%	dollars	250	24877	23636	442.22	42	3367	1375	1204	0.14

Note: n is sample size; *SE* is standard error. Data are from Clark County, Nevada, Assessors Office and CVM survey.

Table 12c presents reported variables from the second WTP question (CVM2) and the estimated values from HPM data. The ratios of CVM2/HPM are also reported. CVM2 respondents reported a 24% greater mean house sales price for all homes than estimated HPM prices. CVM2 respondents reported a 14% larger house size than the HPM reported. The CVM2 data set contained a greater number of older homes than the

HPM data set by 5%. It is noted that the CVM2 survey respondents reported higher sales prices, dwelling square footage, house age, and percentage of pools than were reflected in the HPM data.

Table 12c

Comparisons for Common Variables of HPM and CVM2 Data

			HPM				CVM2			CVM2/ HPM
Variable Name	Units	*n*	Mean	Median	*SE*	*n*	Mean	Median	*SE*	Ratio
house price all	dollars	500	317090	300000	4096.03	37	417216	400000	20074	1.32
house price nonxeri	dollars	250	306851	295500	5704.86	10	405500	400000	46538	1.32
house price xeri	dollars	250	327329	311000	5818.70	18	437056	400000	32093	1.34
house size all	ft^2	500	1801	1738	20.93	43	2087	1750	99	1.16
house size nonxeri	ft^2	250	1801	1756	29.08	12	2042	1750	206	1.13
house size xeri	ft^2	250	1801	1728	30.16	22	2136	1750	144	1.19
house age all	years	500	8.52	8.50	0.15	43	8.93	8.00	0.69	1.05
house age nonxeri	years	250	8.50	8.50	0.20	12	10.46	8.00	1.60	1.23
house age xeri	years	250	8.54	8.50	0.21	22	8.34	8.00	0.93	0.98
pool all	yes	500	0.13	0.00	0.02	43	0.37	0.00	0.07	2.85
pool nonxeri	yes	250	0.13	0.00	0.02	12	0.33	0.00	0.14	2.54
pool xeri	yes	250	0.13	0.00	0.02	22	0.41	0.00	0.11	3.15
xeri value 7.3%	dollars	250	23895	22703	424.77	23	3388	2000	888	0.14
xeri value 7.4%	dollars	250	24222	23014	430.58	23	3388	2000	888	0.14
xeri value 7.6%	dollars	250	24877	23636	442.22	23	3388	2000	888	0.14

Note: n is sample size; *SE* is standard error. Data are from Clark County, Nevada, Assessors Office and CVM survey.

The comparisons in Table 12c indicate that the xeriscape values from the HPM results were an average of 7 times greater than the xeriscape values (CVM2) reported from the survey. Again, these results indicate rejection of the third null hypothesis, that there is no difference between CVM2 and HPM value estimates. The ratio comparisons of CVM2/HPM represent a range of ratios from 0.14 to 3.15, with xeriscape (*xeri*) having a ratio of 0.14 and pool (*pool*) having the largest ratio at 3.15. The greatest difference between CVM2 responses and HPM data were regarding the presence of pools. The second greatest difference between the CVM2 and HPM data was regarding xeriscape value estimates.

The next chapter will present the summary and discussion.

CHAPTER 5

SUMMARY AND DISCUSSION

This chapter reviews the purpose of the study and the major methods in the study and summarizes and discusses the implications of the results. This chapter is divided into three sections: (a) review and summary; (b) discussion of results; (c) implications and recommendations.

Review and Summary

The purpose of this study was to use both the HPM and the CVM to estimate the benefits of a private environmental good, xeriscape landscaping, and to compare value estimates obtained using each method. The benefits of xeriscape landscaping for homeowners in Clark County, Nevada were estimated by analyzing participant responses to a survey, real estate market data, and socioeconomic data. There were a total of 500 homes used in this study that were sold between January 2004 and June of 2005, 250 homes with xeriscape landscaping and 250 homes with non-xeriscape landscaping.

The study used the HPM to analyze the real estate market data and socioeconomic data through regression analysis. The study used a CVM survey eliciting responses from homeowners about their preferences and WTP for xeriscape. The benefit estimates from the HPM and the CVM were compared.

The key findings of this study are:

- Market participants valued xeriscape landscaping.
- Survey respondents valued xeriscape landscaping.
- The mean HPM estimated benefits were greater than the mean CVM reported benefits for the private environmental good, xeriscape.

Hypotheses Tests Discussion

Hypothesis Test 1

Do market participants value xeriscape landscaping? The null and alternative hypotheses based on this research question were, respectively, that the mean HPM estimate was equal to zero and that it was greater than zero. Before the first hypothesis test could be performed a coefficient needed to be estimated. A preliminary test, Test 1a, provided this necessary information. The null hypothesis was that the coefficient from the HPM regression analysis for xeriscape was equal to zero, while the alternative was that it was greater than zero. β was the coefficient for xeriscape estimated from the HPM regression analysis using multivariate analysis

The coefficient of the private environmental good, xeriscape, was estimated using regression analysis of four models. For all four models together, there were 32 coefficients out of 44 that were significant at the 1%, 5%, and 10% levels. The independent variables explained 56% of the variation in the sales price indicated by the mean adjusted R^2 of the four models at 0.56. The mean adjusted xeriscape (*xeri*) coefficient of the four models was 0.074. There was a positive and significant coefficient at the 5% level on the xeriscape (*xeri*) dummy for all four models. The positive sign of xeriscape suggests that xeriscape is a benefit to consumers and is considered an amenity.

The null hypothesis was rejected because the xeriscape (*xeri*) coefficients in all four models were greater than zero.

Next the mean WTP value for the HPM data using the average of the xeriscape (*xeri*) coefficients from Models 1, 2, 3, and 4. The null and alternative hypotheses were, respectively, that the mean HPM estimate was equal to zero and that it was greater than zero. The resulting mean of the estimated benefits for xeriscape using the HPM was $24,222. The null hypothesis was rejected because the mean estimated value for xeriscape was greater than zero.

Figure 6 depicted the distribution of values for xeriscape estimated by the HPM, illustrating that the majority of people were willing to pay between $15,000 and $35,000 extra to have a home with xeriscape landscaping, suggesting that xeriscape is a positive environmental amenity. Again, the null hypothesis was rejected because the mean estimated value for xeriscape was greater than zero.

Hypothesis Test 2

Do survey participants report a positive WTP value for xeriscape landscaping? The null and alternative hypotheses based on this research question were, respectively, that the mean reported WTP value through a CVM study was zero dollars and that it was greater than zero dollars. The one-sample *t* test was used, in two separate tests, to test if the mean WTP for the private environmental good, xeriscape, in CVM 1 and CVM 2 was zero. Since the *p* values for both CVM 1 and CVM 2 were very small, both close to zero, the null hypothesis was rejected at the 1% level of significance, with WTP CVM 1 and CVM 2 values greater than zero.

Figures 7 and 8 report discrete categorical data estimating preferences between xeriscape and nonxeriscape landscaping. The results represented in both of these figures indicate a rejection of the second null hypothesis because the mean reported WTP value through a CVM study was not equal to zero dollars. WTP for xeriscape was not only greater than zero dollars, but was significantly greater.

Hypothesis Test 3

How does a value estimate from the HPM and a reported WTP value from the CVM compare for xeriscape landscaping? The null and alternative hypotheses based on this research question were, respectively, that the mean HPM estimate was equal to the mean reported WTP value through a CVM study and that they were not equal.

Tables 10a and 10b contain results from the Kolmogorov–Smirnov (K–S) test. The K–S test tried to determine if xeriscape values derived from two methods differ significantly. The K–S test derived a value $p < .0001$, less than 1% for both tests of CVM 1 and CVM 2 with HPM. These results were clearly statistically significant. The probability of the K–S Z statistic was well below .05 for both of the comparisons. This indicated that the mean reported CVM 1 value and the estimated HPM value, and the mean reported CVM 2 value and the estimated HPM value, were significantly different at the 1% level. Thus the third null hypothesis was rejected.

