PUBLIC PERCEPTIONS OF CLIMATE CHANGE: A 'WILLINGNESS TO PAY' ASSESSMENT

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Abstract. In this paper, we examine for a sample of Los Angeles residents their willingness to pay to prevent significant climate change. We employ a fractional factorial design in which various climate change scenarios differing in ways consistent with existing variation in climate are presented to respondents. These are contrasted to respondents' current climate before willingness to pay is elicited. Thus, the focus is on climate change as it may be experienced locally. We also try to determine the kinds of value that are driving respondents' concerns. Among the key findings are that for these respondents, climate change leading to warmer local temperatures is a greater worry than climate change leading to colder local temperatures. In addition, climate change leading to less precipitation locally is of more concern that climate change leading to more precipitation locally. Finally, use value may be the most important kind of value, but a more cautious interpretation is that respondents are not yet able to clearly distinguish between different climate change consequences.

1. Introduction

There is a widespread belief that sound environmental policy requires assessments of the most relevant tradeoffs. Often those tradeoffs are considered at least partly in economic terms. Consequently, the economic value of various environmental 'goods' is frequently required.

The past two decades has seen remarkable growth in studies attempting to place a value on environmental goods of various kinds. Among the topics addressed have been the protection of water fowl (Hammack and Brown, 1974), improved visibility in the Southwest (Randall et al., 1974), air quality (Harrison and Rubinfeld, 1978), clean drinking water (Carson et al., 1993), and environmental assets more generally (Willis and Benson, 1993). Perhaps the most visible and controversial effort, however, has been the attempt by a group of economists and ecologists to place an overall value of the earth's 'ecosystem services' (Roush, 1997).

There has been a parallel literature on methods to undertake such valuations. Some are primarily focused on theoretical issues (Mitchell and Carson, 1989, pp. 17–53), some on the tradeoffs between different valuation methods (Cropper and Oates, 1992) and some on problems with particular empirical approaches (National Oceanic and Atmospheric Administration (NOAA) Panel, 1993; Portney, 1994; Hausman, 1993; Diamond and Hausman, 1994; Hanemann, 1994). In each case,

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the research reflects a need to develop 'instruments' by which value can be properly measured.

Within both literatures, there are a small but increasing number of studies on global climate change. As far as we have been able to determine, the studies that address the economic tradeoffs in climate change have generally been of two varieties. The first kind builds on existing macroeconomic models that include equations for energy use and makes modest alterations to allow for various kinds of policy changes such as carbon taxes (Nordhaus, 1993; Kolstad, 1993). Entire national or regional economies are modeled. The second kind focuses on particular environmental or production assets such as land values (Yohe et al., 1996), agriculture (Adams et al., 1995), or forests (Nilsson, 1995) and attempts to link climate change to variation in value.

As important as this work on climate may be, it ignores public perceptions of the value of the current climate. Insofar as the public will be involved in the policy decisions surrounding climate change, it would seem to be important to have sound measures of what the public thinks about such matters. Expert assessments would seem to be insufficient. In this light, there has been to our knowledge only one published study on the public valuations of climate. In 1995, Berk and Schulman reported findings from a factorial survey undertaken in Southern California in which the public 'willingness to pay' was estimated as a function of various characteristics of local climate: for temperature and rainfall, differences in the average, the variability, the extremes, and the clustering of extremes. Respondents were presented with sets of hypothetical climate scenarios, assembled in a factorial experimental design, and asked for their willingness to pay to prevent that climate scenario from materializing. Among the major findings were:

1. Respondents were able to make sense of relatively complicated climate scenarios.
2. Respondents provided reasonable figures for the amounts they were willing to pay and in the aggregate, produced the expected downward sloping demand curve.
3. Respondents were much more responsive to changes in temperature than changes in precipitation.
4. Respondents were more responsive to changes in the average temperature, than any of the other three dimensions of temperature change (i.e., variability, extremes, clustering of extremes).
5. It took very large changes in climate from a scientific point of view to generate even modest changes in willingness to pay.
6. Respondents seemed most concerned about climate 'use value' rather than such things as 'existence value'.
7. Valuation of future climate change depended in part on the respondent's current climate; perceptions of climate change were clearly relative.

All of these conclusions (and others), however, had to be qualified with caveats about how the climate scenarios were designed. First, it was not clear that respondents could digest all of the information provided in the manner it was presented. Thus, the salience of average temperature may have been the result of a conceptual default: it may have been the dimension with which respondents were most familiar a priori. Second, it was not fully clear what kinds of value respondents were considering: use value, existence value, stewardship, altruism, and so on. Third, the role of the respondent's budget constraint was unclear. Perhaps many respondents were ignoring their budget constraint altogether. Finally, the climate scenarios presented were designed solely with psychometric properties in mind. The realism of the scenarios was not considered; indeed some scenarios were probably impossible from a meteorological point of view. Therefore, at least some of the results were irrelevant to policy since they were based on future climates that almost certainly could not happen.

In response, the study we report here was designed. The goals were to correct particularly the deficits of the earlier work and then see how the findings might change. First, the scenarios were simplified and written in a more easily digested manner. Second we included questions meant to tap the kinds of value respondents were concerned about. Third, we included wording to make the respondent's budget constraint more salient. Finally, we designed climate scenarios to better reflect more scientifically credible climate change. Thus, this paper addresses two related issues: instrumentation and empirical findings. Instrumentation is important because there is no consensus within the scientific community about how to elicit from the public credible measures of value for environmental 'goods'. Without such methods, empirical results and their policy implications are highly suspect. Similar issues have surfaced with respect to how the physical dimensions of global warming are measured. Our methodological discussion can be found in Section 3.

However, without data, discussions of methods can be very unsatisfying. One key test of any measurement procedure is whether the empirical results make scientific sense. Consequently, we report key findings in Section 4 and discuss their implications in Section 5. It is perhaps important to stress at the outset that our study addresses climate change as locally experienced and perceived. We did not ask respondents to consider climate change in the abstract. Abstract questions risk reproducing the popular rhetoric of the moment.

2. Some Background

Climate valuation methods that make use of economic concepts and techniques have met with considerable philosophical resistance. In brief, environmental 'goods and services', biodiversity, and the like are not considered by some to be commodities that may be exchanged for money (Sargoff, 1988; Oksanen, 1997). Just as a potential tradeoff between the life of a fetus and the health of a mother is not measured in monetary terms, one should not weigh in dollars the possible tradeoffs between, for example, logging and preservation of certain endangered species. One key implication of this position is that welfare economics and its utilitarian roots are fundamentally inappropriate when applied to environmental concerns (O'Neil, 1997). Thus on the issue of valuation, 'Different values are incommensurable; there is no unit through which the different values to which appeal is made in managing a particular site can be placed on a common scale' (O'Neil, 1997, p. 548). And with no price, the entire apparatus collapses.

Some economists have responded by acknowledging the normative positions inherent in modern economics and then by trying to defend them (Pearce and Moran, 1995). For example, with utilitarianism can come markets that by mediating the distribution of commodities and allocating a society's productive resources can resolve disputes over preferences. The political solutions favored by the anti-utilitarians have certainly not been shown to be superior.

We do not see any effective compromises in the offing for these kinds of fundamental disagreements. At stake are deeply held, culturally loaded, world views that organize entire bodies of thought. As a practical matter, however, monetary tradeoffs are increasingly used in environmental policy decisions, whatever their moral status. How those values are determined, therefore, cannot be ignored.

Unfortunately, here too there are serious disputes. We have in earlier work (Berk and Schulman, 1995) reviewed the major positions, and there are excellent and more complete treatments readily available (e.g., Cropper and Oates, 1992; Turner, 1993; Bromley, 1995). Nevertheless, a brief taste of the more popular approaches to environmental valuation will provide further context for the remainder of the paper.

