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PUBLIC KNOWLEDGE AND CONCERN ABOUT POLAR-REGION WARMING

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ABSTRACT

In 2006 and 2010, before and after the International Polar Year, the General Social Survey asked cross sections of the U.S. public for their knowledge and opinions about polar regions. The opinion items sought respondents' levels of concern about global warming in polar regions, and whether they favored opening Antarctica for development or reserving it for science. Polar knowledge scores show significant improvement from 2006 to 2010, while general science literacy scores and opinions remain largely unchanged. Regression of concern and Antarctic items on demographic characteristics, ideology, education and the two knowledge tests finds that ideology and knowledge have the most consistent effects. Conservative ideology negatively predicts all six concern items, and support for reserving the Antarctic. Polar knowledge exhibits a positive effect on most of the concern items, and on support for reserving the Antarctic. General science knowledge, on the other hand, has effects that vary with ideology. These findings support two contrasting views about the role of information: that more science information leads to greater concern about environmental changes, or greater support for science; but also that some high-information, partisan respondents acquire new information selectively, so that it reinforces their belief systems and makes them the most polarized.

INTRODUCTION

In 2006 and again in 2010, before and after the International Polar Year (IPY, 2007–2008), the General Social Survey (GSS) carried a set of questions addressing knowledge and concern about polar regions. The GSS is a biennial survey that interviews cross-sections of the U.S. public. It gathers social and economic data on many different topics, including knowledge and beliefs about science. Its polar questions extended GSS science interests to high latitudes to assess levels of public knowledge and concern, and watch for possible changes in the wake of IPY.

A preliminary comparison of the 2006 and 2010 GSS found significant improvements in knowledge about polar regions, but little change in concern (Hamilton et al. 2012). Better knowledge could reflect an IPY benefit, acting together with other events that raised the salience of polar realities. Unchanged levels of concern, however, give less encouragement — particularly in light of many studies and some dramatic new reports from scientists documenting polar environmental changes through this period (summarized in NOAA 2011 and previous years).

This paper explores the seeming paradox of rising knowledge but stagnant concern by looking more closely at the relationship between those two domains. Public concern has particular importance with regard to climate change due to the relatively high salience of this issue, and the costs or tradeoffs required by possible mitigation or adaptation policies.[1] Previous research established that the effects of formal education and of self-assessed understanding on environmental concern depend on people's ideology or partisan identity. Environmental concern (especially concern about climate change, including its polar aspects) tends to rise with education among liberals or Democrats, but to remain level or even decline with education among conservatives or Republicans (Hamilton 2008, 2011a; McCright and Dunlap 2011). Self-assessed understanding exhibits similarly divergent effects depending on political outlook (Malka et al. 2009; Hamilton 2011a–c). Other studies ranging from surveys to psychological experiments and political analysis provide varied but substantively convergent explanations that fit this interaction pattern.

Objectively-measured science/numerical literacy may influence risk assessments in a non-additive way (Kahan et al. 2011b), but the effects of knowledge on other kinds of environment-related opinions have been less well explored. Most scientists might hope that members of the public acquainted with basic science information and concepts will be more likely to take seriously the environmental changes scientists write about. Science-communication efforts often are built on this premise. Two sets of science-knowledge questions carried on the 2006 and 2010 GSS provide an opportunity to test this hypothesis by examining how general-science and polar knowledge affect concern about specifically polar issues.

EDUCATION, "UNDERSTANDING" AND KNOWLEDGE

Previous analyses of the 2006 GSS found that concern about polar aspects of climate change is related to respondent background characteristics in ways similar to those seen for concern about climate change in general, or about other environmental problems (Hamilton 2008; Zhou 2009). These two papers also highlighted complexities in the role of information that underlies people's beliefs about polar regions. Hamilton observed that the effects of education vary with ideology. Among self-identified liberals, higher education is associated with higher probabilities of concern about sea-level rise, polar bear extinction and other issues. Among self-identified conservatives, on the other hand, higher education is associated with *lower* probabilities of concern. Other studies have found similar interaction effects involving a range of climate-related questions, and self-assessed understanding as well as formal education (Hamilton et al. 2009; Hamilton 2011a–c; McCright 2011; McCright and Dunlap 2011; Malka et al. 2009). Education/partisanship interactions occur with non-climate environmental topics as well (Hamilton et al. 2010).