Table 11 presents the results of the parametric t test. This indicated that the reported mean CVM 1 and CVM 2 values and the mean HPM estimate, in all probability, differed significantly. The dollar values of xeriscape obtained through the two methods were significantly different. The t statistics provided evidence for rejection of the third null hypothesis, that the HPM values of xeriscape were no different than the CVM values of xeriscape.

Tables 12a, 12b, and 12c compare common variables from the CVM with the HPM. Again, these results indicated rejection of the third null hypothesis, that there is no difference between CVM 1 + CVM 2 and HPM values, CVM 1 and HPM values, or CVM 2 and HPM values because the values were different. HPM xeriscape value estimates were approximately 7 times greater than the reported CVM xeriscape values.

Table 16 shows the results of the hypotheses tests from chapter 5. In all cases, the null hypotheses were rejected. This table is included for summary purposes.

Table 16

Results

Null hypotheses	H_0 not rejected	H_0 rejected
$H1a_0$: $\beta_{HPM} = 0$		X
$H1_0$: $\overline{X}_{HPM} = 0$		X
$H2_0$: $\overline{X}_{CVM} = 0$		X
$H3_0$: $\overline{X}_{HPM} = \overline{X}_{CVM}$		X

Discussion of Results

This second section will be divided into the following five subsections: (a) relationship of the current study to prior research; (b) explanation of unanticipated findings; (c) theoretical implications of the study; (d) implications for practice; and (e) recommendations for further research.

Relationship of the Current Study to Prior Research

The results of this study are compared with previous related studies in this second subsection. Discussion in this subsection will be divided in the following three groups: (i) HPM discussion; (ii) CVM discussion; and (iii) comparison of HPM and CVM discussion.

HPM Discussion

Eight landscaping valuation studies, using data from a field survey and/or a homeowner survey, were incorporated into market data for regression analysis (see Table 2; Anderson & Cordell, 1988; Des Rosiers et al., 2002; Dombrow et al., 2000; Henry, 1994, 1999; Morales, 1980; Morales et al., 1983; Theriault et al., 2002). The mean valuation for trees and/or landscaping for these eight studies was 5.7% added to house sales price, compared to the 7.4% value estimated from the HPM for this study, so the xeriscape value estimates of this study for the HPM are within range of 23% of the previous studies' value estimates for trees and landscaping.

Variables selected from three previous studies (Des Rosiers et al., 2002; Henry, 1994 & 1999; Theriault et al., 2002) were used for Models 1, 2, and 3, respectively (see Table 7). The results of Models 1–3 are compared with results from the Theriault et al. (2002), Des Rosiers et al. (2002), and Henry (1994, 1999) studies in the following subsections.

HPM Model 1 Comparisons

Model 1 in the present study (Table 8) was based on the Theriault et al. (2002) study, which valued the impact of mature trees on property value. A semi-log form was used for regression for both the Theriault et al. study and the present study. The variance inflation factor (VIF) was less than 5 in the Theriault et al. study and less than 3 in the current study, and thus multicollinearity was well under control (Theriault et al., 2002).

Heteroskedasticity in both models was minimal due to the use of the semi-log form. Socioeconomic factors were reported to impact house values in the Theriault et al. study. The house size (*hsize*), house age (*hage*), lot size (*lot size*), and median household income (*incmed*), four socioeconomic (neighborhood) variables in the present study were highly significant in Model 1. Pool (*pool*) college graduate (*edugrad*) and xeriscape (*xeri*) were also significant in Model 1.The presence of children (*child*) had a negative impact, but was not significant in Model 1. The Model 1 results for house size (*hsize*), median household income (*incmed*), and presence of pools (*pool*) and children (*child*) were similar to the results of the Theriault et al. study. The impact of mature trees on house value had an average of 0.03 ($3,422) in the Theriault et al. study and 0.074 [*xeri* (*H-P adj.*)] ($24,222) for xeriscape in the present study. The percentage of house sales price estimates attributed to an environmental attribute from the Theriault et al. study and the present study were positive values.

HPM Model 2 Comparisons

The Des Rosiers et al. (2002) study was used for Model 2 of the current study. Des Rosiers et al.'s semi-log model estimated an average 0.078 ($8,624) increase in property value related to various types of landscaping. There was a 0.074 [*xeri* (*H-P* *adj.*)] ($24,222) increase in property value for xeriscape in the present study, which is comparable to the result from Des Rosiers et al. The present study results are within 8% of the estimates reported by Des Rosiers et al. The highest VIF was 2.9 in the Des Rosiers et al. study and 1.4 in the current study. These comparable results suggest that multicollinearity was kept within very acceptable limits for both studies (Des Rosiers et al., 2002). The R^2 was 0.869 for Des Rosiers et al. and 0.543 for the present study. The adjusted R^2 was 0.866 for Des Rosiers et al. and 0.536 for the present study. These R^2 and adjusted R^2 results suggest that the independent variables in the Des Rosiers et al. study explain more variation in the sales price than the independent variables in the current study's Model 2. The F value of the Des Rosiers et al. study was 258.4, while the F value of the current study was 73.0. The positive impact of house size (*hsize*) and college graduates (*edugrad*) in the present study were similar to the results of the Des Rosiers et al. study

HPM Model 3 Comparisons

Two studies by Henry (1994, 1999) were used for Model 3 in the present study. In both of Henry's (1994, 1999) studies, house sales price increased an average of 7% with improved landscaping. Percentage-wise, this increase is identical to the present study's unadjusted xeriscape estimate of 7%. The average VIF for Henry's (1999) study was 2, compared to the average VIF of the current study of 1.12. Both VIF averages were under 10 and averaged 2 or less.[47] These VIF results indicate that multicollinearity was kept within very acceptable limits for both the Henry (1999) study and the Model 3 results of the present study (Des Rosiers et al., 2002). The R^2 was 0.636 in the Henry (1994) study

[47] According to Pfaffenberger and Patterson (as cited in Henry, 1994), no VIFs in the regression should be greater than 10 or have an average greater than 2.

and 0.745 in the Henry (1999) study. These results were within 23% of the results of the current study, which reported an R^2 of 0.58. The adjusted R^2 was 0.619 in the Henry (1994) study and 0.735 in the Henry (1999) study. These results were within 22% of the results of the present study, which reported an adjusted R^2 of 0.58. The F value for the Henry (1994) study was 37.91, and for the Henry (1999) study, the F values had an average of 67. For the present study's Model 3, the F value was 135.706. The F value for the current study's Model 3 was twice as large as the average F value in the Henry (1999) study and over 3 times as large as the F value in the Henry (1994) study. The RMSE of the Henry (1994) study was 0.224, and for the Henry (1999) study, it was an average of 0.367. The RMSE from the present study for Model 3 was 0.200, close to the results of the Henry (1994) study but considerably smaller than the results of the Henry (1999) study. The positive coefficient for house size (*hsize*) in the Henry (1999; 1994) studies was similar to the present study.

HPM Model 4 Comparisons

The results of Model 4 (Table 8) will be compared with the eight landscaping valuation studies reported in Table 3.