Traditional economics has long relied on 'revealed preference' methods to infer prices from observed behavior. For environmental assets, for instance, 'travel cost methods' infer the value of some natural site by estimating how much people pay traveling to visit that site; this includes the cost of fuel, lodging, admissions fees and so on. Among the many criticisms that can be raised, however, are the failure to include any sources of value beyond direct use (e.g., biodiversity), difficulties determining accurately the opportunity costs of on-site and travel time, and a number of thorny measurement and model specification problems.

'Hedonic pricing' is another revealed preference method popular in traditional economics. The basic idea is that land values incorporate environmental attributes such as green spaces, climate, or ocean views and as a result, one can infer the value of environmental attributes by comparing the market prices of land parcels. However, land parcels first must be equated statistically on all other attributes that would affect their market prices, such as the quality of the housing. This raises a host of very difficult measurement and econometric problems. Hedonic methods must also assume that the market for real estate is functioning well, which for many environmentally sensitive areas is problematic in the face of government regulations. Finally, hedonic methods rely on cross-sectional comparisons that can sometimes be very misleading for drawing longitudinal inferences, especially for issues such as global warming where *change* is a key defining characteristic (Schneider, 1997). To take a simple illustration from epidemiology, it would very risky to infer what the health problems of today's teenagers will be when they are in their 60's by comparing the health problems of today's adolescents with the health problems of today's senior citizens. (This is known as the age-period-cohort problem in demography.)

Contingent valuation (CV) methods were developed partly in response to the well known imperfections in revealed preference approaches as applied to environmental valuation (e.g., Kopp et al., 1997). The goal is to elicit from people what they would be willing to pay to protect some environmental asset or what they would have to be paid to give it up. Survey questionnaires are used to extract this 'willingness to pay' or 'willingness to accept' (respectively), which means that the accuracy of contingent valuation methods depends on the quality of the survey instrument and how well people can make the assessments required. Critics quite properly worry that the values elicited in CV surveys incorporate some preferences that may have little to do with the value of the environmental asset in question. For example, respondents may increase the value elicited to simply make themselves feel good about their hypothetical largesse. Or, respondents may choose not to 'play', preferring instead to provide values that are really 'protest votes'. And perhaps most fundamentally, CV may simply ask too much of the cognitive skills of respondents. They may find it difficult, for instance, to provide a value only for the asset in question, independent of what it more generally represents (e.g., protecting a particular species versus biodiversity in general).

At this point, it seems that all valuation methods used for environmental assets have significant problems. Still, in our view, these methods have merit. First, the process of collecting valuation data itself may help to inform the policy process. What is relevant and what is not? Whose opinions should matter? What sorts of tradeoffs need to be considered? How should one balance the long run against the short run? In other words, the debates about how to value environmental assets are a learning process that may well improve the quality of political decisions.

Second, as long as environmental tradeoffs are a policy reality, some common scale would seem to be useful. Monetary values such as dollars are a metric with which people have lots of practice and consequently, they provide a scale with considerable psychometric power. At the same time, it would be foolish to take any monetary estimates at face value to reflect the 'true' price of some environmental good or service. As we have argued elsewhere (Berk and Schulman, 1995), monetary values have a scale with a true zero and equal interval units, while the monetary values produced by valuation methods are sometimes no better than ordinal.

Third, imperfect as the existing environmental valuation methods may be, they may still be superior to other means by which tradeoffs are gauged. For example, no one has ever shown that opinions informally canvassed at legislative hearings are a better way of measuring tradeoffs. No one has ever shown that integrating the views of subject matter experts is better either. Considerations of valuation methods, therefore, must always be put in the context of *'compared to what?'*.

Finally, it is important to not overstate the centrality valuation methods in the decision-making process and then judge their merits in this inflated role. We do not envision either in theory or practice valuation numbers replacing the political process. To treat valuation methods as if they were going to be definitive is to set up a straw man and require of those methods that which they cannot deliver.

We also do not think that at this point a case can be made that one valuation method is always better than another. To categorically favor one approach is effectively a 'rush to judgment'. Yet valuation applied to climate change, which is the subject matter of this paper, would seem to be ideally suited for contingent valuation. Since climate change is just now becoming visible, *there is no past behavior in response to a rapidly changing climate from which value may be inferred*. Thus, revealed preference methods necessarily depend on very large inferential leaps exploiting past behavior in surrogate situations as a proxy for what really needs to be studied. With all of its problems, contingent valuation methods at least address the issues directly.

3. Study Design

3.1. DESIGNING CLIMATE SCENARIOS

In an effort to replicate the earlier finding (Berk and Schulman, 1995) that assessments of climate change depend on respondents' current climate, the study design called for selecting respondents from two micro-climates in the Los Angeles area.[1] One micro-climate was meant to reflect the experience of people living in coastal communities. The other micro-climate was meant to capture the experience of people living in the area's inland valley communities. These locales represent the two most different, yet still heavily populated, micro-climates in the Los Angeles metropolitan area and were to serve as the baseline climates from which respondents could evaluate possible climate change. We chose to maximize the variance in micro-climate to place an upper bound on the impact of the baseline. Moreover, if no baseline effects were found, it would be unlikely that any would be found by comparing other micro-climates in the Los Angeles area.

We chose the meteorological station at the Los Angeles International Airport (LAX) to represent the coastal community, while for the inland valley, the station at Pasadena was selected. The Los Angeles Civic Center station, located in the downtown area, represents a transitional locale between the coastal and valley micro-climates. All three stations have nearly unbroken data records extending back to the 1940s.

Climate, of course, has no simple definition. Still, measures reflecting temperature and precipitation characteristics can be useful to specify a particular climate type and to delineate among the range of types. The best measures are those with which the public is familiar from the news media. For example, with regard to temperature, we believe the public in Los Angeles is more sensitive to the maximum daily temperature than either the minimum or daily mean values, and thus, all references to temperature in this report represent the daily maximum value. At the very least it is the daily maximum that gets the most prominent coverage in the media and for much of the year, it is the daily maximum that will most affect local quality of life.

The coastal and inland valley locales clearly possess different climates, but it is in the summer season that the distinction between them is most pronounced. Owing to the goals of the study, it was decided, therefore, to treat the summer and winter seasons separately.

Rather than employ conventional meteorological definitions for the seasons, the historical record was examined to determine appropriate local definitions. Like other cities along the U.S. west coast, Los Angeles receives the bulk of its precipitation during the winter season, concentrated in the four month period spanning December to March. Due to local orography, Pasadena typically receives a little more precipitation than LAX during this period, and is also a bit warmer, but these differences were judged to be unimportant, and so we assumed no difference existed between the 'experience' in the coastal and valley communities during the winter season. Therefore, the Civic Center station was used to represent both locales. From this station's approximately 40 year data record, seasonal (December–March) averages for both daily maximum temperature and total seasonal precipitation accumulation were computed and used to represent the climatic 'normals'. These were roughly 68 °F (20 °C) and 12 inches (30.5 cm), respectively.

Summer arrives late on the west coast, with the warmest temperatures usually extending well into September in Los Angeles. The data for LAX and Pasadena suggested that the period spanning from July through September represented an adequate local definition of the summer season. During this period, the inland valleys are largely isolated from the moderating influence of the cold ocean waters, resulting in an average 12 °F (6.7 °C) difference between typical summertime daily maximum high temperatures in the coastal and valley locales. This was judged to be a significant part of the difference between the coastal and valley 'experience'.

The next step was to design local climate change scenarios that would be consistent with plausible climate change in the real world. Lacking specific and substantive guidance from climate modelers, we decided it would be more sound to not only consider a full range of possible future climates, but also to restrict the scenarios to the natural range of variation that has occurred in the Los Angeles area and, therefore, has either been experienced by the respondents or could be reasonably understood by them. The problem was then to define the natural range of variation. For winter precipitation, only the seasonal accumulation is probably meaningful and thus, the range of variation could be cast in terms of the interannual variability of this accumulation about its long-term seasonal average value of about 12 inches (30.5 cm). In only a few extreme cases, has the seasonal rainfall totals been either above 25 inches or below 4 inches, for example, and this would be taken to represent the range of the normal.

