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A comparison of direct methods for valuing environmental amenities: A case study of the White Mountain National Forest

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A COMPARISON OF DIRECT METHODS FOR VALUING ENVIRONMENTAL AMENITIES: A CASE STUDY OF THE WHITE MOUNTAIN NATIONAL FOREST

BY

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DEDICATION

This dissertation is dedicated to my husband. Patrick Cunningham. Thank you for all of your love and support and for being my best friend.

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ABSTRACT

A COMPARISON OF DIRECT METHODS FOR VALUING ENVIRONMENTAL AMENITIES: A CASE STUDY OF THE WHITE MOUNTAIN NATIONAL FOREST

By

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University of New Hampshire, May 2000

New Hampshire's White Mountain National Forest is well known for its mountain scenery as well as its many recreational opportunities. Upcoming changes in the electric utility industry may work to change the average level of visibility in the White Mountain National Forest. While the contingent valuation method has been extensively used to value public goods (in instances such as the case above), some view the procedure with skepticism. As a result, alternative methods such as conjoint analysis have been receiving more attention. This dissertation presents the results of a face-to-face survey that attempted to directly compare conjoint analysis and contingent valuation techniques using the White Mountain National Forest as a case study area.

INTRODUCTION

The valuation of non-market and public goods has long been a concern for economists. Specifically, quantities and qualities of non-market and/or public goods are often affected when policies change. However, as these goods are not traded in conventional marketplaces, it becomes difficult to assign values, or prices, to such goods. And thus it becomes difficult to determine losses or gains in consumer surplus. Yet despite this difficulty, it is important to assign values to these goods when weighing the costs and benefits of policy changes. Policy changes can, and do, impact our environment. Goods such as air and water may be degraded or improved as a result of a change in governmental policy.

One method used for valuing environmental amenities has been the contingent valuation method. This method involves asking individuals to state their value for an environmental good. Although this method is often employed it is not without its flaws, and much work has been done to refine the method to improve precision and accuracy in the estimates of value. In an attempt to improve stated preference methods a technique used in marketing called conjoint analysis has been employed in valuing environmental amenities. Conjoint analysis asks individuals to rate rather than price bundles of commodities; values of the various attributes then are extracted. This method may provide an improvement over the contingent valuation method. As it may reduce some of the difficulties commonly associated with the contingent valuation method.

As both the contingent valuation method and conjoint analysis are based in utility theory, they should result in the same valuation for the good in question. Recent studies (Boxall et al. (1996), Roe et al., (1996)) have indicated that conjoint analysis and contingent valuation may result in different values for the same good. This dissertation will report on an ongoing experiment designed to test for this difference.

The case study relates to the deregulation of the electric utility industry in New Hampshire. With deregulation residents will be able to choose their power provider and deregulation will result in cheaper power for many New Hampshire residents. This is clearly a benefit and is easily measured by examining reductions in each consumer's power bills. However, it is possible that the availability of this cheaper power will result in increased production of electricity in older coal fired plants, many of which are in the Midwest. Due to weather patterns, sulfur emissions from these power plants are the largest contributors to hazy conditions in the White Mountains of New Hampshire. Therefore, one of the costs of the upcoming deregulation is a potential deterioration of air quality in the White Mountain National Forest. The question investigated here thus becomes: how can a dollar value be assigned to the deterioration of air quality, so that the costs and benefits of utility deregulation may be appropriately weighted?

The component of air quality that will be examined here is the deterioration of the visual qualities (such as color, contrast and sharpness) of a vista, called "visibility" which is measured in visual range. Visibility is a measurable quantity. Specifically, the loss of value to visitors associated with deterioration in visibility in the White Mountains will be explored. Assigning a value to a change in an environmental amenity such as a change in visibility is a matter of some controversy in the environmental economics literature

(Portney, 1994). As cost/benefit analysis becomes more prominent as a tool for evaluating policy changes, it becomes increasingly useful to develop methods to accurately value changes in non-market goods/environmental amenities. A technique that produces inaccurate values for a change in an environmental amenity, such as visibility or air quality in general may lead to the adoption of an inappropriate policy. This would result in inefficiencies and inappropriate choices.

This dissertation is organized as follows: the first chapter serves as an introduction that describes the good being valued [visibility] and the case study area. It also provides an overview of other visibility studies and presents the objectives of the dissertation. The second chapter describes the different methodologies used in valuing non-market goods. The indirect or revealed preference methods will be discussed first. The hedonic and travel cost methods use observations of market behavior to infer values or prices for environmental (dis) amenities. Next, the direct or stated preference methods will be discussed. This group of methods relies on surveys or questionnaires to ascertain individual values. Because these methods do not rely on market outcomes, they are often viewed with skepticism. However, these methods are often the only option when dealing with certain environmental goods and are the only methods available for measuring non-use values. The two stated preference methods, which are the focus of this paper, are the contingent valuation method and conjoint analysis.

The third chapter focuses on the theory behind conjoint analysis and the contingent valuation method. It will be demonstrated that conjoint analysis and contingent valuation have the same theoretical underpinnings and would lead us to expect to see similar values from surveys. The remainder of the dissertation will focus on a case study designed to test the hypothesis that CVM and CA will produce similar valuation measures. In chapter four the survey design and implementation are presented, along with a discussion of the previous work which led up to the survey. Chapter five presents the results and Chapter six offers discussions of other relevant works and concluding remarks.

CHAPTER ONE

PROBLEM STATEMENT AND OBJECTIVES

This first chapter will be concerned with introducing the environmental issue at hand and will discuss the nature of visibility as well as its importance to the New Hampshire economy. Electric utility deregulation will also be discussed and past visibility studies will be reviewed. Finally, the objectives will be presented.

1.1 What is Visibility

In this section, visibility will be defined and the sources of its impairment discussed. Recent developments regarding haze will be discussed as will the air quality in New Hampshire. Then a link between air quality and economic activity will be made. The scenic quality of a vista is strongly influenced by particulate matter in the atmosphere (Malm, 1999). Visitors to National Parks and Wilderness areas have consistently rated visual air quality as one of the most important values. Visibility is thought to influence visitor behavior and thus economics. This project tests explores hypothesis.

1.1.1 Haze and Visibility Impairment

Visibility is often quantified as the distance at which an object can be viewed on the horizon. Visibility can also include the clarity of the object as well as the clarity and contrast of the surrounding vista. In this case study, the focus is on visibility that is impaired by regional haze. "Haze obscures the clarity, color and texture and form of what we see" (EPA, 1999, p.1). Both natural and human made sources generate haze. In the Northeast, anthropocentric sources cause the vast majority of haze. Haze-causing pollutants are generated when gases such as sulfur dioxide and nitrogen dioxide are released into the air and oxidize into particles. Or pollutants may be directly emitted into the air by "sources such as electric power generation, industrial and manufacturing process, [and] auto emissions" (EPA, 1999, p.1).

In 1977 Congress established the national visibility goal in Section 169A of the Clean Air Act. A subsequent EPA haze established the regulatory program. Under this program 156 parks and wilderness areas were designated as Class I airsheds. Class I airsheds are protected from visibility impairment under section 169 of the Clean Air Act. Under the Clean Air Act, states and federal land managers are charged with the prevention of any future and remedying of any existing impairment of visibility in mandatory Class I areas. Regional haze has been in the news recently as the U.S. Environmental Protection Agency (EPA) established new haze regulations on Earth Day, April 22, 1999. The new haze regulations call for the return to natural conditions in Class I areas within a sixty-year period. The new haze regulations (which are currently being debated in court) call for "States to establish goals for improving visibility conditions in national parks and wilderness areas and to develop long term strategies for reducing emissions for air pollutants that cause visibility impairment" (EPA, 1999, p.1). This includes states that do not contain Class I airsheds.

Regional haze is by definition generated locally and is a classic example of an economic externality. An economic externality occurs when the price of a product (in this case, this would include any product made by a process which generates haze causing emissions) does not accurately reflect all the costs of production. Further, consumers who enjoy the lower price of the product do not generally bear the burden of the un-priced costs.

The concept of externality is easily illustrated by the recent legal activity surrounding the new regional haze rules. Industry groups petitioned the EPA in Federal Court, arguing that the new haze rules were adopted with inadequate public process. The electric utility industry may be affected by the tighter emissions standards under the new haze rules and would be required to begin to internalize some of the un-priced costs. Some environmental groups have petitioned the Court in support of the EPA, while other groups are critical, stating that the rule does not go far enough.

New Hampshire asked to join the legal defense of the EPA's haze rules on September 29, 1999 (Walsh, p.1). In a separate Court action, the State of New York will launch a legal action against 17 Midwestern utility plants (largely sulfur emitters) "charging that pollution from the plants has for decades crossed state lines and eroded air quality in the Northeast" (Revkin, 1999, p.1).

The above discussion illustrates that a significant proportion of visibility impairment in the Northeast is largely generated outside the Northeast and is the result of coal-burning power plants in the Midwest region (mainly along the Ohio River). The next section will summarize the current conditions in the Northeast generally and the Great Gulf Wilderness in New Hampshire, specifically.

1.1.2 Visibility Conditions in the Northeast

This section will draw largely from a report by Hill et al. (1999). Hill et al. (p. 3) summarize the changing visibility conditions in the Northeast as follows:

> As compared to estimated natural conditions, the visibility in the entire Eastern United States is significantly impaired. One estimate of median natural visibility is given by Trijonis (1982), 60 miles plus or minus 30 miles. EPA (1998) estimates mean natural visibility to be about 80-90 miles, which takes into account natural organic haze in the Southeast. In New England, due to less stagnant atmospheric conditions, average natural visibility may be higher, in the range of 90-120 miles. Thus, comparing current visibility with estimated natural average visibility, current visual range is about one quarter to one third of estimated natural visual range in the eastern United States. In addition, current trends in visibility conditions on the haziest days at many eastern Class I airsheds suggest little of no improvement in visibility (Sisler and Damburg, 1997) despite national reductions in sulfur dioxide emissions, from 23.2 million tons in 1988 to 20.4 million tons in 1997, as reported by EPA (1998).

Hill et al. also report on air quality monitoring and visibility impairment in the Great Gulf Wilderness, the Class I airshed, the area that is the focus of this dissertation's case study. Visibility monitoring in the Great Gulf Wilderness has been a joint effort between the Appalachian Mountain Club (a non-profit conservation organization) and the U.S. Forest Service. Visibility in the Great Gulf has been monitored via a camera (in place from 1985 to 1997), an Optec nephelometer, fine particulate monitors (Harvard/Turner Impactors) and by the IMPROVE[1] network since 1995.

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[1] Inter Agency Monitoring for Impaired Visual Environments.

The visibility camera took photographs of the Great Gulf Wilderness three times daily to create a visual record of visibility in the Great Gulf. A nephelometer was placed near the visibility camera in 1995. The nephelometer is "a continuous electronic visibility measurement device based on light scattering" (Hill et al., p. 6). In addition, a variety of monitors measure the presence of fine particulate matter (less than 2.5 microns) in the Great Gulf Wilderness, and thus, its relationship to haze can be determined. The data collected show that "average visibility in the Great Gulf Wilderness is approximately one third of estimated natural conditions, impaired by anthropogenic aerosol (fine particles less than 2.5 microns in diameter) particles, which in turn, are dominated by hygroscopic (moisture-absorbing) sulfate compounds" (Hill et al., p. 8).

The EPA's haze regulations, discussed in the previous section, are designed to return Class I airsheds to near natural conditions. In a statement supporting the EPA's haze regulations, New Hampshire's governor Jeanne Shaheen stated: "Visibility is not just about aesthetics. It has a dramatic impact on tourism, the state's second largest industry" (Walsh, p.1). The next section will explain the validity of the governor's concerns.

1.1.3 Economic Importance of Visibility

The White Mountain Region is defined as one of six tourism regions in New Hampshire. The region consists of Northern Carroll and Northern Grafton Counties and all of Coos County. The White Mountain National Forest (WMNF) is a central focus of tourism in the region covering approximately 780,000 acres (DRED, 1995). The National Forest extends throughout much of the southern half of the tourism region.

One of the most significant attributes of the White Mountain experience is the numerous scenic vistas and mountain top overlooks. Popular travel guides claim that views can extend over 130 miles on a clear day (Tree and Randall, 1994). In fact, the most distant object viewed from the Mount Washington Observatory is the Adirondak Mountains, over 130 miles distant. This figure sets a high standard for traveler expectations. Some of the more popular and well-known attractions include the Kancamagus Highway (Route 112), a popular scenic drive that winds between Lincoln and North Conway. The Kancamagus is the only designated National Scenic Byway in the Northeast. The White Mountain region also supports an expansive trail system highlighted by the Appalachian Trail that traverses through southwest to the northeast corners of the WMNF. Other popular destinations include the Franconia Notch area along Interstate 93 (Highway 3) and Pinkham Notch area near the Presidential Range itself (Tree and Randall, 1994). Near the Pinkham Notch area is the Mt. Washington Auto Road, which non-hikers and hikers alike can travel to enjoy the views from the Northeast's highest peak.

In the state of New Hampshire, tourism ranks third, behind manufacturing and retail trade in terms of bringing money into the state. Tourism is the state's second most important export industry in terms of jobs generated. In 1994, total direct spending on travel (approximately 2.5 billion dollars) reflected 9.5 percent of the gross state product. This direct spending can also be translated into approximately 56,000 jobs. Overall, total direct and indirect employment generated by tourism accounted for almost 12 percent of the total employment and approximately 7 percent of total payroll in the state (INHS, 1995).

In the White Mountain region, tourism is the most important 'export' industry, with manufacturing following close behind. More specifically, in northern Carroll and northern Grafton counties (which includes part of the WMNF) tourism represents the most important export industry. In Coos county, tourism is second only to manufacturing in importance. Overall, the importance of the tourism sector is likely to be sustained or grow in the future. The long-term trend suggests that tourism will increase its exports (traveler spending) at a higher rate than that of manufacturing (INHS, 1995; Northern Economic Planners, 1995).

Visitors to the White Mountain Region spend more per day than do visitors to any of the other six travel regions in New Hampshire. Further, visitors to the White Mountain Region rank second in overall average spending per trip, relative to other travel regions. Since forty percent of the total visitors to the White Mountains visit during the summer months, it is worth noting that visibility and haze conditions are at their worst in the summer. That is, when visibility is at its worst, tourism is at its peak. The second largest tourist season is winter, as the White Mountains are the sixth largest alpine skiing destination in the United States in terms of skier attendance (Northern Economic Planners, 1995). Haze is also a winter time phenomena, but to a lesser extend due to the higher frequency of northerly winds and lower relative humidity.

1.3 Other Studies

There have been several studies that in attempt to value changes in the visual range involving both hedonic and survey based methods. One of the first applications of the contingent valuation method involved changes in air quality. Randall et al. (1974) focused on the impact of plumes generated by coal fired plants in the Four Corners area of the United States on visitors to the Grand Canyon. The study also examined visual dis-amenities surrounding the plant such as power lines and associated coal mining. The study was split into several user groups (recreationalists and residents, for example) and the payment vehicle used here depended on the group, either a sales tax or a change in the respondents' electric bill. In a similar experiment Brookshire et al. (1976) examined visual disamenities associated with a proposed power plant. The payment vehicle used was an increase in the entrance fee to the recreation area (Lake Powell). Rowe et al. (1980) used photos to assess the value of visibility over distance of visitors and residents of the Four Corners region in New Mexico and Arizona. The payment vehicle was a change in the electric bill or a change in income tax. In a comparison (Schulze et al. 1981) found three studies (The Four Corners experiment, The Lake Powell experiment and the Farmington Experiment[2]) to have consistent results. This is important, as all three studies have focused on the Southwest area.

A study in the Los Angeles basin area compared hedonic data with data collected from surveys (Brookshire et al., 1982). This survey used maps and photos to pinpoint regional differences in air quality. The two valuation techniques were shown to be reasonably comparable.

In an Oregon study, Crocker and Shogren (1991) also use computer-generated haze in photographs of a wilderness vista (the Cascades Range) and urban vistas. This study added an interesting component by first asking respondents about their perception of the occurrence of changing vistas (either during their visit of over the summer if they were residents). The payment vehicle was either an additional entrance fee or a contribution to a fund (depending on whether the respondent was a visitor or a resident respectively).

In 1980, households in Denver, Los Angeles, Albuquerque and Chicago participated in a study to measure the value of visibility in the Grand Canyon and Parklands in the Southwest (Schulze et al. 1983). The payment vehicle was either an admission fee or electric utility bill. The choice of payment vehicle depended on the respondent's use of the area.

A study undertaken in the spring of 1980 in San Francisco examined the willingness to pay for changes in both visibility and health, as health outcomes relate to air quality (by Loehman, Park and Boldt (1994)). The payment vehicle here was a monthly contribution to a fund to improve air quality in the San Francisco region. Table 1.1 summarizes the studies discussed here.

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[2] The three experiments were reported individually in Randall et al. (1974), Brookshire et al. (1976) and Rowe et al. (1980).

Table 1.1: Previous Visibility Studies

Authors	Location and Group Surveyed	Interesting Points	Results
Randall, Ives and Eastman (1974)	• Four Corners Area, Southwest U.S. • Surveyed residents and users	• Used photos to represent environmental damage • Used electric bill as payment vehicle for subgroup of respondents • Used a bidding game • This study is seen as the first application of the survey approach	• Found aggregate bids of $11.25 mil/year to $15.54 mil/yr. to reduce pollution by 70000 tons annually • Found aggregate bids of $19.31 mil/year to $24.57 mil/yr. to reduce pollution by 96000 tons annually
Rae (1983)	• Mesa Verde and Great Smoky Mountains National Park • Surveyed visitors to parks	• Used a contingent ranking methodology (traditional model) • Varied attributes over visibility, congestion and entrance fee	• At Mesa Verde found average WTP to be $4.75 per vehicle trip to move from an intense haze to clear visibility • At Great Smoky found average WTP to be $14.80 per vehicle trip move from intense haze to clear visibility
Schulze et al. (1983)	• Parklands of the Southwest • Surveyed households in Denver, Los Angeles, Albuquerque, and Chicago	• Used electric bill as a payment vehicle • Used willingness to pay to preserve average air quality	• Found a willingness to pay of $3.72 - $5.14 per month to preserve visibility in the Grand Canyon • Found a willingness to pay of $6.61 - $9.64 to preserve visibility in entire parkland region

Table 1.1: Continued

MacFarland Malm and Molenar (1983)	• Used slides representing Mesa Verde, Grand Canyon and Zion National Park	• Used open ended WTP questions • Used entrance fee as payment vehicle • Compared WTP to an allocation of time methodology	• At the Grand Canyon, the mean bid for improving the visibility from poor to average was $1.61 per day. From poor to good was $2.75. • At Mesa Verde, the mean bid for improving the visibility from poor to average was approximately $1.40 per day. Poor to good was approx.$2.65. • The values from Zion fell between the Grand Canyon and Mesa Verde
Loehman, Park and Boldt (1994)	• San Francisco Bay Area • Surveyed Households in Bay Area	• Compared WTP to avoid and WTP to obtain (open-ended monthly contributions to a fund) • Found evidence of the endowment effect • Found bids were consistent with values from an earlier hedonic study	• Averages of $6.02 - $38.33 to avoid changes in visibility • Averages of $5.69 to $10.08 to obtain gains in visibility (ranges are due to differences in magnitudes of changes considered)
Brookshire, Ives and Schulze (1976)	• Lake Powell in Glen Canyon National Recreation Area • Surveyed residents and recreationalists	• Used willingness to pay to prevent degradation • Self described as "quite similar to the Randall study" • Included the factory in the photo as a dis-amenity	• Found a value of $1.58 - $2.77 per month to avoid changes • Aggregated to $727,600 to $414,000

1.4 Objectives

This section will present the primary and secondary objectives of the dissertation.

1.4.1 Primary Objective

- *To compare and contrast, empirically and theoretically, two methods of valuation for non-market commodities such as visibility. Insight as to which (if either) might be the more appropriate technique to address the problem at hand will be provided.*

For the past ten to twenty years, the contingent valuation method (CVM) has been the method most often used for valuation of non-market commodities (Mitchell and Carson, 1994). However, this method may be far from ideal; some economists have viewed the use of surveys with skepticism and CVM may be subject to numerous biases that may result in under- or over- estimation of consumer surplus.

More recently, economists have begun to employ conjoint analysis in the valuation of non-market goods. Originally used in marketing (e.g. Green and Srinvasan, 1990), conjoint analysis asks individuals to rate or rank different commodities. Through this method, the utility (and thus implicit prices) derived from individual attributes can be estimated. To best describe this technique, think of any good as a bundle of attributes. The utility from each attribute may be estimated from the responses of consumers to changes in the level of attributes. Televisions can be used as a simple example: color televisions are priced higher than black and white televisions. It can be inferred that color is a more valuable attribute for a television. Taking this a step further, consider a range of televisions with various attributes (remote control, cable ready, built in VCR, screen size, etc.). By asking consumers to rate or rank this set of televisions, the conjoint analysis technique allows us to infer the weights (and thus the utility) of the various attributes.

Many economists may be more familiar with this approach in the form of hedonic pricing for goods. In hedonic theory. variation in housing prices (for example) is said to reflect different levels of public good provision as well as values for environmental amenities or disamenities. The market value of the different levels of public goods can be empirically determined by comparing statistically identical houses in different communities. However. for decision making. this application of hedonic theory may be of little use if the public good in question is unique (as. it could be argued. are the vistas of the White Mountain) or if the affected area is sparsely populated (Brookshire et al.. 1982). The various methods employed to value environmental amenities will be discussed at length in chapter two.

In this dissertation. two bundles of commodities that are alike in every attribute but two will be compared. This is much like comparing two houses which are similar in every respect with the exception of price and distance to an environmental amenity (or dis-amenity as the case may be). By exploring the differences in the price and distance to an amenity. an implicit value for the amenity could be found. The application of conjoint analysis and the contingent valuation method in this dissertation will work much in the same way. The advantage of the conjoint method is that it asks people to rate different commodity bundles as opposed to constructing values for single goods in their minds. Typically. price is one of the attributes of the commodity to be valued. In this dissertation. the contingent valuation method and conjoint analysis will be directly compared using the same data pool.