Zhao's analysis of the 2006 GSS polar questions focuses on the reinforcing spirals model: views on climate change are shaped by "two intertwined and mutually reinforcing processes — the impact of audience characteristics on media choice and the effects of media use on audience attitudes and behaviors" (2009, p. 699). That is, people attend to information sources compatible with their pre-existing beliefs; and information received from such sources further strengthens their beliefs. Although Zhao did not apply this model to interaction effects like those noted by Hamilton, Malka and coauthors or McCright and Dunlap, it provides a plausible explanation for them. The most educated or high-information citizens have the most polarized views on climate change because they more actively seek out and retain information that reinforces their pre-existing belief systems.

The deepening polarization on climate change, especially among educated or high-information elites, has drawn attention from other authors. Alternative conceptual explanations have been proposed from different perspectives, often sharing common themes that overlap with the reinforcing spirals. Kahan et al. (2011a) write of biased assimilation and cultural cognition, referring to a process whereby individuals acquire information selectively, in keeping with their pre-existing values. Through this process more scientifically literate individuals become more prone to cultural polarization (Kahan et al. 2011b). Taber and Lodge (2006) apply ideas of motivated scepticism and disconfirmation bias to characterize the phenomenon of seeking counterarguments against new information that contradicts prior beliefs. Both the biased assimilation (motivated information acquisition) and disconfirmation bias (motivated information rejection) processes can be recognized in descriptions of ideological filtering and information processing, as well (Borick and Rabe 2010; Wood and Vedlitz 2007). Filtering or processing also refer to the selective acceptance/rejection of information and sources depending on compatibility with prior beliefs and ideology. While Kahan et al. (2011b) note the influence of cultural peers, other authors emphasize the role of cues from political and other elites in guiding what people choose to believe (Brulle 2012; Darmofal 2005; Krosnik et al. 2000). All of these overlapping, empirically supported concepts match the polarization of high-information respondents observed in the 2006 GSS data. Being well-informed to begin with enhances the ability of people with strongly partisan perspectives to find and assimilate information that supports their bias.

GSS SCIENCE KNOWLEDGE MEASURES

Since 1972 the GSS has annually or biennially interviewed cross-sections of the U.S. public, asking a wide range of social and economic questions. The National Opinion Research Center (NORC) at the University of Chicago, supported by the National Science Foundation (NSF), conducts this survey and publishes the data as a resource for research (NORC 2011; Smith et al. 2011). The current format of the GSS includes background and recurring opinion questions, along with topical modules that vary from year to year, designed to investigate specific areas of interest such as public perceptions and understanding of science. Recent science modules have included a small set of quiz-like questions that test general science knowledge, used to form a “science literacy” score (National Science Board 2010).

In 2006 the GSS science module also included a sub-module of polar questions, modeled on the general science questions. The polar questions were developed through an iterative process of discussion, review and pre-testing, with support by the NSF Office of Polar Programs (OPP). OPP scientists worked with other researchers from NSF’s directorate for Social, Behavioral and Economic Sciences, the Science and Technology Policy Program of SRI International, the Survey Research Center at the University of Michigan, and NORC. The polar module was designed to elicit public understanding and attitudes concerning polar science and policy, on the eve of the International Polar Year (IPY, 2007–2008). Most of the same polar questions were repeated on the GSS in 2010, allowing before and after-IPY comparisons.

The upper part of **Table 1** lists 11 general questions used to form a *science literacy* score, together with the percent of right answers on the 2006 and 2010 GSS.[2] These percentages and other statistics reported in this paper employ probability weights recommended for the GSS data. A total of 1,862 respondents answered the polar questions in 2006, and they form the basis for the 2006 column in Table 1. In 2010, 1,006 respondents answered the polar questions, but that total includes 309 people who had answered the same questions in 2006 — a panel feature of the GSS sampling design. For Table 1 and elsewhere in this paper, the 309 re-interviews in 2010 have been set aside, so we focus on an apples-to-apples comparison of only those 1,862 respondents who answered for the first time in 2006 with the 1,006–309 = 697 who answered for the first time in 2010.[3] In terms of *science literacy* we see some up and down shifts but no general change; mean scores are the same for both years (59 percent correct).[4]

