Climatic Change (2008) 90:343–358
DOI 10.1007/s10584-008-9428-7

The effects of information and state of residence on climate change policy preferences

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Received: 31 March 2006 / Accepted: 18 February 2008 / Published online: 19 June 2008

Abstract Discerning the general public's support of climate change policies is a significant part of understanding the political and social dynamics of mitigating climate change. National level surveys are a useful tool for furthering this understanding but present multiple challenges, two of which are addressed in this paper. The first challenge is that the U.S. public's limited knowledge of climate change issues requires that information is provided in the survey, and that the content of this information is thought to be critical in eliciting accurate responses. Second, the use of national surveys may mask regional and state differences that result from the distribution of predicted climate change impacts and varying social contexts. We explore these issues by assessing the impacts of (a) the provision of information on climate change impacts at different scales (national and regional) and (b) the respondent's state of residence (Michigan or Virginia) on climate change policy support. We found a modest relationship between state of residence and policy support, with Michigan residents less likely to support climate change mitigation policies than residents of Virginia. The provision of information on the regional versus national level of predicted impacts of climate change did not influence climate change policy support.

1 Introduction

There has been much speculation that public opinion on climate change policies is greatly influenced by how the public understands climate change. One common belief is that

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understanding local and regional impacts will make this issue more "real" to individuals and that this information is needed in order to mobilize people to take action on climate change. This belief is reflected in the Intergovernmental Panel on Climate Change (IPCC) chairman Rajendra Pachauris's statement that "there is an opportunity for much political debate when you start to predict the impact of climate change on specific regions. But if you want action you must provide this information" (Schiermeier 2003). In this study, we test whether local and regional information and geographic location influence climate change policy support.

National surveys are frequently conducted and used to inform federal level policy decision-making, but how to best conduct and utilize them raises multiple questions. For environmental issues, especially climate change, respondents may have little familiarity with the problem being considered (Dietz and Stern 1995). Hoehn and Randall (1987) have asserted that providing relevant information about an environmental resource can reduce individuals' uncertainty in making decisions about that resource and can result in more accurate responses to surveys. In 1993, the National Oceanographic and Atmospheric Administration convened a panel to make recommendations for the improvement of contingent valuation studies, surveys conducted to elicit willingness of respondents to pay for a proposed course of action (known as willingness-to-pay or WTP). The resulting recommendation for provision of "full and unbiased information" (Arrow et al. 1993) to improve the quality of survey responses raised many questions about what key components of information are necessary to reach this ideal.

A secondary challenge to utilizing national surveys to investigate climate change is that the national level may ignore differences between regions or states. For climate change policy this is hypothesized to be important as the economic and environmental consequences of climate change and its mitigation policies are not predicted to be evenly distributed across the nation (National Assessment Synthesis Team [NAST], 2000). If people are weighing the costs and benefits of supporting a specific policy action to themselves, then their geographic location may be an important factor in their decision. In addition, the social context, which can be defined by the respondent's surroundings (or location) and how others in their community act, can also have an influence on people's beliefs and attitudes (Settersten 1999).

In this study, we consider the effects of information provision and geographic location on respondents' preferences for policies to reduce the burning of fossil fuels. We begin by summarizing the literature on people's understanding of climate change, which demonstrates the need for providing climate change information in surveys. We then summarize prior work on information effects and the effects of geographic location, providing a theoretical rationale for expected relationships between state of residence and survey information given to our respondents and their support of climate change-related policies.

1.1 The need for provision of climate change information

Several studies have found that the American public lacks a basic understanding of global warming, its causes, and the actions that can be undertaken to slow the rate of climate change. Individuals tend to confuse the problems of global warming and ozone depletion and view weather and climate as the same (Kempton 1991; Bostrom et al. 1994; Read et al. 1994, McDaniels et al. 1996; Henry 2000). Consistent with these misunderstandings, Bostrom and colleagues (1994) found that their study participants focused on ineffective actions to stop climate change, such as not using spray cans, and underemphasized the importance of energy conservation.

A Gallup study with a representative sample of the U.S. population (Dunlap 1998) also found low levels of global warming knowledge. In this study, only 11% of the Americans sampled said they understood global warming "very well." Furthermore, when asked to state the main causes of global warming, 12% mentioned fossil fuel use (the same was also found in a study by Brechin 2003); respondents mentioned ozone and CFCs much more frequently as causes. Knowledge appeared to increase when respondents were given causes from which to choose (68% of those surveyed selected automobile exhaust and 65% selected coal and oil power plants as causes; Dunlap 1998).

