




## Climate Change Education: Goals, Audiences, and Strategies: A Workshop Summary

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Sherrie Forest and Michael A. Feder, Rapporteurs; National Research Council

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# CLIMATE CHANGE EDUCATION

## Goals, Audiences, and Strategies

A WORKSHOP SUMMARY

Sherrie Forrest and Michael A. Feder, *Rapporteurs*

Board on Science Education

Division of Behavioral and Social Sciences and Education

NATIONAL RESEARCH COUNCIL  
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This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the NRC. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We thank the following individuals for their review of this report: Richard M. Amasino, Depart-



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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the report nor did they see the final draft of the report before its release. The review of this report was overseen by Cary I. Sneider, Portland State University. Appointed by the NRC, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors and the institution.

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Joseph E. Heimlich, *Chair*  
Steering Committee on Climate Change  
Education Goals and Objectives

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# Acronyms

|        |  |
|--------|--|
| CCEP   | Climate Change Education Partnership Program         |
| CLEAN  | Climate Literacy Education Awareness Network Pathway |
| CWM    | conservative white male                              |
| EPA    | Environmental Protection Agency                      |
| IPL    | Interfaith Power and Light                           |
| NASA   | National Aeronautics and Space Administration        |
| NOAA   | National Oceanic and Atmospheric Administration      |
| NRC    | National Research Council                            |
| NSF    | National Science Foundation                          |
| NWF    | National Wildlife Federation                         |
| USGCRP | U.S. Global Climate Research Program                 |



# 1

## Introduction and Goals of Climate Change Education

### INTRODUCTION

The global scientific and policy community now unequivocally accepts that human activities cause global climate change (Intergovernmental Panel on Climate Change, 2007; National Research Council, 2010a). The scientific consensus has been translated for a broad public and policy makers in a variety of recent reports (National Research Council, 2010b; National Science Foundation, 2009; U.S. Climate Change Science Program, 2009). Although information on climate change is now readily available, the nation still seems unprepared or unwilling to respond effectively to climate change, due partly to a general lack of public understanding of climate change issues and opportunities for effective responses (Leiserowitz, 2003; Leiserowitz and Smith, 2010; Leiserowitz, Moser, and Dilling, 2007; Patchen, 2006; Pew Research Center for the People and the Press, 2007, 2009). The reality of global climate change lends increasing urgency to the need for effective education on earth system science, as well as on the human and behavioral dimensions of climate change, from broad societal action to smart energy choices at the household level (Gardner and Stern, 2008).

The public's limited understanding of climate change is partly the result of four critical challenges that have slowed development and delivery of effective climate change education. First, research over the past 15 years has demonstrated that the underlying science of climate change is inherently difficult for most learners to comprehend (Boyes and Stanistreet, 1993, 1997, 2001; Coyle, 2005) and for educators or schools

to competently teach (Abbasi, 2006; National Research Council, 2007; Storksdieck, 2006). Furthermore, the connection between science and society that is implied in climate change education aimed at changing people's behavior makes the task of teaching and learning more difficult still (Gardner and Stern, 2008; Heimlich and Ardoin, 2008). Second, achieving the broad range of goals of climate change education requires a cross-disciplinary approach, blending education with the learning, social, behavioral, and economic sciences as well as earth systems science. Third, the myriad of federal agencies, nongovernmental organizations, and businesses invested in climate change education may duplicate efforts and waste limited resources without a forum for coordination, cooperation, and alignment of overall education strategies. Fourth, like evolution, climate change has become a highly politicized topic in the policy arena and in education, and people's willingness to be educated or to learn depends on their attitude toward the issue itself (Gardner and Stern, 2008; Leiserowitz and Smith, 2010).

### Workshop Origin

As one response to these challenges, Congress, in its 2009 and 2010 appropriation process, requested that the National Science Foundation (NSF) create a program in climate change education to provide funding to external grantees to improve climate change education in the United States. The Climate Change Education Partnership (CCEP) Program is part of a major investment of the federal government directed toward climate change education, involving a variety of players, including, among others, the National Science Foundation; the National Oceanic and Atmospheric Administration (NOAA); the National Aeronautics and Space Administration (NASA); the U.S. Environmental Protection Agency (EPA), the U.S. Departments of Agriculture, Education, and Energy; and the U.S. Geological Survey.

To support and strengthen these education initiatives, and in response to the 2009 congressional mandate connected to NSF's funding for a climate change education program, the Board on Science Education of the National Research Council (NRC), in collaboration with the Committee on Human Dimensions of Global Change and the Division on Earth and Life Studies, created the Climate Change Education Roundtable. The roundtable provides a forum for dialogue between practitioners and experts in multiple disciplines relevant to climate change education. It facilitates collaboration across federal agencies and private organizations, helping to promote unique contributions and align overall education strategies.

The roundtable has funding to convene two workshops on issues of particular concern. At its first meeting, roundtable participants expressed

a need for greater clarity regarding the goals, audiences, and effective practices in climate change education. Consequently, for the first workshop, the roundtable decided to focus on the goals of climate change education for various target audiences and the potential challenges in reaching those goals across the range of these audiences, among both the public and decision makers. The Steering Committee on Climate Change Education Goals and Objectives was thus established by the NRC to conceptualize and conduct a workshop not only to inform the roundtable members, but also to address a broader stakeholder community; attendees of the workshop included climate change education researchers, educational practitioners, government agencies, nonprofit institutions, and information users. This summary will be made available to these communities and can be shared with and distributed throughout their networks.

A second workshop will be held to address climate change education in formal education settings, including grades kindergarten through high school and undergraduate studies.

### Workshop Goals and Organization

The overarching goal of the workshop, held in Washington, DC, on October 21 and 22, 2010, was to advance transdisciplinary climate change education efforts undertaken by various climate change educators and stakeholders by developing a common understanding of the range of climate change education goals, the various audiences for climate change education, and strategies that are effective for addressing specific goals with specific audiences. The steering committee—representing expertise spanning behavior and decision science, psychology, sociology, environmental science, climate science, and the learning sciences—planned and implemented the workshop, focusing on two primary topics: public understanding and decision maker support. In an effort to provide a common frame for the workshop participants, the steering committee based the initial assumptions about climate change on the recent NRC report *Advancing the Science of Climate Change*: that climate change is happening, is based largely on human actions, and is supported by multiple lines of scientific evidence (National Research Council, 2010a). Beyond this initial assumption, the workshop did not discuss, nor intend to explore, the science of climate change or related climate issues but rather to confine the discussions to informing the climate change education community.

To explore these topics, the steering committee structured the workshop to provide ample opportunity for discussion among expert researchers and practitioners in complementary fields that often operate in relative isolation from one another. These fields include decision making and risk analysis, education, learning and cognitive science, behavioral and envi-



ronmental economics, workforce analysis and green jobs, public literacy and communication, and physical and natural sciences.

### **About This Report**

This report is a summary of the workshop presentations and discussions. Chapters 1 through 3 summarize discussion during the first three sessions. Chapter 1 addresses questions related to the goals of climate change education. Chapter 2 addresses questions related to the audiences of climate change education, and Chapter 3 focuses on the implications of audience segmentation for climate change education strategies and research. The final chapter is a synthesis of the key issues that arose during the workshop.

Appendix A provides the workshop agenda and a list of the participants. Appendix B lists the members of the Climate Change Education Roundtable. Appendix C contains brief biographical sketches of the workshop presenters, steering committee members, and staff. To provide additional information for the discussions at the workshop, the steering committee arranged for a number of background papers to be prepared. Box 1-1 lists their titles and authors, organized by workshop session.<sup>1</sup>

It is important to be specific about the nature of this report, which documents the information presented in the workshop presentations and discussions. Its purpose is to lay out the key ideas that emerged from the workshop and should be viewed as an initial step in examining the research and applying it in specific policy circumstances. The report is confined to the material presented by the workshop speakers and participants. Neither the workshop nor this summary is intended as a comprehensive review of what is known about the topic, although it is a general reflection of the literature. The presentations and discussions were limited by the time available for the workshop.

This summary was prepared by two independent rapporteurs, and it does not represent either findings or recommendations that can be attributed to the steering committee. Indeed, this document summarizes the views expressed by workshop participants, and the steering committee was responsible only for the quality of the agenda and the selection of participants. Also, the workshop was not designed to generate consensus conclusions or recommendations but focused instead on the identification of ideas, themes, and considerations that contribute to understanding the topic.

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<sup>1</sup>The papers are available online at [http://www7.nationalacademies.org/bose/Climate\\_Change\\_Education\\_Workshop1\\_Table\\_of\\_Contents.html](http://www7.nationalacademies.org/bose/Climate_Change_Education_Workshop1_Table_of_Contents.html).

**BOX 1-1**  
**Background Papers Prepared for the Workshop**

**Session 1: Goals of Climate Change Education**

Into the Breach

*Andy Revkin*

Climate Change Education for Sustainable Development

*William Solecki*

Climate Change Education Funding Goals: NSF, NOAA, NASA

*Sherrie Forrest and Jeremy Flattau*

**Session 2: Mapping Current Public Climate Change Goals and Outcomes to Various Audiences**

Connections Between Climate Literacy and Audience's Climate Change Beliefs and Attitudes

*Anthony Leiserowitz*

Sociological Perspective of Climate Change Education Audiences

*Aaron McCright*

Social Context for Climate Change Education

*Susan Clayton*

America, the Ocean, and Climate Change: Key Findings

*The Ocean Project*

**Session 3: Implications of Audience Segmentation for Education Strategies and Research**

Climate Change Education for Diverse Audiences

*Elaine Andrews*

Climate Change Education and the Media

*Heidi Cullen*

Climate Change Education for Opinion Leaders

*Matthew Nisbet*

Climate Change Education for Faith-Based Groups

*Greg Hitzhusen*

Climate Change Education for Sportsmen, Nature Enthusiasts, Evangelical Groups, and Other Interest Groups

*Kevin Coyle*

Informing an Effective Response to Climate Change: Report in Brief

*National Research Council*

**GOALS OF CLIMATE CHANGE EDUCATION**

Climate change education has various goals, which include understanding the basic science of climate and climate change; supporting informed decision making by individuals, organizations, and institutions; behavior change; and stewardship where appropriate—all of which are

often summarized under the term “climate literacy.” The ultimate goal is sometimes stated as positive impacts on the climate, mostly in terms of stabilizing and mitigating emissions of greenhouse gases, but increasingly also including the increased capacity to adapt to the consequences of climate change.

More specifically, some educational efforts focus on improving understanding of the climate system, climate science, the impacts of climate change, mitigation and/or adaptation to climate change, and related issues. Others strive to draw connections between climate change and economics, social justice, and other societal issues. Both of these strategies (a narrow focus on the science of climate change and a broader treatment of the human-climate interaction) are represented in the *Atlas of Science Literacy* (American Association for the Advancement of Science, 2007) and in the draft of the conceptual framework for science education under development at the NRC (2011). Still others aim to go beyond improving understanding to changing behavior, for example, by improving the quality of decision making toward stewardship. For example, many programs at science and nature centers follow an explicit goal of influencing behavior, such as the Climate Change in California exhibit at the California Academy of Sciences (2008), which aims to “help the public understand climate change and take action” or the Bill Nye’s Climate Lab exhibit at the Chabot Space and Science Center (2010), which encourages children to collect “solutions.” These differences in the underlying goals of climate change education efforts pose barriers to developing a community of practice with a common language.

Session moderator Wändi Bruine de Bruin (Carnegie Mellon University) explained that the first workshop session aimed to explore (1) the goals of climate change education, as defined in different fields and for various audiences; (2) the indicators of success; and (3) the groups that are pursuing the various goals (including segments of the population that tend to dismiss the reality of or the human causes of climate change). She added that the session was designed to help individuals engaged in climate change education from various and often disconnected fields to understand the goals of their colleagues. In this way, the session would provide a foundation for later workshop discussions through a common understanding of the range of climate change education goals.

### **An Environmental Education Perspective**

Nicole Ardoin (Stanford University), whose research focuses on motivations for environmental behavior, opened her presentation by defining environmental education as a process of informing individuals’ knowledge, attitudes, motivations, and commitment to the environment. She

stressed that environmental education aims to provide individuals with the skills needed to work individually and collectively toward solutions to current environmental problems and to prevent future ones. From this perspective, the goals of environmental education are to foster awareness and concern about economic, social, political, and ecological interdependence in urban and rural areas; to enhance the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; and to create new patterns of behavior toward the environment.

Ardoin's recent work includes several initiatives on climate change education, energy efficiency and environmental behavior, and a number of research projects looking at community-based decision making around natural resource use. On the basis of this work, Ardoin sees a tremendous opportunity for climate change education to draw on both behavior change theory and education theory, enabling people not only to learn facts, but also to better understand why climate change matters.

Ardoin observed that the ultimate goal of education is to teach people how to learn and think, so that they can most effectively react to a changing planet in the short and long term. She highlighted the importance of thinking about education as a lifelong strategy, distinguished by its long-term, cyclical, and iterative nature, and suggested that providing opportunities for people to engage in all aspects of this cycle could encourage them to think critically and creatively about environmental solutions. Ardoin also pointed to the potential of integrating social strategies, such as marketing and communications, with education strategies, to make climate change education efforts more powerful in motivating individuals to live more sustainable and climate-friendly lifestyles.

Ardoin cautioned that climate change education efforts will have limited impact if educators do not recognize that knowledge alone is insufficient to motivate changes in behavior. A range of behavior theories suggests that individuals' emotions, values, skills, and opportunities to act all affect responses to public education campaigns (Ardoin et al., 2009; Gardner and Stern, 2008; Heimlich and Ardoin, 2008; Kollmuss and Aygeman, 2002). In the case of climate change education, she suggested that initiatives could not so much encourage individuals to take specific actions, but instead aim to support them in making ongoing informed decisions.

As an example, Ardoin pointed to the importance of systems thinking in developing educational efforts focused on climate change mitigation and adaptation. Increased understanding of the broader systems and context in which climate change occurs allows individuals, communities, policy makers, and thought leaders to adapt their understanding and behavior to new realities. She ended by observing that the goals of climate change education extend beyond improved understanding of

the climate system, carbon cycles, ocean acidification, and related issues and suggested that the field needs a broad set of goals similar to those of environmental education.

### A Social Science Perspective

David Hassenzahl (Chatham University), whose research, teaching, and outreach focus on risk analysis and sustainability, took the perspective that it is critical to attend to the lessons of social sciences when thinking about climate education. He began on a cautionary note, explaining that adult individuals are not likely to change their minds or behaviors toward issues related to climate change and have probably already identified their trusted sources of knowledge. He added the corollary that “individuals do not make decisions” but rather are constrained by the norms created by culture and society, which often limit the scope of individual decisions by limiting available choices, for instance in what to eat or wear and how to live.

Hassenzahl stressed that, despite these societal and cultural limitations, large-scale changes are possible and do happen. He suggested that reaching the goals of climate change education may require practitioners to think beyond “how do we change individuals” to the role of generational shifts in behavior and what choices are made available. To support such a shift, everyone may not need to understand climate change, but a select few people may need to be well informed. Striving to inform only a few people does not mean abandoning the ideal of a scientifically (or climate-) literate public, but it recognizes who makes decisions and how decisions are made and aims to support these decision makers in a more targeted way.

Hassenzahl gave an example of the positive changes that have occurred over the past century in sanitation, health care, and air quality—Los Angeles being a good example of the latter. He noted that social scientists have learned a great deal about how such changes come about and suggested that climate change education efforts can benefit from their findings. He called for avoiding the “deficit model” of climate change education, which aims only at increasing individuals’ understanding of how and why climate change occurs. He noted that climate change education includes changing attitudes, decision-making processes, and behaviors and that research clearly indicates that knowledge alone does not lead to these changes (Ardoin et al., 2009; Gardner and Stern, 2008; Heimlich and Ardoin, 2008; Kollmuss and Aygeman, 2002). In fact, some people act to limit the impacts of climate change without fully understanding the processes underlying it. For example, behaviors that would limit carbon dioxide emission, such as energy savings, may be motivated not by concern about climate change, but for simple economic reasons

(cost savings, thrift) or security concerns related to homeland security or energy independence.

Hassenzahl addressed the question of whether widespread actions to mitigate or adapt to climate change would be more likely to occur with a well-informed public or a “dogmatic” public—that is, a public that is comfortable following broad, overarching ideas rather than one that makes individual informed decisions on most issues most of the time. He suggested not ruling out the option of people who understand the scientific evidence on climate change becoming more dogmatic on the issue, to parallel the (often highly successful) approach of those who argue publically against human-induced climate change. In his view, it is possible that this approach could be more likely to lead to widespread pro-environmental behaviors, even as such a perspective challenges the common view that well-informed citizens and consumers should weigh the evidence in every single detailed decision they are making.

Hassenzahl ended by stressing that public opinion about climate change and related issues is important since it influences those who wish to be responsive to public concern and public tastes. The importance of the issue is reflected in coal companies billing themselves as “clean,” oil companies advertising their research and development of alternative fuel sources, and the convening of this workshop.

### **A Federal Agency Perspective**

Frank Niepold (National Oceanic and Atmospheric Administration) also observed that climate change education has many goals, adding that many groups are engaged in education efforts targeting a variety of audiences. He sees the range of educational goals, groups, and target audiences as one of the challenges to engaging in a coherent discussion about climate change education. To illustrate this point, he described the range of goals of the climate change education programs operated by the U.S. Global Climate Research Program (USGCRP), EPA, and NOAA.