Polar knowledge, on the other hand, shows significant improvement from 2006 to 2010. The lower part of Table 1 lists five questions about polar regions that together define a 0–5 point *polar knowledge* score analogous to the 0–11 point *science literacy* score. Unlike the general-science questions that define *science literacy*, the polar questions include two that are related to climate change (but without reference to its cause). The percentage of correct answers rose on all five questions, climate and otherwise. In 2010, significantly more respondents knew that the North Pole is on ice over the Arctic Ocean; that Inuit live north of the Arctic Circle; and that climate change presents a challenge to polar bear survival. Mean *polar knowledge* scores improved from 53 to 59 percent correct.

OPINIONS ABOUT POLAR ISSUES

Table 2 lists seven opinion items that form the other main component of the GSS polar module. The first six are posed as hypotheticals: How much would it bother you if this consequence of global warming actually happened? One of them (polar bears extinct by 2020) appears unrealistic, but others do not specify timing and have been widely discussed in research (ACIA 2005; IPCC 2007; NOAA 2011). As we will see, individual background and knowledge factors predict responses to the polar bear question in much the same way they do for other concern questions in Table 2.

Four of these opinion questions were asked both in 2006 and 2010, but show no significant change. The question about Arctic seals was asked of cross-section respondents only in 2006, and a similar one about Antarctic penguins only in 2010, so these cannot be directly compared. In both years, respondents tend to express higher concern about sea level or ice melting than about impacts on Inuit or wildlife. The northern ice cap question was meant to reference melting sea ice, which would not by itself much affect global sea levels, but other research has shown that many people are unclear about the distinction between sea ice and land ice impacts on sea level (Leiserowitz et al. 2010). High concern over northern ice cap melting likely reflects some of this confusion. More scientifically grounded concerns about global impacts of Arctic sea ice decline (such as consequences for ecosystems, ocean circulation or mid-latitude weather) have received less attention in popular media than the threat of coastal flooding.

Unlike the polar knowledge changes in Table 1, none of the polar concern changes in Table 2 reach the level of statistical significance. A seventh question in Table 2 asks whether the Antarctic should be opened for tourism, fishing, oil exploration and other commercial purposes, or whether it should be reserved primarily for science. In both 2006 and 2010, 46 percent favored reserving it for science.

Hamilton et al. (2012) break down the GSS samples in more detail, comparing responses from 309 panel members interviewed both in 2006 and 2010, and then separately comparing the 1,553 cross-section respondents (1,862–309 = 1,553) who were interviewed only in 2006 with the 697 cross-section respondents interviewed only in 2010. That breakdown leads to slightly different percentages but the same general conclusions. Significant 2006–2010 improvements in *polar knowledge* scores are visible whether we compare the same individuals or two independent samples. Opinion items related to polar climate or the Antarctic, on the other hand, show no consistent up or down change.

Previous analyses found that both *science literacy* and *polar knowledge* scores correlate positively with levels of polar concern. If knowledge were the only factor affecting concern, the *polar knowledge* improvement seen in Table 1 might lead to an expectation that concern should be rising as well. Multivariate analysis of the 2006 GSS, however, demonstrated that a number of other factors also affect polar concerns. In particular, conservative political outlook exhibits consistently negative effects on concern, and on support for reserving the Antarctic for science (Hamilton 2008). Moreover, that study and others cited above emphasize the non-additive complexity of relationships involving politics and education or self-assessed understanding. The next section pools the 2006–2010 GSS data to test whether such complexity occurs with objectively-measured science knowledge as well.

EFFECTS OF SCIENCE KNOWLEDGE ON LEVEL OF CONCERN

Hamilton’s (2008) analysis of the 2006 GSS focused on ordered logit regression models for six polar concern items. Each concern item (the same ones defined in Table 2, except for *penguins*) was regressed on a common set of background and science knowledge measures. Gender, political outlook and objectively-measured science knowledge (both *polar knowledge* and *science literacy*) had the most consistent effects. Ideology moderated the effect of education: education positively affected concern among liberals or moderates, but negatively affected concern among conservatives.

