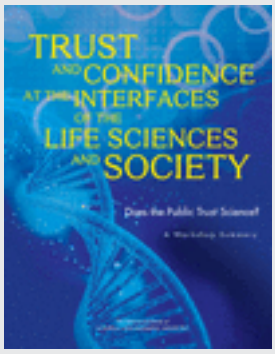

Trust and Confidence at the Interfaces of the Life Sciences and Society: Does the Public Trust Science? A Workshop Summary

DETAILS

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Does the Public Trust Science?

A Workshop Summary

Helaine E. Resnick, Keegan Sawyer, and Nancy Huddleston, Rapporteurs

Roundtable on Public Interfaces of the Life Sciences

Board on Life Sciences

Division on Earth and Life Studies

Board on Science Education

Division of Behavioral and Social Sciences and Education

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This workshop summary has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published workshop summary as sound as possible and to ensure that it meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this summary:

Rick Borchelt, U.S. Department of Energy

Robert Dorit, Smith College

Audrey Huang, Johns Hopkins University

Kirk Englehardt, Georgia Institute of Technology

Beth Shapiro, University of California, Santa Cruz

Although the reviewers listed above provided many constructive comments and suggestions, they did not see the final draft of the workshop summary before its release. The review of this summary was overseen by Stephen Berry of the University of Chicago. He was responsible for making certain that an independent examination of this workshop summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this workshop summary rests entirely with the authors and the institution.

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1

Introduction

"We need to understand not just the rhetoric of trust, but the mechanisms of trust."
—Rick Borchelt

"Building trust is an explicit process that depends on human beings and the institutions they create, and the choices that both human beings and those institutions make. Trust is in itself something about which we actually have a great deal to learn."—Molly Jahn

Does the public trust science? Scientists? Scientific organizations? What roles do trust and the lack of trust play in public debates about how science can be used to address such societal concerns as childhood vaccination, cancer screening, and a warming planet? What could happen if social trust in science or scientists faded? Those types of questions led the Roundtable on Public Interfaces of the Life Sciences (PILS) of the National Academies of Sciences, Engineering, and Medicine to convene a 2-day workshop on May 5-6, 2015 in Washington, DC on public trust in science.

The vision of the PILS Roundtable is that all scientists will have access to the knowledge and tools needed to develop proactive, collaborative, science-based approaches to public engagement in the life sciences. As a science communicator, PILS member, and co-organizer of this workshop, Rick Borchelt of the US Department of Energy, has thought a lot about scientists' engagement with the public. Borchelt said that George Seurat's famous painting *A Sunday in the Park on the Island of La Grande Jatte* is to him the perfect metaphor for science communication (Figure 1-1). An example of pointallism[2], the painting's picture emerges from the blend of about 3 million dots. "Scientists," Borchelt says, "are very effective at talking about those dots, but the public wants to know about the picture." Borchelt thinks that for scientists today, however, it's not only about connecting the dots to the larger picture but about whether scientists can communicate with members of the public in a way that maintains trust, that doesn't offend values that people hold dear, and that doesn't hype or oversell the science. Borchelt emphasized that communication has become an issue of managing the trust portfolio of life scientists, their institutions, and the collective life-sciences community.

[2] A form of painting in which tiny dots of primary-colors are used to form images and secondary colors.

Figure 1-1 *A Sunday in the Park on the Island of La Grande Jatte*. Borchelt used this painting by Georges Seurat to illustrate the state of practice of science communication among research scientists. Scientists describe the dots. Members of the public want to understand the picture. SOURCE: Borchelt Workshop Slide 7

Plant breeder, PILS member, and workshop co-organizer Molly Jahn provided her perspective on the changing nature of trust in science in her opening remarks. She said that the world is facing a number of choice points such as the actions to take in order to address issues discussed at the UN conferences on climate change or to achieve the sustainability goals set out in the Millennium Transition Goals. She emphasized that the world faces a number of tough problems, such as the pressures on the food system for animal derived protein, for which there are not yet solutions. Even though science is crucial to each of those topics, she said, "science doesn't rule," but rather, "we're in dialogue" – science is not the only voice in conversations about the future of society.

She recalled a visit to her university by an agency just as a set of new technologies were being developed and applied to plant breeding—technologies that offer a lot of potential. The agency asked them to "keep things ordinary and not make any mistakes, because they were in important discussions about the technologies." At that moment Jahn recognized that the regulatory process is also a negotiated process.

"Building trust," Jahn said, "is an explicit process that depends on human beings and the institutions they create—and the choices they make. It is not a monolithic feature of how humans work, but operates on many levels. It can be stewarded, built, protected, and broken."

It was in that context that the workshop explored the meaning of trust in science, how trust is established and maintained, and how it can be lost and rebuilt. The 2-day workshop included presentations and panel discussions by experts from academia, the federal government, the media, and non-profit organizations. Speakers examined a number of themes, including how trust in science is defined, what is known about the public's perception of science and scientists, factors that can enhance and erode trust in science, and how scientists and institutions can build and maintain trust. The workshop concluded with breakout sessions and a plenary discussion that explored factors that can constrain or increase trust in the fields of vaccination, synthetic biology, and breast cancer screening. The sessions allowed participants to develop and share ideas for building, maintaining, and restoring trust in those fields. The workshop agenda is provided in Appendix A. The statement of task for the workshop planning committee is presented in Box 1-1.