The USGSRP’s overarching vision is to create “a nation, globally engaged and guided by science, meeting the challenges of climate and global change.” Its mission does not include behavior change, but it does include informing actions and decisions through coordinated and integrated federal programs of research, education, communication, and decision support. Niepold pointed out that the new strategic plan for EPA emphasizes the goal of “taking *action* on climate change and improving air quality,” and it is working to educate the public about climate change and the actions people can take to reduce greenhouse gas emissions. Thus, the agency’s goals include both changing people’s understanding of climate change and fostering individual and collective action that could prevent it.

Climate change education is reflected in NOAA's long-term goal of "an informed society anticipating and responding to climate and its impacts." The agency is working to develop a climate-literate public that understands climate change and makes informed decisions. To track progress toward this goal, NOAA is collecting evidence regarding how well key segments of society understand the risks related to climate change and use this knowledge to increase resilience to climate change impacts. The agency also tracks comprehension and use of climate science concepts by educators and other outreach professionals.

Despite the disparate goals for climate change education, Niepold indicated that these federal agencies have agreed on a shared definition of climate literacy. *Climate Literacy: The Essential Principles of Climate*, developed by 13 federal agencies and many other science and education organizations, defines a climate-literate person as someone who "understands the essential principles of Earth's climate system, knows how to assess scientifically credible information about climate, communicates about climate and climate change in a meaningful way, and makes informed and responsible decisions with regard to actions that may affect climate" (U.S. Climate Change Science Program, 2009). He emphasized that the key point in *Climate Literacy* is that knowing more about science is not enough to accomplish the ultimate goal of informed decision making and actions. This presents a large challenge to education systems, requiring a long-term commitment, he said.

Niepold proposed that the climate change education and communication communities could adopt the recommendations of a recent NRC study, *America's Climate Choices: Informing Effective Responses to Climate Change* (National Research Council, 2010b). These include the following:

- Establishing "a national strategy and supporting network to coordinate climate change education and communication activities for policy makers and the general public."
- Establishing baseline levels of public understanding and responses to climate change and monitoring changes in American climate literacy, including knowledge, risk perceptions, and behavior.
- Assessing the effectiveness of different climate change education and communication strategies and programs.
- Providing federal support to increase the capacity of educational institutions, scientists, and students to collaborate with diverse groups and stakeholders needing climate change information.
- Promoting teacher training programs for climate education.
- Developing climate change-related educational tools, materials, and technologies, including web-based materials.



- Setting national climate education goals and providing support to states to design and implement climate education standards.
- Providing guidelines and support for climate change education in “informal environments, such as museums, zoos, and aquariums.”

Niepold also mentioned a background paper prepared for the workshop by Matthew Nisbet (2010), which argues that increased public understanding of climate change will not by itself lead individuals to consider climate impacts in their decisions and actions. Nisbet describes how climate change education is often discussed narrowly in terms of promoting a knowledgeable spectator public. He argues that these discussions tend to view Americans as spectators in a political system in which the real decisions about climate change are made by experts, policy makers, environmentalists, and industry. Proponents of this view assume that increased public understanding of climate change science will lead to increased public concern and wider acceptance of scientific expertise, ultimately leading to a decrease in societal conflict over climate change policy.

Nisbet, however, argues in his paper that research on learning, decision making, and behavior suggests that the goals of climate change education should be broad, extending far beyond technical understanding of climate science alone. The goals should emphasize civic education and engagement, “which means empowering, enabling, motivating, informing, and educating the public on not just the technical but also the political and social dimensions of climate change” (Nisbet, 2010). If such broad goals were adopted, Nisbet continues, climate change education initiatives would need to include affective outcomes, like trust in scientific sources of information or a sense of future success. They would also require a new communication infrastructure and participatory culture, one in which citizens’ act as peer educators who can help others learn, connect, and engage. In addition, communication and education initiatives would refrain from blaming the public for a “knowledge deficit”; instead, they would view education as a two-way process in which experts and decision makers seek input and learn from the public, as well as vice versa.

Niepold ended by saying that he had provided an extremely broad range of goals for climate change education and called for these goals to be addressed quickly, strategically, and skillfully.

### **Climate Change Education Goals: Panel Discussion**

Following the presentations, moderator Bruine de Bruin facilitated a discussion of the goals of climate change education among three pre-



senters: William Solecki (Hunter College), Kit Batten (Heinz Center), and William Spitzer (New England Aquarium). She began the discussion by asking what education strategies are most likely to lead to changes in behavior or climate literacy.

Solecki responded that the most successful strategies connect with the issues, concerns, mandates, and missions of particular stakeholder organizations. A deep understanding of the various audiences' objectives, values, and interests makes it possible to frame climate change in a manner that each audience will be receptive to. Solecki argued that gaining such understanding is a critical first step in any education effort.

Batten added that not all scientists are skilled at communicating their results to nonscientist audiences. To support climate change education, scientists need to clearly explain their research and understand the media world and the policy-making process. In her view, climate change education is at a turning point, and now is the time for scientists to think about communicating more effectively using both new and more traditional media. She agreed with the emphasis of the presenters that education about how and why climate change is occurring is not enough, calling for a greater focus on communicating how science works, what scientific uncertainty is, and how individuals can use science to make decisions.

The panelists then discussed the goals that climate change education efforts could address beyond increased understanding of facts about climate change. Spitzer stated that museums and aquariums are trying to educate people as civic actors and participants in a democracy. He sees "a real opportunity to develop successful efforts" by applying findings from cognitive science and communications science. Informal learning institutions can crystallize knowledge in ways that excite people and inspire them to act, which is critical to advance the broader goal of creating a generational shift in people's connection with the environment. In his view, the goals are ultimately about stewardship and people taking responsibility, not just individually, but as social actors.

Solecki stated that it is also important to consider how and where different audiences access information about climate change. He observed that a great deal of information does not reach any audience because it was created without serious attention to audience needs or information-seeking habits. Hassenzahl proposed that the first step in developing an effective education initiative is to ask, "How much do we know about these different audiences?" and "Do we know what those access points are for the different audiences?"

Spitzer responded that one set of access points consists of informal education institutions. These institutions and their employees are good at tailoring their interactions to align with people's understanding of, and interest in, climate change on a given day. They know a lot about

working with audiences with different levels of understanding of, and interest, in climate change. Spitzer suggested that these institutions' staffs could have a positive effect in climate change education because they are trusted by the public and generally are skilled at working with diverse groups. Batten added that the media represent another important type of access point. She observed that as people increasingly choose what media sources they watch or listen to, the sources have become more polarized and specialized; as a consequence, individuals receive less and less common information.

Niepold outlined a process of developing successful education strategies for diverse audiences, which begins with observing others' strategies and selecting those that appear promising. The next steps are to test the strategies with different audiences, make adjustments based on the test results, and finally to share the results with other climate change education efforts. This process represents an improvement over the previous practice of making broad assumptions about what might work and then applying these assumptions without any evaluation of impacts. Spitzer added that testing is also useful to answer questions about how best to frame a message (such as whether to use the term "climate change" versus the term "global warming"). Testing can help climate change educators recognize when they have found a good metaphor that can appeal to values that are shared across diverse audiences.

Solecki suggested that another effective strategy for connecting with a particular target audience is to ask a well-respected leader or innovator in this audience to deliver the message. It is also important to connect the message to the local needs, issues, and concerns of the audience, particularly when speaking to decision makers and policy makers who seek information that is framed in a context that is meaningful to them. For example, it may be productive to frame an education effort, not in terms of climate change, but rather in terms of sustainability, energy security, access to cheaper energy, or other related issues.

### **Audience Comments and Questions**

Elaine Andrews (University of Wisconsin–Madison) asked what indication there is that the goals of climate change education are being reached. Niepold responded that one indicator of success is the growing number of states that include climate change in their science education standards, and another is the increasing public understanding of climate change. In his view, however, more work is needed to develop measures of progress toward other goals of climate change education efforts targeted to diverse audiences. Ardoin agreed that, because of the variety of goals and audiences, there is an attendant need for a variety of evaluation metrics. For

example, some climate change education efforts have defined their goals in collaboration with target communities. A single metric cannot assess progress in reaching goals defined by and for diverse audiences. Measures of emotions, skills, actions, and engagement are needed to assess progress toward the broader goals of climate change education, such as thoughtful, engaged participation in climate change debates and in climate change mitigation and adaptation initiatives.

F. Stuart Chapin (University of Alaska) noted that his fellow scientists most often focus on the information that they think the public needs in order to better understand scientific findings related to climate change. He asked if scientists should focus more on the information that the public wants and needs to know in order to make informed choices. The panelists thought that gaining understanding of what type of information the target audience wants and would find most useful for decision making would help scientists communicate more effectively about climate change.

Ted Willard (American Association for the Advancement of Science) asked if the goals for climate change education include behavior change and, if so, whether that is still considered education rather than communication or advocacy. Niepold responded that, although the question of how education can create behavior change has not been clearly resolved, some climate change efforts include the goal of behavior change and tend to advocate for certain behaviors. However, some people view simply teaching about the science of climate change as advocating that climate change is occurring and is important. Although most educators are uncomfortable engaging in advocacy or being viewed as advocates, the reality is that education often includes some level of advocacy, and this is not necessarily bad.

Niepold stressed that education efforts should be designed to encourage the application of knowledge to make informed decisions, which could represent a change in behavior. He noted, however, that education efforts may be justly criticized as advocacy if they push people to adopt specific behaviors or to make specific decisions. He cautioned that education efforts that move past filling the audience's perceived "information deficit" in the basic science of climate change, to include information on how to limit or adapt to climate change, need to be considered carefully as to whether they are moving toward advocacy.

Aaron Datesman (U.S. Department of Energy) asked if it is better to teach about global warming rather than climate change, since, in his view, global warming is much easier for people to grasp. The panelists said that focusing only on global warming would be problematic for various reasons. Spitzer explained that people do not experience climate; they experience—and are concerned about—the local weather, which often influences their understanding of climate change. For example, when

people experience record snow falls or colder than average weather, they begin to doubt whether global warming is occurring. He also noted that climate disruptions have impacts that are not solely related to warming, and climate change education would not connect these impacts to climate change if warming were the sole focus.

### **Breakout Group Discussions**

At the end of Session 1, the workshop participants were divided into five groups and moved to separate rooms. Three of the groups consisted of people who are primarily concerned with public education, and two groups consisted of people primarily concerned with informing decision makers. A carousel brainstorming technique was used to facilitate discussion (see Box 1-2). To initiate the conversation, the workshop steering committee provided the following guiding questions:

1. What are the highest priority goals and outcomes of climate change education (from your perspective)? What indicators would suggest to you that these goals have been achieved?
2. What stakeholder groups are you involved with or know of that are invested in climate change education (including groups who may deny or be skeptical of climate change or its human causes)? What goals and outcomes are these groups pursuing?
3. What assets do various stakeholders (e.g., physical/natural scientists, educators, social scientists, federal agencies, advocacy groups, etc.) bring to climate change education?

During the breakout group discussions, participants discussed the fact that climate change education has been changing over the past several years. Participants in some groups expressed a desire to move beyond working on climate change education as unconnected individuals and groups to more coordinated and collaborative efforts. Some groups identified development of a community of practice in climate change education as a priority. In addition, groups identified several other high-priority goals of climate change education, including understanding the process of science, empowering informed decision making, and motivating changes in behavior. Within the goal of behavioral changes, several more specific subgoals were identified, including

- increase stewardship of the environment;
- decrease fossil fuel use;
- increase energy efficiency, conservation, and the use of renewable energy resources;

### **BOX 1-2** **Carousel Brainstorming**

Carousel brainstorming is a small-group activity embedded in a larger group session. Its purpose is to activate existing knowledge and encourage synthesis across different individual understandings and knowledge about a topic when a group is too large for meaningful full-group discussion and when there are multiple topics, questions, or ideas to bring to the discussion.

Topics, questions, or ideas are written on a flip chart and posted around the room. The larger group is divided into subgroups, one per flip chart (the ideal group size is 5-7 people). Each group is given a different colored pen or marker and assigned a “home” question or topic.

The task is for each group to read the statement/question/topic and then brainstorm about what it knows, believes, or thinks, and record the group’s ideas on the sheet. Each group is given a set amount of time to discuss and record its ideas. At the end of the time limit, each group moves to the next flip chart with a new question. At each new flip chart, the groups are tasked with reading what the prior groups wrote and responding to those comments: they note if they strongly agree with something, make comments on ideas they disagree with, add ideas, and generally build on the prior groups’ thinking. Subsequent rounds have less time than the original round. The groups continue to rotate through until all groups are back at their home question or topic.

In the final round, each group reads and summarizes all the comments on the page. At the end, each group reports what is on the sheet. It is vital that a short time limit be enforced so that groups summarize the most salient points and do not simply read everything on the sheet. Full-group discussion can follow to prioritize, clarify, strategize, or synthesize across all questions or topics.

During the workshop, five breakout groups were formed following each of the three panel discussions: two groups focused on informing and educating decision makers and opinion leaders, and three groups focused on informing and educating the public. The groups included approximately 20-30 participants, who included members of the steering committee, presenters, and audience members. Each room was set up with chairs, easel pads, colored pens, sticky pads, and a digital audio recorder.

- make more green consumer choices available; and
- increase preparedness to respond to the impacts of climate change.

In all the breakout groups, participants brought up the idea that climate change educators need to have a better understanding of what influences behavior change.

In response to questions 2 and 3, group participants discussed the many stakeholders with various assets for climate change education. For example, federal and state agencies were identified as stakeholders whose

assets include funding, education resources, and information sources; scientists were identified primarily as sources of new climate science findings. Universities and cooperative extensions were seen as having critical assets for translating scientific research into education resources, conducting climate and education research, and providing outreach to local communities. The primary assets of nongovernmental organizations, advocacy groups, and faith communities lie in their potential to connect with local communities. Finally, people in the groups saw audience researchers, communication experts, and marketing experts as stakeholders whose assets include knowing how to craft messages that resonate with different target groups.

When considering various stakeholder assets, people discussed the need to tailor education processes or practices to match different audiences' interests, motivations, values, and knowledge of climate change. This approach moves away from a deficit model of education, recognizing and building on the funds of knowledge that diverse populations already possess.

One challenge discussed in a few of the groups is that some audiences have trouble understanding the underlying science of climate change, or they simply do not believe that climate change is caused by human impacts (in part because it seems counterintuitive that humans could change the whole atmosphere in such profound ways). Nevertheless, individuals in these audiences have probably experienced the effects of climate change in their local areas, whether through increased flooding, more frequent severe storms, changes in natural environments and wildlife populations, or higher energy costs. When developing education efforts for these audiences, people said, it seems important to focus on locally relevant impacts of climate change. In addition, having a trusted source of information in the community being addressed may also lead to more productive education efforts.



## 2

# Climate Change Education Goals and Outcomes for Various Public Audiences

The second workshop session built on the earlier discussion of the goals for climate change education (see Chapter 1) to explore effective strategies for engaging with various target audiences. The session was framed around audience segmentation strategies that are becoming increasingly common to climate change discussions, such as addressing people's receptivity to information about climate change or their capacity to comprehend various messages around climate change based on their underlying mental models. In this session, experts examined the nature of understanding and engagement with climate change across diverse audiences and the cultural and political factors that influence them. They also considered whether particular goals are more appropriate—or more likely to be realized—for different target audiences and discussed where various target audiences currently obtain climate change information.

Moderator Charles “Andy” Anderson (Michigan State University) introduced the session, emphasizing that it would explore how to identify and communicate effectively with different types of audiences.

### **DIVERSE AUDIENCES FOR CLIMATE CHANGE EDUCATION**

Anthony Leiserowitz (Yale University) introduced a series of research studies that examined how different segments of the American public respond to climate change information and the important role that emotion, imagery, associations, and values have in shaping those responses (Leiserowitz, Moser, and Dilling, 2007). His presentation focused pri-



marily on his most recent study, which investigated knowledge about climate change gained through learning in both formal and informal science education environments (Leiserowitz and Smith, 2010). The study, which is ongoing, is based on interviews conducted with a representative sample of 2,030 adults ages 18 and older between June 25 and July 22, 2010. According to some preliminary results that Leiserowitz described, knowledge about climate change can be divided into several general and overlapping categories:

- knowledge about how the climate system works;
- specific knowledge about the causes, consequences, and potential solutions to global warming;
- contextual knowledge placing human-caused global warming in historical and geographic perspective; and
- practical knowledge that enables individual and collective action.

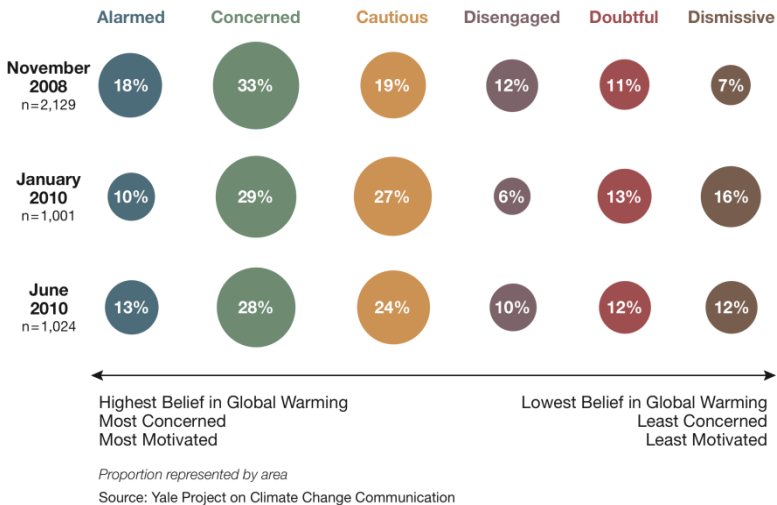
The study included a series of questions asking respondents to rate their level of knowledge in terms of each of these dimensions. Other questions addressed the respondents' desire for more information, trust in different information sources, perceptions of the risks of climate change, policy preferences, and behaviors.

