

# Utilization of Science-Based Information on Climate Change in Decision Making and the Public Policy Process - Phase I



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# Project Overview and Design

The focus of this report is an examination of the extent to which climate change is seen as a potential problem by key U.S. stakeholders and the role of scientific and technological information in framing stakeholders' evaluations of climate change and related policy choices.

## Project Objectives

The overarching research focus was on developing a deeper understanding of how decision makers—individual citizens, policy makers, and climate change scientists—utilize science-based information on climate change in their individual and collective decision processes. This focus was consistent with NOAA's mission goals of: 1) understanding climate variability and change, and in enhancing the ability of society to plan and respond to these factors; and 2) serving society's needs for weather and water information and its interest in seeing this information play an important role in decision making (NOAA, 2003). According to the National Research Council (1999), many unresolved issues linger with regard to the human dimensions of global climate change. Of particular interest to this project is the National Research Council's recognition that there is a need to improve methods for decision making about global climate change, to improve our understanding of the role of institutions and their climate change policies at all levels (National Research Council, 1999, p. 295).

In order to serve these needs effectively, accurate data are needed on the way science-based information is defined, transmitted, received and used along with the many other factors that influence decision making in this complex area. Much attention in the area of climate change is focused on the science itself—is there consensus among scientists; is the information accurate or biased; are the models refined enough to be useful decision tools? These are legitimate and significant issues. Our research focused on a different set of questions—how climate change science is actually received, understood and used by decision makers.

## Research Questions

The tracing of climate change information flow and the identification of the facilitators and barriers to its acquisition and use will be important aspects of the research. This project addressed three general and a number of more specific research questions:

- How do stakeholders evaluate the issue of climate change?
  - How important is the climate change problem compared to other issues?
  - What are the time scales of the climate change problem?
  - Who is more or less likely to view climate change as a problem?
- How do information users and consumers receive, process, interpret, and utilize science-based information on climate change? More specific questions included:
  - Where do stakeholders get their information about climate change?
  - How trusted are various climate change information sources?
  - What factors influence how climate change risk is assessed by stakeholders and what is the role of scientific information on this assessment?
  - What role does this science-based information play in the development of public policies in response to the reality of climate change?
  - What is the level of science-based information on climate change among members of the public?
  - How do scientists evaluate the accuracy of climate change information in the media?
- How is science, and climate science, developed within NOAA, and in particular within the NOAA lab structure? More specific questions included:
  - How is the research agenda with NOAA and NOAA labs set, and by whom?
  - How has climate change, as an issue, risen on the NOAA research agenda and what are the implications for NOAA?

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- What is the research process like and how is a new emphasis on output and products changing NOAA?
  - How do NOAA agencies and NOAA scientists view the policy process and their interactions with this process?
  - What are the implications from shifts in management, budget and structure within NOAA?

## Research Activities and Methodology

### Surveys

The project involved three separate surveys of key stakeholders. One surveyed a national sample of the American public. Another looked at key state, local and regional decision makers with authority over jurisdictions that were vulnerable to the effects of climate change. The final survey queried top U.S. climate scientists on their views of climate change science, issues and information sources.

#### Survey of Climate Change Scientists

The survey of climate scientists employed a journals-based sampling frame. Using climate science consultants tasked to the project, we selected thirteen internationally renowned scientific journals expected to place most climate change science articles. We looked at all the articles in these thirteen journals for the time period 1995-2004 that had key words related to global warming, global climate change and related terms. We identified (after removing non-eligibles) a total of 929 U.S. authors. We surveyed them between March and September 2005 using several contact modalities including mail, the web and personal telephone interviews. We were able to complete 514 scientist interviews for a response rate of 55%.

#### Survey of Decision Makers

We next sought to interview a representative sample of state and local officials and business leaders (and Coast Guard regional personnel) whose responsibilities included planning for the possible effects of climate change in their jurisdictions. We identified key city, county and state level leaders serving in public agencies ranging from public health to planning, state leaders in agencies ranging from economic development to environment, local chambers of commerce and Coast Guard Officials. The decision maker sampling frame is in the appendix, as is the relevant questionnaire instrument. We targeted a total sample of 780 of these state and local decision makers from around the nation and we successfully interviewed 579 for a response rate of 74.2%. Each respondent was sent a letter and contacted by phone and could choose to take the survey on line, over the phone, or through some other delivery mechanism. The survey was conducted from March 2006 to October 2006.

#### National Public Survey

The national public survey was conducted from July 13 to August 10, 2004. The survey focused on how U.S. citizens evaluated the climate change problem relative to other problems and on various time scales, where they got their information, how knowledgeable they were and what policy options they preferred. The survey respondents were selected randomly and the interviews were conducted by a professional telephone survey firm. The interviews averaged about 40 minutes each and 1093 were completed. Following American Association for Public Opinion Research conventions and algorithms, the response rate was 12.0%, the cooperation rate was 18.6%, and the completion rate was 69.1%.

### Interviews and Bibliographies

This project also involved a more systematic assessment of climate change, as an issue for research, with NOAA and the NOAA labs. The primary mechanism for conducting this research was a series of in depth interviews with NOAA lab personnel and other NOAA personnel. These interviews were evaluated and the relevant themes and issues were identified according to standard social science practices. Eighteen interviews were conducted for this aspect of the project and were supplemented by content analysis and literature

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reviews. These interviewees are referred to as anonymous in this report in order to maintain the human subjects requirement for this study.

In addition to the interviews, we developed two detailed annotated bibliographies on climate change and public health, and climate change and agriculture. The full bibliographies are available on the project website.

# Literature Discussion and Empirical Findings

## Surveys

### Views of the Climate Change Issue for Each Group of Survey Respondents

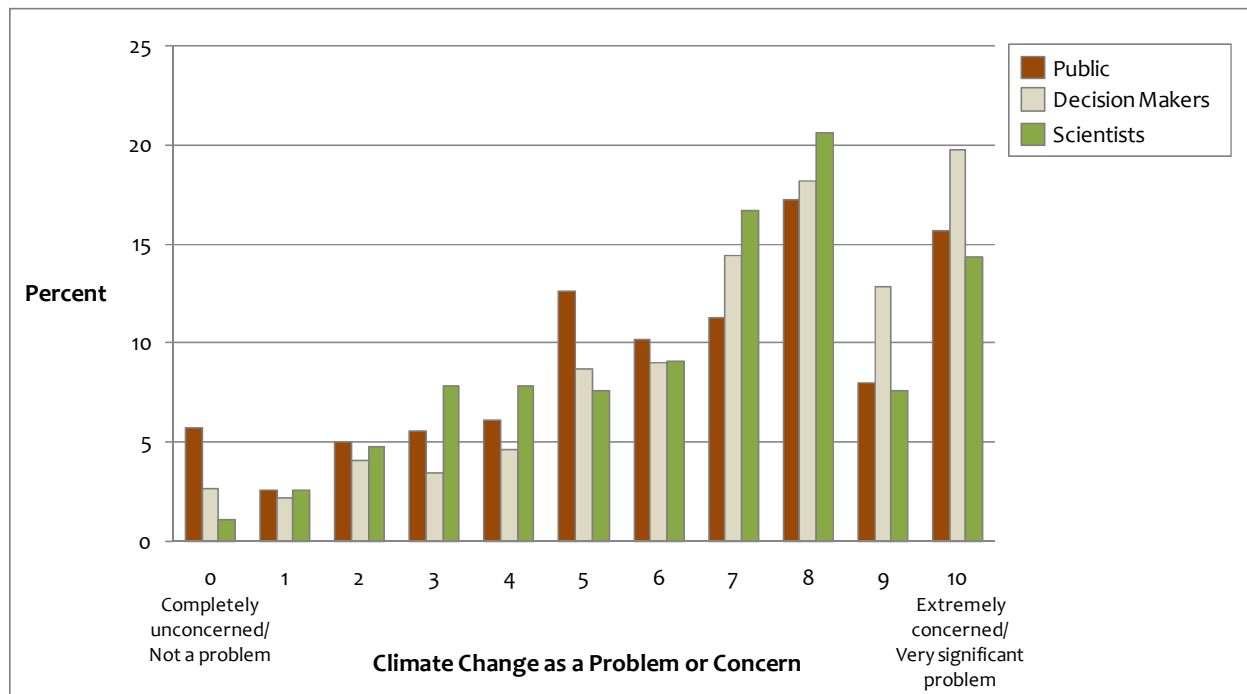
The key survey research goals for the project were to discover the perception of the climate change issue, the role of scientific information in the awareness, problem identification and decision making processes regarding climate change and the view of various climate change policy alternatives by our three key groups of respondents—the public, local and regional decision makers and scientists. We organize our discussion and findings, then, by those conceptual categories and for each of the three groups of respondents.

### Perceptions of the Climate Change Issue

Studies have shown that concern for climate change has been growing over the past several years. Surveys of the public (Bord, Fisher, & O'Connor, 1998; Kellstedt, Zahran, & Vedlitz, 2008; Krosnick, Holbrook, Lowe, & Visser, 2006; Lorenzoni & Pidgeon, 2006; Lubell, Zahran, & Vedlitz, 2007) and content analysis of the media (Liu, Vedlitz, & Alston, 2008; McComas & Shanahan, 1999) indicate a steadily growing awareness of climate change and a perception of it as creating significant risks. Scientists, too, have evidenced growing concerns for this problem as reflected in their individual publications and in important national and international reports (the IPCC reports of 1990, 1996, 2001, and 2007; National Research Council, 2001). The same is true of local and regional decision makers as they seek to understand the problem, assess its possible impacts in their areas and seek action strategies (Zahran, Brody, Grover, & Vedlitz, 2008). These concerns are not balanced across all population groups, however. Some societal and political groups are much more likely than others to perceive climate change as a problem (Wood & Vedlitz, 2009).

Figure 1 presents the extent to which respondents in each of our three samples are concerned about climate change or see it as a problem.

Figure 1. Awareness of the Climate Change Issue



Note: The public and decision makers were asked to rate concern about climate change from a 0 to 10 scale, with 0 being completely unconcerned and 10 being extremely concerned. Scientists surveyed were asked to rate

whether they viewed climate change as a problem on a scale of 0 to 10, with 0 being *Not a problem* and 10 being *Very significant problem*.

It is very clear from Figure 1 that all three groups of respondents—the public, decision makers and scientists—see climate change as a significant problem. The mean score for climate change as a problem or concern among our respondent groups was 6.3 for the public, 6.9 for decision makers and 7.5 for scientists.

When compared to other issues of importance in the U.S. policy context, climate change, while not being the highest ranked, is seen by both decision makers and the public as relatively important. Table 1 reports the mean importance scores for several key issues for both the public and decision maker samples.