BOX 1-1
Statement of Task

An ad hoc committee will plan and convene a public workshop to explore public confidence and trust in key elements of the life sciences enterprise-- e.g., its institutions, the science/discovery process, and in scientists themselves. The workshop will feature invited presentations and provide opportunities for discussion between expert researchers and practitioners in complementary fields that often operate in relative isolation from one another, such as decision making and risk analysis, science communication, cognitive science, behavioral economics, diffusion-of-innovation theory, and the life sciences (e.g. agricultural and food sciences, ecology, and biomedical sciences). Workshop discussions will explore empirical evidence on public opinion and attitudes toward life sciences as they relate to societal issues, whether and how contentious debate about select life science topics mediates trust (for example, de-extinction, synthetic biology, embryonic stem cells, and genetically modified organisms, among others), and the roles that scientists, business, media, community groups, and other stakeholders play in creating and maintaining public confidence in life sciences. The workshop will highlight research on the elements of trust and how to build, mend, or maintain trust; and examine best practices in the context of scientist engagement with lay audiences around social issues. The committee will develop the agenda topics, select and invite speakers and discussants, and moderate the discussions. An individually authored summary of the presentations and discussions at the workshop will be prepared by a designated rapporteur in accordance with institutional guidelines.

The workshop was attended by 78 persons, 86 joined via webcast, and on-line participants were encouraged to ask questions and contribute to discussions via Twitter at #NASInterface. Archived videos of all presentations are available on the PILS Web site.[3] The list of participants who attended in person and biographies of speakers and the workshop planning committee can be found in Appendixes B and C, respectively.

ABOUT THIS SUMMARY

Written by a rapporteur, this publication is a factual summary of the workshop's presentations and discussions. The workshop organizing committee did not participate in the writing of this summary. The opinions expressed in the summary are those of the individual workshop participants and are not necessarily the opinions of all workshop participants, the organizing committee, or the National Academies of Science, Engineering, and Medicine. This document does not establish any conclusions or recommendations of the National Academies; instead, it focuses on the issues and ideas presented by the speakers and workshop participants.

[3]"Public Interfaces of the Life Sciences," *The National Academies of Sciences, Engineering, and Medicine,* http://nas-sites.org/publicinterfaces/.

2

What Is Trust?

"*I do not see a definition in the literature that says trust is about thinking like me*."
—Cary Funk

"Trust in science means different things to different people."—Tim Caulfield

There is no universally accepted definition of trust. Available definitions are complex, and vary by academic discipline and context. Workshop participants described and discussed several definitions of trust, what is known about the components of trust and distrust, and the history of trust in science.

DEFINITIONS OF TRUST

What is the meaning of *trust*? "Trust is complex," according to Tim Caulfield of the University of Alberta. There is a large literature base on trust in different disciplines, and the definitions are "somewhat abstract", said Cary Funk of the Pew Research Center. Caulfield and Funk highlighted several of the academic definitions of trust (Box 2-1). Key aspects of the definitions include perceived benefits and risks, uncertainty, credibility, and vulnerability. Funk pointed out that although "the credibility of a messenger delivering a message" is an important component of trust, such a narrow definition does not capture "the two-way dialogue concept behind public engagement." Caulfield particularly embraced a definition developed by science blogger, Liz Neeley, which combines multiple academic definitions of trust as: "your willingness to embrace the advice of a group of strangers because you believe they (a) know the truth, (b) will tell you the truth as they know it; and (c) have your best interest at heart," all of which depend on "(d) who you are, (e) who they are, and (f) what you're talking about."[4]

[4] Neeley, L., "What the Science Tells Us About 'Trust in Science,'" *COMPASSblogs*, August 12, 2013, http://compassblogs.org/blog/2013/08/12/trust-in-science/.

BOX 2-1
Some Definitions of Trust

- A "standing decision" in which someone is given the benefit of the doubt. [a]
- A relationship among people in which the relationships facilitate ongoing interactions that involve risk-taking and uncertainty about future interactions. [b]
- A focus on the source of a message, where we believe the source provides credible information.[c]
- The public's willingness to be vulnerable to the actions of the designers, creators, and operators of science on the expectation that they will behave in a way beneficial to the public.[d]

a. Rahn, W. M. and Transue, J. E. "Social trust and value change: The decline of social capital in American youth, 1976-1995." *Political Psychology* 19, no. 3 (September 1998): 545-565.
b. Resnick, D.B. "Scientific research and the public trust." *Science and Engineering Ethics* 17, no. 3 (September 2011): 399-409.
c. Petty R.E. and Cacioppo J.T. *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer-Verlag, 1986.
d. Roberts, M.R., G. Reid, M. Schroeder, and S.P. Norris. 2013. "Causal or spurious? The relationship of knowledge and attitudes to trust in science and technology." *Public Understanding of Science* 22, no. 5 (July 2013): 624-641.

TRUST AS A RELATIONSHIP

Funk emphasized the need to think about trust in terms of *actors*. She explained that individuals, groups, and institutions are involved in the scientific enterprise, and all these actors have roles in the trust landscape. Thus, a framework for thinking about trust is to consider it "a set of expectations among this broad amorphous collection of people, groups, and institutions", Funk said. James Grunig of the University of Maryland emphasized that there is not a single, homogenous "public," but many "publics." He identified three ways in which publics interact with science information:

- *Active publics* seek information and enter into a relationship around an issue.
- *Passive publics* have a low level of involvement, and neither are affected by nor see a connection to a particular scientific problem.
- *Hot-issue publics* arise in response to intense media attention on specific issues such as vaccines.

Different publics behave in distinct ways in response to different circumstances, Grunig added. Caulfield described the results of a survey conducted in New Zealand that

mapped out public attitudes that influence trust in science.[5] The study identified six population segments with distinct feelings about science: confident believers, educated cynics, concerned supporters, uninformed individualists, confused and suspicious people, and those feeling left behind. "For all of these different groups, trust plays out very differently," Caulfield said.