A study in 1980 by Morales is the first previous landscaping study shown in Table 2. In Morales, a site inspection was used in determining whether or not trees contributed to residential property value. Morales's results indicated an average of 0.06 ($2,686) increase in sales price for homes with tree cover. In the present study, a 0.074 increase ($24,222) in sales price was estimated for homes with xeriscape. The percentage valuation estimates for Morales were within 19% of the percentage valuation estimates of the current study—reasonably close. The most significant variables in the Morales study were location, house size, sale date, tree cover, and number of fireplaces. In the present study (house size [*hsize*] and four neighborhood variables were significant (single family [*single family*], median household income [*incmed*], change of population [*popch05*], rate of housing change [*houch05*]), ranging from significant to highly significant at the 1%, 5%, and 10% levels. The environmental characteristic xeriscape (*xeri*) was also highly significant in the present study, as was the environmental characteristic tree cover in the Morales study. The present study's results confirm Morales's findings that (a) an increase in home value was due to landscaping attributes, (b) neighborhood variables were significant, (c) house size was significant, and (d) the environmental landscaping characteristics were significant.

In a later study by Morales et al. (1983), which is the second previous landscaping valuation study using HPM in Table 3, an appraiser's guide was used for valuation. The guide was used to estimate the contribution of trees to home value. An increase of 0.107 ($6,000) in home value was estimated using the appraiser's guide. This percentage estimation was greater than the average 0.074 ($24,222) attributed to xeriscape landscaping reported in this study. The percentage valuation estimates from Morales et al. and those of the present study were within 31% of each other.

The third previous landscaping valuation study using HPM, given in Table 3, was by Anderson and Cordell (1988), who valued the presence of trees on residential properties. Their results indicated an estimated average of 0.04 ($1,613) premium on house values attributed to the presence of trees. This is lower than the estimated 0.074 ($24,222) average result of the current study for the presence of xeriscape landscaping. The value estimates from Anderson and Cordell were within 46% of the value estimates of the present study—not as close as the Morales (1980) and Morales et al. (1983) study ranges. The R^2 reported by Anderson and Cordell (1988) was an average of 78%. This R^2 was much higher than the average R^2 of all four models of the present study of 57%. All coefficients were statistically significant in the Anderson and Cordell study.

The fourth previous landscaping valuation study using HPM included in Table 3 is Henry (1994). The Henry study valued the contribution of landscaping to property values using a field survey and market data. An average of 0.07 ($6,936) increase in house value was attributed to upgrading from average/poor to good or excellent landscaping in the Henry study. In the present study, 0.074 was the average estimate ($24,222) attributed to xeriscape landscaping from the four models. This 0.074 is quite similar to the 0.07 from Henry's results. These percentage estimates are within 5% of each other. Henry reported an R^2 of 0.0636 and an adjusted R^2 of 0.0619 These results are quite similar to the present study's results of 0.0565 and 0.0556 for R^2 and R^2 adjusted, respectively. The F value reported by Henry was 37.91, lower than the average F value for the present study of 80.89. The RMSE reported by Henry was 0.224, slightly higher than the average RMSE of the present study of 0.192.

The fifth previous landscaping valuation study using HPM given in Table 3 is the study by Henry (1999). This Henry study valued the contribution of landscaping to property values using a field survey and market data. An average 0.07 ($5,444) increase in house value was again attributed to upgrading from average/poor to good or excellent landscaping in the Henry study. In the present study, there was a 0.074 ($24,222) average increase in housing value attributed to xeriscape landscaping from the four models. The results were quite similar for both studies. Henry (1999) reported an R^2 of 0.0745 and an

R^2 adjusted of 0.0735 These values were higher than the present study results of 0.0565 and 0.0556 for R^2 and R^2 adjusted, respectively. The *F* value reported by Henry was 67, slightly lower than the average *F* value for the present study of 80.89. The RMSE reported by Henry was 0.367, higher than the average RMSE of the present study, which was 0.192.

The sixth previous landscaping valuation study using HPM given in Table 3 is by Dombrow et al. (2000), who valued the contribution of mature trees to house sales price. The percentage estimate added to sales price for the Dombrow et al. study was 0.019 ($1,800). This percentage was much lower than the present study's estimated mean of 0.074 ($24,222). Dombrow et al. reported little evidence of multicollinearity, but heteroskedasticity was evident. In the present study, there was little evidence of either multicollinearity or heteroskedasticity. The R^2 in the Dombrow et al. study was 0.085 much higher than the average of 0.0565 of the present study. There was much higher variation being explained by the dependent variables in the Dombrow et al. study than in the present study.

The study by Des Rosiers et al. (2002) is the seventh previous landscaping valuation study given in Table 3. The results of the Des Rosiers et al. study indicated that a high percentage of lawn cover (nonxeriscape) commands a substantial market premium. Des Rosiers et al. reported premiums averaging $8,624 (0.077) using HPM. The HPM results for the present study show the opposite, with xeriscape commanding a higher market premium than nonxeriscape: The mean estimated value for xeriscape homes was higher than for nonxeriscape homes, as reported in the descriptive statistics of Table 5. In addition, the mean adjusted estimated value for xeriscape for all four models from

Table 5 is 0.074, which results in a $24,222 estimated premium for the 250 xeriscape homes. Therefore the results using HPM for this study do not agree with the previous findings by Des Rosiers et al. (2002) concerning the type of landscaping commanding a higher market premium. The results of the present study, however, do agree with Des Rosiers et al. in the valuation of landscaping as a positive environmental amenity associated with residential housing, without specifying a type of landscaping.

The eighth previous landscaping valuation study using HPM given in Table 3 is by Theriault et al. (2002). Although there were two types of surveys used by Theriault et al., the resulting data were incorporated into the market data for analysis. Theriault et al. used the data to assess the contribution of mature trees to house value. Theriault et al. reported that multicollinearity was limited with VIFs less than 5. This is similar to the results of the present study, with VIFs less than 4 for all four models. Theriault et al.'s study results also indicated that heteroskedasticity was minimal due to the use of the semi-log form of regression, as was also the case with the present study. The mean percentage estimation of the impact of mature trees on house sales price in Theriault et al. was 0.03 ($3,422). This 0.03 is more than half as much, percentage-wise, as the percentage estimate from the present study of 0.074 ($24,222).

The ninth previous landscaping valuation study using HPM given in Table 3 is by Netusil (2005). The combined amenity, trees and stream (*trees and stream*) were estimated to add 0.129 ($33,014) to house sales price in the Netusil study. This previous study's 0.129 ($33,014) increase of house sales price, percentage-wise, is substantially greater than the present research estimate of 0.074 ($24,222) impact of xeriscape on house sales price, while the dollar values are less in the previous study.

CVM Discussion

This section discusses the results of the CVM estimates in comparison with previous studies. This section will be divided into two subsections related to xeriscape preferences and the impact of xeriscape on housing prices: (a) CVM comparisons with six landscaping preference studies (Cotter & Croft, 1974; Des Rosiers et al., 2002; Hurd, 2006; Lockett et al., 2002; Spinti et al., 2004; Thayer, 1982) and (b) CVM comparisons with three landscaping valuation studies.

CVM Comparisons With Landscaping Preference Studies

Four previous studies reported that xeriscape/native landscaping was popular and considered attractive (Cotter & Croft, 1974; Kirkpatrick et al., 2007; Spinti et al., 2004; Thayer, 1982). In the present study, two questions on the CVM survey were directly related to attractiveness of xeriscape, as reported in Table 7: (a) xeriscape is pleasing (*xeri_pleasing*) and (b) xeriscape looks attractive (*look_attractive*). In responding to the question that xeriscape is pleasing (*xeri_pleasing*), 80% of the respondents agreed that water-conserving landscapes, called *xeriscapes*, were aesthetically pleasing. In answering the question if xeriscape looks attractive (*look_attractive*), 76% of the respondents agreed that they would use desert plants in landscapes because they look attractive. These results are in agreement with the previous studies.

In contrast to the studies given in the previous paragraph, the Lockett et al. (2002) study had some responses indicating that xeriscape was not aesthetically pleasing. In the present study, in response to the question about whether xericape landscaping was pleasing or not (*xeri_pleasing*), 20% of respondents did not agree that water-conserving landscapes, called *xeriscapes*, were aesthetically pleasing. These results are in agreement with the Lockett et al. study.