1.4.2 Secondary objectives

The objectives listed here will be explored in the data collection process for this dissertation. The analysis of the information collected will be presented in other formats however.

- *To derive estimates of the impact of visibility changes in the White Mountains on visitors to the region*

The data set will be collected in New Hampshire's White Mountain National Forest. Due to the abundance of scenic vistas in the region, it becomes reasonable to assume that any visitor to the area will receive some amount of utility from the natural surroundings. The impact of a change in the average level of visibility on the utility derived from a visit to the White Mountain region will be examined.

- *To use these estimates to determine part of the potential economic impact of deregulation of the electric industry in New Hampshire.*

One of the defining attributes of New Hampshire's White Mountain travel region is the number of scenic overlooks and vistas. Clearly, an important reason for visiting the area is to enjoy the White Mountains themselves. If the ability to view the White Mountains was diminished, one would expect that the reasons for visiting the White Mountain region would be lessened. This could have an impact on a regional economy in which tourism is the largest sector.

CHAPTER TWO

VALUATION METHODOLOGIES

2.1 Indirect Methodologies - Hedonic and Travel Cost

The hedonic method "uses changes in the price of complementary goods to infer a willingness-to-pay for a higher quality environment" (Bate, 1996, p.1). Typically, the hedonic method uses real estate prices as the complementary good, although wages have also been used (see Bloomquest et al. (1988) and Clark and Kahn (1989) as examples). The hedonic method has traditionally focused on air and water pollution, however other environmental dis-amenities or amenities have been included (landfills and open - space for example). This method breaks housing prices up into the prices of the various attributes. Attributes might include number of rooms, lot size, distance to work or highways, local school characteristics, local air and water quality and/ or distance to the environmental amenity. This method therefore uses observed market behavior to determine the price (or value) of the non-market good in question. The hedonic method is most useful in valuing local or location specific environmental goods. It is not able to value national or global environmental concerns, such as species extinction, biodiversity loss and damage to wilderness areas. It is also unable to ascertain the value of visitors to or occasional users of environmental amenities. These weaknesses make a strict application of the hedonic method inappropriate for this case study.

Harold Hotelling first proposed the travel cost method (TCM) in a 1947 letter to the park service (the same year CVM was proposed by Ciriacy-Wanthrup). This method was first discussed at length in Clawson and Knetsch (1966). The TCM suggests that a measure of the price of an environmental service (a park or a lake perhaps) can be derived from the amount of money spent to arrive at the environmental amenity. A demand curve is then constructed using costs incurred as a proxy for price. Consumer surplus estimates can then be generated for a change in either the price or quality of the environmental amenity. One difficulty in this approach is determining an accurate measure of the user's time, or more formally, taking into account differing opportunity costs between users (see Bishop and Heberlein, 1979). Further, as with the hedonic method, national or global environmental concerns can not be considered.

Related to the hedonic method is a measurement of averting costs. Under this method, the amount that individuals spend to avoid changes in an environmental good can be interpreted as a measurement of willingness to pay. These methods are typically employed when looking at the value of health outcomes and make the implicit assumption that individuals can correctly predict the health benefits of their behavior.

The primary advantage of the valuation methodologies described above is the interpretation of actual market behavior. That is, the choices that individual's make are observable by the researcher. However, the indirect methods are not without weaknesses. As mentioned above, they are unable to determine the value of non-local resources. Further, they are limited to discovering use values, rendering all valuation using these techniques as capturing the lower bound of value only. The distinction between use and non-use value can be traced to Krutilla (1967). While use value may have an obvious definition, non-use value has a more debatable definition. For the purposes here, non-use value will be assumed to include option, bequest and existence value. Option value refers to the utility or value that an individual might obtain from future use of the resource. Bequest value refers to utility gained by an individual from knowing that future users will enjoy the resource. That is, the individual gains utility from knowing that the resource continues to be available for either her future use (option) or the use of her children or more generally, future generations (bequest) (Chapman, 1999). This would not be captured by a direct observation of market behavior. A further component of nonuse value is existence value. This value is much more difficult to capture for economists as it is essentially the value of an environmental resource for which the individual has no possibility of ever using. That is, the individual sees the continued existence of environmental goods as having worth and value (Callen and Thomas, 1996). Measurement of these types of values (not only environmental values, one might also consider religious or moral values) are not easily captured by traditional utility analysis}

2.2 Direct Methodologies (CV and CA)

This section will review the two direct preference methodologies that are being compared in this dissertation. The first section will review the contingent valuation method and will be followed by a section that discusses potential biases in contingent valuation survey design. The next sub-section will review the conjoint analysis methodology. The final section contains a discussion of how the conjoint methodology might reduce some of the biases commonly associated with the contingent valuation method.

2.2.1 Contingent Valuation

The contingent valuation method is one of the first stated preference models and was first used in 1962 in a study of Maine hunters (Davis, 1963). In this work, the contingent valuation method was compared to the travel cost method. The two methods were found to produce similar results. This began the idea that contingent markets could be appropriate proxies for established markets and that hypothetical values could be used to proxy real values. The clear advantage of the contingent valuation method over revealed preference models was the ability to value non-local environmental amenities. More specifically, stated preference methods allow researchers to capture non-use values (such as biodiversity, wilderness areas (Loomis (1999) and Brookshire et al. (1983) as examples)). The contingent valuation method gained headway in the late 1970s and early 1980s primarily with several studies of visual air quality over the Grand Canyon (Randall et al. (1974), Schulze et al. (1983) and MacFarland et al. (1983) for example). It is not surprising that contingent valuation methodology came into prominence just as the environmental movement was beginning.

The contingent valuation method (CVM) develops hypothetical situations and asks individuals for their willingness to pay for a change in an environmental good or for their willingness to accept compensation for a given change in an environmental good. Individuals may be approached using face to face, phone or mail interviews. Valuation questions (willingness to pay or willingness to accept) were initially framed as open-ended questions; due to the vagueness of open-ended questions, iterative bidding style questions and payment cards were substituted. Due to biases introduced through these methods, most CV surveys currently use some form of a referendum type question. This yes or no format (also referred to as dichotomous choice or take it or leave it) is thought to be the easiest for respondents to answer as it most closely simulates a market situation. However, as Mackenzie (1993, p. 593) notes this "only identif[ies] upper or lower bounds on their underlying valuations." The cost of avoiding the biases associated with the open-ended CVM questions is the lost information from the yes or no format. Recently however work has been done on a double bounded or yes/no with follow up approach. In this approach, the respondent is asked an appropriate follow up question after their initial response. Although this technique may look to improve informational efficiency, some questions have arisen about the internal consistency of this approach. (Whitehead et al., 1999)

Also important in the CVM framework is the payment vehicle. In what form will the individual be asked to reveal their value? It is perhaps helpful here to define more formally what is meant by value. Value is defined as how much of one good (a) an individual will give up to obtain some other good (b) or vice versa. In this case, good a is money income and good b is visibility. An important consideration here is what form the money will take, that is, will it be in the form of a tax, a one-time donation, or a change in a related payment? Various payment vehicles have been used by researchers with differing success rates. Referring back to table 1.1, Schulze et al. (1983) used an electric bill as a payment vehicle, while Randall et al. (1974) used the electric bill or a sales tax, depending on the respondent's place of residence. MacFarland et al. (1983) and

Rae (1983) both used entrance fees as payment vehicles. The improper selection of a payment vehicle may introduce unintended bias.

2.2.2 Biases resulting from CVM

While the contingent valuation method is often the only appropriate method for valuing certain public goods and is currently the only widely used measure for capturing non use values, it is not without its limitations. The limitations are often discussed in the form of biases (potential or otherwise) and can often be minimized by careful survey design. In this section, some of the potential biases will be discussed.

2.2.2.1 Part-Whole Bias

This essentially refers to the bias that occurs when the respondent values a different good than the researcher intends. For example, the researcher may specifically define the location of the good (visibility in the White Mountains) while the respondent may answer with their value of a broader good (visibility in New England). This is referred to as geographical part-whole by Mitchell and Carson (1988, p. 236). The respondent may also assume that the benefits of the change in environmental quality will fall to a larger or smaller group than the researcher intends. Referred to as benefit part-whole by Mitchell and Carson (1988, p. 236). This bias is thought not to be a failure of the contingent valuation method but rather a result of survey design (Boyle et al. 1994). Careful wording and the use of aids (like photographs) may reduce this bias.

2.2.2.2 Embedding (Scope) Effect

Related to the part-whole bias is the so-called embedding effect. Kahneman and Knetsch (1992) introduced this variation of the part-whole bias. Kahneman and Knetch asked some subjects for their willingness to pay for improved disaster preparedness and other subjects for their willingness to pay for improved rescue equipment and personnel. The improved equipment and personnel were "embedded in" the improved disaster preparedness. so the preparedness included the equipment and personnel. as well as other things. This indicates that preparedness. as it contains more elements. should have a higher value. However. willingness to pay was about the same for the larger good and for the smaller good included in it. Kahneman and Knetsch called this the ``perfect embedding effect." because a demonstration of it requires perfect equality of willingness to pay of the two different goods.

When subjects were asked their WTP for the smaller good after they had just been asked about the larger one. they gave much smaller values for the smaller good than for the larger one. and much smaller values than those given by subjects who were asked just about the smaller good. This order effect is called the "regular embedding effect". It demonstrates that a good seen as embedded in a larger good has reduced value. Kemp and Maxwell (1993) replicated this regular embedding effect. starting with a broad spectrum of public goods. and narrowing the good down in several steps. obtaining WTPs for an embedded good that were 1/300 of WTP for the same good in isolation. The embedding effect indicates that individuals may be purchasing something other that the good the researcher proposes. Kahneman and Knetsch (1992) suggest that respondents may be purchasing moral satisfaction from doing "the right thing."

According to Hanemann (1994), the embedding effect has come to mean several things and this has resulted in some confusion. Specifically between scope and sequencing. the scope effect is perhaps the more studied. The *scope effect* refers to the difference that should be generated when (for example) individuals are asked to clean up one lake versus twenty lakes. In the study mentioned above and in an often-cited study by Desvousges et al. (1992)[3] scope effects were not present. The absence of scope effects could indicate trouble for the contingent valuation method, as this would imply that respondents are not answering the question at hand. However, as pointed out by Hanemann, there have been several studies (twenty-five, including a meta-analysis of air quality studies (Smith and Osborne, 1996)) which do in fact show evidence of the scope effect. Further, Hanemann argues that both the Kahneman and Knetsch and the Desvousges study were flawed in their design. Again careful wording and explicit definition in survey design is important here (see Carson and Mitchell (1993) for additional arguments).

2.2.2.3 Hypothetical bias

Hypothetical bias, as it has been generally discussed in the literature, refers to the lack of realism in CVM surveys. That is, if you "ask a hypothetical question" you will "get a hypothetical answer". However, as pointed out by Mitchell and Carson (1989, p. 216), hypothetical bias doesn't really refer to bias but to random error. That is, instead of introducing a bias in the estimation process, unrealistic scenarios will cause a greater variance of the estimator, making it potentially inefficient but not necessarily biased. Realism should thus improve the estimate of willingness to pay, but should not result in any bias.

The hypothetical nature of the question may result in protest behavior however. A respondent who indicates a zero willingness to pay when the respondent does in fact

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[3] The Desvousges et al. study examined willingness to pay to prevent the deaths of 2,000, 20,000, and

place value on the good in question may be demonstrating protest behavior. Or protest behavior may be observed by outrageously high willingness to pay responses (higher than the respondent's income for example).

Protest behavior may also be manifested as a non-response or zero value. That is. the respondent simply rejects the question. In this instance. non-response might also be a result of indifference on the part of the respondent between the choices offered. It might also indicate a lack of knowledge about the good in question. Maynard (1996) argues that the hypothetical framework of the contingent valuation method could aggravate part whole and embedding biases. This is due largely to the fact that respondents may be unfamiliar with the notion of purchasing environmental goods and therefore do not know what the good would be worth to them. If this were the case. it would follow that researchers would find that respondents' value different levels of environmental quality equally. Section 2.2.4 will discuss how conjoint analysis might address these biases.

2.2.3 Conjoint Analysis

In response to the numerous reported biases associated with the contingent valuation method. researchers have been looking into alternate stated preference methods. One such method. used primarily in marketing research. is conjoint analysis. While still a relatively new methodology to the environmental economics literature. conjoint analysis is becoming more widely used and accepted (see for examples Stevens et al. 1997; Mackenzie. 1993; Adamowicz. Louviere and Williams. 1994). Instead of asking respondents to hypothetically purchase a good or service, CA asks respondents to rate or

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200,000 waterfowl in the Rocky Mountain Flyway.

select from different scenarios. The good in each scenario is defined as bundles of attributes and although the good in each scenario is essentially the same, the attributes will vary in quantity and/or quality. For example in a recent on-line survey valuing open space (Mackenzie 1999), the attributes which vary include type and amount of open space (orchard, pasture or woods), development potential of abutting acreage (up for commercial sale or under easement) and abutting land which is currently developed (i.e. with houses). The amount of acreage of potentially and currently developed land also varied.

There are several forms of conjoint analysis. A binary preference (or contingent pair) model might ask respondents to compare two scenarios and state which one they prefer. An extension would be to allow for indifference and give the respondent three choices. That is, A is preferred to B, B is preferred to A or neither (A and B are equal). A contingent ranking model will ask respondents to rank several different scenarios in order of preference. Finally, respondents can be asked to rate different scenarios on a researcher defined scale. All the information gained in the previous models should be recoverable from a ratings model. This study will employ a ratings model and will use this information to simulate the previous models as well. Mackenzie says of this model "they can represent indifference or ambivalence uniquely, and they may convey information on relative intensities of preferences as well. The contingent rating approach also has considerable practical appeal because most respondents are easily familiarized with ratings scales." (1993, p. 596)

2.2.4 Conjoint Analysis and Contingent Valuation - Biases

This section addresses the possible improvements that the conjoint analysis methodology can make regarding the biases associated with the contingent valuation method (see section 2.2.2 for a review of those biases). Maynard (1996) argues that embedding and part whole biases may be introduced if multiple environmental resources are being valued in one survey. One might further extend this argument and say that if an environmental good with many attributes is being valued then these biases may be introduced. It may not be apparent to researchers in either of these cases, which of the various attributes or resources is being valued. Maynard also adds that researchers may not include substitutes or complements for a resource which may further contribute to ambiguity and increase the likelihood of embedding or part whole bias. An advantage of conjoint analysis here is the method's ability to derive relationships among differing attributes of a good (see Adamowicz, Louviere and Williams (1994)). Further, if "respondents can choose among ...four environmental resources [or attributes], one can use conjoint analysis parameter estimates to determine substitute and complementary relationships between resources" (Maynard, 1996, p. 31).

The conjoint analysis technique was designed to examine multi-attribute goods and may thus be better designed to examine multi-attribute resources. This may lead to the reduction of part whole and embedding biases, or at least give researchers some insight into the causes of these biases.

A further consideration regarding the advantages of conjoint is the use of the environmental ethic, as argued in Maynard (1996) the conjoint analysis method may be better at extracting values from individuals who have a strong environmental ethic.

Environmental ethic in this case may be taken to mean those who feel that the environment has value apart from those values that are imposed by humans. And it is not appropriate for researchers to attempt to place a dollar value on environmental goods, as dollars are a distinctly human creation. This ethic has been associated with existence value but has been underrepresented in valuation techniques. Since the conjoint method as applied in this experiment involves rating this may not be a consideration, but when conjoint involves choosing (or ranking) this is an appropriate way to capture the values that are associated with the environmental ethic. These values may not be captured or may result in protest bids in the contingent valuation method.

The conjoint methodology asks respondents to rate or rank rather than price environmental amenities. In this respect, conjoint may be less susceptible to protest behavior from respondents who reject the notion of placing a dollar value on environmental goods. That is, in the conjoint setting the respondent is not asked to behave like a consumer but rather to indicate her preferences. By reducing the potential biases involved in survey design, the conjoint analysis methodology may provide more accurate measures of consumer surplus. The next chapter will investigate the theoretical differences or similarities between the two methods.

CHAPTER THREE

THEORETICAL MOTIVATIONS

This chapter will begin with a brief review of both public goods theory and of welfare theory. The theoretical basis for dichotomous choice contingent valuation and conjoint analysis will then be presented. The two will be shown to be theoretically consistent.

3.1 Theory of Public Goods

The following discussion of public goods theory comes primarily from Varian (1996). A public good is defined as a good that is both non-excludable and non-rival (Varian uses clean air as an example of a public good[4]). The efficient provision of a continuous public good will now be discussed[5], starting with a simple two good economy with two individuals. One of the goods will be the public good, *G*, while the other good,

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[4] One of the questions which be could addressed here is whether clean air is a public good or a common pool resource. In both Mitchell and Carson (1989) and Samuelson (1954) clean air is listed as a public good along with national defense. In Mawkin however, clean air is listed as a common pool good. The relevant question may be is clean air a rival good? That is, at some point, if I consume clean air (by polluting) does this mean that there is less clean air for someone else to consume (by trying to look through it, for example)[5] However, as indicated by the results from the pilot survey a threshold may be determined. That is, based on survey results a line may be drawn between clean and dirty, thus making air quality a discrete public good or a congestible (partially rival) good.

x, will be the private good. Think of x as money spent on consumption of all private goods. Both individuals have some initial endowment, w, which they can divide between private consumption and the public good, such that the budget constraint will be:

$$x_i = w_i - g_i$$

where g_i is the i^{th} individual's contribution to the public good. Assuming that utility is strictly increasing in the consumption of both the public and private good (it can be assumed that marginal utility diminishes but does not become negative or zero), $u_i(G, x_i)$ is the utility function for individual i. Since this is continuous public good assume that increased quality of the public good will result in increased per unit cost. This is a reasonable assumption for air quality, as pristine air would require more expensive emissions reduction techniques than smoggy air, which might require no emissions reduction techniques. Further as the level of air quality improves it becomes more expensive (in terms of abatement technology) to continue to reduce emissions.

Let c(G) be the cost function for the public good. To find the efficient outcome for the provision of the public good, individual one's utility can be maximized while holding individual two's utility constant and subject to a budget constraint. The result is that the public good should be funded up until the point where the marginal cost of an additional unit of the public good is equal to the sum of the marginal rates of substitution (between public and private goods) for all individuals. More formally,

$$MRS^1_{G,x1} + MRS^2_{G,x2} = MC\ (G)$$

The equation above is one of the Samuelson conditions for the efficient provision of a public good (Samuelson, 1954). To make this more compatible with this application, c(G) can be thought of as a compensation function for the public good. As the quality of the public good is diminished or degraded, there must be increasing compensation to the individuals. In this instance the public good would be diminished until the marginal compensation made is just equal to the sum of the marginal rates of substitution between the public good and the private good.

3.2 Welfare Theory

Welfare changes are typically measured by evaluation of the gains or losses from a change in the price of a particular good (for example by a change in compensating or equivalent variation). In the case investigated here, the price of visibility does not change when air quality is worsened. It is in fact a qualitative change, thought of as a change in the quantity of scenic vistas being reduced. The theoretical framework outlined below is taken from Freeman (1993).

The consumer's problem is as follows:

$$\underset{X,Q}{\text{maximize}}\ u = u(X,Q) \text{ subject to } P^*X + R^*Q = I$$

where:

I is money income;
X is a vector of private goods;
Q is a vector of environmental services;
P is a vector of prices of private good;
R is a vector of prices of environmental services ($r_i \geq 0$).

Solving the consumer's problem results in demand curves for market goods that are conditional on the amount of environmental services the consumer receives.

$$x_i = x_i\,(\mathbf{P},\ I\text{-}RQ,\ Q)$$

Substituting the conditional demands back into the utility function leads to the indirect utility function:

$$v = v(P,\ I\text{-}RQ,\ Q).$$

To arrive at the expenditure function, invert the conditional indirect utility function above. This results in the conditional expenditure function (below) which is necessary to obtain u_0, the status quo level of utility:

$$e = e(\mathbf{P},\ R,\ Q,\ u_0).$$

For simplicity, assume that R=0 and that only one good is in the vector Q, called q. Because q is determined exogenously and then given to the individual, the individual cannot satisfy conventional optimizing conditions. The relevant measures of welfare change are therefore compensating and equivalent surplus. According to Freeman (1993, p. 48) "compensating surplus [is defined as the] measure [which] asks what compensating payment or offsetting income change will make the individual indifferent between the original situation and the opportunity to purchase the new quantity of the good whose price has changed. Equivalent Surplus [is the] measure that asks what change in income is required, given the old prices and consumption level, in order to make the individual as well off as she would be with the new price set and consumption point." These definitions do not exactly represent the case discussed here, as prices in fact are not changing in the case of a change in q. Both equations can be represented in the form that follows:

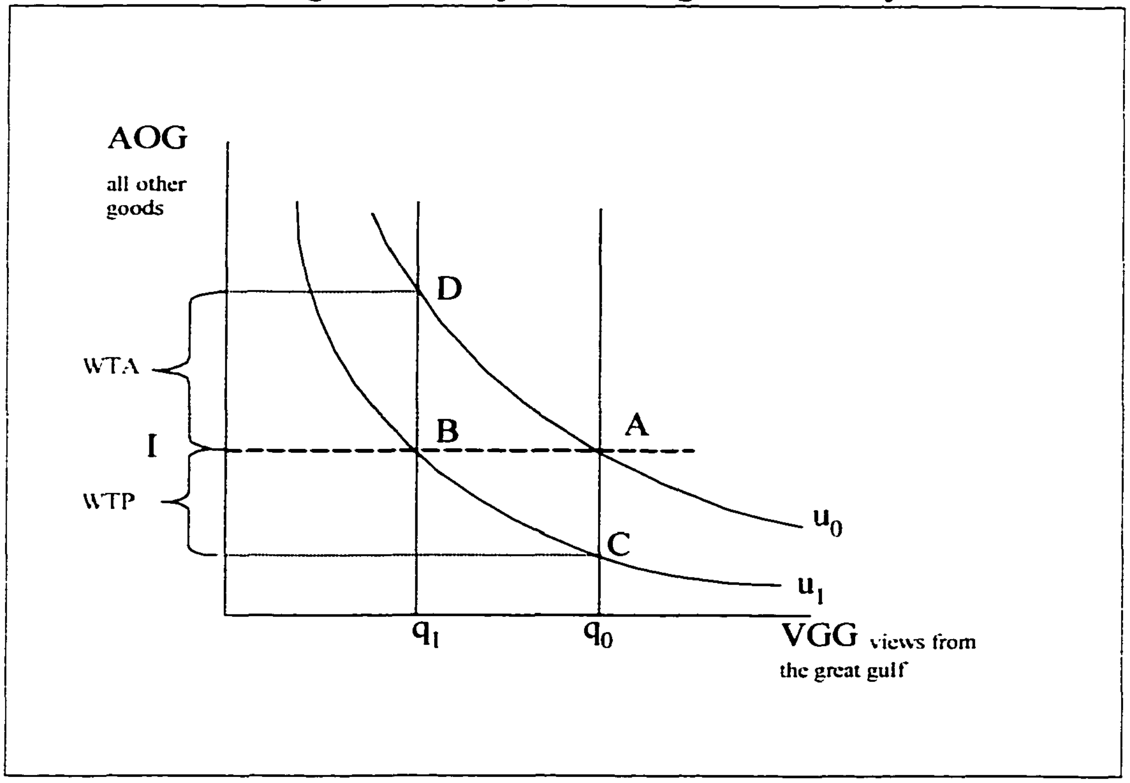
$$CS = e(\mathbf{P}, q_0, u_0) - e(\mathbf{P}, q_1, u_0) = I - e(\mathbf{P}, q_1, u_0)$$

and

$$ES = e(\mathbf{P}, q_1, u_1) - e(\mathbf{P}, q_0, u_1) = e(\mathbf{P}, q_0, u_1) - I$$

These measures can be also examined graphically for the case where R=0. Consider figure 3.1:

Figure 3.1: Alternate Measures of Consumer Surplus (Willingness to Pay and Willingness to accept) for Changes in Visibility



Assume that a hiker consumes two goods, views from the Great Gulf Wilderness (VGG) and all other goods (AOG). Further assume that the price of views from the Great Gulf are zero, such that the hiker can consume q_0 amount of views, which is set exogenously, and I amount of all other goods (where I is the hiker's income). The hiker thus consumes at point A and enjoys a level of utility represented by u_0. If views in the Great Gulf are for some reason diminished to q_1, the hiker will now consume at point B. Differing measures of consumer surplus can now be investigated. Note that in this example, the relative price of the two goods remains unchanged. Thus, only the income effect is relevant in this instance.

