FRAME WORKS INSTITUTE

"Just the Earth Doing Its Own Thing"

Mapping the Gaps Between Expert and Public Understandings of Oceans and Climate Change

A FRAMEWORKS RESEARCH REPORT

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JULY 2013

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I. Introduction

Since publication of *Environmental Values in American Culture*,[1] researchers, including those at the FrameWorks Institute, have studied how people's deeply held worldviews and widely held assumptions about the relationship between science, society and the environment affect their understanding of climate change.[2] Beginning in 2002, FrameWorks undertook research for an array of leading environmental groups designed to understand the deep patterns of thinking about climate change that challenge public understanding. Working with the Pew Commission on Oceans, FrameWorks also began a parallel inquiry in 2002 to understand how Americans think about oceans. These projects — one focused on climate change, the other on oceans — have yielded a set of recommendations, based on research with more than 4,300 North American informants, that have been used extensively by science communicators in formal and informal science settings.[3] Over the last decade, the FrameWorks Institute has continued to work with a number of organizations, including The Ocean Conservancy, the National Resources Defense Council, the David Suzuki Foundation and the Pew Oceans Commission, on translating the science of ocean and climate change.

Over the years, other researchers have suggested new ways to frame these issues based on different methods of communications research. Working with scientists and science educators who aspire to bring science to the public in a way that fosters engagement, FrameWorks recently set out to update and expand its existing research on climate change and oceans. In so doing, we sought to test our existing and newly formed hypotheses about how best to help Americans understand the underlying science. Given the richness of recommendations operative in the field of climate change communications, and the recent prominence of climate change issues in media and public discourse, this inquiry promised to yield important insights into what endures in public thinking and what may have changed. Moreover, by bringing together research on both climate change and oceans, FrameWorks sought to provide science communicators with a systematic snapshot of enduring and emerging American thinking about these two areas of science.

The research presented here was conducted by the FrameWorks Institute and sponsored by the National Science Foundation, as part of its support for the National Network for Ocean and Climate Change Interpretation (NNOCCI). This report is part of a larger, multi-method project designed to shift and expand the public conversation around oceans and climate change. The goal of this research is to generate a broader public understanding of oceans and climate change and, in turn, to increase public support for meaningful policies and programs necessary to address the issue.

Our findings show that, while climate change and ocean issues may be more salient in public discourse than they were a decade ago, the public has no more science thinking available with which to process these reports than it did a decade ago. In this respect, the highly patterned and shared ways of implicitly thinking about the world that we identify as

cultural models in this report are strikingly similar to past FrameWorks conclusions (see Appendix B for more on cultural models). This is particularly true when it comes to cultural models the public uses to think about the ocean, pollution, causes of climate change, climate change solutions and climate science. Throughout the report, we refer to these past findings in order to highlight enduring challenges in public thinking on these issues. This allows us to compare findings across time and focus reframing attention on the most durable and stubborn aspects of the public understanding. Without addressing these barriers to a wider discourse on oceans and climate change, public thinking will remain where it has been for the last 15 years — stuck.

At the same time, we offer new and important observations about public thinking at the interstice of oceans and climate change. Strong evidence exists to explain why connecting climate change to weather creates cognitive problems. Similarly, the cultural models identified here explain why the public's reliance on local evidence and backyard observation is problematic, and shed light on the counterintuitive finding that appealing to the ocean's beauty and associated emotional attachment serves to dampen engagement with solutions. In sum, this report offers an analytical framework by which scientists and science communicators can better judge their communications hypotheses and practices.

II. Summary of Findings

The Expert View of Oceans and Climate Change

- The climate is composed of multiple interdependent systems, including oceans, land and atmosphere. Oceans play a critical role in regulating the climate system.
- There are both natural and human (anthropogenic) causes of climate change. However, human activity is causing measurable changes to the climate system that cannot be attributed to natural variability.
- Human activity affects the climate primarily through carbon dioxide emissions, which trap heat in the earth's atmosphere and result in such impacts as increasing temperatures, sea level rise, more extreme weather events, amplification of existing weather events, melting of the ice caps, and increases in ocean temperatures.
- Carbon dioxide emissions are also changing the earth's oceans and marine systems through a process called ocean acidification, whereby carbon dioxide dissolves in sea water to form carbonic acid, which disrupts the ocean and the larger climate system of which it is part.
- Climate change will alter the earth's ecosystems, and will impact human lives in multiple and long-term ways — including coastal flooding, changes in disease and migration patterns, and food and water shortages. The specifics of these impacts are difficult to predict and will vary by region.
- Policies to reduce global carbon dioxide emissions are critical to mitigating the effects of climate change.

The Public View of Oceans and Climate Change

Members of the public struggle to pull their thinking about climate change together into a coherent story and have difficulty reasoning about climate change, its relationship to oceans, and appropriate responses. Much of this difficulty is due to the fact that people lack a clear understanding of how climate systems work.

- Informants frequently viewed oceans in terms of their value as food sources and spiritual symbols.
- Problematically, pollution was top of mind in informants' thinking about how oceans change. They assumed that people affect oceans by dumping waste into them. Informants had not heard of the term "ocean acidification," but drew on assumptions about pollution and acid rain when asked to think about the term.

- The "climate system" was a missing concept for informants, who conceptualized oceans, atmosphere, climate and weather as discrete concepts rather than as an integrated system.
- Informants expressed strong views that the climate was warming, but had limited ability to reason about why this was happening. They often considered the cause of the warming to be gaseous pollution that is destroying the ozone layer and letting more of the sun's radiation into the atmosphere.[4]
- While informants sometimes treated scientists as authorities, at other times they viewed scientists with suspicion, explaining that scientists exaggerate and overstate what they know.
- Lacking understanding of the mechanisms behind climate change, informants suggested familiar environmentally friendly practices, such as recycling, as responses to climate change.
- At times, informants invoked models of change as "natural" and nature as self-correcting to proclaim that human action was not necessary to combat climate change and could actually do more harm than good.

Gaps in Understanding

Comparing the expert and public perspectives on these issues revealed a set of conspicuous gaps in understanding. These gaps are likely to impede the public's ability to access science messages about oceans and climate change, and therefore should be targets for strategic communications research to address.

- **Natural and human causes of climate change: Both vs. either.** Experts advance an integrated account of the causes of climate change, explaining that natural causes and human causes both play a role, while the public views these causes as mutually exclusive, assuming that *either* human beings are causing climate change *or* it is caused by natural processes.

- **Carbon dioxide: The driver of climate change vs. something natural we need.** While experts identify carbon dioxide emissions as the primary cause of anthropogenic climate change, members of the public lack awareness of carbon dioxide as a cause of climate change and widely assume that carbon dioxide — because it is a naturally occurring substance — cannot have harmful effects.

- **How climate change works: Heat absorption vs. ???? or ozone depletion.** While experts explain that rising levels of carbon dioxide cause climate change by trapping heat within the atmosphere, members of the public have difficulty explaining climate change or incorrectly attribute the phenomenon to holes in the ozone.

- **How people affect oceans: Carbon emissions vs. dumping.** While experts emphasize that carbon emissions have major effects on oceans, members of the public assume that humans affect oceans by dumping pollutants into them.

- **The impacts of climate change: A complex chain vs. a short list.** The public is only aware of a small subset of the effects of climate change that experts cite, lacking awareness of downstream effects like effects on food and water supplies or changes in disease patterns.

- **Degree of effects: Just how severe vs. maybe it will be okay.** Members of the public share with experts the belief that we cannot know for sure exactly what the effects of climate change will be, but, while experts are confident that the effects will be severe, the public assumes that uncertainty implies that everything might turn out fine.

- **What to do: Reducing carbon emissions vs. more recycling.** The public lacks experts' laser focus on reducing carbon emissions, suggesting instead a broad range of environmentally friendly "green" actions as possible responses to climate change, including recycling, reducing waste or limiting pollution.

- **Taking action: An urgent necessity vs. something to consider.** Experts emphasize that many of the effects of climate change are already in motion and that we must act now to avoid catastrophic consequences. Lacking understanding that our activities now will have effects that reverberate throughout the climate system for years to come, members of the public fail to understand the urgency of the situation.

- **Who should respond?: Policy solutions vs. individual actions.** Experts view policy measures as necessary responses to climate change, while the public prefers voluntary steps at the individual level.

- **Science: Source of knowledge vs. mixed attitudes.** While experts assume that science is a valid source of knowledge, members of the public are often distrustful of scientists' motives and skeptical about how much science can tell us.

Cognitive Holes

In addition to the gaps, there was a set of issues on which members of the public simply have no model from which to reason and, as such, have difficulty engaging.

- **The climate system:** While experts consistently describe climate as an integrated system, the public treats oceans, atmosphere, climate and weather as discrete topics or entities and consistently fail to see these concepts as part of a larger system.

- **Trouble with trends:** The public shares with experts the understanding that weather is short term and climate is long term, but members of the public have difficulty

reconciling short-term variability in the weather from season to season and year to year with the knowledge that the climate is consistently getting hotter over time.

- **Ocean acidification:** Experts speak of the dangers posed by ocean acidification, yet members of the public are entirely unaware of the concept and its effects, underscoring problems in connecting land and water effects.

Future Directions

FrameWorks' previous research has proven the effectiveness of specific values and metaphors in addressing many of the gaps and holes identified here. However, the breadth and complexity of the communications challenges revealed in this new round of research point clearly to the fact that new tools will be necessary to expand public thinking about oceans and climate change. Tasks for future research include the following:

- Developing an explanatory metaphor for ocean acidification is necessary to help people think about how the ocean absorbs carbon and the effects of this process.
- Concretizing a systemic understanding of the relationship between land, oceans, atmosphere and climate change, and clarifying how these systems and processes affect humans, will require the use of additional frame elements.
- Finding the most effective way to communicate about carbon dioxide is imperative. Communications research must explore ways to get around problematic assumptions about pollution in order to effectively communicate the role of carbon dioxide in climate change.
- Identifying values that productively orient thinking will serve to highlight the urgency of action, deflect skepticism about climate science, shift discussion away from ideologically driven discourses, avoid fatalism about the future, and frame government action in positive rather than negative terms.
- Integrating natural and human causes is necessary in order to overcome the public's current model of viewing these causes in mutually exclusive terms.
- Testing the effectiveness of different types of messengers is strongly suggested by our analysis of the models that the public uses to evaluate claims about climate change.
- Improving understandings of "science" represents an overarching communications need. Part of the problem with the public's understanding of claims about climate change is a lack of understanding about the role of uncertainty in science. A better understanding of how science works should lead to a better understanding of scientific claims.