In previous research, Leiserowitz (Maibach, Roser-Renouf, and Leiserowitz, 2009) identified six unique segments of the American public, referred to as Global Warming's Six Americas, each of which responds to information about climate change in distinct ways. The Six Americas represent a broad spectrum of responses to climate change, from active engagement to complete dismissal. They are categorized as follows:

1. The "Alarmed" represent the most engaged public; they believe that global warming is occurring, that it is human-caused, and that it is a serious threat.
2. The "Concerned" believe that global warming is a serious but distant threat and are less personally engaged with the issue.
3. The "Cautious" are less certain that global warming is happening or that it is human induced and do not have a sense of urgency about it.
4. The "Disengaged" don't know or think about the issue.
5. The "Doubtful" are split between believing and disbelieving in global warming, but those who accept global warming are most likely to believe that it is due to natural causes and does not pose a threat to people.
6. The "Dismissive" are actively engaged with the issue but do not believe global warming is happening, represents a threat, or warrants a national response.

Leiserowitz noted that his nationally representative surveys from fall 2008 to January 2010 show a significant decrease in the group identified as “Alarmed,” coupled with a significant increase in the percentage of respondents who could be classified as “Dismissive” (see Figure 2-1). He noted that this research complements other national polls that seem to indicate that the public’s acceptance of climate change and its human causes has decreased (Pew Research Center for the People and the Press, 2007), which he attributed to several causes including the economy and high unemployment, the concurrent major decline in media coverage, two snowy winters on the east coast, an active and effectual denial industry, and the “climategate scandal.”

Leiserowitz highlighted several survey questions in his current research that ask about respondents’ belief in global warming and its relationship to human actions, noting that the responses show stark differences among the Six Americas segments. The percentage of respondents who expressed belief in climate change and its human causes declined steadily across the groups, from the Alarmed to the lowest level among the Dismissive. In response to the question of whether respondents are worried about global warming, there was a large drop in the percentage expressing a great deal of worry, from 71 percent of the Alarmed to only 18 percent of the Concerned. Leiserowitz noted that many people who are



**FIGURE 2-1** Changes in opinions about climate change by audience segmentation. SOURCE: Leiserowitz et al. (2010).

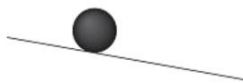
not part of the Alarmed, but do accept global warming as a scientific fact, see it as a problem distant in time and space.

Commenting on results from a line of questioning that explored whether people understood the greenhouse effect and global warming's relationship to the earth's protective ozone layer, Leiserowitz observed that many people believe that climate change and the ozone hole are the same problem, or that the ozone hole is the cause of global warming, and therefore come to the wrong conclusions about the appropriate solutions. He also pointed to the fact that more accurate knowledge about climate science may not trump other fundamental beliefs or agendas that stand in competition to addressing climate change.

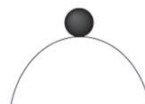
In an attempt to gauge individuals' deeper understanding of the climate system, Leiserowitz' study participants were asked to select one of several alternative conceptual models of climate change. The models were composed of five figures representing the climate system as (1) a gradual, incremental process; (2) a fragile system easily pushed to catastrophic events; (3) a stable system able to keep itself in balance; (4) a system that would remain in balance within certain thresholds but would become a new system if pushed beyond; and (5) a completely random and unpredictable system (see Figure 2-2). Almost half of the Dismissives picked the stable model, suggesting that, even if they could be convinced that global warming is occurring and is caused by greenhouse gases, they believe that these changes would not affect the climate system much. These respondents view human activities as too insignificant to affect the global climate system. One positive note from the study was that most respondents (except those in the Doubtful and Dismissive groups) indicated that they were not well informed about climate change and demonstrated overwhelming support for more education, including a national education effort targeting children.

Leiserowitz explained that this study also examined the types of information needed to reach different audiences. He noted that the Dismissive and Doubtful most frequently sought answers to such questions as "How do you know that global warming is occurring?" and "Why should I trust the messenger?" and that demographically these respondents tended to be white men. Overall, however, the variations in responses were more strongly associated with personal perceptions about what individuals "knew" and felt to be true than with gender, race, or other demographic factors.

Leiserowitz concluded that there are important gaps in the public's knowledge of climate change and how to respond to it, including widespread misconceptions about climate change and the earth as a system. These misconceptions lead some people to doubt that global warming is occurring or that human activities are a major contributor; misunder-

**Gradual**

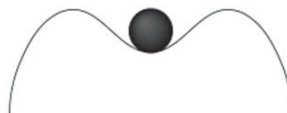
Earth's climate is slow to change. Global warming will gradually lead to dangerous effects.

**Fragile**

Earth's climate is delicately balanced. Small amounts of global warming will have abrupt and catastrophic effects.

**Stable**

Earth's climate is very stable. Global warming will have little to no effects.

**Threshold**

Earth's climate is stable within certain limits. If global warming is small, climate will return to a stable balance. If it is large, there will be dangerous effects.

**Random**

Earth's climate is random and unpredictable. We do not know what will happen.

**FIGURE 2-2** Conceptual models used to gauge understanding of climate change. SOURCE: Leiserowitz and Smith (2010).

standing the causes of climate change and therefore the solutions as well as the risks. Reiterating that the Six Americas groups respond to climate change information in very different ways, he emphasized that people actively interpret information and construct their own mental models based on what they personally know, value, and feel. Leiserowitz ended by saying that knowledge is necessary but insufficient to meet the needs of different audience segments.<sup>1</sup>

<sup>1</sup>More information on this research is available at <http://environment.yale.edu/climate>.

## AUDIENCE SEGMENTATION, MENTAL MODELS, AND TARGETING CLIMATE CHANGE EDUCATION

Ann Bostrom (University of Washington) focused on three topics: audience segmentation, mental models and decision making, and the issue of targeting messages to different audience segments. She began by drawing on some of her previous research (Reynolds et al., 2010) to compare Leiserowitz's work on the Six Americas with her own research on audience segmentation. Although she referred to the group he calls Dismissives as "discounters" and to his Alarmed as "enthusiasts," the groups demonstrate similar characteristics. The enthusiasts/Alarmed tend to believe in everything that represents environmental good practice and accept any information that explains climate change or supports ways to combat it. The Disengaged tend to say they don't know or care about this information. And the discounters/Dismissives tend to be well informed on questions of climate science but don't believe in the basic scientific content or that climate change is influenced by human activity; consequently, they do not see any need for taking action.

Bostrom then turned to the importance of mental models—representations of reality people construct to explain phenomena and that are congruent to varying degrees with representations of reality favored by scientific research. She cited a study (see Bostrom et al., 1994; Read et al., 1994; Reynolds et al., 2010) demonstrating the tendency of enthusiasts/alarmists to adopt what she described as an environmental good practice model. Based on this mental model, group members tend to think that anything considered environmentally "bad" is contributing to climate change, from toxic chemicals in the air to stratospheric ozone depletion. She observed that the enthusiasts' belief in the effectiveness of a climate change mitigation strategy was related to whether they viewed the strategy as an environmentally good practice in general. She stated that these findings reinforce the research conclusions of Leiserowitz that these types of beliefs can lead enthusiasts/alarmists to support climate change mitigation policies that are ineffective or nonspecific. Bostrom emphasized that climate change communicators and educators need to think carefully about this problem when working with enthusiasts/alarmists. Drawing on the background paper by Nisbet (2010), she observed that providing information to correct this group's misconceptions could be an effective strategy but cautioned that the information must be rooted in the appropriate context. In addition, she stressed that false current beliefs or misconceptions can only be addressed with effective and appropriate alternative conceptions, mental models that resonate with the learner and that address the issue in a scientifically acceptable way.

Bostrom ended by addressing targeting, asking whether it is more effective to target a message based on understanding of individuals'

mental models and beliefs about climate change, or to target opportunities for reaching specific audiences, that is, information channels that people already use and trust. She referred to a recent study of risk analysis (unpublished data), noting that some people have already had personal experiences of climate change. For example, gardeners have noticed the earlier onset of spring, and Montana residents have experienced more wildfires. Although these individuals may consist primarily of enthusiasts, they have the ability to serve as opinion leaders and help to educate their communities about climate change.

### **BELIEFS ABOUT CLIMATE SCIENCE AND CONCERN ABOUT GLOBAL WARMING**

Aaron McCright (Michigan State University) introduced his current research on public understanding of climate change, explaining that it follows from previous research on the subject (McCright, 2010). Noting that his findings reinforce Leiserowitz's research on the Six Americas, he said that his research indicates that "the strongest predictors of climate change acceptance and concern can be loosely characterized as environmental values, environmental identity, belonging to environmental groups, and having pro-ecological values versus anthropocentric values." The second and third strongest predictors are political ideology and party identification.

Analyzing Gallup Poll data from 2001 to 2010, McCright addressed two related questions: (1) what social, political, and economic variables relate to individuals' beliefs and attitudes about climate change and (2) what are the social, political, and economic characteristics of climate change deniers (McCright, 2010). The answers to these questions, he said, increase understanding of patterns and trends in the American public's opinions on climate change. Identifying the characteristics of individuals more likely to accept or deny the reality and seriousness of climate change may allow leaders of public education efforts to more effectively frame their messages to key audience segments and/or identify barriers to existing education efforts.

McCright found a sizable political divide between liberals/Democrats and conservatives/Republicans on the issue of global warming, with liberals and Democrats more likely to hold beliefs consistent with the scientific consensus and to express concern about this environmental problem than conservatives and Republicans. Noting that this divide has grown substantially over the past decade, he argued that flows of political messages and news about global warming are likely to be contributors to the divide. People's political orientations moderate the relationship between level of educational attainment and level of belief in climate

change and between level of educational attainment and level of concern about climate change. He cited a study by Hindman (2009) that argues that individuals with different ideologies or political affiliations are likely to receive very different or even conflicting information on global warming—in ways that reinforce their existing political differences.

McCright argued that his findings about the influence of political orientation challenge the common assumption of climate change educators that more information will help convince people of the need to respond to climate change. Simply providing more information seems particularly unlikely to prove effective for reaching the large segment of the public on the right of the political spectrum—especially if the information is provided through established scientific communication channels. He emphasized that public opinion about global warming is significantly polarized. Observing that ideological and political elites have become increasingly polarized on a wide range of issues in recent decades—including environmental issues, such as climate change—McCright said that the public has followed this trend of political polarization. Even if this polarization trend slows or reverses, the political divide in the American public will remain much larger than it was in 2001—the year that the Intergovernmental Panel on Climate Change clearly established the current scientific consensus on climate change (Intergovernmental Panel on Climate Change, 2001).

In closing, McCright turned to research focused on conservative white males (CWMs) and the characteristics of climate deniers. He noted that research findings provided strong evidence that conservative white males are more likely than other adults to espouse climate change denial (McCright, 2010). Furthermore, CWMs who report that they understand global warming very well—a group he referred to as “confident” CWMs—express the greatest degree of denial. Even controlling for this denialism, McCright found that Republicans, more religious individuals, and those unsympathetic to the environmental movement are more likely to report denialist beliefs than their respective counterparts.

Like several speakers before him, McCright also concluded by cautioning that these research findings pose a challenge to the deficit model of public education campaigns, which try to simply get more information out. He noted that a careful analysis of the different factors associated with climate change denial can help illuminate the importance of trust in sources of information on controversial topics.

## **SOCIAL CONTEXT FOR CLIMATE CHANGE EDUCATION**

Psychologist Susan Clayton (College of Wooster) opened her talk by emphasizing that education is a social interaction in which those who give



a message and those who receive it play social roles and are influenced by the surrounding context. Although education is typically thought of as a process of increasing knowledge by transmitting an informational message, the acceptance of a message involves emotional and behavioral components as well as cognitive ones. The strong emotional responses evoked by climate change are an inextricable part of the way in which people evaluate information about the phenomenon. In an age of information overload, social context helps an individual decide whether to pay attention to a message, encourages the individual to continue to think about a message after the delivery, and provides an interpretive framework for making sense of information.

Clayton stressed that the social context can create negative emotional responses to a message about climate change, which may include fear, shame, guilt, or anxiety. Although some emotional response is useful in attracting attention or avoiding complacency, too much fear or anxiety can make people shut down in denial. Moreover, if a message makes people feel that their lifestyles are being personally attacked, they are likely to respond defensively by trying to discredit the message and its source. However, a message may also generate positive emotional responses, as people may feel proud of what they or their social groups are doing to address climate change and working together may enhance feelings of connectedness to one's community.

Clayton said her research indicates that the emotional response to a climate change message will also affect the behavioral response. In her view, climate change education will be effective only if it convinces people to change their behavior, such as modifying unsustainable lifestyles or advocating for policies to address the problem. She observed that many people do not act because of uncertainty about the best course of action or a feeling that they are incapable of effective action. Clayton proposed that education should train people in the behaviors and skills most effective in addressing climate change. In the best case, this type of climate change education would enhance perceptions of self-efficacy, motivate people to learn more, and, as a result, become even more effective in their actions.

Information about what others are doing is also both informative and motivational, according to Clayton. Conformity is a very powerful force, she said, and substantial research is showing that some people will behave in ways that are completely inconsistent with their own beliefs and values in order to follow social norms. To motivate individuals to act, education efforts might include not only factual information, but also concrete examples of the ways in which specific individuals are working to address climate change.

In closing, Clayton argued that the context in which a climate change message is received is an important factor that can foster the educational



mission. The context is particularly influential in informal education, but it can also be important in formal settings. An educational message that fosters social interaction can attract individuals' attention, promote their retention of the message, and encourage them to engage with the message. Social interactions around climate change education may strengthen social capital and the bonds between individuals in a group. In some cases, such interactions may encourage people to feel a stronger sense of community and social connection. For example, such connections developed in six small Kansas communities that joined a climate and energy project and greatly reduced their energy use, despite residents' skepticism about global warming. The project focused on "thrift, patriotism, spiritual conviction, and economic prosperity" to encourage residents to conserve energy; the program resulted in up to 5 percent decline in energy use within these communities in comparison to other areas (Kaufman, 2010). The success of this project, Clayton said, reinforced her earlier point that people who may deny or reject climate change can be reached by talking about topics they relate to and consider part of their social identity.

### **MAPPING GOALS AND OUTCOMES TO PARTICULAR AUDIENCES: PANEL DISCUSSION**

Session moderator Anderson facilitated a discussion among the presenters and the audience. As an entry point, he asked each member of the panel to answer the question of whether different goals are appropriate or more likely to be realized with different audiences.

Leiserowitz responded that, given the broad challenge of climate change and the diversity of the American public, there is not a one-size-fits-all approach to climate change education. Individuals take on many different roles that potentially influence or are influenced by climate change, acting at different times as energy users, consumers, members of a political party or religious organization, and citizens. He argued that the goals of various education initiatives focusing on these different roles are completely different, suggesting that educators need to carefully develop their messages to align with the desired goals or outcomes.

McCright stated that most people do not consider their political preferences to be a master identity, because other roles and values—such as their identity as parents or their position in the workplace—are more important. He explained that, when communicating about behavioral change rather than simply transmitting information, it is possible to approach individuals in ways that do not provoke the political divide. He expressed concern about messages that reinforce political divisions

around climate change, as the different groups may become increasingly unwilling to communicate.

Elaborating on Leiserowitz's earlier suggestion that education strategies focus on goals, Clayton observed that, since climate change education has many different goals, a single education effort cannot attempt to achieve every one of them simultaneously. She identified several possible goals, such as enlightening the public, creating behavior change, or invoking a sense of community and responsibility, emphasizing that a particular educational message can be matched to a particular goal. She agreed with McCright that people do not have a single identity and may best be reached through messages tailored to their different roles.

### Audience Comments and Questions

Thomas Bowman (Bowman Design Group) asked the panelists how important it is to improve climate literacy as a step toward developing new cultural values that would lead Americans to respond effectively to climate change. Clayton responded that climate literacy is important if the goal is a long-term increase in public understanding and development of solutions, but it may not be the most important factor if the goal is short-term behavior change. In either case, a population that understands basic climate science and can interpret scientific information will help to advance all of the various goals of climate change education. Bostrom added that an exciting aspect of the National Research Council's Roundtable on Climate Change Education, which generated the idea for the workshop, is its integration of both formal and informal education. Noting that the current generation of students receives almost no formal education in climate change, she said that integrating informal and formal learning may be the best way to increase climate literacy.

Roundtable chair James Mahoney asked whether the panelists' observations extended to decision makers who deal with climate change in their work. Leiserowitz responded that climate change educators need to be able to provide the level of sophisticated information required by professionals, emphasizing that educators should help to prepare a workforce of experts, researchers, and communicators trained to solve current and evolving climate change challenges. Clayton explained that the workplace provides a social context in which people may more readily receive climate change information, and McCright encouraged the climate education community to draw on the research on the sociology of organizations and organizational change.