For temperature, however, the inter-annual variation of seasonal average temperature is very small: only about 2 °F (1 °C) for both the summer and winter seasons, as defined previously. In our judgment, the public is more cognizant of the temperature variation that can occur within a given season, and thus, we elected to define the natural range of variation with respect to the given season's historical extremes. For example, during the winter season as defined previously, only 5% of days in the past had maximum temperatures that were either below 57 °F (14 °C) or exceeded 83 °F (28 °C). What if either tail of the distribution became normal? By combining the temperature and precipitation variations, we can hypothesize future climates that are either much wetter or drier than the present climate while simultaneously being either much warmer or colder.

As noted above, Southern California receives very little precipitation during summer. Due to the relatively high persistence exhibited by the weather during the summer, however, we reasoned that people might also be sensitive to clusters or 'spells' of extreme weather (hot or cold) that might occur. For each station, extremes were set by the 5% and 95% levels of maximum daily temperature as recorded over a 40 year period. A warm (cold) spell was then defined as an episode for which there were four or more days in which temperatures above (below) the extreme were recorded within a seven day period. For the coastal community (represented by LAX), the extremes were 85 °F (29 °C) and 70 °F (21 °C), while for Pasadena, they were 99 °F (37 °C) and 77 °F (25 °C). By this definition, neither warm nor cold spells were frequent occurrences in the past at either locale. However, what if they started arriving several times per summer? While we certainly could not say whether these climate scenarios might properly represent the Los Angeles area of the future, we can say that they are not outside the range of past weather variations.

Next, we had to consider whether respondents could properly interpret and remember the content of climate scenarios cast solely in such terms. After much consideration, we opted for giving each climate scenario a geographical reference point. For example, coastal respondents would be asked to consider a future in which the average daily maximum temperature during summer increased from the present 76° to 88°, increasing the mean summer maximum temperature to a level presently reached there less than 5% of the time during the summer season. This scenario would actually elevate the present summer temperature in the coastal community to equal that experienced by present residents of Pasadena. Thus, it was decided to supply additional information, and relate each possible future scenario to the present climate at some other locale. The advantage of providing such contextual information is obvious, as is the disadvantage; respondents would have to be cautioned to consider only the climate of a locale, and not any extraneous and climatically irrelevant social and/or economic characteristics.[2]

TABLE I

Scenario design for winter season: Precipitation and temperature for the four reference sites

	Wetter	Drier
Warmer	Hawaii	Manzanillo
Cooler	Eureka	Mojave

For the summer season, respondents were asked to evaluate a possible increase (decrease) in summer mean daily maximum temperature with concomitant change in the likelihood of hot (cold) spells. The coastal respondents were offered Pasadena and San Francisco as geographical references for the future climates, while for the inland valley respondents, the scenarios referenced the California cities of Barstow (in the Mojave Desert) and Santa Monica (a coastal community in the Los Angeles basin). These locales presently have average summer maximum temperatures that were reached less than 5% of the time in the respondents' microclimate over the last 40 years or so. The frequency of hot (cold) spells, as defined separately for community, would then increase from one every few summers to several per summer for each community.

In the winter scenario presented to both communities, respondents were asked to evaluate changes in two climatic dimensions, representing average daily maximum temperature and seasonal precipitation accumulation. Respondents were presented with scenarios that were combinations of temperature (warmer/colder) and precipitation (wetter/drier) changes. As noted above, the inter-annual variation in seasonally averaged temperature over the past 40 years or so has been quite small, so we elected to define the winter temperature scenario in terms of the historical daily variation recorded in Los Angeles (at the Civic Center) through the winter season, where only 5% of days had maximum temperatures that were either above 83 °F (28 °C) or below 57 °F (14 °C), as noted above.

Still, this scenario proved problematic, since there is no locale in the contiguous United States that is significantly warmer than the Los Angeles area. For the cooler component of the scenario, the California cities of Mojave (also in the Mojave Desert) and Eureka (a coastal city in Northern California) were chosen as proxies of drier and wetter climates, respectively. Hawaii was chosen as a locale that was both warmer and wetter during winter, while Manzanillo, Mexico, a locale on Mexico's west coast, was selected to represent a warmer and drier climate.

The research design for the eight scenarios is summarized in Tables I and II. Note that all respondents received the same set of four winter scenarios, but that the coastal sample and the valley sample received different sets of two summer scenarios each.

TABLE II

Scenario design for summer season: Sample locale and temperature for the four reference sites

	Coast sample	Valley sample
Warmer	Pasadena	Barstow
Cooler	San Francisco	Santa Monica

3.2. WORDING OF THE CLIMATE SURVEY

For the climate scenarios to be properly evaluated by respondents, four wording issues had to be addressed. The way these were handled drew on the past research of Berk and Schulman, extensive pilot testing of the instrument developed in this study, and the expertise of Response Analysis Corporation, the survey research firm that collected the data.

3.2.1. *Introducing the Issues to Respondents*

First, the scenarios required a general introduction that at the same time did not lead the respondents in any predetermined direction. Additionally, since our goal was to measure current public opinion, not public opinion as it might be some time in the future with more exposure to the issues, we made a conscious effort not to educate respondents about the possible consequences of climate change.[3] Our introduction to the scenarios was, therefore, as follows:

"Many climate experts expect the average global temperatures to rise in the future because of fossil fuel use and other human activity. Although most places on the Earth should get warmer, it is at least possible that some areas, such as Southern California, might actually get cooler. Also, the precipitation we receive may change as well, possibly becoming wetter or drier than at present.

Now, let's discuss temperature and climate conditions in your area during summer (or winter) months."[4]

3.2.2. *Characterizing Current Climate for Respondents*

The second wording issue was how to tell respondents about their current climate. We wanted to convey their current situation in simple but accurate ways that anticipated how the later scenarios would describe climate change.

For the summer scenarios, the most salient climate dimensions were taken to be daily high temperatures and spells of unusually hot or cold weather. Recall that these climate characteristics (high temperatures and weather 'spells') were chosen because they were likely to be familiar to respondents from news reports, etc.

For the coastal communities, we settled on the following wording anticipating the summer scenarios.

"In Southern California, summer runs from July through September. Although it varies from year to year, the average high temperature during that period where you live is about 76°. But, sometimes you get hot spells or cold spells during the summer for 4 days or more. During a hot spell, high temperatures rise above 85°, while during a cold spell, high temperatures stay below 70°."

For the valley communities, summer climate is somewhat different. Nevertheless, we were able to use almost identical wording based on the same general rationale.

"In Southern California, summer runs from July through September. Although it varies from year to year, the average high temperature during that period where you live is about 88°. But, sometimes you get hot spells or cold spells during the summer for 4 days or more. During a hot spell, high temperatures rise above 99°, while during a cold spell, high temperatures stay below 77°."

The 'set-up' for the winter scenarios was a bit different. Both temperature and rainfall had to be addressed. Again, we relied on the sorts of information routinely conveyed in weather reports to help us choose effective wording.

Since in the winter the climates in the coastal communities and the valley communities are very similar, one summary of current winter climate was sufficient.

"In Southern California, winter runs from December through March. Although it varies from year to year, the average high temperature during that period is about 68°, and the total winter rainfall is about 12 inches."

3.2.3. *Wording of the Climate Scenarios*

The third problem to be solved was how to word the climate scenarios. We discussed the rationale for their design above and as we indicated, there were eight climate scenarios: two different summer scenarios each for the coastal and valley communities and four winter scenarios for all respondents regardless of where they lived. The wording of these scenarios is as follows.