III. Research Methods

Expert Interviews

FrameWorks researchers conducted 15 one-on-one interviews by phone with leading scientific experts on ocean systems and climate change between September and November, 2012. The interviews lasted approximately one hour and, with the informants' permission, were recorded and subsequently transcribed for analysis. To locate experts, FrameWorks solicited recommendations from the NNOCCI project's advisory committee and used snowball sampling techniques with the initial set of experts identified.

Expert interviews consisted of a series of probing questions designed to capture the expert understanding of the causes and impacts of climate change and the relationship between climate change and oceans. In essence, FrameWorks' interviewers asked experts to identify what they felt the public needed to know about ocean systems and their role in climate change in order to be sufficiently well informed on these issues so that they could evaluate public policy solutions. In each interview, the interviewer went through a series of prompts and hypothetical scenarios designed to challenge expert informants to explain their research and experience, break down complicated relationships, and simplify concepts and findings from the field. Interviews were semi-structured in the sense that, in addition to preset questions, interviewers repeatedly asked for elaboration and clarification, and encouraged experts to expand upon those concepts that they identified as particularly important.

Analysis employed a basic grounded theory approach. Common themes were pulled from each interview and categorized, resulting in a refined set of themes that synthesized the substance of the interview data. The analysis of this set of interviews resulted in the drafting of an initial summary of expert perspectives on the field of oceans and climate change.

Cultural Models Interviews

Informants

The cultural models findings presented below are based on 40 in-depth interviews conducted in Asheville, N.C., Boston, Mass., Monterey, Calif., and Philadelphia, Pa., by four researchers between October 2012 and January 2013.[5] A sizable sample of talk, taken from each of our informants, allows us to capture the broad sets of assumptions — cultural models — that informants use to make sense and meaning of information. Recruiting a wide range of people and capturing a large amount of data from each informant ensures that the cultural models we identify represent shared patterns of thinking about a given topic. And, although we are not concerned with the particular nuances in the cultural models across different groups at this level of the analysis (an

inappropriate use of this method and its sampling frame), we recognize and take up this interest in subsequent parts of the larger research project.

Informants were recruited by a professional marketing firm and were selected to represent variation along the domains of ethnicity, gender, age, residential location (inner metro, outer metro and regional/rural areas up to three hours from city centers), educational background, political ideology (as self-reported during the screening process), religious involvement and family situation (married, single, with children, without children, age of children).

The sample included 19 men and 21 women. Thirty-three of the 40 informants self-identified as Caucasian, four as African American, two as Latino, and one as Native American. Eighteen informants described their political views as "middle of the road," 14 as liberal and eight as conservative. The mean age of the sample was 41 years old, with an age range from 21 to 69. Six informants had high school degrees, 10 had some post secondary education, 11 had a college degree and the remaining 13 had post-graduate degrees. Fourteen of the 40 informants were married, and 15 had at least one child under the age of 18.

Interviews

Informants participated in one-on-one, semi-structured "cultural models interviews" lasting 1 to 2½ hours. Cultural models interviews are designed to elicit ways of thinking and talking about issues — in this case, what oceans and climate are, how oceans and climate work, what climate change is and what causes it, and what we can do to address climate change. As the goal of these interviews was to examine the cultural models informants use to make sense of, and understand, these issues, it was key to give them the freedom to follow topics in the directions they deemed relevant. Therefore, the interviewers approached each interview with a set of areas to be covered but left the order in which these topics were covered largely to the informants. All interviews were recorded and transcribed. More specific information about the interviews can be found in Appendix A.

Analysis

Analytical techniques employed in cognitive and linguistic anthropology were adapted to examine how informants understand issues related to oceans and climate change. First, patterns of discourses — or common, standardized ways of talking — were identified across the sample. These discourses were analyzed to reveal tacit organizational assumptions, relationships, logical steps and connections that were commonly made, but taken for granted, throughout an individual's transcript and across the sample. In short, our analysis looked at patterns both in what was said (how things were related, explained and understood) as well as what was not said (assumptions). In many cases, analysis

revealed two, often conflicting, models that people brought to bear in thinking about the same issue. This is a normal feature of cognition, though it is rare that both of these conflicting models are given equal weight. More commonly, one of these models is given more weight than the other, and FrameWorks researchers identify these as dominant and recessive.

IV. Findings

Expert Interviews

The themes that emerged from expert interviews can be categorized as responding to four foundational questions:

1. What is climate and what is climate change?
2. How does human activity affect oceans and climate?
3. What are the impacts of climate change?
4. What should be done about climate change?

1. WHAT IS CLIMATE AND WHAT IS CLIMATE CHANGE?

- **"Climate" is an integrated system of interdependent components.** Experts asserted that climate consists of multiple components, including the atmosphere, the oceans, sea ice and glaciers, which function as an integrated system. Because they are interdependent, changes in one component of the climate system propagate changes throughout the system. Experts emphasized, in particular, the critical role that oceans play in regulating other aspects of the climate system.

- **Climate is distinct from weather.** Climate, in the expert view, refers to long-term and relatively stable patterns in environmental parameters, while weather refers to the short-term variability in these patterns. Weather is related to climate inasmuch as climate represents the integration of multiple weather cycles over long periods of time. Experts used this distinction to explain, for example, why it is entirely possible for a region to experience record snowfall in the context of climate change characterized by warming temperatures.

- **Climate change is measurable.** Experts highlighted time scale and geospatial scale as defining features of climate change, asserting that climate change refers specifically to those changes that exceed expected levels of variability over long periods of time (i.e., decades or more), and which occur on a global (as opposed to regional or local) level. Experts argued that scientific data tell us that changes to the climate are observable, and are occurring at an extremely fast pace.

- **Climate change is both a natural and anthropogenic (human) phenomenon.** Experts pointed to phenomena such as naturally occurring changes in ocean temperatures and currents, for example, as illustrations of natural "causes" of climate change — often referred to as climate "modes." Against this backdrop of naturally occurring change, however, they argued that human activities are causing changes in climate that cannot be attributed to natural variability. Both types of change are important in order to fully understand climate change.

2. HOW DOES HUMAN ACTIVITY AFFECT OCEANS AND CLIMATE?

- **The primary cause of anthropogenic climate change is the release of carbon dioxide through the burning of fossil fuels.** Experts were consistent in asserting that human activities — particularly the burning of fossil fuels — have contributed to climate change. They described how carbon normally cycles between the land, the oceans and the atmosphere — but that the increased burning of fossil fuels has disrupted this balance by introducing enormous amounts of carbon into the atmosphere that would not otherwise be there. When carbon is released, it interacts with oxygen in the atmosphere to form carbon dioxide, which then absorbs heat from the planet that would normally be released into space. Experts described how, by mapping historical measurements of the earth's climate onto trends in carbon dioxide emissions, scientists have been able to link warming temperatures with increases in fossil fuel use.

- **Carbon dioxide emissions are changing the oceans.** Experts noted that carbon dioxide emissions are impacting both the temperature and the acidity of the earth's oceans. Oceans absorb heat from the atmosphere; therefore, as atmospheric temperatures warm because of the increased concentration of carbon dioxide, so too do oceans. Experts also noted that oceans absorb carbon dioxide, and, in so doing, have in fact slowed the progression of climate change associated with warming atmospheric temperatures. However, the ocean's ability to absorb carbon dioxide has also changed its chemical makeup. When carbon dioxide dissolves in the ocean, it forms carbonic acid — thereby making the water more acidic. Experts asserted that this increase in acidity is affecting ocean ecosystems and, because of the interdependent nature of climate systems, affecting global ecosystems more broadly.

3. WHAT ARE THE IMPACTS OF CLIMATE CHANGE?

- **The impacts of climate change are widespread, already evident and growing.** Experts emphasized that anthropogenic climate change is fundamentally changing the planet. Species and ecosystems that are able to adapt to these changes will survive, while those species that are more sensitive to the climatic perturbations may not — thus changing, potentially dramatically, the planet's ecology. Experts asserted that warming temperatures caused by carbon dioxide emissions will trigger a cascade of changes, including sea level rise and coastal flooding, more extreme weather events, severe drought, species loss, and amplifications of existing weather patterns. Experts also described a number of "downstream" impacts of climate change, including changes in human disease and migration patterns. These indirect impacts were predicated on a nuanced understanding that the impacts of climate change will inevitably affect interactions between humans and their environments.

- **The impacts of climate change will vary spatially.** Experts noted that it is difficult to predict how climate change will affect any one region or location. Even given a global trend towards warming temperatures, substantial variability will persist in both patterns and impacts of climate change. Some basic principles can be applied, such as wet regions getting wetter and dry regions getting dryer, although these principles are not absolute.