In a study by Des Rosiers et al. (2002), a high percentage of lawn cover was one of the features that commanded a substantial market premium. In the present study, a high percentage of lawn cover (nonxeriscape) was valued more than xeriscape in the Preferences and Willingness to Pay section of the CVM survey in response to the question about preference of nonxeriscape landscaping and willingness to pay for that preference (*chose_nonxeri 5E+wtp*). It must be noted, though, that only one person responding to this question chose nonxeriscape with a WTP of $10,000. In the second WTP question asking respondent if they preferred a nonxeriscape landscaping in a second photo group (*chose_nonxeri 5G+wtp*), lawn cover (nonxeriscape) was not valued more than xeriscape (*chose_xeri 5H+wtp*). The values respondents reported for xeriscape were, in fact, more than double the values reported for nonxeriscape in the second question. So discounting the one answer to the first WTP question, the results of the present study agree with the results of Des Rosiers et al. in valuing landscaping as an environmental amenity but disagree on the type of landscaping that was more valued.

In the study by Lockett et al. (2002), education was also positively linked with usage of native plants (xeriscape). The more education participants had, the more likely they were to use native plants in their landscapes. In the current study, 57% of the survey participants had more education, and 43% had less education. Sixty-five percent of the 57% of respondents who had more education also reported having xeriscape in their yards. These results are therefore in concurrence with previous studies in that the more education a participant had, the more likely that participant was to use native plants in the participant's landscapes.

In the study by Spinti et al. (2004), a lower percentage of survey respondents reported actually having desert landscaping, compared to those reporting that they were willing to use desert plant materials. In the present study, from Table 7 in responding the the question about whether xeriscape provided the type of landscaping they desired (*xeri_desire*), 71% of the respondents reported that it did. There were 64% who reported they actually had xeriscape landscaping in their yards (*actual_xeri*). These results are similar to the results of the Spinti et al. (2004) study, with a lower percentage reporting having xeriscape than were willing to use desert plants.

In a study by Hurd (2006), respondents in two out of three cities did not prefer xeriscape. In a study by Kirkpatrick et al. (2007) a native gardens was the most popular form of landscaping. In the present study, it can be seen in the preferences (photos 1A, 1B, 1C, and 1D) section in Table 7 that more respondents preferred nonxeriscape than xeriscape in responses labeled 1A, like nonxeriscape (*like_nonxeri 1A*), 1B, like xeriscape (*like_xeri 1B*), 1C, like nonxeriscape (*like_nonxeri 1C*), and 1D, like xeriscape (*like_xeri 1D*). More respondents, though, preferred xeriscape than nonxeriscape in the responses to the questions in the willingness to pay section labeled chose 5E, nonxeriscape (*chose_nonxeri 5E*), 5F, chose xeriscape (*chose_xeri 5F*), 5G chose nonxeriscape (*chose_nonxeri 5G*), and 5H chose xeriscape (*chose_xeri 5H*). So the present study reported conflicting preferences, with some respondents preferring xeriscape and others not preferring xeriscape. These results are conflicting as are the previous study results reported by Hurd (2006) and Kirkpatrick et al. (2007).

CVM Comparisons With Landscaping Valuation Studies

Three landscaping valuation studies[48] used homeowner or consumer surveys, providing values that could be used for comparisons with this study, as cited in Table 3 (Behe et al., 2005; Hardy et al., 2000; Morales et al., 1983). There was an average value of 0.126 ($11,886) added to the house sales price attributed to landscaping or tree cover for these three studies. It must be noted that the dollar value was not adjusted for inflation and represents value estimates from the years 1983, 2000, and 2005. The present study does not have a percentage value to compare with these previous studies' percentages. There is, however, a dollar value estimate for xeriscape of $3,622 (*wtp_xeri 5F+5H*) to compare with the previous surveys' average value estimates of $11,886 for landscaping or tree cover. The previous surveys' dollar value estimates were almost three times greater than the present study's results. The previous studies were not specifically valuing xeriscape, but rather valuing landscaping as a whole, quality of landscaping, or landscaping elements, and this may have contributed to the differences revealed between the results.

A previous landscaping valuation study by Morales et al. (1983) used a site inspection and a homeowner survey in one portion of the study to estimate the contribution of trees to home value. The site inspection and responses to the homeowner survey provided an estimated increase of $9,500 of home value attributed to tree cover. This estimation is greater than the average $3,622 (*wtp_xeri 5F+5H*) attributed to xeriscape landscaping reported in the present study. It must also be noted that the Morales et al. value estimates were from 1983 and that the values would be even greater

[48] A fourth study by Theriault et al. (2002) used a homeowner survey, but the responses were combined with data from a field survey and market data before analysis. Therefore the survey results could not be used for comparison with the present study.

today due to inflation factors. Thus the differences between the two studies' results would be even greater.

Another previous study reported in Table 3, by Hardy et al. (2000), involved a survey in which homeowners were asked to estimate how much landscaping contributed to house value. The results showed a $23,147 increase in the perceived value of the home from the least valued landscape to the most valued landscape. The mean xeriscape value reported for the two WTP questions (*wtp_xeri 5F+5H*) was $3,622 for the present study, more than six times lower than in the Hardy et al. study. The results from Hardy et al. were not exactly comparable to the results of the present study due to the specific environmental landscaping commodity being assessed. Nevertheless, Hardy et al. did provide a value for landscaping as a positive environmental amenity associated with residential housing. This was in agreement with the present study results of xeriscaping being valued as a positive environmental amenity.

Another previous landscaping valuation study given in Table 3 is a survey by Behe et al. (2005). The mean value of landscaping contribution to sales price was estimated at $3,012 in Behe et al. This is very similar to the present study's mean xeriscape value of $3,622 reported for the willingness to pay questions (*wtp_xeri 5F+5H*).

In summary, CVM results from the present study are comparable to the previous xeriscape preference survey results. There is one exception, though, with regard to the Hurd (2006) study, where xeriscape was not preferred in two out of three cities.

Comparison of HPM and CVM Discussion

This section discusses the results of the HPM and CVM of the current study compared with previous studies. This section is divided into two subsections: (a) nonlandscaping valuation comparison studies discussion and (b) landscaping valuation comparison studies discussion. The studies reported in Tables 1 and 3, respectively, are used for these comparisons.

Landscaping Valuation Comparison Studies Discussion

Table 3, presented in chapter 3, provides 11 previous studies involving various methods of landscaping valuation relating to housing properties. Thirteen value estimates are reported.[49] The average value reported for the landscaping, including values from the Netusil (2005) study valuing trees and stream and slope and stream was 0.062 for the studies involving surveys and HPM. If the Netusil (2005) studies were not included and only the tree and landscaping valuation studies the average value reported was 0.076 The mean xeriscape value estimate obtained from the HPM for the present study for all four models was 0.074, or $24,222, and the mean xeriscape value reported by the CVM respondents was $3,622 (*wtp_xeri 5F+5H*). The HPM value estimates were close to seven times greater than the CVM values reported. The HPM estimates from the present study were 0.074 compared to previous studies average of 0.076, very comparable. The results for HPM and CVM on this xeriscape variable were statistically significant.

Nonlandscaping Valuation Comparison Studies Discussion

In a CVM-HPM (PDA) comparison study of flood risk reduction valuation by Shabman & Stephenson (1996), given in Table 1, the hedonic mean estimates were more

[49] Morales et al. (1983) reported separate value and percentage estimates for both the survey and HPM methods, so these are separated here.

than four times larger than the CVM estimates in comparison with the present study where the HPM estimates were seven times larger than the CVM estimates. Shabman and Stephenson cite difficulties with respondents being able to place a willingness to pay value on flood risk reduction even though the subject matter was familiar and had a direct effect on their lives. Perhaps the same explanation would apply to the present study, which used a survey of recent home buyers. Buying a house and their marginal WTP for a particular environmental characteristic was very familiar to them (Earnhart, 2006).