Under normal circumstances and when the relationship between us and an actor is good, we assume that the motives of the scientist or science institution actor are good, Funk said. It is easy to trust because we expect favorable future interactions, she explained. However, when the relationship is bad and there is an expectation of unfavorable future interactions, trust can diminish or be eliminated. In this way, Funk emphasized the implicit connection between trust and risk.

TRUST AND RISK

On the basis of his decades of research on public relations, Grunig defined trust as the "willingness to open oneself to risk by engaging in a relationship with another party." He explained that trust has three dimensions: *integrity*, the belief that a person or organization is fair and just; *dependability*, the belief that a person or organization will do what they say; and *confidence*, the belief that a person or organization has the ability to do what they say they will do.[6] However, Grunig emphasized that a person's "openness to risk is the important element" of trust.

Rose McDermott of Brown University explained that trust has a biological component that is determined in part by a person's oxytocin concentration. Oxytocin, a mammalian hormone released by the pituitary gland, plays a role in social bonding and such other biological functions as contraction of uterine muscles, lactation, and parental care. Social bonding can be seen as a "precursor to trust," she said. McDermott described research by Paul Zach that demonstrates that people with higher oxytocin concentrations are "more willing to bear risk of all kinds in their social interactions." However, she stressed that the biological mechanisms that underlie trust involve human universals – broader and more complex psychological processes of which oxytocin concentration is only one component (Box 2-2).

DISTRUST

What does it mean to distrust? Is it ok to be distrustful? Grunig explained that trust and distrust are not opposites. "Distrust is not the absence of trust," nor is trust the absence of distrust he said. He explained that distrust has two dimensions: lack of *credibility*, the belief a person or organization is not accountable, is unethical, or does not respect laws or policies; and *malevolence*, a person or organizations willingness to lie to increase profits, to deceive

[5] Hipkins, R., W. Stockwell, R. Bolstad, and R. Baker, *Commonsense, trust and science: How Patterns of beliefs and attitudes to science pose challenges for effective communication* (New Zealand Council for Educational Research/ACNielson for the Ministry of Research, Science and Technology, 2002).
[6] Hon, L.C. and J.E. Grunig, *Guidelines for Measuring Relationships in Public Relations* (Institute for Public Relationship, 1999).

BOX 2-2
Human Universals Involved in the Biology of Trust

McDermott listed examples of human universals, cognitive processes involved in how and why people trust or distrust:

- How we receive and screen information.
- How we process information.
- How we alleviate the unknown (uncertainty).
- How we detect untruth (cheater detection).

SOURCE: McDermott Workshop Slide 4

members of the public, or to take more than is given.[7] He added that because trust and distrust are not two sides of the same coin, they should be conceptualized individually in thinking about building public trust in science. Grunig shared his view that "distrust is more salient than trust." The asymmetry of negative information—the idea that negative information has a stronger effect on public perceptions than positive information—was discussed throughout the workshop in relation to its impact on public trust in science.

"The flip side of trust is betrayal," McDermott stated. "We talk about trust as though it's all good, that we should trust everybody, but in fact we shouldn't," McDermott noted. She said that people have built in "cheater detection," a psychological response to environmental cues that information or a person is not trustworthy. "Our survival has been potentiated by being able to figure out people who are trying to take advantage of us – to cheat us," she explained.

AN HISTORICAL PERSPECTIVE ON TRUST IN SCIENCE

Although there is a lack of consensus on the definition of trust, several workshop attendees noted that the relationship between science and members of the public has changed. Marcia Kean of Feinstein Kean Healthcare offered a historical perspective on the change through the lens of health care. In the past, scientists made up a small and exclusive "golden circle" that conducted its work in prestigious academic institutions, she noted. That small group, whose research was supported primarily by federal government tax dollars, was validated when its findings were published in peer-reviewed journals. She said that the mechanism through which members of the public learned about new research findings was coverage of peer-reviewed publications by highly regarded journalists who had expertise in science and medicine. Kean described that period as "a trust fabric built on authority"—when health-care research and its societal implications were "framed by a professional class in the biotechnology ecosystem". She said that the system worked well for 30 years as "an implicit

[7] Hon, L.C. and J.E. Grunig, *Guidelines for Measuring Relationships in Public Relations* (Institute for Public Relationship, 1999).

social contract" in which the public played a passive role. The public supported science through taxes and trusted the government and other institutions, such as science-advocacy organizations, to regulate science as they saw fit.

In recent years, Kean said, that authoritative trust fabric has deteriorated. She argued that a new social contract is needed between science and the public that reflects the landscape in which science is conducted today and the new ways in which the public intersects with and consumes scientific findings. In the 21st century, there is an increasing convergence of science disciplines—such as combinations of biology, engineering, and digital technologies—to address societal challenges, she noted. Alongside the changing approach to scientific research, the public is exchanging its historically passive role for one that is more active and interactive. Kean warned that the "elite ecosystem" is not prepared for these changes. The historical reliance on funding from federal agencies and charitable organizations is now enhanced by other strategies, and the professional class of scientists that has been leading the charge in science for the last few decades has little experience with the new tactics. Crowd funding and other innovative models of investment offer the public opportunities to be more active in deciding what science is funded and how it is conducted. The new approaches contrast with the historical model in which decisions about funding support were left to experts who were often selected by other experts in a manner that was obscure to the public.

Kean explained how changes in the availability of data have influenced the public's expectations of its role in science. Access to individualized data through various platforms—including new research strategies that allow participants to provide and receive data in the course of research activities—has contributed to what Kean called "an increased sense of me" with regard to data availability and sharing. She emphasized that a new trust fabric of "partnership, participation, and peer groups" will need to be built. That backdrop provided a framework for considering the many definitions of trust that were discussed during the workshop.