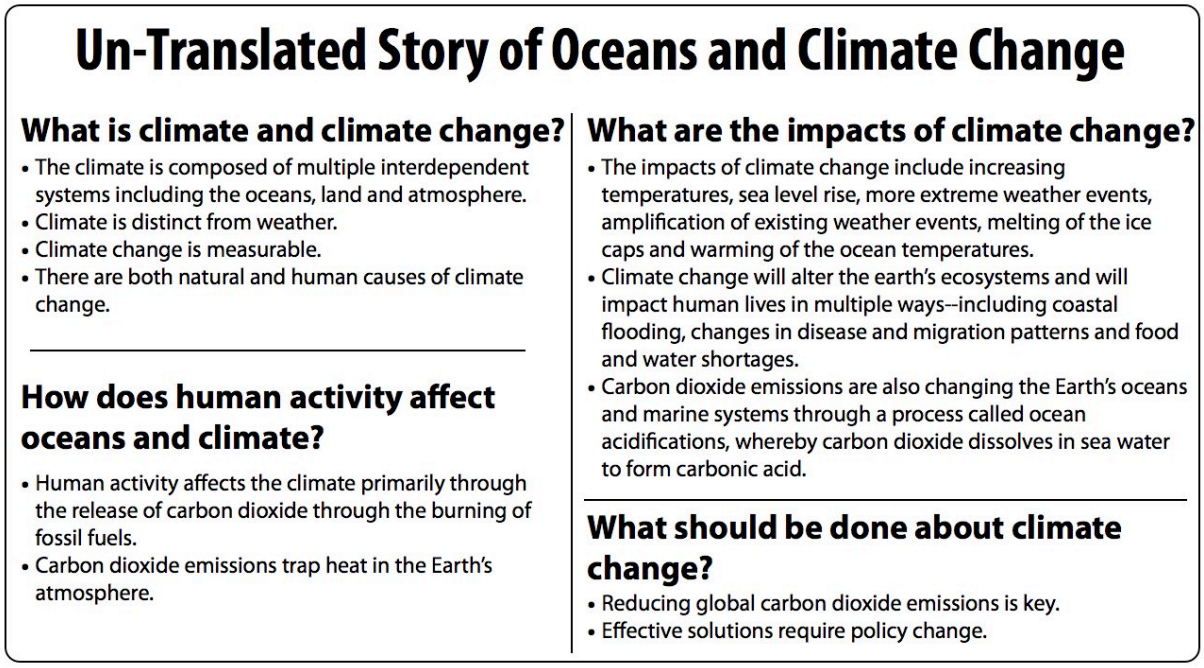
- **There will be long-term impacts of climate change but the specifics of these changes are difficult to predict.** Experts emphasized that climate change is associated with "short-term consequences and long-term catastrophes." They noted, however, that while climate change will almost certainly have catastrophic long-term impacts, the exact nature of these impacts is more difficult to predict. Such predictions depend on a full understanding of how ecosystems interact, particularly when under severe stress, and how changes in one part of an ecosystem propagate and accelerate deleterious changes throughout the entire system. Accurately predicting the exact nature and timing of the long-term catastrophes caused by climate change, therefore, remains difficult.

4. WHAT SHOULD BE DONE ABOUT CLIMATE CHANGE?

- **Reducing global carbon dioxide emissions is key.** Experts argued that moving away from a fossil fuel–based energy system is the ultimate way to address climate change. They also noted that there are more practical short-term ways to mitigate some of the effects of climate change. These include slowing the rate of carbon dioxide emissions and reducing other human activities that damage ecosystems. For example, marine systems might be better able to adapt to warming temperatures and ocean acidification if pollution and over-fishing weren't also stressing the adaptive capacities of these systems. Still, experts emphasized that mitigation strategies only "buy time" — and that long-term solutions require eliminating the burning of fossil fuels.

- **Effective solutions require policy change.** Experts argued that mitigating the effects of climate change requires more than just changing individual behavior. Instead, they emphasized the need for governments to implement policies that both reduce future carbon dioxide emissions and address the existing impacts of climate change by making investments in new technologies and infrastructure.

See Figure 1 below for a summary of the expert account of oceans and climate change.



Cultural Models Interviews

Analysis of public thinking about oceans and climate change is organized according to the following seven basic questions:

1. What are oceans?
2. How do oceans change?
3. What is climate?
4. How does climate change?
5. What are the effects of climate change?
6. What is the role of science in understanding climate change?
7. What should be done about climate change?

For each of these questions, we identify and describe the "cultural models"[6] — those deep, often implicit, assumptions and patterns of understanding that are broadly shared among Americans — that structured informant thinking on that particular question. Many of these models contain multiple "nested" propositions and assumptions. A nested assumption is an issue-specific assumption that fits into a broader cultural model. When this is the case, we summarize the general model and then lay out its constituent assumptions. We also note the implications of these models for communicators.

The meta-finding in this analysis is that, while Americans know some basic facts about oceans and climate change, they lack an understanding of the processes underlying connections between, and changes in, oceans and climate. This lack of understanding represents something of a "black box," wherein the specific mechanisms at play remain opaque and poorly articulated in people's thinking. That said, the models people draw on to fill in this black box when pushed to think about how things work and explain process are highly consistent. Below, we describe the cultural models that together guide public thinking about issues related to oceans and climate change, starting with a basic definitional question.

1. WHAT ARE OCEANS?

When asked to describe oceans, informants relied on three cultural models.

A. **The *Oceans as a Resource* model.** Informants' most top-of-mind association with oceans was as a food source.

> **Informant:** There's seaweed and there's underwater plants and we can eat seaweed and very healthy stuff in there. Seashells, clams and oysters — the ocean is a big part of our food chain, the fish part. We get a lot of our food out of there.

This *Oceans as a Resource* model was also evident in informants' focus on the oceans as a form of transportation and facilitator of trade. From this perspective, threats to the ocean were conceived as threats to the availability of consumable resources and income.

Previous FrameWorks research has also identified the *Oceans as a Resource* model,[7] which is related to a foundational American *Consumerist* model in which people compare the world to a marketplace and understand outcomes as a result of rational actors who calculate costs and benefits in order to maximize their profit in a free market system.[8]

B. **The *Oceans are Vast and Awesome* model.** Perceptions of the ocean as awe-inspiring, expansive, powerful and a source of internal peace dominated informant thinking. Also present in prior FrameWorks research on oceans,[9] this model links several attributes of the ocean (vastness, beauty, destructive power and mystery) with peace and serenity, but also with recreation.

> **Informant:** It's a big expanse as far as you can see of water, kind of like looking at the sunset where it meets the sky — looking out and just seeing forever on a flat plain. It has a feeling that is different, so there's probably real energy that

> feels different to be near to the ocean, and probably a calming type of feeling it gives people.

In speaking of the unknown and mysterious nature of the ocean, informants sometimes compared the ocean to the moon or to space. This confirms findings in previous FrameWorks research that people sometimes talk about the ocean as a "different world" that is alien and beyond human understanding.[10] When contemplating the ocean using this model, informants thought of the ocean as a different kind of environment that is beyond our control.

C. **The *Basis of Life* model.** Informants made occasional references to the ocean as the "basis of life." This understanding of oceans was less commonly employed in discussions and was "thin." That is, when people expressed the assertion that "water is the source of all life," they were unable to further explain what they really meant and, instead, employed vague references to the fact that humans are composed largely of water.

> **Informant:** If you look at things from the perspective of, you know, life emerged from the sea and evolved onto land … that makes the ocean the very basis of life.

This model did not enable people to think through why marine systems are important or about how they work in any concrete or specific ways. And, unlike experts, public informants were not able to expand on this idea to think about the complex ways that ocean systems are connected to climate systems.

Implications:

1. *The Oceans as a Resource model has mixed implications.* On one hand, this model is problematic in that a strictly utilitarian approach to oceans mutes attention to their importance beyond satisfying human consumption. On the other hand, the model highlights the importance of oceans for humans. FrameWorks recommends that communicators leverage this model carefully. It can be helpful in making concrete the connection between humans and oceans, and explaining how changing oceans affect human populations. However, the model should always be situated in discussions that push past this specific aspect of the relationship to highlight the role that oceans play in larger climate systems and to extend to other ways in which they affect human populations.

2. *The Oceans are Vast and Awesome model undermines thinking about the ability of human actions to affect oceans.* There is a danger that, when employing this model to think about oceans, people will conclude that the majesty and power of the ocean (and of nature more broadly) dwarfs human actions, making it extremely unlikely

that human activity could have meaningful or lasting impacts. As documented in previous research, this model obscures thinking about the importance of taking concrete steps to address ocean and climate change issues.[11] Because of the model's tendency to undermine perceptions of many aspects of the expert account of oceans and climate change, communicators should avoid activating this model in their messaging.

3. *The Basis of Life model lacks depth.* Speaking of oceans as the basis of life may be a useful starting point for engaging the public, but due to the thinness of the model — particularly its inability to productively structure reasoning about important "how does it work" questions — such references are unlikely, on their own, to prompt productive thinking about complex systems. If prescriptive research can identify an explanatory metaphor or other tool that helps people understand how oceans function as part of the broader climate system, the *Basis of Life* model might be productively harnessed to raise the salience of that system.

2. HOW DO OCEANS CHANGE?

Informants talked about the fact that the oceans were changing, and not for the better. They talked predominantly about the reasons for this change in two ways: (1) humans are directly affecting the oceans by polluting them, and (2) the warming of the earth is causing ocean temperature and sea levels to rise. These two processes and the cultural models underlying them are described below.

A. **The *Pollution* model.** Informants shared a common assumption that humans are causing oceans to change by dumping solid and liquid pollutants into them — including trash, sewage, oil and toxic waste.

> **Interviewer:** How do people affect oceans?
>
> **Informant:** Well they affect oceans in terms of — I mentioned there's pollution in the oceans. Now that could be from either dumping trash into the oceans or even just riding their boat — the different materials that are left from the boat like the oil which could affect the color of the ocean which could affect the animals that it touches or the plants that are surrounding it.
> —
>
> **Informant:** Human actions have dumped things, foreign objects … and that has impacted the biodiversity that we talked about that. So you see dolphins are choking on the soda cans.

Informants saw pollution as destroying sea life as well as humans.

> **Interviewer:** Do people affect the oceans?
>
> **Informant:** Oh, for sure … polluting them with sewage comes to mind, especially in the Los Angeles area. People are getting … even seeing the results of it, not just dying populations of fish but people getting diseases — lots of eye infections and things like that for people going swimming. Surfers.
> —
>
> **Interviewer:** And what's the effect of all that pollution?
>
> **Informant:** What's the effect? Well, dead fish.

B. **The *Melting Ice* model.** Regardless of whether or not informants explicitly stated that they "believed" in climate change, when they were asked "if and how oceans are changing," most informants asserted that sea levels are rising because the polar ice caps are melting.

> **Interviewer:** How is the ocean changing?
>
> **Informant:** Global warming, melting glaciers and ice, and therefore leading to a raised sea level, or a warmer ocean, probably. And then by changing something as simple as the sea level or, you know, I'm picturing the little polar bears stranded and falling, and then they're not — then they're dead, they're not preying on the normal organisms that they do.
> —
>
> **Informant:** So I don't know a lot about global warming, but that's when I picture that polar bear floating away on the iceberg.

This model was dominant in shaping thinking about how oceans are changing, even for informants who later in the interview denied that climate change was even happening.