Table 3 extends this analysis using a pooled dataset that combines 2006 and 2010 cross sections. An indicator for survey year tests and controls for possible differences in response levels between years. Number of high school science courses had been considered as a possible predictor in the earlier analysis, but proved to have no significant effects either there or in the new data, so is set aside to obtain more precise estimates of the other effects here. More importantly, a key finding from the earlier analysis was the existence of *ideology×education* interactions, meaning that education had opposite effects on concern among liberals and conservatives. Similar interactions occur in the pooled 2006/2010 data, and have been noticed in other studies. Recent findings on self-assessed understanding (e.g., Malka et al. 2009; Hamilton 2011a), however, along with ideas such as biased assimilation, motivated skepticism and the reinforcing spirals model, shift the emphasis to information. Education most likely enters interaction effects because in part it is a proxy for the more active assimilation by educated respondents of information that fits their pre-existing beliefs. To test whether basic science knowledge exhibits the non-additive effects seen elsewhere for education and self-assessed understanding, the Table 3 models include *ideology×science literacy* in place of *ideology×education* interactions.[5]

The predictor variables in Table 3, with weighted percentages or means, are as follows:

- *Age* in years (18 to 89 years, mean 45.7);
- *Female* (coded 0 = male or 1 = female, 55% female);
- *Family income* (coded 1 = under $1,000 to 25 = $150,000 or more; median about $45,000);
- *Education* (originally coded 1 = high school or less to 4 = postgraduate, mean 1.75, but centered to zero mean for modeling purposes);
- *Ideology* (originally coded 1 = extremely liberal to 7 = extremely conservative, mean 4.1, centered for modeling);
- *College major*, natural-science college major (coded 0 = no or 1 = yes, 9% yes);
- *Well informed*, self-assessed level of information about polar regions (coded 0 = don't know to 5 = very informed, mean 3);
- *Polar knowledge*, number of correct answers to five polar-knowledge questions seen in Table 1 (from 0 to 5, mean 2.7);
- *Science literacy*, number of correct answers to 11 non-polar science knowledge questions seen in Table 1 (from 0 to 11, mean 6.5, centered for modeling);
- *Ideology×science literacy* (interaction term defined as the product of centered *ideology* times centered *science literacy*).
- *Year* of survey, coded 0 for 2006 and 1 for 2010.

Centering by subtracting means from variables involved with interaction terms helps to reduce problems of multicollinearity, and to simplify the interpretation of main effects in models containing interactions.

Across all the climate-change concern items in Table 3 (but not reserving the Antarctic), women express greater concern than men do. Higher-income respondents tend to be more concerned than others about polar bears, sea level, or Arctic ice, but no different with respect to other items. Controlling for multiple knowledge factors, education shows little effect on concerns about anything but sea level. Political ideology, in contrast, affects everything. Conservative respondents less often say they would be bothered by polar bear extinction, sea level rise, a melting ice cap, Inuit losing their traditional way of life, Arctic seals threatened, or Antarctic penguins threatened. Conservatives more often support Antarctic commercial development.

Among the science knowledge indicators, a college major in natural sciences is associated with lower concern on four items. This finding may appear counterintuitive, but note that it estimates the effect of college major alone, among people who otherwise are identical in knowledge (as measured by *well informed*, *polar knowledge* and *science literacy*). Natural science majors are defined broadly (following National Science Board 2010) to include the fields of agricultural, biological, health, physical, earth, atmospheric and ocean sciences, along with mathematics and computer science. The numbers in climate-related fields, however, are small—3 people in geology, 7 in chemistry, 1 in statistics, for example.

Other things being equal, having information about polar regions, whether measured by respondent self-assessments (*well informed*) or by the more objective *polar knowledge* score, increases the odds of being concerned about polar climate change. Respondents with higher *polar knowledge* scores also tend to support reserving the Antarctic for science. The same is true for *science literacy*, which has positive and statistically significant main effects on all items except for the Inuit way of life. Due to the centering used, we can interpret these main effects as the effects of *science literacy* for individuals with an "average" political ideology (*ideology* values of 4.1 on a 1–7 scale, which corresponds to self-identified moderates). The next section focuses on the interaction term *ideology×science literacy*, which quantifies how the effects of *science literacy* shift among people with more partisan views.