3

What Do We Know About Public Trust in Science?

"*We have to understand better what the perceived risks are—that suggests where we would go to look for the perceptions of trust*."—Cary Funk

"*When you talk about trust you have to know the way a group thinks , how they interact, how they communicate, how they educate. You have to know what their roles and relationships are. What are their values? Their practices? What are the expected behaviors*?"
—Phyllis Pettit Nassi

Drawing from social science research, survey data, and experiences in community engagement, workshop speakers shared available evidence on public perceptions of science and the factors that may erode their trust.

MEASURES OF TRUST

"We know it pays to be mindful of trust because it's much easier to destroy than it is to build back up after it's eroded," opened Cary Funk of the Pew Research Center. She noted that low levels of trust in government, the media, and the criminal justice system are examples of why it is important to be mindful of the role that trust plays in public debate. Funk shared data from several large public opinion surveys that provide insight into public perceptions about science and scientists. The data show "some good news and bad news," about public trust in science, she said. First, the good news. Data on public confidence in institutions from General Social Survey[8] demonstrates that confidence in the scientific community has remained relatively stable since 1973.[9] "Trust does not look to be on the decline over time," Funk said. The GSS data also show that 95% of surveyed individuals agree that scientists are "helping to solve challenging problems," and 88% agreed that scientists are "dedicated people who work for the good of humanity," (Figure 3-1). However, Funk emphasized that data suggests there may be an "ambivalence about science," in the American public. In the Virginia Commonwealth University (VCU) Life Sciences

[8] The General Social Survey has gathered data on contemporary American society, including trends, attitudes, behaviors, and attributes, since 1972. "Confidence in the scientific community," *NORC at the University of Chicago*, https://gssdataexplorer.norc.org/variables/458/vshow.
[9] Smith, T.W. and J. Son, *Trends in Public Attitudes about Confidence in Institutions. General Social Survey 2012 Final Report* (NORC at the University of Chicago, 2013).

Surveys, 50% of respondents strongly or somewhat agree that, scientific research has created as many problems for society as it has solutions, and near 50% of respondents strongly or somewhat disagreed (Figure 3-1).

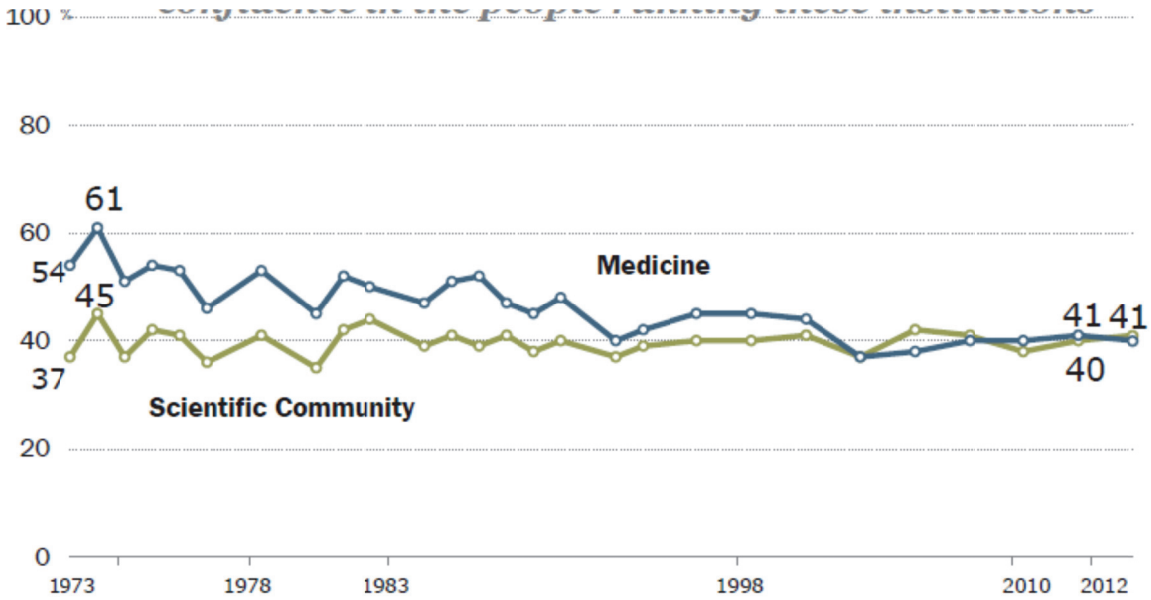

Figure 3-1 Confidence in the Scientific Community 1973 to 2013. Data from the General Social Survey on the percent of US adults that say they have a "great deal of confidence" in the in the people running these institutions. SOURCE: Funk Workshop Slide 5