The measure of compensating surplus is indicated in the figure by WTP, or the distance between points B and C as measured on the vertical axis. This measures how much the hiker is willing to pay in order to restore visibility to its original level.

The measure of equivalent surplus is indicated in the figure by WTA, or the distance between points B and D as measured on the vertical axis. This measures the compensation that the hiker would require to be just as happy as before the change in views occurred.

3.3 Contingent Valuation and Conjoint Analysis

Both Conjoint Analysis and the Contingent Valuation Method are based in random utility theory. In random utility theory, it is assumed that the utility function can be known up to some random component. The theoretical model for the dichotomous ("take-it-or-leave-it") contingent valuation question presented here will follow the approach presented in Hanemann (1984). The model developed for conjoint analysis follows Roe et al. (1996). The work in Roe et al. is essentially an extension of the Hanemann paper.

3.4 Dichotomous Choice Contingent Valuation

Assume that a hiker receives utility from two sources, mountain views (m) and money income (y). Money income (y) represents consumption of all other goods. (Note that in this section, money income is no longer being represented by the variable I[6]). The utility function can be described as follows:

$$u(m, y; z) \qquad (1)$$

where z is a vector of demographic characteristics and other observable characteristics. This utility specification deviates from the one specified in the previous section as only one of the arguments of the "q" vector changes, the level of visibility, now called *m*. The rest of the arguments typically included in q are suppressed for this discussion. Here, $m = 1$ will indicate the status quo (that is, the current "average" level of visibility) and $m = 0$ will indicate degraded visibility. The standard "more is preferred to less" (local non-satiation) assumption will be made here. That is, the hiker is assumed to gain more utility from a better (i.e. clearer) view. This leads to the following: if the hiker experiences average visibility then her utility can be described as: $u_1 = u(1,y;z)$. If the hiker experiences less than average visibility then her utility is represented as: $u_0 = u(0,y;z)$, where $u_1 > u_0$.

The above utility functions are known to the hiker (or at least she behaves as if she knows them), however they are not known to the economic investigator. From the perspective of the investigator u_0 and u_1 are random variables and can be transformed into an indirect utility function as follows:

$$u_i(m, y; z) = v_i(m, y; z) + e_i \quad m = 0,1 \qquad (2)$$

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[6] The switch in notation was not intended to be confusing but instead it was intended to follow the notation

Where e_i is an independent, normally distributed random variable.

When offered a sum of money to accept the degraded views, the hiker accepts if:

$$v(0, y + A; z) + e_0 \geq v(1, y; z) + e_1 \quad (3)$$

where A is some dollar reduction in the hiker's electric bill. "A" is added to the hikers income as A will increase the hiker's ability to purchase other goods. As will become evident later, the probability that any given hiker will accept the degraded views given the amount offered is of interest. Define:

$$P_0 \equiv \Pr\{\text{individual prefers status quo}\} = \Pr\{v(1, y; z) + e_1 \geq v(0, y + A; z) + e_0\} \quad (4)$$

and

$$P_1 \equiv \Pr\{\text{individual prefers degraded visibility with compensation}\} = 1 - P_0 \quad (5)$$

As stated above, P_1 is of interest, that is the probability that the hiker accepts the degraded view and decreased electric bill. Hanemann (1984) defines: $\eta = e_1 - e_0$ and calls $F_\eta(.)$ the cumulative density function of η, so that the probability that an individual prefers the status quo can be written as:

$$P_0 = F_\eta(\Delta v) \quad (6)$$

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generally used in the discussion of the relevant theory.

where

$$\Delta v \equiv v(1, y; z) - v(0, y + A; z) \qquad (7)$$

All of this is important to determine whether the statistical model is compatible with economic theory[7]. Hanemann next offers a choice of functional forms of statistical models of v, then computes Δv. For simplicity, consider the following specification.

$$v(m, y; s) = \alpha_m + \beta \ln y \quad \beta>0, m = 0,1 \qquad (8)^8$$

This will result in

$$\Delta v \approx (\alpha_0 - \alpha_1) + \beta_1 (1 - A/y) \qquad (9)$$

Of interest is the probability that the hiker will reject the offer. This probability is $F_\eta(\Delta v(A))$, if the hiker rejects the offer it must be that her true willingness-to-accept (WTA) is greater that the amount offered [WTA > A] otherwise she would have taken the offer. Thus, $F_\eta(\Delta v(A))$ is the same as the probability that WTA > A (Bowker and Stoll,

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[7] "If the statistical binary response model is to be interpreted as the outcomes of a utility-maximizing choice, the argument of Δv is a utility difference, then the binary response model is interpreted as the outcome of a utility maximizing choice" (Hanemann (1984) p. 334).
[8] It is important to note that several studies performed since 1984 have found a better statistical fit using a logarithmic form for an approximation of the utility difference. It is important to note that the logarithmic approximation does not have the theoretical underpinnings of Hanemann's specifications. One such specification would be $dV = \alpha_1 + \beta_1 \log A + \beta_2 \log y + \alpha_0 \mathbf{z}$

1988). Following Hanemann, assume that willingness to accept is randomly distributed and estimate WTA using its expected value:

$$E[WTA] = \int F_{\eta}(\Delta v(A))\, \Delta A \quad (10)$$

The theoretical model just described is consistent with a utility maximizing choice. Therefore a consistent estimate of consumer surplus should be the result, whether using dichotomous choice contingent valuation or binary choice conjoint analysis. Several steps must be taken in order to transform conjoint rating data into a result similar to that outlined above. These steps are outlined below.

3.5 Conjoint Analysis

Following Porras (1999) this section will begin with a presentation of the traditional ratings model of conjoint analysis. It will be followed by a presentation of the ratings difference model, this model will be shown to be theoretically consistent with dichotomous choice CV (Roe et al. 1996). Finally, the transformation of the conjoint ratings to the yes/no format will be discussed.

3.5.1 The Traditional Model

The traditional conjoint model has used the form shown below

$$r^i = k + b_1 q_1^i + ... + b_k q_k^i + b_p p^i \quad (11)$$

Where r^i is the rating (typically 1 -10), q's are the attributes and p is the price. The b's are therefore the weight associated with each attribute. If the total differential is set to zero, the marginal weights are:

$$dr^i = b_p dp^i + b_1 dq_1^i + ... = 0 \quad (12)$$

And the marginal rate of substitution between price and an attribute can be found. Thus the implicit price of the attribute is as follows:

$$dp^i / dq_1^i = -b_1/b_p \quad (13)$$

Note that the implicit price does not give information about the movement of one attribute level to another. To do this and to understand how conjoint can be compared to contingent valuation the ratings difference model must be discussed.

3.5.2 The Compatibility of Conjoint Analysis with Dichotomous Choice Contingent Valuation (The Ratings Difference Model)

First, assume that the conjoint rating (r^i) can be transformed (monotonically by Φ) to an indirect utility function. In this application, m will be a vector of environmental services.

$$r^i(p^i, \boldsymbol{m}^i\ y, z) = \Phi[v^i(p^i, \boldsymbol{m}^i, y, z)] \qquad (14)$$

This specification of utility differs from Hanemann in that it includes the price of the environmental amenity. If the individual is indifferent between the status quo (initial visibility) and no change in electric bill, then:

$$r^i(p^i, \boldsymbol{q}^i\ m - C^i, z) - r^0(p^0, \boldsymbol{q}^0\ m, z) = 0 \qquad (15)$$

Where C^i is Hicksian compensating variation. Note that in the current application C^i would be negative and is not the same as A in the section above. To resolve the two frameworks, think of the difference in the "price" as the offered change in the electric bill made to the hiker (i.e. $A = p^i - p^0$). C^i would be a lower bound measure of the respondent's willingness to accept.

Solving for C^i, find the following:

$$C^i = y - g[r^0(p^0, \boldsymbol{m}^0\ y, z), p^i, \boldsymbol{m}^i, z] \quad (16)$$

Where g(.) is the inverse of r^i with respect to income, assume utility is separable and linear in income.

$$r^i(p^i, \boldsymbol{m}^i\ y, z) = r(\boldsymbol{m}^i, z) - r(\boldsymbol{m}^0, z) - a(y - p^i) \quad (17)$$

where a is a constant, taking the difference find:

$$\Delta r^i(p^i, \boldsymbol{m}^i\ y, z) = r(\boldsymbol{m}^i, z) - r(\boldsymbol{m}^0, z) - a\Delta p^i \quad (18)$$

$$where \quad \Delta p^i = p^i - p^0$$

Again, think of Δp^i as the reduction in the electric bill offered to the hiker. To solve for C, the offer Δp^i is changed until there is no difference in the rating of the two pictures: that is, until (15) is equal to zero. This results in:

$$C^i = [\{r(\boldsymbol{m}^0, z) - r(\boldsymbol{m}^i, z)\}/a] - \Delta p^i = -\Delta r^i(\Delta p^i, \boldsymbol{m}^i\ \boldsymbol{m}^0, z)/a \quad (19)$$

Following Roe et al., equation (18) can be estimated and the parameters used to derive C^i according to (19). Roe et al. argue that (19) is consistent with (4) described above. This shows that, theoretically at least, the results of conjoint analysis and contingent valuation will be consistent. The dissertation will become even more interesting if the two methods yield empirically different results. If this occurs, this work may be able to shed light on the preferable method of valuation.

Further a significant difference in the values inferred from conjoint analysis and contingent valuation will have an important implication for any policy that impacts the environment. Efficient use of a market-based system depends on efficient non-market estimations. Inaccurate estimates of the value placed on any non-market good may result in inappropriate and incorrect policy decisions. A finding of a significant difference will open up many avenues for research into the cause of the difference. Two possible reasons for differences are discussed below.

It was assumed in the presentation above that both the contingent valuation method and conjoint analysis would result in the same estimate of consumer surplus. It should be noted that this rests on the assumption that the definition of the attributes under the conjoint framework will sum to the definition of the whole good as defined under the contingent valuation framework. That is, for the two methods to yield consistent estimates of consumer surplus, consumer surplus must be defined for the same good. It would not be a useful exercise to compare measures of change in consumer surplus for apples and oranges. If this assumption does not hold, that is, if in fact the two methods are estimated consumer surplus yielded by different goods, then the two methods would not be expected to result in similar estimates. The survey instrument employed in this dissertation limited the number of attributes to two to avoid this problem of definition. It could be said that the conjoint analysis instrument was "stripped down" to facilitate the comparison between the two methods.

It was also assumed in the presentation above that respondent's will behave according to known (to the respondent) utility functions. The utility function maps with certainty a defined set of bundles over which the respondent can express indifference or preference. However, it is possible that the respondent may be influenced by the type choice he or she is being asked to make. In the contingent valuation method the respondent is asked to evaluate a price change whereas in conjoint analysis the respondent is asked to make a choice. The way a person is asked to express preference may change the perception the individual has of the bundles and would result in behavior seemingly inconsistent with economic theory. This behavior should not be ruled out as inconsistent however but should instead be understood as a perceived change in the choice set by the respondent. That is, the conjoint analysis framework and the contingent valuation method, although they may appear identical, may in fact represent two choices over very distinct bundles of goods. It may be that the researcher compares changes in consumer surplus for apples and oranges without realizing it. This is a question for further study and will not be investigated in this dissertation.

3.5.3 The Binary Choice Model

This model essentially transforms the ratings data into a yes or no question and can be derived from equation 18. The hiker is asked to rate each scenario on a scale of 0 to 10, with 10 indicating that they are definitely willing to accept the scenario. Assume that visibility level i will be chosen if:

$$\Pr\{\text{level } i \text{ is selected}\} = \Pr\{(v^i(p^i, \boldsymbol{m}^i, y, z) \geq v^j(p^i, \boldsymbol{m}^j, y, z)\} \quad (20)$$

Recall from equation 14 that the indirect utility function can be transformed into the rating via some transformation function . This model thus becomes essentially the same as the dichotomous choice contingent valuation (Roe et al., 1996) presented in section 3.4.

This indicates that theoretically at least the binary choice conjoint analysis is expected to yield an estimate of consumer surplus that is consistent with that of random utility method derived above (Roe et al., 1996). This is to be expected as both models have been shown to have the same basis in expected utility. This is not necessarily the case with the traditional ratings or ratings difference models. However, if consumers are consistent in their preferences, all estimates of consumer surplus should be similar. Thus, the expected result of this dissertation is that there will be no difference in the consumer surplus estimates from any of the four models discussed here.

If differences are found, attention should revert back to the discussion at the end of the previous chapter. Here the idea that conjoint analysis may reduce some of the biases associated with contingent valuation was discussed. If this hypothesis is true, some differences in measures of consumer surplus should be detectable. Further investigation will need to be undertaken to determine the source of any differences in consumer surplus measures. The remainder of this dissertation will design and implement a survey to test for differences in the contingent valuation and conjoint analysis methods. The next chapter will discuss the design of that survey.

CHAPTER FOUR

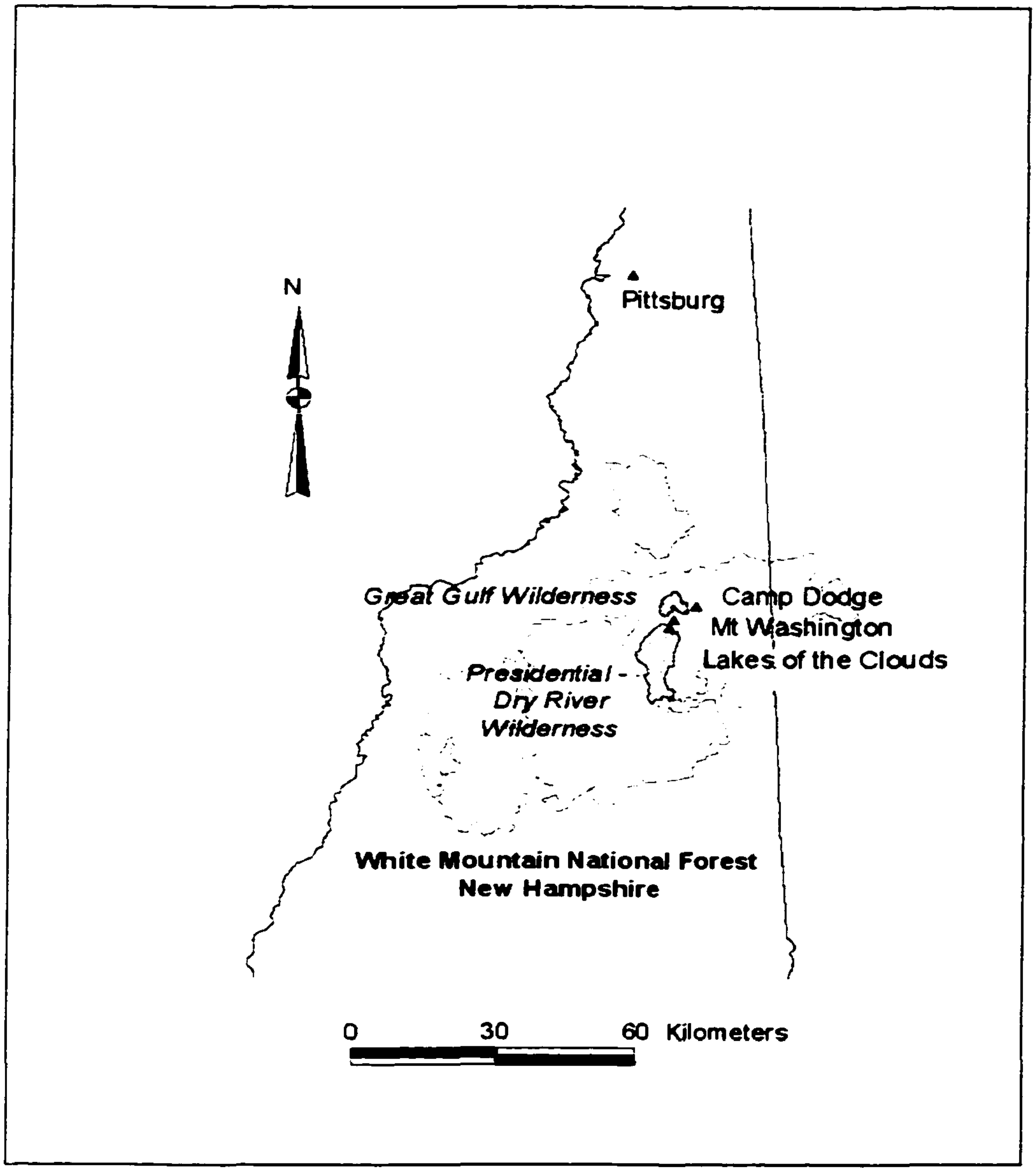
THE SURVEY ADMISTRATION AND DESIGN

This chapter will discuss the White Mountain case study area as well as some of the implementation of the survey and provide a justification for the use of photographs in this particular study.

4.1 A sense of place

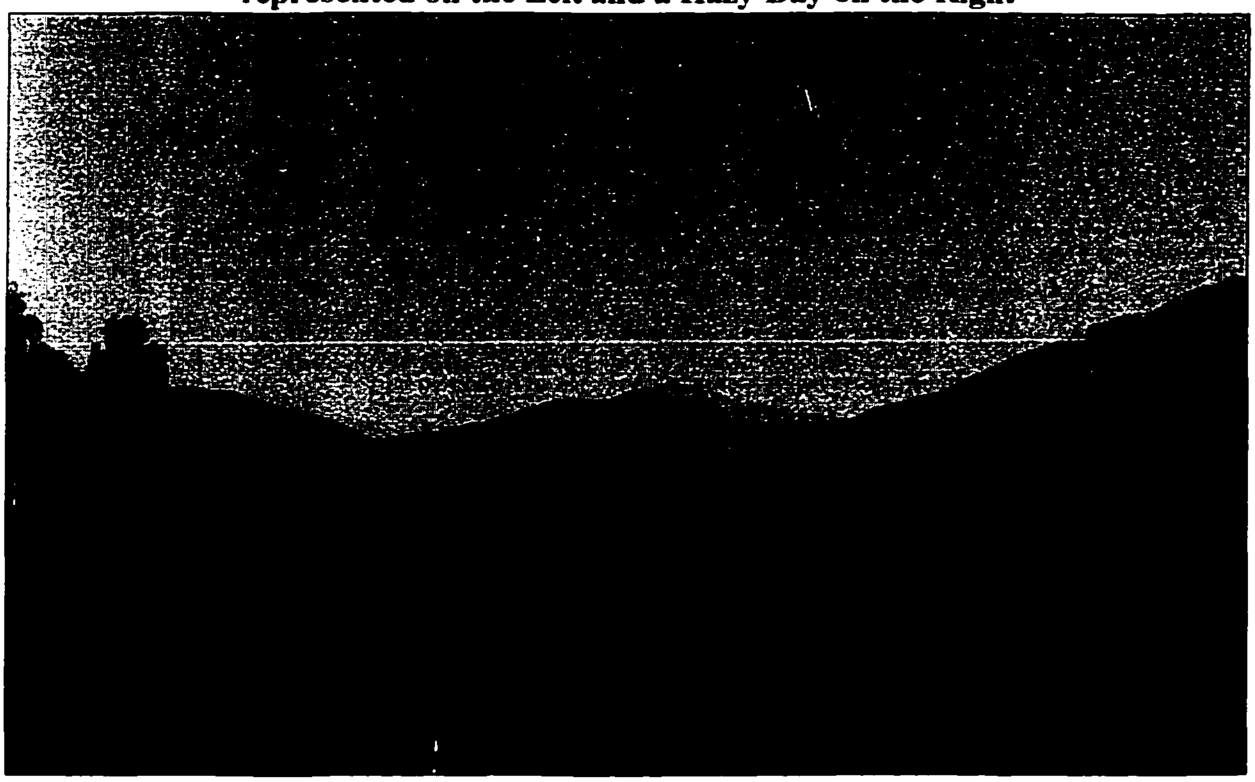
There has been a history of visibility and air quality research in the White Mountain National Forest for the past decade. In 1985, the U.S. Forest Service placed a visibility camera at Camp Dodge (see figure 4.1) to monitor changes in the visual range. In 1988, the Appalachian Mountain Club (AMC) began monitoring the level of fine particulate matter (a cause of visibility impairment). From 1990 to 1992 the AMC in conjunction with the Harvard School of Public Health conducted research on the impact of ozone on hiker lung function (Korrick et al. 1998). The current project was developed from a project the AMC began in 1996 with support from the U.S. Forest Service and the John Merck Fund.