Survey *year* (2006 or 2010) is included as a final predictor in these models. We earlier saw no significant changes in simple percentages associated with any of the opinion items. Table 3 confirms that even controlling for 10 other predictors, there were no significant changes in six of the seven items. The exception is concern about sea level rise, which (net of science knowledge, ideology and other effects) declined from 2006 to 2010.[6]

INTERACTION OF IDEOLOGY WITH SCIENCE KNOWLEDGE

Coefficients on the interaction term *ideology×science literacy* are negative and statistically significant for five of the seven items in Table 3. Coefficients for the remaining two items (*seals* and *penguins*) also are negative and have similar magnitudes, but they fail to reach significance because they involve smaller samples (2006 or 2010 data only). The positive main effects together with negative interaction effects mean that among politically liberal, moderate or even slightly conservative respondents, concern about polar climate change, or support for reserving the Antarctic, tend to increase as *science literacy* goes up. Among the most conservative respondents, however, concern about climate and support for reserving the Antarctic stays level or even slightly declines as *science literacy* goes up.

Figure 1 visualizes such interactions as a conditional effect plot, graphing the predicted probability that respondents say they would be bothered a great deal if sea level rises 20 feet, flooding coastal areas. The probability climbs steeply with *science literacy* among extremely liberal respondents, and slightly declines with *science literacy* among extremely conservative respondents. In-between political outlooks would appear as curves between these two; for moderate or slightly conservative respondents, such curves still have an upward slope. Probabilities for this conditional effects plot are calculated from a simplified version of the *sea level* regression in Table 3, using a binomial logit instead of ordered logit model but with all of the same predictors. Predictors other than *science literacy* and *ideology* are fixed at their means for this graph (although not for the models), so the graph depicts the relationship between *science literacy* and *sea level* conditional on *ideology* at its lowest or highest values, and other variables at average values.[7]

Figure 1 bears a family resemblance to the plot for *ideology×education* in Hamilton (2008), or similar conditional plots for *political party×education* and *political party×understanding* based on other survey data in Hamilton (2011a).[8] More generally it also has the same flavor as *party×self-assessed knowledge* interaction effects found by Malka et al. (2009), as well as other interactions in McCright and Dunlap (2011) and sources they cite. Table 3 and Figure 1 add new information by demonstrating significant interactions between ideology and objectively measured general-science knowledge, even while controlling for the effects of formal education (*education* and *college major*) and polar knowledge, whether self-assessed (*well informed*) or measured (*polar knowledge*). The previously-observed pattern of polarization among high-information respondents thus extends to those with higher background science knowledge. This information-elite polarization occurs not only regarding climate change, but even support for preserving the Antarctic.

CONCLUSION

This analysis supports previous findings of polarization among high-information respondents, while adding several new elements. First, the dependent variables involve specifically polar issues, six of them related to future impacts of global warming and the seventh to opening or reserving the Antarctic. Second, the independent variables include demographic factors (age, gender and income), political ideology (liberal to conservative), and respondent levels of information represented by five distinct items: education, college major, self-assessment, and brief objective quizzes on general science and specifically polar knowledge. Each information indicator affects one or more of the concern measures, but the objective knowledge scores show the strongest and most consistent effects. In particular, objective knowledge together with political ideology are the only background factors that significantly predict Antarctic opinions. Political ideology affects polar opinions consistently, as seems to be the case with virtually any environment-related views. Gender proves to have notable effects here as well — women express higher levels of concern on all six climate items. Finally, we see improvements in knowledge but little change in concern, or in views on Antarctica, when comparing responses from surveys in 2006 and 2010.

General-science knowledge exhibits positive effects on polar-climate concern (or Antarctic views) among self-identified liberals or moderates, but near-zero or slightly negative effects among the most conservative respondents. This extends previous findings of partisan interactions with education or self-assessed knowledge on climate and other environmental concerns. It agrees also with Kahan et al.'s (2011b) finding of ideology interactions with knowledge affecting climate risk assessments, and thus it adds support to their cultural polarization perspective. The support is only partial, however.