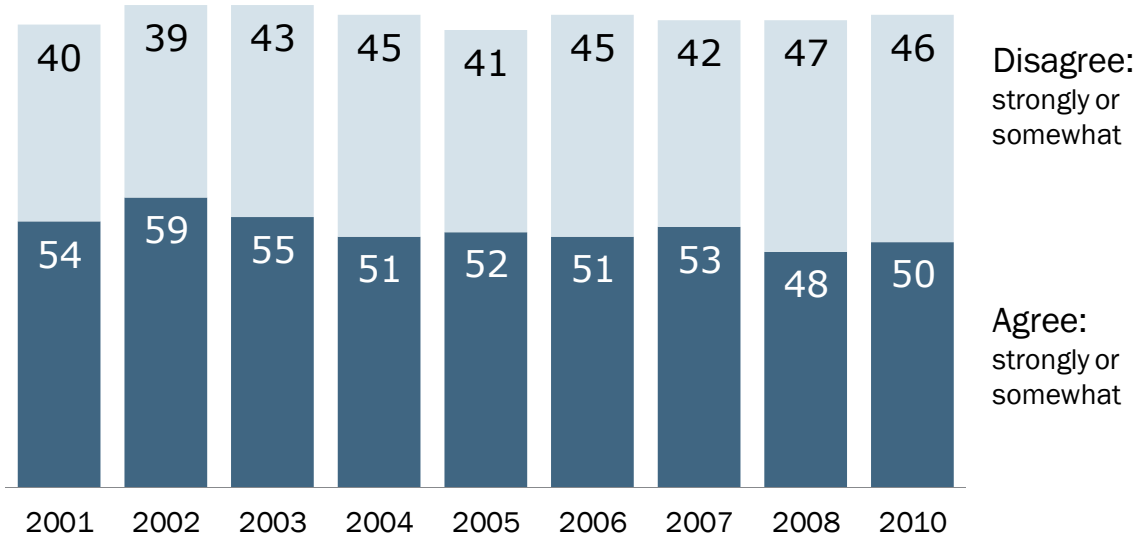

Figure 3-2 VCU Life Science Surveys on whether scientific research has created as many problems for society as it has solutions. Data collected between 2001 and 2010 that demonstrates a consistent near even divide in US public opinion about science. SOURCE: Funk Workshop Slide 7

Funk also shared data from the GSS and VCU survey on perceived motives of scientists relative to other groups. These data suggest that scientists are more trusted than, for example, religious leaders[10] or elected officials[11]. However, for select scientific topics, trust in the *motives* of scientists may not be particularly high. For example, in a 2001 VCU Life Sciences Survey, only 39% of respondents said they trust information on stem cell research "a lot" when it comes from scientific or medical researchers. However, this level of trust was higher than the 15% and 4% of respondents who reported that they had a lot of trust in the same information when it came from religious leaders and members of Congress, respectively. Funk interpreted other results as suggesting that the public may be anxious about the ability of scientists and government to ensure public safety and well-being around certain issues like genetic research. When taken as a whole, Funk emphasized that the data suggest there is trust in scientists' motives and expertise, but the members of the public are skeptical about specific issues and the ability of scientists and government to keep the public safe around those issues.

[10] VCU Center for Public Policy, *VCU Life Sciences Survey* (VCU Life Sciences, 2001).
[11] Smith TW and J. Son. 2013. *General Social Survey 2012 Final Report. Trends in Public Attitudes about Confidence in Institutions*. NORC, Chicago

CULTURE AND TRUST

Phyllis Pettit Nassi of the Huntsman Cancer Institute shared her observations about public trust in science in the context of Native American History and Native Americans' experiences with majority culture in the United States. Nassi provided context to her remarks by explaining that culture shapes beliefs, customs, values, practices, roles, relationships, expected behaviors, and how people interact with each other. All of these factors influence peoples' trust in science. She said that in her work, which involves community-based health education and research, trust in science is critically important. Native culture respects traditional practices that contribute to survival, it emphasizes respect for, and understanding of the environment and the land, and it has a belief system in which spirituality is intimately connected to health. However, because of historical events, Native communities face multiple challenges today, including markedly less favorable health indicators, lower insurance coverage and educational attainment, and high smoking and poverty rates. Nassi pointed to the Indian Boarding School System—a federal policy that aimed to educate Indian children and assimilate them into European language and culture–as an example of historical trauma and unresolved grief in many Native communities that impacts their contemporary responses to scientists' efforts to conduct research in their communities. Historical experiences continue to challenge the communities' trust in mainstream U.S. institutions including research and healthcare, and these challenges are exacerbated by a multitude of cultural differences that impact how individuals and institutions interact with one another. Nassi contrasted differences between traditional culture and mainstream American culture (Box 3-1), and she said that these differences create meaningful challenges for trust in science.

BOX 3-1
Cultural Factors That Influence Trust in Science

Traditional Native Culture	Mainstream U.S. Culture
Cooperative	Competitive
Group/tribal emphasis	Freedom, progress, efficiency
Large role for the extended family	Individualism
Modesty	Sexy
Patience/passive	"Getting ahead in life"
Non-materialistic	Material comfort
Respect for age	Emphasis on youth
Spirituality	External conformity
Indirect criticism	Direct criticism
Harmony with nature	Conquest of nature

SOURCE: Nassi Workshop Slide 13

Referring to the challenges of conducting research in Native communities, Nassi explained, "It's harder because of our past…when anything has to do with the federal government, and that's where most [research] money comes from… there's that caution. There's that fear." She stressed the need for adequate time to prepare for new projects, including getting to know the community and doing an adequate job of explaining the project. She said, "I ask for a year before we start anything. Become part of the community. We want to participate, but we're afraid of what has happened." The object of distrust, "it's not the science, it's the scientists," Nassi emphasized.

CELEBRITY SCIENTISTS

Declan Fahy of American University added to the discussion with his research on the rise of "celebrity scientists" and how these intermediaries help the public become more engaged in science[12]. Fahy focused on the careers of Carl Sagan, Stephen J. Gould and Neil deGresse Tyson as examples of the rise of "celebrity" scientists—scientists who are widely known to, and trusted by the lay public.

Before the public can trust science, it first needs to "make sense of science" Fahy said. Fahy described three levels of scientific literacy[13] that contribute to the ability of members of the public to make sense of science:

- Knowing basic science facts and ideas.
- Knowing how science works, including knowledge about scientific thinking, the role that evidence plays in drawing conclusions, the different types of studies that are conducted in various research settings, and the peer-review process.
- Knowing how science *really* works, which includes understanding competition among scientists, the role of uncertainty, evidence, and scientists' drive for excellence.