Figure 4.1: Map of the Case Study Area



The 1996 survey had two goals: first, to determine whether individuals can accurately rate visibility conditions and second; to determine if a threshold level of acceptable visibility could be determined. This survey was based on the Denver Visibility Study. In the Denver Study, the city was able to develop local haze standards based on the results of their survey (Ely 1991). To accomplish the goals of the AMC survey, individuals were presented with 23 pictures (see figure 4.2) to rate from 1 to 5 (clear to hazy) and to rate as acceptable or unacceptable. The pictures, taken by a stationary visibility camera, are of Mount Jefferson in the Great Gulf Wilderness, one of the two Class I airsheds in the White Mountain National Forest. Each photograph is correlated with a measurement of optical extinction measured via a nephelometer. Poor visibility conditions arise from the presence of light scattering or light absorbing particles or gases in the air. The extinction measure consists of both light scattering and light absorption. Both the visibility camera and the nephelometer are located at Camp Dodge, near the base of Mount Washington.

Figure 4.2 Split View of the Picture Shown to Respondents, A Clear Day is represented on the Left and a Hazy Day on the Right



In the 1996 pilot survey, data were collected at four sites in New Hampshire. The first was near the Pinkham Notch Appalachian Mountain Club lodge, which is at the base of Mount Washington. The other sites were the observatory which is at the summit of Mount Washington, at the base of Mount Cardigan and at the Lakes of the Clouds AMC hut. Surveys placed at these locations capture a variety of recreational users of the White Mountains. The observatory at the summit of Mount Washington is accessible not only by foot but also by car and cog railway. Mt. Cardigan is a fairly easy hike that attracts hikers and recreationalists of all abilities. Hikers at the Pinkham Notch and Lakes of the Clouds locations may include more dedicated hikers, as many difficult trails are accessible from these locations.

Data from 1997 were collected at the Pinkham Notch, Mt. Cardigan and Observatory sites. The Mt. Cardigan and Observatory sites were later dropped due to staffing issues at the Mt. Cardigan site and lighting issues at the observatory site.

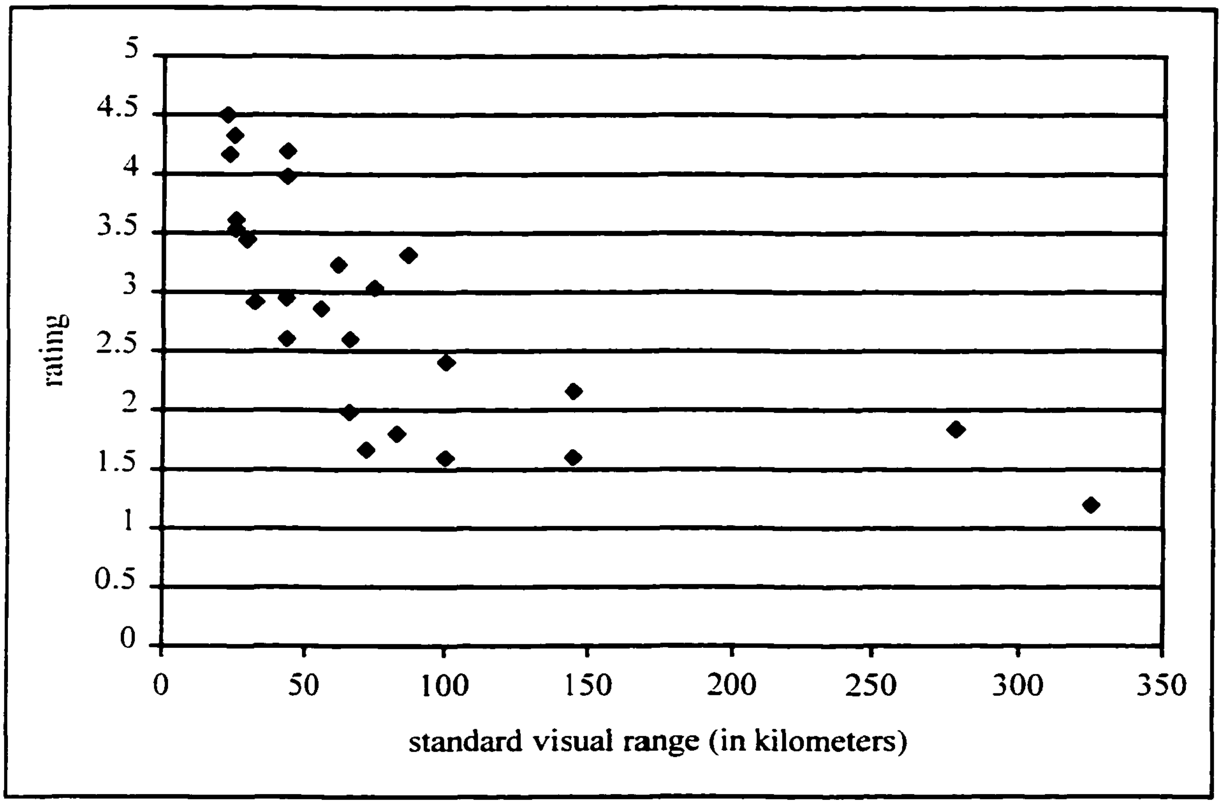
4.2 Results from the Pilot Survey and the Use of Photos

As discussed in section 2.2.2, the good being valued must be carefully defined. This section will present results that support the use of photographs in the valuation section described below.

4.2.1 Consistency in Ranking

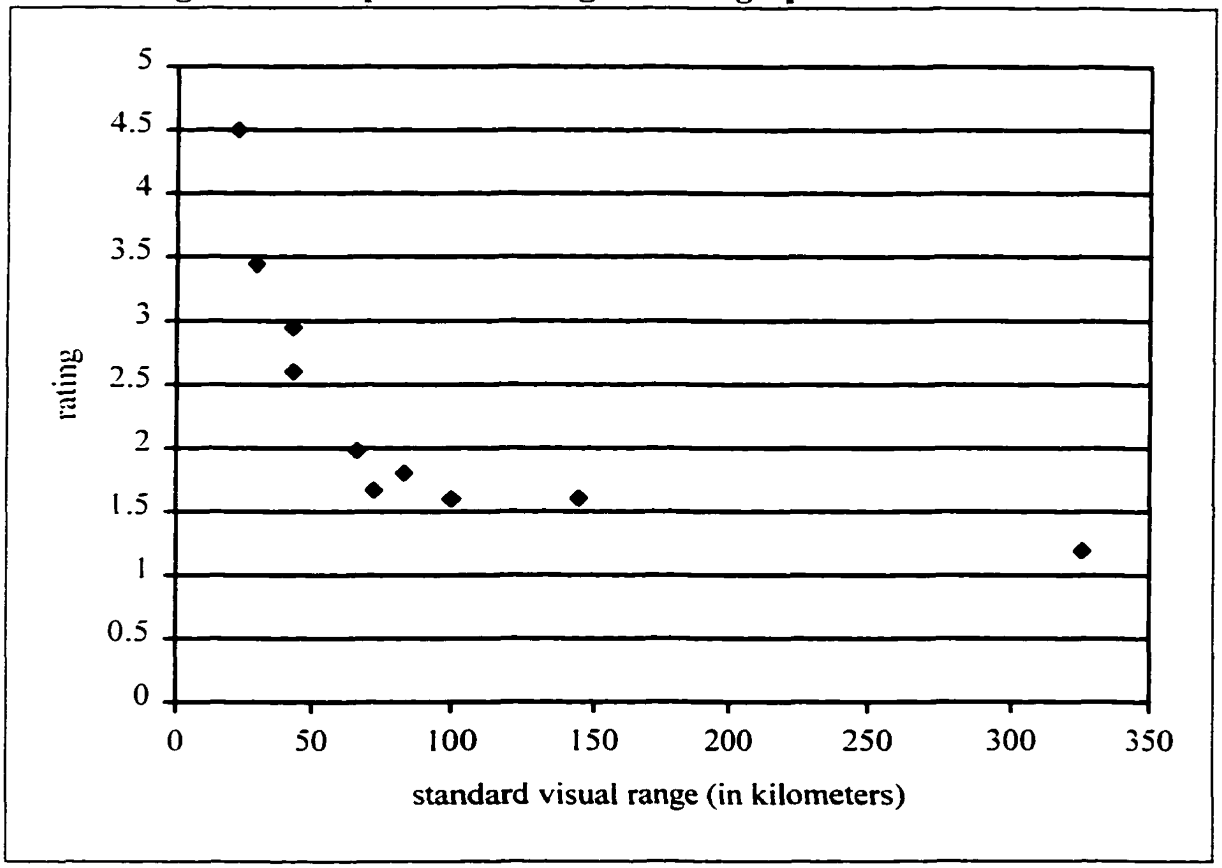
Recall, the perceptions study asked visitors to rate visibility conditions in a series of photographs from 1 to 5 (clear to hazy). If the ratings decline as visibility improves, this would indicate a fair degree of accuracy in detecting changes in visibility. (Note, one would not expect survey respondents to be able to perceive the same changes in visibility as those perceive by the nephelometer.)

Figure 4.3: Respondent Ratings of Photographs - Clouds Included



As can be seen in figure 4.3, there is a negative relationship between visibility and ratings as would be expected. However, there is also quite a bit of "noise". In thinking about the case study area, it is helpful at this point to consider the weather. As anyone who has visited the region for an extended period of time knows, it is rainy or overcast quite often. Mt. Washington, which is just to the left of the peak being considered, is covered with clouds 60% of the year. Further, the visibility camera took photographs regardless of weather. Therefore the set of photographs respondents were asked to rate included cloudy pictures (included by clever survey designers to test the effect of weather on perceptions of visibility). In the scatterplot below clouds are removed from consideration.

Figure 4.4: Respondent Ratings of Photographs - Clouds Removed



As can be seen in figure 4.4, the "noise" found in figure 4.3 is reduced when the cloudy photographs are removed, and a relationship between ratings and visibility is observed.[9] When ordering pictures using the flip book (that is, respondents could not compare photos side by side) and accounting for clouds. thirty four percent of respondents placed the photographs in correct order. When allowing for one picture out of place sixty three percent of the respondents ordered pictures correctly. Eighty eight percent of respondents were able to order the photographs from clear to hazy misplacing only two. This can be considered quite good given the visual range of the photograph (8km) and the relatively small changes in the visual range caused by haze (66km to 72 km for example). To test this result more rigorously an ordered probit model was used. The model was as follows:

rating = f(physical measure of visibility{scattering coefficient}, cloudiness of the photograph{each photograph was either cloudy or not cloudy}, demographic characteristics)

Table 4.1: Results of Probit Analysis for Understanding Effects on Ratings

Variable	Coefficient	Standard Error
Constant	-0.43699*	0.14078
Scattering Coefficient	16.775*	0.60821
Cloud (if picture is cloudy = 1. not cloudy = 0)	0.49041*	0.60738E-01
male (male = 1. female = 0)	-0.91248E-01	0.60784E-01
education	0.53948E-01	0.41659E-01
age	0.25125E-02	0.22567E-02
income	-0.13407E-04	0.14447E-04

* Indicates significance at 5% level.

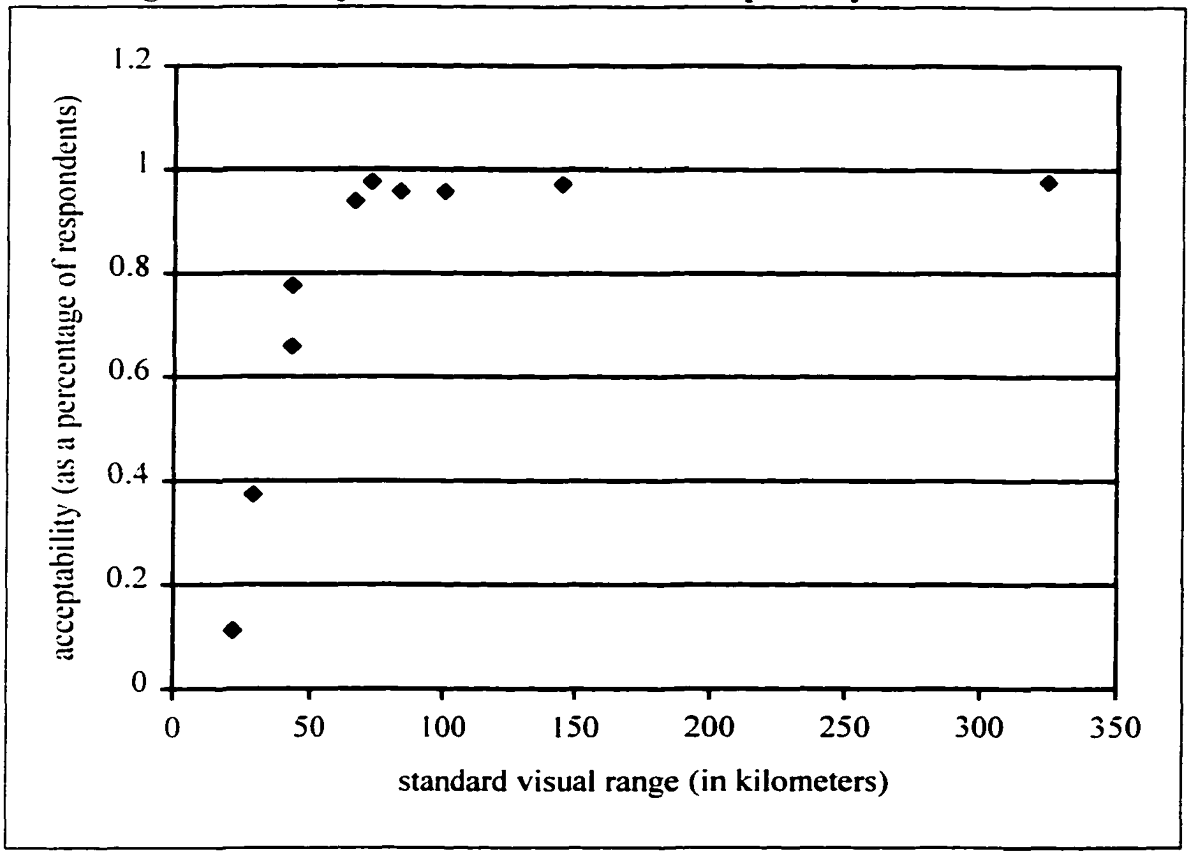
[9] The scattering coefficient (Bext) is transformed into standard visual range (SVR) using the Koschmeider relationship. which is SVR = 3.9/Bext

Results found the significant influences on a respondent's ratings to be the scattering coefficient (the physical measure of visibility) and the presence of clouds. Of these variables, each coefficient was significant at the 5% level. As expected, as visibility worsened, the average rating increased (recall that a rating of 5 indicates very hazy). The presence of cloud cover caused respondents to rate the photograph as hazier. For example, the survey contained a pair of photos, one cloudy, one clear with the same scattering coefficient of 0.091 km^{-1} (which translates to a standard visual range of 42.86km) to test for the effect of cloud cover on ratings. The clear picture received an average rating of 2.9, while the cloudy picture received an average rating of 4.0. Other influences not found to be significant at the 10% level were gender, education, age and income.

4.2.2 Acceptability Issues

As noted earlier, federal land managers are charged, under the Clean Air Act, with protecting Class I areas from visibility deterioration due to new sources. Thus, when screening applications for permits for new sources of emissions (such as power plants or industrial smoke stacks) it is useful for the federal land managers and state regulators to have an idea of what level of visibility individuals find "acceptable." It may be useful to know the threshold at which visitors may find visibility conditions unacceptable. Such a threshold may be used as a "critical value" not to be exceeded in a wilderness area (such as the Great Gulf), and may be considered a basis for rejecting such a permit if new emissions would cause the "acceptability" critical threshold to be exceeded. Towards the end of determining a threshold level of visibly, a scatterplot again is useful (figure 4.6).

Figure 4.5: Respondents Indication of Acceptability - Clouds Removed



It can be seen from figure 4.6 that photographs representing a visual range of 60 km or greater are rated as acceptable by over ninety percent of respondents. A probit model was again used here. The model estimated was:

Acceptability = f(physical measure of visibility{scattering coefficient}, cloudiness of the photograph{each photograph was either cloudy or not cloudy}, demographic characteristics)

Table 4.2: Results of Probit Analysis for Understanding Effects on Acceptability

Variable	Coefficient	Standard Error
Constant	1.8950*	0.19398
Scattering Coefficient	-17.487*	0.81853
Cloud (if picture is cloudy = 1, not cloudy = 0)	-0.42165*	0.79758E-01
male (male = 1, female = 0)	0.23712*	0.80201E-01
education	-0.64463E-01	0.41659E-01
age	0.68967E-03	0.30041E-02
income	-0.54925E-05	0.19776E-04

* Indicates significance at 5% level.

The scattering coefficient and cloud cover were once again found to be significant, with the expected influence. As visibility worsened (indicated by an increase in the scattering coefficient), acceptability declined; the presence of clouds had a negative effect on acceptability. The influence of clouds is again easily seen by comparing the results on the two photographs mentioned above. The survey included two photographs with the same scattering coefficient of 0.091 km^{-1} (which translates to a standard visual range of 42.86km). The cloudy picture was rated as acceptable by fifteen percent of the respondents while the non-cloudy picture was rated as acceptable by seventy one percent of the respondents. Thus, cloud cover is a significant confounding variable.

An interesting result from the probit analysis is that gender becomes a significant variable. It appears that men are more likely to rate a photograph as acceptable. This is consistent with their tendency (although insignificant) to rate photographs more favorably.

The impact of these results is two-fold. First and most important, survey respondents can perceive visibility accurately. This gives us confidence that when asked to choose between different levels of visibility, respondents will in fact be choosing between what they perceive to be distinct choices. Second, photographs used in the future should be relatively cloud free. This second issue will be addressed by the future use of the Win-Haze[10] program. This program will allow us to hold weather conditions constant while changing only visibility conditions[11]. As discussed above, the presence of clouds influenced the respondents rating of visibility conditions. Computer generated images will allow respondents to focus only on haze and not on weather conditions.

4.2.3 Implications

Results of this study are encouraging for those researchers seeking to use visual cues in direct preference valuation methods. One of the prime considerations in CVM and other related methods is that the contingent markets be specified as precisely as possible; that is, respondents must be able to discern change in the provisional level of the good they are valuing. Clearly in our study respondents displayed a relatively high degree of sophistication in perceiving changes in visibility. In addition, insights are gained into what levels of visibility might be deemed "acceptable" by the public,

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[10] Win-Haze 2.7.0 is available as freeware from Air Resource Specialists, Inc 1901 Sharp Point Drive Suite E Fort Collins, CO 80525 or at www.air-resource.com.

[11] This program begins with a clear picture of the Great Gulf Wilderness, this image is then digitized and entered into the program using information from topographical maps as well as weather and air quality data from the day the original photo was taken. Win-haze then uses this information to generate visually

although this study's sample is likely biased due to the data collection sites chosen. If contingent valuation researchers are confident that respondents really do know what they are "paying for." efforts can then be directed at the myriad of other problems and biases inherent in using the technique.

4.3 The 1998 Valuation Study

In the 1998 survey. respondents were asked again about preferences and acceptability. They were also asked either a conjoint or a contingent valuation question as well as travel and demographic questions. As discussed in sections above. it is important to carefully construct questions and scenarios so that individuals can give answers which accurately reflect their value of the good in question. The valuation questions were designed to provide a link between visibility in the White Mountains and electric power production. The payment vehicle (which will be discussed below) was a change in the respondent's electric bill. This links the value question with the very familiar (to New Englanders) topic of electric utility deregulation. This set up is shown in figure 4.7.

Visitors to the Pinkham Notch visitor center were approached and asked if they would take 5 to 10 minutes to complete a survey regarding air quality. They were then read the following introduction:

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accurate representations of differing air quality levels as requested by the researcher. The importance of the win-haze program is that it allows for control of weather conditions.

Figure 4.6: Verbal Introduction to the Survey

SCRIPT:

(Hi, would you be interested in taking a survey?
You would, great!) – or something similar

We're looking at how people perceive and value visibility in wilderness areas, specifically we are looking at the Great Gulf Wilderness. This wilderness area is highlighted by Mt. Jefferson, which you can see here on the computer screen. This survey is broken up into several sections, section one contains five photos and is a warm up in which you will rate different pictures of the Great Gulf (or Mt. Jefferson) from one to five, one being clear and five being hazy.

Section two contains 15 photos. In this section, we ask that you create a visibility standard for wilderness areas in your mind. That is, if you could set the standard for the amount of haze allowed in a wilderness area. We are then going to ask you to look at the photos and indicate whether the amount of haze in each photo would be acceptable or unacceptable under your standard.

Section three will ask a longer question and should be self-explanatory.

Sections four and five ask for demographic and travel information, and are hopefully also self-explanatory.

We have an instruction sheet for you here, which will cover the directions I've just given in case anything is unclear – or feel free to ask me any clarifying questions.

You will be asked for a survey number at the beginnings of sections one, three, four and five. Your survey number is: .

To best take advantage of the "win-haze" program, the survey was self-contained on a Gateway Solo 9300[12]. The survey was designed and run in Microsoft Access 97. The survey was self-explanatory once the person began taking the survey. Starting with the perceptions and acceptability questions used in previous studies, respondents were shown a total of 20 photos. For the perceptions study the visual ranges represented by

[12] The Appalachian Mountain Club Research Department generously provided the computer.

the photographs corresponded to 144, 9, 237, 32 and 87 kilometers. To view a sample page, please refer to appendix A. In section two of the survey, the visual ranges presented were 39, 107, 144, 354, 48, 19, 59, 237, 11, 87, 9, 71, 2, 32, and 144 kilometers. To view a sample page, refer to appendix A.