1.2 Information effects

Considering the lack of public understanding about climate change, we hypothesized that the information provided in a survey on climate change could have an influence on respondents' support for policies to mitigate the effects of climate change. A body of research has explored the effects of information provision on willingness to pay for environmental resources. This research has encompassed a broad range of environmental issues including wetlands, irradiated food, general natural resources, and climate change. The types of information manipulated in these studies included the causes of the resource degradation, the costs of limiting the degradation, the nature of the impacts, the quality of the resource, the substitutability of the resource, and the amount of information. The effects of these information manipulations on WTP (willingness-to-pay) have been mixed. For instance, Blomquist and Whitehead (1998) varied the description of the quality of the wetlands and found that it was a determinant of WTP to preserve the wetland. Hoehn and Randall (2002) found that willingness-to-pay values were sensitive to the magnitude of natural resource degradation (geographic extent and toxicity), but that the details of the "injury" to the natural resource were less important in determining the values. See Munro and Hanley (1999) for a comprehensive review of information effects and willingness to pay.

A few studies have focused specifically on climate change. O'Connor et al. (1999), seeking to alter people's risk perceptions and beliefs as little as possible, provided information about the causes of climate change but not the potential impacts in their survey instrument. Knowledge about the causes of climate change was a powerful predictor of behavioral intentions; however, knowledge possessed prior to the survey was the key predictor, not the information read within the survey prior to answering questions. Berrens et al. (2004) found that when giving participants only basic information on climate change versus the option to access enhanced information on climate change through utilization of a web survey, respondents tended to seek only a minimal amount of information. Among those who sought information, greater expenditure of effort in seeking information (measured as number of pages clicked and time spent seeking information) was related to higher willingness to pay. Berk and Schulman (1995) provided complex climate change scenarios to a sample of Southern Californians and theorized that respondents would identify the most salient information aspects and provide WTP values based on those pieces of information. Respondents' WTP was more affected by changes in temperature than by changes in precipitation, but the magnitude of the change itself did not seem to influence responses. Another study (Berk and Fovell 1999), conducted with a sample of Los Angeles residents, varied information about the expected changes in climate consistent with variations in current predictions. WTP values were higher among those respondents whose surveys predicted warmer local temperatures compared to those whose surveys predicted cooler local temperatures.

1.3 Spatial scale of information and climate change policy preferences

We chose to explore the possible differences between the provision of regional and national scales of information because there is a strong sense in the climate change research community that information on impacts at the regional level are more relevant to public and political engagement than information at the national or global level (Easterling 1999; Cash and Moser 2000; Holman et al. 2005). Building on the above research, our study considers the effects of varying the geographic scale, or resolution, of information about the environmental and economic impacts of climate change on values, attitudes, and climate change policy preferences. This survey was fielded to the general populations of Michigan and Virginia and since most of the general public does not have extensive knowledge about climate change, background information on how climate change may affect the region of the country people reside in was provided to one half the sample in each state, while information on expected national impacts was given to the other half of the sample in each state. By region, we mean major sub-sections of the country as defined by the U.S. National Assessment of the Potential Consequences of Climate Variability and Change. Michiganders in the local treatment group received information about the Great Lakes region while Virginians in the local treatment group received information about the Mid-Atlantic region. In both cases, information was extracted from the regional reports of the U.S. National Assessment of the Potential Consequences of Climate Variability and Change (http://www.usgcrp.gov/usgcrp/nacc/background/regions.htm).

The explanation as to why we might see differences between local and national information treatments is nuanced, but is based on the scientists' belief that it is important to understand impacts at finer spatial scales. It is assumed that the geographic scale at which people perceive an environmental impact is a factor in how they perceive the impacts affecting them and their consequential willingness to act to mitigate climate change. One way to think of this is as a logical consequence of the logic of commons. The more local the resource or impact, the more it resembles a private rather than a public good, and thus the more willing those within the area under consideration might be to take action to avert degradation (Dietz et al. 2001). This, however, has not been explored in the context of climate change and the content of information given in a survey.

In addition to the general work on commons, two lines of research also provide theoretical and empirical underpinnings for this hypothesis. There is evidence that people value resources differently based on their spatial distance from the resource. Averting behavior is one such piece of evidence; people have been found to be willing to pay to move further from a negative environmental impact (Smith and Desvouges 1986; Smith 1997). The second line of research stems from work on the Environmental Kuznets Curve (EKC). Evidence on the EKC indicates that effects that are distant in time and space do not decrease with increasing gross domestic product (GDP) while more localized impacts do decrease at high levels per capita GDP (Arrow et al. 1995; Ansuategi 2003). Others (Brechin and Kempton 1994; Inglehart 1995; Dunlap and Mertig 1997) have also found that the presence and observation of objective environmental problems in people's local area or country contributes to whether they are willing to make financial sacrifices to protect the environment. Anyone who has witnessed the social phenomena of "not in my backyard" (NIMBY), where communities organize to keep a negative environmental impact (e.g., a garbage incinerator or coal plant) out of their local community, has seen first hand how the proximity of the risk can influence willingness to act (Hannon 1987; Dear 1992). NIMBY illustrates that people tend to be more willing to mitigate a local impact and less willing to mitigate an impact outside their proximate environment. NIMBY is just one

example of spatial discounting—the idea that people decrease their valuation of (discount) environmental impacts the further the impact's distance is from their location (Perrings and Hannon 2001). Thus willingness to support policies to mitigate an environmental impact is expected to be higher the closer the impact is perceived by the respondent, with decreasing willingness to support policies the further away the impact is perceived to be. These lines of research suggest there will be greater public support for localized issues compared to ones scaled at a broader (e.g., national) level.