C. **The *Acid Rain* model.** This model was invoked when informants were asked questions about "ocean acidification." Interviewers asked if informants had ever heard of the term ocean acidification, and the answer was a universal "no." When asked what that term might mean, informants' most frequent response was that the term meant the oceans were becoming more acidic. In explaining their answer, informants often relied on the *Pollution* model described above, wherein the dumping of sewage and waste serves to turn the ocean more acidic. Alternatively, they drew

upon the *Acid Rain* model, in which acid rain was understood to fall onto water and land and eventually end up in the oceans, turning them more acidic.

> **Interviewer:** Are you familiar with that term, ocean acidification?
>
> **Informant:** No but I can directly relate it to acid rain.
> —
>
> **Informant:** Exhaust from factories goes into the air. The rain mixes the hydrogen sulfide gas and takes it back down to the earth and goes into the water and the water goes back out to the ocean. This is what we call acid rain. Now there's certain fish that can only tolerate a really small range of PH change in the water. So if you increase the acidity, decrease acidity and increase the bases then you're going to kill the fish. The acid rain falls on the trees, kills trees. But anyway those acids that make it into the water and the oceans …

Implications:

1. *The Pollution model focuses attention on direct human pollution.* As demonstrated in previous FrameWorks research,[12] this narrow view of the way that people affect oceans makes it harder to see gaseous carbon as a danger, and obscures the movement of carbon dioxide from the atmosphere into the ocean. In explaining carbon absorption in the oceans to members of the public, communicators will need to overcome the strong assumption that the main threat to oceans is material waste. When thinking in terms of the *Pollution* model, the public fails to see the importance of efforts to reduce carbon emissions and, instead, focuses on picking up trash and limiting dumping as the best solutions to ocean and environmental problems.

2. *The Melting Ice model defines the issue of ocean and climate change with respect to a very narrow set of effects.* This model hides the wide range of ways in which oceans and climates are changing, and the myriad effects of these changes, by focusing people's attention on ice caps and polar bears. Communicators might be able to expand this model by leveraging it to help people see the interdependence of the ice caps and polar bears with a larger climate system and set of impacts. However, the model and its associated imagery are so dominant that expansion may not be possible. Future communications research should explore these images and assertions.

3. *The Acid Rain model diverts attention away from ocean acidification's true cause.* The word "acid" in the term "ocean acidification" causes people to misidentify the cause of the phenomenon. The good news is that that the public can quickly

understand the effects of acidification, even if they misunderstand its cause. Many public informants who were skeptical of the evidence for global warming were confident that evidence for acidification would be both easy to gather and convincing. Thus, if an understanding of causal mechanisms can be built into the public's conception of ocean acidification, there is tremendous potential to use this issue as a way of broaching and reframing climate change discussions more broadly. Future research should, therefore, focus translational attention on the concept of ocean acidification.

3. WHAT IS CLIMATE?

Before looking into how informants thought about climate change, we describe a dominant model that was used in thinking about what "climate" is.

The *Climate = Yearly Weather Patterns in a Place* model. When asked to define and explain the concept of "climate," informants relied on an assumption in which "climate" was understood in terms of the yearly temperature and weather patterns in a particular place. The idea of seasons played a large role in this model, as informants described climate by referencing more specific seasonal patterns in weather and temperature in particular geographic locations.

> **Informant:** Climate is … well, it's different changes in the temperature, or whether it's sunny or rainy or cold or windy. You can have a warm climate and a cold climate, and a very rainy tropical climate.
> —
> **Informant:** Generally when I use the word climate I guess I'm referring to a certain region. "Oh, the climate in Monterey Peninsula." "The climate in the rainforest." It's already a set description for that area.

In addition to asking informants to define and explain the concept of climate, researchers probed about the connections between concepts like climate, oceans, atmosphere and weather. In response to these questions, informants consistently maintained that "it's all connected," but were unable to move beyond this surface-level acknowledgment of relationship to think and talk more deeply about this connection — that is, to explain how "it's all connected." This suggests the lack of a model of climate as a complex system.

Implications:

1. *The Climate = Yearly Weather Patterns in a Place model is insufficiently long-term.* This model sets people's temporal frame at "a year" and makes longer-term — much longer-term — perspectives of time difficult to process. This suggests that one of the primary tasks for communications research is to develop and test tools that can help shift and

expand the temporal perspective that people bring to discussions of "climate" change. If people remain in the annual frame when thinking about patterns and change, they are at a cognitive disadvantage in understanding patterns that operate on very different time scales.

2. *The focus on particular places in thinking about climate makes global systems difficult to conceptualize.* When the public considers climate as a description of the weather patterns in a particular place, it becomes difficult to productively consider global climate systems and change. Communications need to widen the public lens so that climate is interpreted in terms of global systems with local impacts —in short, that people's understanding of local is always in the context of global.

3. *The absence of the concept of "the climate system" is a major barrier to science translation.* Without a concept of climate as a system, the parts of the climate system are conceptualized as discrete domains, rendering their connections hard to think. Providing the public with a concrete way of understanding climate as a system is a top priority for future communications research.

4. HOW DOES CLIMATE CHANGE?

Informants used the following four models to think about how the climate might change.

A. The *Climate Change = Warming* model. The most dominant model in thinking about climate change was through the understanding that climate change is about the earth getting *warmer*. This relationship between "climate change" and "warming" was a highly shared assumption across the interviews.

> **Interviewer:** If you had to guess how climate was changing what would your guess be?
>
> **Informant:** I read a poll not too long ago of how they've been doing studies on trees and how they showed temperature change over time, and in over the past 50 to 75 years, they've been able to see the potential increase in temperature. It's much hotter now than it was a hundred years ago.

Despite this associative model, informants had difficulty reasoning about how or why warming was happening. This was evident in the trouble that informants had in reconciling knowledge of a general warming trend with inconsistency in the weather and, at times, their sense that it is not actually getting warmer.

After documenting this initial difficulty in answering these "why" questions, interviewers continued to probe by posing alternative questions and posing hypothetical scenarios. This additional probing showed that, when pushed,

informants fell back on two models to explain why climate changes might be happening.

B. The *Unnatural Pollutants* model. With a few exceptions, informants believed climate change to be connected to human activity and that pollution was the mechanism through which humans are causing the climate to change. This is consistent with previous FrameWorks research.[13] More specifically, in the current research, informants distinguished between *natural* substances, which were considered harmless, and *artificial* chemicals, which were assumed to be harmful. They explained that it is through the introduction of these artificial chemicals that humans are causing the climate to change, though they were unable to explain exactly *how* this change happens. Reasoning from this assumption, informants explained that carbon dioxide — which they clearly placed in the "natural substance" category — could not be part of the problem. The following example shows the power of this natural/artificial categorization in people's thinking about pollution and climate change.

> **Informant:** Yeah that's the pollution stuff that we're causing … no-no. Carbon monoxide. Isn't that the bad stuff?
>
> **Interviewer:** I don't know — you tell me.
>
> **Informant:** Wait, so we take in oxygen and we send out carbon dioxide …
>
> **Interviewer:** You're going to be using Google on this one, too.
>
> **Informant:** Am I right? We breathe in oxygen and give off carbon dioxide. And carbon monoxide is the bad thing that we cause through our pollution and that's why I have the carbon monoxide detector in my house.

Informants often moved from this way of understanding the causes of the climate change to a much more specific, but misleading, model to explain why the climate is changing.

C. The *Letting the Sun In* model. While many informants failed to provide coherent explanations of how climate change works, those who were able to provide such explanations consistently provided the same (scientifically inaccurate) account. They suggested that unnatural gaseous pollutants are "eating" holes in the ozone layer. These proliferating and expanding holes let in more heat from the sun, which causes the earth to warm and the climate to change. This story — which was also documented in previous FrameWorks research — was remarkably consistent across informants, and provided the only available model of how global warming happens.[14]

> **Informant:** Well, the ozone layer protects us from the sun and the more pollution we put into our beautiful skies … it has an effect where it starts to break apart this protection that we have, and it creates pockets, holes within it. That's where we get more of the sun's rays and the heat, and that warms up Earth.

D. The *Change Is Natural* model. This model was often invoked in opposition to beliefs about anthropogenic climate change. According to this model, nature is cyclic and is in a state of constant change and evolution. From this perspective, informants reasoned that the changes in the climate that we see today are a result of "natural" planetary cycles and that humans, therefore, play no role in climate change.[15]

> **Informant:** I think that's just the earth doing its thing. It's adapting and changing like it has for thousands of years.
> —
>
> **Informant:** I think it does change and I think it changes naturally. There's a cycle to life. Things have ebbs and flows and I think that naturally happens. Just like the earth warming, the ice age and the warming and all of that.

The same informants toggled between the *Change Is Natural* model and the more anthropogenic *Unnatural Pollutants* and *Letting the Sun In* models at different moments in their talk, rather than integrating natural and human causes into a single explanation.

Implications:

1. *The Unnatural Pollutants model has mixed implications for communicating how climate change works*. The upside of the model is that it predisposes people to accept that the byproducts of industrial production are responsible for causing climate change. The downside is that its natural/artificial categorization creates great difficulty in communicating about the damaging effects of excess carbon dioxide (or other "natural" substances such as methane) by equating "natural" with "good" and "artificial" with "bad." The understanding that follows from this model is that, because carbon dioxide is natural, it could not possibly be bad and there is therefore no reason to limit its emission. As long as this pattern of thought persists, it will continue to be extremely difficult for the public to appreciate the dangers of carbon dioxide and its effects on the oceans and climate. Successfully communicating the expert story of oceans and climate change — a story built on carbon dioxide as the "bad guy" — will first require communications research to find a way of inoculating against this artificial/natural categorization.

2. *The Change Is Natural model is a highly unproductive way of thinking about the causes of climate change.* Thinking through this model, people are predisposed to view climate change as a natural phenomenon that will fix itself. This will depress people's sense of urgency and negatively impact public support for climate change policy. Communicators should be careful not to inadvertently activate this model through myth/fact communication strategies (i.e., by presenting and debunking the "change is natural" explanation) and instead, as recommended below, should focus attention and resources on constructing concrete and understandable explanations of the basic processes underlying climate change. The *Heat-Trapping Blanket* is one such tool.[16]

3. *There is a need for communication tools that explain the basic mechanisms of climate change*. Drawing on the *Unnatural Pollutants* and *Letting the Sun In* models, people fundamentally misunderstand the processes through which global warming and climate change are happening. FrameWorks has developed and tested an explanatory metaphor, *Heat-Trapping Blanket*, to explain how carbon emissions form a heat-retaining layer in the atmosphere — thereby correcting thinking by replacing the mechanism in the *Letting the Sun In* model with one that is in line with the science. Communicators should use this metaphor to unseat the unproductive parts of the *Unnatural Pollutants* and *Letting the Sun In* models.