The third section of the survey was the valuation question. Before the question was asked a realistic scenario needed to be defined. In this section, electricity bills were linked to visibility degradation. As will be discussed in a later section, this was felt to be a realistic scenario and would be familiar to most respondents.

Figure 4.7: Introduction to Valuation Questions

For the next question, consider the following: Currently, many states are debating the issue of deregulation in the electric utility industry. If deregulation occurs in your state, you may be able to choose your own power provider. Assume for the purposes of this question that cheaper power (that is, less than what you currently pay) is available through a mid-western power company. Further, this power company produces electricity by burning coal. Increased demand for this company's cheaper power will contribute to air pollution and poor visibility in the White Mountains.

In this section, respondents were also asked to enter their average monthly electric bill. By entering this before the valuation question, the respondent (hopefully) is already thinking about that figure. The valuation question was then asked, either a contingent valuation (figure 4.9) or conjoint (figure 4.10) question, including the following pictures:

Figure 4.8A: Photo Representing the Status-Quo (Scenario A) Level of Visibility

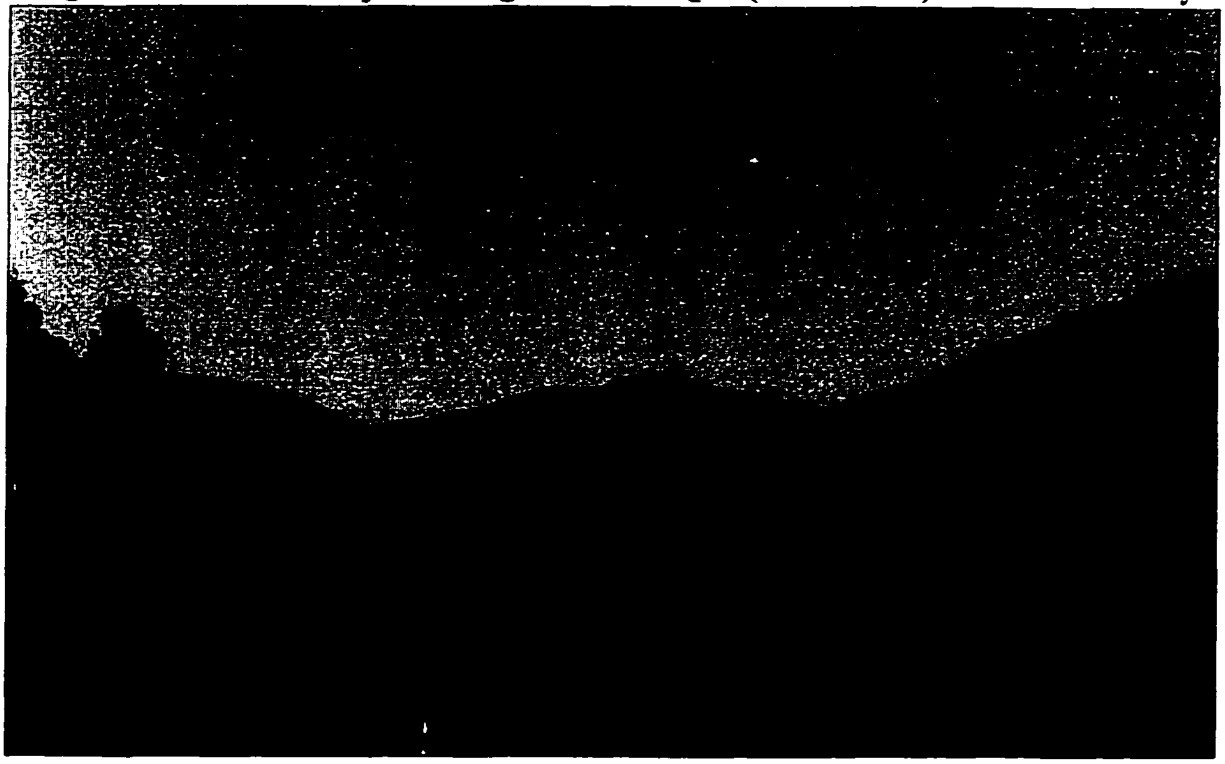


Figure 4.9B: Photo Representing the Degraded (Scenario B) Level of Visibility

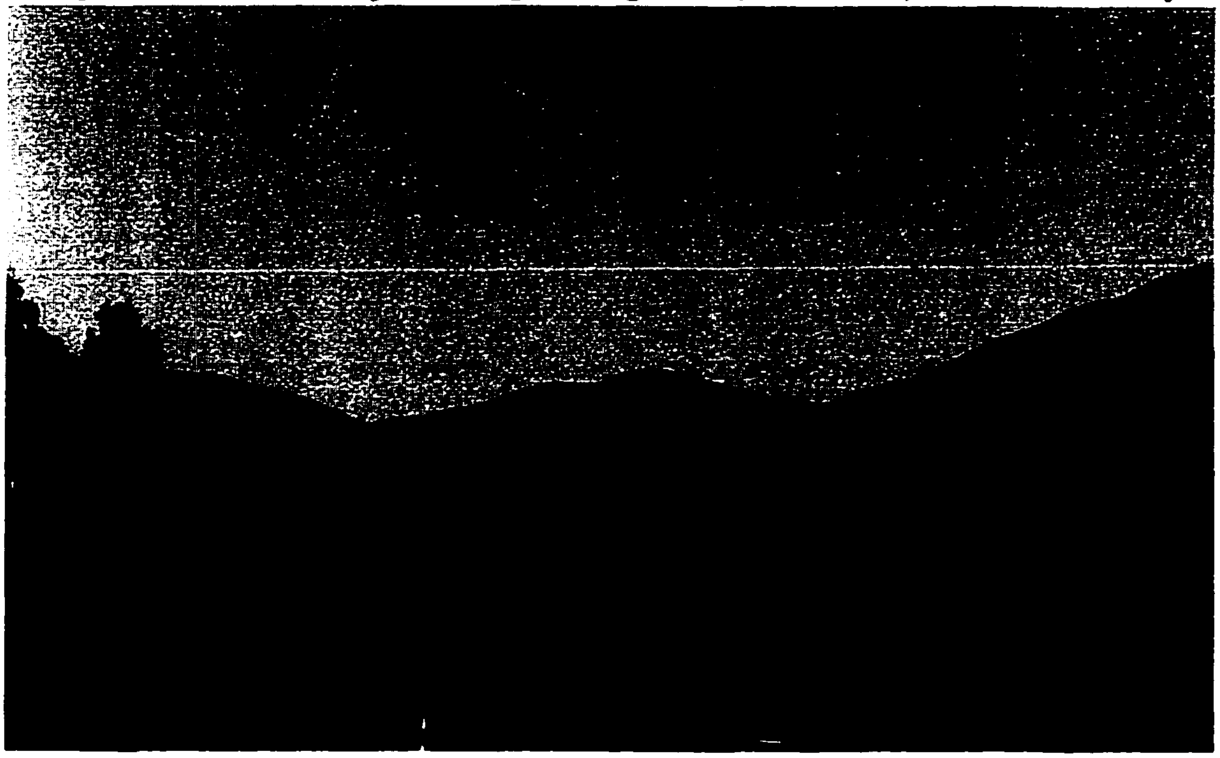


Figure 4.9: Contingent Valuation Question

Now suppose picture A represents the level of visibility most often experienced in this region during the summer months. Further suppose that you were faced with a situation where the visibility level would change to that in picture B. The purposes of this question assume that visibility would change ONLY in the White Mountain National Forest.

Would you be willing to accept this new level of visibility (indicated by picture B) in the White Mountain National Forest if your monthly electric bills were reduced by $___

YES NO

Figure 4.10: Conjoint Analysis Question

Now suppose picture A represents the level of visibility most often experienced in this region during the summer months. Further suppose that you were faced with a situation where the visibility level would change to that in picture B. The purposes of this question assume that visibility would change ONLY in the White Mountain National Forest.

How would you rate the situation in photograph A on a scale of 0 to 10, with 0 being totally unacceptable and 10 indicating that you would definitely be willing to accept this level of visibility along with no change in your monthly electric bill? {enter 0-10}

How would you rate the situation in photograph B on a scale of 0 to 10, with 0 being totally unacceptable and 10 indicating that you would definitely be willing to accept this level of visibility along with a $ decrease in your monthly electric bill? {enter 0-10}

Refer to the appendix to see the full screen view of the different valuation questions. The visual range represented in picture A is 87 km, while the visual range represented in picture B is 48km. The visual range for picture A was selected using the median visual range from the previous two summers. Following the valuation question, respondents answered questions regarding travel and demographic characteristics. Some of the information collected included: age, gender, education, income, miles traveled, and dollars spent on trip. Please refer to appendix for more information on the questions asked in this section.

4.4 Issues in Survey Design

In this section, some of the more interesting features of the survey will be presented. Specifically, the use of willingness to accept as opposed to the more commonly used willingness to pay will be discussed. The selection of the monthly electric bill as a payment vehicle will also be presented.

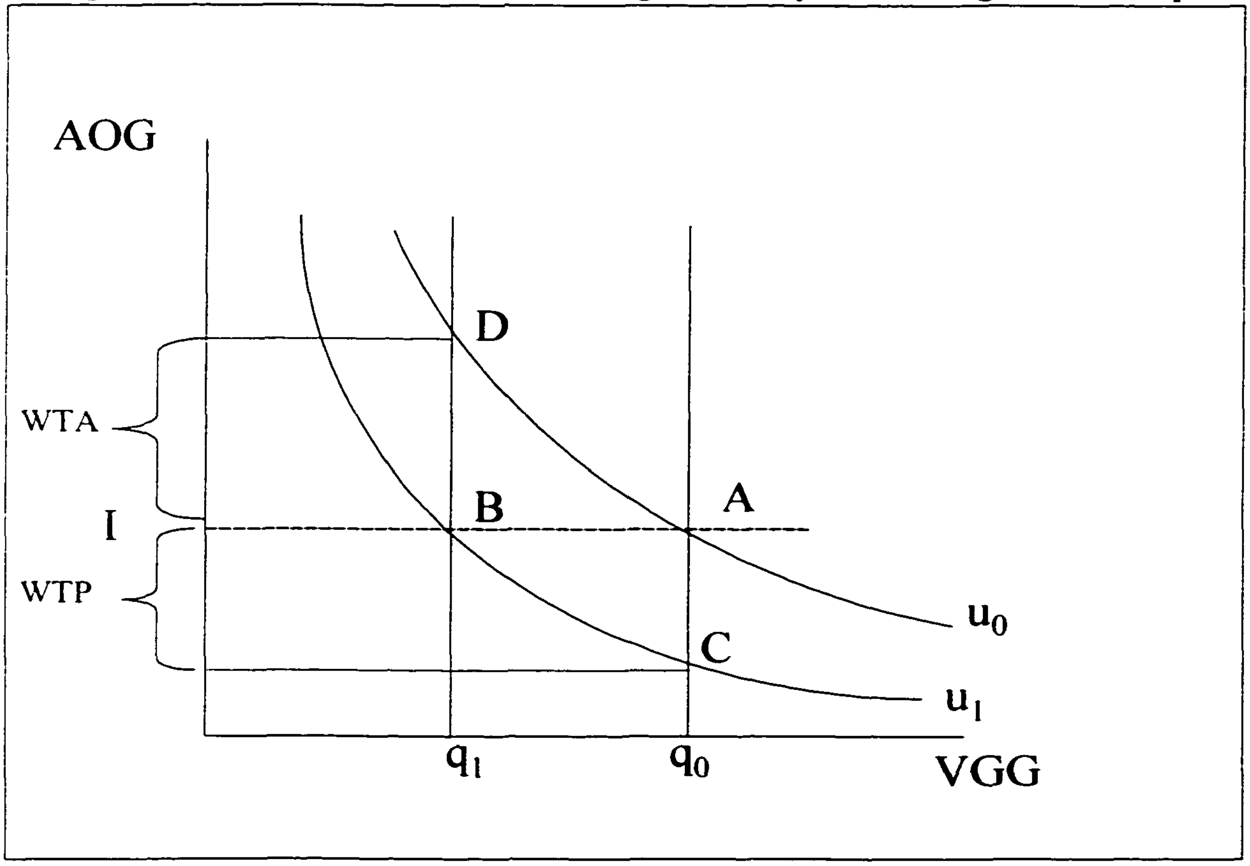
4.4.1 Willingness to accept vs. Willingness to Pay

An important consideration in the design of any survey is the choice between willingness to accept and willingness to pay. The willingness to pay measure has been the most frequently used, primarily due to the assumption that willingness to pay may be more reliable than willingness to accept (Levy et al., 1995). This assumption is based on the observed differences between willingness to accept (WTA) and willingness to pay (WTP). Specifically, studies (Hammock and Brown, 1974; Randall et al., 1976) had found that willingness to accept is larger than willingness to pay and economists have been unable to reconcile this with economic theory (Willig, 1976; Randall and Stoll, 1980, for example). In traditional understanding of economic theory it seems that the WTP and WPA measures should be similar, in fact they should differ only by the income effect. An interesting debate has sprung up as to the source of the divergence, this section will begin with a brief look at the theory behind willingness to pay and willingness to accept. Next the debate will be summarized and the two opposing sides presented, with focus on the substitution effect. Finally, given the debate an argument regarding the use of willingness to accept in this instance will be presented.

4.4.1.1 Willingness to Accept and Willingness to Pay: Theoretical Derivation

Recall figure 3.1, shown as figure 4.11 here:

Figure 4.11: Differences between Willingness to Pay and Willingness to Accept



Recall that a hiker consumes two goods, views from the Great Gulf Wilderness (VGG) and all other goods (AOG) and the price of views from the Great Gulf is zero. The hiker can consume q_0 amount of views, which is set exogenously, and I amount of all other goods (where I is the hiker's income). The hiker thus consumes at point A and enjoys a level of utility represented by u_0. If views in the Great Gulf are for some reason diminished to q_1, the hiker will now consume at point B. The distance between points A and C shows the measure of WTP. The measure of WTA is shown by the distance between points B and D as measured on the vertical axis. It can be seen here that WTA and WTP are nearly identical, and "in most applications the error of approximation will be very small" (Willig, 1976, p. 589). For a more rigorous explanation of this see Chapter three section 3.2. The next section will discuss observed differences between WTA and WTP that are greater than the differences implied by this section.

4.4.1.2 Empirical Differences

Numerous studies (see Mitchell and Carson 1989 for examples) have shown that a large empirical difference between willingness to pay and willingness to accept exists, a difference typically much larger than one would expect given the explanation in the earlier section. However, there is still much debate as to why this difference exists. The debate focuses on whether respondents are behaving in accordance to economic theory when they answer WTA questions. The debate can be split essentially down two lines. One side argues that respondents are not behaving in accordance with economic theory, they are either unsure of their preferences or are using some type of value function (not a utility function) when answering WTA questions. In these cases, respondents value their initial endowment more highly (endowment effect) and are thus more cautious in moving away from this initial position (thus WTP is underestimated and WTA overestimated).

The second side of the debate, lead largely by Hanemann (1991) argues that the large empirical differences can be explained by economic theory if the substitution effect is taken into account. A small difference between WTP and WTA should be expected only when the good being valued has substitutes available. This is typically not the case when valuing environmental amenities, many of which are considered unique and thus have no close substitutes. Once this has been taken into account, economic theory does in fact explain the observed differences in WTA and WTP.

As disscussed in the preceding section, WTA and WTP should differ by the income effect, traditionally thought to be small and certainly not of the magnitude found in many empirical studies. If WTP and WTA diverge by more than the income effect this might imply that respondents are not reacting according to the predictions of economic theory. This line of thinking is captured in the endowment effect literature (Knetsh, 1989) and essentially assumes that the value of a good changes once an individual comes to possess that good. However, Hanemann (1991) has developed an argument that explains the disparity between WTA and WTP as consistent with economic theory. Next the endowment effect and Hanemann's substitution effect will be briefly summarized. Table 4.5 presents the research that has been done since reports of these two differing effects have been published.

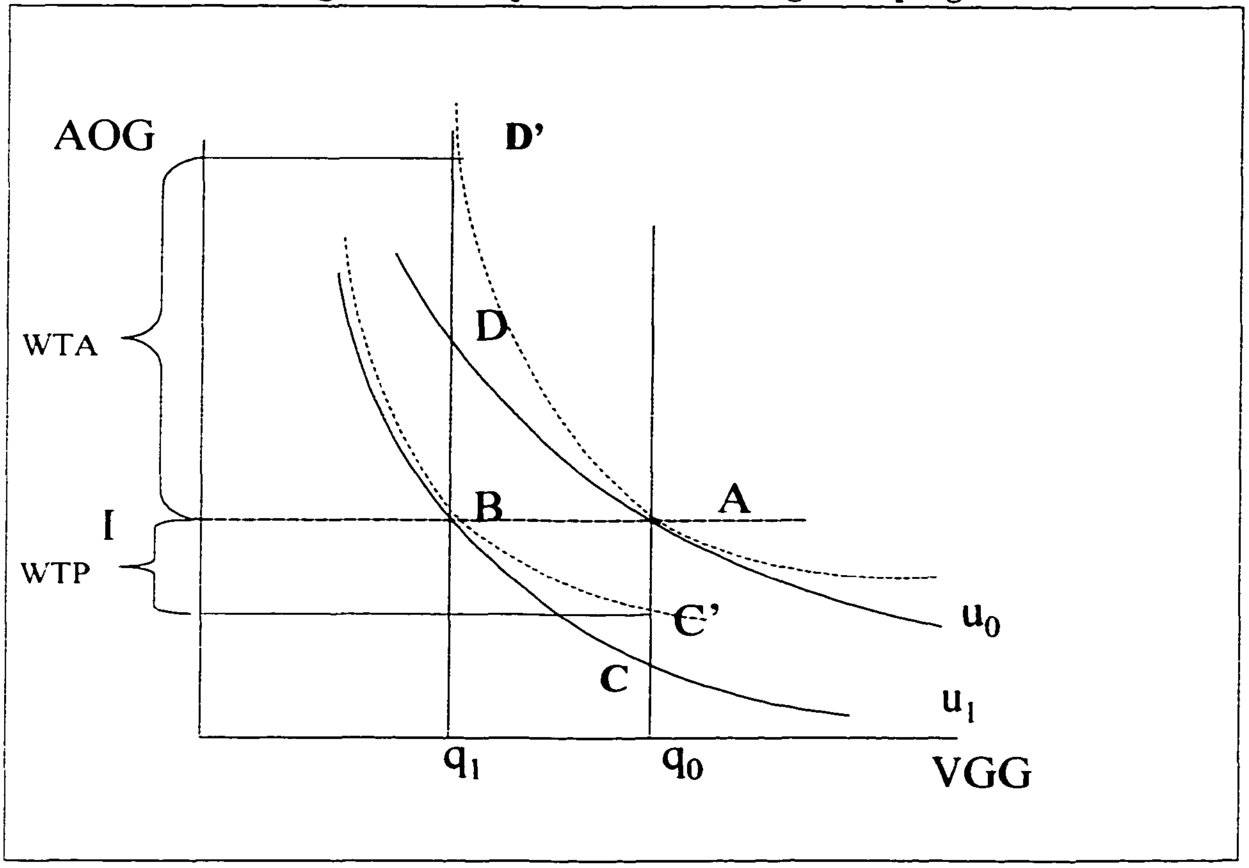
4.4.1.3 The endowment effect

The endowment effect is also referred to as loss aversion and was presented formally as prospect theory by Kahneman and Tversky (1979). The endowment effect explains the difference between WTP and WTA by claiming that individual's value a good more highly once they possess that good. Borrowing from psychological theory. individuals are said to refer to changes around the status quo. Or, individuals value decisions not with their entire utility function in mind, but just in reference to the point at which they are currently consuming. That is, "relative to their status quo (or other reference point). people dislike losses more than they like gains" (Rabin, 1998, p. 11). Here "the utility function is replaced by a value function that evaluates changes in income from the current level. Increases in income are weighted by a relatively small marginal utility. Decreases in income are weighted by a much larger marginal utility" (Coursey et al., 1987, p. 679). This implies that there may be two identifiable value functions that a respondent considers, depending on the way a question is asked (see Knetsch and Sinden. 1984, p. 519).

4.4.1.4 Hanemann's substitution effect

Contrary to the derivation in the first section. Hanemann claims observable differences between WTA and WTP should be expected. In his paper, he demonstrates that for public goods the relationship between WTP and WTA will differ by both income and substitution effects. Further, the substitution effect would be expected to show a larger influence on the difference between WTA and WTP. Hanemann argues that because public goods have only imperfect at best substitutes, differences in the two measures would be expected. Consider figure 4.12, this is a reconsideration of figure 4.11.

Figure 4.12: The Substitution Effect: the difference between Willingness to Pay and Willingness to Accept when considering a unique good.



In figure 4.12 it is assumed that visibility in the Great Gulf is unique and has no close substitutes in all other goods. If this is the case, the initial utility curves in fact look more like the dashed blue curves than the solid curves used in previous explanations. When indifference curves reflect the fact that visibility is in fact a unique good, then it can be seen that willingness to accept would be expected, theoretically, to be larger than willingness to pay.

4.4.1.5 The evidence

As with any debate the evidence has been mixed, and no conclusion has yet been reached. Table 4.3 presents results of some experiments designed to test both the endowment and the substitution effect.