**Table 1. Importance of Climate Change Compared to Other Key Issues**

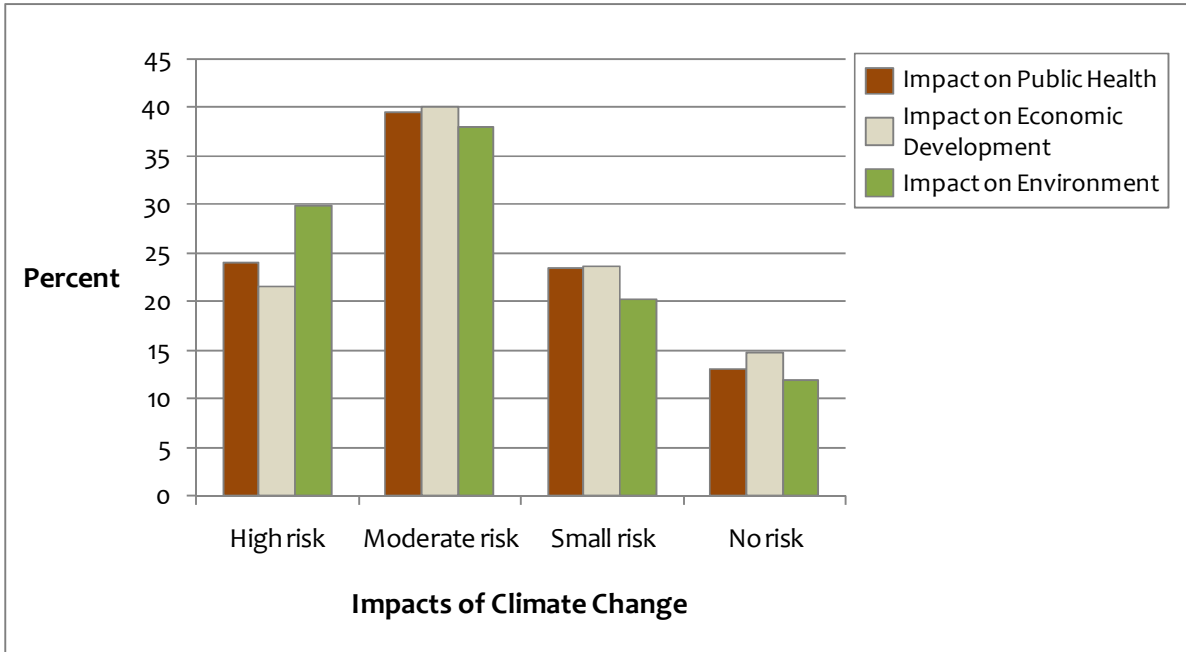
Issue	Public	Decision Makers
Health Care	8.1	7.9
Education	8.0	7.5
Energy	7.9	8.7
Environment	7.9	8.1
Poverty	7.6	7.4
Social Security	7.5	6.9
US Economy	7.5	7.2
Terrorism	7.8	6.9
Pollution	7.6	7.5
Government Debt	7.1	7.1
<b>Global Warming and Climate Change</b>	<b>7.0</b>	<b>7.7</b>
Economic Globalization	6.9	6.7
Genetically Modified Foods	5.5	4.5

The study next sought to discover what kinds of risks climate change posed and to what elements of society. The public sample was asked to rate the extent of climate change risk on public health, economic development and the environment. There is little distinction on the impact of climate change across the three sectors. The public assesses climate change to be a moderate level risk across all three (Figure 2a).

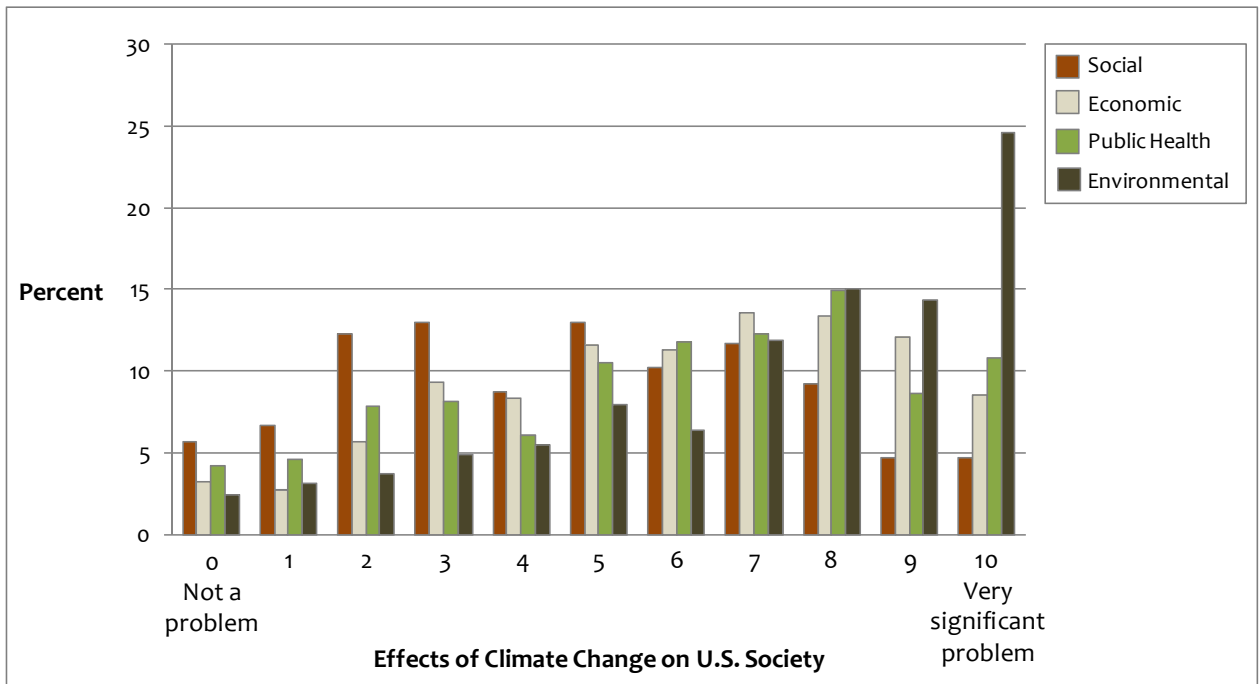
The decision maker sample was asked for a little more detail in their survey. Since they have to deal directly with the consequences of climate change impacts in their jurisdictions, we asked them to rate, on an 11 point scale, where 0 = not a problem and 10 = very significant problem, the impact of climate change on social, economic, public health and environmental sectors. The findings are reported in Figure 2b.

For decision makers, climate change is seen as a significant problem for several sectors but a very significant one for the environment. Just how negatively our scientists and decision makers view the effects of climate change is seen more clearly in Figure 2c. While both groups of respondents, scientists and decision makers, view the overall effects of climate change as substantially negative, it is the decision makers who actually see the most negative consequences. This is a telling statement of the threat local decision makers see on the horizon for their communities as climate change forces continue to grow and have impacts on the physical environment.

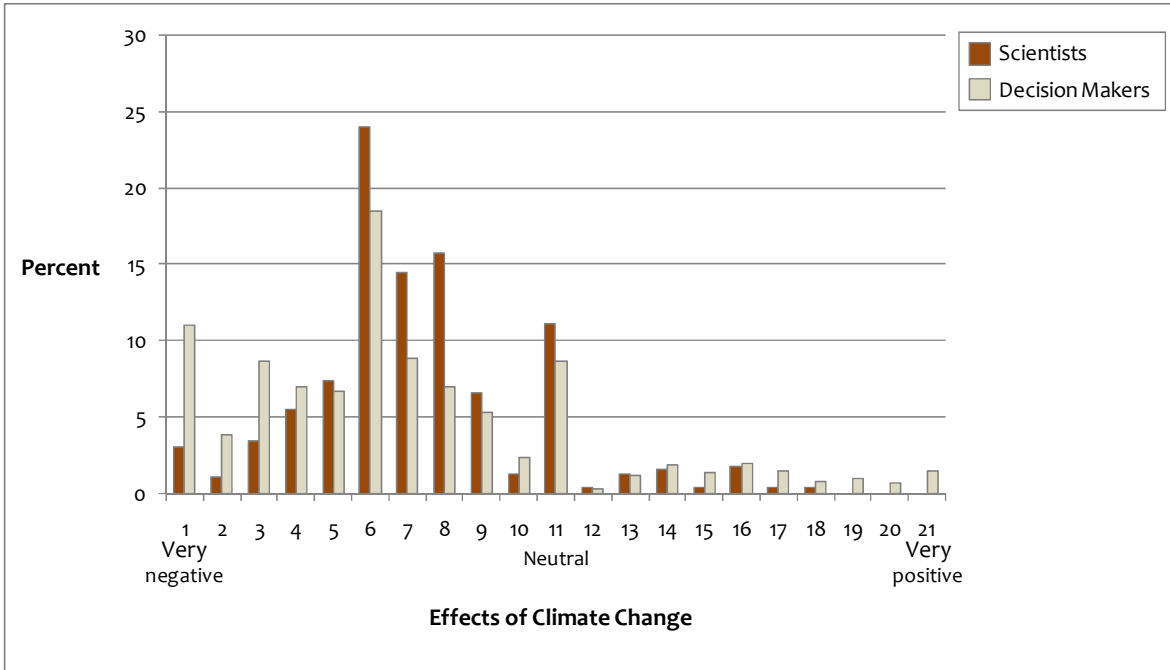
**Figure 2a. Public's Views toward the Impact of Climate Change**



**Figure 2b. Decision Makers' Views of Climate Change Effects on U.S. Society**



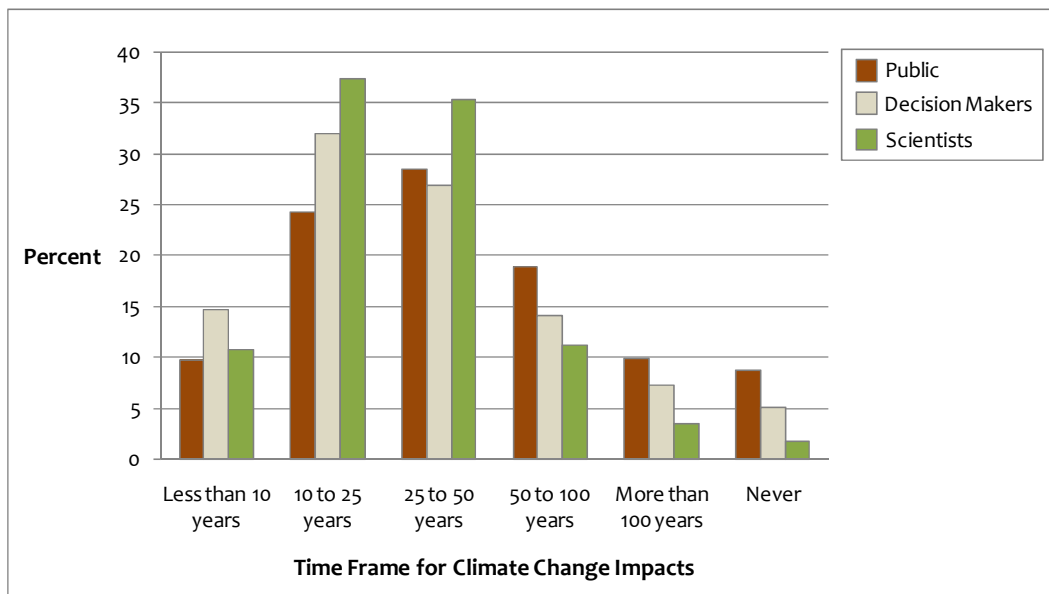
**Figure 2c. Comparison of Scientists' and Decision Makers' Views of the Effects of Climate Change**



It is clear, then, that all three major stakeholder groups evidence significant concern for climate change and its effects on their communities. The next question that emerges is the time frame for the likely significant impacts of climate change effects. Figure 3 arrays the percentage of each sample of respondents who say the impacts will be felt in the near term or the long term.