5. WHAT ARE THE EFFECTS OF CLIMATE CHANGE?

In thinking about the effects of climate change, informant discussion revealed two cultural models.

A. The *Climate Change = Warming* model. Not surprisingly, the most dominant understanding of "how climate changes" also structures the way that people think about *effects* of climate change. Informants focused on temperatures getting warmer and on the tangible effects that these increases in temperature might cause, such as loss of plant and animal species.

> **Informant:** I worry about it. I think about how hot is it actually going to get. Is it going to be hot, too hot so that we can't even live here anymore? That's what I'm thinking. Or [I'm thinking about] all the foods that we might lose, the animals that we might lose. People have heat strokes.

B. The *Delicate Balance* model. Informants also drew on a broader model of "nature" to think about the effects of climate change. Thinking through this model, human activities threaten to upset the earth's natural, delicate balance.

> **Interviewer:** So, when scientists are talking about climate change, what are they talking about?
>
> **Informant:** I think that what they're talking about is how we are misusing what we have here in our planet and how it is destroying the natural balance … and again how the oceans are affecting the weather and the atmosphere to cause these major changes in different parts of our world.

This model rests on several more-specific assumptions and propositions:

- *Nature is an interconnected system*. Informants described nature as an interconnected "chain of life," and assumed that what happens in one domain of nature affects what happens in other domains. On its surface, the claim that "it's all connected" echoes the expert story on the inter-relationships between different components of the climate system. However, the public's thinking lacked a deeper and more substantive understanding of relationships among natural systems and could, therefore, be considered a discursive refrain rather than a causally structured model.

- *Nature's proper functioning depends on balance among its parts.* Informants viewed the components of natural systems as standing in mutually supportive relationships with one another. Again, however, these relationships were thinly understood and rarely specified or explained.

- *Human activity is separate from, and damaging to, nature's balance.* The model compartmentalizes human beings and nature, treating human beings as having a disruptive influence on naturally balanced processes.

- *If natural balance is upset, consequences will be dire*. Informants consistently talked about how pollution might somehow "break" nature's delicate balance, throwing the entire system "out of whack" and resulting in consequences for the entire system.

Implications:

1. *The Climate Change = Warming model has mixed implications.* On one hand, informants are correct that the average global temperature is warming, and that most of the negative effects we experience stem from this increase in temperature. On the other hand, the narrow association between climate change and warming fails to capture the full picture of climate changes and their effects. Communicators are already aware of the challenges associated with the term "global warming." Nonetheless, FrameWorks' research shows that merely substituting the term "climate change" for "global warming" does not lead people

in substantially different directions, because of what have become deep connections between "climate change" and the notion of warming.

2. *The Delicate Balance model needs to be filled in with specific process understandings.* The model provides a thin foundation for understanding human effects on marine and climate systems, but does not provide the resources necessary to understand *how* these systems work and can be affected. As such, this model does not get members of the public any further in their thinking about solutions to climate change issues. Instead, in its lack of process, the model contributes to the strong sense of fatalism — the perception that the problem is too big to do anything about — associated with these issues. In order to fill in the "black box" of process understanding, communicators need tools to explain how different types of human activity, such as burning fossil fuels, can threaten the balance of oceans and climate systems and what the results of this disequilibrium will be. FrameWorks will focus on developing and testing tools that do this work and that can be used in conjunction with the *Heat-Trapping Blanket* explanatory metaphor to provide members of the public both specific and general understandings of the processes and effects associated with climate change.

6. WHAT'S THE ROLE OF SCIENCE IN UNDERSTANDING CLIMATE CHANGE?

Below we describe three models of "science" and explain how they shaped informants' thinking about climate change.

A. The *Science Authority* model. Some informants treated scientists as authorities to be trusted. This model invoked the deeply held, typically implicit assumption that scientists' claims are valid and even indisputable. This assumption was reflected in informants' tendency to adopt an uncritical orientation toward scientific findings, and is consistent with FrameWorks' research on climate change among Canadians.[17] When reasoning through the *Science Authority* model, informants showed little interest in rationally inspecting scientific claims and treated scientists as unquestioned authorities in this domain.

> **Interviewer:** And you believe that those things are all actually happening.
>
> **Informant:** Yeah … I mean I've read the articles, they're peer reviewed. I trust when the journal *Nature* publishes something. I trust that as a valid.

While informants using this model were not always sure about the details of the scientific consensus on climate change, they were confident that this consensus, whatever its content, must be correct.

B. The *Science Skepticism* model. Informants also often understood both "climate change" and "global warming" as scientific buzzwords and treated claims about the terms with suspicion.

> **Informant:** There's a lot of talk about climate change and global warming but they don't really go into the topics really deeply. They just kind of use those buzzwords to try and … I don't want to say scare people. And those two terms could mean about 5,000 different things. So it'd be nice if they could talk about a specific issue rather than just say buzzwords.

Some informants suspected scientists of exaggerating the effects of climate change to procure grant money or advance a political agenda.

> **Interviewer:** What are scientists talking about when they're talking about climate change?
>
> **Informant:** They're pushing an agenda and some, I think, firmly believe it.
>
> **Interviewer:** So are they being political then?
>
> **Informant:** I believe that a lot of times they will justify the outcome depending on ideology, yeah.
> —
>
> **Informant:** Global warming is a huge moneymaker. You get people to buy into certain things. It's just like my husband swears by all this organic stuff — it's a huge moneymaker. If something's organic, people are going to buy it because they think it's better, but it doesn't necessarily mean it's completely organic. It's a selling point. And so, I don't know if it's the same thing with global warming, and I don't know all of the stuff concerning that, per se, but I do know that it's not as bad as everybody says. It's not the end of times.

Others were skeptical because they assumed that there were limits to what scientists could predict about the climate, just as there were limits to what scientists could predict about the weather.

> **Informant:** You never know for certain if there is such a thing as climate change and global warming. Let's say for instance it's been scientifically proven that the ice at the poles is melting away and the temperature is increasing by one degree every thousand years, okay? And it's been doing that for the last 50,000 years but what's to say that in 500 years instead of it getting warmer it just all of the sudden becomes colder? Like, for instance, we can't say right now that a hurricane's going to happen in five years in Philadelphia, you know it

> happens. Like certain things — especially weather — we can't really predict. I mean we can see, for instance, the hurricane we saw coming like maybe a week ahead of time. But not years out.

Lastly, some informants expressed skepticism because science messages do not fit with their own personal experiences of "climate." Informants assumed that if scientific claims comported with their own experience, then these claims were likely true, and if they did not comport, then the claims were probably untrue.

> **Informant:** Personally, from my small perspective, I mean I've lived in New England all my life. I don't really think it is changing that much.

C. The *Science Is Uncertain* model. Informants also relied on an assumption that scientists are unable to make firm predictions or offer definitive findings. This assumed uncertainty was used as a reason to not be worried about climate change, implicitly assuming that scientists' inability to predict the precise effects of climate change in decades to come means that these effects will most likely be minimal. One informant drew on this assumption to explain why people are turned off by the idea of global warming.

> **Informant:** It's a new idea. We can make predictions of what's going to happen but we don't know if they're actually going to happen. And if they do happen, are they even going to affect us? So there's a lot of information that we know but there's so much more information that we don't know. I think that that level of uncertainty is really what gets to people and is why they either don't buy into it or they don't even want to hear about it.

As this example illustrates, the assumption that uncertainty about effects means those effects may be minimal not only undermined informants' sense of urgency but also provided a basis for occasional annoyance with talk about global warming and climate change. This model was often linked with the *Science Skepticism* model described above.

Implications:

1. *The Science Is Uncertain model undermines urgency.* Members of the public took the assumption that science is uncertain as a sign that things might not be as bad as expected. Communications strategies about the effects of climate change could benefit from explaining the role of uncertainty in science itself, so that uncertainty about exact predictions is not interpreted as uncertainty about the effects themselves.

2. *The treatment of "climate change" and "global warming" as buzzwords threatens to undermine engagement with climate science.* These terms may prevent engagement with climate science by generating skepticism, as well as politicizing the issue. FrameWorks recommends that communicators not lead with these terms. Instead, messages will avoid skepticism and be more effective if they begin by laying out causes, effects and solutions associated with these issues. In other words, the messages can simply talk about specific processes without labeling them up front.

7. WHAT SHOULD BE DONE ABOUT CLIMATE CHANGE?

Most informants readily acknowledged that human action was necessary to curb the effects of climate change. Nonetheless, the solutions they envisioned were largely disassociated from the true causes of climate change. This, again, evidences the major finding from this report — that the public lacks process knowledge in the domains of oceans, climate and climate change. Informants drew on five models in reasoning about what to do about climate change.

A. The *Pollution* model. Here again, informant thinking was shaped by the *Pollution* model. Informants reasoned that, since pollution is the cause of the problem, the solution is to clean up the ocean and environment — that is, to remove existing pollution and stop future pollution.

> **Interviewer:** If people were to try to prevent changes in the oceans, what do you think people could do?
>
> **Informant:** Recycling rather than using the ocean as a dumping ground, putting together community action groups where you actually go down to the oceans and the rivers and the wetlands and clean up trash.

B. The *Individualism* model. As informants considered these pollution- and lifestyle-oriented solutions, they located the individual as the agent of change and remediation. This finding is also in line with previous FrameWorks research and that of other scholars.[18] Using this model, informants assumed that responsibility for responding to climate change lies with individuals, and suggested solutions such as recycling, turning off lights, buying a hybrid, riding a bike to work and using solar panels.

> **Informant:** It needs to start right here with you and I. Maybe you should get solar panels and maybe you shouldn't throw out your leftovers and maybe you guys eat leftovers one night a week. And then I think if we each do little things it goes on from there. My age group is so wasteful. We just throw electronics out which causes pollution but the new phones come out and we get rid of the old ones. I have this fight with my husband all the time — I don't need a new

> this or that. I didn't need the 500 dollar tablet. I'm okay with the 200 dollar one.

When thinking through this model, informants were resistant to seeing public policies as part of the solution and assumed that government action would involve bans on consumption or mandated individual action.