Polar knowledge, measured by a different scale, is positively related to concern and Antarctic views with no sign of interactions. General science knowledge too is positively related to concern and Antarctic views for a majority of the respondents (except the most conservative). Moreover, the zero-order correlations between each of the concern or Antarctic measures and either polar knowledge or general science knowledge are substantially stronger than their zero-order correlations with ideology. These observations suggest that apart from the well-confirmed reality of polarization, there also remains a substantial non-ideological, non-partisan impact from science knowledge: a science literacy effect that is complicated but not removed by politics.

The general science literacy scale used here involves no climate-related questions. The polar knowledge scale has two, although these do not mention causes, and as predictors behave much like the other polar knowledge items. Correct answers to the non-climate "sun never shines" and "North Pole is on ice sheet" knowledge questions are just as effective in predicting climate-related concerns as are the climate-related "polar bear hunting" or "ice caps smaller" questions. Polar information has rising public salience today largely in the context of climate change, however. Together these mixed findings suggest that general science knowledge, like education and self-assessed understanding, exhibits interaction effects because it identifies people who can, if so inclined, more effectively find and assimilate information that reinforces their beliefs. The polar knowledge questions function differently here because they come closer to the *content* of such information. For example, people who believe the globe is warming could be more likely to retain and credit information about ice caps melting, compared with people who believe the globe is not warming. Biased assimilation and related ideas discussed earlier imply that some climate-related information is accepted because it fits broader beliefs about the reality of climate change, rather than shaping those beliefs in the first place. The prospect that retention of certain climate facts or "facts" could behave like a dependent variable, predicted from general beliefs, suggests hypotheses for future research.

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Table 1: Science and polar knowledge questions, with the weighted percent of correct responses on the GSS in 2006 and 2010. This table and other analyses include all 2006 polar module respondents (*n* = 1,862), but only those 2010 respondents (*n* = 697) who did not answer the polar module in 2006. Statistical significance results are from design-weighted *F* tests.

In 2006 and 2010, the GSS asked 11 questions testing general knowledge of scientific terms and concepts.

"Now, I would like to ask you a few short questions like those you might see on a television game show. For each statement that I read, please tell me if it is true or false. If you don't know or aren't sure, just tell me so, and we will skip to the next question. Remember true, false, or don't know."

		2006	2010
1.	"First, the center of the Earth is very hot. Is that true or false?" (T)	80	82
2.	"All radioactivity is man-made." (F)	70	67
3.	"It is the father's gene that decides whether the baby is a boy or a girl." (T)	64	58*
4.	"Lasers work by focusing sound waves." (F)	45	50
5.	"Electrons are smaller than atoms." (T)	53	52
6.	"Antibiotics kill viruses as well as bacteria." (F)	56	49**
7.	"The universe began with a huge explosion." (T)	33	39*
8.	"The continents on which we live have been moving their locations for millions of years and will continue to move in the future." (T)	79	80
9.	"Human beings, as we know them today, developed from earlier species of animals." (T)	43	47
10.	"Now, does the Earth go around the Sun, or does the Sun go around the Earth?" (Earth around Sun)	75	75
11.	"How long does it take for the Earth to go around the Sun: one day, one month, or one year?" (one year)	56	52

	2006	2010
These 11 questions define the 0–11 point *science literacy* score used in Table 3.	59	59
An alternative 0-9 point version without items 7 and 9 yields very similar results.	64	63

The 2006 and 2010 GSS also included five questions meant to test knowledge about the north and south polar regions. The first four are true–false:

"The next few questions are about the Arctic and the Antarctic. The Arctic is the region around the North Pole; Antarctic is the region that contains the South Pole. These questions are like ones you might see on television game show. If you don't know or aren't sure, just tell me so, and we will skip to the next question. Remember true, false, or don't know."