The findings in Figure 3 clearly indicate that most think the largest negative effects of climate change will occur in the 10-25 and 25-50 year time frames. Decision makers are a little more likely to fear the near term, but all three groups believe they have some time before the most burdensome effects of climate change will be experienced.

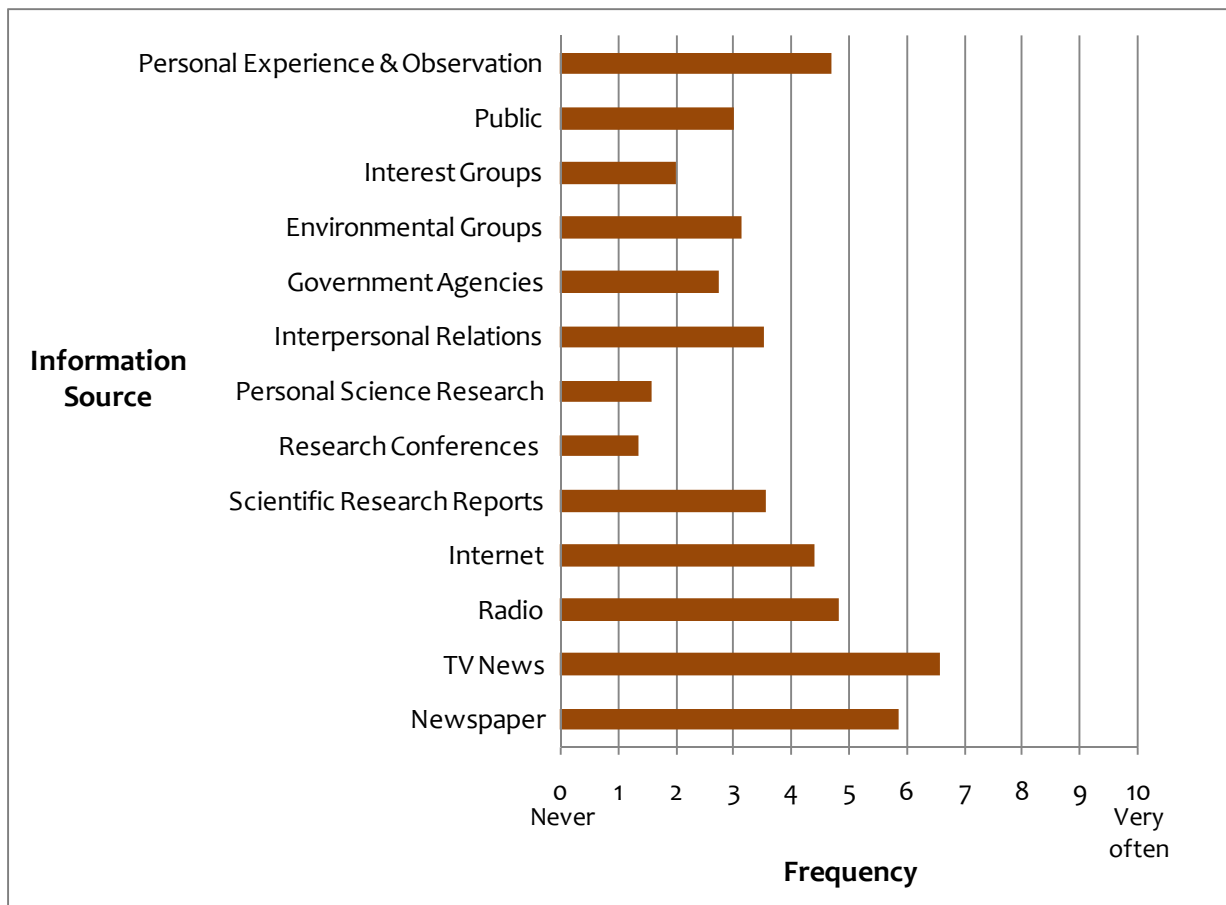
**Figure 3. Time Frame for Global Warming/Climate Change to Exert Significant Impact on the U.S.**



## The Sources of Scientific and Technical Information

Climate change is a very complex set of scientific and technical relationships and presents significant uncertainty for those who seek to understand its complexities and act on its likely consequences. The next major research question we sought to investigate, for our samples of stakeholders, then, is the awareness of scientific and technical information about climate change, the sources of this information and levels of trust in that information. In their public utterances, many notable scientists have asserted that if the public knew as much as they did, and understood things as much as the scientists did, then the public and decision makers would see the problem more like scientists do (Bucchi and Neresini, 2008; Wynne, 1991; 1995). The literature on the awareness of scientific information on climate change indicates that the public and its officials have limited understanding of the science of climate change, but that there are some who do know more about such things as the suspected causes of global warming (Kellstedt, Zahran, & Vedlitz, 2008; Krosnick et al., 2006; Sundblad, Biel, & Gärling, 2007). Large and important questions remain about how stakeholders and the public get their information about climate change and climate science and which sources of information they are more likely to trust. This information will, after all, be one of the foundations on which policy choices and resource allocations will be made. Knowing more about information sources and trust levels can help public agencies better structure education and outreach programs for the public and decision makers that can help individual and public decision processes. We first present the sources of climate change information and trust in that information for each of our three groups of respondents. We next identify the levels of knowledge our respondents have about climate change.

**Figure 4a. Public Survey – Information on Climate Change, Sources and Frequency of Use**



Mean of responses to question: “Please indicate how often you use each of the following sources for information on Global Warming and Climate Change, using a 0 to 10 scale where 0 is Never and 10 is Very often.”

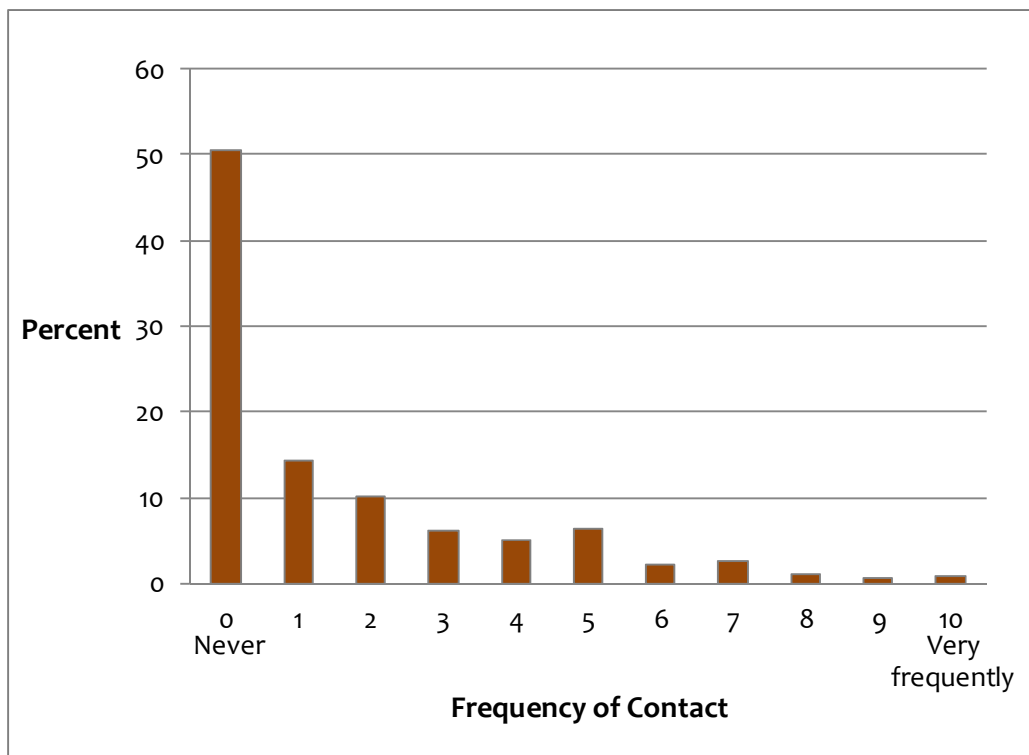


There is a little bit of a surprise in these findings. While everyone would expect that television and newspapers would be a key source of information about climate change, it is interesting to note that personal experience & observation is also highly ranked. This indicates a high level of interest in the public in this issue area and a personal commitment to seek and assimilate information. This can be very important for education or related campaigns that might be desired later.

Since scientific and technological information is at the core of much of the climate change policy debate, it is useful to know how much scientists, themselves, are participating in providing information to inform this discussion. Clearly, scientists speak through their research publications and scientific societies and their published reports, but we sought to examine how much scientists were directly involved in the provision of their findings and opinions to information consumers and the media. Figure 4b presents the extent to which decision makers report contacting scientists for information on climate change issues and Figure 4c presents scientists' reports of how much they have been contacted.

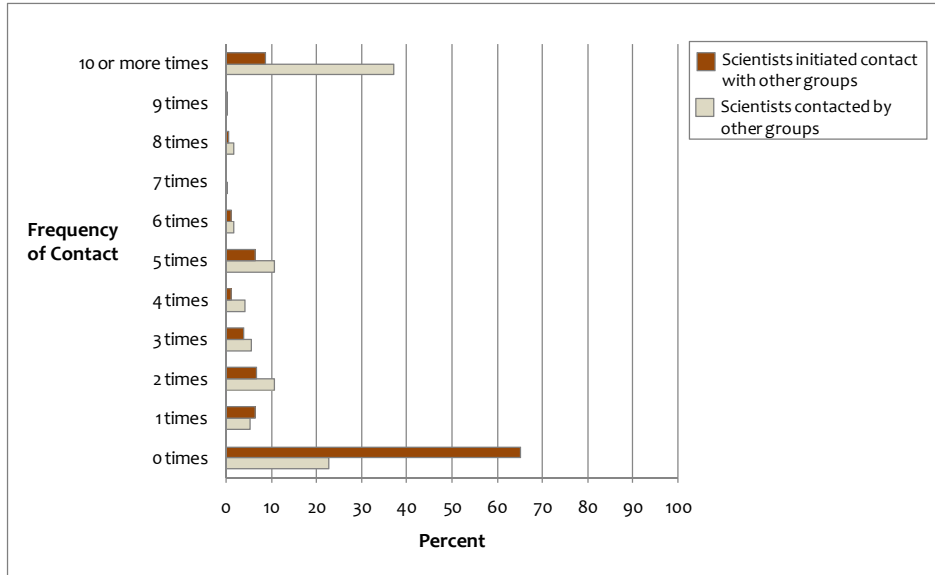
It is clear that most scientists have never been contacted by decision makers and the modal category for those actually being contacted is only one contact. A few decision makers, however, report making a lot of contacts. Even though few scientists are being contacted, it does appear that those making the contact do extend throughout the interested parties in the climate change policy debate—the news media, interest groups and public officials. The stark reality is that only a few decision makers are regularly seeking scientists for their direct opinions.