In integrating spatial discounting into decisions, there are two factors to be considered: where the respondent is located spatially (their state of residence for our analysis) and where the respondent perceives the environmental impact to be located spatially. As mentioned earlier, the provision of information allows the respondent to construct a specific scenario and develop the value they associate with the environmental impacts described. We hypothesize that those receiving the local information treatment will construe climate change as having a more localized impact than those receiving national information, and thus would be more willing to support policies to avoid those impacts. Those receiving national level information would perceive the impacts as being further away and because of spatial discounting would be less willing to support policies that mitigate the effects of climate change.

1.4 State effects

While up to this point we have mainly discussed the effects of information provision on policy preferences, the inclusion of individuals from two different states may also affect policy preferences. Sociologists have long recognized the importance of social context (in this study defined as state of residence) on individuals' attitudes, beliefs and experiences (Settersten 1999). Michigan and Virginia have similar population demographics (U.S. Bureau of the Census 2000) and about 70% of the population in both states is urban, although both states have 9–10 million acres in agriculture, so agriculture is important. Michigan has been traditionally dependent on automobile and manufacturing industries, while Virginia has many government employers and some parts of the state are dependent on coal mining (U.S. Bureau of the Census 2000).

The literature also suggests that the geographic location of the respondent is important because baseline climatic conditions in one's local area might impact his/her willingness to support climate change policies. The climates of Virginia and Michigan, both highly variable within each state, differ from each other significantly. For the year this survey was fielded (2004), Virginia had a mean temperature of 56°F. and 51 in. of rain, while Michigan had a mean temperature of 45°F. with 37 in. of rain (NCDC 2004). More generally, Michigan has cold, snowy winters while Virginia has mild winters but hot, humid summers. Berk and colleagues' findings (Berk and Schulman 1995; Berk and Fovell 1999) suggest that the baseline microclimate people live in and the nature of the climatic change described to individuals are important determinants of their willingness to support various climate change policies. Thus Michiganders may be less willing to support policies to mitigate predicted warming impacts if they feel their current climate is cooler than desirable. Likewise, if Virginians feel that their region is warmer than the optimum temperature, then their support of policies to avoid potential warming effects of climate change may be heightened. We also hypothesize that the predicted cooling or warming of their local area will be more easily determined from local information than from national, and thus local information will have a greater effect on willingness to support mitigation policies than will national level information. Under this hypothesis, we would

expect an interaction between information on projected climate change and state of residence.

2 Methods

The experiment on the effects of information provision and state of residence on policy preferences was part of a broader eight-page survey to examine a range of predictors of policy support and attitudes about climate change. One thousand households were randomly selected from telephone listings provided by GENESYS Inc, a company that specializes in sampling lists. Half of the households resided in Michigan and the other half in Virginia.

As noted previously, within each state, households were randomly divided into two experimental groups: group 1 received within their survey a one-page summary of climate change information for their region of the country (either Great Lakes or Mid-Atlantic) and group 2 received a one-page national climate change summary. The climate change information was taken from recent reports generated for the U.S. Global Change Research Program (Mid-Atlantic: Fisher et al. 2000; Great Lakes: Sousounis and Bisanz 2000; National: NAST 2000). All information treatments included sections on recent climate trends, future climate trends, and key issues in each region/nation (as defined by each report). Major issues in the Great Lakes were water resources, land issues, and health and quality of life, while key issues in the Mid-Atlantic included coastal and water areas, land issues, and ecosystems. The climate trends predicted for the Great Lakes were an increase in temperature of 3.6 to 7.2°F. and 25% wetter by the end of the twenty-first century. The mid-Atlantic climate trends were similar predicting 2°F. increases by 2030 and an additional 3°–8° increases by the end of the twenty-first century with an unknown increase in wetness. Water issues, ecosystems, and quality of life were highlighted in the national climate change summary. The national summary did not include examples specific to the Great Lakes or Mid-Atlantic regions to avoid confounding regional and national level information. The three one-page summaries are provided in Appendix A.