Fahy explained that the ability to facilitate an understanding of how science *really* works is a key aspect of why celebrity scientists like Sagan, Gould and deGrasse Tyson have enjoyed so much success as science communicators. He noted that Sagan is an early example of a scientist who took advantage of the "emerging media culture to take [his] message about science directly to public audiences." Fahy said that Sagan's ongoing dialogue with the public was a dramatic departure from the traditional, inwardly-focused scientific communication described by Marcia Kean of Feinstein Kean Health Care. He emphasized that Sagan's openness toward the public is largely responsible for his enduring appeal.

But how do a few scientists become well-known, trusted figures while most remain unknown to the public? Fahy said that for celebrity scientists, "professional authority at the start [of their careers] is grounded in, and draws from science itself." Both Gould and deGrasse Tyson established their expert authority in traditional academic settings before they

[12] Fahy, D., *The New Celebrity Scientists. Out of the Lab and Into the Limelight* (Rowman & Littlefield Publishers, 2015).
[13] Durant, J. "What is scientific literacy?" *European Review* 2, no. 1(January 1994): 83-39.

started moving toward more public-facing interactions. Highlighting the dichotomy between the two settings, Fahy first discussed "expert culture"– the culture of academia, scientific journals, and specialized activities in which celebrity scientists first establish themselves as legitimate authorities in their respective fields. He then described a "public culture" involving citizens and groups that consume these ideas. Fahy said that over time, scientists like Gould and deGrasse Tyson became proficient at moving between the expert and public cultures, never losing their legitimacy in either.

One way that these scientists helped the public engage with science was by communicating directly with the public through non-academic publications. Both Gould and deGrasse Tyson wrote for *Natural History* magazine. In this role, Fahy said they enhanced public understanding of the scientific enterprise by describing how science develops, and by explaining concepts like uncertainty and the strength of evidence in ways that promoted scientific literacy and trust. He suggested that the ability of these scientists to write effectively for non-academic audiences was a critical aspect of their ability to bridge the gap between the expert and public cultures. By extending their legitimacy outward to embrace a wider audience of non-experts, these celebrity scientists were able to draw the public into science by helping it to understand "how science *really* works."

Another way that these celebrity scientists helped bring the public into science was by voluntarily blurring the distinction between their public and private lives. DeGrasse Tyson's autobiography discussed the professional challenges he faced because of his race, and Gould shared his experiences as a cancer patient through his writing. Fahy explained that the scientists' willingness to share their stories demonstrated to the public that scientists are "regular people" whose personal concerns mirror their own. These shared experiences promoted trust in science because they forged experiential bonds between scientific figures and the public, a notable departure from the "golden circle" described by Kean. Fahy's concluding remarks stressed the importance of scientists' ability to move between expert and public cultures, particularly at a time when public discourse about science is heavily influenced by new, public-facing media and information sources with which scientists historically have little experience.

FACTORS THAT ERODE TRUST

Tim Caulfield of the University of Alberta emphasized that discussions about the alleged "war on science" should begin with two questions:

- Why don't some members of the public trust scientists when there is so much supporting evidence for their findings like with climate change and vaccine safety?
- Why do people believe conspiracy theories such as the Food and Drug Administration is deliberately preventing the public from receiving cures for cancer[14]?

[14]Oliver, J.S. and T. Wood. "Medical Conspiracy Theories and Health Behaviors in the United States." *JAMA Internal Medicine* 174, no. 5 (May 2014): 817-818.

Caulfield discussed several interrelated factors that he believes may be contributing to an erosion of public trust, at least for some science issues. Some of the factors stem from the scientific community itself. The perception of some members of the public that the scientific process is not working stems from scholarly editorials[15] and research publications[16] that suggest that most findings in published scientific literature are not true or that "results are greatly exaggerated", Caulfield said. Methodological shortcomings in study design, researcher's conflicts of interest, and inappropriate statistical analysis are a few of the concerns cited. Layered on top are "concerns about retractions" and the perception that "scientists cannot make up their minds" (Figure 3-3). Caulfield emphasized that repeated conflicting headlines in media, for example in health research, leads some members of the public to stop listening to health messages because the messages are perceived to be unreliable.

Some factors that may contribute to erosion of public trust in science stem from outside of the scientific community, such as hype and exaggeration of scientific findings by the media and scientific facts or advice given by popular non-scientist celebrities. For example "the popular press greatly exaggerates the definitiveness of vitamin D research."[17] Health advice given by celebrities also contributes to public confusion, noted Caulfield. For example, a systematic review on the advice given by Dr. Oz found that almost half of the TV celebrity's advice conflicts with scientific literature[18]. "When you have that kind of confused message around science, it is no surprise that the public is so incredibly confused", Caulfield said.

[15] Horton, R. "Offline: What is medicine's 5 sigma?" *The Lancet* 385, no. 9976 (April 2015): 1380.
[16] Ioannidis, J.P.A. "Why most public research findings are false." *PLOS Medicine* 2, no. 8 (August 2005): e124.
[17] Caulfield, T.C., M.I. Clark, J.P. McCormack, C. Rachul, C.J. Field. "Representations of the health value of vitamin D supplementation in newspapers: media content analysis." *BMJ Open* 4, no. 12 (December 2014): e006395.
[18] Korownyk, C. *et al.* "Televised medical talk shows—what they recommend and the evidence to support their recommendations: a prospective observational study." *BMJ* 349 (December 2014): g7346.