David Hassenzahl asked if the research findings on the segmentation of different audiences within the American public helps to identify points of entry, in which climate change education is likely to garner the greatest

effects. Leiserowitz responded that, although climate change has become the latest issue in the broader debate over environmental protection, it represents a much larger and more fundamental challenge to the nation. He argued that it is very important for the climate change education community “to break out of the environment box, and the political box, to avoid being mired down in the ongoing cultural wars.” Leiserowitz observed that climate change can be legitimately and accurately characterized as a public health issue, an economic competitiveness issue, a national security issue, and a moral and a religious issue. He advocated framing messages in these contexts, to help all audience segments recognize that their values are at stake in climate change.

David Blockstein (National Council for Science and the Environment) noted that two types of goals for climate change education had emerged in the discussions: a knowledge goal and a behavioral influencing goal. He asked whether the panelists had been able to distinguish the extent to which people’s belief in the reality of climate change is generated by their attention to scientific findings rather than attention to behavioral changes. Leiserowitz responded with his finding that the Dismissives who belong to the group most likely to disbelieve in climate change are driven, not by scientific findings, but by the threat of a policy solution that violates their values. He noted that a Yale study targeting climate change skeptics found that, when skeptics were told directly that climate change was a serious problem that required action, they responded overwhelmingly with disbelief (Leiserowitz and Smith, 2010). However, if they were told that nuclear power was the best way to solve climate change, skeptics were more likely to accept that climate change is occurring and poses a threat.

Bostrom agreed with Leiserowitz that the framing of questions influences the extent of public support for climate change mitigation policies. She mentioned a study showing that, when people were directly asked to support carbon taxes, they responded negatively, but when asked to support programs that offset the costs of emissions, they responded positively<sup>2</sup> (Hardisty, Johnson, and Weber, 2010). McCright added that the direct effects of political ideology or party identification on preferences for alternative policies to reduce carbon dioxide emissions are very small or nonexistent. Overall, 75-80 percent of the public favors a range of policies to address climate change, but there may not be the political will to move forward.

Jill Karsten (National Science Foundation) asked whether studies of audience segmentation—similar to the Six Americas study—had been used to develop successful strategies for climate change education.

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<sup>2</sup>Also supported by data recently collected and analyzed by Daniel Read, currently unpublished.

Leiserowitz responded that he is analyzing responses to climate change–related questions included in the Gallup World Poll, with data from more than 150 countries. His research group has found huge differences across countries and world regions; for example, climate change is not an issue in Latin America and South America, and, globally, 4 out of 10 people have never heard of climate change. He described this lack of awareness of climate change as “an education challenge.”

Clayton added that the relationship between one’s belief or disbelief in climate change and one’s political views is very different in different countries. For example, in China, where the government strongly supports taking action to address climate change, one cannot be pro-government and deny climate change, as in the United States. Leiserowitz added that the United Kingdom’s approach to climate change provides an interesting counterpoint to the United States. Although the right side of the political spectrum in the United States has made denial of climate change part of their election strategy, Prime Minister David Cameron’s Conservative Party was elected (in coalition with the Liberal Democrats) in 2010 on a platform that “absolutely accepted climate change.” Leiserowitz suggested that this demonstrates that a conservative ideology need not prevent accepting and responding to climate change.

### BREAKOUT GROUP DISCUSSIONS

During the breakout sessions, the carousel brainstorming technique was again used to facilitate discussion. To initiate the conversation, the steering committee provided the following guiding questions:

1. Based on the goals identified in Session 1 and considering the research on audiences, what are the most important climate change education goals for each audience?
2. What factors and barriers must be addressed to realize the indicated goals for audiences (e.g., values, incorrect mental models and preconceptions, receptivity, misconceptions)?
3. Should certain audiences be higher priority than others? Which ones? Why?

During the breakout sessions, participants revisited the goals of climate change education that had emerged in the earlier session and grouped them into several major categories, noting that reaching each set of goals will require intervening steps. One major category includes knowledge and action goals. In this category, participants discussed the idea that climate change educators could focus first on the learning (knowledge) goals, followed by skill development to increase the audi-

ence's capacity for action. Participants noted that, although knowledge is essential, skills are necessary to translate knowledge into behavioral changes. People in several groups emphasized the need to speak with members of the various audiences to establish the right set of goals for that particular audience, and they cautioned against focusing on the need to simply fill a person's knowledge and skill deficits. Rather, they said, educators need to focus on what experience and information they can share that would have value to that audience.

Most of the breakout groups expressed the view that audience segmentation is useful in prioritizing strategies for communicating about climate change, but they had different perspectives on the usefulness of considering the Six Americas study specifically. One group thought the study findings were impractical; other groups viewed them more favorably. However, participants in every group expressed the need for prioritization of audiences and messages in order to make best use of available resources.

People in several groups thought that the most strategic way to prioritize audiences is to determine whether a particular audience can influence others. They identified several audiences as high priority, based on this capacity for influence, including formal educators, informal educators (e.g., weather forecasters), and decision makers. Bostrom's earlier comments about the need to be practical when prioritizing target audiences resonated with a number of participants.

Several groups focused on priorities in terms of the audiences identified in the Six Americas study. They described the alarmed group as a natural audience for climate change educators. However, at least one participant was distressed by the serious misunderstandings in this group, which climate change educators have reached most successfully. People responded that educators can help the alarmed group to develop a better understanding of the science to solidify their support for real solutions, to show this group how to take actions that will truly have a positive impact on climate change problems, and to activate the group as educators for peers in their social environment.

Several groups also described the concerned audience as important because its members already lean toward accepting and understanding climate change issues. Participants discussed the idea of connecting with the concerned group by framing climate change as a concrete issue with real-world effects. For example, educators could emphasize the local or regional effects of climate change. Other participants noted that focusing on local impacts might also be helpful to reach the discounters/Dismissives and the doubtfuls. Various groups reflected on the successful program in Kansas described by Clayton (Kaufman, 2010). Participants noted that, by responding to community needs and respecting local

opinions and values, the program helped people find their own reasons to reduce their use of fossil fuels.

In the discussions, three fairly distinct categories of barriers to understanding the science of climate change, accepting the need to act to mitigate climate change, and actual behavior that would effectively address the issue were identified: (1) personal-level barriers, such as the mental models described by Bostrom; (2) social-level barriers, which can be viewed as people's normative interactions with one another and reinforcement for one another's actions; and (3) institutional or structural-level barriers, which enable action or prevent it from occurring. Some people thought that the climate change education community would be wise to target the decision makers who influence civic and private infrastructure, from public transportation to the energy efficiency of consumer products, and thereby determine the range of options available to consumers and private citizens. And others said that climate change educators could target local, regional, and national opinion leaders in politics, media, art, civic society, and business who can shape the cultural and political discussions on climate change and, in part, determine shared cultural values that provide the social context in which individuals navigate their own identities.



## 3

# Implications of Audience Research and Segmentation for Education Strategies

During the third session of the workshop, discussions centered on practical approaches to educating both the public and decision makers about climate change. A panel of six leaders in climate change education described effective and ineffective education strategies and explored how to scale up the most effective strategies. Representing practitioner and scholarly perspectives, the panelists' discussion set the stage for the afternoon breakout sessions, which provided an opportunity for participants to delve into the strategies more deeply.

To launch the discussion, moderator David Blockstein (National Council for Science and the Environment) asked each panelist to provide an example of a climate change education activity that was successful in reaching the public and to comment on why it was successful.

### **CLIMATE CHANGE EDUCATION FOR SPECIFIC AUDIENCES**

#### **Sportsmen and Other Interest Groups**

Kevin Coyle (National Wildlife Federation) described the approach developed by the National Wildlife Federation (NWF) to engage leaders in influential communities as voices for both personal and civic actions on climate and broader policy reforms (Coyle, 2010). From 2007 to 2010, the NWF trained 5,000 leaders in climate education from selected constituent groups. The training programs were developed based on lessons learned in an initial effort focused on hunters and anglers.



Coyle noted that 35 million people in the United States are part of the hunter and angler community. Many live in rural areas, have fairly conservative political views, and belong to the National Rifle Association. About 50 percent declare themselves to be evangelicals, and approximately 80 percent voted Republican in the last two presidential elections. This community's characteristics pose a potential challenge to effectively educating members about climate change. Nevertheless, over several years, the NWF reached out to hunters and anglers to educate them on climate change through an extensive training program in 35 states. The goals were to address their skepticism about climate change, improve their capacity to discuss the subject, and motivate them to support climate change legislation and other government initiatives.

The NWF directly tested different content and visual presentations in pilot courses attended by selected leaders of state and national hunting and angling organizations. The participants suggested several approaches to be included in the courses: (1) use local rather than international or even nationwide examples of global warming's effects, (2) stay sharply focused on habitat and wildlife when educating about problems and solutions, and (3) have a format that allows ample time for participants to describe their own observations and experiences. After incorporating these suggestions into the training materials, the program began to show signs of success. For example, as trained cadres of leaders began to talk to others in their respective states, there were evident shifts in hunter and angler support for policy reforms. Organizations that had been reluctant to support climate change legislation or even to admit there was a problem started to become advocates. When the NWF brought hunters and anglers to Washington, DC, to talk with congressional leaders, more than 90 of 100 participants participated as a result of relationships that they had formed during their NWF training. The training program and the relationships it fostered also contributed to 670 national, state, and regional hunting and fishing groups signing a letter to the 111th Congress urging passage of the American Clean Energy and Security Act.<sup>1</sup>

Based on this success, the NWF staff used survey research to identify and develop training aligned with the cultural sensitivities, conceptual frames, and informational needs of several other constituencies. Training was targeted to the unique interests and concerns of environmental and civic activists, master gardeners, conservative faith-based organizations, watershed conservationists, land trust leaders, birders, university groups, coastal wetland conservation organizations, and business leaders. For each community, the training had three goals:

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<sup>1</sup>The U.S. House of Representatives approved the act in June 2009, but the bill died in the Senate.

1. educate key members on the basic science of climate change,
2. familiarize them with solutions to the problems of greenhouse gas reduction and natural resource adaptation, and
3. win their support for taking action on climate change, both personally and in terms of policy reforms.

Coyle said that aligning the training with each group's conceptual frames and concerns was critical to inspiring the diverse groups to be more supportive of climate change actions and reforms. For example, surveys of Christian Coalition members indicated that the training program should frame the value of learning about climate change around energy independence, self-determination, and caring for God's creation.

### Faith-Based Groups

Greg Hitzhusen (Ohio Interfaith Power and Light) opened his remarks by explaining that he is both a researcher and education practitioner engaged with faith-based communities on issues of climate change and environmental ethics and education. He described his work with Interfaith Power and Light (IPL), the largest faith-based climate change organization in the United States, which works with more than 10,000 congregations in 38 states.<sup>2</sup> He noted that the community of faith-based organizations is growing to include the National Religious Partnership for the Environment, the National Council of Churches Eco-Justice Programs, the Evangelical Environmental Network, and the Coalition on the Environment in Jewish Life.

Hitzhusen provided several examples of successful climate change education efforts involving faith-based communities. The Cincinnati Archdiocese was the first signatory to the Catholic Climate Covenant, also called the St. Francis Pledge to Care for Creation and the Poor. The pledge asks Catholic individuals, parishes, and congregations to pray about climate issues; learn about climate change; assess what they can do, for example, an energy audit of church or home; act on that assessment; and advocate and talk to legislators about the importance of these issues.

To help the archdiocese achieve these goals, Ohio IPL assisted in setting up a Climate Change Education Day, focusing on what individual congregations could do to respond to climate change. The response was much larger than expected, with participation from approximately 67 churches. At the same time, the Greater Cincinnati Energy Alliance created a fund to help nonprofits retrofit their buildings for energy efficiency. They picked up on the education day event, realizing that old churches

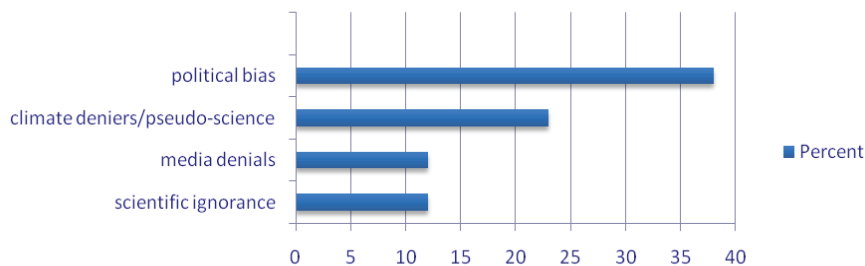
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<sup>2</sup>For more information, see <http://interfaithpowerandlight.org>.

were a prime target, as they generally are not energy efficient. Today, 28 congregations in the Cincinnati area, including a mosque, a Jewish day school, and several Christian churches, have received funding of up to \$15,000 to retrofit their buildings. In addition, the education day led participants to visit their legislators—both in the Cincinnati area and in Washington, DC—to advocate for climate change policy reforms.

Hitzhusen pointed out that this successful example raises basic principles for effectively communicating about climate change. The first principle is to work within the values of the community, as the Catholic Climate Covenant does. The second principle is to touch people through their hearts rather than solely through their heads, and to recognize that multiple values matter. The third principle is that, although it is essential to emphasize values when working with faith communities, overlapping concerns must also be considered. For example, it can be valuable to frame climate change not only as a moral issue but also as a way to save money.

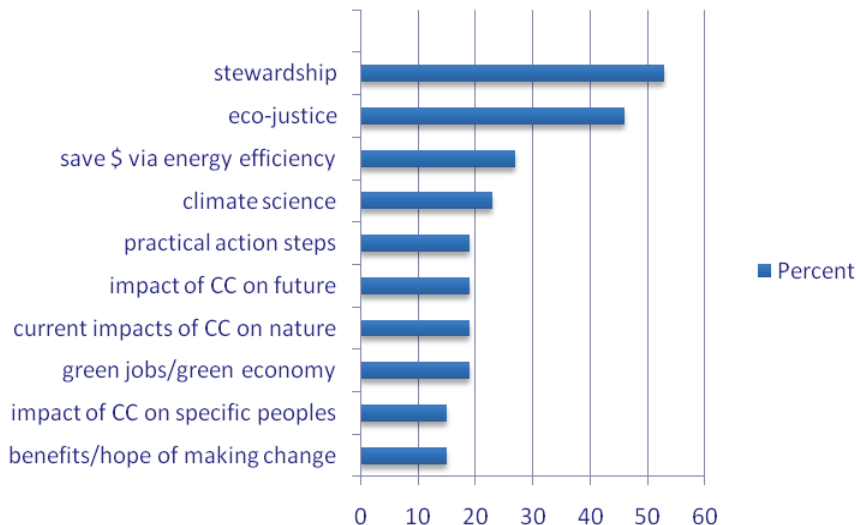
In closing, Hitzhusen discussed findings from a survey of directors of the state affiliates of IPL (Hitzhusen, 2010), who identified several key barriers to the acceptance of climate change information in faith-based audiences (see Figure 3-1). The respondents most frequently identified political bias or partisanship as a barrier, followed by the influence of climate deniers and pseudo-science (Hitzhusen, 2010). State directors also reported that, across audiences, messages framed in terms of certain values, including stewardship and eco-justice, were successful (see



**FIGURE 3-1** Barriers to acceptance of climate change information in faith-based audiences.

NOTES: IPL directors identified several key barriers to the acceptance of climate change information in faith-based audiences. Political bias or partisanship was cited by 38 percent of the directors; the influence of climate deniers and peddlers of pseudo-science was cited by 23 percent; vocal deniers in the media were identified by 12 percent, as was scientific ignorance among Americans.

SOURCE: Hitzhusen (2010).



**FIGURE 3-2** Most successful and resonant climate change (CC) messages perceived by IPL state directors as delivered to faith based audiences.

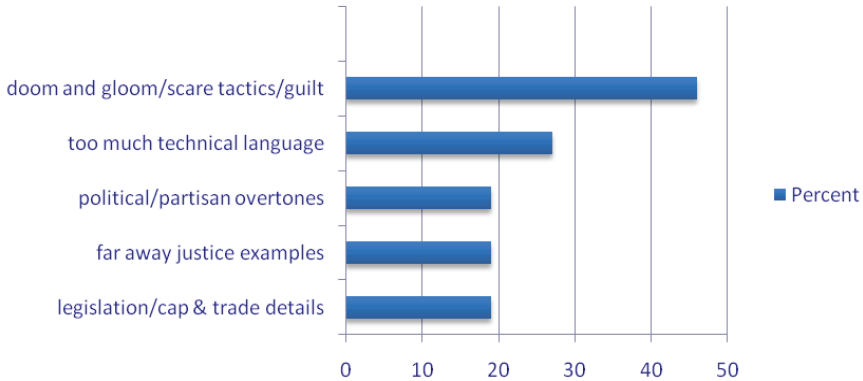
NOTES: A total of 53 percent identified basic stewardship; 46 percent a basic eco-justice message; 27 percent emphasized a message of saving money through energy efficiency; 23 percent identified the science of climate change; 19 percent identified each of the following: practical steps to help respond to climate change, the impact of climate change on future generations, current observations of the impact of climate change on the natural world, and green jobs/green economy opportunities. A total of 15 percent emphasized personalized messages about the impact on specific people(s) or the benefits and hope that come from making change.

SOURCE: Hitzhusen (2010).

Figure 3-2), whereas those framed in other ways (e.g., scare tactics, technical descriptions of the climate cycle) were consistently ineffective (see Figure 3-3).