The surveys were mailed in the fall of 2004. Well-established mail survey data collection protocols were followed (Dillman et al. 1974; Mangione 1998; Dillman 2000). All potential members of the sample were initially sent a letter explaining the nature of the study, a copy of the survey, consent information, a return envelope with prepaid postage, and a small token of appreciation. Three follow-up letters were used to maximize the response rate. In households with more than one adult, the adult whose birthday came next to the date of the participation letter was asked to participate.

Three hundred sixteen surveys were completed, with almost equal returns from each of the four state and information groups. Twenty-three percent of the sample was in the Michigan regional group, 28% in the Virginia regional group, 26% in the Michigan national group, and 23% in the Virginia national group. Sixty-five survey packets were returned due to bad addresses or undeliverable mail. It is unclear why the response rate was not higher, but we offer two explanations. First, all potential participants were initially told that their participation would include a second, follow-up survey, so this study was more involved than one-time only surveys.[1] Second, surveys were sent in the months before the U.S.

[1] The second survey involved an experiment in deliberation between study participants and will not be discussed here.

presidential election while many polling organizations were also contacting people during this time.

The low response rate compared to historical norms for mail surveys (Dillman 2000) is a limitation of this study.[2] The comparison between sample and Census demographics, however, suggests sampling biases may not be too extreme. The samples in both states had similar gender and age compositions and median age range, but had a lower proportion of non-whites (except a higher percentage of Asians in the Virginia sample than in the population) and more persons with post-college education. There were no differences in demographic characteristics between respondents in Virginia and Michigan, except for occupations (consistent with the differences described previously). Furthermore, a comparison of our sample's support for each of the policies to the support levels of the samples in the studies of O'Connor and colleagues (1999; 2002) indicated that similar percentages supported each of the policies.

Respondents ranged from age 18 to age 90, with an average age of 51 (standard deviation=15.1). Two-thirds of respondents were married, half were female, and the average number of years of education was 15 (SD=2.9, range=6–26). Fourteen percent of the sample had annual income less than $25,000; 23% had income in the $25,000–$49,999 range, 27% in the $50,000–$74,999 range, and 37% had income over $75,000. Forty-two percent of the sample considered themselves conservative, one-third said they were independent, and one-quarter were liberal.

Eight items were used to measure policy support, six of which were adapted from the work of O'Connor et al. (1999; O'Connor et al. 2002) and two were newly designed. Respondents were asked to indicate the probability they would support a referendum on different policy options to reduce the burning of fossil fuels. Response options were "definitely no" (1), "probably no" (2), "probably yes" (3), and "definitely yes" (4). While many people express general support for the environment and environmental policies, when given specific information about the costs of such policies, support tends to drop significantly (O'Connor et al. 1999). Therefore, most of the policy questions included an estimate of how much the policy would cost per household on average. Table 1 lists the policy proposals.

To analyze the data, ordered probit regression (McKelvey and Zavoina 1975; Maddala 1983) was utilized with STATA since policy preferences were measured on a four-point ordinal scale. Dummy variables reflecting state of residence (Virginia vs. Michigan) and information condition (national vs. regional) were entered into the models as predictor variables, with an interaction variable (state×information condition) entered into the model at the second step.

3 Results

The average level of support for each of the policies is provided in Table 1 by state and information condition, with the percent of respondents saying they would probably or definitely vote for each policy presented in Fig. 1. Respondents in all four groups were least likely to support the gas tax (overall only 18% were inclined to vote for this) and the tax on large vehicles (less than half the sample supported this). There was not as much opposition to the proposal to increase automobile fuel efficiency (61% were inclined to vote for this

[2] Some recently published social science studies report mail survey response rates, based on Dillman data collection procedures, similar to ours (e.g., Swoboda et al. 1997; Miller et al. 2002; Kaplowitz et al. 2004).

Table 1 Policy preferences by experimental condition: Means (standard deviations) on a 1–4 scale