In a CVM–HPM comparison study by Ready et al. (1997), given in Table 1, CV estimates were reported to be lower than HPM estimates but within 20% of each other. This study's CVM–HPM value estimate comparisons were within 86% of each other, not at all similar to the Ready et al. results. Ready et al. suggested that their 20% difference may have been due to no statistical significance and possible random error. In the present study, there was statistical significance associated with 32 out of 44 variables in the HPM models in Table 8, so this reason for differences is not as strong in the present study. There were two separate studies valuing the same environmental good using two different methods, the HPM and the CVM (Tyrvainen, 1997 [HPM]; Trvainen & Vaananen, 1998 [CVM]). The benefit estimates from both studies positively impacted housing prices. The present study's benefit estimates also positively impacted housing prices, the same as the previous two studies.

The fourth study in Table 1 by Belhaj (2003) mean WTP estimated by the HPM was quite similar to the estimates obtained using the CVM where distance to the town center was used as a proxy for environmental factors. This was not consistent with the findings of the present study.

The fifth study in Table 1 conducted by Nijland et al. (2003) used the HPM and CVM results in a cost-benefit analysis. The benefits were greater than costs in the Nijland et al. study, confirming the same results from the present study.

The sixth study in Table 1 by Qiu et al. (2006) using the HPM, CVM and PDA examined amenity benefits for open space and riparian buffers. The WTP values from the CVM were consistent with the economic values estimated using the HPM. This does not confirm the findings of the present study where HPM estimates were greater than CVM estimates.

Explanation of Unanticipated Findings

The comparison of the CVM results from the present study with the previous studies' landscaping valuation results using HPM, field surveys, homeowner surveys, and/or consumer surveys shows great differences. Values reported from the previous studies summarized in Table 3 are much greater than the values estimated from the present study. Since dollar values were the only way to compare results, the effect of inflation over years may have accounted for some differences. Another reason for the differences may be related to the differences in the specific landscaping elements that were valued in each study.

It was not expected that the HPM estimated benefits would be substantially larger than the CVM estimated benefits in the present study. Whitehead (2006), citing Boyle et al., attributed the lower CVM estimates to the tendency of open-ended questions to produce lower estimates of WTP than dichotomous choice question formats. The present study also used an open-ended WTP question format, which may have contributed to the lower CVM estimates. In a meta-analysis of 83 revealed and stated preference study comparisons, Carson et al. (1996) reported that CVM estimates were smaller, but not grossly smaller, than revealed preferences and cautioned that this may not always be the case. The fact that the CVM values in the present study are lower is consistent with results from the Carson et al. study, but being grossly smaller by 7 times indicates that more research may provide additional information for further explanation.

Differences between the values estimated and reported from the two methods in the present study may be due to nonresponse bias since only 49 participants (10%) responded to the CVM survey out of a possible 500. Nonresponse in and of itself does not indicate that the data are biased. According to Schwarz, Groves, and Schuman (1998), bias occurs when the individuals responding to a survey differ from nonrespondents on variables relevant to the survey. A systematic examination of nonrespondents determines if bias does or does not exist (Rogelberg & Luong, 1998). This study had the advantage of having access to limited information about nonrespondents through the HPM data set. The 49 respondents to the survey who were part of the entire 500 sample HPM data set could not be identified, exactly, due to privacy requirements of the study. The socioeconomic characteristics from the 49 CVM respondents, though, were able to be compared with the entire HPM data set, which included respondents as well as nonrespondents, to determine any potential nonresponse bias.

Key characteristics of the HPM and CVM samples were compared to see if the CVM sample was representative of the HPM population. Any differences in characteristics may provide possible explanations for differences between HPM and CVM xeriscape values. The HPM socioeconomic data were not exactly matched with the sample homes in that data set, but rather from zip code profiles for the residential neighborhoods where the participants lived. The comparisons are presented in Appendix E and summarized hereafter.[50]

There was a 10% response rate to the CVM survey. Of those 10%, there was a greater percentage of people responding in the 35- to 65-year-old age group (0.78) compared to the HPM sample 35- to 65-year-old age group (0.55). House sales price was reported as $395,000 by the survey respondents versus a mean $317,090 market value estimate of homes used in the HPM portion of the study. More respondents (0.59) to the CVM survey indicated that they had lived for more than 20 years in the desert versus respondents to the HPM study (0.28). The mean household income reported by CVM respondents was $102,500, over twice the amount of income estimated for the HPM participants of $47,209. The income, home sales price, age groups, residency, and the CVM small sample size may all be factors explaining differences in xeriscape values reported and estimated from the two methods in this study. Because of the small sample size in the CVM survey and the differences found between four of the key characteristics in the CVM and HPM samples, caution must be used in drawing conclusions.

Implications and Recommendations

Theoretical Implications of the Study

The National Oceanic and Atmospheric Administration (NOAA) panel recommended and encouraged studies that use revealed preference (RP) frameworks to validate contingent valuation estimates from a stated preference (SP) method (Arrow et

[50] The entire population of Clark County is also represented in Appendix E to see if the samples from the two methods are representative of the population from which the samples were drawn.

al., cited in Loureiro et al., 2003). This study used the HPM, an RP framework, and the CVM, an SP framework as the NOAA panel recommended. The results of this study show that market participants and survey participants both estimated a positive willingness to pay for a private good, but the HPM value estimates were considerably greater than the CVM. The findings in prior studies, as in this study, have reported inconsistent results between HPM and CVM values when estimating public or quasi-public goods and comparing estimates.

Azevedo et al. (2003) suggests if there are any discrepancies occurring between the individual parameter estimates when using revealed preference and stated preference methods, it does not necessarily indicate either method's failure. The research goal is not to validate either the CVM or the HPM but to ensure that the valuation estimates are defensible (Haab & McConnell, 2002). One should not be "concerned with whether stated preferences work better or worse than behavioral methods, or whether stated preferences measure true values, but given that one has chosen an approach, how the data should be handled to ensure defensible valuation estimates" (Haab & McConnell, 2002, p. 4).

Since this is the first comparison study valuing a private good using the HPM and CVM, the findings provide a foundation for other future comparison studies to examine consistency. Not only will this provide a foundation for studies specifically using the HPM and CVM for valuing private goods, but it will also provide a foundation for studies using other RP and SP methods for public and quasi-public goods.

A recommendation by Loureiro et al. (2003) is also applicable to this study "Since there are findings both for and against consistency of RP (revealed preference) and SP (stated preference) studies in the literature, more empirical work is needed to better under stand under what conditions and why researchers have come to these differing conclusions. The results may depend not only on whether both sets of preferences are identical, but also on how SP and RP are measured and monitored" (p. 54).

Adamowicz, W.L. (2004) reports that simply recognizing "that revealed preference data alone are not sufficient for understanding preferences and trade-offs is a major advance in the profession" (p. 435). Shabman and Stephenson (1996, p. 444) suggest that "different benefit estimates from different techniques are not to be explained away, they are to be expected." In summary Chattopadhyay et al. (2005) suggest that comparing "two econometric methodologies is not only an important empirical exercise, it may also provide better understanding as to what needs to be done to bridge the gap between the welfare results from the survey-based and market-based approaches' (p. 358).

Implications for Practice

The results from this study suggest that there are benefits of planting xeriscape landscapes for real estate developers building new homes and homeowners changing their landscapes. It appears that homes with xeriscape do command a higher sales price in the marketplace than homes with non-xeriscape landscaping. While this study estimated xeriscape benefit for single family homeowners, this research would suggest that xeriscsape landscaping used for multi-family dwellings and commercial buildings would also derive benefits for the building owners and the community. Appraisers, real estate sales people, and real estate marketing companies should be able to add xeriscape as a feature when they evaluate properties or place xeriscape properties on the market.