C. The *Government As Protector* model. Although *Individualism* was the dominant model for thinking about solutions to climate change, some informants viewed government intervention as necessary. This seems to reflect an awareness, evidenced in FrameWorks' research on environmental health,[19] that the government has responsibility for regulating pollution as part of its role as public protector.

> **Informant:** The governments are responsible for creating the policy — and not just creating it, but enforcing the policy, because this is a big problem.

When using the *Government As Protector* model, informants were much more likely to focus on emissions and limiting emissions than when using the *Individualism* model, where they focused on recycling and individual behavior change as solutions to climate change.

Whereas the previous three models explained how people think about action to combat climate change, the following two models structure a way of thinking in which there is nothing humans can do about the problem.

D. The *Change Is Natural* model. In addition to being used to think about causes, informants used the *Change Is Natural* model to think about solutions to climate change. From this perspective, informants reasoned that the changes in the climate that we see today are a result of "natural" planetary cycles, and that there is therefore no need for human intervention. Informants concluded that, even if climate change poses a genuine and significant threat to society, there is little point in intervention because changes in the climate are natural and thus inevitable.

> **Informant:** You know, I heard the sun has been going through some cycles that are very long, you know? And so, we might see one or two degree temperature changes because of that. And they talk about all the time, I mean, this one or two degree temperature change could ruin life on earth. Well, I'm thinking to myself, there's not a whole lot we can do sometimes. You know, and not that I want to be fatalistic.

E. The *Nature as Self-Correcting* model. In talking about solutions, informant discussion also evidenced the assumption that nature has the capacity to repair itself. This capacity was understood to be virtually unlimited, and nature and the planet were discussed as robustly resilient, impossibly vast and immune to human harm. Reasoning from this assumption, pollution and other human effects might momentarily disrupt nature, but larger natural processes will restore balance.

> **Informant:** The earth always finds a way to get back to its natural balance. That's what I see from science and a few statistics that I've looked at. It has a way to even itself out.
> —
>
> **Informant:** I think the ocean has ways of cleaning itself and doing that — just like animals can do that. And I just think that animals have ways of adapting. And if it's not cleaning itself, it's adapting and changing so that it can survive. I think of Darwin's theory — survival of the fittest … that's how evolution happens. So I do think that it adapts. The ocean does too, naturally. But I do think it can clean itself. I do think it has ways — whether it's through fish … I don't know how it happens but I do believe that it happens.

Implications:

1. *The Individualism model is a major obstacle to communicating about policy solutions*. The assumption that government responses necessarily limit individual freedoms incites resistance to government actions to address climate change. Based on their cognitive function, values[20] will likely be an important tool in channeling people towards more productive ways of thinking about the role of government and inoculating against narrow individualist orientations to the issue of climate change and its solutions.

2. *The Change Is Natural and Nature is Self-Correcting models are non-starters for science communicators*. These models diminish understanding of the anthropogenic causes of climate change and create a sense that human intervention is unwarranted, inappropriate and ineffective. As recommended above, communications must help the public understand *how* climate change is caused, and the relationship between natural and anthropogenic factors in this process.

3. *The Government As Protector model is promising*. The model can be used to persuade people of the need for, and value of, government responses to climate change. As such, future communications research must find effective ways of activating this model and embedding these strategies in science messages.

V. Mapping the Gaps and Seeing the Holes

The goals of this analysis have been to: (1) document the way experts talk about and understand oceans and climate change; (2) establish the ways that the American public understands these same issues; and (3) compare and "map" these understandings to reveal the gaps between the perspectives of these two groups. We now turn to this third task.

Comparing the expert and public views of oceans and climate change reveals significant gaps in understanding. In addition, this comparison throws into stark relief those areas of people's thinking about climate change where "cognitive holes" are operative. Cognitive holes are areas in which people simply lack the kinds of understandings needed to arrive at opinions and views from which science messages can be productively considered.

Gaps in Understanding

- **Natural and human causes of climate change: Both vs. either.** Experts advance an integrated account of the causes of climate change, explaining that natural causes *and* human causes *both* play a role, while the public typically views these causes as mutually exclusive, assuming that *either* human beings are causing climate change *or* it is caused by natural processes. Communications research needs to identify strategies to inoculate against the public's tendency to use mutually exclusive categories and, instead, provide ways for people to acknowledge that natural causes play a role in climate changes while simultaneously seeing that the increased rate of climate change is due, in large part, to human activity.

- **Carbon dioxide: The driver of climate change vs. something natural we need.** While experts identify carbon dioxide as the primary cause of anthropogenic climate change, members of the public lack awareness of carbon dioxide as a cause of climate change and widely assume that carbon dioxide — because it is a naturally occurring substance — cannot have harmful effects. Filling this gap by creating a story for the public in which carbon dioxide can play a clear role as the causal agent in the problems created by climate change will be key in overcoming public resistance to the current story of climate change.

- **How climate change works: Heat absorption vs. ???? or ozone depletion.** While experts explain that rising levels of carbon dioxide cause climate change by trapping heat within the atmosphere, members of the public have difficulty explaining climate change, or incorrectly attribute the phenomenon to the ozone hole. This widespread misconception has been documented in social science research since 1994,[21] and is consistent with the findings of other FrameWorks research.[22] The public's lack of understanding of how climate change works is a crucial gap that must be bridged. The explanatory metaphor developed in previous FrameWorks research — *Heat-Trapping*

Blanket — is part of the answer to this gap and provides a tested way of unseating the *Letting the Sun In* model and providing a more scientifically accurate, but still highly thinkable, causal model for the public.[23]

- **How people affect oceans: Carbon emissions vs. dumping.** While experts emphasize that carbon emissions have major effects on oceans, members of the public assume that humans affect oceans by dumping pollutants into them. This was the only specific means of affecting the oceans that was cognitively accessible to the public. Members of the public were generally aware that oceans are warming and that this relates to climate change, but, as discussed above, they did not understand how this process works. Moreover, the public has difficulty understanding that carbon dioxide enters oceans by dissolving into them from the atmosphere. Effective translation of the climate system — of the complex processes connecting oceans and ocean change to climate, climate systems and climate change — will require careful communications work. Concretizing this system has the potential to inoculate against a powerful cultural model (the *Pollution* model) and to model the climate system through one of its key dimensions.

- **The impacts of climate change: A complex chain vs. a short list.** The public is only mindful of a small subset of the effects of climate change that experts discuss, and lacks awareness of downstream consequences like effects on food and water supplies or changes in disease patterns. Addressing the key gap identified in this research by focusing on explaining processes of climate change and making the climate system more thinkable should have the added benefit of helping people understand downstream effects of climate change.

- **Effects: Just how severe vs. maybe it will be okay.** Members of the public share with experts the belief that we cannot know for sure exactly what the effects of climate change will be, but, while experts are confident that the effects will be severe, the public assumes that uncertainty means that everything might turn out fine. Communicators need to make clear that, although scientists cannot predict the exact timing and nature of effects, they are certain that the climate is changing and that this change will have effects for human populations. In short, science messages should focus at levels about which consensus is solid and do not require hedging statements. Such statements are read as uncertainty — and uncertainty depresses urgency and leaves room for false optimism. At the same time, communicators should avoid speaking about climate change as a "crisis," as previous research has demonstrated that this line of argumentation is unproductive.[24]

- **What to do: Reducing carbon emissions vs. more recycling.** The public lacks experts' laser focus on reducing carbon emissions, suggesting a broad range of environmentally friendly "green" actions as possible responses to climate change, including recycling, reducing waste, or limiting pollution. The public's inability to think

expansively about appropriate solutions further highlights the lack of a clear understanding of how climate change works. This gap points to the need for process-based understandings that allow people to appreciate the climate as a system, and to see how this system works. The successful communication of these process understandings will structure more robust and productive thinking about necessary and effective solutions.

- **Taking action: An urgent necessity vs. something to consider.** Experts emphasize that many of the effects of climate change are already in motion and that we must act now to avoid catastrophic consequences. Lacking understanding that our activities now will have effects that reverberate throughout the climate system for years to come, members of the public fail to understand the urgency of the situation.[25] This is yet another gap that is likely to be filled via a more robust understanding of the climate system and its mechanisms.

- **Who should respond? Policy solutions vs. individual actions.** There is a consistent gap between experts and the public over who should respond to climate change: Experts view policy measures as necessary responses to climate change, while the public most readily identifies voluntary steps at the individual level and, at times, pushes back against the idea of government intervention. Communications must make clear that policy solutions are necessary, but need not involve direct regulation of individual behavior. Much of the individual-to-collective orientational shift required to fill this gap will be accomplished through *values* — tools that have the ability to orchestrate these broad perceptual turns. Previous FrameWorks research has found that *Responsible Management*, *Interconnectedness*, and *Ingenuity* can be effective in reframing this sense of responsibility.[26]

- **Science: Source of knowledge vs. mixed attitudes.** While experts assume that science is a valid source of knowledge, the public is sometimes distrustful of scientists' motives and skeptical about how much science can tell us. The gap between experts' and the public's attitude toward science must be taken into account for science translation efforts to be successful. Previous FrameWorks research has found the choice of messenger to be particularly important with respect to this gap.[27] Future research should continue to explore the role of messengers in public perceptions of this issue and support for its solutions.

Cognitive Holes

In addition to the gaps, there was a set of issues on which members of the public simply have no model from which to reason, and, as such, have difficulty engaging. These are areas of public understanding to address in communications research. Such research should aim to develop tools to fill these holes and structure more productive thinking on oceans and climate change.

- **The climate system.** While experts consistently describe climate as an integrated system, the public treats oceans, atmosphere, climate and weather as discrete entities and lacks an understanding of these concepts as part of a larger system. Providing a deeper understanding of how climate change works will involve structuring a robust understanding of the climate as system and will thus fill this hole.

- **Trouble with trends.** The public shares with experts the understanding that weather is short term and climate is long term, but the public has difficulty reconciling short-term inconsistency in the weather with the knowledge that the climate is generally getting hotter. Again, this hole should be addressed by providing the public with more robust understandings of the climate system and how it works.

- **Ocean acidification.** Experts consistently speak of the dangers posed by ocean acidification, yet members of the public are entirely unaware of the concept and its effects. Filling this hole requires a tool dedicated to concretizing the processes underlying ocean acidification in a way that points to the effect of this phenomenon on the larger climate system.