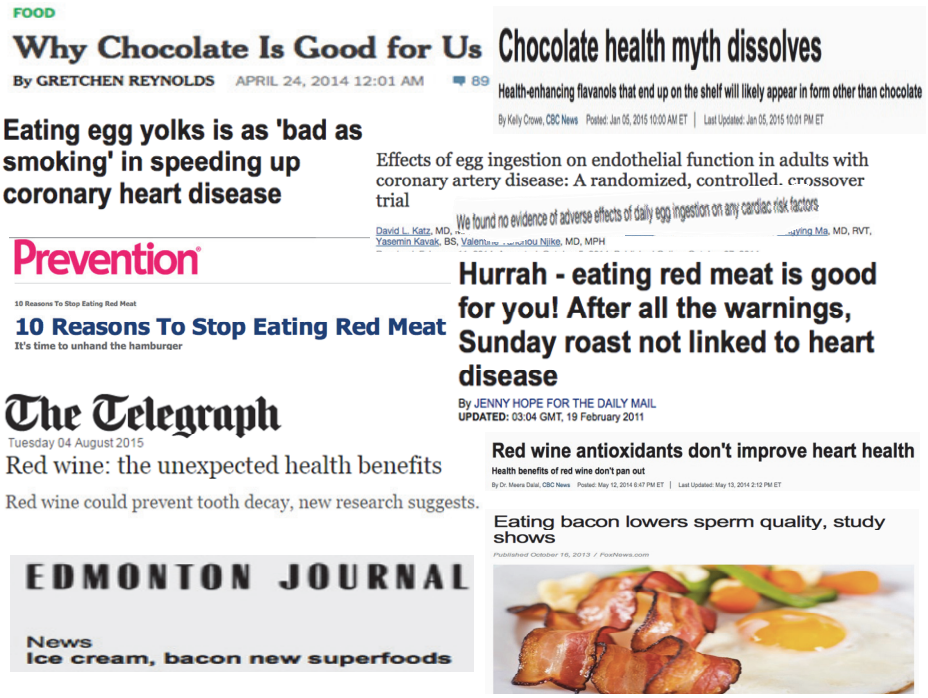

Figure 3-3 Conflicting Messages About Science. Caulfield shared images conflicting headlines on the health effects of chocolate, eggs, red meat, red wine, and bacon to illustrate conflicting public messages about science. SOURCE: Caulfield Workshop Slide 12.

Caulfield challenged workshop attendees to consider why the public should be expected to trust the scientific establishment when its leaders appear to have limited confidence in the peer-review process and the conflicting results it generates.

Overall, the information shared by speakers concerning what is known about public trust in science suggested a complex landscape in which personal characteristics like culture, religion, values, and personal histories—when combined with science's own shortcomings like inconsistent findings and conflict of interest–can promote lack of trust in both scientists and the scientific enterprise. Kathleen Hall Jamieson of the Annenberg School for Communication at the University of Pennsylvania talked about the concept of *ethos*, the ethics or credibility of a person, from classical literature. Ethos was thought to reside in the speaker and to the extent you were a person of good reputation, you increased your ethos. What the classics got wrong, she said, is the belief that credibility resides in a person and stays there; they failed to account for the fact that the audience brings its own values and can ascribe good or bad traits to the speaker. Trust can be taken away from a person over time. It's easier to make negative perceptions stick due to a phenomenon that social scientists call the "negative asymmetry of information." For example, in the 2000 elections—Al Gore lost his credibility as his opponents sent out the message that he believed he invented the Internet.

Further using politics as an example, Jamieson said we elect presidents to act in unanticipated events. We want strong, competent, honest and trustworthy leaders whom we believe will act in our best interest. She thinks scientists, as communicators, need to convey warmth and competence better, traits associated with credibility and ultimately trustworthiness[19]. Jamieson said we're at a point that the adjectival traits of scientists are in question.—not "science" but "scientists." She emphasized that no one is questioning the scientific method, they are questioning whether scientists adhere to it. All the things causing concern about science—such as the problem in being able to reproduce results in medical and other research--risk the good standing of the scientific enterprise.

[19] Fiske, S.T. and C. Dupree. "Gaining trust as well as respect in communicating to motivated audiences about science topics." *Proceedings of the National Academies of Sciences* 111, suppl. 4 (April 2014): 13593–13597.

4

Government, Politics, Science, and Trust

"*Never overestimate the knowledge of the people and never underestimate their wisdom*."
—Rush Holt

"*Producing & protecting good independent science is one of the most important functions of government in a liberal democracy…this idea of independence is core to the issue of trust.*"
—Tim Caulfield

Science does not exist in isolation. Public discussions of new discoveries, applications, or concerns about science take place in a sociopolitical context. During the workshop, a panel of current and former scientist policy-makers, moderated by David Goldston of the Natural Resources Defense Council, discussed the intersections of government, politics, and science, and the influence of those intersections on public trust.

EXPERIENCES AT THE INTERSECTION OF SCIENCE AND GOVERNMENT

As political debates about an issue become more polarized, science is increasingly used as the "ultimate trump card," Goldston said. Politicians bring science and scientists into the policy arena in an effort to say "the science is on my side." However, this strategy, which tries to leverage the trust that the public's historical trust in scientists, to move political agendas forward has a serious downside: the American public, which generally has an unfavorable view of politicians, can extend its negative feelings toward science when it perceives that science is being used for political purposes, Goldston warned. That warning echoed the assertion of James Grunig of the University Maryland, that when there is societal debate, public trust often becomes a function more of political ideology than of scientific fact— a consideration that brings trust out of the scientific domain and places it in a political one. Goldston said that scientists' involvement in such debates offers great opportunity, but also substantial risk. People try to "elevate" scientists to use their credibility for political debates, but the only way for an opposing interest to win the argument is to "knock the scientist off the pedestal." He explained that "more than science is at stake. Everyone tries to play on trust in science, but that puts both scientists and policy makers in a trap." Kathleen Hall Jamieson of the Annenberg Public Policy Center expanded on that idea with her observation that "if the motive of the scientist is anything other than seeking knowledge…we run the risk of saying that the scientist is just another form of advocate who is selectively using evidence in order to engage in a persuasive campaign." Goldston advised, "We should

always be asking, 'What is the role of science in the policy debate?'" To begin to answer that question, he described four scenarios in which science and public policy intersect (Box 4-1).