Daily et al. (2000) suggest that "reliance on individual preferences to construct social values, although defensible on ethical grounds, has serious pitfalls...The outcome of economic valuation is in this respect not more informed than the people whose values are being assessed" (p. 395). Other municipalities considering water conservation policies promoting xeriscape should evaluate results from this study and also consider Daily et al.'s suggestion in their decision-making. "Valuation is a way of organizing information to help guide decisions but is not a solution or end in itself. It is one tool in the much larger politics of decision-making" (Daily et al., 2000, p. 396).

Recommendations for Further Research

This study focused on the benefit estimates of xeriscape to homeowners and to the community. There are additional benefits of establishing native plant communities, which in turn reintroduce fauna that were once native to the region and a part of the native plant communities. In future studies evaluating xeriscape benefits the scope of a study could be broadened to include these types of ecosystem benefits. It is also important to consider estimating the negative impact that may occur from the spread of non-native plants sometimes used in xeriscape landscapes under certain conditions. Xeriscape landscapes use water-conserving plants that comprise both native and non-native plant materials.

This study examined the relationship between preferences and economic values during a relatively short period of time and did not allow for changes in preferences over time. It is recommended that future researchers examine the relationships among preferences and economic values of xeriscape further, across geographical regions and time. Demand for a private good, such as xeriscape, may change over time due to more attention placed on water shortages, prices of related goods (e.g., cost of watering grass), and potential changes in rebate policies. Given the dynamics of consumer water demand, it is recommended that researchers consider comparing benefit estimates across geographical regions where water prices are high and low, respectively. Future research could focus on the natural resource aspect of the water conserved in xeriscape and how water is connected with "the sustainability of human well-being" (Arrow et al., 2007, p. 1365).

APPENDIX A

TABLE OF PRIVATE GOODS COMPARISON STUDIES

Author	Year	Good	Method
Neill et al.	1994	paintings	CVM, Vickrey auction
Cummings et al.	1995	juicers, chocolates, calculators	Real dichotomous choice (DC) questionnaires, Hypothetical DC questionnaire,
Loomis et al.	1996	art print	Hypothetical WTP and Actual WTP
Johannesson, Lijas, & Johansson	1998	chocolates	CV, Real purchase decisions
Willis & Powe	1998	recreation entrance fee	CVM and Real economic commitment
Blumenschein et al.	2001	asthma management program	CVM dichotomous choice or actually enroll in program
Bhatia & Fox-Rusby	2003	mosquito nets	WTP, Actual purchase

APPENDIX B

SURVEY

LAS VEGAS VALLEY RESIDENTIAL LANDSCAPING PREFERENCES SURVEY

Background Information

After more than five years of drought in the West, regional water storage reservoirs on the Colorado River have been significantly depleted (currently Lake Mead is less than 60 percent full and Lake Powell is less than 40 percent of capacity). Water conservation is important to extend these supplies as new sources are developed and to assure current water resources are used as efficiently as possible.

Landscape irrigation dominates residential water use (65 to 90 percent of the water used in single-family residences is used outdoors – mostly for watering grass). For this reason, the use of water-smart landscaping (a.k.a. xeriscape) is encouraged to save on outdoor water use. In this area, xeriscape is typically considered to be composed of drought-tolerant vegetation and a mulch layer that is commonly irrigated by use of a low-flow or drip system.

Research has demonstrated that landscaping with xeriscape at homes saves an average of approximately 56 gallons per square foot when used in place of traditional turfgrass landscaping. For this reason, local governmental jurisdictions are permitting the installation of xeric-only landscaping in the front yards of new homes and also significantly restricting back yard turf in new homes. To further encourage landscape conversion of current turfgrass to xeriscape, the Southern Nevada Water Authority (SNWA) is offering an incentive rebate of $1.00 for each square foot that is converted.

But what is the impact of such efforts on home desirability and home value? To better understand this, we are conducting a study to explore which types of landscaping residents prefer and how their opinions may influence the resale value of their homes. As part of this research, we would appreciate your valuable input. Your individual response will be kept strictly confidential and will not be given or sold to a third party, nor will it be used for special solicitations by SNWA or its member agencies.

We want to consider which type of landscaping you, as a homeowner or renter, prefer and get your opinions about turf-dominated and drought-tolerant xeriscape landscapes. Photos of landscapes will be part of this survey. The two types of landscaping we would like you to consider are described below:

TURF-DOMINATED LANDSCAPES - defined as having non drought-tolerant, high-water-use turfgrass and plants covering 51 to 100 percent of the landscaped area at maturity.

XERISCAPE LANDSCAPES - defined as having drought-tolerant plants and trees covering 51 to 100 percent of the landscaped area at maturity, with the entire area surrounding plants covered with mulch or rock.

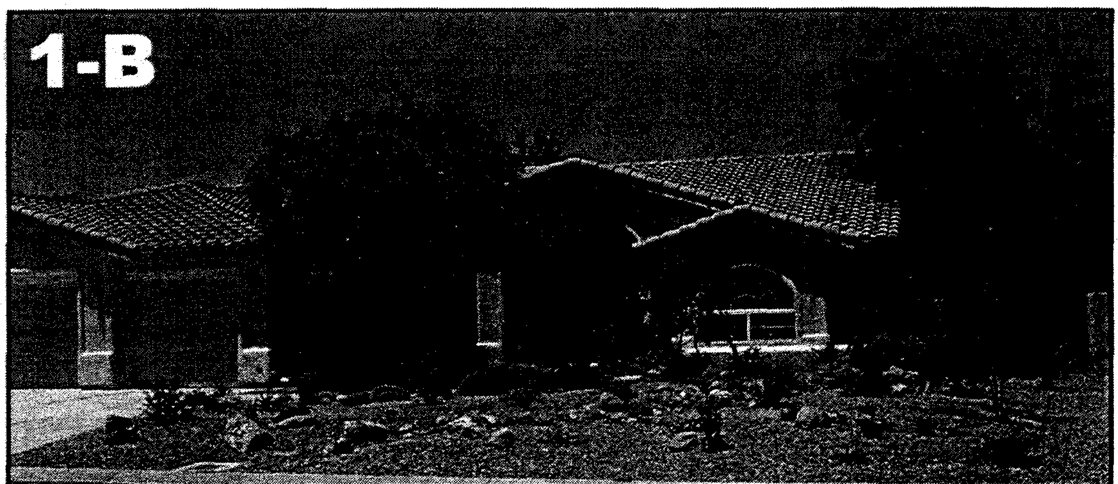
We are very grateful that you are willing to use some of your valuable time to help us to complete this survey--you have taken advantage of an opportunity for your voice to be heard. Thank you.

TURF-DOMINATED AND XERISCAPE LANDSCAPE PHOTOS

PLEASE RANK THE LANDSCAPING (not the houses) **& ANSWER THE QUESTIONS** (Circle Your Answer for each one)
Below and on the next page are four photographs with different types of landscaping: Please circle the response that best describes your opinion to each question. Please rank the landscape photos (A, B, C, D) in the order of your preference - which landscape (not house) do you like the most and would want in your yard -- for the one you like most, circle #1, for the one you like 2nd, circle #2, the one you like third, circle #3, the one you like fourth, circle #4.