Policy	MI regional	VA regional	MI national	VA national
Shifting federal government subsidies away from the fossil fuel industry (coal, oil, natural gas) to the renewable energy industry (wind, solar, biomass, etc.) to encourage cleaner forms of energy. This would make fossil fuels more expensive and renewable energy less expensive. Scientists cannot estimate the exact amount by which energy prices would change. The policy also might cause job losses in some industries and gains in others	2.9 (0.8)	3.0 (0.8)	2.8 (0.8)	2.9 (0.8)
An *energy tax* to fund a new government program to replace power plants that burn coal. The program would replace coal plants with new plants that would use cleaner sources of energy. The program would cost about $20 per household per month	2.6 (0.8)	2.7 (0.9)	2.6 (0.8)	2.6 (1.0)
Tough new regulations to discourage the use of coal. This would lead to a loss of jobs in the coal industry but may increase jobs in other energy industries. These regulations would raise the price of electricity, adding about $20 per month to the typical electrical bill	2.5 (0.8)	2.6 (0.9)	2.3 (0.8)	2.6 (0.9)
A *federal tax subsidy* to households and businesses that use solar and wind energy. Paying for the subsidy to those who use solar and wind energy would increase the average family's income tax bill by about $100 per year	2.7 (0.9)	2.7 (0.9)	2.3 (0.8)	2.8 (0.8)
A national *tax on businesses* that use coal and oil as fuels in their manufacturing. This encourages energy efficiency and the use of fuels that don't cause climate change. This tax would raise the cost of most things you buy by 2 percent.	2.6 (0.8)	2.6 (1.0)	2.3 (0.9)	2.6 (0.8)
A 60-cent per-gallon *gasoline tax*, over and above existing gas taxes, to encourage people to drive less	1.7 (0.8)	1.9 (1.0)	1.6 (0.7)	2.1 (0.9)
A 10% "*gas guzzler*" *tax* on vehicles that get less than 25 miles to the gallon. This would add about $2,000 to the price of a $20,000 vehicle	2.3 (1.0)	2.6 (1.1)	2.2 (1.0)	2.8(1.0)
A requirement that *automobile fuel efficiency* be increased from the current average of 28 mpg to 33 mpg. To maintain comfort and performance, new car prices would go up by an average of $2,000 per car	2.6 (0.9)	2.9 (1.0)	2.4 (0.9)	2.9 (0.9)

policy). In contrast, shifting government subsidies away from the fossil fuel industry to encourage cleaner forms of energy received the most support (supported by three-fourths of the sample); it is notable though that this was the only policy proposal that did not include a specific cost estimate. Just over half of the sample said they would be inclined to vote for the other five policy proposals.

Results from the ordered probit regressions are presented in Table 2. Robust coefficients, obtained from Stata 8.0, are listed. While the actual coefficients are difficult to interpret, similar to other regression modules, positive coefficients signify a greater probability of support for a policy as the independent variable increases in value and negative coefficients

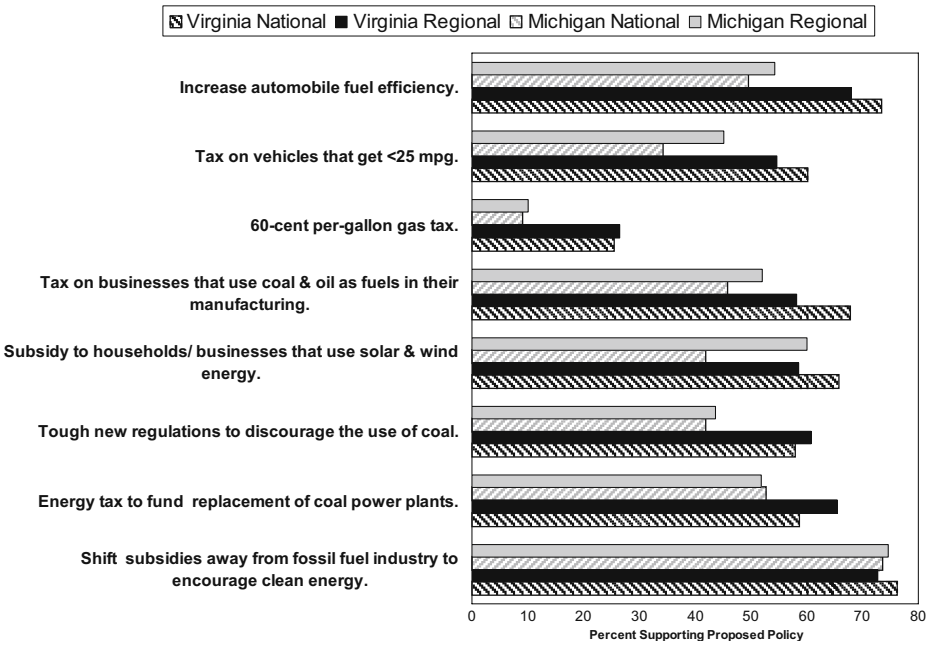

Fig. 1 Climate change policy support as a function of information treatment and state. Note: percentages reflect "probably yes" and "definitely yes" response options

signify a lower probability of support for a policy. For instance, a negative coefficient for state of residence on the gas tax indicates that Michiganders have less support for the gas tax than Virginians. Michiganders were less likely to support six of the eight policies than respondents from Virginia. There were no statistically significant differences across states in support for the policies to shift federal subsidies and to have an energy tax. Since the amount of explained variance for each of the models was quite small, however, the relationship between state of residence and policy support is modest at best. To examine whether employment in the auto industry accounted for these differences, we also estimated models in which we controlled for whether or not a member of the household was employed in the auto industry (19% of the Michigan sample). This variable was not significant and did not alter the effect of state of residence, so the Michigan effect is not an artifact of the greater number of auto industry employees in our sample. We also considered whether state differences reflected the fact that a larger portion of the Virginia sample reported living in urban areas (84%) than did those in the Michigan sample (74%, $Chi^2 = 10.8$, $p<0.05$), given that urban dwellers have been found to have higher levels of environmental concern (Freudenburg 1991; Uyeki and Holland 2000). Inclusion of this variable though did not have an impact on the effect of state.