Summer Scenarios

- "(Warmer for coastal communities). Now imagine that the summer climate where you live changed, so that it was normally like the summer in Pasadena. By this, I mean that the average summer high temperature would be 88°rather than 76°. At the same time, the frequency of hot spells would increase from once every few summers to several per summer. Cold spells would be very rare. During a hot spell, high temperatures rise above 85°, while during a cold spell, high temperatures stay below 70°."
- "(Cooler for coastal communities). Now imagine that the summer climate where you live changed, so that it was normally like the summer in San Francisco. By this, I mean that the average summer high temperature would be 72°rather than 76°. At the same time, the frequency of cold spells would increase from one every few summers to several per summer. Hot spells would be very rare."

- "(Warmer for valley communities). Now imagine that the summer climate where you live changed so that it was normally like the present summer in Barstow. That's out in the high desert. By this, I mean that the average summer high temperature would be 100°rather than 88°. At the same time, the frequency of hot spells would increase from once every few summers to several per summer. Cold spells during the summer would be very rare."
- "(Cooler for valley communities). Now imagine that the summer climate where you live changed so that it was normally like the present summer in Santa Monica. By this, I mean that the average summer high temperature would be 76 rather than 88°. At the same time, the frequency of cold spells would increase from once every few summers to several per summer. Hot spells during the summer would be very rare."

Winter Scenarios

- "(Warmer and wetter for both communities). Imagine that the climate changed so that the average high temperature increased to 83 degrees, and the winter rainfall more than doubled to 28 inches. Currently, only about one winter in twenty is that warm and wet, but this would become normal. This would make the climate similar to the present winter climate in Hawaii."[5]
- "(Warmer and drier for both communities). Imagine that the climate changed so that the average high temperature increased to 83°, and the winter rainfall dropped by more than half to about 4 inches. Currently, only about one winter in twenty is that warm and dry, but this would become normal. This would make the climate similar to the present winter climate in Manzanillo, Mexico, located south of us on Mexico's West Coast."
- "(Cooler and wetter for both communities). Imagine that the climate changed so that the average high temperature decreased to 57°, and the winter rainfall more than doubled to about 28 inches. Currently, only about one winter in twenty is that cool and wet, but this would become normal. This would make the climate similar to the present winter climate in Eureka, on the California coast north of San Francisco."
- "(Cooler and drier for both communities). Imagine that the climate changed so that the average high temperature decreased to 57°, and the winter rainfall dropped by more than half to about 4 inches. Currently, only about one winter in twenty is that cool and dry, but this would become normal. This would make the climate similar to the present winter climate in Mojave, California, out in the high desert."

3.2.4. *Wording of the Scenario Questions*

The goal of the scenarios questions was to elicit a willingness to pay after first asking about those aspects of climate change about which respondents might be concerned. Recall that the goal was not just to obtain estimates of willingness to pay, but to also try to characterize the kind of value to which respondents were reacting.

Each scenario was, therefore, followed by five questions (not one) 'tuned' to that scenario.

The wording was as follows for each scenario, where '(location)' means that one of the locales linked to climate change would be inserted (e.g., Pasadena, Santa Monica, Mojave, etc.).

a. "How concerned would you be about how the change in climate would affect your *overall quality of life*, such things as air pollution, water availability, outdoor recreation, and comfort on the job or at home? On a scale of 1 to 10, where 1 is not at all concerned and 10 is very concerned, how concerned would you be? Please keep in mind that I only want you to consider the *climate* of (location) when you answer."
b. "How concerned would you be about the well-being of *wildlife habitats* in the area? Remember, I only what you to consider the *climate* of (location) when you answer."
c. "How concerned would you be with the *local economy*: industry, jobs, and agriculture?"
d. "How concerned would you be that the children born in the next few years would not be able to experience the climate you did?"
e. "Keeping in mind that this is a hypothetical situation, would you be willing to pay (X dollars) per month to prevent the climate here from becoming like (location). Please keep in mind, not just what you would like to do, but what you would be able to do on a regular basis. There is no right or wrong answer. You can say 'yes' or 'no' depending on how you feel."

The value for 'X dollars' was selected at random with equal probability from the following dollar amounts: \$1, \$2, \$10, and then in \$10 increments up to \$100. These values were picked based on past research (Berk and Schulman, 1995) to represent the range of likely dollar amounts respondents would be willing to pay. Particular values were selected at random to avoid any association with content of the scenarios or backgrounds of respondents. Research has shown that closed formats such as the one we employed are preferable to open formats (e.g., 'How much would you be willing to pay... ?), which, among other things, can sometimes elicit unrealistically high values as a kind of 'protest vote' (Hanemann, 1994; Berk and Schulman, 1995). For the five questions, 'don't know' and 'refused' were also acceptable responses.

3.3. IMPLEMENTING THE QUESTIONNAIRE

The survey instrument was developed in two sections. The first section was comprised of the eight climate scenarios and their follow-up questions. The second section was a series of more typical survey questions included to gather information about why respondents might differ in their reactions to the climate scenarios.

Anticipating that the interviews would be conducted by telephone using computer aided telephone interviewing (CATI), potential order effects were addressed by programming that rotated the order of scenarios. That is, whether a respondent was given the winter or summer scenarios first was determined by the equivalent of a coin flip. Then, whether for the summer or winter scenarios, the order of each was rotated at random.

The instrument was pretested on 36 respondents. Members of the research team from Response Analysis Corporation were on hand to monitor the interviews. Following the interview session and interviewer debriefing, the responses were tabulated and examined. Based on respondent reaction during that pretest, some minor revisions were made to the questionnaire to improve clarity and promote interviewer-respondent rapport. However, since changes were minimal and were determined not to affect the data, all interviews from the pretest were retained as part of the study data.

3.4. SAMPLING

One properly can think of the research design as two randomized experiments fielded in two different locates for two random samples of about 300 respondents each. As noted above, there was a random sample of respondents living in Los Angeles, coastal communities and a random sample of respondents living in Los Angeles, valley communities.

Random digit dialing telephone numbers were mapped to the two Los Angeles areas. The coastal sample was defined to include Santa Monica, Marina Del Rey, and Malibu. These are contiguous cities. The valley sample was defined to include Pasadena, Altadena, and San Marino. These too are contiguous. A random respondent was chosen in each household by the nearest birthday method. Interviews were conducted only with adults (i.e., older than 21) and only with people who could manage in English. While the decision to limit the study to respondents who were sufficiently fluent in English may limit the generalizability of the study, past research suggests the biases are not large, especially after the data are weighted to match key demographic variables in the population (Berk and Schulman, 1995).

Despite aggressive follow-up procedures, including up to 20 call-backs and specially trained interview 'converters', the response rate was only 54%. While the 54% figure is a cause for some concern, it is in line with responses rates routinely found acceptable in telephone surveys done in large metropolitan areas. Moreover, 54% is probably conservative since is was computed using the CSRO (Council of American Survey Research Organizations) formula. We suspect that the low response rate is explained in part by the fact that the study was done during the late summer when many people are away on vacation.

4. Findings

4.1. DESCRIPTION OF THE SAMPLE

The two samples, each with over 300 respondents, represent a good cross-section of the two Los Angeles communities. Given the income it takes to live in either the coastal areas or in and around Pasadena, one would expect respondents who are better educated and more affluent than the typical Los Angeles resident. One might also expect the sample to be more environmentally aware than average so that if our scenarios are too demanding for our respondents, they are likely to be too demanding for a more representative sample of the Los Angeles area overall.

Median age for the respondents is around 35 with 10% of the sample between 18 and 24 years of age, and about 5% is 65 or older. More than half have a college degree and 22% have advanced degrees. Virtually all of the sample have graduated from high school. A bit more than a quarter earn over $75,000 a year. A little over 60% are working full-time and another 13% are working part-time. About 11% are retired. Nearly 60% of those working are employed in executive, professional or technical professions. Nearly 80% work indoors. In short, the sample has a somewhat 'yuppie' character, just as one would expect for the communities sampled.