Table 4.3: Selected Experiments Regarding Difference between WTP and WTA

Authors	Experiment	Results
Rowe, D'Arge and Brookshire (1979)	Used a bidding game to illicit WTP and WTA for air quality changes in Four Corners area	Found WTA to be up to five times WTP (Note: this experiment was not designed to test either hypothesis)
Adamowicz, Bhardwaj and Macnab (1993)	Elicit both WTP and WTA from same individuals using movie tickets (open-ended) and tickets to a hockey game (closed-ended)	In second experiment found support for Hanemann's hypothesis however do make allowances that other effects may play a role.
Loehman, Park and Boldt (1994)	Compared WTP to avoid and WTP to obtain (open-ended monthly contributions to a fund) for air quality and health	Found evidence of the endowment effect found bids were consistent with values from an earlier hedonic study
Shogren, Shin, Hayes, and Kliebenstien (1994)	Used several types of goods to test the substitution hypothesis: mugs, candy bars and health risks.	For market goods with close substitutes divergence disappears, with good with no close substitute "the divergence is robust and persistent, even given repeated market participation and full information on the charact-eristics of the good." p. 256
Morrison (1997)	Used chocolate bars and mugs and juniors and seniors to test the endowment effect.	Finds evidence to support Knetsch and dispute significance of Hanemann
Dubourg, Jones-Lee and Loomes. (1994)	Look at imprecise preferences over avoidance of injuries from automobile accidents	Finds support for reference point affect "whereby respondents tend to weight deterioration from the reference level more heavily than improvements." p. 128
Morrison (1998)	Used chocolate bars and mugs and juniors and seniors to test the endowment effect.	Finds evidence to support Knetsch and dispute significance of Hanemann

4.4.1.6 Property Rights

Important in the discussion of willingness to pay or willingness to accept is the assignment of property rights. The choice of methods under which the question is asked can reflect differing assumptions of the assignment of property rights. As argued in Levy et al. (1995) the public (through the government) owns public lands (including designated Wilderness Areas). "Fundamental to the concept of ownership is the right to unfettered enjoyment of property and that persons adversely affecting such rights must cease activities or pay for their interference" (Levy et al., 1995, p. 13).

That is to say, the property rights in this case belong to the visitor to the White Mountain National Forest. Further, under the Clean Air Act and according to the EPA's new haze rules, visual air quality should be returned to natural levels. The measure that is consistent with the placement of property rights is the willingness to accept measure. Levy et al. argue that WTA questions "should provide conceptually correct values for changes in visibility" and that WTP "appears likely to understate the value of visibility improvements" (1995, p. 12). As this dissertation seeks to compare two methodologies for valuing non market goods it is important to use the theoretically correct measure of consumer surplus, as well as the measure which is consistent with the assignment of property rights. In this case, that measure is willingness to accept.

4.4.2 The Use of the Power Bill as a Payment Vehicle

As noted earlier a realistic scenario is important in increasing efficiency of the estimate. Several payment vehicles could have been employed in this case study. Payment vehicles can also be a source of introduced bias or can introduce an unintended negative reaction amongst respondents. Different forms of taxes have often been used as payment vehicles in CV studies, in this case taxes were inappropriate for two reasons. The first was that the survey took place in New Hampshire, a very tax-averse state. Second, degraded visibility in the White Mountains is a true externality, so it seems inappropriate to change the tax rate for those who suffer the burden of the externality (the respondents) rather than those who create it.

Admissions fees have also been used in past studies. In this case poor timing and political considerations were factors in eliminating this from the choice set. In 1998, the White Mountain National Forest took part in a pilot program under instituted a type of entrance fees in the form of a parking sticker. That is, users could still enter the forest freely, but just could not park there for free. As this program was just getting underway and was unfamiliar to many visitors, it seemed that this payment vehicle was inappropriate. Further, the study has been supported by the Appalachian Mountain Club (AMC). The AMC had formed a position on the parking fee (it was against it) and it would have been inconsistent for the survey to then ask a question about a parking or admissions fee.

Finally, what was deemed to be the most realistic scenario was chosen. Electric utility deregulation has been a much-discussed issue in New England recently, and electric power generators do in fact contribute to hazy conditions in the White Mountain National Forest. Further, an increase in fossil fuel based electric generation might be a result of the consumers' choice of cheaper power. It was decided to link these two issues to come up with the payment vehicle. As will be discussed in the following results section, a high price for realism may have been paid.

CHAPTER FIVE

ECONOMETRIC RESULTS

This chapter will present the results of the 1998 valuation survey. The chapter will begin with a comparison of the results of the contingent valuation and the binary choice conjoint analysis model. These two models are directly comparable, so they will be compared side by side. Next, the ratings difference model will be presented and finally the traditional ratings model. Table 5.1 will summarize the models to be estimated and Table 5.2 presents the description of variables for all models:

Table 5.1: Summary of Models to be Estimated for Visibility Valuation

Methodology	Dependent Variable	Independent Variables	Estimation Procedure
Contingent Valuation	Willingness to Accept (WTA) degraded view (Yes = 1, No = 0)	• Income • Electric Bill reduction • Demographic characteristics	Probit
Conjoint Analysis	• Binary Choice Rating B (alternative) > A(status quo) = 1, 0 otherwise	• Same as above	Probit
	• Ratings Difference A (status quo) - B (alternative)	• Same as above	OLS, Tobit
	• Traditional Ratings (0 - 10)	• Same as above and visibility level	OLS

Table 5.2 Description of Variables Used in the Estimation of Models for Visibility Valuation

Variable	Description	Mean	Standard Deviation
Dependent Variable - CVM	0 = rejects a degraded view 1 = accepts a degraded view	0.15306	0.3619
Dependent Variables - CA rating of status quo	rating from 0 to 10 with 10 being totally unacceptable	6.25	3.147183
rating of alternative	rating from 0 to 10 with 10 being totally unacceptable	2.453125	2.965033
rating difference	status quo rating minus alternative (A-B) scale = -10 to 10	-3.71014	3.98195
binary response model	alternative ≥ status quo = Yes (1), 0 otherwise	0.2000	0.4031
Independent Variables - all			
Gender	0 = male	0.35814	0.480572
Electric Bill	respondents average monthly electric bill	57.21652	40.85277
Electric Bill reduction	offered reduction in respondent's bill	9.279817	6.068376
Education	0 = some high school, 1 = completed high school, 2 = college, 3 = graduate school	2.28837	0.736628
Age	in years	38.96279	21.70745
Income	Respondent's annual income (from income blocks)	43702.68	33602.71

The results of both the contingent valuation and binary choice conjoint survey will be presented below. These models are the easiest to compare side by side.

As discussed in chapter four, the respondents of the survey were visitors to the White Mountain National Forest. The survey pool was comprised of individuals who were significantly different from New Hampshire residents.

Table 5.3: Demographic Characteristics Comparison of Survey Respondents and New Hampshire Residents

Characteristic	Census (1990) for New Hampshire	Survey
Age	34.2	38.9
Gender (% male)	49	65
education		
some high school	18	2
high school	52	8
college	23	47
graduate school	7	43
average income (per capita)	$21,522 (in 1998 dollars)	$43.700
58% of survey respondents live in New England		

5.1 Side by Side Comparison

In this section, the results of the contingent valuation and the conjoint analysis survey will be compared. Results of both survey groups will be presented side by side to facilitate comparisons and avoid repetition. The model will attempt to explain the probability of an individual's acceptance of the alternative scenario as described in chapter three. That is, the goal is to predict the likelihood of an individual's acceptance of degraded visibility when compensated by a lower electric bill. Following the discussion from chapter three, it is believed that the offered reduction and demographic characteristics will influence the likelihood of acceptance. More formally:

Probability of Accepting visibility reduction = f (electric bill reduction, income, education, age, gender)

The reduction in the electric bill is expected to have a positive sign. That is, as the compensation increases the individual becomes more likely to accept the degraded view. Further, it is expected that as income increases individuals would be less likely to accept a degraded view. This follows the logic that environmental quality may behave like a luxury good. This logic is central to the debate regarding international trade and environmental degradation. Continuing with this train of thought it would be expected that education would have a negative impact on the probability of acceptance. Here education is acting as a proxy for information about the resource. There is no a priori assumption about the signs of age and gender. Table 5.4 summarizes the expected signs.

Table 5.4: Expected Signs on Coefficients

Variable	Hypothesis	Expected Sign
Reduction in Electric Bill	Individuals would be more likely to accept the degraded view if they were able to enjoy more of other goods.	Positive
Income	As income increase, individuals will be more able to afford goods like visibility.	Negative
Education	As education (information) increases, individuals will be less likely to accept a degraded view.	Negative
Age	No hypothesis	Positive or Negative
Gender	Earlier work had found that men are more likely to label a view as unacceptable, this may indicate that men would be less willing to accept a degraded view.	Positive

For the first set of results, the binary response CA will be compared with the CV model. Recall that in the binary response CA model it is assumed that if the alternative is rated more favorably than the status quo (B>A) then this corresponds with a YES answer in the CV framework. It is worth noting here that the least restrictive assumption in transforming the rating data to a yes/no framework is being made. The most restrictive assumption (and some might argue the only appropriate assumption) would be that only the responses where scenario B was rated as a 10 would be equivalent to a yes. This is due to the wording of the question, a 10 indicates that the scenario is totally acceptable to the respondent, thus resulting in a yes equivalent. For the purposes here however, the least restrictive assumption will be employed. Table 5.5 presents the results of a probit model. The model presented below was estimated using the logs of both the reduction in the electric bill and income, following footnote 2, chapter three. Alternative functional forms were tested and results were similar.

Table 5.5: Comparison between Dichotomous Choice Contingent Valuation and Binary Choice Conjoint Analysis

Variable	Contingent Valuation	Conjoint Analysis
Constant	-5.2714** [2.3998]	4.9392* [2.6280]
reduction in electric bill (log)	0.50483 [0.48615]	-0.36578E-01 [0.19086]
Income (log)	0.34090* [0.21127]	-0.56504** [0.27855]
Gender (male = 1)	-0.51399 [0.36063]	-0.17220 [0.44098]
Education (0=some hs. 1= hs grad. etc.)	0.78711E-01 [0.25022]	-0.27360 [0.31665]
Age	-0.6812E-02 [0.12961E-01]	0.22524E-01 [0.16397E-01]
	N=98. Pseudo $R^2 = 0.06$ Chi-Squared = 5.30	N=66. Pseudo $R^2 = 0.09$ Chi-Squared = 5.97

** indicates significance at the 5% level; * indicates significance at the 10% level.
[Standard deviation in []]

As can be seen. neither model can explain the behavior of the respondents in any satisfactory way. All variables with the exception of income have a coefficient that is not significantly different from zero. thus either the assumption regarding the signs of the coefficients were incorrect or the assumption regarding significance was incorrect. Of interest however is the sign(s) on the income variable, only in the CA model does income have the expected sign. This detracts from our hypothesis that the two models will yield similar results. The different sign on income may indicate that each model is capturing different behavior. That is, income has the opposite effect on a respondent's willingness to accept under the CA framework than under the CV framework. Perhaps there is something happening in the CV question which was not anticipated.

Also of interest, a simple t-test revealed that the means from the two samples were not statistically different from each other. That is, the percentage of yes responses in the contingent valuation sample was not different (statistically) from the number of yes responses in the conjoint sample. This was unexpected as the offered reduction was different for each sample (this was due to an improvement in the computer program during the survey period). Again, this may re-enforce the hypothesis that the two methods yield similar results. Also of interest is the reported chi-squared statistic. This statistic reports the likelihood ratio and is similar to the F-test[13]. In that it tests the hypothesis that all of the slopes of the regression are zero. The reported statistics indicate we fail to reject the null hypothesis, that all slopes in the regression are equal to zero.

Normally at this point, values for changes in the visual range would be estimated. However the poor performance of the model, most specifically the lack of influence of any factor other than income, leaves any reliable estimation of value unattainable. Specifications other than the one used above were also tested with similar results. Other specifications included travel data, change in visitation habits given a change in visibility and dropping the use of logs for the income and reduction variables. It should be noted that the above results do not imply that visitors place zero value on visibility changes. Rather due to the reasons to be discussed in the next chapter, the models were unable to capture respondent's true willingness to accept.

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[13] According to Greene, p. 161, under large sample the distribution of the likelihood ratio test statistic is chi-squared.

Although the comparison between conjoint analysis and contingent valuation did not lead to the expected results, it should be remember that there is additional information to be gained (at least theoretically) from the CA model. In the sections below the ratings difference and the traditional ratings model will be explored.

5.2 Ratings Difference Model

This model has an advantage over the traditional ratings model as it can use the individual's rating on scenario A as a way to center the ratings. In this instance what is relevant is not the numbers given as ratings for scenario A and B. but the difference between the two ratings. Using this method, each response will be centered individually. The model to be estimated is as follows:

Rating Difference (A-B) = f (electric bill reduction, income, demographic characteristics)

Recall scenario A represents the status quo and B represents the degraded visibility and improved electric bill. The results of an ordinary least squares (OLS) regression are shown below.

Table 5.6: Ratings Difference: Ordinary Least Squares

Variable	Coefficient	Standard Deviation
Constant	6.0166	6.1312
Gender	0.34655	1.1097
Education	1.4052*	0.82224
Age	0.38328E-01	0.41638E-01
Income (log)	-1.3858**	0.63074
Reduction in electric bill (log)	0.19634E-01	0.91047E-01

**indicates significance at 5% level; * indicates significance at 10% level
Adjusted R-squared = 0.04716, F-statistic = 1.67

Again, results similar to earlier models are obtained. That is, it appears that the reduction in the electric bill does not have any impact on the ratings difference. Income is negative and significant, which indicates that as the individual's income goes down, the ratings difference increases. This is an unexpected effect. It was assumed that as the individual's income decreases they would find scenario B more attractive (higher monthly income). It is also of note that the binary choice model of conjoint analysis found the expected sign on income. Also of note is the extremely low R-squared. The F statistic indicates that the model as a whole should be rejected $\{Pr > F = 0.15412\}$. The results were similar for other specifications of the model.

The results of the Tobit model can now be explored, with a few qualifications. First, the Tobit is based on the above OLS model. As mentioned above, the F statistic indicates that the OLS model should be rejected and this indicates that any information that the Tobit model yields should be viewed with suspicion. With this in mind:

Table 5.7: Ratings Difference, Tobit Model

Variable	Coefficient	Standard Deviation
Constant	2.2606	8.3607
Gender	-0.94202	1.7824
Education	3.0318*	1.7948
Age	0.55974E-01	0.70943E-01
Income (log)	-1.5146	0.98562
Reduction in electric bill (log)	-0.22693*	0.11645
σ	2.8763**	0.92373

**indicates significance at 5% level; * indicates significance at 10% level
Pseudo $R^2 = 0.03$

As can be seen the reduction in the electric bill is significant in this instance. While this could be cause for celebration, these results should be viewed with skepticism. As pointed out above, this model is based initially on the OLS model in table 5.5. Further, this model seems to be very sensitive to specification. When the reduction in the electric bill is measured in dollars (not logged dollars) the results once again show no statistical significance in the reduction in the electric bill.

5.3 Traditional Ratings Model

Recall from the section above that the traditional ratings model suggests that the rating given by a respondent is a function of the weighted attributes of the good in question and a price (also weighted). Although Tobit and ordered logit are possibilities

Porras (1999) will be followed and this model will be estimated using ordinary least squares. Porras rejects the use ordered of logit as the number of "categories for the data [may cause] a substantial loss in efficiency" (Porras, p. 53). The model to be estimated is therefore:

Rating (0 - 10) = f (log electric bill, log income, education, age, gender, scenario A)

Where scenario A is a dummy variable which is one if the rating is for picture A and 0 if the rating is for picture B. The visibility range in miles or kilometers could also have been used. however as there were only two choices in this survey, a dummy variable was deemed sufficient (results were similar when the values in kilometers were used in estimation). The results are presented in table 5.8 below:

Table 5.8: Traditional Ratings Model (1)

Variable	Coefficient	Standard Deviation
Constant	2.2586	3.4529
Income (log)	0.64640E-01	0.35419
Reduction (log)	-0.18565E-01	0.51127E-01
education	0.50473E-01	0.46172
age	0.74668E-03	0.23381E-01
gender	-1.0234*	0.62313
scenario A	3.7101**	0.52552

**indicates significance at 5% level; *indicates significance at 10% level
Adjusted R-squared = 0.25766; F-statistic = 8.93

Here only gender and the visual range have significant effects on ratings. This follows somewhat with the results presented above, in that the reduction in the electric bill does not seem to have an impact on the rating. The F-test indicates that the null hypothesis, that all coefficients in the model are zero, is rejected. Unlike the results presented above, functional form does seem to play a role in the results. If the reduction on the electric bill is left in dollars and is not logged the following results:

Table 5.9: Traditional Ratings Model (2)

Variable	Coefficient	Standard Deviation
Constant	2.1584	3.4125
Income (log)	0.12909	0.35232
Reduction	-0.40839E-01*	0.24564E-01
education	0.62337E-01	0.45715
age	-0.20764E-02	0.23000E-01
gender	-0.98028*	0.58703
scenario A	3.7101**	0.52033

**indicates significance at 5% level; *indicates significance at 10% level
Adjusted R-squared = 0.27227; F- statistic = 9.81

With this model an improvement in the R-squared is found (and in both models the F test indicates a failure to reject the model as a whole). Implicit prices are also estimated according to equation 13 from chapter three. The implicit price is $90.93 per month for the total change in visibility or $0.80/kilometer per month. This high implicit price may shed some light onto the lack of yes responses in the binary response and CV models. This will be discussed further in the next chapter.

5.4 Pooled Data

For reasons discussed above estimates of value for changes in visibility in the White Mountain National Forest were not obtained. However, the original objective was to look for differences between the CV and CA models. In an earlier section, it was noted that the different models gave different signs on the coefficient on income. Another way to test for differences is to pool the data. In this case, the model presented in section 5.1 will be revisited, however a dummy variable will be added. The dummy variable will indicate if the observation came from the CV data pool or the CA data pool. The dummy variable is equal to one if the observation is from the CV data pool:

Probability of Accepting visibility reduction = f (electric bill reduction, income, education, age, gender, Dummy)

The results of a logit model are presented below:

Table 5.10: Pooled Model

Variable	Coefficient	Standard Deviation
Constant	-0.75127	2.1166
Income (log)	-0.58504E-01	0.26099
Reduction (log)	-0.34133E-01	0.28884
education	-0.16093	0.32897
age	0.99083E-02	0.16434E-01
gender	-0.45098	0.47165
Dummy (CV = 1, CJ = 0)	-0.26966	0.43648

*indicates significance at 5% level; **indicates significance at 10% level
Pseudo $R^2 = 0.02$; chi-squared = 1.99

Interestingly, the coefficient on the dummy variable is not statistically different from zero. This was expected however, it is inconsistent with the earlier observation that the binary choice CA and dichotomous choice CV gave differing signs on the income variable. Also it should be noted in this model that no variable was significant. This result held true with various functional forms of the model. This is puzzling, again referring back to the results shown in earlier models. Although earlier models did not perform as expected, some variables did have an influence on an individual's willingness to accept compensation for degraded visibility. In this instance, none of the variables had any influence on an individual's willingness to accept compensation. As will be discussed in the following chapter this leaves one wondering what can be inferred from this conflicting evidence.

5.5 Discussion of Results

The results presented above certainly did not provide the anticipated information; however, they did yield many interesting insights. Given the results, no statistical difference can be determined between contingent valuation and conjoint analysis can be discussed. The choice of the willingness to accept measure coupled with the choice of the electric utility bill may have confounded our ability to measure people's value of visibility. This, along with the insights that were gained in the process will be discussed in this section.

There are several possible reasons for the lack of explanatory power in the models presented. One possible reason could be sample bias. As stated earlier, the survey was conducted at a major trailhead/ visitor center in the White Mountain National Forest. Simply by their presence at this location it may be inferred that the respondents will have a high valuation for visibility[14]. Certainly, one of the main features of the White Mountain National Forest is the presence of scenic vistas and overlooks. It is possible that this group is not willing to make a trade-off regarding a change in visibility.

A second (and related) possible explanation is limitations within the payment vehicle. The electric bill made up at the maximum 5.8% of a respondent's income, and on average 3.3%. It may not be possible to offer a reduction sufficient to induce respondents to make this trade off. Conventional wisdom puts the savings due to deregulation at 20%. The on-site survey used this figure as a basis for reductions offered. As discussed earlier the electric bill was chosen as a payment vehicle in part due to its realism. It could in fact be this realism that hindered our ability to get results. Consider the figure below. This illustrates the hypothesized relationship between the probability of acceptance of the offer and the reduction offered.

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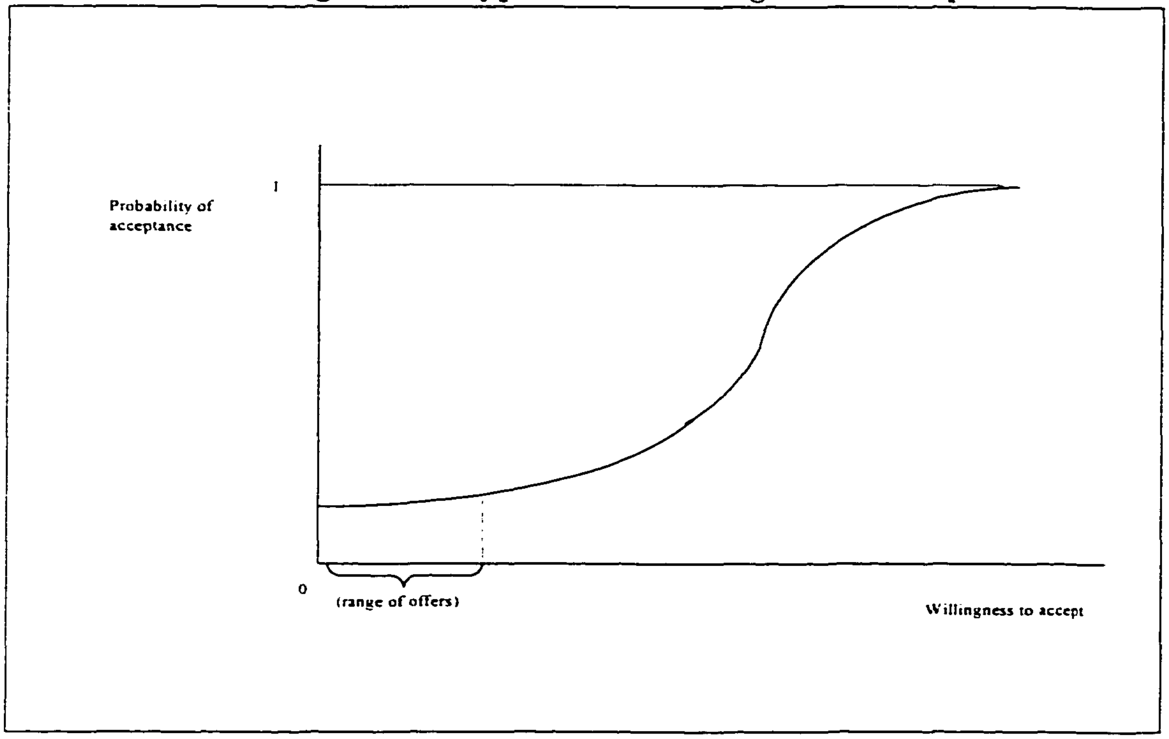
[14] However, it should not be assumed that this group is not willing to make trade-offs regarding environmental quality. For example, this might be seen by the large collection of SUV's located in the visitor center parking lot.