Contrary to our hypothesis, the type of information provided did not have an impact on policy support. The interaction effect between information and state was significant only for the proposal for a tax subsidy for using solar and wind energy where it appears that providing information on regional impacts countered the negative effect of residence in Michigan. The effect of information type is consistently small compared with its standard error, such that the estimated effects would have to be between twice and five times as large, depending on the policy item considered, to be statistically significant in this sample.

Table 2 Probit regression results: Effects of state of residence and information provision on climate change policy support

	Michigan	Regional information	Interaction effect[a]	Pseudo R^2
Shift fed gov't subsidies away fossil fuel industry to encourage clean form energy.	−0.15	0.06	0.05	<0.01
Energy tax to fund new gov't program to replace power plants that burn coal.	−0.09	0.14	−0.10	<0.01
Tough new regulations to discourage the use of coal.	−0.37*	0.01	0.17	0.01
Federal tax subsidy to households/businesses that use solar & wind energy.	−0.53**	−0.10	0.53*	0.01
National tax on businesses that use coal & oil as fuels in their manufacturing.	−0.34*	−0.02	0.31	<0.01
60-cent per-gallon gas tax.	−0.57**	−0.21	0.26	0.02
Gas guzzler tax on vehicles that get <25 mpg.	−0.58**	−0.23	0.33	0.02
Policy to increase automobile fuel efficiency.	−0.60***	−0.10	0.27	0.02

*$p<0.05$

**$p<0.01$

***$p<0.001$

[a] The interaction effect is 1 for Michigan respondents who received regional information and 0 for all other respondents.

In the introductory section, we describe prior research that found the extent of knowledge before a survey is an important predictor of environmental concern rather than information provided within a survey. While we cannot assess individuals' climate change knowledge objectively, we did ascertain self-perceived knowledge in the survey. Respondents indicated whether they know "very little about it [climate change]" (1), "something about it" (2), or "a lot about it" (3). When included in the multivariate probit model, self-assessed knowledge was only positively predictive of support for the gas tax policy and the policy to shift government subsidies to the renewable energy industry ($p<0.05$). Since self-assessed knowledge is only predictive of two of the eight climate change mitigation policies, we cannot conclude that prior knowledge impacts policy support.

4 Discussion

There was a modest relationship between state of residence and policy support. This difference could not be accounted for by any of the social psychological or social structural variables included in our survey. Rather some more general factor in Michigan's culture may make residents less supportive of climate change mitigation policies. For example, though we asked respondents if they or their family works for the auto-industry and auto industry employment did not affect policy support, the effects of the auto-industry in Michigan may be more pervasive than direct economic interest. The strong economic influence of the auto industry in Michigan may shape the information and framing of climate change policy support in more subtle ways in the region. Thus, the prevalence of the automobile industry in Michigan may affect more than just those employed in the industry. More research is clearly needed to better understand the relationship between the state or region respondents live in and its relation to levels of climate change policy support.

Despite our expectations, we did not find evidence that regional information about climate change's impacts increased support for policies to mitigate climate change compared to those receiving national information. This finding contradicts conventional thinking that issues that have a direct impact on individuals' daily lives will receive greater support than those that are seen as further away. However, ours is not the first study to find that provision of information within a survey did not affect environmental preferences (e.g., O'Connor et al. 1999). Bord et al. (2000) found that it was not knowledge of impacts that predicted climate change policy support, but rather accurately knowing the causes of climate change.

We identify three potential alternative explanations for these results: (1) the provision of straightforward information in the survey did not engage respondents, (2) the regional versus national treatments were not distinct enough to yield different responses, or (3) people do not discern between regional and national impacts in the case of climate change.

It may be that straightforward provision of written information in a survey is not an adequate vehicle to engage respondents. It is difficult to assess if people meaningfully process or even read the provided information. This suggests that, on issues where public understanding is low, respondent education and eliciting accurate survey responses is not a simple task.

Alternatively, it may be that the information given in the survey was processed but that the differences in regional and national information treatments were not strong enough to yield different responses. The three reports, though highlighting some differences, did not vary much in terms of predicted climate change and the effects. Furthermore, it may be that the hypothesized differences in effects of national and regional information do not exist, at least for the kinds of impacts anticipated in the National Assessment.