About a third of the respondents are married and about a third are single. Nearly 15% are divorced or separated. About a third live in single-person households, another third live in two-person households, and the rest live in larger households (although less than 8% live in households having more than 4 people). A little less than half of the respondents have children and about 15% have grandchildren. Perhaps the major message is that most households are composed of either a single person or a nuclear family. Also, very few households have more than 2 children. There are virtually no respondents with an extended family living under one roof. Again, the 'yuppie' flavor of the sample is apparent.

4.2. EXPERIMENTAL EFFECTS

Feedback from interviewers suggested that the questionnaire was well received and that respondents took the questions seriously. This is consistent with the very small number of respondents who failed to provide answers to the scenarios (typically less than 5%) and with the overall pattern of responses to the willingness-to-pay items. In particular, we found the expected downward sloping demand curve; with increases in the dollar amount offered, the proportion of respondents who accepted the offer declined. Berk and Schulman (1995) found a similar pattern, which they also took as good news.

4.2.1. *Willingness to Pay*

Perhaps the most important results of the study are respondents' willingness to pay to prevent climate change. Tables III and IV show the results. For the winter and summer scenarios, we show the locale referent, the proportion of respondents who were willing to pay the random dollar amount inserted into the willingness-to-pay question, and the mean dollar amount respondents were willing to pay.

Overall, about 40% of the respondents were prepared to pay to prevent the climate change scenarios from materializing, and 60% were not. The 60% who refused represent the percentage who were not willing to pay the *average dollar amount* (about $40) inserted at random into the willingness-to-pay question. One must not forget that some respondents were asked to pay a very small amount per month, and some were asked to pay a large amount per month. Thus, one *cannot* conclude that the 60% would not pay anything to prevent climate change. No doubt, some who were not willing to pay the monthly amount mentioned, would have been willing to pay less. For example, if one considers just the scenarios for which the dollar amount mentioned was $1, the reported percentages in Tables III and IV are increased by between 20% and 40% (e.g., the figure for Pasadena is about 80%).

The grand mean for the amount respondents are willing to pay is $13.70 a month. This figure along with the means in Tables III and IV were computed by adding $0 to the sum for instances in which respondents were unwilling to pay the amount inserted into the willingness-to-pay question. The means do not represent only the subset of respondents who were willing to pay something. Thus, they are a minimum value estimate of the average amount *all* respondents were willing to pay. Perhaps the major message of the grand mean is that on the average, respondents found the future climates we constructed aversive compared to the climates they currently experience. Climate change was not perceived as irrelevant to their lives, let alone as beneficial.[6]

Turning now to more detailed results for the winter scenarios, in Table III, we see that respondents seem prepared in each case to pay non-trivial dollar amounts to prevent climate change: well over $10 a month. While for the methodological reasons we have mentioned at various points, one should not take the precise figures literally, *it is almost certain the average willingness to pay is greater than zero*.

A little more than 30% of all respondents accepted the dollar offer to prevent a wetter climate, while over 50% accepted the dollar offer to prevent a drier climate. That difference is statistically significant.[7] The average willingness to pay differs by about $7 a month. Thus, respondents seemed to more prepared to invest in preventing a drier winter climate than a wetter one. Given the longstanding concerns about water supply in Southern California and two severe droughts over the past 15 years, these worries make sense.

Roughly 40% were willing to pay the dollar amount mentioned to prevent either a warmer or cooler climate, and the average dollar amounts are necessarily very similar as well. That is, if respondents were asked to choose between a future winter climate that was warmer or cooler, it would be a draw; both are equally undesirable. The row means in Table III are both greater than zero but about the same value.[8]

Turning now to the summer climate scenarios, which only involve temperature, the results in Table IV are bit more complicated. We again find an overall will-

TABLE III

Results for winter season – proportion willing to pay and mean dollar amount

	Wetter	Drier
Warmer	Hawaii	Manzanillo
	0.31	0.52
	$9.74	$16.70
Cooler	Eureka	Mojave
	0.37	0.53
	$11.10	$18.18

ingness to pay to prevent climate change. Based on row averages, over 50% were willing to pay the dollar amount mentioned to prevent a warmer summer climate. By the same token, however, far less than 30% were willing to pay the mentioned dollar amount to prevent a cooler summer climate. The dollar differences between the two are also substantial: about $10 per month. All of these differences are statistically significant. Clearly, the respondents are more concerned about experiencing warmer summers in the future than cooler ones.

Recall that for the summer scenarios, there were really two totally separate studies, one for the coast respondents and one for the inland valley respondents. That difference is represented by the column averages in Table IV. Respondents from the coastal communities seem a bit more willing to pay to prevent summer climate change. The difference is about $2, which is statistically significant. We will explore later what might explain this difference. Note that since where a respondent lives was not randomized (for obvious reasons), there is the real possibility that some other factor than location is driving the difference in willingness to pay.

Finally, for inland valley residents, only 17% would be willing to pay to prevent a summer climate like the one found currently in Santa Monica. This is the lowest figure in Table IV, and represents a statistically significant interaction effect. It suggests that many inland valley respondents may prefer Santa Monica's current summer climate over their own, and therefore this seems to be the only climate change scenario for which one might argue there is no serious concern regarding the future.

In summary, within the range of future climate scenarios we have considered, *there seems to be substantial evidence that respondents are prepared to incur at least some costs to prevent change*. Note that the climate changes we had them evaluate are at least empirically possible and historically plausible. For the winter scenarios, the major concern is with precipitation, not temperature, and there is greater anxiety about drier winters than wetter ones. For the summer scenarios,

TABLE IV

Results for summer season – proportion willing to pay and mean dollar amount

	Coast	Valley
Warmer	Pasadena	Barstow
	0.51	0.59
	$17.45	$19.92
Cooler	San Francisco	Santa Monica
	0.34	0.17
	$11.13	$4.40

concerns center around the possibility of a warmer climate, but a fraction of the respondents are also apparently willing to pay something to prevent cooler summers as well.

One of the interesting implications of these results is that a substantial number of respondents are apparently willing to pay to prevent climate change, even climate change that many would think is an improvement in their current climate. This suggests respondents are taking more into account than just their physical comfort. Still unaddressed, however, are the specific concerns about climate change that may be driving willingness to pay. We need, therefore, to consider the results for the rest of the questions asked after each climate scenario.

4.2.2. *Concerns about Climate Change*

Recall that after each scenario four questions were asked about concerns respondents might have about climate change: quality of life, wildlife habitats, impact on the economy, and what the next generation would inherit. By looking at responses to those items we can learn a bit about what may lay behind respondents' willingness to pay.

Tables V–VIII address the four concerns for the winter climate scenarios. The Tables are constructed as before, but with the mean level of concern and the sample size in each cell. Overall, the levels of concern are a bit above the middle of the 10 point scale, suggesting at least moderate amounts of concern.

In general, there is a bit more concern with the impact of climate change on quality of life and wildlife habitats than with the impact on the economy or on the climate that future generations will experience. However, the differences are not really large enough to be important, especially given the error inherent in all such survey measures. Perhaps the major message is that the climate change raises concerns in each of the four areas and that measures of value, such as willingness to pay, should be understood as capturing far more than use value.

TABLE V

Results for winter season – concern about quality of life: Mean and *N*

	Wetter	Drier
Warmer	Hawaii 5.9 575	Manzanillo 7.4 575
Cooler	Eureka 6.2 573	Mojave 7.6 573

TABLE VI

Results for winter season – concern about wildlife habitats: Mean and *N*

	Wetter	Drier
Warmer	Hawaii 6.4 571	Manzanillo 7.5 566
Cooler	Eureka 6.5 565	Mojave 7.5 569

TABLE VII

Results for winter season – concern about the economy: Mean and *N*

	Wetter	Drier
Warmer	Hawaii 5.9 570	Manzanillo 6.8 565
Cooler	Eureka 5.3 572	Mojave 7.0 573

TABLE VIII

Results for winter season – concern about what children will experience: Mean and *N*

	Wetter	Drier
Warmer	Hawaii 5.6 573	Manzanillo 6.5 569
Cooler	Eureka 5.7 572	Mojave 6.7 572

TABLE IX

Results for summer season – concern about quality of life: Mean and *N*

	Coast	Valley
Warmer	Pasadena 7.3 293	Barstow 8.1 282
Cooler	San Francisco 5.7 293	Santa Monica 4.6 284

Also instructive are the patterns within each table. Consistent with the willingness to pay measures, there is substantially more concern about drier winters than wetter winters. For each table, the difference in concern between wet and dry winters is statistically significant. In contrast, whether the winters are warmer or cooler does not affect levels of concern very much. The differences in concern are small and not statistically significant.[9]

The results for the summer climate scenarios are found in Tables IX–XII. Overall, the levels of concern are about the same as for the winter climate scenarios, though the details are rather more complicated.