Figure 5.1: Hypothesized Willingness to Accept



As can be seen, in the range of reductions actually offered in the survey the slope of the willingness to accept function is almost zero, however this should not be interpreted as zero willingness to pay. It could simply mean that the data collected was not able to measure enough of the willingness to pay function to make a reliable estimate of true willingness to pay.

It should also be mentioned here that some researchers (Porras 1999) feel that there is a joint product issue at work here. That is, when individuals are considering the trade-off between visibility and a lower electric bill, they are also considering human or ecological health effects. This additional impact of visibility reduction (a perceived change in health outcomes) was not modeled in this research. This possibility will be discussed in the next chapter.

Finally, it may be of use to examine the use of the willingness to accept measure; this will be more thoroughly discussed in the next chapter. It is worth noting here that the willingness to accept measure is not limited by income and the offered reduction (or the WTA measure) was limited not only by income but also by the respondents electric bill. Thus the results seen here may be due to an inconsistency in survey design.

Turning our attention to the insights gained, the comparison of the two models (table 5.5) pointed out some interesting differences. In both the dichotomous choice CV and binary choice CA, only two variables were statistically significant. Interestingly, the variables had different signs in each model. The first variable was the intercept term. The second and more interesting variable was the income variable. In the CA model income was significant and of the hypothesized sign. In the CV model income was significant and of the opposite sign. This would indicate that different behavior is being captured in each model. this affords some insight into empirical differences between the two models.

The first ratings difference model provided an interpretation consistent with the binary choice CA model. Education becomes significant and positive in the ratings difference model. That is, as education levels increase, the gap between the rating of scenario A and scenario B increases (or scenario A is rated more highly that scenario B). It is unclear how this could be interpreted. If education acts as a proxy for awareness and information regarding environmental issues, it is possible that as awareness increases respondents are less likely to find the alternative scenario attractive. Or, the more one knows the more highly one values the environment. Again, referring to the debate regarding environmental effects from increased international trade, it is observed that countries with higher education levels and incomes "purchase" more environmental protection (see Bhagwati (1994) for example). This story is consistent with the results shown here.

Gender is statistically significant in the traditional ratings model and indicated that women rated each scenario lower (that is, less favorably) than men did. Income was not significant in this model.

Perhaps the most intriguing result comes from the pooled model. This model was designed as a yes/no model. In this model, *none* of the variables were significant and this was consistent across specifications. Importantly, the coefficient on the dummy variable indicating whether the observation was from the CV or CA survey was not statistically different from zero. This indicates that the format (CV or CA) does not influence the acceptance of degraded visibility. This does present a bit of a puzzle when thinking about this result and the differing signs on income in the comparison between dichotomous choice CV and binary choice CA. The next chapter will attempt to provide insights into this puzzle.

CHAPTER SIX

CONCLUSIONS

This chapter will provide a summary and further discussion of the implications of the results presented in the previous chapter. It will also summarize other related research, and provide suggestions for future research. Finally, conclusions and final comments will be presented.

6.1 Summary

The primary objective of this dissertation was to provide a comparison of two direct valuation methods. Chapter three provided a theoretical comparison and chapter five presented the results of the comparison based on an on-site survey in the White Mountain National Forest. The survey was constructed so as to have a similar response pool for each group. The results presented from chapter five, while unable to answer the primary question about the valuation of visibility did point out some of the important advantages and disadvantages of the two methods.

While the contingent valuation method yielded only yes or no answers, the conjoint question yielded a much richer data set. As discussed in earlier chapters the answers to the conjoint question can be manipulated in a series of ways, through the traditional ratings model, ratings difference or converting into a "yes/no" format. While in this case additional information was not gained, due to the issues which will be discussed below, one could easily argue that the conjoint question would yield information not gained by the contingent valuation question.

There are some differences inherent in the two methods that may pose difficulties for later experiments. In the case presented here, the use of a conjoint question was warranted as two different realistic choices could be offered. In the case of the payment vehicle, two scenarios were presented which would be two choices that the respondent might face in the "real world." That is, the respondent might be faced with the ability to choose a power provider which results in a lower electric bill, further this cheaper power may have environmental consequences. In a situation where the respondent is faced with a government policy, in which he is able to accept or reject the policy based on the assumed outcomes then conjoint may not be the appropriate method as one can only say yes or no to the policy not rate the policy on a scale of 1 to 10. Clearly, setting up the experiment to contrast conjoint analysis and contingent valuation may result in some weaknesses for both methods. Conjoint analysis is designed to examine multi-attribute goods where as contingent valuation is designed to examine changes in a single attribute. Conjoint may prove to be a more adaptable methodology for both multi- and single attribute goods. Clearly more work is needed in this area.

Choices made in survey design that were critical in the results have been defended in previous chapters but are worth a review here. The choice of the willingness to accept measure may be strongly criticized but should be just as strongly defended, as it is the theoretically correct measure as demonstrated chapter three. When testing two different methods one should not allow a risk of an empirical irregularity win out over considerations of theory. That is, the test must match the theory. Further, in this instance, (in that a non-market good is being examined) it would be expected that Hanemann's hypothesis would hold. That is, the Great Gulf Wilderness is a strictly unique good. It would thus be expected that the willingness to accept measure to be larger than the willingness to pay measure (which was the result in this case, in that willingness to accept was so large that it was not measurable by the survey described here). However, due to the assumption of property rights, this is in fact the appropriate measure. In order to carry out a convincing test of the two methods, the willingness to accept measure is the appropriate measure, despite the controversy and supposed empirical irregularities surrounding willingness to accept.

The choice of the electric bill as a payment vehicle should also be reviewed here. As discussed earlier this was the least problematic of the variety of payment vehicles available and there is some history of the electric bill as a payment vehicle in earlier air quality studies (see Randall et al., (1974) and Schulze et al., (1983) as examples). As reviewed earlier the electric bill was too realistic in that it was limited while the willingness to accept value is not. The electric bill reduction, which is limited narrowly by the actual electric bill and more broadly by a respondent's income, could not have been large enough to measure the true willingness to accept, which is not limited by income (refer to figure 4.13). To clarify, the offer to the respondent could realistically be (at most) the value of the respondent's electric bill. The offer, or proxy for willingness to accept, is thus limited by the respondent's electric bill. However, the respondent's true willingness to accept is not limited in this way. If the respondent is considering the value of degraded visibility, she is unlimited in the amount she may choose and in fact she may consider visibility to be of a higher value than her electric bill. This problem is exaggerated in a situation with a unique good (again refer to figure 4.13).

As can be seen in the traditional ratings results, respondents valued clean air at $0.80/kilometers per month or approximately $90 for the entire proposed change in the visual range. If this were translated into a twenty- percent electric bill reduction (the amount used in the survey), the respondent's electric bill would have to be $450.00 per month. And given that the electric bill made up at most 5.5 percent of respondent's income, this would translate into a yearly income of approximately $100,000, a figure which is well above the average income of $43,700 reported in the survey.

This result is unfortunate, however it was still the most appropriate choice given the nature of the problem. Further, when offering respondents two scenarios it is important to keep these scenarios realistic to garner meaningful responses. Given the political climate in the study site, taxes, entrance fees and emissions fees would have generated an unacceptable level of protest behavior.

6.1.1 Objectives

The primary objective of this dissertation was to compare and contrast, empirically and theoretically, two methods of valuation for non-market commodities such as visibility. Insight as to which (if either) might be the more appropriate technique to address the problem at hand will be provided. This dissertation was successful in theoretically contrasting the two methods. The theoretical discussion demonstrated that the two methods should produce theoretically consistent results, particularly between the ratings difference conjoint analysis model and the dichotomous choice contingent valuation model.

The empirical comparison proved to be more difficult however. Due to reasons discussed previously no solid conclusions could be drawn about any differences between the two methods. The results offer no statistical evidence of difference between the two models. Adjustments to the survey design in future research may lead to insights between the empirical similarities or differences between the two methods.

Even though direct empirical support was not found to support the theoretical claim that the two methods will produce similar results, this research did yield some interesting insights. These insights are discussed in the concluding section. The next section discusses other research that was undertaken to investigate the same issue discussed here.

6.2 Other Concurrent Research

This study has not been the only research conducted using this subject. The University of Massachusetts - Amherst (UMass) has conducted both a person to person and a mail survey. This study was more successful in reporting results and discovering statistically significant relationships between the dependent and independent variables that the study discussed here. Using the traditional ratings model, the UMass study found an implicit price of $2.25 per mile for the person to person survey and $0.648 per mile for the mail survey. Converting to kilometers, $1.40 per kilometer and $0.40 per kilometer respectively, it is seen that the per kilometer values obtained in the White

Mountains are roughly in the middle of the off-site values. The off-site mail survey found that a compensation of $100 to $120 per month was required for the average respondent to accept a degraded view (Porras, 1999, p 93). This supports the hypothesis posited earlier regarding the limitations of the payment vehicle. This is a large offer to be made particularity in light of the size of the average respondent's electric bill. The off site study concluded that "in general, many respondents are not willing to make trade-offs between electric bill and visibility at the White Mountains of New Hampshire" (Porras, 1999, p. 94).

An interesting feature of the UMass study was the discussion of the joint product issue. Porras argues that respondents were not considering only changes in visibility when responding to survey questions as they were instructed. Rather they were considering health or ecological effects in addition to the changes in the visual range. Before concluding that these issues were apparent in the on site survey as well, recall that in the on site survey respondents were shown several photographs and answered questions which asked specifically about visibility. It is assumed that the respondents would have followed instructions and only considered visibility when they arrived at the valuation question. If this is the case however, an argument for the conjoint method as the appropriate method to value visibility may be strengthened. If respondents cannot separate visibility from health effects in their minds, then researchers should ask questions specifically to separate them. That is, the health effects and ecological effects should be brought in as other attributes. As mentioned earlier, conjoint analysis may be the method best suited to this.

6.3 Suggestions for Future Research

The research presented and discussed here is part of a larger on going project which, of course, should be continued. This is an important line of research in that it seeks to improve the selection of methodologies for valuing environmental amenities. As the United States grows richer, more resources will become available which can be spent on environmental protection and clean up. And as the man-made world further encroaches on the natural world there will be more opportunities to spend our growing wealth on environmental protection. The question becomes how can the resources be best allocated to protect the natural world from the impacts of human economic activity? For an answer to such a question to be found, different valuation methodologies must be examined and the appropriate or best methodology should be determined for a variety of situations. Therefore, despite the discouraging results presented here this research should continue. On going research includes the study above as well as a limited on-site study using a willingness to pay to avoid format, carried out during the summer of 1999. Due to the uniqueness of the good in question as well as the limits to the willingness to pay format (that is, WTP is limited by the respondent's income), differences would be expected.

Future research should include other mail surveys to increase the pool of data. Different locations should also be investigated; these locations should have similar air quality issues as those found in the White Mountain National Forest. This way comparisons can be made between the various studies. Further, different payment vehicles should be explored. The sensitivity to the depth of the vista used might also be tested as well as sensitivity to the composition and contrast of the scene.

If the willingness to accept measure continues to be used, a payment vehicle which is also without limits, or at least has fewer limitations as to value than the electric bill should be investigated. Finally, the use of the willingness to accept measure itself must be addressed. It is of the utmost importance to use the method that is theoretically consistent with the assignment of property rights. It may be possible to explore an area where the public does not hold property rights and then employ the willingness to pay measure. However, it may be more worthwhile to first examine the perception regarding property rights and federal land. In this study the willingness to accept measure was chosen and it was assumed that the public was aware that the government acted in their interest as property owners. This may not prove to be an accurate assumption however. Investigation of the perception of ownership would be an important element to the future selection of the willingness to pay or willingness to accept format. If the general public or visitors to public lands do not perceive themselves to be owners or perceive the property rights to be unclear then the selection of willingness to pay or willingness to accept may be made according to other criteria.

6.4 Conclusions

While this dissertation did not meet the stated goal of discovering which valuation methodology was better suited for valuing visibility changes in the White Mountain National Forest, several important points were brought out. First was the apparent unwillingness of respondents to make trade-offs regarding visual air quality. This indicates that respondents do place a high value, certainly higher than this study was able to capture, on visibility in the White Mountain National Forest. This is important information considering recent events, such as electric utility deregulation and the court battle over the EPA's new haze rules. Second, this study did illustrate one of the advantages of the conjoint analysis method. That is, information was gained in this instance through the use of the traditional ratings model whereas little information was gained from the contingent valuation method. Third, this study highlighted the importance of the selection of a payment vehicle as well as the choice between the willingness to pay and willingness to accept formats.

Although no definitive answers can be given regarding the appropriateness of one method over another, insights were presented which should inform and direct future research in this area. It does appear that the conjoint method may have advantages in the valuation of visibility in the White Mountain National Forest.

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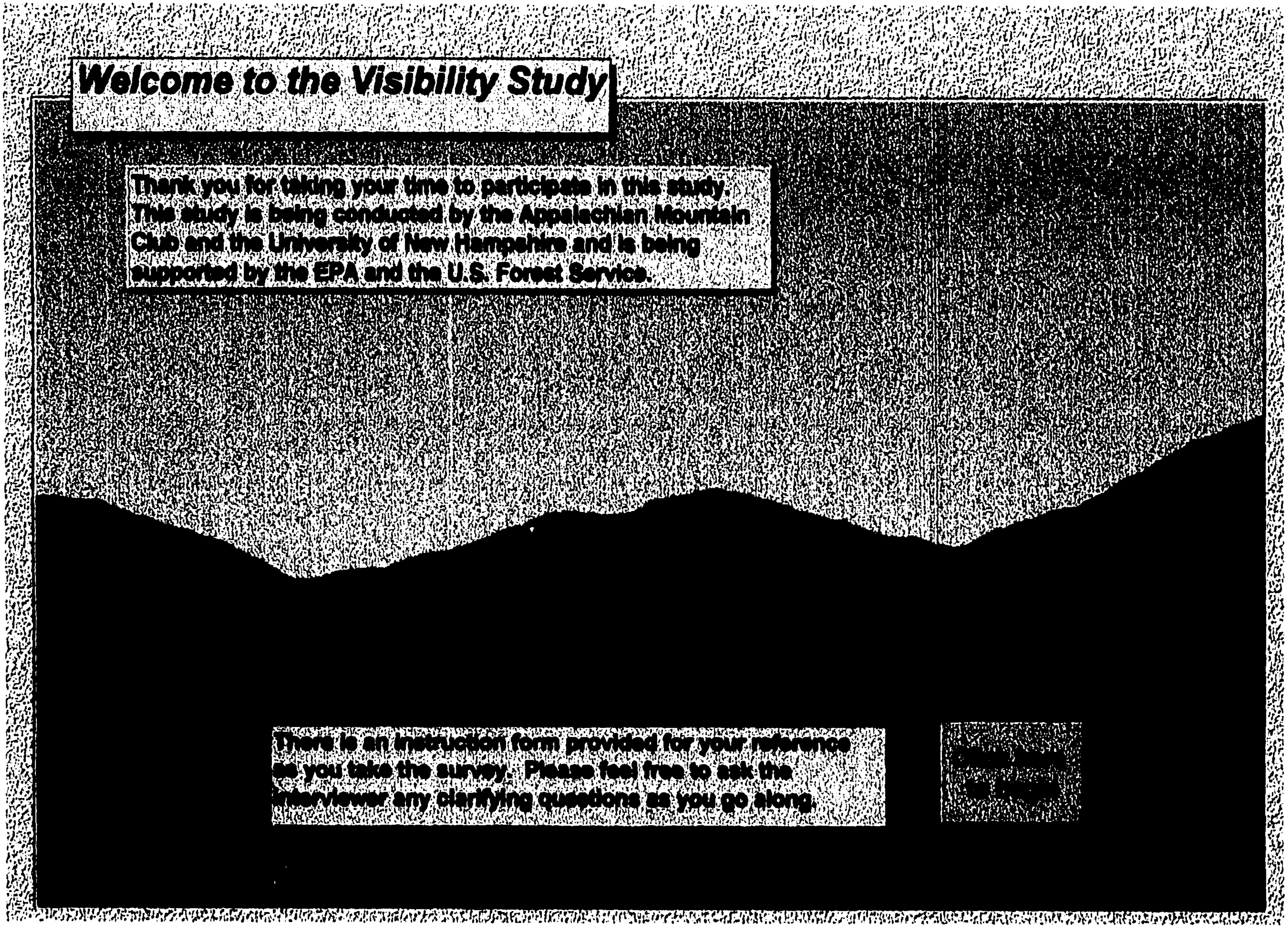
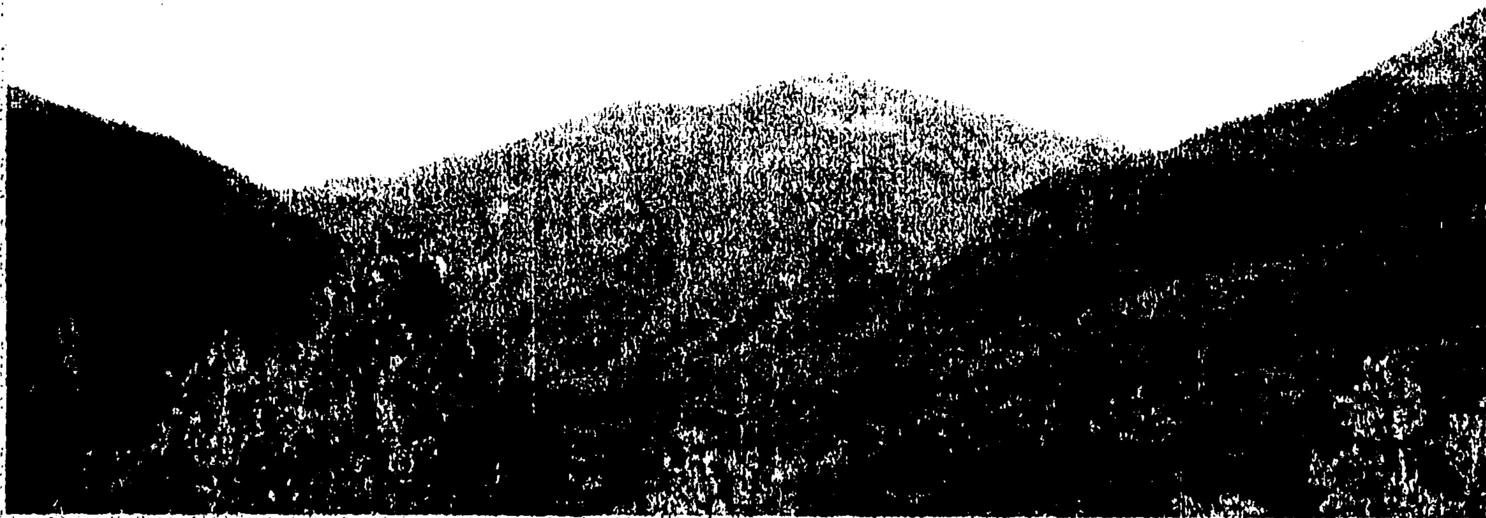
APPENDICES


Welcome to the Visibility Study
Thank you for taking your time to participate in this study. This study is being conducted by the Appalachian Mountain Club and the University of New Hampshire and is being supported by the EPA and the U.S. Forest Service.
There is an instruction form provided for your reference as you take the survey. Please feel free to ask the interviewer any clarifying questions as you go along.