		2006	2010
1.	"The North Pole is on a sheet of ice that floats on the Arctic Ocean." (T)	41	47*
2.	"The sun never shines at the South Pole." (F)	67	69
3.	"Inuit (often called Eskimos) live north of the Arctic Circle." (T)	44	51**
4.	"Hunting is more likely than climate change to make polar bears become extinct." (F)	36	46***

A fifth question asks,

		2006	2010
5.	"Would you say the polar ice caps have gotten larger or smaller over the last 25 years?" (Smaller)	77	81

	2006	2010
These five questions define the 0–5 point *polar knowledge* score used in Table 3.	53	59***

* 2006–2010 difference statistically significant at $\alpha = .05$
** 2006–2010 difference statistically significant at $\alpha = .01$
*** 2006–2010 difference statistically significant at $\alpha = .001$

Table 2: Polar concern questions, with weighted percentages from unique 2006 (*n* = 1,862) and 2010 (*n* = 697) respondents. None of the 2006–2010 differences shown here are statistically significant (evaluated by design-weighted *F* tests).

"Scientists predict that global warming may soon have big effects on the polar regions. I will describe some of these possible effects and, for each one, please say whether it would bother you a great deal, some, a little, or not at all if it actually happened."

		2006	2010
Sea level	"Sea level may rise by more than 20 feet, flooding coastal areas."	70	67
Ice cap	"The northern ice cap may completely melt."	63	67
Inuit	"Inuit and other native peoples may no longer be able to follow their traditional way of life."	45	47
Bears	"By 2020, polar bears may become extinct."	45	49
Seals	"Arctic seals may be threatened."	43	…
Penguins	"Antarctic penguins may be threatened."	…	48

Answers for *sea level* through *penguins* were coded from 1, "not at all," through 4, "a great deal." Percentages above refer to those saying they would be bothered "a great deal."

Antarctic	"Some people think that Antarctica should be reserved primarily for scientific purposes. Others think it should be open for tourism, fishing, exploration for oil, and other commercial purposes. Which statement best describes your view on this issue?"	46	46

Answers for *Antarctic* were coded from 1, "strongly support opening Antarctica to other purposes," through 5, "strongly support reserving Antarctica for scientific purposes." Percentages above refer to those saying they somewhat or strongly support reserving Antarctica for science.

Table 3: Degree of concern about six possible results of global warming, and views on reserving the Antarctic for science (defined in Table 2), predicted from respondent background characteristics and indicators of science knowledge (Table 1). Coefficients and tests are from probability-weighted ordered logit regression models, estimated using pooled 2006 and 2010 cross section data . The pooled sample has a maximum *n* of 1,862 + 697 = 2,559, but the estimation samples are smaller due to missing values: about 2,186 for the first five items, 1,573 for *seals* (2006 only) and 613 for *penguins* (2010 only).

	Dependent variables						
Independent variables	*Bears*	*Sea level*	*Ice cap*	*Inuit*	*Antarctic*	*Seals*	*Penguins*
Background							
Age	.002	–.003	.008*	.003	.001	.001	.006
Female	**.504*** **	**.357** **	**.391*** **	**.764*** **	.176	**.610*** **	**.973*** **
Income	**.032** **	**.034** **	**.032** **	.016	–.003	.021	.019
Education	.002	**.140***	.015	–.054	.034	–.035	–.057
Ideology	**–.177*** **	**–.132*** **	**–.170*** **	**–.143*** **	**–.146*** **	**–.193*** **	**–.235*** **
Science							
College major	**–.361***	**–.533** **	–.038	**–.398***	.029	**–.511** **	–.633
Well informed	**.125** **	.084	**.180*** **	**.103***	.043	**.158** **	.065
Polar knowledge	**.215*** **	**.128** **	**.250*** **	.081	**.186*** **	**.180*** **	**.201***
Science literacy	**.110*** **	**.086** **	**.159*** **	.028	**.076*** **	**.085** **	**.102***
Interaction term							
Ideology×science lit	**–.032***	**–.036***	**–.062*** **	**–.047** **	**–.026***	–.029	–.051
Year	–.027	**–.318** **	–.019	–.216	–.161	....	...