Again, consistent with willingness-to-pay items, the major concern is about hotter summers, and the warmer-cooler distinction has a statistically significant impact on levels of concern in each table. There is a small and statistically significant effect for whether the respondent lives in a coastal community or in an inland valley

TABLE X

Results for summer season – concern about wildlife habitats: Mean and *N*

	Coast	Valley
Warmer	Pasadena 7.0 288	Barstow 7.5 283
Cooler	San Francisco 6.3 288	Santa Monica 5.3 282

TABLE XI

Results for summer season – concern about the economy: Mean and *N*

	Coast	Valley
Warmer	Pasadena 6.3 291	Barstow 7.3 281
Cooler	San Francisco 5.8 289	Santa Monica 5.0 283

TABLE XII

Results for summer season – concern about what children will experience: Mean and *N*

	Coast	Valley
Warmer	Pasadena 6.2 290	Barstow 7.2 284
Cooler	San Francisco 5.1 287	Santa Monica 4.5 283

TABLE XIII
Willingness to pay as a function of climate change concerns

Variable	Coefficient	Stand. error	Odds multiplier
Constant	–2.841	0.131	
Quality of life	0.235	0.021	1.27[a]
Wildlife habitats	0.082	0.023	1.08[a]
Economy	0.048	0.021	1.05[a]
Children	0.003	0.019	1.00+

[a] P-values less than 0.05 for a two-tailed test.

once the unusually low value for the Santa Monica scenario is taken into account. That is, valley residents are slightly less concerned once the relative desirability of a Santa Monica climate for valley residents is taken considered. However, while these effects are statistically significant, they are too small to be of great interest.

To summarize, for the winter scenarios, concern revolves around too little rain. For the summer scenarios, concern revolves around too much heat. All four kinds of concerns are affected in much the same fashion.

We can be substantially more specific about the relationships between the four items measuring concern about climate change and willingness to pay. Table XIII shows the results of a logistic regression with willingness to pay (i.e., pay or not) as the response variable and each of the four concern items as explanatory variables: concern about quality of life, about wildlife habitats, about the economy, and about what future generations will inherit. The unit of analysis is the scenario (pooled over respondents), so that the total sample size is 3264. The four columns include respectively, the variable name, the regression coefficient, the standard error, and the odds multiplier. On this and subsequent tables, starred odds multipliers represent values that are statistically significant at the 0.05 level (two-tailed test) and the plus sign represents 'more than'.

Even allowing for the within-person correlation,[10] three of the four regression coefficients are statistically significant at conventional levels. These include quality of life, wildlife habitats, and the economy. As the odds multipliers indicate, however, only quality of life is strongly related to willingness to pay. For each point increase on the 10 point scale of concern about quality of life, the odds of accepting the dollar amounted mentioned in the scenario are multiplied by a factor of 1.27. Thus, 5 point increment is associated with value for the odds that is over 3 times larger ($1.27^5 = 3.3$). Each of the other odds multipliers are very small by comparison. Thus, for concern about wildlife habitats, a 10 point increment is only associated with a doubling of the odds of being willing to pay the amount indicated.

The results in Table XIII would seem to suggest that willingness to pay is associated most strongly with direct use value. However, as our earlier discussion of

TABLE XIV
Results for summer season: Pasadena

Variable	Coefficient	Stand error	Odds multiplier
Constant	–3.689	1.182	
Dollars	–0.032	0.006	0.969[a]
Summer scenario 1st	0.248	0.684	0.992
1st Summer scenario	–0.292	0.705	0.748
Quality of life	0.212	0.088	1.236[a]
Wildlife	0.184	0.095	1.202[a]
Economy	0.079	0.092	1.082
Children	0.035	0.082	1.036
Age	–0.000	0.015	0.999
Male	0.889	0.373	2.434[a]
Married	0.331	0.458	1.392
College, adv. degree	1.231	0.389	3.421[a]
Work fulltime	0.169	0.476	1.184
Manager, professional	–0.311	0.411	0.732
Have children	0.004	0.465	1.004
Work inside	–0.067	0.475	0.936
Work driving	0.109	0.463	1.115
Number of cars	0.267	0.219	1.306
AC at home	–0.975	0.485	0.377[a]
Income	0.00000596	0.00000986	1.00

[a] P-value less than 0.05 for a two-tailed test.

the concern implied, there are substantial similarities among the concern measures. In fact, all four had means between 6 and 7, and the correlations among the four items were all between 0.65 and 0.72. Regressing any of one of the four items on the other three lead to an R^2 value of around 0.60.

As a result, it is very hard to make the case that any single concern item is the key driver for willingness to pay. The concern items are sufficiently alike so that depending upon which three of the four are included as explanatory variables, any item or subset of items may be dominant. The findings in Table XIII, therefore, are rather unstable and are a consequence of the slightly stronger zero order association between concern about quality of life and willingness to pay. This association is translated into a relatively larger regression coefficient (and odds multiplier) because of multicollinearity among the four items concern items. In other words, Table XIII gives the impression of greater distinctions among items than can really be justified.

TABLE XV

Results for summer season: San Francisco

Variable	Coefficient	Stand error	Odds multiplier
Constant	–4.309	1.027	
Dollars	–0.020	0.006	0.980[a]
Summer scenario 1st	–0.031	0.676	0.970
1st Summer scenario	–0.100	0.690	0.905
Quality of life	0.082	0.086	1.086
Wildlife	0.159	0.084	1.171[a]
Economy	0.082	0.090	1.085
Children	0.108	0.076	1.114
Age	0.019	0.014	1.019
Male	–0.173	0.357	0.841[a]
Married	0.664	0.457	1.942
College, adv. degree	0.090	0.350	1.094
Work fulltime	–0.105	0.457	0.900
Manager, professional	–0.555	0.389	0.574
Have children	–0.493	0.471	0.951
Work inside	0.231	0.443	1.259
Work driving	0.076	0.442	1.079
Number of cars	0.307	0.207	1.359
AC at home	–0.202	0.481	0.817
Income	0.00000229	0.00000969	1.00

[a] P-value less than 0.05 for a two-tailed test.

In summary, there may be a hint in the data that of the four concern items, concern about quality of life is most strongly related to willingness to pay. However, a more robust interpretation is that all four items are related in a similar fashion to willingness to pay, and trying to disentangle their independent effects pushes the data too hard. The reason for this, however, is not obvious. When consumers, for example, consider the purchase of an automobile, they are able to distinguish between attractive styling, good gas mileage, and the availability of air bags. They can weigh these factors when they consider how much to pay for the vehicle. It may be that consumers are not yet able to make such distinctions when thinking about climate change. Another possibility is that the different kinds of concerns we raised are, in the minds of respondents, about equally affected by the climate changes described. That is, the high correlations among the concern items reflect real, well-formed perceptions (whatever their accuracy) more than conceptual confusion.