Section One

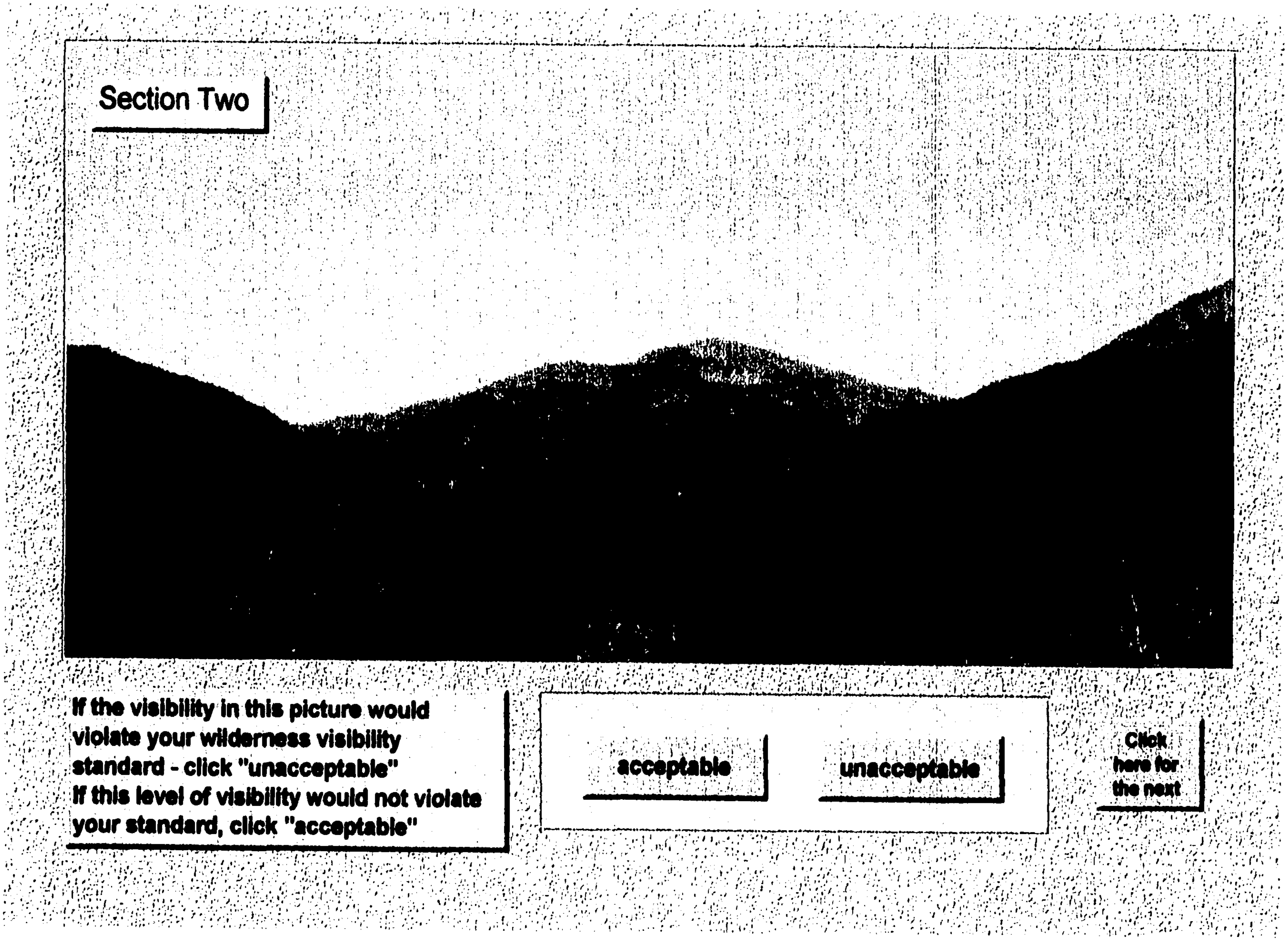


Please enter your survey number here -0

Please rate the photo above from one to five based on how much haze you see. 1 is very clear and 5 is very hazy.

one **two** **three** **four** **five**

Click here for the next photo


Section Two
If the visibility in this picture would violate your wilderness visibility standard - click "unacceptable"
If this level of visibility would not violate your standard, click "acceptable"
acceptable
unacceptable
Click here for the next

Section Three

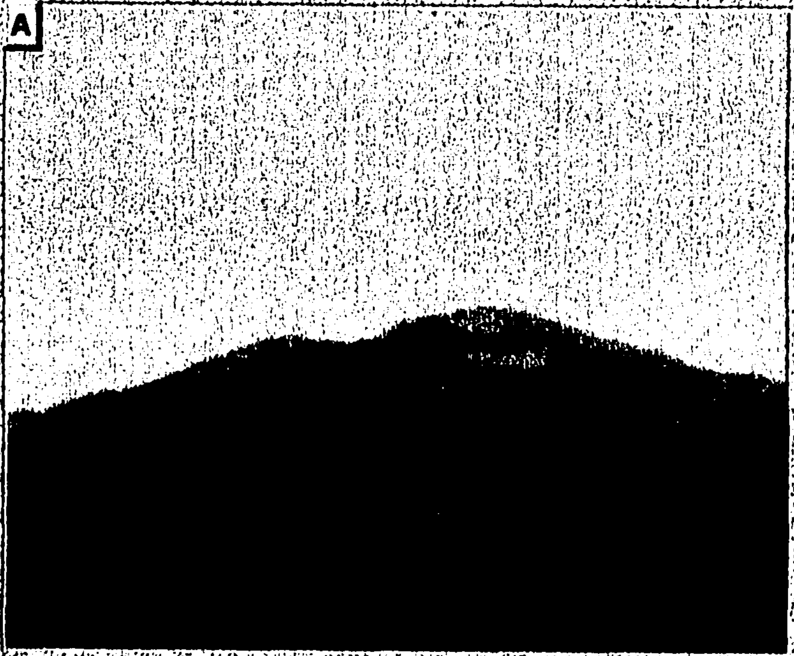
Please enter your survey number here 22222

Please enter your estimated monthly electric bill $22.00

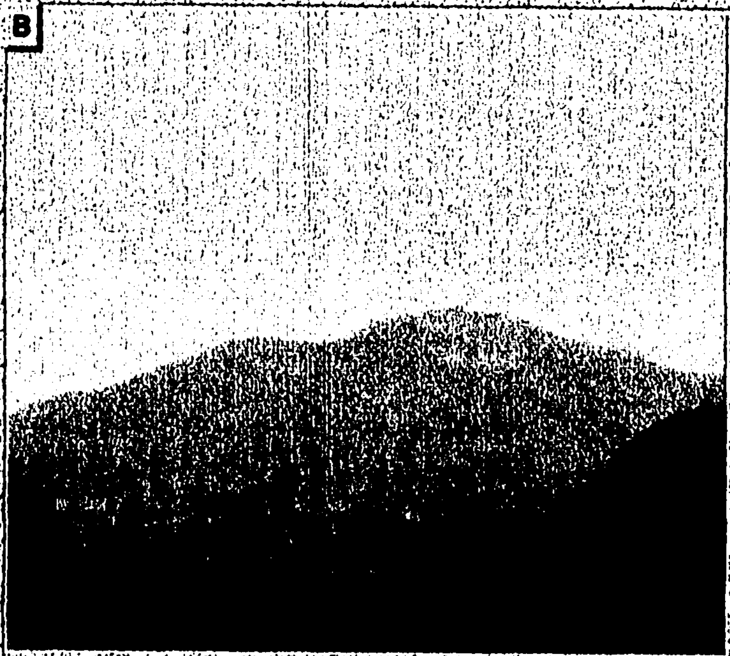
For the next question, consider the following: Currently, many states are debating the issue of deregulation in the electric utility industry. If deregulation occurs in your state, you may be able to choose your own power provider. Assume for the purposes of this question that cheaper power (that is, less than what you currently pay) is available through a mid-western power company. Further, this power company produces electricity by burning coal. Increased demand for this company's cheaper power will contribute to air pollution and poor visibility in the White Mountains.

Click here to continue

A



B



Now suppose picture A represents the level of visibility most often experienced in this region during the summer months. Further suppose that you were faced with a situation where the visibility level would change to that in picture B. The purposes of this question, assume that visibility would change ONLY in the White Mountain National Forest.

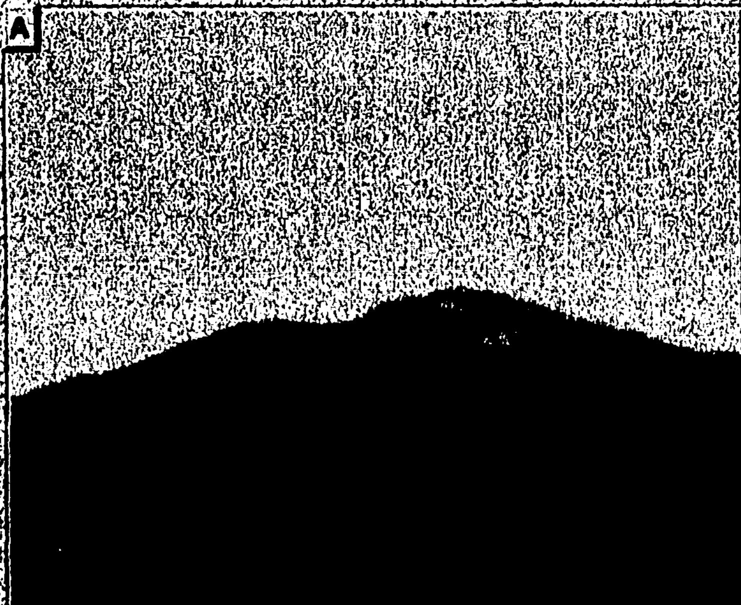
Would you be willing to accept this new level of visibility (indicated by picture B) in the White Mountain National Forest if your monthly electric bills were redu #Name? $?

yes

no

Click here for the next section

A



B

Now suppose picture A represents the level of visibility most often experienced in this region during the summer months. Further suppose that you were faced with a situation where the visibility level would change to that in picture B. The purposes of this question, assume that visibility would change ONLY in the White Mountain National Forest.

How would you rate the situation in photograph A on a scale of 0 to 10, with 0 being totally unacceptable and 10 indicating that you would definitely be willing to accept this level of visibility along with no change in your monthly electric bill? 0

How would you rate the situation in photograph B on a scale of 0 to 10, with 0 being totally unacceptable and 10 indicating that you would definitely be willing to accept this level of visibility along with $10.00 decrease in your monthly electric bill? 0

Section four - Travel Information

Please enter your survey number here 0

Approximately how many miles did you travel to reach the White Mountains? 1

Are the White Mountains your primary travel destination?
- ○ yes
- ○ no

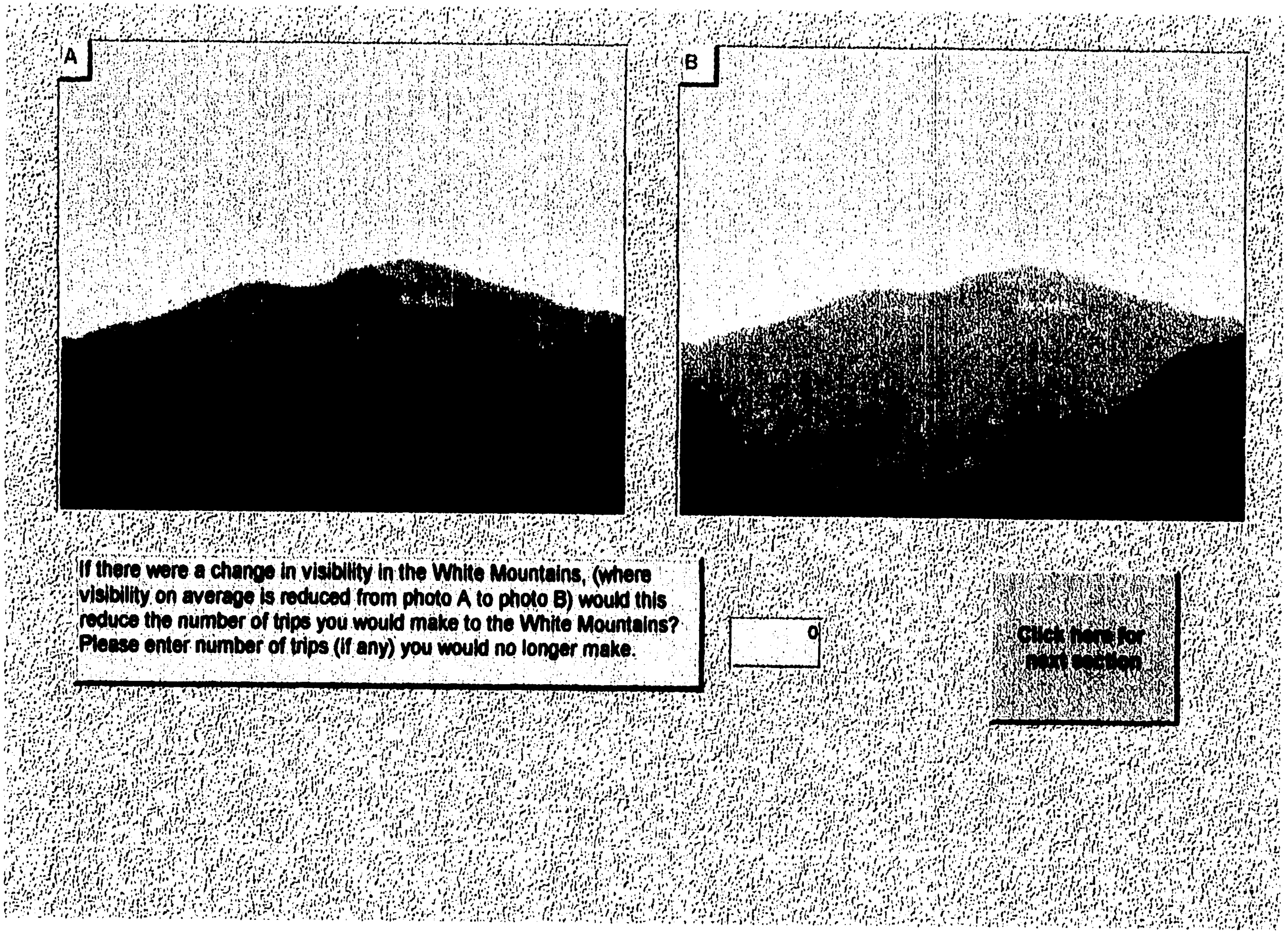
How many trips do you plan to make to the White Mountains this year? (please include trips you've already made as well) 0

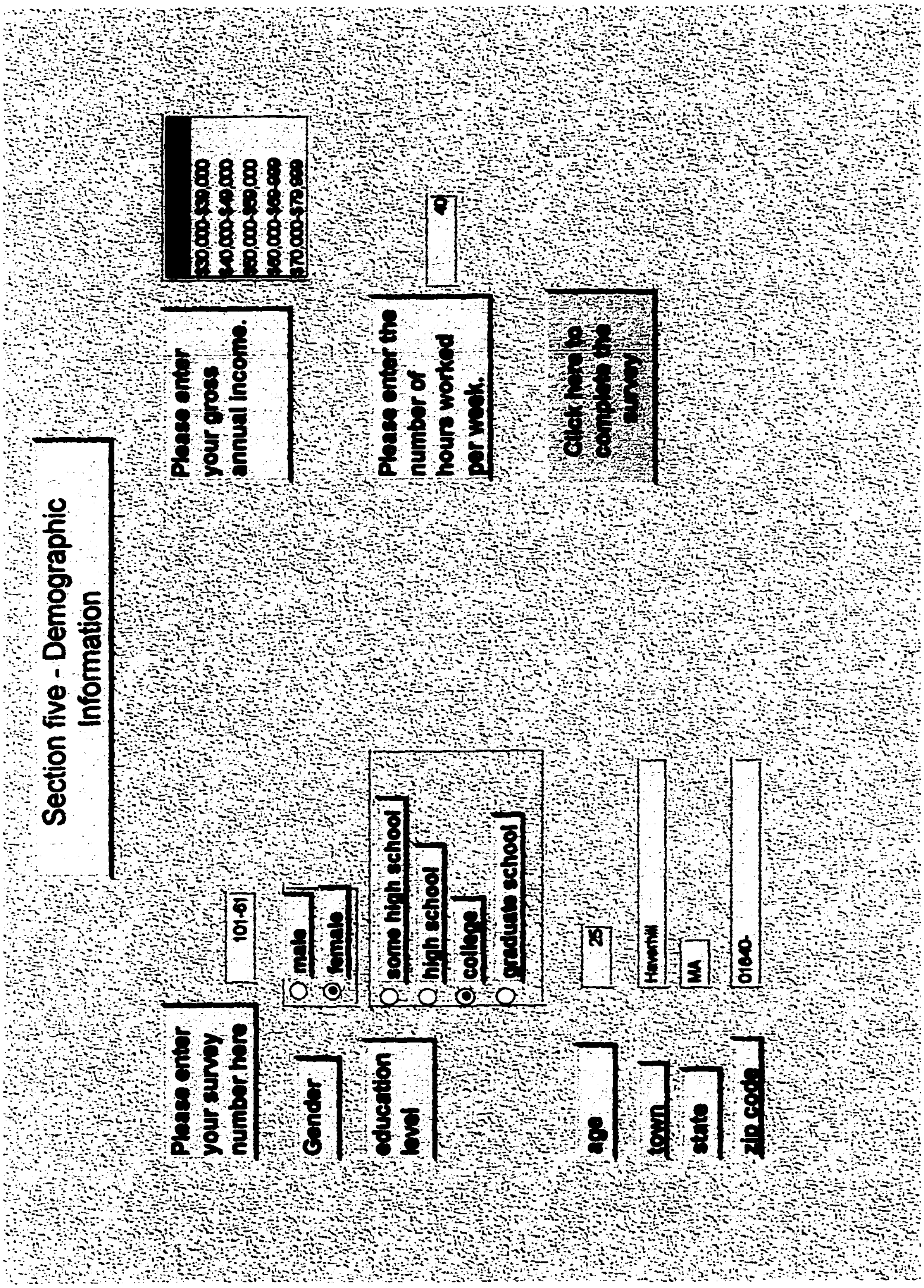
Approximately how much money do you spend per trip on travel?(gas, rental car, tolls, etc.) $0.00

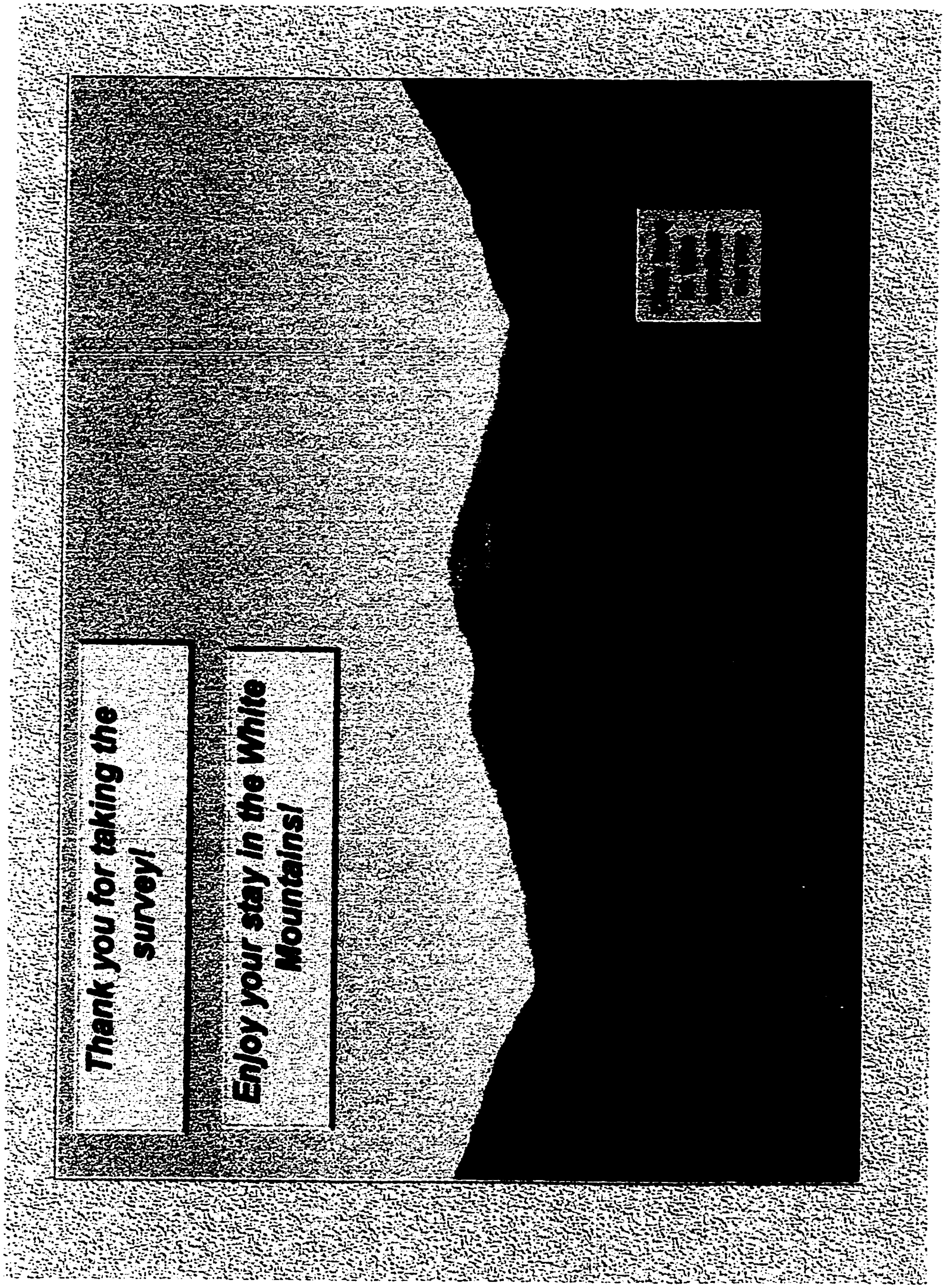
Approximately how much money do you spend per trip on lodging?(campsite fees, hotel, hut, etc.) $0.00

Approximately how much money do you spend per trip on food? (meals and snacks) $0.00

Click here for the next section


A
B
If there were a change in visibility in the White Mountains, (where visibility on average is reduced from photo A to photo B) would this reduce the number of trips you would make to the White Mountains? Please enter number of trips (if any) you would no longer make.
0
Click here for next section


Section five - Demographic Information
Please enter your survey number here
101-61
Gender
male
female
education level
some high school
high school
college
graduate school
age
25
town
Haverhill
state
MA
zip code
01840-
Please enter your gross annual income.
$30,000-$39,000
$40,000-$49,000
$50,000-$59,000
$60,000-$69,999
$70,000-$79,999
Please enter the number of hours worked per week.
40
Click here to complete the survey


Thank you for taking the survey!
Enjoy your stay in the White Mountains!

UNIVERSITY OF NEW HAMPSHIRE

Office of Sponsored Research
Service Building
51 College Road
Durham, New Hampshire 03824-3585
(603) 862-3564 FAX

LAST NAME	Halstead	FIRST NAME	John
DEPT	Resource Economics and Development	APP'L DATE	1/27/97
OFF-CAMPUS ADDRESS (if applicable)		IRB #	Assurance Copy
		REVIEW LEVEL	EXE
PROJECT TITLE	Comparison of Direct Methods for Evaluation of Environmental Policy		

The Institutional Review Board for the Protection of Human Subjects in Research has reviewed the protocol for your project as Exempt as described in Federal Regulations 45 CFR 46, Subsection 46.101 (b) (2), category 2 .

Approval is granted to conduct the project as described in your protocol. Changes in your protocol must be submitted to the IRB for review and approval prior to their implementation.

The protection of human subjects in your study is an ongoing process for which you hold primary responsibility. In receiving IRB approval for your protocol, you agree to conduct the project in accordance with the ethical principles and guidelines for the protection of human subjects in research, as described in the Belmont Report. The full text of the Belmont Report is available on the OSR information server at http://www.unh.edu/osr/compliance/belmont.html and by request from the Office of Sponsored Research.

There is no obligation for you to provide a report to the IRB upon project completion unless you experience any unusual or unanticipated results with regard to the participation of human subjects. Please report such events to this office promptly as they occur.

If you have questions or concerns about your project or this approval, please feel free to contact me directly at 862-2003. Please refer to the IRB # above in all correspondence related to this project. The IRB wishes you success with your research.

For the IRB,

Kara L. Eddy, MBA
Manager, Regulatory Compliance

cc: File
Wendy Harper - Graduate Student Research Assistant