VI. Conclusion and Future Directions

> *"This state of public opinion raises critical questions as to the effectiveness of twenty or more years of public education, outreach, and engagement approaches used to render a complex scientific issue meaningful and actionable for lay audiences. A growing body of literature on public attitudes, as well as on other aspects of the communication process, can help us understand not only the larger trends in public opinion, but also the challenges and opportunities for more effective approaches to climate change communication."*[28]

While many scholars who study public understandings of climate change acknowledge that widely held cultural beliefs impede productive discourse,[29] this report reveals the specific cultural models that account for the current state of public thinking on climate change. Without recognizing the cultural roadblocks that derail communications on climate and oceans, experts and advocates will find it difficult to build a more constructive conversation.[30] As such, this report complements other recent studies, such as the Yale Project on Climate Change Communication's "Global Warming's Six Americas,"[31] and provides a deeper context for the ways that Americans express concern (or not) for ecological changes. The report also responds to the field's call for an interdisciplinary approach to map out the challenges and opportunities in reframing the public conversation in a way that leads to meaningful change.[32]

Perhaps the most significant finding from this research is the existence of a prominent cognitive hole in the public's understanding of climate change: The public lacks a clear conception of the climate system and, in turn, struggles to understand how the parts of the climate system are connected, specifically with oceans. This cognitive hole prevents the public from being able to organize the facts that it has learned into a coherent and meaningful story. Having a story that aligns with science messages around why and how to address climate change is a prerequisite to meaningful change on this issue.

Previous FrameWorks research has developed proven strategies and tools for bridging the gaps between expert and public understandings of oceans and climate change. In particular, the explanatory metaphor of *Heat-Trapping Blanket* is designed to provide more productive ways of thinking about how carbon dioxide in the atmosphere leads to warming. This past research has also tested several values — *Innovation*, *Responsible Management*, and *Interconnectedness* — which help to orient people's thinking about solutions in constructive directions.[33]

Future prescriptive research can generate additional tools and strategies to supplement those that have emerged from existing research. The following list represents a preliminary outline of key tasks for future research:

- **Develop an explanatory metaphor that helps people think about how the ocean absorbs carbon and the effects of this process.** The effectiveness of *Heat-Trapping Blanket* can be leveraged by a complementary metaphor that explains how carbon dioxide interacts with the oceans. Both of these metaphors can demonstrate the mechanism by which excess carbon dioxide precipitates climate change.

- **Develop an explanatory metaphor that concretizes a systemic understanding of the relationship between land, oceans, atmosphere and climate change** and clarifies how these systems and processes affect humans.

- **Develop an explanatory metaphor for the interrelated parts of the climate system.** While the *Heat-Trapping Blanket* metaphor and a new metaphor for ocean acidification can address key causal gaps, a larger systems-oriented metaphor is required so that the public can put all parts of the story on the same page. This metaphor should help people understand how the land, oceans and atmosphere are inter-related, and how this system affects human populations.

- **Determine the most effective way to communicate about carbon dioxide.** Communications research must explore ways to get around problematic assumptions about pollution in order to effectively communicate the role of carbon dioxide in climate change.

- **Identify additional values that might productively orient thinking.** In addition to the previously identified values, new values should be identified and tested to deal with the specific challenges identified in this report. In particular, values will be instrumental in highlighting the urgency of action, deflecting skepticism about climate science, shifting discussion away from ideologically driven discourses, getting the public away from fatalistic ways of thinking about the future, and framing government action in positive rather than negative terms.

- **Integrate natural and human causes.** Future research should explore ways of integrating human and natural causes of climate change in order to overcome the public's current model of viewing these causes in mutually exclusive terms.

- **Test the effectiveness of messengers.** The models that the public relies upon to evaluate claims about climate change suggest that different types of messengers may be needed to convince the public of the reality and urgency of this issue.

- **Improve understandings of "science."** Part of the problem with the public's understanding of claims about climate change is a misinterpretation of the role of uncertainty in science. For example, when a scientist communicates about a range of possible outcomes, the public may interpret this uncertainty as doubt about what is happening, or as the possibility that climate change may not happen at all. A better

understanding of how science works should lead to a better understanding of scientific claims.

Pursuing this research agenda will provide a strong foundation for translating climate science and for effective messaging about policy measures needed to respond to climate and ocean change.

APPENDIX A: RESEARCH METHODS

We were careful to recruit a sample of civically engaged persons for this project in order to increase the likelihood that our informants could speak to the issues at hand with some degree of knowledge and opinion. Because cultural models interviews rely on our ability to see patterns of thinking — the expression of models in mind — through talk, it is important to recruit informants who are more likely to actually talk about the issues in question, but who are not experts or practitioners in the field. To help ensure that informants were likely to have ready opinions about these issues without having to be primed by asking them directly about the target issue[34] — in this case, oceans and climate change — the screening procedure was designed to select informants who reported a strong interest in news and current events, and an active involvement in their communities through participation in community and civic engagements.

Cultural models interviews require gathering what one researcher has referred to as a "big scoop of language."[35] Thus, a sufficiently large amount of talk, taken from each informant, allows us to capture the broad sets of assumptions that informants use to make sense of information. These sets of common assumptions and understandings are referred to as "cultural models." Recruiting a wide range of people allows us to ensure that the cultural models we identify represent shared, or "cultural," patterns of thinking about a given topic.

As the goal of these interviews was to examine the cultural models Americans use to make sense of, and understand, issues of oceans and climate change, a key to this methodology was giving informants the freedom to follow topics in the directions they deemed relevant and not in directions the interviewer believed most germane. Therefore, the interviewers approached each interview with a set of topics to be covered and questions to ask, but left the interview open enough to thoroughly follow each informant's train of thought.

Informants were first asked to respond to a general issue ("What do you think about X?") and were then asked follow-up questions — or "probes" — designed to elicit explanation of their responses ("You said X, why do you think X is this way?" or "You said X, tell me a little bit more about what you meant when you said X," or "You were just talking about X, but before you were talking about Y, do you think X is connected to Y? How?"). This pattern of probing leads to long conversations that stray (as is the intention) from the original question. The purpose is to see where and what connections the informant draws from the original topic. Informants were then asked about various valences or instantiations of the issue at hand, and were probed for explanations of these differences ("You said that X is different than Y in this way, why do you think this is?"). In this way, the pattern of questioning began very generally and moved gradually to differentiations and more specific topics.

Informants were first asked a series of open-ended questions about oceans and climate change that provided them the opportunity to speak to whatever associations came to mind. The first lines of questioning asked informants to describe their understandings of the terms "oceans," "atmosphere," "weather" and "climate"; whether and how those concepts are inter-related; and whether and how they change. A similar line of questioning then asked about whether and how *people* affect the oceans, atmosphere, weather and climate, and to what extent changes in the climate system should be viewed as a cause for concern. Informants were also asked to share their associations with a number of specific terms, including "extreme weather," "global warming," "carbon dioxide" and "ocean acidification."

APPENDIX B: THEORETICAL FOUNDATIONS

The following are well-accepted characteristics of cognition and features of cultural models that figure prominently into the results presented in this report and in FrameWorks' research more generally.

1. Top-down nature of cognition

Individuals rely on a relatively small set of broad, *general* cultural models to organize and make sense of information about an incredibly wide range of *specific* issues and information. Put another way, members of a cultural group share a set of common, general models that form the lens through which they think and make sense of information pertaining to many different issues. Or, as Bradd Shore notes, "Culture doesn't determine reality for people. It provides a stock of conventional models that have a powerful effect on what is easily cognized and readily communicated in a community. Cultural codes socially legitimate certain ways of thinking and acting. They also affect the cognitive salience of certain experiences."[36]

This feature of cognition explains why FrameWorks' research has revealed many of the same cultural models being used to think about seemingly unconnected and unrelated issues — from education to health to child development. For example, FrameWorks' research has found that people use the *mentalist* model to think about child development and food and fitness — seemingly unrelated issue areas. For this reason, we say that cognition is a "top-down" phenomenon. *Specific* information gets fitted into *general* categories that people share and carry around with them in their heads. Or, again as Shore notes, "You could reason from the part to the whole."[37]

2. Cultural models come in many flavors but the basic ingredients are the same

At FrameWorks, we often get asked about the extent to which the cultural models that we identify in our research, and that we use as the basis of our general approach to social messaging, apply to ALL cultures. That is, people want to know how inclusive our cultural models are and to what extent we see/look for/find differences across race, class or other cultural categories. Because our aim is to create messaging for mass media communications, we seek out messages that resonate with the public more generally and, as such, seek to identify cultural models that are most broadly shared across society. We ensure the models are sufficiently broad by recruiting diverse groups of informants in our research, who help us confirm that the models we identify operate broadly across a wide range of groups. Recruiting diverse samples in our cultural models interviews often confuses people who then think we are interested in uncovering the nuanced ways in which the models take shape and get communicated across those groups, or that we are interested in identifying different models that different groups use. To the contrary, our aim is to locate the models at the broadest possible levels (i.e., those most commonly

shared across *all* cultural groups within a large social group), and to develop reframes and simplifying models that advance those models that catalyze systems-level thinking. The latter does not negate the fact that members of different cultural groups within a larger cultural group may respond more or less enthusiastically to the reframes, and this is one of the reasons why we subject the reframes that we recommend to our clients to rigorous experimental testing using randomized controls that more fully evaluate their mass appeal.

3. Dominant and recessive models

Some of the models that individuals use to understand the world around us are what we call "dominant," while others are more "recessive," or latent, in shaping how we process information. Dominant models are those that are very "easy to think." They are activated and used with a high degree of immediacy and are persistent, or "sticky," in their power to shape thinking and understanding — once a dominant model has been activated, it is difficult to shift to or employ another model to think about the issue. Because these models are used so readily to understand information, and because of their cognitive stickiness, they actually become easier to "think" each time they are activated — similar to how we choose well-worn and familiar paths when walking through fields, and, in so doing, these paths become even more well-worn and familiar. There is, therefore, the tendency for dominant models to become increasingly dominant unless information is reframed to cue other cognitively available models (or, to continue the analogy here, other walking paths). Recessive models, on the other hand, are not characterized by the same immediacy or persistence. They lie further below the surface, and while they *can* be employed in making sense of a concept or processing information about an issue — they *are* present — their application requires specific cues or primes.