### The Business Community

Katie Mandes (Pew Center on Global Climate Change) explained that the Pew Center on Global Climate Change's primary mission is to engage the business community on climate change issues, providing credible information and workable solutions. The Pew Center realized from the beginning that solving climate change would never happen without the positive involvement of the business community. In the 1990s, when the center started its work, the issue of climate change was already polarized, with



**FIGURE 3-3** Ineffective messages identified by IPL directors.

NOTES: A total of 46 percent said that “doom and gloom,” “scare tactic,” and “guilt trip” messages do not work; 27 percent found too much technical language ineffective; and 19 percent cited each of the following: talking about climate change in a political way or with partisan overtone, giving environmental justice examples from faraway places like Africa or Bangladesh, and details about legislation or talk of “cap and trade.”

SOURCE: Hitzhusen (2010).

the mainstream business community on one side and the environmental community on the other.

From 13 corporations that signed on at the start in 1998, the program has grown to work with 46 large companies, with combined revenues of \$2.5 trillion and over 4 million employees. Because these companies come from a variety of energy-intensive sectors, including manufacturing, chemicals, and agriculture, they may not all come out as “winners” in a changed energy and policy landscape. In its work with the corporations, the center’s primary goal is to work with these businesses to elicit change in federal policy, but also to provide assistance with implementing changes in company processes and technologies.

Although the center historically provided research and analysis to help chief executive officers make informed decisions, in recent years the companies have requested it to work with their employee base. In response, the center devised an employee engagement program called Make an Impact—Save Energy, Save Money, Save the Environment. The goal of this program is to support existing sustainability goals and link a corporation’s employees to the communities in which it operates. For example, employees were given access to a carbon calculator so they could calculate their home emissions, learning more about their carbon footprint

and personal impact on the environment. The corporations hoped the lessons learned would transfer into the work environment. The program also educated employees on programs already in place in the companies. The goals of this part of the program were to weave sustainability into the fabric of the workplace and empower employees to be part of the solution to climate change.

Mandes explained that she quickly learned about the importance of framing appropriate messages. For example, blue-collar workers across the country are not interested in being told what to do by somebody from Washington. To engage this audience, she frames climate change in light of their concerns, which may include energy security, energy independence, saving money, or stewardship of the earth. Following this framing, the center provides the workers with information on energy use and tools and resources to help make positive changes. The information is localized and distributed by company managers and other community members.

Mandes ended by saying that, although climate change remains a polarizing issue in the United States, there are ways to communicate effectively about the challenges and engage government, business, and individuals in finding solutions. She noted that peer-to-peer learning is very effective for climate change education.

### **The Media**

Heidi Cullen (Climate Central) explained that Climate Central, a non-profit science and journalism organization, tries to localize the issue of climate change. She said that one goal of climate change education is to engage the American public in considering what each individual can do to address the problem of climate change. The basic education challenge facing the climate science education community, she said, is that a relatively small group of people (climate scientists) strongly suggests that burning fossil fuels to power the modern economy is extremely harmful to the climate over the long term. This small group is asking the much larger public to reconsider the reliance on its primary energy sources (fossil fuels) and focus increasingly on sustainable energy resources. Because climate educators are asking a great deal of the American public, they need to build a strong and clear case for action.

Cullen explained that, during her transition from a career as engineer and climate scientist to an on-air climate expert with The Weather Channel, she received a crash course in communication through the news media. Ultimately, she learned that storytelling was the only way to cultivate and grow an audience that is both engaged and passionate. In her experience, there are three components to creating successful content:

1. Knowing your audience and what it cares about.
2. Building a strong, personal narrative that speaks to your audience.
3. Providing clear, actionable takeaways.

Cullen described three websites illustrating these principles. The first was created by the newspaper *The Tennessean* during an episode of national flooding. The second, called Black Saturday and produced by the Australian Broadcasting Corporation, is an interactive website that can be viewed as a map, a timeline, or a narrative to help users understand the devastating fires that took place in Victoria, Australia, in February 2009.<sup>3</sup> The third, Climate Matters, was created by Jim Gandy, chief meteorologist with WLTX television in Columbia, South Carolina; it is a series of 30-second segments designed to help the audience understand that climate change already impacts their daily lives.<sup>4</sup>

Cullen also emphasized that effective communication strategies will always be somewhat different for different audiences and across different platforms. At Climate Central, they work across print, TV news, and web platforms to capitalize on events that make it into the news cycle and therefore grab the attention of the public. For example, by seizing on extreme weather events, there is a tremendous opportunity to reach large portions of the public at key moments.

Cullen described a successful tool for providing data created by Climate Central: infographics that seize on breaking news and provide a “climate context.” They are consistently among the most popular items on the Climate Central website and are frequently cross-posted to other websites. To reach professional audiences, Climate Central developed a website called Climate Center, which mirrors ESPN’s SportsCenter. Climate Center provides 2-minute segments on such topics as weather statistics for specific cities, products from the National Oceanic and Atmospheric Administration, forecasts, outlooks, and the local impacts of such events as El Niño and La Niña. These segments are released through Climate Central’s partners and picked up by other sites that deliver climate change information.

## IMPLICATIONS OF AUDIENCE SEGMENTATION STRATEGIES

Elaine Andrews (University of Wisconsin–Madison) approached the question of audiences in terms of how they function in communities, whether as neighbors, coworkers, or members of the same club or organization. Communities may be based on the place where one lives, on

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<sup>3</sup>See <http://www.abc.net.au/innovation/blacksaturday/#/stories/mosaic>.

<sup>4</sup>See <http://www.wltx.com/weather/climate-matters.aspx/>.



one's interests, one's work or hobbies, or one's sense of identity. She asked the workshop participants to consider Karen O'Brien's use of integrative theory to analyze climate change (O'Brien and Hochachka, 2010). O'Brien sees climate change not simply as an environmental problem, but also as an issue involving human development, social justice, equity and human rights, and the capacity of individuals and communities to respond to an external threat. Andrews addressed three questions:

1. How can groups of like-minded people function to bring leadership and change?
2. How can scientists and educators identify and access these groups of like-minded people?
3. What educational and engagement strategies are effective in building effective public responses to climate change?

Andrews noted that, although there is no shortage of information and education, the real challenge for climate change educators is to take advantage of the scientific and opinion research to create more sustainable communication strategies. Such strategies recognize that people learn by participating in social systems and not just by receiving information, that social systems are structured by cultural tools and norms, and that learning involves affective and motivational factors.

Andrews presented slides depicting increases in global surface warming and greenhouse gas emissions, mitigation, and adaptation as a reminder that audiences come from a wide range of perspectives and relate differently to different strategies for mitigation and adaptation. She also highlighted that looking at audiences from the viewpoint of how different sectors contribute to greenhouse gases (some through natural processes) can be helpful in constructing decision-making processes about choosing audiences and thinking about how to work with them.

She identified four strategies to lead effective climate change education:

1. continue to identify the various communities with a stake in climate change,
2. develop learning and action networks of communities,
3. implement proven educational and decision support strategies, and
4. achieve a high level of social engagement and action.

Sharing an idea highlighted in a special issue of *Frontiers in Ecology and the Environment: Connectivity* (June 2008), she closed by emphasizing the need to bring together communities and organizations with a stake in cli-



mate change, such as in the cooperative extension system, and to connect scientists with all varieties of communities.

### IMPLICATIONS OF RISK COMMUNICATION RESEARCH

Wändi Bruine de Bruin (Carnegie Mellon University) explained that she works with experts in various fields—including engineers, economists, health practitioners, and scientists—to help them understand how to communicate with the public and how people make decisions. She observed that experts are trained to talk about their specific knowledge within their communities, but rarely do they have training in communication with people outside their field.

Bruine de Bruin pointed out that, although there have not been extensive literature reviews on successful strategies in climate change communication, there have been extensive studies in the domain of public health communication. In public health, the standard practice is to conduct a randomized controlled trial to test whether a particular risk communication is effective. Meta-analyses of such trials, which provide information across many studies as a way to discern patterns of effects, have identified several features of successful communication: it is developed by experts from multiple domains, based on extensive research on what the audiences want and need to know, and designed to teach not only basic facts but also how people can change their behavior.

To illustrate the need for an action-oriented approach to risk communication, Bruine de Bruin used an example of the national threat-level system. The system shows the current national threat level through a series of colors, with the basic message to keep traveling but be extra careful when a color changes to a higher threat level. At the time of the workshop, the threat level was at yellow, which indicates an “elevated” level of threat.<sup>5</sup> However, this system does not provide travelers with an understanding of what the color means, what to do when the color changes to protect themselves from risk, or what steps they should take to travel safely. Therefore, the information provided does not provide a useful mechanism to help individuals make more informed decisions as they travel.

In the context of climate change, Bruine de Bruin reiterated that studies have found that different audiences have different information gaps and misconceptions and want to know different things. Even those who are convinced of the reality of climate change do not necessarily know how to change their behavior. Surveys show that most people believe

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<sup>5</sup>Since this workshop was held, the color-coded Homeland Security Advisory System has been replaced by The National Terrorism Advisory System (see <http://www.dhs.gov/files/programs/ntas.shtm>).

that the most important steps to save energy at home include turning off the lights or turning off the thermostat on the air conditioning unit. In fact, however, they might save more energy by installing a programmable thermostat or energy-efficient light bulbs or adding insulation. She emphasized the value of drawing on findings from other areas of risk communication for use in climate change education.

### AUDIENCE SEGMENTATION STRATEGIES: PANEL DISCUSSION

Following the panelists' individual remarks, moderator Blockstein engaged them in a panel discussion.

In response to a question, Cullen discussed the work of Climate Central in several states and regions. In Georgia, for example, Climate Central focused on coal, the risk of associated climate impacts, and carbon-capturing storage technology. In the state of Washington, it highlighted forest fire risks caused by the local impacts of climate change. She also explained that Climate Central developed a case study of NASA satellites tracking sea ice melt in Greenland to show people the concrete evidence underlying scientists' findings that sea ice is melting.

Blockstein referred to the successful energy-saving project in Kansas discussed earlier in the workshop (Kaufman, 2010; see Chapter 2), in which climate change was not directly addressed. He asked the panelists if they believe it is best not to use the term "climate change" when much of the audience would fall into the doubtful and dismissive categories identified previously by Leiserowitz (Leiserowitz and Smith, 2010; Maibach, Roser-Renouf, and Leiserowitz, 2009).

Hitzhusen responded that various IPL state directors have found that certain regions of the country have a higher percentage of people from each category. In the Northeast and the Midwest, most IPL audiences include few skeptics and are mostly comprised of the "concerned" group. In southern and western states, IPL directors encounter a wider range of views about climate change, and they assume that those who attend IPL programs generally belong to the concerned group, whereas others who do not attend are assumed to be skeptical.

Hitzhusen stressed that these perceptions about audience segments are based on the IPL directors' outreach to particular religious communities and not on a random sample of the public in a region or state. Various individuals may fall into any of the six audience segments identified by Leiserowitz (Leiserowitz and Smith, 2010; Maibach, Roser-Renouf, and Leiserowitz, 2009), but they all belong to a community that shares a set of religious beliefs. In general, the communities that IPL reaches are respectful of each other, regardless of their views on climate change.

There is a communal bond among the members on which IPL leaders try to capitalize in their outreach efforts.

Hitzhusen stressed that IPL directors, when communicating about climate change, emphasize the common values that draw their audiences together. They focus their messages on stewardship and justice issues associated with climate change that resonate with the values of faith communities. In particular, when working with skeptical audiences, IPL directors have said that they do not try to drive home a message about climate change. Instead, they talk about environmental stewardship and why people of faith think environmental stewardship is important.

Coyle said that, in his view, educators need to directly address climate change when communicating with doubtful and dismissive audiences. He stated, “You have to talk about climate in a way that makes sense within the community” you are trying to reach. In addition, he encouraged the workshop participants not to give up entirely on people who fall into the dismissive category, reminding them of the NWF’s climate change training with hunters and anglers. The training program was successful, as many of the hunters and anglers later encouraged their governors to support legislation on climate change issues.

Cullen reinforced Coyle’s message, recounting that at a recent meeting she was asked whether educational efforts should stop explicitly focusing on climate change, and she replied “absolutely not.” Cullen stated that it is very important for climate change educators not to lose the science message. She pointed to research by Jon Krosnik at Stanford (ABC News/Planet Green/Stanford University, 2008) suggesting that the single strongest predictor of concern about climate change is the belief that it is caused by human activity. This research indicates the importance of helping people understand the connection between human activity and climate change.

Bruine de Bruin cautioned that one strategy often suggested for engaging doubtful and dismissive audiences—framing the message in terms of saving money by reducing energy use—may not translate well for people concerned about climate change. Her research with graduate student Daniel Schwarz found that people who have relatively strong pro-environment attitudes become less motivated to enroll in energy saving programs when these are described as saving money (Schwartz et al., 2011). This finding is akin to many studies that have shown that providing extrinsic rewards, such as paying people for good behavior, can lower intrinsic motivation, as study participants begin to feel that their actions are motivated by an extrinsic motivation, such as earning or saving money (Frey and Oberholzer-Gee, 1997; Gneezy and Rustichini, 2000). These examples add to the case for the value of audience segmentation.

Andrews observed that the first step in developing effective educa-

tion is to research the audience, including its values, motivations, and understanding of climate change. Education activities can then be tailored to what is appropriate. Andrews described an approach called “appreciative inquiry” that she uses when working with local government officials in Wisconsin. She asks people in the room to talk about their experiences with climate change. This technique promoted meaningful discussions of climate change among individuals with a wide range of perspectives.

### Audience Comments and Questions

Roberta Johnson (National Earth Science Teachers Association) asked Hitzhusen how social justice related to climate change is perceived by faith communities. He responded that, although environmental and climate change issues have been part of the “culture wars” for some time, a Christian Coalition voter guide for the McCain-Obama election showed that the two candidates differed on every issue except climate change. He added that the biblical tradition provides a particular approach to the concept of justice and that most faith communities see social justice as an important issue. Although there is also a long history of faith communities being involved in environmental issues, in the past groups have struggled to convince people that the environment was a serious moral, ethical, and religious issue.

Today, Hitzhusen stated, the IPL speaks about climate change as a social justice issue by illustrating the disproportionate impacts of climate change on the poor and the vulnerable. When framed this way, messages about climate change resonate with faith communities’ dedication to addressing moral and social justice issues. He noted that both the National Council of Churches and Catholic Church groups address climate change primarily in terms of eco-justice. He again stressed that IPL leaders do not seek out hostile audiences—they work primarily with faith communities that are interested in climate change as an issue of justice and stewardship.

Kit Batten asked how audiences—such as these faith communities—that are engaged with climate change issues could be leveraged to inspire other audiences. Cullen suggested that, when climate change educators consider how to prioritize audiences, they could focus first (or primarily) on the audiences that they know the most about. For example, in her work at Climate Central, she strives to identify issues that resonate with people at the local level, such as a message about fly fishing for trout in Montana.

Edward Maibach (George Mason University) agreed with Bruine de Bruin’s earlier point that research on public health communication can serve as a valuable resource for climate change education. Reviews of many public health education programs have been published in journals,

and he suggested that climate change educators should similarly review and evaluate the impacts of their work. Maibach observed, "The descriptions of programs that the panel has provided have been inspirational; now we desperately need case studies or evaluations of these programs in the literature." Blockstein responded that a new interdisciplinary journal of environmental studies and sciences (*Journal of Environmental Studies and Sciences*<sup>6</sup>) being launched in 2011 would provide a venue for publishing such program evaluations and related research.

Joshua Rosenau (National Center for Science Education) added that the National Center for Science Education focuses on defending the teaching of evolution in public schools. He observed that the arguments raised regarding the teaching of evolution are similar to the arguments being raised regarding teaching about climate change.

Blockstein concluded the general discussion by mentioning that the National Science Foundation has funded and is continuing to fund multiple climate change education projects.

### BREAKOUT GROUP DISCUSSIONS

During the breakout session, the carousel brainstorming technique was again used to facilitate discussion. To initiate the conversation, the steering committee provided the following guiding questions:

1. Thinking of all the general public's identified on day one of the workshop, what do you know that has/has not worked to reach them on a topic like climate change?
2. How could we scale up exemplary programs?

Ann Bostrom listed the major takeaway messages from the breakout group discussions of the first question. She began by observing that there is no silver bullet for climate change education. No single message, program, resource, or activity will be effective in reaching the broad goals of climate change education for all audiences. Instead, it is important to frame education efforts differently for different groups and align them with each group's values. That said, she outlined some general guiding principles that could be applied in many situations:

- It is valuable to understand where people get their information and what sources of information they trust. This understanding makes it possible to leverage existing information networks, communication nodes, or influential individuals in communities when

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<sup>6</sup>See <http://aess.info/> [September 2011].

conveying a message about climate change. Some participants observed that a growing percentage of the population obtains information from social networking websites or media channels and emphasized that people often trust the social network sites or media that their peers suggest. In fact, one survey found that individuals who fall into the dismissive category (as defined by Leiserowitz, Maibach, and Light, 2009) most trust information from friends and family (or the resources they recommend).