Finally, the lack of impact of regional information on policy support may be specific to climate change and not reflect other environmental issues. Perhaps issues like toxic waste and degradation of local animal habitats are easier for individuals to identity with as far as personal impacts compared to climate change. Furthermore, climate change tends to be framed in the media as a national rather than regional phenomenon, so the public's large source for climate change information is focused on national and global effects. Thus it might be useful to contrast information on global impacts, national impacts, regional impacts and impacts at the community level and to compare information provision about climate change to other environmental issues.

This study indicates that before the scientific community can conclude that public support is greater for localized issues, more empirical research is needed to better understand the role of framing issues at different geographic scales. In reflecting on what the findings of this survey may mean for climate science, we argue, as many have before us, for a more deliberative process between climate science and the public. While it is certainly true that high resolution local information on impacts is necessary for enabling specific groups of decision-makers to adapt, we ought not assume that the public cares only about regional impacts or all regional impacts. Research indicates that the public currently does indeed perceive the issue of climate change as a global phenomenon. Leiserowitz (2006) found that people have a higher level of risk perception about the global aspects of global warming and 58% state they are most concerned about "people all over the world," while only 12% are most concerned for themselves and their family. This same research has highlighted the role of imagery of climate change and the attached positive or negative emotion (affect). Those who identified imagery like melting glaciers and polar bears were most likely to support climate change policies. Additionally, research we conducted (Dietz et al. 2007) identified the role pre-existing beliefs about the consequences of climate change

and general trust in environmental agencies and industries had in determining policy preferences. In designing future climate research agenda, as well as future surveys, it is important to engage the public to find out what they care about in their lives and provide information on how climate change impacts those things, moving us closer to the NRC recommendation "getting the science right, and getting the right science."

Acknowledgement This research was funded by the National Science Foundation (Grant # SES-0340621) and the Environment Research Initiative of Michigan State University.

Appendix A Climate change information given to study participants

National information sheet

The next set of questions pertains to proposals to reduce the negative effects of burning fossil fuels, including coal, fuel oil and gasoline. Research indicates that using fossil fuels contributes to climate change. Below is some information about how these issues may affect the United States. This information was taken from a 2000 report by a federal research program that was conducted by university and government scientists. Because climate change is quite complex, none of the information we have about its effects are absolutely certain. This is a summary of the best understanding scientists have at present, but most scientists agree things could be much worse, or not nearly as bad.

Recent climate trends Over the twentieth century, the average temperature in the U.S. has risen by about 1°F. About half of this rise has occurred since the late 1970s. The coastal Northeast, the upper Midwest, the Southwest, and parts of Alaska have experienced about 4°F increases in the annual average temperature over the past 100 years. Precipitation has increased nationally by 5–10% over the last century. The warming is also causing Arctic permafrost to thaw, and is melting sea ice, snow cover and mountain glaciers. Global sea level rose 4–8 in. during the twentieth century because ocean water expands as it warms and because melting glaciers are adding water to the oceans.

Future climate trends The temperature in the US is likely to increase on average by 5°–9°F over the next 100 years, which is more than the projected global increase. This rise is expected to result from greater precipitation and faster evaporation of water, causing greater frequency of both very wet and very dry conditions.

Key effects of climate change

Water issues Sea-level rise is very likely to result in the loss of coastal wetlands, which provide habitats for many fish species, and put coastal communities at greater risk of storm surges, especially in the Southeast.

Reduction in snowpack will very likely alter the timing and amount of water supplies, potentially increasing water shortages, particularly throughout the western U.S. The melting of glaciers in the high-elevation West and in Alaska would represent the loss or diminishment of unique national treasures of the American landscape.

Ecosystems Natural ecosystems are most vulnerable to the harmful effects of climate change. Some ecosystems that are already constrained by climate, such as alpine meadows in the Rocky Mountains, are likely to face extreme stress, and disappear entirely in some places. As another example, the species composition in the Northeast forests is predicted to change, including the loss of sugar maples.

Quality of life Large increases in the heat index and in the frequency of heat waves are likely. These changes will at a minimum increase discomfort, particularly in cities. In various parts of the nation, cold-weather recreation like skiing will very likely be reduced, and air conditioning usage will likely increase.

Michigan regional information sheet

The next set of questions pertains to proposals to reduce the negative effects of burning fossil fuels, including coal, fuel oil and gasoline. Research indicates that using fossil fuels contributes to climate change. Below is some information about how these issues may affect the Great Lakes region. This information was taken from a 2000 report by a federal research program that was conducted by university and government scientists in the Great Lakes area. Because climate change is quite complex, none of the information we have about its effects are absolutely certain. This is a summary of the best understanding scientists have at present, but most scientists agree things could be much worse, or not nearly as bad.

Recent climate trends for the Great Lakes region The average temperature has increased over the past 20–30 years in the Great Lakes region, but has remained within the range of temperatures experienced over a longer historical period. Annual precipitation has increased, with many of the changes quite substantial, including as much as a 10–20% increase over the twentieth century.