TABLE XVI
Results for summer season: Barstow

Variable	Coefficient	Stand error	Odds multiplier
Constant	–2.756	1.038	
Dollars	–0.020	0.005	0.980[a]
Summer scenario 1st	0.238	0.331	1.268
1st Summer scenario	–0.229	0.327	0.796
Quality of life	0.265	0.095	1.303[a]
Wildlife	0.021	0.087	1.021
Economy	0.148	0.080	1.160
Children	0.001	0.080	1.001
Age	–0.000	0.014	0.999
Male	0.134	0.321	1.568
Married	–0.486	0.377	0.615
College, adv. degree	0.306	0.366	1.358
Work fulltime	0.697	0.414	2.006
Manager, professional	0.557	0.384	1.745
Have children	0.579	0.367	1.784
Work inside	–0.517	0.439	0.596
Work driving	–0.577	0.430	0.573
Number of cars	0.119	0.159	1.126
AC at home	–0.590	0.340	0.554[a]
Income	0.0000086	0.0000092	1.00

[a] P-value less than 0.05 for a two-tailed test.

4.3. MULTIVARIATE RESULTS FOR EACH OF THE EIGHT CLIMATE SCENARIOS

To further explore factors that might affect willingness to pay, we applied logistic regression to each of the eight climate scenarios, using as the response whether the dollar amount offered was accepted. Included as explanatory variables were:

1. the dollar amount offered (to test how sensitive respondents were to 'price');
2. measures of any questionnaire order effects;
3. answers to each of the 'concern' questions (to better determine the kind of value involved); and
4. a number of respondent background characteristics.

Note that each regression analysis is a 'within scenario' procedure. Thus, the scenario content is being held constant for each logistic regression. This also implies that for the summer scenarios, the reference climate (coast or inland valley) for the respondent is a constant and cannot be included in the analysis. However,

TABLE XVII
Results for summer season: Santa Monica

Variable	Coefficient	Stand error	Odds multiplier
Constant	–4.40	1.131	
Dollars	–0.021	0.007	0.979[a]
Summer scenario 1st	0.325	0.467	1.364
1st Summer scenario	–0.143	0.450	0.866
Quality of life	0.247	0.111	1.280[a]
Wildlife	0.165	0.107	1.179
Economy	–0.021	0.117	0.979
Children	–0.000	0.101	–0.999
Age	–0.000	0.014	0.999
Male	0.796	0.437	2.221
Married	0.096	0.481	1.100
College, adv. degree	0.641	0.502	1.414
Work fulltime	0.904	0.620	2.470
Manager, professional	–0.107	0.523	0.899
Have children	0.754	0.501	2.125
Work inside	–0.804	0.564	0.448
Work driving	0.062	0.556	1.064
Number of cars	0.354	0.207	1.126
AC at home	0.246	0.447	1.279
Income	–0.000039	0.000014	0.999

[a] P-value less than 0.05 for a two-tailed test.

it can be included in the analysis of the winter scenarios because both sets of respondents evaluated all of the winter scenarios. Clearly, then, our major concern is whether the respondents' backgrounds affect willingness to pay, although other issues are also addressed. Unlike the earlier analyses, comparisons between scenarios are not of interest. We commence with the summer season results.

Table XIV shows results for the summer scenario in which the coastal climate would change to be more like Pasadena. The dollar amount offered ('Dollars') has a statistically significant negative effect, as one would expect if respondents were taking the study seriously. The negative effect is large; the odds multiplier of 0.969 implies a that the odds of accepting the dollar offer are reduced by a factor of about 0.75 for each \$10 increase in the dollar amount (i.e., 0.969^{10}). Thus, the odds that a \$100 offer would be accepted are virtually zero. In short, the expected downward sloping demand curve is very strongly apparent.

The second major finding in Table XIV is that the question ordering didn't matter. While we effectively guaranteed no impact on willingness to pay by ran-

TABLE XVIII

Results for winter season: Hawaii

Variable	Coefficient	Stand. error	Odds multiplier
Constant	–3.434	0.765	
Dollars	–0.021	0.004	0.979[a]
Coast sample	0.387	0.280	1.473
Winter scenario 1st	0.077	0.259	1.080
1st Winter scenario	–0.321	0.353	0.725
2nd Winter scenario	0.102	0.328	1.107
3rd Winter scenario	–0.218	0.347	0.804
Quality of life	0.176	0.065	1.192[a]
Wildlife	0.228	0.070	1.256[a]
Economy	0.019	0.065	1.019
Children	0.042	0.062	1.042
Age	–0.005	0.009	0.999
Male	0.226	0.247	1.254
Married	–0.552	0.295	0.577
College, adv. degree	0.554	0.270	1.740[a]
Work fulltime	–0.062	0.321	0.939
Manager, professional	–0.254	0.281	0.776
Have children	0.344	0.302	1.411
Work inside	–0.234	0.314	0.791
Work driving	0.041	0.312	1.042
Number of cars	0.227	0.136	1.255
AC at home	–0.365	0.291	0.694
Income	–0.000004	0.000007	0.999

[a] P-value less than 0.05 for a two-tailed test.

domizing scenario order, it is useful to know that even if we had not, the order effects would not have been important.

Of the remaining variables in the Table, only three survive a test of the null hypothesis.[11] Individuals with an air conditioner at home are less willing to pay, more highly educated people are more willing to pay, and people who are more concerned about the impact of climate change on their quality of life are more willing to pay. None of the other explanatory variables seem to matter much.

We can see in the remaining summer scenario tables (Tables XV–XVII) that having a home air conditioner reduces willingness to pay to prevent climate change leading to warmer temperatures, but has no role when the change is to a cooler summer climate. This is logical. The role of education is less clear. The sign is

TABLE XIX
Results for winter season: Manzanillo

Variable	Coefficient	Stand. error	Odds multiplier
Constant	–2.19	0.720	
Dollars	–0.027	0.004	0.973[a]
Coast sample	0.295	0.274	1.343
Winter scenario 1st	–0.042	0.261	0.958
1st Winter scenario	–0.210	0.346	0.812
2nd Winter scenario	0.357	0.320	1.429
3rd Winter scenario	–0.303	0.330	0.737
Quality of life	0.257	0.071	1.309[a]
Wildlife	0.118	0.072	1.125
Economy	0.064	0.063	1.066
Children	–0.015	0.058	0.985
Age	–0.005	0.009	0.999
Male	0.052	0.236	1.053
Married	–0.481	0.286	0.618
College, adv. degree	0.731	0.251	2.077[a]
Work fulltime	–0.227	0.310	0.797
Manager, professional	0.215	0.274	1.240
Have children	0.350	0.291	1.419
Work inside	–0.169	0.291	0.845
Work driving	–0.179	0.303	0.836
Number of cars	0.137	0.131	1.147
AC at home	–0.787	0.281	0.455
Income	–0.000004	0.000007	0.999

[a] P-value less than 0.05 for a two-tailed test.

always positive, but only for one scenario is the null hypothesis rejected. We are inclined to believe that the positive effect exists, but that its size is inconsistent.

With one exception, the concerns about quality of life are related to willingness to pay. The greater the concern, the more willing the respondent is to pay. The lone exception is for the cooler summer scenario for the coastal respondents, but even there, the sign is positive. We suspect that lack of statistical significance is a Type II error. In short, if one takes quality of life as a key indicator of use value, use value clearly dominates the motivation of respondents in these multivariate results. None of the other concerns weigh in, with the single exception of concern about wildlife habitats for one of the four scenarios. In short, willingness to pay seems to be primarily about use value.

TABLE XX
Results for winter season: Eureka

Variable	Coefficient	Stand. error	Odds multiplier
Constant	–3.139	0.735	
Dollars	–0.029	0.004	0.971[a]
Coast sample	0.469	0.268	1.598
Winter scenario 1st	–0.009	0.262	0.991
1st Winter scenario	0.078	0.348	0.081
2nd Winter scenario	–0.034	0.323	0.967
3rd Winter scenario	–0.135	0.326	0.874
Quality of life	0.251	0.064	1.285[a]
Wildlife	–0.004	0.068	0.996
Economy	0.110	0.068	1.116
Children	0.084	0.060	1.087
Age	–0.002	0.009	0.998
Male	0.346	0.236	1.413
Married	0.101	0.281	1.106
College, adv. degree	0.249	0.252	1.283[a]
Work fulltime	0.233	0.313	1.262
Manager, professional	0.067	0.272	1.069
Have children	0.124	0.291	1.132
Work inside	–0.315	0.303	0.730
Work driving	0.038	0.295	1.039
Number of cars	0.294	0.125	1.342[a]
AC at home	–0.290	0.272	0.748
Income	–0.000001	0.000006	0.999

[a] P-value less than 0.05 for a two-tailed test.