**Figure 4b. Decision Makers' Contacts of Scientists for Climate Change Information**



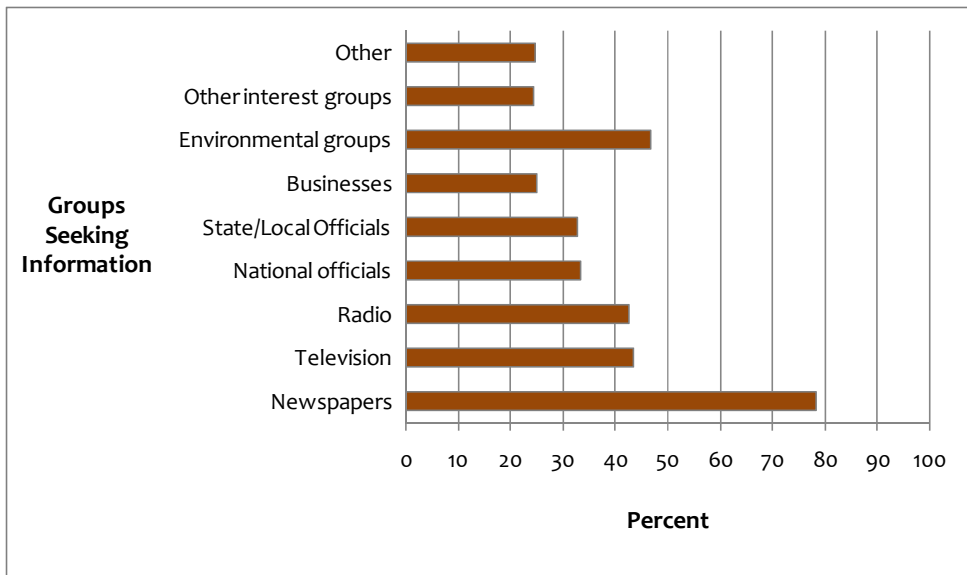
Responses to survey question: "On a scale of 0 to 10 where 0 is *Never* and 10 is *Very frequently*, how often do you contact scientists for information related to global warming and climate change."

**Figure 4c. Scientists' Survey – Frequency of Contacts For Climate Change Information**



Responses to questions: “About how many times in the last 5 years have you been contacted by any member of the media, a public official, or an interest group representative for information on global climate change?” and “About how many times within the last 5 years have you initiated contact with some member of the news media, public officials or interest groups to give them information on global climate change?”

**Figure 4d. Groups or Individuals Seeking Information on Global Climate Change from Scientists**

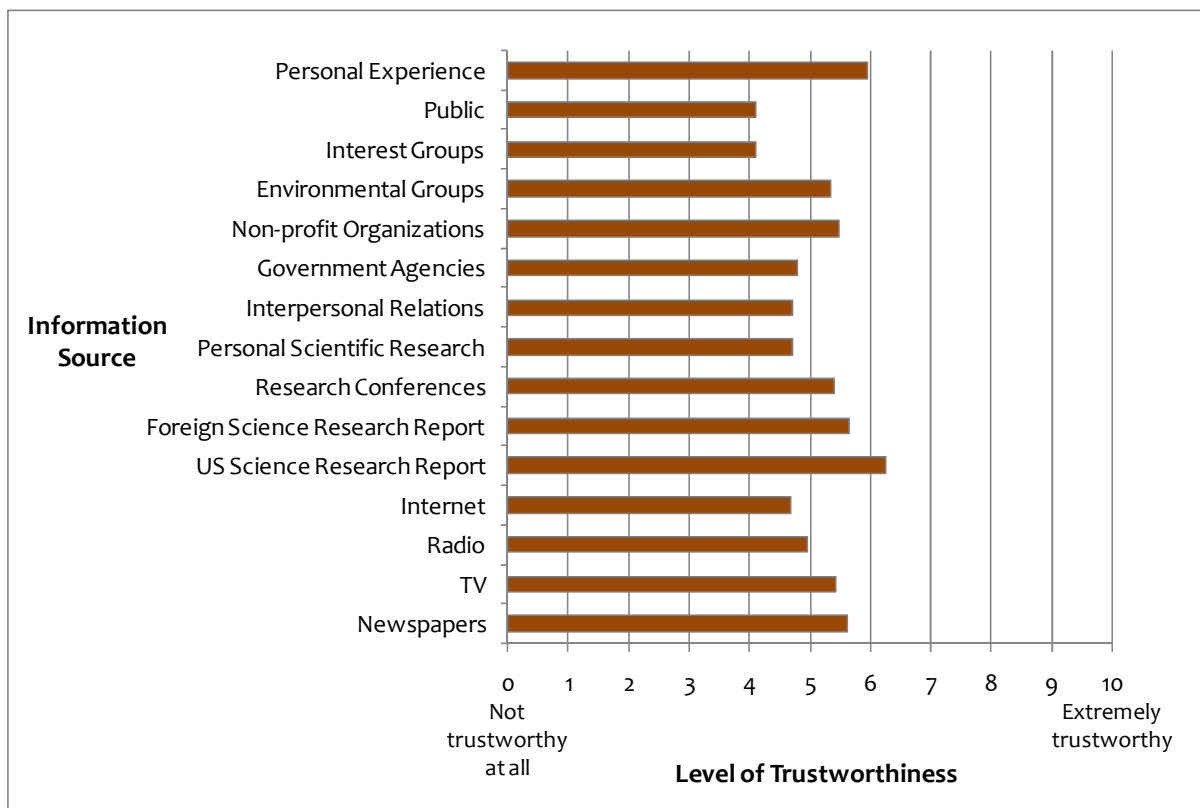


Responses to question: “What kinds of individuals or groups have contacted you within the last 5 years for information on global climate change?”

We also see that scientists report initiating few contacts with other groups and that only 40% of scientists report being contacted by other groups. As Figure 4d illustrates, most of these contacts are from the news media. These contact data indicate that only a few scientists are directly informing the climate change debate through direct contacts with other key stakeholders, and when they do, the contacts are usually with media, not with relevant decision makers. It would appear, then, that scientists are mainly limited to indirectly informing the climate change debate through their research publications and those of their professional societies. Since publications and academic society reports take years to become public, scientists may be missing many aspects of the important policy debate in real time. This situation needs to be addressed and considered by scientists, their associations and the government science establishment if scientific input is to be useful in real-time discussions and decisions.

We asked the respondents in the public sample to say how much they trusted the sources of information that were available for climate change. The findings are reported in Table 5a. U.S. scientists research reports and publications are seen as the most trusted, with personal experience again being highly ranked. It is interesting that not one source is seen as overly trusted (receiving a score of 7 or above). There seems to be, in this public sample, significant concerns about the trustworthiness of those providing the information about climate change. It doesn't seem that this lackluster expression of trust has affected the extent to which the public views climate change as an important problem. We will see later if this limited trust affects levels of support for various climate change mitigation policies.

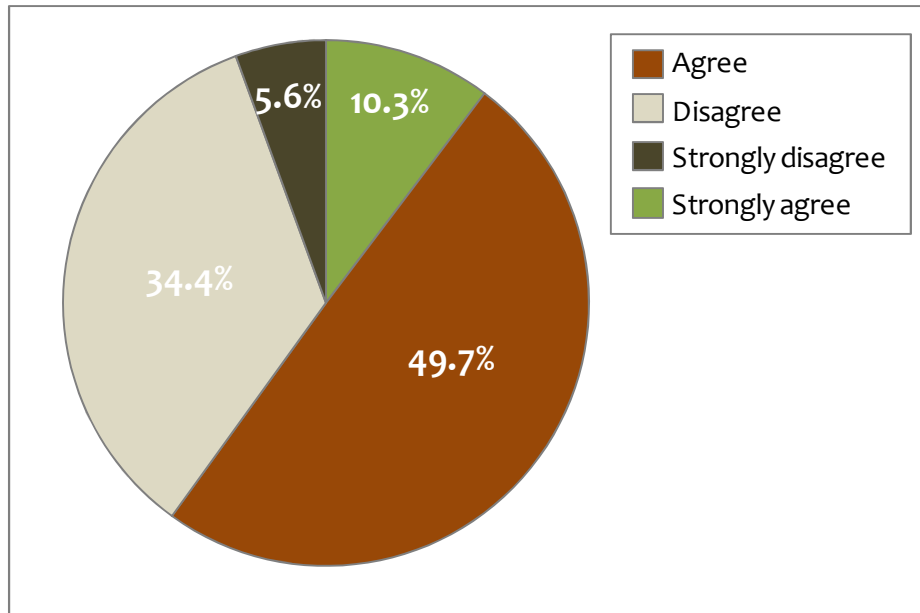
**Figure 5a. Public's Views -Trust in Information Provided by Sources**



Response to survey question: "Place the following information sources on a scale from 0 to 10 in terms of the trustworthiness of information provided on Global Warming and Climate Change, with 0 indicating the source is not trustworthy at all and 10 indicating the source is extremely trustworthy."

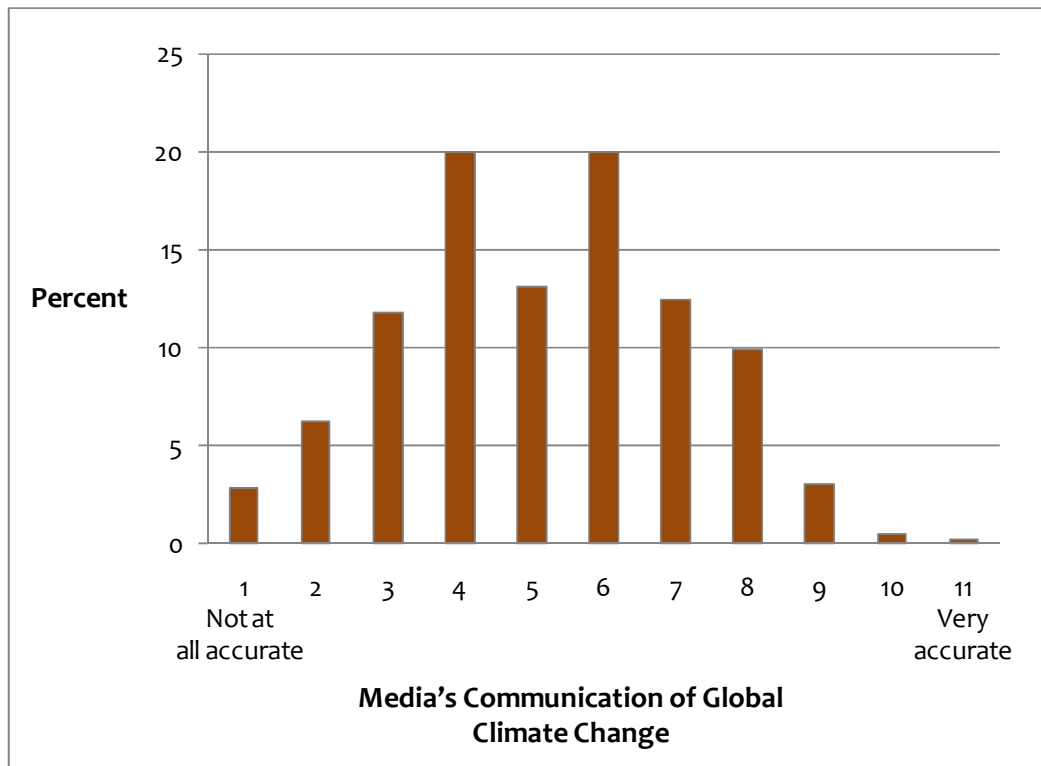
We asked the sample of decision makers how much they trusted the information provided by scientists and we asked scientists how much they believed that the media transmitted scientific information about climate change to the public accurately. The findings are reported in Figures 5b and 5c.