* Coefficient statistically significant at α = .05
** Coefficient statistically significant at α = .01
*** Coefficient statistically significant at α = .001

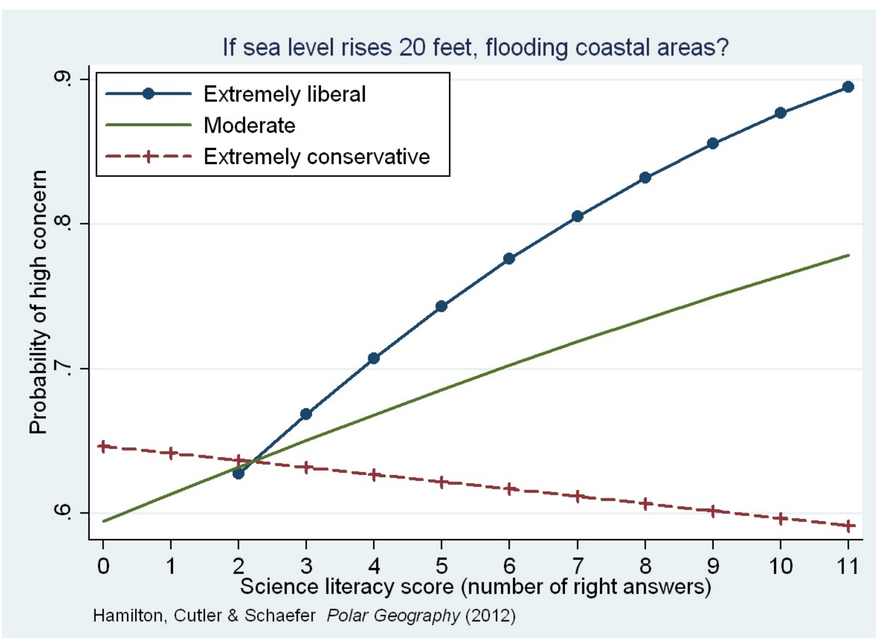

Figure 1: Conditional effect plot for effects of science literacy on probability respondent is bothered “a great deal” if sea level rises. Calculated from weighted logit regression model with the 11 predictors in Table 2; predictors other than science literacy and ideology held at their means for this plot.

ENDNOTES

1. Burstein (2006) distinguishes between issues with public importance, where public opinion often affects policy, and other issues with less public importance where interest groups are more likely to dominate. Although climate change does not show up as a top priority on most polls, it receives substantial media attention — particularly with respect to polar changes, and also extreme weather events. Moreover, the topic recurs often in U.S. political discourse, such as statements by political candidates in the 2012 presidential campaign.

2. Some people have questioned the inclusion of Big Bang and evolution items on the GSS science literacy list, arguing that those two items conflate knowledge with beliefs (Bhattacharjee 2010). Their inclusion does not affect the general conclusions of this paper, however. The signs, significance and magnitudes of coefficients for these models in Table 3, including their interaction effects, turn out to be quite similar regardless of whether science literacy is represented by the original 0–11 scale or a truncated 0–9 version.

Kahan et al. (2011b) construct a combined science literacy/numeracy scale (with different data) partially based on eight of the 11 items in the upper part of Table 1 — without Big Bang, evolution or continental drift. For most of these the eight, the percent of correct answers by respondents from their pool appear substantially higher than either of the GSS samples in Table 1. This different knowledge measure, together with a different sampling approach, different dependent variable (risk assessment vs. degree of concern), and different control variables likely accounts for the divergence in our findings.

3. For comparisons of responses by the 309 panel respondents in 2006 and 2010, see Hamilton et al. (2012).

4. A secondary analysis, not shown, established that science literacy scores did not significantly change among college graduate or non-graduate subsets of the sample.

5. *Ideology×polar knowledge* interaction terms also were tested, but found to have no significant effects. They did raise problems with multicollinearity, and for both of these reasons are left out of the Table 3 models.

6. Several *year* interaction terms were tested to detect possible changes between 2006 and 2010 in the effects of other predictors. These interactions brought no improvement in fit and raised problems with multicollinearity, however, so they are left out of the final models.

7. See Hamilton (2009) for practical details on conditional effect plotting.

8. Versions of the models with *ideology×science literacy* interactions (Table 3) performed as well or slightly better than alternatives containing *ideology×education* interaction terms instead (not shown). Although we could not include both types of interactions in the same models due to multicollinearity, the *ideology×science literacy* versions here should be viewed not as a rejection of earlier *ideology×education* findings, but as an equally supported and more interpretable alternative.