As noted earlier, however, the apparent dominance of concerns about quality of life is an inflated rendering the differences among the concern items. Multicollinearity makes it very difficult to determine the unique effects of each individual concern measure. A more robust conclusion is that all four concerns are related to willingness to pay, although the concern item may be a bit more strongly related.[12]

For the four winter scenarios (Tables XVIII–XXI), the story is about the same. We again find the downward sloping demand curve with increasing dollar amounts offered. We again find no question order effects, a suggestion of educational effects, and willingness to pay dominated by measures of use value. The only new finding is that we do not find any strong evidence within the winter climate scenarios that where respondents live makes an important difference in their willingness to pay,

TABLE XXI
Results for winter season: Santa Monica

Variable	Coefficient	Stand. error	Odds multiplier
Constant	–2.060	0.686	
Dollars	–0.022	0.003	0.978[a]
Coast sample	–0.065	0.250	0.937
Winter scenario 1st	–0.282	0.237	0.754
1st Winter scenario	0.036	0.337	1.037
2nd Winter scenario	–0.384	0.301	0.706
3rd Winter scenario	0.234	0.291	1.263
Quality of life	0.179	0.065	1.196[a]
Wildlife	0.099	0.063	1.104
Economy	0.028	0.060	1.028
Children	0.017	0.051	1.017
Age	0.008	0.008	1.008
Male	0.109	0.221	1.115
Married	–0.295	0.267	0.744
College, adv. degree	0.490	0.237	1.632[a]
Work fulltime	–0.304	0.295	0.738
Manager, professional	–0.193	0.252	0.824
Have children	0.105	0.270	1.117
Work inside	–0.169	0.291	0.845
Work driving	–0.196	0.287	0.822
Number of cars	0.224	0.130	1.251
AC at home	–0.467	0.258	0.627
Income	–0.000008	0.000006	0.999

[a] P-value less than 0.05 for a two-tailed test.

other factors being equal. This is not surprising because, as we noted earlier, the winter climates of the coastal and valley communities are very similar. Indeed, this result justifies our decision to combine the two communities for the winter scenario.

5. Conclusions

We introduced into this work a number of methodological refinements. Those designed to make the questionnaire more accessible seem to have worked. Respondents were able to make sense of the scenarios and provide sensible answers. In addition to the reports from interviewers, the downward sloping demand curves and the overall reasonableness of the dollar estimates suggest that respondents took the interview seriously and understood the questionnaire's content.

The refinements included to make the climate scenarios more realistic also seem to have been successful. Perhaps the key point is that survey research on climate change can usefully link real-world climate conditions to survey measures of value. One does not have to rely on 'sound-bite' characterizations of climate change, or on hypothetical scenarios exploiting psychometric principles alone. One can construct climate change scenarios that reflect good survey science and good climate science.

For our samples of Los Angeles area residents, we were able to place at least rough estimates of value on climate scenarios that reflect potential patterns of climate change. For these respondents, we have taken a step toward being able to link public sentiments about the value of climate to real-world manifestations of climate change. Given certain rather specific and empirically possible kinds of climate change, we now have a better idea about the relative importance of various climate dimensions and perhaps even some sense of how much those dimensions are valued.

More specifically, willingness to pay to prevent various forms of climate change from materializing seems to be driven primarily by increases (not decreases) in temperature for the summer scenarios. For the winter scenarios, willingness to pay is driven primarily by reductions (not increases) in precipitation. Changes in temperature seem to be less important, at least within the range of climate changes we explored. However, like Berk and Schulman (1995), we stress that questionnaire assessments of climate change can be significantly affected by the climate in which respondents live. Context-free surveys risk serious errors. Thus, one cannot automatically generalize our substantive findings to other geographical areas.

Willingness to pay also seems to be associated with each of the four value types we measured: quality of life, effect on wildlife habitats, economic impact, and effect on the next generation. While there is a hint that concerns about quality of life are most important, our data did not allow us to effectively disentangle the separate roles of the four value types. This may reflect a weakness in our data or how we have analyzed it. Alternatively, it may reflect the empirical reality that our respondents are (at least presently) unable to make clear distinctions between the various implications of climate change. Or, it may be that the different implications of climate change, while conceptually distinct, may in fact be empirically indistinguishable.

Finally, we have provided some dollar estimates for how the public values climate. The dollar values represent willingness to pay to prevent a change from some current climate to some future climate. While these figures appear sensible, we stress that they should not be taken literally and at face value. The survey methods we employed would benefit from further refinements. Perhaps most important, our willingness-to-pay estimates are *site-specific*. The current climate, plausible future climates, as well as the public reaction to those possible climate changes, might well be very different in other parts of the country.

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Notes

[1] This is an important issue because all other survey research of which we are aware on the public's views about climate change have ignored the climate individual respondents experience.

[2] While we will consider the issues again later, the only way to really address the impact of providing geographical references points would have been to build that into the scenario design; a random set would have such reference points and a random set would not. Unfortunately, we did not have the resources to collect information from a large enough sample of respondents to make that possible.

[3] Additionally, even if we had tried to educate respondents about the impact of climate change, choosing effects on which there is scientific consensus would have proved impossible. 'Integrated assessment' is currently among the most difficult and controversial aspects of climate change research.

[4] The words 'winter' or 'summer' and the corresponding scenarios to follow were selected at random to remove any order effects.

[5] Owing to the way the climate scenarios were constructed, the statement 'only about one winter in twenty is that warm and wet' should actually read 'only about one winter day in twenty is that warm and only about one winter season in twenty is that wet'. Recall that the temperature and precipitation dimensions were separately defined in terms of the historical intra-seasonal and inter-annual variations, respectively. As presented to the respondents, the statement inadvertently suggests a much larger inter-annual seasonal temperature variability than has actually existed in Los Angeles. This misstatement, which also affects the other three cases within the winter scenario, arose during the process of revising the instrument, when we were trying to word the questions in the most simple and succinct language possible. The effect of this misstatement is unknown, but it will be shown later that the public was not very sensitive to variation in the temperature dimension of the winter scenario. If the error in wording had made a material difference, one would have expected exactly the opposite. The impact of temperature should have been inflated. Thus, it may be reasonable to conclude that the misstatement is a harmless error.

[6] Recall that all dollar amounts inserted were selected at random with equal probability. We sampled with equal probability to allow estimates of willingness to pay for each dollar amount to have the same statistical power. Since the mean was computed by adding each dollar amount multiplied by the the proportion who were willing to pay that amount, sampling with equal probability is irrelevant to the validity of the mean value. However, it is likely that the mean would vary if the dollar amounts inserted had been different and in particular, if the maximum had been larger. Thus, the mean may be conservative on these grounds too, although extrapolating from our data, it is very unlikely that many respondents would have been willing to pay monthly sums larger than the maximum we used (i.e., $100).

[7] The issues discussed above with respect to the overall proportion and grand mean apply to the proportions and means in each cell.

[8] There is also no statistically significant interaction effect in the Table.

[9] In addition, there are no statistically significant interaction effects in any of the winter scenario tables.

[10] Scenarios are nested within respondents, much as in a repeated measures design or as in a hierarchical model.

[11] This test is overly optimistic because the within-person correlations reduce the estimated standard errors somewhat. However, the results are robust to tests of the importance of the within-person correlations. See Berk and Schulman (1995) for technical details.

[12] The lack of statistical significance for the majority of the concern items, compared to the results for the earlier analyses, results from a combination of smaller sample sizes and the far larger number of control variables.

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