**Figure 5b. Decision Makers' Trust in Information Provided By Scientists**



Responses to question: "Climate change scientists can be trusted to communicate unbiased information about global warming and climate change."

**Figure 5c. Scientists' Views – Trust in Information Provided by the Media to the Public**



Responses to question: "How well do you think the news media communicate an accurate picture of global climate change to the public?"

It appears that decision makers, too, evidence only moderate levels of trust for scientific information on climate change (60%). In a similar show of limited trust, scientists report that the media’s communications on climate change are not that accurate. There is clearly a disconnect between the producers of scientific information on climate change and information consumers. This disconnect can prevent the successful and effective use of scientific information as a decision tool by public officials and the public. This is a clear concern for all stakeholders in this important policy arena who need to work to improve the trust between information providers and consumers in order to create better pathways between scientists and the people who need their information.

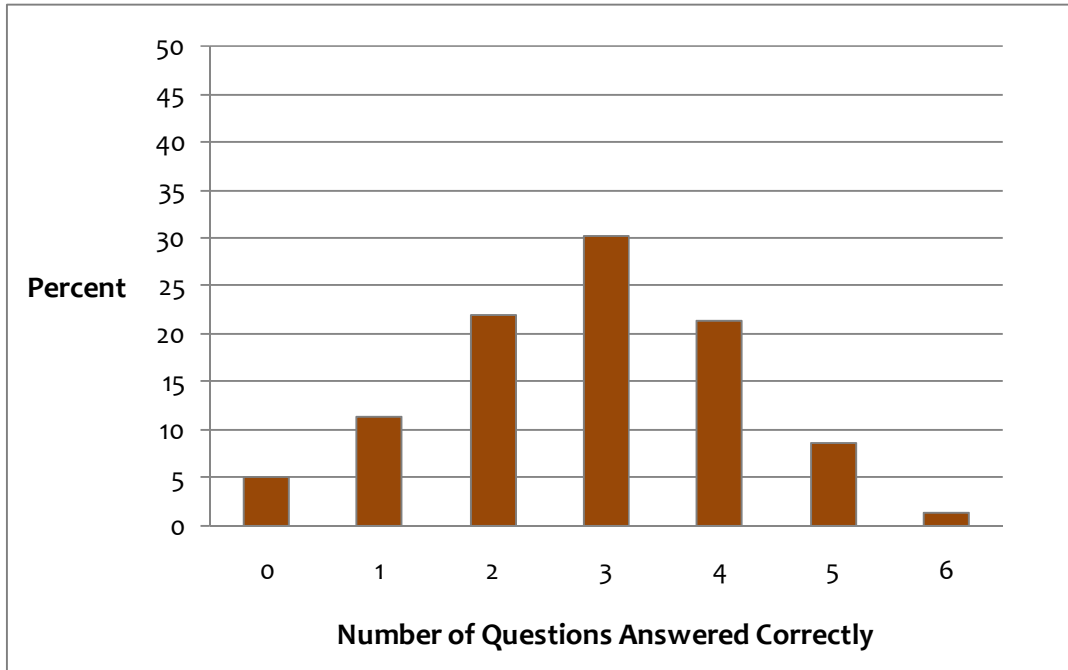
We next sought to discover how well informed our public and decision maker samples were on the specific elements of climate change. We selected a number of statements about climate change and greenhouse gases and then examined the level of agreement or disagreement with those statements by our public sample. The findings are reported in Table 2.

**Table 2. The Public's Knowledge Levels – Climate Change Questions**

Climate Change Specific Questions	Percent Answering		Correct Answer
	TRUE	FALSE	
Nitrous Oxide is a greenhouse gas.	61.26	38.74	TRUE
The major cause of increased atmospheric concentration of greenhouse gases is human burning of fossil fuels.	84.41	15.59	TRUE
Biological diversity will increase as global temperature increases.	51.67	48.53	FALSE
Forest growth is likely to decrease as a result of climate changes that are caused by Global Warming.	75.78	24.22	TRUE
Aerosols are airborne particles that are known to contribute to the formation of clouds and precipitation.	55.47	44.53	TRUE
Water vapor is the principal greenhouse gas.	33.66	66.34	TRUE

We see in Table 2 that the public does have a pretty good grasp on climate change causal agents. The public correctly recognizes that burning fossil fuels is a major cause in the increase in greenhouse gases (CO<sub>2</sub>), the importance of Nitrous Oxide and that forest growth will be hurt by increased warming. And these may be the three most important things to know. On other specifics like species diversity, aerosols and water vapor, knowledge is more limited but may not be that important a knowledge gap in identifying potential problems and seeking solutions. For later analyses in the project report, we computed a climate change knowledge index which gave respondents a score of 1 for each correct answer. The distribution of the public sample respondents’ scores on this knowledge index is reported in Figure 6.

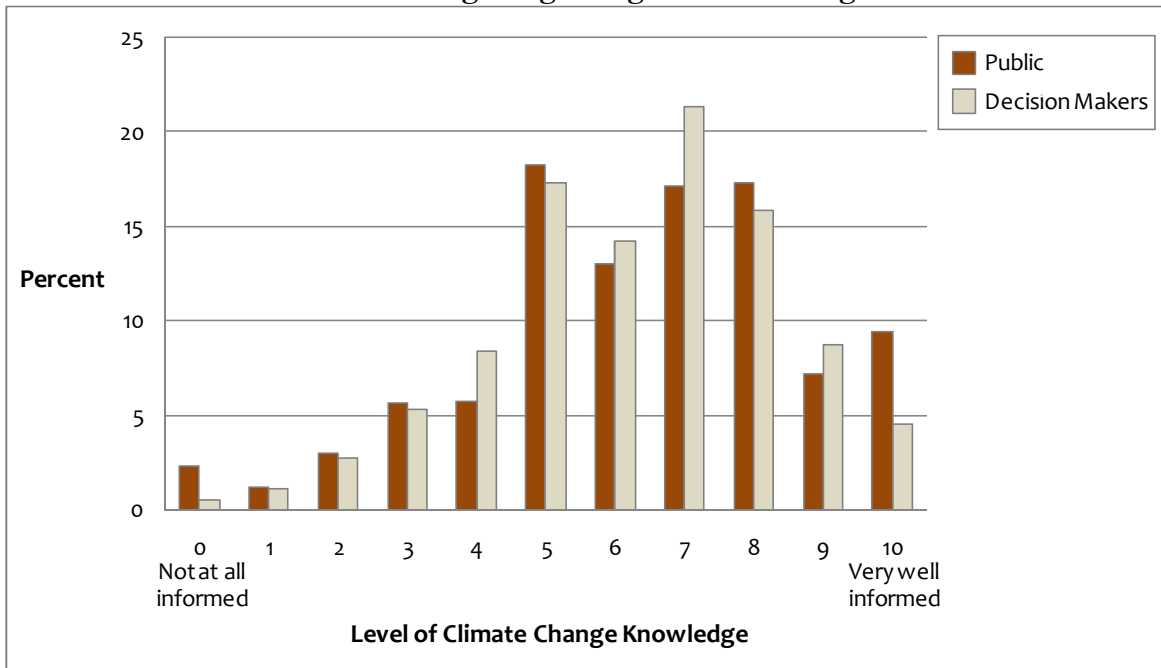
**Figure 6. Climate Change Knowledge Index**



While the scores are less than perfect, the public sample does a pretty good job on the objective knowledge index, with 3 correct being the modal position but with substantial numbers of the public being able to answer more questions than three correctly.

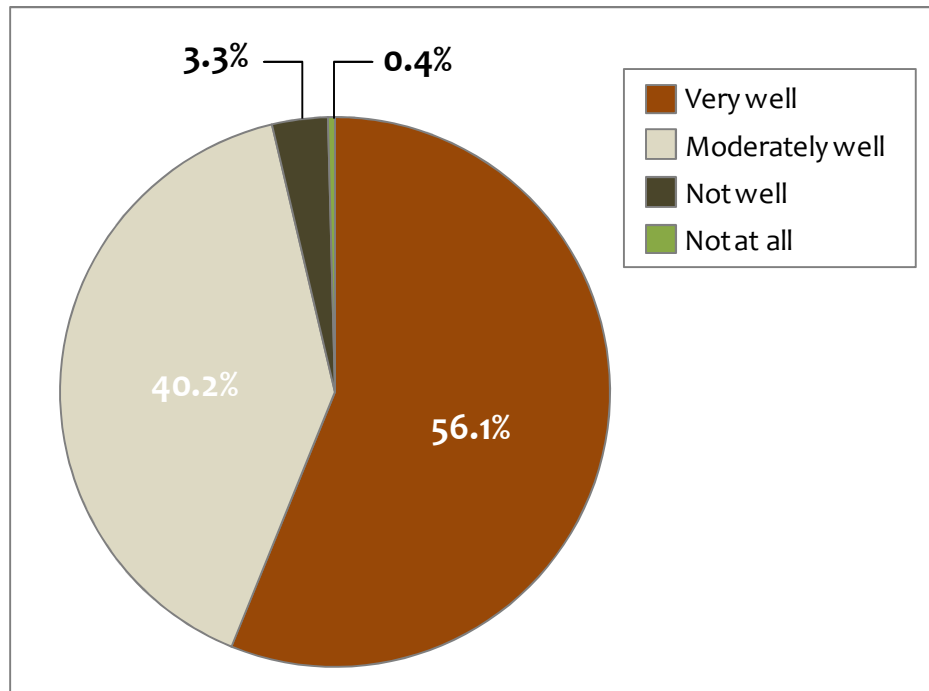
How much stakeholders *think* they know about something may be as important as objective knowledge in determining how they will behave toward an issue or problem (Kellstedt, Zahran and Vedlitz, 2008). Figure 7a reports the findings when we asked decision makers and the public to rate how informed they thought they were about climate change.

**Figure 7a. Public and Decision Makers' Subjective Levels of Knowledge Regarding Climate Change**



Both sets of respondents clearly think they are well informed about the issue, and the objective tests earlier indicate that this may not be that much of an exaggeration. As Figure 7b illustrates, scientists, too, think that fellow scientists understand global climate change at a pretty high level.

**Figure 7b. Scientists' Subjective Levels of Knowledge of Climate Change**



Responses to question: "How well do you think climate scientists understand global climate change?"

So all three respondent groups are confident that they are knowledgeable and informed about this important problem. This means that the issue is clearly on the policy agenda and is ready to go to the policy making phase. This does not mean that there will necessarily be agreement on what policy options may be the most favored, merely that the consideration of policies is not out of line at this time. We will examine the support or opposition to these policy options in the next section.