- Once the appropriate communication channels have been identified, storytelling is a powerful strategy for engaging audiences. By using meaningful and locally relevant stories, climate change education efforts can align with local needs, values, and interests. The stories can highlight tangible events and draw on the audience's experience. Climate change educators can also directly engage individuals in storytelling, to help them share their personal experiences with the impacts of climate change.
- Although connecting to local events is an effective way to align education efforts to the audience's interests and values, it is also important to connect these local events to the larger, global nature of climate change. Several participants noted that one way to make this connection is through citizen science initiatives, which allow individuals to explore the local impacts of climate change and connect to others around the world who are experiencing similar and different impacts. Another benefit of citizen science initiatives is that they engage individuals in the processes of science. To engender trust in information about climate change, individuals need to understand both the scientific results and how those results were produced. Citizen science initiatives provide opportunities to learn about both.
- It is important for climate change education to provide opportunities for understanding both problems and their potential solutions. Education programs need to engage people in individual as well as community actions, and organizations involved in climate change education need to practice what they preach through sustainable activities and behaviors.

Turning to the second question, about the keys to scaling up exemplary programs, Bostrom noted that some of the breakout group discussions focused on funding issues, partnering, and developing and sharing evidence-based practices. The groups discussed the need for scale-up to develop through top-down as well as bottom-up processes. Top-down leadership could include sharing the most effective education strategies or policy changes—such as regulations or incentives—to require or encour-

age people to take action to mitigate impacts of climate change. Bottom-up processes include building momentum by engaging communities and utilizing networks to extend community efforts.

On the topic of funding, some participants suggested that more funding sources need to be encouraged to support climate change education efforts. In addition, some suggested that funding agencies learn how to finance programs that encourage people to make investments that yield long-term benefits—such as equipping homes with solar panels. Funding programs could lead to wider use of solar panels, reducing consumption of fossil fuels over the long term.

Some breakout group participants expressed the view that climate change education programs are more likely to succeed and grow if education organizations create partnerships in the community they are targeting. For example, the green schools movement grew by establishing local partnerships that brought individuals and organizations together to address shared concerns about school improvement, energy consumption, and other local issues. In considering which programs should be scaled up, people said, it is important to first understand which ones are most effective. Although many participants were skeptical about using standard evaluation methods to measure the effectiveness of climate change education programs, they thought that the field needs evidence to inform the design of strategies and programs. Developing such evidence will require program evaluations, including careful thought about expected goals and outcomes. Climate change educators could also draw on the existing research on climate change education and on public education campaigns more generally.

Finally, many of the breakout groups discussed the difficulty of sharing or finding out about successful programs, practices, presentations, messages, or strategies. Participants noted that, although there are many online sites with links to numerous climate change education resources, these sites rarely review the resources or describe what programs have been successful and why. When some participants said that a single clearinghouse with this sort of information would be invaluable, others commented that the National Science Foundation is funding the creation of such a clearinghouse—the Climate Literacy Education Awareness Network (CLEAN) Pathway.<sup>7</sup>

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<sup>7</sup>See <http://www.cleaneet.org/>.



## 4

# Major Messages

During the final session of the workshop, presenters, panelists, steering committee members, and workshop attendees discussed the themes and issues that emerged. The session began with the perspective of James Mahoney, chair of the Roundtable on Climate Change Education, followed by comments of workshop participants and closing remarks by the steering committee chair and the directors of the Board on Science Education and the Committee on Human Dimensions of Global Change. This chapter is organized by the major themes that emerged during this discussion.

### GOALS OF CLIMATE CHANGE EDUCATION

A broad range of goals for climate change education were discussed during the workshop, representing a variety of objectives pursued by communities with interest in a climate-literate public and climate-literate decision makers: from increasing basic knowledge of climate science to enhancing the capacity of individuals and groups to respond to the challenges posed by climate change. Few common definitions or directions exist across those communities, however. Although documents have been developed that define the term “climate literacy,” further elaboration of its meaning is needed, particularly around expectations for actions or activities to combat climate change (“stewardship”).

Thomas Bowman explained that the goals of climate change education can be expressed as a continuum from climate literacy (or under-



standing how and why climate change is occurring) at one end to social change that will reduce societal impacts on the climate at the opposite end, with stewardship somewhere in between. At a more fine-grained scale, the goals of climate change education include improving understanding of climate-related issues (e.g., climate systems, climate change, and the impacts of climate change), raising awareness of the potential strategies for limiting the impacts of climate change, encouraging specific action to minimize human impacts and adapt to the changing climate, and helping individuals and groups to make climate-friendly choices. Bowman gave an example of a simple educational metaphor (a thermometer that describes what is likely to occur at various average increases in global temperature) to illustrate how complexity can be reduced in ways that allow general audiences to grasp the seriousness of the climate threat.

William Spitzer echoed the idea that the goals of climate change fall along a continuum, adding that climate literacy is different from other kinds of literacy in that understanding climate has become a politically charged issue. Therefore, stewardship education becomes a “battle for hearts and minds” of the public, with the goals to encourage long-term intergenerational change in what people fundamentally believe in and do. The realization that there is only so much that individuals and communities can accomplish within any given time results in a common sentiment, expressed by many participants at the workshop, that there is a need for a social change movement based on basic values and behaviors congruent with a more climate-friendly culture and economy.

During the session, some participants identified the existence of a split between goals that are focused on education about climate change and options to address it (cognitive and behavior change) and goals that are related to intention and seek to motivate individuals and groups to take action (whatever that may be). Many participants found it difficult to bridge the divide between cognitive- and action-oriented goals. Several questions around this issue were raised but not answered:

- Why do we want people to know something if we do not expect them to act on that knowledge?
- Why do we expect people to act if they do not know why action is needed or what actions will address the issue?
- What is the connection between cognition and action? How does the connection between cognition and action relate to beliefs and values?
- Where is the line between education for increased capacity and advocacy in the area of climate change?

## THE ROLE OF SCIENTISTS

Physical and natural scientists were identified as a group that tends to focus on the cognitive goals of climate change education. Mahoney explained that scientists see their role in climate change education as “developing information on climate change, testing the validity of that information, and then making sure that this information, which is so important to the public and to nature overall, is conveyed as broadly as possible.” Scientists, he remarked, are most comfortable sharing knowledge and information developed through measurements, interpretations, and model projections. However, most scientists do not share their findings directly with the public but instead disseminate information about climate change in peer-reviewed journals or science media; the role of scientists is to be honest brokers or neutral arbiters of information, he said. William Solecki stressed that scientists should not overstep these roles or they risk losing their considerable legitimacy and trust. He further noted that there is, in fact, a tendency for scientists to hesitate when asked to speak directly about their research in ways that relate to the concerns or values of specific audiences, or to discuss the actions that can be taken to address their scientific findings. Left to interpret the science themselves, the media, with its increasingly fewer resources may therefore report on scientists’ results in a gee-whiz manner that simplifies the claims, ignores the remaining uncertainty, and fails to describe the collective validation processes in scientific communities.

Mahoney went on to explain that scientists are rightfully concerned with going beyond the knowledge of the “what” and “why” of climate change, because they don’t want to be viewed as advocating for certain types of actions that are not supported by (their) evidence and thus lose their status as objective researchers. He also suggested that the scientific community needs to keep doing the basic science, keep communicating, and develop better connections with the education community so that their work can be leveraged by education efforts.

## CONTEXT

Martin Storksdieck (Board on Science Education) raised the issue of the frames in which climate change education takes place, expressing concern that educators could lose track of the very idea of educating about the climate for the sake of connecting to audiences. He noted that many excellent suggestions to avoid resistance by skeptical audiences were posed, such as framing the issues as a matter of energy independence and security. Yet he cautioned that this raises a question about whether climate change education is a frame for discussing related issues, or whether the issues of energy independence, national security, and so forth are

the broader context in which climate change could be discussed. Some participants, including Don Duggan-Haas, thought that climate change cannot be understood without also understanding the earth as a system, and the implications of climate change cannot be understood without also understanding how they fit into the social system.

Kristopher Krause (National Environmental Education Foundation) thought that framing climate change as an issue of individual rights would be more productive. During the workshop, several participants discussed the point that dismissive groups often feel as though their rights are being infringed upon by climate change education efforts because they are being told they need to act in a certain way. A more productive frame might be to show how individual rights are being infringed upon by not passing greenhouse gas legislation or mitigation measures, because without such legislation people cannot, for example, exercise their right to a cleaner and safer environment. This moves the argument away, he said, from a policy focus (e.g., fossil fuel subsidies) to something that people value more: their individual rights.

Mahoney observed that the climate change education community needs to balance the fact that climate change is a massive issue that affects the overall earth system, with the reality that individual actions often result in limited, if any, impact on mitigation. This can pose a problem for communicating with individuals or specific groups, who may find it difficult to make the link between climate change and their own behavior, or why they should support the election of political representatives who support climate change mitigation or adaptation policies.

## AUDIENCES

Many of the discussions highlighted the importance of understanding the various target audiences and the need to tailor information and educational services to the specific needs of various groups. Audience segmentation, such as the work of Leiserowitz with the Six Americas, was found to be a useful mechanism for thinking about how to identify and serve different segments of the public and defined communities, such as local decision makers. However, several participants commented that even groups with similar interests often may not agree on or be receptive to the same types of information. Audience segmentation may refine the approach, but it will not solve many of the fundamental issues for climate change education that were identified over the course of the workshop, they said.

Steering committee chair Joseph Heimlich (Ohio State University) emphasized the need to contextualize educational efforts and the teaching-learning exchange. This would allow individuals to situate

themselves in the learning in a very authentic manner. He further stated that the climate change education community needs to recognize that within the various target audiences are embedded multiple social rules, identities, life stages, and community values that are often in conflict with values associated with addressing climate change. He suggested that educators consider places where that conflict can move individuals in positive ways. He went on to state the need to include the affective, motivational, behavioral, and cognitive strategies available in educational efforts and rely on assistance from people with expertise in these areas to provide the proper framing and (technical) support. He reiterated that many successful strategies were highlighted during the workshop and emphasized the need to transfer these strategies into the appropriate communities and programs.

Mica Estrada-Hollenbeck (California State University, San Marcos) mentioned the need to consider issues of diversity, pointing to the lack of it in the climate change education community (exemplified by the participants at the workshop). She observed that demographics in the United States are changing, emphasizing the need to be literate in terms of cultures as well as science and to partner with communities that are currently underserved in science, environmental, and climate change education.

## PRACTICES

Heimlich observed that the lessons learned at the workshop may reinforce the participants' understanding of the inherent complexity in climate change education and reiterated the need to employ many approaches and strategies targeted at different audience and goals. He went on to say that meeting these needs requires active listening by both climate change scientists and educators, who must engage with the public in meaningful ways. He said this includes "courageous listening," in which scientists and educators are receptive to and honor ideas and statements with which they may disagree. As part of this engagement, clearer insights into people's wants and needs are required to help guide the matching of the message and goals to those receiving them. In sum, he said, climate change education communities need to exhibit respect for multiple audiences and not simply try to change people's beliefs, values, and understandings to reflect those of the scientists and educators themselves.

Several workshop participants subsequently stressed the importance of reaching out to so-called influentials or opinion leaders. These are individuals who, by their standing in their community, can influence peers and engender community and group engagement—something of particular importance for youth and adolescents. Another approach

that was mentioned repeatedly is the need for education strategies to be action-oriented, whether targeted toward the public or decision makers, not necessarily because behavior change is often defined as the ultimate goal of climate change education, but because many audiences would like guidance on what they can do personally and immediately to address climate change issues. These actions should not only address issues of mitigation, but also focus on adaptation, a topic many educators are still reluctant to address, it was noted. Heimlich then cautioned that actions should not simply lead to isolated behaviors, but rather move toward transferable ways of encouraging both critical thinking and changes in behavior patterns.

Connecting with local issues and engaging with people on their own terms resonated with many workshop participants. Kevin Coyle and Greg Hitzhusen provided compelling examples through their work with communities that are often skeptical of climate change information: the hunter and angler communities and faith-based groups, respectively. Aaron McCright further noted that most individuals have multiple identities, and educators need to find the rules of evidence and modes of argument that are accessible to all members of the population.

The need for multidisciplinary approaches was also mentioned by many participants. Michel Boudrias (University of San Diego) pointed to the importance of multidisciplinary training approaches for college and university faculty, K-12 teachers, and informal and other educators who are engaged directly with climate change education. He further emphasized that the multidimensional nature of climate change requires people with various expertise to work together. To meet this need, the idea of creating a network of networks, with the goal of capturing the vast expertise that already exists across climate change education communities, gained traction among a number of people.

Paul Stern (Committee on Human Dimensions of Global Change) observed that an essential focus of the workshop was to build capacity and bring together people who do not interact in their daily work to learn about the legitimate perspectives of their colleagues. He noted that many participants may now realize that the concept of climate change education was not the same for everyone. A successful outcome for the workshop would be more communication between people from various communities.

## CHANGING THE TRANSITION MODEL

The comments of the workshop participants on the goals, audiences, and effective practices for climate change led some to question the need for a new model of how knowledge is transferred to nonscientist audi-

ences, the rationale being that the public generally accepts scientific findings, but many individuals do not believe the scientific findings related to climate change. The predominant way that scientists have framed their messages, as one participant noted, has been “trust us, we have the best scientists in the room, we considered this repeatedly.” Simply informing the public that several rounds of assessments have led to incontrovertible evidence about climate change has not led to overall changes in public understanding, interest, or engagement in climate change issues. This leads to core questions about the role of scientific information in climate change education efforts: “What scientific information is really needed to bring about collective action?” “What is the type of scientific information that needs to be communicated?” “What are key strategies for providing the public with information regarding climate change?”

Following this thread, the plenary discussion went on to consider how education fits with values and beliefs and how to approach and truly communicate with people who disagree with one’s positions. A question was raised about effective entry points to finding common ground between communities that differ in their values and beliefs and how the focus can shift from “where we are separate to areas in which we are actually the same.”

Several responses suggested a new system of knowledge transfer, characterized by:

- messages and information tailored to the specific needs, values, attitudes, and interests of the audience;
- engagement in active learning experiences as an individual and as part of a group; and
- interactive and ongoing interactions to sustain relationships.

Furthermore, messages could be tailored to the audience’s specific needs, values, attitudes, and feelings in a system of productive climate change information transmission for the public and decision makers. Tailoring messages in this way is a key aspect of the work discussed by Coyle, Hassenzahl, and Solecki, each of whom stressed that to be successful is to create a dialogue with people and groups based on respect for their values and interests.

It was also noted that engaging audiences in active learning experiences is critical. Efforts can move from expecting the broad goals of climate change education to be reached by having audiences read journal articles, hear presentations, or watch science-focused TV. As discussed during the earlier sessions of the workshop, Gober suggested audiences can have the chance to engage in scientific observations and have interactions with changing ecosystems, data collection, and discussions of

empirical data. Susan Clayton added that engaging in such activities supports a more social learning process, an important aspect of climate change education for the public.

Heimlich followed up by emphasizing the need to intentionally create many different intersections between educators and audiences; people need multiple access points to be receptive to climate-related messages. He asked “How do we look at the intersections of people’s lives in the social roles and communities in which they belong, considering both the ascribed communities as well as the affectational communities?” “How do we begin to give people multiple opportunities and intentionally create consistent messages from our formal education programs all the way through to various alternative ways of reaching people?”

Many participants shared the view that effective education and communication efforts directed toward the public and decision makers are interactive and ongoing. Participants indicated the need to move beyond one-off interactions, which fail to build trust or momentum or to engage stakeholders. These efforts were seen as ineffective because they do not allow for feedback of shared knowledge or provide a forum for sustained discussions of implications for decision making. Decision makers typically take the information from the scientists and make decisions based on community values, needs, and interests. Many workshop participants thought the presentations and discussions during the workshop made it clear that meaningful efforts in climate change education need to engage the audience in a dialogue in which all viewpoints are understood and considered. Such interactions would provide people and groups with opportunities to learn about different views of climate change and be confronted with the idea that there are multiple plausible ways to address the impacts of climate change (including some they may not have thought of).

## FEDERAL FUNDING

Jill Karsten (National Science Foundation) gave a brief overview of the coordination in climate change education across the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA) and described NSF’s climate change education funding efforts. She emphasized that federal agencies are currently working in a more coordinated fashion; discussions among NSF, NOAA, and NASA in 2009 led to the development of the Climate Change Education Partnership (CCEP) Program.

In addition, Karsten noted, the U.S. Global Change Research Program (USGCRP) has developed an interagency working group related to education. This ad hoc group, which is not officially part of the USGCRP



structure, led by Frank Niepold (NOAA) and Min-Ying Wei (NASA), engenders cross-agency conversations that include the Environmental Protection Agency, the Department of the Interior, the U.S. Geological Survey, the Forest Service, and other agencies involved in the climate research agenda, in order to create a strategic plan at the federal government level for addressing climate change education.

Within NSF, Karsten pointed out, because of the pervasiveness of climate change across all NSF scientific and education activities, individual climate change education efforts could be funded through nearly any of the core programs. Janet Kolonder (National Science Foundation) pointed out that climate change education has many different components that are also important to other kinds of education. Thus, research on how climate change is best taught and learned can be informative for other kinds of education, which should be considered when seeking funding for climate change education, she said.

### FUTURE RESEARCH NEEDS

Various research questions were proposed as ways to encourage further development of climate change education. Hassenzahl reminded the audience that climate change educators are interested in changes in attitudes over long periods of time. Thus, not only is there a need for careful studies on what it is effective in terms of changing individual behaviors and attitudes in the short run, but also to understand how and why longer term changes occur and how they can be sustained. This may require retrospective work on how and why people became aware of climate change, since it seems that even people who are skeptical of climate change science are engaged in a conversation about it. And there is a need to better understand what would be likely to change the attitudes and behaviors of substantial numbers of people, an issue of considerable complexity and a serious challenge for education researchers, he said. Hassenzahl noted that thinking needs to go beyond examining measurable outcomes to measuring effective processes for achieving the desired results.