Mapping recessive models is an important part of the FrameWorks approach to communication science, and a key step in reframing an issue. It is often these recessive patterns of thinking that hold the most promise in shifting thinking away from the existing dominant models that often inhibit a broader understanding of the role of policy and the *social* aspect of issues and problems. Because of the promise of these recessive models in shifting perception and patterns of thinking, we discuss them in this report and will bring these findings into the subsequent phases of FrameWorks' iterative methodology. During focus group research in particular, we explore in greater detail *how* these recessive models can most effectively be cued or "primed," as well as how these recessive models *interact* with and are *negotiated* vis-à-vis emergent dominant models.

4. The "nestedness" of cultural models

Within the broad foundational models that people use in "thinking" about a wide variety of issues lay models that, while still general, broad and shared, are *relatively* more issue-specific. We refer to these more issue-specific models as "nested." For example, in our

past research on executive function, when informants thought about basic skills, they employed a model for understanding where these skills come from, but research revealed that this more specific model was nested into the more general *mentalist* cultural model that informants implicitly applied in thinking this issue. Nested models often compete in guiding or shaping the way we think about issues. Information may have very different effects if it is "thought" through one or another nested model. Therefore, knowing about which models are nested into which broader models helps us in reframing an issue.

About The FrameWorks Institute

The FrameWorks Institute is an independent nonprofit organization founded in 1999 to advance science-based communications research and practice. The Institute conducts original, multi-method research to identify the communications strategies that will advance public understanding of social problems and improve public support for remedial policies. The Institute's work also includes teaching the nonprofit sector how to apply these science-based communications strategies in their work for social change. The Institute publishes its research and recommendations, as well as toolkits and other products for the nonprofit sector, at www.frameworksinstitute.org.

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Volmert, A., Baran, M., Kendall-Taylor, N., Lindland, E., Haydon, A., Arvizu, S., & Bunten, A. (2013). *"Just the Earth doing its own thing": Mapping the gaps between expert and public understandings of oceans and climate change.* Washington, DC: FrameWorks Institute.

[1] Kempton, W., Boster, J.S., & Hartley, J. (1995). *Environmental values in American culture*. Cambridge, MA: MIT Press.

[2] Bostrom, A., Morgan, M.G, Fischoff, B., & Read, D. (1994). What do people know about climate change? *Risk Analysis, 14*(6), 959-970; Kempton, W. (1991). Lay perspectives on global climate change. *Global Environmental Change: Human and Policy Dimensions, 1*, 183–208; Kempton, W., Boster, J.S., & Hartley, J.A. (1995). *Environmental values in American culture*. Cambridge, MA: MIT Press.

[3]See: http://cleanet.org/cln/ccep/NNOCCI.html for an example of this work.

[4] Aubrun, A., & Grady, J. *Keeping the oceans alive: Cognitive elicitations with residents of oceanside communities.* Washington, DC: Cultural Logic. Prepared for the FrameWorks Institute. Aubrun, A., Brown, A., & Grady, J. (2006). *Global warming as a "black box": Findings from cognitive elicitations and media analysis in Canada. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[5] In addition to these 40 cultural models interviews, this analysis drew upon findings from 22 interviews previously conducted in Canada and 20 interviews previously conducted in the United States.

[6] Quinn, N., & Holland, D. (1987). Culture and cognition. In D. Holland & N. Quinn (Eds.). *Cultural models in language and thought* (pp. 3-40). Cambridge, England: Cambridge University Press.

[7] Aubrun, A., & Grady, J. *Keeping the oceans alive: Cognitive elicitations with residents of oceanside communities.* Washington, DC: Cultural Logic. Prepared for the FrameWorks Institute.

[8] See, e.g., Kendall-Taylor, N., & Bales, S. (2009). *Like Mars to Venus: The separate and sketchy worlds of budgets and taxes.* Washington, DC: FrameWorks Institute.

[9] Aubrun, A., & Grady, J. *Keeping the oceans alive: Cognitive elicitations with residents of oceanside communities.* Washington, DC: Cultural Logic. Prepared for the FrameWorks Institute. Aubrun, A., Brown, A., & Grady, J. (2006). *Global warming as a "black box": Findings from cognitive elicitations and media analysis in Canada. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

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[11] Aubrun, A., & Grady, J. *Keeping the oceans alive: Cognitive elicitations with residents of oceanside communities* (p. 25). Washington, DC: Cultural Logic. Prepared for the FrameWorks Institute.

[12] Aubrun, A., & Grady, J. *Keeping the oceans alive: Cognitive elicitations with residents of oceanside communities* (p. 6). Washington, DC: Cultural Logic. Prepared for the FrameWorks Institute.

[13] Aubrun, A., Grady, J., & Robinson, E. (2007). *Canadians' grasp of global warming: Results from a cognitive survey. A FrameWorks research report*. Washington, DC: FrameWorks Institute.

[14] Aubrun, A., Brown, A., & Grady, J. (2006). *Global warming as a "black box": Findings from cognitive elicitations and media analysis in Canada. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[15] Some polling methods, such as those conducted by Jon Krosnick, assert that the public believes climate change is caused by both natural and human causes. These findings do not contradict our conclusions here. Rather, there is a methodological difference. Giving informants an option to choose "both" is different than probing the cultural models that they bring to bear on thinking about this issue in an open-ended way.

[16] Aubrun, A., Brown, A., & Grady, J. (2007). *The "carbon dioxide blanket" as an explanatory model for global warming: Findings from TalkBack Testing. A FrameWorks research report.* Washington, DC: FrameWorks Institute; Bales, S. N. (2009). *How to talk about climate change and oceans*. Washington, DC: FrameWorks Institute.

[17] Aubrun, A., Brown, A., & Grady, J. (2006). *Global warming as a "black box": Findings from cognitive elicitations and media analysis in Canada. A FrameWorks research report* (p. 7)*.* Washington, DC: FrameWorks Institute..

[18] See, e.g., Lindland, E. H., & Kendall-Taylor, N. (2011). *People, polar bears and the potato salad: Mapping the gaps between expert and public understandings of environmental health*. Washington, DC: FrameWorks Institute; Chart, H., & Kendall-Taylor, N. (2008). *Reform what? Individualist thinking in education: American cultural models on schooling. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[19] Lindland, E. H., & Kendall-Taylor, N. (2011). *People, polar bears and the potato salad: Mapping the gaps between expert and public understandings of environmental health.* Washington, DC: FrameWorks Institute.

[20] Simon, A. (2012) *The pull of values.* Washington, DC: FrameWorks Institute.

[21] Bostrom, A., Morgan, M. G, Fischoff, B., & Read, D. (1994). What do people know about climate change? *Risk Analysis 14*(6), 959-970; Kempton, W. (1991). Lay perspectives on global climate change. *Global Environmental Change: Human and Policy Dimensions, 1*, 183–208; Kempton, W., Boster, J.S., & Hartley, J.A. (1995). *Environmental values in American culture*. Cambridge, MA: MIT Press.

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[24] Bales, S. N. (2009). *How to talk about climate change and oceans.* Washington, DC: FrameWorks Institute.

[25] Aubrun, A., Brown, A., Grady, J. (2006). *Global warming as a "black box": Findings from cognitive elicitations and media analysis in Canada. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[26] Aubrun, A., Grady, J., & Robinson, E. (2007). *Canadians' grasp of global warming: Results from a cognitive survey. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[27] Aubrun, A., Grady, J., & Robinson, E. (2007). *Canadians' grasp of global warming: Results from a cognitive survey. A FrameWorks research report.* Washington, DC: FrameWorks Institute.

[28] Moser, S., & Dilling, L. (2011) Communicating climate change: Closing the science-action gap. In: Dryzek, J. S. Norgaard, R. B., & Schlosberg, D. (Eds.). *Oxford Handbook of Climate Change and Society* (pp. 161-176). New York, NY: Oxford University Press.

[29] Bostrom, A., Morgan, M. G, Fischoff, B., & Read, D. (1994). What do people know about climate change? *Risk Analysis 14*(6), 959-970. 1994; Kempton, W. (1991). Lay perspectives on global climate change. *Global Environmental Change: Human and Policy Dimensions, 1*, 183–208; Kempton, W., Boster, J. S., & Hartley, J. A. (1995). *Environmental values in American culture*. Cambridge, MA: MIT Press; Behringer, W. (2010). A cultural history of climate. Cambridge, England: Polity Press; Bryson, R. A. (1994). On integrating climate change and culture change studies. *Human Ecology, 22*(1), 115-128; Anderson, D. G., Maasch, K., & Sandweiss, D. H. (Eds.). (2007). *Climate change and cultural dynamics: A global perspective on mid-Holocene transitions.* London, England: Academic Press; Moser, S., & Dilling, L. (2011) Communicating climate change: Closing the science-action gap. In: Dryzek, J. S. Norgaard, R. B., & Schlosberg, D. (Eds.). *Oxford Handbook of Climate Change and Society* (pp. 161-176). New York, NY: Oxford University Press.

[30] Reser, J. P., & Swim, J. K. (2011). Adapting to and coping with the threat and impacts of climate change. *American Psychologist, 66*(4), 277–289; van der Linden, S. (2012). *Understanding and achieving behavioural change: Towards a new model for communicating information about climate change.* London, England: London School of Economics and Political Science, Grantham Research Institute on Climate Change and the Environment.

[31] http://environment.yale.edu/climate-communication/article/Six-Americas-March-2012/

[32] Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist, 66*(4), 315-328.

[33] Bales, S. N. (2009). *How to talk about climate change and oceans*. Washington, DC: FrameWorks Institute.

[34] Priming informants with the content can be problematic in these interviews, as the ability to identify and describe cultural models relies on getting "top-of-mind" answers and explanations from informants, rather than carefully thought-out and pre-constructed responses to the issue in question. If primed with the focus of the interview, informants tend to "prepare" by doing "research" on the subject, yielding results that are actually not representative of their own understandings and explanations of issues.

[35] Quinn, N. (2005). *Finding culture in talk: A collection of methods* (p. 16). New York, NY: Palgrave Macmillan.

[36] Shore, B. (1998). *What culture means, how culture means* (p. 31). Worchester, MA: Clarke University Press.

[37] Shore, B. (1998). *What culture means, how culture means* (p. 32). Worchester, MA: Clarke University Press.


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