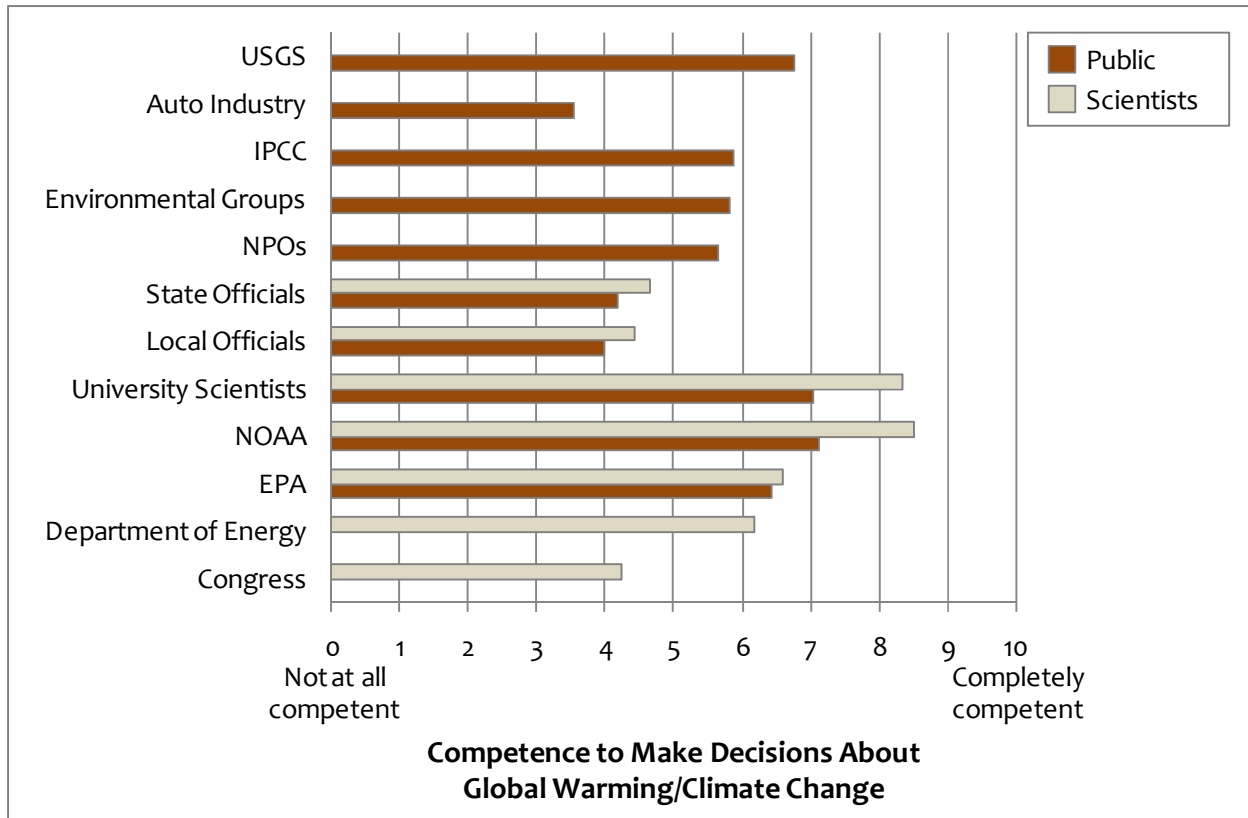
### **Evaluation of Climate Change Policy Options**

As they evaluate the likelihood of climate change and its possible effects on their lives and livelihoods, decision makers, scientists and the public have many possible policy options to examine and evaluate. Mitigation policies focus on lessening the causes of climate change, principally the reduction of greenhouse gases. Adaptation policies focus on the acceptance of the likelihood of climate change and working to reduce its impacts on communities and economies. In this report we will focus primarily on mitigation policies, but we will include, for comparison purposes, one adaptation strategy as well. Previous studies that have looked at environmental policy development have found that, in the U.S., personal background characteristics like education, wealth, gender and age and personal psychological characteristics like political party identification and ideology are significantly related to the acceptance or rejection of various environmental policy options (Davidson and Freudenburg, 1996; Elliott, Seldon, and Regens, 1997; Gutierrez Karp, 1996; Jones and Dunlap, 1992; Lubell, Zahran, and Vedlitz, 2007; Wood and Vedlitz, 2007). Younger citizens, women, Democrats and liberals seem to be more supportive of policies that mitigate environmental problems while older citizens, men, Republicans and conservatives are less supportive. The tables and figures in this section illustrate confidence in various decision makers and the overall support or opposition to various climate change policy options by our three samples. We then focus on the general acceptance of "mitigation," reducing green house gases at their source, as an acceptable policy strategy. Finally, we present a multivariate

analysis combining both these personal variables and climate change knowledge knowledge/information variables in seeking to determine the major factors affecting climate change policy support or opposition.

We first look at who the public and scientists see as “competent” to make climate change policy decisions. The survey question wording was **“I am going to read a list of public and private groups that make decisions that have an impact on Global Warming and Climate Change. Using a scale of 0 to 10, where 0 means not at all competent, and 10 means completely competent, how would you rate the competence of each group to make decisions about global warming and climate change?”** The findings are reported in Figure 8.

**Figure 8. Competence of Categories of Decision Makers on Climate Change**



There are generally high views of competency for university scientists and federal governmental agencies among both samples. The public sees about equal competency for university scientists and federal agencies. Scientists place their highest levels of competency in university scientists (folks like them) and the federal agencies, particularly NOAA (with whom many of them work). It is very important that the public places a high level of confidence in scientists at both universities and the agencies. This can give a platform on which to increase the relatively modest levels of trust the public had in climate change science findings themselves. If this can be accomplished, then the use of science findings as an important decision tool for both the public and policy makers may be more possible to achieve and the gap between scientists and the consumers of their information may be reduced.

Table 3 arrays the support for several climate change policy options across each of our three respondent groupings.



**Table 3. Support/Strong Support for Selected Climate Change Policies  
by Respondent Groups**

Policy Options	Percent Supporting the Policy		
	Public	Decision Makers	Scientists
Tax Industry from Practices Contributing to Global Warming	75.69	69.47	85.71
Ratify the Kyoto Protocol	82.21	76.49	83.30
Require More Energy Efficient Appliances	85.63	90.87	93.95
Develop Renewable Energy Sources	96.32	99.31	98.46
Improve Agricultural Management Practices	80.97	82.91	
Protect Coastal Settlements with Dikes and Sea Walls	74.05	43.60	
Increase the Price of Fossil Fuels	46.50	53.11	81.57
Use Market Incentives to Reduce Emissions	86.87		96.01
Tax Individuals from Practices Contributing Global Warming	52.79		71.62
Educate the Public on Climate Change Issue	93.67		99.12
Set Higher Prices for Environmentally Unfriendly Goods	33.21		89.22
Require More Fuel-Efficient Vehicles from Auto Industry	91.15		95.11

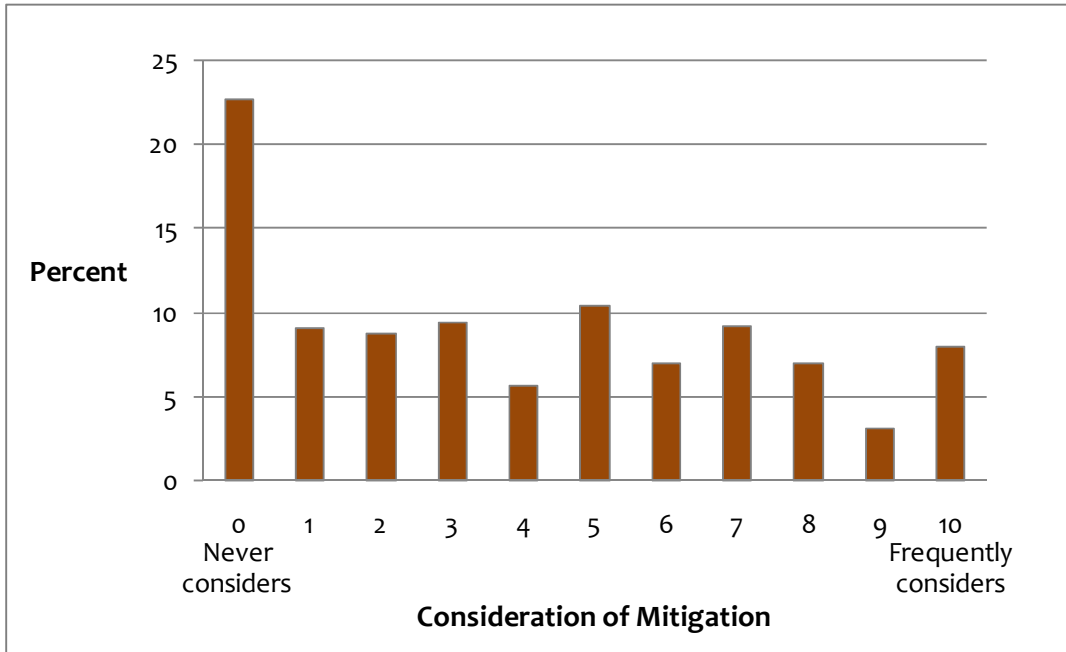
Note - The details of the policies are provided below:

1. Impose a tax on industry to discourage industry practices that contribute to global warming.
2. Ratify the Kyoto Protocol, committing the US to reducing carbon dioxide emissions.
3. Legally require more energy efficient appliances, and industrial systems.
4. Develop renewable energy sources, like hydro power, solar power, and windmills that emit no carbon dioxide.
5. Improve agricultural management practices by reducing the level of methane produced in raising cattle and in rice farming.
6. Protect coastal settlements and water supplies from rising sea levels with publicly funded dikes and sea walls.
7. Increase the price of fossil fuels (like gasoline) to encourage people to save energy and encourage the development of energy efficient devices.
8. Use market incentives to encourage industries to reduce emissions.
9. Impose a tax on individuals that discourages them from practices that contribute to global warming.
10. Educate the public on the human causes of climate change and variability.
11. Set higher prices for types of energy and other consumer goods that are not environmentally friendly.
12. Require automobile companies to build more fuel-efficient vehicles.

It appears that, while there is substantial support for the policy options across all three groups, there are important differences. Scientists are the most supportive of all policies, and they include large majorities who support even controversial policies like higher prices for environmentally unfriendly goods. The decision makers sample has the next highest level of policy support. Even though their absolute levels of support are still high, they are more skeptical, especially for coastal protection and fuel prices. The public sample, like scientists, shows support that is fairly high across the board, except for the two price increase policies.

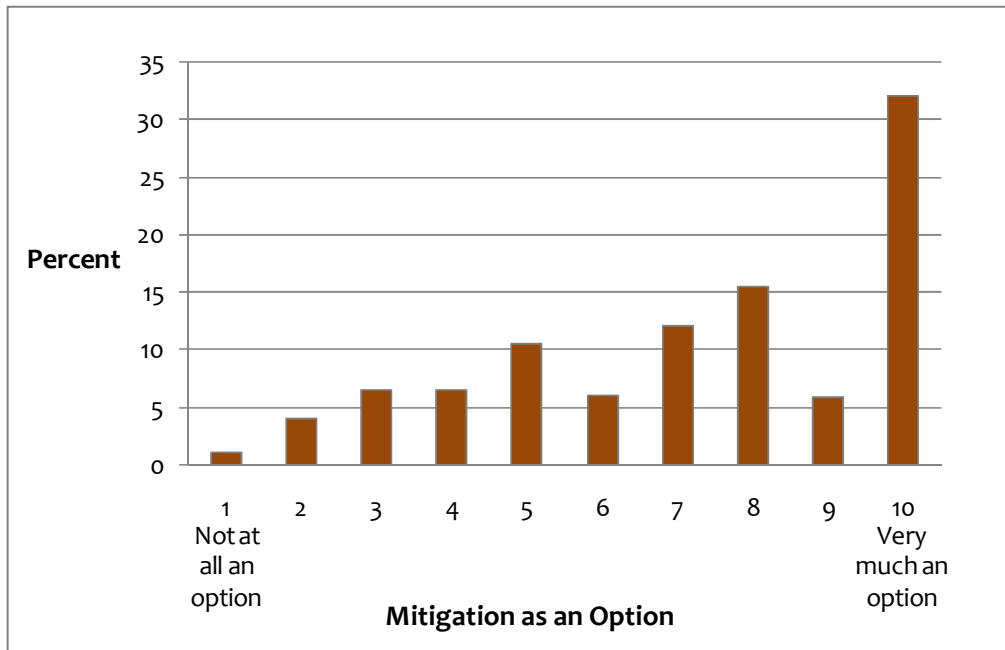
We next look at the extent to which scientists and decision makers view mitigation generally as a viable policy strategy. All the policies listed in Table 3 except one, coastal protection, are policies aimed at mitigating climate change conditions by reducing greenhouse gas emissions. It is important to see how mitigation, as a general strategy, is viewed. In Figures 9a and 9b, we look at mitigation strategies for scientists and decision makers.