### FINAL WORDS

Storksdieck thanked participants for their active contributions to the workshop and reminded them that the workshop was proposed by the Climate Change Education Roundtable, an activity of the National Research Council that brings together federal agencies involved in climate change education with various experts to discuss issues of common concern. He noted that similar activities have become more common in Washington, an encouraging sign for increasing awareness about the



need to coordinate climate education efforts. Moreover, he interpreted the many activities around climate change as the sign of a changing cultural dialogue in which, despite the controversies and challenges, society is slowly moving toward the realization that the issue of climate change needs collective attention.

Storksdieck noted that as the community reaches out to different audiences, it is important not to lose sight of core audiences. He emphasized the need to grow from a base and connect with an increasingly larger number of people who share common values and beliefs. He continued by noting the limits of education in addressing climate change and that incentive systems, infrastructure, and culture provide powerful determinants for personal behavior. Referring to previous remarks by Heimlich, Storksdieck noted that much of people's behavior and actions occurs subconsciously, unconsciously, as habit or ritual, and that informed decision making is not primarily guiding how people behave in everyday life. He closed with what he saw as important realization: in addressing climate change, there is no single strategy, approach, or community.

Stern, in reflecting on the goals of the workshop, focused on ideas of quality, legitimacy, and capacity. In his view, climate change education should lead to "good-quality decisions," based on wide acceptance of the science and an increasing "capability to do decisions well in the future." He noted that the workshop focused on today's decision makers, but that a future workshop might tackle the education of the next generation of citizens through formal and informal education.

He noted the value of bringing together communities with different goals and audiences. As the workshop demonstrated, interesting and fruitful learning may occur when different sub-communities of the larger climate change community interact with one another. To Stern the workshop suggested a variety of near-future priorities that federal agencies and private foundations could focus on, including solid evaluation research on climate change education projects based on clearly defined indicators for various goals.

Michael Feder (Board on Science Education) closed the workshop by pointing to the value of building a climate change education community that sees itself connected to the various communities it serves based on shared values and common ground.

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# Appendix A

## Workshop Agenda and List of Participants

### Workshop on Climate Change Education for the Public and Decision Makers

October 21-22, 2010

*October 21, 2010*

8:30-9:00 am Individual discussions with panelists and  
commissioned authors

9:00-9:30 **Introductory Remarks**

*Martin Storksdieck*, Board on Science Education Director  
*James Mahoney*, Climate Change Education Roundtable  
Chair

*Joseph Heimlich*, Workshop Steering Committee Chair

9:30-10:15 **Session 1: Goals of Climate Change Education**

Speakers:

*Nicole Ardoin*, Stanford University

*David Hassenzahl*, Chatham University

*Frank Niepold*, National Oceanic and Atmospheric  
Administration

Panel Participants:

*William Solecki*, Hunter College

*Kit Batten*, Heinz Center

*William Spitzer*, New England Aquarium

Moderators:

*Wändi Bruine de Bruin*, Steering Committee Member  
*Joseph Heimlich*

Questions and Discussion

10:35-10:45

Break

10:45 am-  
12:15 pm

Small-Group Discussions

12:15-1:15

Continued Discussion of Goals (Lunch)

1:15-1:30

Session 1 Breakout Discussion Synthesis  
*Wändi Bruine de Bruin*  
*Joseph Heimlich*

1:30-2:15

**Session 2: Mapping Current Public Climate Change Goals and Outcomes to Various Audiences**  
Speaker: *Anthony Leiserowitz*, Yale University

Panel Participants:

*Ann Bostrom*, University of Washington  
*Aaron McCright*, Michigan State University  
*Susan Clayton*, College of Wooster

Moderator: *Edward Maibach*, Workshop Committee Member

Questions and Discussion

2:35-2:45

Break

2:45-4:15

Small-Group Discussions

4:15-4:30

Overview of Day 2  
*Michael Feder*, National Research Council

4:30-4:45

Session 2 Breakout Discussion Synthesis  
*Charles Anderson*, Workshop Committee Member

October 22, 2010

- 8:30-9:00 am Individual Discussions of Day 1
- 9:00-10:00 **Session 3: Implications of Audience Segmentation for Education Strategies and Research**  
 Panel Participants:  
*Elaine Andrews*, University of Wisconsin–Madison  
*Wändi Bruine de Bruin*, Carnegie Mellon University  
*Heidi Cullen*, Climate Central  
*Katie Mandes*, Pew Center on Global Climate Change  
*Greg Hitzhusen*, Ohio Interfaith Power and Light  
*Kevin Coyle*, National Wildlife Federation
- Moderator: *David Blockstein*, Workshop Committee Member
- Questions and Discussion
- 10:20-10:30 Break
- 10:30 am-12:00 pm Small-Group Discussions
- 12:00-1:00 Continued Discussion of Implications (lunch)
- 1:00-1:30 Session 3 Breakout Discussion Synthesis  
*Ann Bostrom*, Workshop Committee Member
- 1:30-2:00 **Workshop Implications and Next Steps**  
*Joseph Heimlich*  
*James Mahoney*
- 2:00-2:45 **Audience Discussion: Workshop Implications and Next Steps**  
 Moderator: *Joseph Heimlich*
- 2:45-3:15 **Final Words**  
*Martin Storksdieck*  
*Paul Stern*, Committee on Human Dimensions of Global Climate Change Director



**WORKSHOP PARTICIPANTS**

Joan Abdallah, American Association for the Advancement of Science  
Richard Ades, Project on Climate Science/Prism Public Affairs  
Aixa Aleman, U.S. Environmental Protection Agency  
Catherine Allen, U.S. Environmental Protection Agency  
Jeannette Allen, Sigma Space Corporation at National Aeronautics and  
Space Administration  
Charles W. Anderson, Michigan State University  
Elaine Andrews, University of Wisconsin–Madison  
Martin Apple, Council of Scientific Society Presidents  
Nicole Ardoin, Stanford University  
Nickie Athanason  
Ana Ivelisse Aviles, U.S. Government Accountability Office  
Peter Banks, National Academy of Sciences  
Sapna Batish, Koshland Science Museum, National Academy of Sciences  
Kit Batten, Heinz Center  
Eugene Bierly, American Geophysical Union  
Meagan Biwer, American Association for the Advancement of Science  
Andrea Bleistein, National Oceanic and Atmospheric Administration  
David Blockstein, National Council for Science and the Environment  
Ann Bostrom, University of Washington  
Michel Boudrias, University of San Diego  
Thomas Bowman, Bowman Design Group  
Leslie Brandt, Forest Service, U.S. Department of Agriculture  
Carolyn Breedlove, National Education Association  
James Brey, American Meteorological Society  
Wändi Bruine de Bruin, Carnegie Mellon University  
Sharon Burton, U.S. Department of Education  
Antonio Busalacchi, University of Maryland  
Brian Campbell, National Aeronautics and Space Administration  
David Campbell, National Science Foundation  
Phillip Chalker, American Association for the Advancement of Science  
Virginia Chanley, U.S. Government Accountability Office  
F. Stuart Chapin III, University of Alaska, Fairbanks  
Lynne Cherry, University of Colorado, Boulder  
Caron Chess, Rutgers University  
Inés Cifuentes, American Geophysical Union  
Connie Citro, National Research Council  
Susan Clayton, College of Wooster  
Marile Colon Robles, National Aeronautics and Space Administration  
Kevin Coyle, National Wildlife Federation  
Greg Crosby, U.S. Department of Agriculture  
Heidi Cullen, Climate Central

LuAnn Dahlman, National Oceanic and Atmospheric Administration  
Amy Daniels, U.S. Forest Service  
Aaron Datesman, U.S. Department of Energy  
Jennifer Daugherty, Ecological Society of America  
Anita Davis, Sigma Space Corporation at National Aeronautics and  
Space Administration  
Aimee Delach, Defenders of Wildlife  
Connie Della-Piana, National Science Foundation  
Alphonse DeSena, National Science Foundation  
Jeremy Diem, Georgia State University  
Shari Dixon, National Weather Service  
Cathy Dowd, U.S. Forest Service  
John Doyle, University of Connecticut  
Don Duggan-Haas, Paleontological Research Institution  
Janice Earle, National Science Foundation  
William Easterling, Pennsylvania State University  
James A. (Jim) Egenrieder, Virginia Polytechnic Institute and State  
University  
Lynn Elfner, Ohio Academy of Science  
Chris Elfring, National Research Council  
Mica Estrada-Hollenbeck, California State University, San Marcos  
Allan Eustis, National Institute of Standards and Technology  
Michael A. Feder, National Research Council  
Jeremy Flattau, Christine Mirzayan Science Technology Policy  
Fellowship Program, The National Academies  
Sherrie Forrest, National Research Council  
Susan Q. Foster, University Corporation for Atmospheric Research  
Catherine Fry, Mobilizing STEM Education for a Sustainable Future  
Robert Gabrys, National Aeronautics and Space Administration  
Susan Gallagher Heffron, Association of American Geographers  
James E. Geringer, ESRI, Inc.  
Greg Gershuny, Office of Science and Technology Policy  
Charlee Glenn, Ecological Society of America  
Patricia Gober, Arizona State University  
Eduardo Guevara, Albert Einstein Distinguished Educator Fellowship  
Program  
Jong-on Hahm, National Science Foundation  
Carolyn Harris, National Aeronautics and Space Administration  
Goddard Institute for Space Studies, Columbia University  
David Hassenzuhl, Chatham University  
Robert Hauser, National Research Council  
Joseph Heimlich, Ohio State University  
Joseph Henderson, University of Rochester

Greg Hitzhusen, Ohio Interfaith Power and Light  
Karen Hollweg, North American Association for Environmental Education  
Bethany Holm, National Science Foundation  
Sharon Horn, Office of Innovation and Improvement  
Robert Horner, University of Oregon  
Nathan Hultman, University of Maryland  
Nina L. Jackson, National Oceanic and Atmospheric Administration  
Jenna Jadin, U.S. Global Change Research Program  
Arundhati Jayarao, Office of Senator Kirsten Gillibrand  
Leigh Jenkins, U.S. Department of Education  
Libby Jewett, National Oceanic and Atmospheric Administration  
Kathy Johnson, Chicago Botanic Garden  
Roberta Johnson, University Corporation for Atmospheric Research  
Amber Jones, National Science Foundation  
Jennifer Jorvig, Columbia University  
Fred Joutz, George Washington University  
Melissa Kagle, Colgate University  
Traci Kallhoff, Exploration Place  
Marlene Kaplan, National Oceanic and Atmospheric Administration  
Jill Karsten, National Science Foundation  
Kevin Kilcullen, U.S. Fish and Wildlife Service  
Eli Kintisch, *Science*  
Lindsay Knippenberg, National Oceanic and Atmospheric Administration  
Kim Knowlton, Columbia University  
Louisa Koch, National Oceanic and Atmospheric Administration  
Janet Kolodner, National Science Foundation  
Mary Koppal, American Association for the Advancement of Science  
Kristopher Kraus, National Environmental Education Foundation  
Jyoti Kulkarni, SysTEM for Analysis, Research and Training (START)  
Michael Lach, U.S. Department of Education  
Carol Landis, Byrd Polar Research Center, Ohio State University  
Tamara Ledley, TERC, Inc.  
Anthony Leiserowitz, Yale University  
Caroline Lewis, Climate Literacy Network  
Kimberly Lightle, Ohio State University  
Russanne Low, Institute for Global Environmental Strategies  
Claudia Ludwig, Institute for Systems Biology  
Laura Lukes, National Science Foundation  
James Mahoney, consultant  
Edward Maibach, George Mason University  
Katie Mandes, Pew Center on Global Climate Change

Carole Mandryk, George Mason University  
Barbara Mann, National Aeronautics and Space Administration  
Deanna Matthews, Carnegie Mellon University  
Sarah Mazze, Climate Leadership Initiative  
Meghan McAvoy, Ecological Society of America  
Aaron McCright, Michigan State University  
Erin McDougal, National Science Foundation  
Carrie McDougall, National Oceanic and Atmospheric Administration  
Katie McGaughey, National Science Foundation  
Gerry Meisels, University of South Florida  
Douglas Meyer, Ocean Project  
Elizabeth Mills, American Meteorological Society  
Pritidhara Mohanty, U.S. Environmental Protection Agency  
Margaret Mooney, University of Wisconsin–Madison  
John Moore, National Science Foundation  
Bruce Moravchik, National Oceanic and Atmospheric Administration  
Teresa Mourad, Ecological Society of America  
Rick Mueller, U.S. Department of Agriculture  
Lynne Murdock, National Park Service  
Diane Murphy, Federal City Communications, X PRIZE Foundation  
Bonnie Murray, National Aeronautics and Space Administration  
Frank Niepold, National Oceanic and Atmospheric Administration  
Jacob Noel-Storr, Rochester Institute of Technology  
Emma Norland, Cedarloch Research LLC  
Eric Norland, U.S. Department of Agriculture  
Dave Oberbillig, U.S. Department of Energy  
Robert O'Connor, National Science Foundation  
Lina Oliveros, Ecological Society of America  
Felix Ortiz III, Green University  
Janet Peace, Pew Center on Global Climate Change  
Jean Pennycook, National Science Foundation  
Georgia Polacek, James Madison University  
Amanda Purcell, National Research Council  
Miriam Quintal, University Corporation for Atmospheric Research  
James Rattling Leaf, American Indian/Alaska Native Climate Change  
Working Group  
Vera Rexhepi, National Council of Science and the Environment  
Cassandra Reyes-Jones, George Washington University  
Joshua Rosenau, National Center for Science Education  
Mary Ann Rozum, U.S. Department of Agriculture  
Chantel Sabus, National Science Foundation  
David Sanford, American Association of Port Authorities  
Joel Scheraga, U.S. Environmental Protection Agency

Jennifer Schwarz, Chicago Botanic Garden  
Theresa Schwerin, Institute for Global Environmental Strategies  
Clark Seipt, SysTEM for Analysis, Research and Training (START)  
Falon Shackelford, Howard University  
Thomas Sheffer, National Park Service  
Jennifer Shieh, Koshland Science Museum, National Academy of Sciences  
Erika Shugart, Koshland Science Museum, National Academy of Sciences  
Viviane Silva, National Oceanic and Atmospheric Administration  
Rebecca Smith, Mississippi State University  
William Solecki, Hunter College  
Mike Specian, Christine Mirzayan Science and Technology Policy Fellowship Program, The National Academies  
William Spitzer, New England Aquarium  
Walter Staveloz, Association of Science-Technology Centers  
Peggy Steffen, National Oceanic and Atmospheric Administration  
Paul Stern, National Research Council  
Carol Stoel, National Science Foundation  
Martin Storksdieck, National Research Council  
Nicholas Sundt, World Wildlife Federation  
Bonnie Sutton, POWEROFUS Foundation  
Vic Sutton, Emaginos.com  
Greg Symmes, National Research Council  
Jason Taylor, consultant  
Carolyn Teich, American Association of Community Colleges  
Laura Tenenbaum, Jet Propulsion Laboratory  
Ann Marie Thro, U.S. Department of Agriculture  
Mike Town, National Science Foundation  
Elizabeth Tran, National Science Foundation  
Will Travis, San Francisco Bay Conservation and Development Commission  
Kate Von Holle, British Embassy  
Carolyn Voorhees, University of Maryland School of Public Health  
Elizabeth Walsh, University of Washington  
Toby Warden, National Research Council  
Cynthia Wei, National Science Foundation  
Ming-Ying Wei, National Aeronautics and Space Administration  
Caroline Weiler, National Science Foundation  
Jill Wertheim, American Association for the Advancement of Science  
John Whittler, U.S. Environmental Protection Agency  
Carl Wieman, Office of Science and Technology Policy  
Ted Willard, American Association for the Advancement of Science

Carolyn Wilson, National Science Foundation  
Joe Witte, WJLA TV and George Mason University  
Elizabeth Wolzak, National Geographic Society  
Karen Yuen, National Aeronautics and Space Administration  
Amy Zeller, National Research Council



## Appendix B

### Climate Change Education Roundtable

James Mahoney (*Chair*), Environmental Adviser  
Charles W. Anderson, Michigan State University  
David Blockstein, National Council for Science and the Environment  
F. Stuart Chapin III, University of Alaska  
Caron Chess, Rutgers University  
Inés Cifuentes, American Geophysical Union  
William Easterling, Pennsylvania State University  
Lynn Elfner, Ohio Academy of Science  
James E. Geringer, Environmental Systems Research Institute, Inc.  
Patricia Gober, Arizona State University  
Joseph Heimlich, Ohio State University  
Roberta Johnson, University Corporation for Atmospheric Research  
Tamara Ledley, Center for Science Teaching and Learning, TERC, Inc.  
Anthony Leiserowitz, Yale University  
Robert Lempert, RAND  
Michael McElroy, Harvard University  
Janet Peace, Pew Center on Global Climate Change  
Walter Staveloz, Association of Science and Technology Centers  
Will Travis, San Francisco Bay Conservation and Development  
Commission



*Ex Officio*

Thomas Armstrong, U.S. Department of the Interior

David Campbell, National Science Foundation

Gregory Crosby, U.S. Department of Agriculture

Jill Karsten, National Science Foundation

Louisa Koch, National Oceanic and Atmospheric Administration

Michael Lach, U.S. Department of Education

Robert O'Connor, National Science Foundation

Joel Scheraga, U.S. Environmental Protection Agency

Bill Valdez, U.S. Department of Energy

Ming-Ying Wei, National Aeronautics and Space Administration

*NRC Staff*

Michael A. Feder, *Study Director*

Sherrie Forrest, *Associate Program Officer*

Martin Storksdieck, *Director*, Board on Science Education

Paul Stern, *Director*, Committee on Human Dimensions of Global Change

Rebecca Krone, *Program Associate*

## Appendix C

### Biographical Sketches of Presenters, Steering Committee Members, and Staff

#### PRESENTERS

**ELAINE ANDREWS** is the director of the Environmental Resources Center in the College of Agricultural and Life Sciences at the University of Wisconsin–Madison, promoting informed decision making on natural resource issues in the state of Wisconsin. She is a past executive director of the North American Association for Environmental Education, a principal investigator for more than 30 national or multistate projects, and author of numerous publications. She received the Walter E. Jeske Award from the North American Association for Environmental Education in 2005 and the Distinguished Service Award from the Wisconsin Extension Environmental and Community Development Association. She has a B.A. in biology from the College of Wooster, an M.A.T. in science education from the University of Chicago, and an M.S. in natural resources policy and management from the University of Michigan.