Future climate trends Models of climate change suggest that over the next century the climate will become warmer, with average temperature increases between 3.6 and 7.2°F in the Great Lakes region by the end of this century. Summertime heat waves may become more frequent. The climate is projected to be about 15–25% wetter by 2100. The models also indicate that there will be fewer cold air outbreaks in winter. In the Lake Erie and Lake Michigan snowbelts, there will be less lake effect snow.

Key issues in the Great Lakes region

Water resources Over recorded history, the Great Lakes have varied in level by about 6.5 feet, with typical changes across seasons of 10–12 in. The 1980s were periods of record high lake levels. Declines in lake levels since then have caused concern among commercial shippers, hydroelectric companies and recreational boaters. Climate models suggest that lake levels may hold steady or decline by as much as 3 feet over the next 30 years, with ice cover decreasing in winter.

These changes in climate will likely decrease the amount of oxygen available for fish in the Great Lakes. The reduced amount of snowfall in winter will also change the spring flow of water into the Lakes from streams and rivers, but the details of what may happen are not understood. There is concern that these changes could impact commercial and recreational fishing.

Land issues The change in climate may lead to declines in economically significant trees such as quaking aspen, yellow birch, jack pine, red pine and white pine. Eventually, black walnut and black cherry may replace them. Some upland game birds, such as ring-necked pheasant and northern bobwhite, may increase, while sharp-tailed grouse and gray partridge may decline. Migratory birds that arrive in spring may decline by as much as one-third, with some kinds of birds, such as the warblers, declining by two-thirds.

Health and quality of life Climate models suggest a significant increase in the number of summer days with temperatures above 90°F. This could lead to greater amounts of heat

stress, dehydration, respiratory diseases, heat stroke or heart attacks. Floods, tornados and blizzards may also become more frequent. It is likely that the number of days with serious ozone air pollution will increase.

Virginia regional information sheet

The next set of questions pertains to proposals to reduce the negative effects of burning fossil fuels, including coal, fuel oil and gasoline. Research indicates that using fossil fuels contributes to climate change. Below is some information about how these issues may affect the Mid-Atlantic region. This information was taken from a 2000 report by a federal research program that was conducted by university and government scientists in the Mid-Atlantic area. Because climate change is quite complex, none of the information we have about its effects are absolutely certain. This is a summary of the best understanding scientists have at present, but most scientists agree things could be much worse, or not nearly as bad.

Recent climate trends for the Mid-Atlantic Over the 20th century, the average temperature has risen 1°F and precipitation amounts have increased about 10% in the Mid-Atlantic region. Sea-level has been rising about 1–2 in. per decade along the coastline. In addition, there have been variations over the years in extreme events, including droughts and floods.

Future climate trends The temperature in the Mid-Atlantic region is likely to increase by 2°F by 2030 and may increase an additional 3° to 8°F by the end of the 21st century. It is likely that average annual precipitation will also increase, but the models used aren't certain about how large the increase will be or in what seasons it will occur. Slight increases in the frequency and intensity of winter storms are also predicted. Sea level is projected to rise 15–40 in. during this century due to climate change.

Key issues in the Mid-Atlantic region

Coastal and water areas Higher temperatures are expected to result in sea-level rise. Sea-level rise may flood coastal regions and raise storm surge levels, which will likely cause significant damage along both the coast and inland. Sea-level rise threatens beaches, beach properties, wetlands, estuaries, barrier islands that help protect the mainland from storm surges, the coasts themselves, and water supplies. Measures to protect the coastland from flooding and other weather related effects and damages occurring from flooding are expensive for the Mid-Atlantic region.

Land issues Maple, beech and birch trees will likely gradually be replaced by hickory, oak and pine, making hardwoods that are valuable for furniture less abundant. Eventually, climate warming may cause trout habitat to shrink, particularly for brook trout, and warmer water fish, like bass, will increase.

The Chesapeake and Delaware Bays are home to two of the largest concentrations of migratory shorebirds in the western hemisphere, including red knot, dunlin, sanderling, semipalmated sandpiper and ruddy turnstone. Projections of warming water temperatures, potential streamflow increases, and larger human populations in the Mid-Atlantic region suggest water quality in the bays may decline and will consequently reduce the amount of shallow water habitat suitable for wintering waterfowl.

Ecosystems Several rare wetland ecosystems are threatened in the Mid-Atlantic. More than 85% of lowland evergreen shrub bogs and upland sphagnum bogs have been lost in some Mid-Atlantic states, and more than 98% of original stands of Atlantic white-cedar

swamp forest have been destroyed. Drainage, pollution, and non-native invasive species pose major threats to fresh water wetlands. Since species are affected differently by climate changes, relationships among species will be altered in the future, thus affecting ecosystem functioning and biodiversity, but the details are not yet understood.

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