**Figure 9a. Decision Makers Consideration of Mitigation Policies**



Response to question on decision makers' survey: "If mitigation is defined as human intervention to reduce the sources of greenhouse gases, is mitigation something your organization considers in its decision making?" Measured on a scale from 0 to 10, where 0 means *Never considers*, and 10 means *Frequently considers*.

**Figure 9b. Scientists' View of Mitigation as an Option to Address Climate Change**



Response to question on scientists' survey: "To what degree is mitigation an option in the U.S.?" (Based on an 11-point scale, where 0 means *Not at all an option* and 10 means *Very much an option*. Note there was an error on the survey questionnaire, and the respondents were only given a 1 to 10 scale, where 1 meant *not at all an option*.)

There is a sharp differential between scientists and decision makers on the relevance of mitigation policy options. Scientists are overwhelmingly supportive of mitigation policies with the highest option being their modal category. By contrast, decision makers are just the opposite. They seldom consider mitigation options as an effective strategy and “never consider” is their modal category. This points out the different perspectives different stakeholders have regarding the climate change debate and how difficult consensus solutions may be to find. Scientists are primarily focused on, and supportive of, mitigation strategies. Decision makers are focused very little on mitigation options.

The last step in our analysis of the survey respondents’ positions on climate change policies was to compute a series of regression equations that examine the role of information and knowledge, controlling for other key variables, on policy option support. We only include here those policy options for which significant and robust models were found. Therefore, if the policy variable is not present, it was not found to have strong, significant relationships with the independent and control variables. We also constructed, for each sample, a mitigation scale/index variable comprised of all the mitigation policy options offered for consideration to that group. For each sample, the mitigation scale/index functioned well and each had a Cronbach’s alpha of .8 or better. For all the policy variables, including the mitigation scale, the answers move from low values=least support to high values = most support. The regression tables are arrayed using pluses and minuses rather than the full coefficients. These can be obtained upon request. The pluses indicate a positive relationship, the minuses a negative relationship, and they are in red face if they are significant at the .1 level using standard, regression t-statistics. We first present the policy option equations for the public sample. Two single policy variables were found to have robust relationships. Those were raising prices and ratifying the Kyoto Protocol. Those with greater subjective and objective climate change knowledge, Democrats and liberals are more supportive of these two policy variables and the overall mitigation policy scale/index.

**Table 4a. Public Regression Models**

PREDICTORS	POLICIES		
	Q93_v1 Raise Prices for Energy & Goods not Env. Friendly	Q94 Kyoto	Generated ( $\alpha=0.8528$ ) Overall Mitigation
College	-	+	-
Female	+	+	+
Democrat	+	+	+
Age	-	+	+
Liberal to Conservative	-	-	-
# Children	-	-	-
Income	+	+	+
Church in Week	-	+	-
Religious Conservative	-	-	-
GW/CC Informed	+	+	+
# Correct	+	+	+

Model Type	Ordered Logit	Ordered Logit	MLR
R <sup>2</sup>	0.0952	0.1191	0.2064

Table 4b. Decision Makers Regression Models

PREDICTORS	POLICIES					
	Q36 Org. Considers Mitigation	Q53 Tax Industry to discourage GW/CC	Q54 Ratify Kyoto	Q55 Req. Energy Efficient Appliances Ind. Sys.	Q59 Inc. Price Fossil Fuels	Generated ( $\alpha = .8055$ )  Overall Mitigation
College	-	-	+	+	+	+
Female	+	+	+	+	-	+
Age	+	-	-	-	-	-
Democrat	-	+	+	+	+	+
Liberal to Conservative	+	-	-	-	-	-
# Children	+	-	-	-	-	-
Income	-	-	-	+	+	+
Church in Week	+	-	+	+	+	+
Religious Conservative	-	-	+	-	-	-
GW/CC Informed	-	+	+	+	+	+
Model Type	MLR	Ordered Logit	Ordered Logit	Ordered Logit	Ordered Logit	MLR
R <sup>2</sup>	0.0859	0.138	0.2093	0.165	0.1407	0.4137

We did not have an objective knowledge test for the decision maker sample, but their subjective information status, as it was for the public sample, is consistently significantly related to the policy options and in the predicted direction. Greater subjective information is associated with greater support for the individual policy options and for the overall mitigation scale/index. Other important variables are again political party identification and gender (which is in the right direction, but not significant).

Our final model looked at the scientist sample. The findings are presented in Table 4c.

**Table 4c. Scientists Regression Models**

PREDICTORS	POLICIES				
	Q63 Raise Prices Energy/Goods not Env. Fr.	Q64 Ratify Kyoto	Q67 Req. Auto Man. Build more Fuel Eff. Vehicles	Q68 Increase Price Fossil Fuels	Generated ( $\alpha=0.8576$ )  Overall Mitigation
Female	-	+	+	+	+
Age	-	+	-	+	-
Liberal to Conservative	-	-	-	-	-
Income	+	-	-	+	-
Church in Week	+	-	+	+	+
Religious Conservative	-	+	-	-	-
Model Type	Ordered Logit	Ordered Logit	Ordered Logit	Ordered Logit	MLR
R <sup>2</sup>	0.0867	0.096	0.0825	0.085	.2213

For the scientists, the only important indicator is political ideology, with the more conservative scientists being less supportive of the various climate change mitigation policy options and the overall mitigation scale/index.

## **NOAA INTERVIEWS: AGENDA SETTING IN NOAA**

Our interviews revealed several consistent themes. This section outlines these themes and related issues. As to be expected, many of the responses contradicted other responses, and there was a distinct variation from lab/scientist response to those from more management level positions within NOAA, particularly in regard to management of the research process. (Note: at the time of the interviews NOAA was undergoing a reorganization of their labs. We do not identify individual labs in this report, nor do we focus on the reorganization.)

According to respondents, the current research agenda with NOAA was the result of an evolutionary process. The most consistent factor, however, were the NOAA scientists themselves as drivers of what the agency focused upon and any new issues that might rise to the surface for administrative support and resources. One respondent felt this incremental approach to research worked well, and that the scientists were well positioned to move NOAA into new areas as interest arose. This was echoed by other respondents, in that the source of change within NOAA is the scientist and the overall environmental research paradigm, a better understanding of the complexities of the environment. This is not necessarily a top down approach, but rather the work of good scientists pushing ideas upwards. It was noted that this consistency could also limit room for new ideas and alternatives as the status quo in NOAA is very powerful in regard to the ability

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to set the agenda or suggest new alternatives. Opportunities for new alternatives could be very slow in coming as this process was related to the conflict within NOAA for finite amounts of money. New ideas compete against existing programs and it is difficult for new ideas to gain traction in an environment of constrained resources.

A more recent agenda driver was the adoption of the PPBES system. Implementation of a new program budgeting process, Planning, Programming, Budgeting and Execution Systems (PPBES) was underway during this time frame. This program budgeting system was a dramatic change in the way NOAA operated. Its impact on the research agenda was seen as significant by respondents as long range planning needed to be considered as the research agenda moved forward from one year to the next. While this was not a focus of this project, it was obvious that PPBES was having an impact on the research agenda, process and product aspects within NOAA. For a more detailed assessment of PPBES in NOAA during this period, see West, Lindquist and Mosher (in press). Current agenda setting, as described in the interviews, is both top down and bottom up as each lab can develop its own agenda, then coordinate with other labs and across programs through the PPBES system. This new approach is supposed to reduce overlap between labs and make NOAA more transparent in its programming and budgeting.

The influence of Congress was also identified as an important factor in agenda setting within NOAA. This was characterized in the interviews as both significant and not very significant. Basically, however, the role of Congress was depicted across multiple levels. Congress was involved with setting NOAA's research agenda at the macro level in their overall support and preference for big ticket items and research, and at the micro level in individual districts and earmarks for pet projects. The individual labs also have their Congressional supporters, as the labs are scattered throughout the country and in different congressional districts. This was seen as a critical source of support for NOAA research. Big ticket items in NOAA, such as satellite systems, could attract a lot of attention from multiple interests, including Congress, the general public, and interest groups and other stakeholders. Political pressure also came from other well organized interest groups, such as the Western Governors Association and their interest in drought issues.

Finally, the role the public and society, in general, was seen to have increased over time. This impacts NOAA's agenda in that they are becoming more sensitive to these demands, and lab managers are being asked to consider the societal impacts of their research. This is also reflected in the suggestions for improving NOAA that came up in these interviews. A summary of these suggestions is included at the end of this report.

### **Climate Change as an Agenda Item**

What has been the impact of the issue of climate change on the research agenda within NOAA? According to respondents, climate change was only a small part of the NOAA agenda in the past. The focus was more on climate variability than change, as currently understood. The shift came 8-10 years ago with more emphasis on climate as an issue within the new strategic planning process. There was a perception from respondents that climate change, as an issue, had replaced many other things on the agenda in recent years resulting in a loss of traction for other issues. This shift was also encouraged and influenced by outside groups, as well as regulatory and legal factors. Most respondents felt that the general public paying more attention to climate was having an influence on NOAA research. In addition, climate change increased in importance in as a result of it becoming more of an overall economic and political issue. The Climate Program within NOAA was viewed as directing a lot of the research for the entire agency.

This new focus on climate change had its supporters and detractors. One positive aspect of the focus has been that the observation side of climate change research in NOAA is perceived as being less political and therefore it would get more money. As ocean observations are generally politically neutral, according to several respondents, this was relatively safe area for research. The rise of climate change on the agenda was also helping NOAA because the agency was perceived as being more productive and involved as they could answer more questions with better research and data. This self-fulfilling aspect of research was also supported by what one respondent characterized as "the country turning the corner" on climate change as the administration, the private sector and international partners were all moving forward on this issue. Finally, climate change has also directed more attention in NOAA to the local level of data needs and use, which was seen as a positive area in which NOAA could expand its research.

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There was a perception of developing problems with this new focus on climate change, however, primarily with NOAA providing science for the climate change debate. The models and projections used by NOAA are never close to 100% certain, which caused problems with the public and decision makers who want certainty from science. So while NOAA was seen as a useful provider of data and information at the same time respondents felt vulnerable to the perception that their science was not “good enough” to satisfy the public and decision makers.

### **NOAA Research Process and Products**

This section of the interview summary focuses on the actual research process and products within NOAA, in general. We were interested in characterizing the process as described by the NOAA lab scientists and administrators, and in how they viewed the products NOAA provided to its constituents. In essence, there was consensus that NOAA should focus on objective, rational science, or as one respondent stated, that although decision makers would always want more, better science, his approach was to make sure NOAA provided “adequate” science, vetted through the peer review and publication process, and that this approach would serve the agency well.