1. **PLEASE RANK THE LANDSCAPING** (not the houses) **& ANSWER THE QUESTIONS** (Circle Your Answer for each one)

A. TURF-DOMINATED LANDSCAPE	1 Most Favorite	2 Second Favorite	3 Third Favorite	4 Least Favorite	
a. Overall, how do you like this landscape?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
b. Would you like this landscape in your front yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
c. Would you like this landscape in your back yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All



B. XERISCAPE LANDSCAPE	1 Most Favorite	2 Second Favorite	3 Third Favorite	4 Least Favorite	
a. Overall, how do you like this landscape?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
b. Would you like this landscape in your front yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
c. Would you like this landscape in your back yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All

1. PLEASE RANK THE LANDSCAPING (not the houses) **& ANSWER THE QUESTIONS** (Circle Your Answer for each one) Below are the final two photographs with different types of landscaping: Please circle the response that best describes your opinion to each question. Please rank the landscape photos (A, B, C, D) in the order of your preference - which *landscape (not house) do you like the most and would want in your yard -- for the one you like most, circle #1, for the* one you like 2nd, circle #2, the one you like third, circle #3, the one you like fourth, circle #4.

C. TURF-DOMINATED LANDSCAPE	1 Most Favorite	2 Second Favorite	3 Third Favorite	4 Least Favorite	
a. Overall, how do you like this landscape?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
b. Would you like this landscape in your front yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
c. Would you like this landscape in your back yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All

D. XERISCAPE LANDSCAPE	1 Most Favorite	2 Second Favorite	3 Third Favorite	4 Least Favorite	
a. Overall, how do you like this landscape?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
b. Would you like this landscape in your front yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All
c. Would you like this landscape in your back yard?	Yes A Lot	Yes A Little	Undecided	Not Much	Not At All

2. Opinions toward water conservation and drought-tolerant plants *(Please circle one answer per question)*

a. Amount of time each week spent in gardening activities indoor or outside.

1-2 hours **3-4 hours** **5-6 hours** **7-8 hours** **9 or more hours**

Aesthetics, Attractiveness, Costs, and Savings of Xeriscapes	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
b. Water-conserving landscapes called "xeriscapes" are aesthetically pleasing.					
c. I would use native, drought-tolerant plants if they were used attractively in the landscape design.					
d. If I could receive long-term savings on my water bill I would convert my front yard landscape from turf to xeriscape.					
e. If I have to pay short-term costs to convert a turf-dominated landscape to xeriscape, it is worth it.					

3. The most important reason to landscape my yard *(Mark one box for each description below)*

Reasons to landscape my yard	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
a. To make my yard more attractive					
b. To make my house more attractive					
c. To increase my property value					
d. To provide a place to play or relax					
e. To provide shade					
f. I enjoy gardening outside					
g. To create areas that contrast the desert					

4. Give your feelings about using desert plants in landscapes *(Mark one box for each description below)*

Feelings about using desert plants	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
a. They look attractive					
b. They provide the landscape I desire					
c. They provide enough green					
d. They are not my favorite plants					
e. They look too much like the desert					
f. They are too expensive					
g. I don't know that much about them					

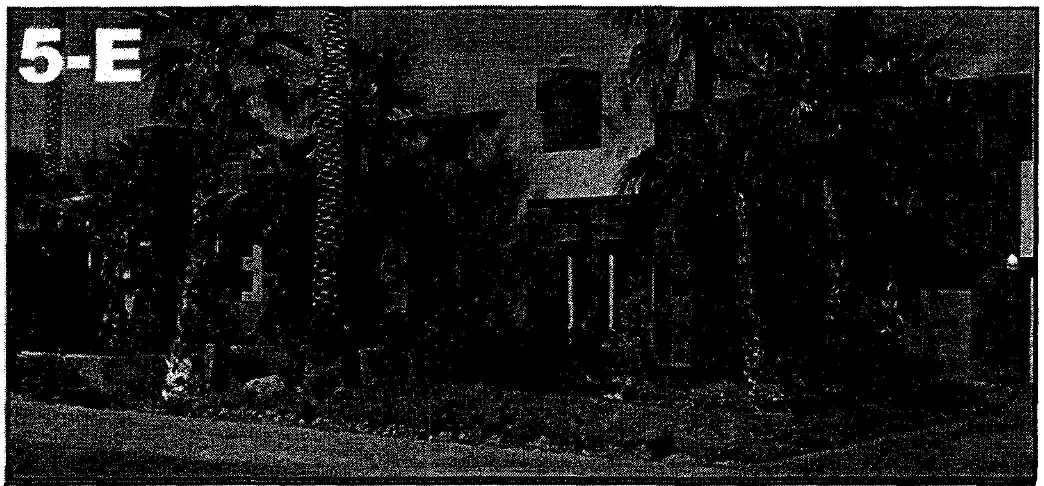
5. **Willingness to Pay** *(Circle the response or fill in the blank that best describes your answer to each question)*

a. Let's assume that you have turf in your yard now, would you be willing to have 51% of your turf converted tto xeriscape landscaping?
Yes **No** **Unsure**

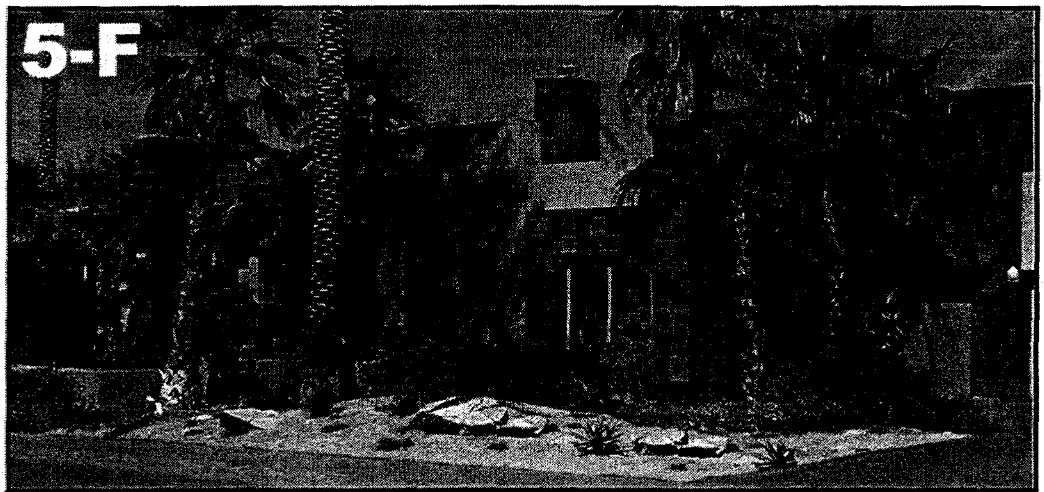
b. How much money (per square foot) would you be willing to pay to convert 51% of your turf landscape to xeriscape? _______________ Please Explain ______________________________

c. Let's assume that you have at least 51% turf in your yard now, how do you feel converting at least 51% to a xeriscape landscape would affect your property value?
Positively **Negatively** **Not Sure**

d. Given these two landscapes below (of the identical house) which one do you prefer? **E** **or** **F**



E. TURF-DOMINATED LANDSCAPE



F. XERISCAPE LANDSCAPE

e. What is the maximum *extra* dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping above (e or f) if you were buying the house?
(Not what you would pay for the house, but for the landscaping only) ___________

5. Willingness to Pay *(Circle the response that best describes your answer to each question)*

f. Given the two landscapes below (of the identical house), which landscape do you prefer? **G or H**

G. TURF-DOMINATED LANDSCAPE

H. XERISCAPE LANDSCAPE

g. What is the maximum *extra* dollar amount, above the price of the house, you would be willing to pay for your preferred landscaping above (g or h) if you were buying the house?
(Not what you would pay for the house, but for the landscaping only) ___________

6. Awareness of Water Conservation *(Please circle the response that best describes your answer to each question)*

Waste Water, Water Regulations & Restrictions and Drought Conditions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
a. I am concerned about water waste I see happening in my neighborhood.					
b. I am aware of water waste regulations.					
c. I am aware that certain times of day, certain days of the week, and certain seasons have different water usage restrictions.					
d. I am aware of the drought conditions in the Las Vegas Metropolitan area.					