**NICOLE ARDOIN** is an assistant professor at Stanford University with a joint appointment in the School of Education and the Woods Institute for the Environment. Much of her material focuses on environmental behavior with reference to sense of place and geographic scale. She was previously a board member of the North American Association for Environmental Education and has worked for the World Wildlife Fund. She has a B.A. in international business and French from James Madison University, an M.S. in natural resource management from the University

of Wisconsin, and an M.Phil. and a Ph.D. in forestry and environmental studies from Yale University.

**KIT BATTEN** is senior science and policy fellow at the Heinz Center and director of its Institute for Science Communication and Policy Development. She has served as the science advisor to the deputy secretary of the U.S. Department of the Interior and before that she was a senior fellow at the Center for American Progress, where she directed the energy and climate change policy team. She has also served in the offices of Senator Dianne Feinstein (D-CA) and Senator Joseph Lieberman (I-CT), where she worked as a legislative assistant on climate change, energy, transportation, and agriculture policy and as an American Association for the Advancement of Science fellow, respectively. As a postdoctoral associate, she worked for the National Ecological Observatory Network at the American Institute of Biological Sciences. She has frequently participated in television, radio, and print media interviews. She has a B.A. in chemistry from Oberlin College and an M.S. and a Ph.D. in ecology from the University of California, Davis.

**SUSAN CLAYTON** is professor of social psychology at the College of Wooster and chairs its Campus Sustainability Committee. She studies how people make personal connections to the natural environment, how it becomes part of their social identity, and how people think about justice in the sociopolitical contexts of environmental issues. She is a fellow of the American Psychological Association, the Society for the Psychological Study of Social Issues, and the Society for Population and Environmental Psychology. She is an editor for the *Human Ecology Review* and the *Journal of the Society for Human Ecology* and is on the editorial board of the *Journal of Environmental Psychology*, *Analyses of Social Issues and Public Policy*, and *PsyEcology*. Previously, she was president of the American Psychological Association's Division 34, the Society for Population and Environmental Psychology. She has published three books and had her work featured in numerous journal publications. She has a B.A. from Carleton College and an M.S. and a Ph.D. from Yale University.

**KEVIN COYLE** is vice president for education at the National Wildlife Federation. Previously, he was president of the National Environmental Education and Training Foundation, leading an organization committed to personal stewardship, science education, improved health care, business management, watershed management, and natural resource management. He is trustee and immediate past chair of the Potomac Conservancy, trustee of the Alice Ferguson Foundation, and past chairman of the Natural Resources Council of America. He has a B.A. in sociology from

LaSalle University, a J.D. in environmental law from Temple University, and the Conservation Leadership Institute Certificate from the Wharton School of Business.

**HEIDI CULLEN** is interim chief executive officer, research scientist, and lead correspondent for Climate Central, a nonprofit organization that analyzes and reports on climate science. The organization has produced programs broadcasted on PBS NewsHour and The Weather Channel (TWC). Previously, Cullen was the climate expert and correspondent for TWC and a scientist for the National Center for Atmospheric Research. She received the Climate and Global Change Fellowship from the National Oceanic and Atmospheric Administration (NOAA) and spent 2 years at Columbia University's International Research Institute for Climate and Society, applying long-range climate forecasts to the water resources sector in Brazil and Paraguay. She won the 2008 National Conservation Achievement Award for science from the National Wildlife Federation and in 2010 published a book titled *The Weather of the Future*. She is also a member of the American Geophysical Union and the American Meteorological Society and is an associate editor for *Weather, Climate, Society*. She has a B.S. in engineering and operations research from Columbia University and a Ph.D. in climatology and ocean-atmosphere dynamics from the Lamont-Doherty Earth Observatory at Columbia.

**DAVID HASSENZAHN** is dean and professor of the School of Sustainability and the Environment at Chatham University. Previously he was a faculty member and department chair at the University of Nevada, Las Vegas (UNLV). His professional career involves work in sustainability and risk analysis and has included experience in both the public and private sectors. His research, teaching, and outreach explore the roles of science and expertise in public and private decision making, focusing on how people conceive, describe, and respond to uncertainty. He is a founding member of the Association for Environmental Studies and Sciences and serves on the Council of the Society for Risk Analysis. He has been awarded the Outstanding Educator Award of the Society for Risk Analysis, the UNLV Foundation Distinguished Teaching Award, and the UNLV Outstanding Department Chair Award. He is a senior fellow for the National Council for Science and the Environment. He has a B.A. in environmental science and paleontology from the University of California, Berkeley, and a Ph.D. in science, technology, and environmental policy from Princeton University's Woodrow Wilson School.

**GREG HITZHUSEN** is a lecturer in the School of Environment and Natural Resources at the Ohio State University. He is also the founding

director and board chair of Ohio Interfaith Power and Light, a faith-based organization offering a religious response to climate change in Ohio. His work examines the intersection of faith and the environment and collaborations between scientific and faith communities; his teaching focuses on environmental communications and religion and ecology. He previously served as the national coordinator of the NatureLink Program at the National Wildlife Federation. He was an associate with the National Religious Partnership for the Environment and the land stewardship specialist for the National Council of Churches EcoJustice Programs. He has a B.S. in ecology from Cornell University, an M.Div. in ecotheology from the Yale Divinity School, and a Ph.D. in faith-based environmental education from Cornell University.

**ANTHONY LEISEROWITZ** is director of the Office of Strategic Initiatives and the Project on Climate Change at the Yale School of Forestry and Environmental Studies. His work focuses on U.S. and international public opinion on global warming, including public perception of climate change risks, support and opposition for climate policies, and willingness to make individual behavioral change. In his research he investigates the psychological, cultural, political, and geographic factors that drive public environmental perception and behavior. He has conducted survey, experimental, and field research at scales ranging from the global to the local, including international studies, the United States, individual states (Alaska and Florida), municipalities (New York City), and with the Inupiaq Eskimo of Northwest Alaska. He also recently conducted the first empirical assessment of worldwide public values, attitudes, and behaviors regarding global sustainability, including environmental protection, economic growth, and human development. He is a member of the Roundtable on Climate Change Education. He has a B.A. in international relations from Michigan State University and an M.S. in environmental studies and a Ph.D. in environmental science, studies, and policy from the University of Oregon.

**KATIE MANDES** is vice president for communications at the Pew Center on Global Climate Change. In this role, she is responsible for creating and implementing the Pew Center's global strategic communication plan. She oversees all aspects of the center's external communications, including paid and earned media, speech writing, design and distribution of center publications, and the center's website. She also identifies and analyzes trends in the media and public opinion. Prior to joining the Pew Center, Mandes worked with the public affairs firm Alcalde and Fay. She is a member of the National Press Club (Washington, DC) and the Public Rela-

tions Society of America. She has a B.S. in communications from Radford University.

**AARON M. McCRIGHT** is an associate professor at Michigan State University, holding a joint appointment in Lyman Briggs College and the Department of Sociology. His scholarship aims to enhance sociological understanding of how political, social, and scientific processes influence society's capacity for recognizing and dealing with environmental degradation and technological risks. His research explains the political dynamics and public understanding of climate science and policy in the United States. He the author of the book *Community and Ecology*, and his research has been published in many social science journals. In 2007, McCright was named a Kavli frontiers of science fellow by the National Academy of Sciences for his work in climate change research. For his learner-centered courses and active learning techniques, he received the 2009 Teacher-Scholar Award at Michigan State University. He has a B.A. in sociology from the University of Northern Iowa and an M.A. and a Ph.D. in sociology from Washington State University.

**FRANK NIEPOLD** is climate education coordinator in the Climate Program Office of the National Oceanic and Atmospheric Administration (NOAA), a member of the NOAA Education Council, cochair of the newly formed Education Interagency Working Group of the Climate Change Science Program (CCSP), a member of the Communications Interagency Working Group, and a founding member of the Climate Literacy Network. At NOAA, he develops and implements climate goal education and other efforts that specifically relate to NOAA's environmental literacy cross-cutting priority. He is coauthor of the U.S. CCSP *Climate Literacy: The Essential Principles of Climate Science* guide. As the cochair of CCSP's Education Interagency Working Group, he works to develop the interagency partnership, coordination, and strategic direction of the federal climate science education efforts to support the development of a knowledgeable and informed nation relative to climate. He has a B.A. in human ecology from the College of the Atlantic and an M.S.Ed. in earth space science education from Johns Hopkins University.

**WILLIAM SOLECKI** is professor in the Geography Department at Hunter College, part of the City University of New York (CUNY) system. His course material focuses on urban environmental change and urban spatial development, with recent specialization on climate change and major cities. Currently, he is the cochair of Mayor Michael Bloomberg's New York City Panel on Climate Change, whose mission is to adapt critical infrastructure to the environmental effects of climate change. He is

the director of the CUNY Institute for Sustainable Cities, an organization committed to creating awareness and understanding of the connections between the everyday lives of urban citizens and their natural world. At the National Research Council, he served on the U.S. National Committee on Scientific Committee on Problems of the Environment. He was recently selected by the Intergovernmental Panel on Climate Change (IPCC) as a lead author on their upcoming Fifth Assessment Report (AR5). He has a B.A. in geography from Columbia University and an M.A. and a Ph.D. in geography from Rutgers University.

**WILLIAM SPITZER** is vice president for programs, exhibits, and planning at the New England Aquarium in Boston and is a member of the Central Coordinating Office team for the National Centers for Ocean Sciences Education Excellence (COSEE) network. Previously he spent 7 years at TERC, Inc., directing research and development projects in science education. He is former chair of the National COSEE Council and principal investigator of COSEE New England. He has served as principal investigator on a number of informal science education projects, including a recent partnership with the Association for Zoos and Aquariums, the Woods Hole Oceanographic Institution, the Frameworks Institute, and the Institute for Learning Innovation. That project will provide training, tools, and support for aquarium and informal science education professionals to interpret climate change in the context of coastal animals and habitats. He has a B.A. in chemistry and physics from Harvard University and a Ph.D. in oceanography from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution.

#### STEERING COMMITTEE MEMBERS AND STAFF

**JOSEPH E. HEIMLICH** (*Chair*) is professor of environmental education and interpretation at the Ohio State University (OSU) and a senior research associate at the Institute for Learning Innovation. He has been engaged in the arena of environmental free-choice learning for 16 years as a professor and before that as an extension associate with OSU Extension. His research focuses on free-choice learning and the environment, program evaluation in free-choice environmental education learning institutions, and life-span learning. He is a past president of the North American Association for Environmental Education (NAAEE) and is active nationally and internationally as an evaluator of environmental education and conservation education programs. He has received multiple awards for his extension work, as well as the NAAEE Outstanding Contributions to Research in Environmental Education award. He is a member of the Roundtable on Climate Change Education. He has a B.A. in communica-



tion arts, theatre, and dance from Capital University and an M.A. in policy education and a Ph.D. in adult education and learning theory from OSU.

**CHARLES W. ANDERSON** is professor in the Department of Teacher Education at Michigan State University. His current research focuses on the development of learning progressions leading to environmental science literacy for K-12 and college students. He has used conceptual change and sociocultural research on student learning to improve classroom science teaching and science teacher education, science curriculum, and science assessment. He is a past president of the National Association for Research in Science Teaching. He has been coeditor of the *Journal of Research in Science Teaching* and associate editor of *Cognition and Instruction*. At the National Research Council, he was a member of the Committee on Science Learning, K-8, served as a consultant to the Committee on Test Design for K-12 Science Achievement, and is currently a member of the Roundtable on Climate Change Education. He was a member of the National Assessment of Educational Progress's Science Framework Planning Committee and its Science Standing Committee. He has a B.A. in chemistry, an M.A. in science education, and a Ph.D. in science education from the University of Texas at Austin.

**DAVID BLOCKSTEIN** is a senior scientist at the National Council for Science and the Environment and organizes its annual National Conference on Science, Policy and the Environment. He also serves as executive secretary for the Council of Environmental Deans and Directors. He has worked on policy issues that include increasing the representation of minorities in science, mechanisms to improve the linkage between science and decision making on environmental issues, and electronic processes to communicate scientific information on the environment. He serves on or has served on committees for various organizations, including the American Association for the Advancement of Science, the American Institute of Biological Sciences, the American Chemical Society, the American Society of Zoologists, the Society for Conservation Biology, the American Ornithologists' Union, the American Bird Conservancy, the World Conservation Union, the Commission on Education and Communication, the Aldo Leopold Foundation, and the Environmental Education Coalition. He is a member of the Roundtable on Climate Change Education. He has a B.S. in wildlife ecology from the University of Wisconsin and an M.S. and a Ph.D. in ecology from the University of Minnesota.

**ANN BOSTROM** is associate dean of research and associate professor in the Daniel J. Evans School of Public Affairs at the University of Washington. Her research focuses on risk perception, communication, and



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**WÄNDI BRUINE DE BRUIN** is assistant professor of social and decision sciences and of engineering and public policy at Carnegie Mellon University. Her research focuses on risk perception and communication targeting people's health, financial, and environmental decisions. Her work has been published in peer-reviewed journals in psychology, public health, and environmental science. She has served on advisory panels and workshops organized by (among others) the U.S. Environmental Protection Agency, the U.S. Food and Drug Administration, the U.S. Federal Reserve, the Dutch central bank, and the U.S. Centers for Disease Control and Prevention. She has a B.S. in psychology and an M.S. in cognitive psychology from the Free University Amsterdam as well as an M.S. and a Ph.D. in behavioral decision theory from Carnegie Mellon University.

**MICHAEL A. FEDER** (*Study Director*) is a senior program officer with the Board on Science Education at the National Research Council. Until April 2011, he was the study director for the Committee on the Review of the National Oceanic and Atmospheric Administration's Education Program and the Climate Change Education Roundtable. Previously, he supported the work of three study committees: the Committee on Learning Science in Informal Environments, the Committee on Understanding and Improving K-12 Engineering Education in the United States, and the Committee on the Review and Evaluation of NASA's Pre-College Education Program. His interests include applications of cognitive and social development theories to student learning, teacher development, research methods in education, and educational research to policy and practice dissemination. He has an M.A. and a Ph.D. in applied developmental psychology from George Mason University.

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**EDWARD MAIBACH** is professor of communication and director of the Center for Climate Change Communication at George Mason University. With over 25 years of experience as a researcher and practitioner of public health communication and social marketing, he now focuses exclusively on how to mobilize populations to adopt behaviors and support public policies that reduce greenhouse gas emissions and help communities adapt to the unavoidable consequences of climate change. Previously, he served as associate director of the National Cancer Institute, as worldwide director of social marketing at Porter Novelli, as chairman of the board for Kidsave International, and in academic positions at George Washington University and Emory University. He has an M.P.H. in health promotion from San Diego State University and a Ph.D. in communication research from Stanford University.

**PAUL C. STERN** (*Senior Scholar*) works primarily with the Committee on the Human Dimensions of Global Change, most recently serving as study director of the committee that produced *Informing Decisions in a Changing Climate*. He also holds an adjunct position as professor II at the Norwegian University of Science and Technology. His research interests include the determinants of environmentally significant individual behavior; participatory processes for informing environmental decision making; and the governance of environmental resources and risks. He has directed many National Research Council studies and served as coeditor of their publications, including *Public Participation in Environmental Assessment and Decision Making* (2008), *Making Climate Forecasts Matter* (1999), and *Understanding Risk* (1996). He won the 2005 sustainability science award from the Ecological Society of America as coauthor of the *Science* article, "The Struggle to Govern the Commons." He is a fellow of the American Association for the Advancement of Science and the American Psycho-

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**MARTIN STORKSDIECK** is the director of the Board on Science Education at the National Research Council. He is also a research fellow at the Institute for Learning Innovation (ILI), where he is involved with research studies of science learning in immersive environments; models of involving researchers and scientists in science museums and science centers; and the impact of science hobbyists, such as amateur astronomers, on the public understanding of science. Previously, he was director of project development and senior researcher at ILI. Prior to that, he was a science educator with a planetarium in Germany, where he developed shows and programs on global environmental change; served as editor, host, and producer for a weekly environmental news broadcast; and worked as an environmental consultant specializing in local environmental management systems. He has an M.S. in biology from the Albert-Ludwigs University in Freiburg, Germany, an M.A. in public administration from Harvard University, and a Ph.D. in education from Leuphana University in Lüneburg, Germany.