While we did not focus on the specifics of the lab structure and restructuring that was going on during the course of this research, respondents by and large considered that there was support for cross lab research and collaboration. Several respondents stated emphatically that the era of the “lone investigator” at NOAA was over, and that lab personnel wanted to work together across labs. There were also comments that some scientists would prefer “to be left alone to do their work,” but that this approach was not realistic in the current NOAA context. There was support for lab and administrative structures to facilitate and encourage this interaction. It was also stated that money, and more resources in general, would help this interaction along, particularly if all parties could contribute and bring money to the table early on in the process. This issue comes up later in the PPBES section, too.

The question of NOAA product drew more varied responses in the interviews. Primarily there was disagreement as to what NOAA should be focusing on and providing to users: applied or basic research. The interviews revealed a distinct line between support for basic or applied research at NOAA, a very fuzzy line one respondent stated, even though there was a realization that both were necessary for meeting NOAA’s vision and goals. This distinction was also mentioned in regard to support for NOAA research in general, as some respondents felt that Congress and the public did not fully understand or appreciate the significance of basic research to the applied research that attracted more attention and support.

Many respondents harkened back to an earlier era in NOAA where “product” and “output” referred to scientific articles and peer reviewed materials. In the early days of PPBES implementation, however, this was seen as changing as more programming and budgeting related monitoring, or “non-science” derived factors were replacing the old metrics. As one respondent characterized the situation, NOAA was providing more science advice, but less of a definitive product as in the past. Still there is a need for articles and internal reports and there is considerable focus on these activities as they provide credibility for NOAA personnel in the broader community. Journal articles were still important as they move knowledge forward, even if they do not drive public policy.

Climate change data was also seen as an important NOAA product. Respondents saw the need for NOAA to provide objective and credible science in order to be taken seriously and to participate in the global debate on the issue. This participation was mentioned several times as being a significant role for NOAA and NOAA scientists. In essence, their participation was also seen as NOAA product. The regional and local interest in climate change, too, was changing NOAA product as local level decision makers were coming to NOAA for information, primarily temperature and precipitation data. To NOAA personnel, this meant that the agency would have to be more involved at the local level to understand what was needed and how they could provide it.

One respondent, however, expressed concern that, to many observers, the National Weather Service “was” NOAA, and that this was having a negative impact on NOAA as it strived to meet its objectives. The focus on NWS products overshadowed other NOAA products and research. This was viewed with in the broader context of PPBES and its programmatic focus and the current emphasis on product and output at the expense of basic research and science. There was also a suggestion that much of what NOAA did was too

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technical for the higher level of NOAA administrators to understand, which was making it difficult for line officers and scientists to “sell” the importance of what they did.

### **Policy Influence and NOAA**

There is a significant link between “product” and “policy” according to the NOAA interviews. At the policy level, policy and decision makers wanted “policy relevant information,” which was often viewed as contradictory to NOAA’s scientific mission. NOAA tried to focus on forecasts, for example, but decision makers wanted these translated, by NOAA, into policy recommendations. There was a sense that these forecasts did need to be translated into policy recommendations, just not by NOAA. This was perceived as diluting the objectivity of the product at NOAA’s expense.

Respondents expressed concern over the lack of understanding between the science and policy communities. This was borne out in the need for more observations to reduce uncertainty, versus a perception of “we have enough data” and this should be enough to make decisions. On the other hand, respondents expressed a perspective that “true or false” could be based on observations, while the political perspective was always based more on different levels of uncertainty, and the desire to reduce same, so politicians always wanted more data for reducing uncertainty in order to make decisions. This conflict was generally expressed across the interviews and was a source of considerable frustration within NOAA. There was also concern expressed that policy makers did not always understand the “no shortcuts to science” approach NOAA had to take in its research. This alludes to the tension between basic and applied research and the lack of understanding of the link between the two.

Within NOAA there was a sense that what NOAA did best was provide good science for policy making but that the individual scientists should not get involved in the policy process. According to respondents, they were discouraged from becoming advocates for one position or another, particularly in the climate change debate. There was a sense that this was a top down perspective from the NOAA administration and that NOAA should focus on “good objective science,” not specific policy positions. As one respondent characterized this situation, NOAA needed to remain an objective broker of information, and scientists degraded this position when they got involved with policy and politics: “NOAA should stick to ‘flat footed science.’” Finally, there was a sense in NOAA that science was important for policy making, but also a realistic understanding that it is not the only factor in the equation and that NOAA should accept its role in the broader policy process context.

### **NOAA Budget and Institutions**

As stated earlier, NOAA was implementing a new programming and budgeting system during the course of this research. The PPBES process itself was a topic of great concern across the interviews as all respondents held mixed reviews of the process. Again, see West, Lindquist, and Mosher (forthcoming) for a more detailed consideration of NOAA and PPBES. As it relates to this report, however, PPBES is viewed as one factor that has impacted the previous issues of agenda setting and how NOAA focuses its resources and attention on products and outputs.

The primary frustration with PPBES as expressed in the interviews was that it was taking up considerable time and effort of the scientists and that they were being transformed into administrators in order to meet the system requirements. This also created tension and conflict between careerists and appointees, and conflict among ideas as they were expressed and supported in PPBES. With no new resources, and the top down approach focusing on placing a “value” on science and research, many of the respondents felt that PPBES was being forced onto NOAA, where it did not belong. The impact on the individual labs was seen as putting them in a position to have to use a more corporate asset management approach, with a lengthy and unwieldy transition period.

Political influence, too, was mentioned in the interviews as one of the reasons for the lab reorganization and institutional restructuring that was occurring during the research time frame. There was a perception of overlap among the labs, because of the names, however several respondents stated that the new PPBES system was providing them with an ability to justify the diversity across labs. This was one of the more positive notes sounded in favor of PPBES, which was shared by management respondents, in general. Another positive aspect from PPBES process from management respondents was that they felt it supported



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better cross program interactions and collaboration. On a more negative side, other respondents were critical of the time and effort required for the new system and that it created more meetings and bureaucracy, it was difficult to measure outputs, and it forced scientists to become administrators and to explain science to politicians and administrators at a 6-8<sup>th</sup> grade level. NOAA, in general, was perceived as being resistant to change, and the adoption of PPBES was no exception. The most negative response stated that the current administration, through its emphasis on PPBES, had taken the joy out of science with an emphasis on applied science and products.

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## Conclusions & Recommendations

This project presents perhaps the most comprehensive examination of key stakeholder orientations to climate change, climate change science, climate change information exchange, and government laboratory roles in climate change to date. The purpose of this study was straightforward—to examine the issue of climate change and the role of climate change science in developing relevant policy responses. The project gathered important empirical information from the public, climate scientists, local and regional decision makers, and government laboratories.

Key themes were found in each empirical investigation. Whether it was the public, decision makers, scientists or government laboratory officials, all stakeholders believed climate change was real and was an important concern with key policy relevance. The information provided by scientists is seen as a central element in understanding the problem and potential policy solutions. Scientific information is valued and scientists' findings are a key element in the policy debate.

Information is sought by all participants as they attempt to work their way to understanding the problem and its potential solutions. The media is important, but not alone, in linking scientific findings and potential users of scientific information about climate change, but it seems that the communications linkages between climate scientists, the producers of climate change information, and the users of that information, decision makers and the public, is not working as well as it could. Consumers of climate change science information report only moderate levels of trust in the information and its sources. And scientists report that the media does a poor job in correctly telling the climate change science story. Scientists seem to be passive actors in the information exchange process. Few climate scientists report initiating a contact to provide information and only a few report being directly asked for their comments. There is a clear disconnect between information producers and consumers that must be improved if the best, most effective and most empirically valid solutions to problems like climate change are to be addressed through public policy.

There are several factors that seem to be influencing stakeholder positions on various climate change policy options. Both subjective and objective knowledge about climate change is seen as important on several policy issues, and for the overall policy mitigation scale/index for both the public and decision makers. Scientists show little variation in their support of aggressive policy actions, with only ideologically conservative scientists opposing the various policy options.

While information seems to have a positive policy influence, it is a limited one. In addition to the information trust and exchange disconnect we discovered, there seems to be a clear distinction between the preferred policy solutions by the various groups of stakeholders. Scientists report the great focus on mitigation policies and the highest levels of support for public policies that will limit greenhouse gases at their source. Local and regional decision makers seem to pay little attention to mitigation concerns, focusing more on adaptation problems. The public falls somewhere in the middle, concerned with mitigation, but not willing to sacrifice economic well being and tax/costs increases to achieve mitigation ends.

The role of the national agencies and laboratories becomes crucial, then, in helping to design programs of research and information flow that can maximize the utility of science information about climate change as a policy tool for all stakeholders. Our interviews, however, reveal that the scientists in the NOAA labs are hesitant to become engaged directly in the policy process, preferring instead to continue their traditional roles of the objective purveyor of science and information. While this is the accepted and comfortable role of the scientist in society, there needs to be more emphasis on moving science into the dynamic, and often conflict resolution, public policy domain, especially in regard to the issue of climate change.

The recommendations from the NOAA interviews address some of these issues. Our interviews revealed several significant suggestions from respondents in the areas of research agenda setting, process and products.

NOAA needs to support more human-science interface research. This was seen as critical as NOAA focuses more on constituency services and products and in understanding how these constituents use NOAA data and products.

NOAA needs to do more outreach and stakeholder forums to both provide info and to seek input and support. This came up in the discussions regarding climate change and NOAA research. There was a sense

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that NOAA needs to be cognizant of the local and regional impacts of climate change and that this level of decision making could be better integrated into NOAA research and output.

In regard to PPBES, while positive attributes were recognized by respondents, there was also the suggestion that the system needed to be morphed and transformed in its implementation within NOAA in order to address the needs and characteristics of a science-based agency. “Research is not like building roads” and the basic essence of science is lost in this system when it is reduced to a matrix or spreadsheet.

NOAA needs to work on their approach to and support for interdisciplinary research and in finding a common language for this research.

NOAA needs to address the inherent conflict between what the public wants in regard to science and what the scientists think they want or need. Both sides need to do a better job with communication in this area.

NOAA should consider focusing its research on one major challenge. One respondent suggested adopting the NASA model of a “grand challenge” for NOAA to focus resources and energy on.

There was considerable interest in improving NOAA's interactions with end users, in particular in how NOAA translates its science for decision makers. This would also improve the perspective the public has towards the relevance of the agency and its scientific output.

There is a great awareness of the climate change issue and a genuine concern among stakeholders to make good decisions based on good scientific information. Information and knowledge about the science is important but limited in its impacts. Obviously, science alone does not reveal or mandate the appropriate policy actions. Policy choices will take into account a number of other factors ranging from the costs of action, public support and opposition to various choices, technological realities and the pressure of other priorities. But scientific information will be a crucial and important element in any policy strategy that will be considered and, therefore, the production of that science, its objectivity, its relevance and its successful communication to relevant stakeholders is not an insignificant concern. New, better and more trusted ways of creating, framing and communicating scientific information about climate change must be developed and implemented to enable this science information to be one of the many important decision tools policy makers and the public will need to make the best decisions for us now and for our futures.

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