Amount of Monthly Water Bills	0 to $20	$21 to $40	$41 to 60	$61 to $80	$80 to $100	$101 to $120	$121 to $140	Over $141
e. What was your *highest* monthly water bill last year?								
f. What was your *lowest* monthly water bill last year?								
g. What was your monthly water bill								

h. How old is your irrigation system?
0 **1 year** **2 years** **3 years** **4 years** **5 years** **6 years or more**

i. How often do you adjust your irrigation controller (clock)?
0 **1-2 times per year** **3-4 times per year**
5-8 times per year **9-12 times a year or more** **I don't Know – someone else does it**

j. Have you visited the Gardens at the Springs Preserve in Las Vegas?
yes **no** **unsure**

k. I am familiar with the xeriscape rebate program (Watersmart Landscapes).
yes **no** **unsure**

7. Your Home *(Please circle the response or fill in the blank that best applies to where you live)*

a. I live in a_____________.
rural area **suburban area** **central city area**

b. The zip code where I live is ________________

c. I own my home.
Yes **No**
My property value is ________.

d. I rent my home.
Yes No
My rent is ________.

e. The age of my home is _________.
1-3 years **4-5 years** **6-10 years** **11-15 years** **16+ years**

f. The square footage of my home is _______.
1000 sq ft or less **1001-2500 sq ft** **2501-3500 sq ft** **3501 + sq ft**

7. Your Home *(Please circle the response or fill in the blank that best applies to where you live)*

h. The total number of bedrooms in my home is ________.
none **1** ***2*** **3** **4** **5** ***6 or more***

i. The total number of people that live in my home is________.

j. I have a swimming pool.
Yes **No**
Size of Pool if you have one ____________

8. Landscaping in your front yard *(Please circle the response(s) that best applies to your landscaping)*

a. I have at least 51% Southwestern Desert-type landscape "Xeriscape" in my front and back yard.
(Mainly drought-tolerant plants, see Photo "B" & "D" above).
Strongly Agree **Agree** **Undecided** **Disagree** **Strongly Disagree**

b. I have at least 51% Traditional "Turf-Dominated" landscape in my front and back yard.
(Mainly turfgrass, & non-native plants, see Photo "A" & "C" above).
Strongly Agree **Agree** **Undecided** **Disagree** **Strongly Disagree**

c. Other. Please describe ____

d. I purchased a home with at least 51% xeriscape landscaping in the front and back yard.
Yes **No**

e. I converted my home to at least 51% xeriscape landscaping in the front and back yard.
Yes **No**

f. I have grass that turns completely brown in the winter.
Yes **No**

g. The landscaping of my home influenced my decision to purchase or rent my home.
Strongly Agree **Agree** **Undecided** **Disagree** **Strongly Disagree**

h. If you have grass in your front yard and/or back yard, what type is it?
Fescue **Bermuda** **none** **unsure**

i. If your yard is at least 51% xeriscape, what type of irrigation system do you have? *(Circle all that apply)*
sprinklers **drip emitters** **bubblers** **microspray** **drip lines** **hand water**

9. Personal Information *(Please circle the response or fill in the blank that best applies)*

a. What is your age?
20 years or less **21–24 years** **25–30 years** **31–40 years** **41–50 years** **51–64 years** **65+ years**

b. What is your gender?
male **female**

c. The annual income bracket for my family is ____________.
0 - $24,999 **$25,000 - $49,999** **$50,000 - $79,999** **$80,000-$125,000** **over $125,000**

d. What is the highest education level you have completed?
High school or less **Some college** **College Graduate** **Master's degree**
Doctoral degree **Trade school** **Professional degree**

e. I consider myself well-informed about environmental issues.
Strongly Agree **Agree** **Undecided** **Disagree** **Strongly Disagree**

f. To how many environmental groups or organizations do you belong?
0 **1** **2** **3** **4** **5** **6 or more**

g. How many years have you lived in any arid, semiarid region, rural area, or the Southwest?
0 years **1 year** **2 years** **3 years** **4 years** **5 years** **6 years or more**

h. What percentage of your lifetime have you spent in any desert environment?
25% **50%** **75%** **100%** **Other**__________

10. Tell Us What You Think

a. About how much time did you spend on the entire survey, not including interruptions?
less than 10 minutes **10 – 20 minutes** **20 – 30 minutes** **30 – 40 minutes**
40 – 50 minutes **50 – 60 minutes** **more than 60 minutes**

b. Comments? Please write suggestions below that could help improve this survey.

APPENDIX C

HUMAN SUBJECTS PROTOCOL APPROVAL

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Social/Behavioral IRB – Expedited Review Approval Notice

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: March 7, 2005

TO: **Dr. Helen Neill**, Environmental Studies Program

FROM: Office for the Protection of Research Subjects

RE: Notification of IRB Action by Dr. Michael Stitt, Chair
Protocol Title: **Valuing Xeriscape: An Examination of Consumer Preferences in the Las Vegas Metropolitan Area**
Protocol #: 0501-1476

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in regulatory statutes 45 CFR 46. The protocol has been reviewed and approved.

The protocol is approved for a period of one year from the date of IRB approval. The expiration date of this protocol is March 7, 2006. Work on the project may begin as soon as you receive written notification from the Office for the Protection of Research Subjects (OPRS).

PLEASE NOTE:
Attached to this approval notice is the **official Informed Consent/Assent (IC/IA) Form** for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond March 7, 2006, it would be necessary to submit a **Continuing Review Request Form** *60 days* before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@ccmail.nevada.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451037 • Las Vegas, Nevada 89154-1037
(702) 895-2794 • FAX: (702) 895-0805

APPENDIX D

HUMAN SUBJECTS SUPPLEMENTARY

PROTOCOL APPROVAL

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Social/Behavioral IRB – Expedited Review
Modification Approved

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for <u>*any*</u> *change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.*

DATE: January 20, 2006

TO: **Dr. Helen Neill**, Environmental Studies Program

FROM: Office for the Protection of Research Subjects

RE: Notification of IRB Action by Dr. Michael Stitt, Chair
Protocol Title: **Valuing Xeriscape: An Examination of Consumer Preferences in the Las Vegas Metropolitan Area**
Protocol #: 0501-1476

The modification of the protocol named above has been reviewed and approved.

Modifications reviewed for this action include:

- Sending of Postcards to the original 500 residents and request that they complete an on-line survey where they will be able to skip questions if they choose.

This IRB action will not reset your expiration date for this protocol. The current expiration date for this protocol is March 27, 2006.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond March 27, 2006, it would be necessary to submit a **Continuing Review Request Form** *60 days* before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@ccmail.nevada.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451037 • Las Vegas, Nevada 89154-1037
(702) 895-2794 • FAX: (702) 895-0805

APPENDIX E

COMPARISON OF SELECTED KEY CHARACTERISTICS OF THE POPULATION AND HPM AND CVM SAMPLES

	Population (Clark County)	Sample 1 (HPM)	Sample 2 (CVM)
population	1,781,363	500	49
age 35-65 (percent)	0.55	0.55	0.78
age 65 + (percent)	0.19	0.18	0.12
hsprice (median, resale)	285,000	317,090	395,000
hsize (mean square feet)	2223	1801	2046
hage (built since 1990) (percent)	0.54	1.00	1.00
single family (percent)	0.57	1.00	1.00
edugrad (percent)	0.35	0.21	0.57
incmed ($)	47,209	58,138	90,778
liveless (percent)	0.08	0.07	0.10
live more (percent)	0.28	0.24	0.59

Note: Table 7, Section Numbers A-3 and A-4 provided the data used in this Appendix. Renters and homeowners were both represented in the Clark County Data. *(Source: Las Vegas Perspective and HPM and CVM data from this study)*

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