Goldston's remarks provided the context for a panel discussion in which three scientists whose work regularly places them in the political sphere —Ann Bartuska of the US Department of Agriculture, Jo Handelsman of White House Office of Science and Technology Policy, and former congressman Rush Holt of the American Association for the Advancement of Science—shared their personal accounts of public engagement and lessons learned about developing trust.

Identifying Common Goals for Trustworthy Forest Partnerships

Bartuska described her experiences in interacting with the public about a project that involved harvesting trees for research purposes. Although the project aimed to maintain forest health by understanding forest dynamics in response to insects, diseases, and wildfires, Bartuska encountered segments of the public that believed that harvesting of trees for research was something to be avoided except perhaps for wildfire prevention. She described how, with that concern in mind, her group worked with the community to prepare for the project. Her efforts began with bringing environmental advocates together with local stakeholders who had interests in timber, wildlife, and fisheries. Joined by Forest Service scientists, these science-government-community groups walked through the scientific process together, including coming to agreement on the scientific question and evaluating the merits and liabilities of various research protocols. "We actually walked through the scientific process. We asked, what is the most important question to be addressed here? Because we all agreed that we wanted to improve the quality of the oak forest, we laid out a common understanding of the scientific question. The community not only helped us to do the analyses on the monitoring

BOX 4-1
Science-Public Policy Intersections

Goldston outlined four scenarios that describe how science can intersect with public policy:

1. A policy issue masquerades as a science issue, for example, whether to label genetically engineered organisms.
2. A policy issue is supported by scientific consensus, for example, the relationship between ozone exposure concentrations and hospital admissions.
3. A policy question that is not supported by a scientific consensus, for example, the question of what, if anything, should be done to restore a forest ecosystem after a fire
4. An emerging issue that does not have either a policy position or a scientific consensus, for example, regulatory considerations associated with synthetic biology or nanotechnology research and development.

of the site but helped to inform the results and conclusions. It was a good example of how you could take a practical experiment and bring the community together to help resolve a thorny issue." Bartuska noted that National Environmental Policy Act clearly shows that community engagement to identify common goals "is an essential first step". She added that the community also assisted in monitoring the research and collaborated readily with federal officials in a manner that improved the overall quality and effect of the project. Bartuska said that an ancillary benefit of such a research strategy is that it increases scientific literacy in the communities where the collaborations occur. She emphasized that starting with a common goal—regardless of how simplistic it seems—is a critical aspect of the process. When asked by Goldston whether she did something special to arrive at a common goal before implementation of the research project, Bartuska responded, "You have to go slow to go fast."

Responsible Leadership During the Ebola Outbreak

Handelsman shared her experience in addressing the Ebola outbreak, which stimulated "mass hysteria". From the science perspective, "we know that this is not a very contagious virus and that the probability that people coming into the [the United States] from Africa and carrying the virus or infecting others was incredibly low." Hence, dedicating substantial resources to screening and quarantine would not be a reasonable science-based policy, she said. "If Ebola had the infectivity of influenza, it would be disastrous, absolutely horrible, but it doesn't." However, Handelsman said, discussing with members of the public such scientific facts as the low transmissibility of the virus and its inability to travel through the air did little to assuage concerns. Handelsman does not consider the Ebola case to be a success story, although she pointed out that scientific editorials in mainstream papers constituted a useful dimension of public discussions. Goldston asked what approaches might help to separate scientific discussions about the magnitude of risk from social value discussion about how much risk is acceptable. Handelsman indicated that responsible science and political leadership can make a difference. "The president often speaks about evidence and about science in an evidence-based way. That has entered the American consciousness," Handelsman emphasized.

Leveraging Scientific Authority During the Anthrax Attack

Holt drew on his experiences as one of the few Congressman-scientists during the 2001 anthrax scare He recalled the anxiety in the US Capitol after letters tainted with anthrax arrived in congressional offices in 2001. The anxiety was accompanied by a desire on the part of some of Holt's colleagues to obtain reliable information about anthrax, and these colleagues approached Holt saying, "You're a scientist, you must know about anthrax." Holt said he was puzzled by that assumption because his scientific training was in physics, a field that has little to do with life sciences or medicine. But the experience demonstrated to Holt that the public wants facts and perceives scientists as the "keepers" of facts. He pointed out that how we teach in the United States has produced the notions in many people that relatively few people "know about science" and that scientific information is accessible to the public only through them. Holt believes that those notions divide the United States into two camps—scientists and nonscientists—and that this division affects public trust in science. He challenged the audience to consider how the public can be expected to trust science when most people believe they cannot understand it. He added, however, that it is important for

scientists to leverage their position when people turn to them for information. "Why not help the public to understand the concept of risk? Why not help the public understand statistical reasoning?"

GETTING AHEAD OF THE ISSUES

Building public trust takes time, and time is of the essence for such issues as the 2014 Ebola outbreak and the 2001 anthrax attack. Is there a way for the science community to "come out in front of the political or cultural narratives that sometimes arise around issues like Ebola and climate change?" asked Jessica Brooks, of the Science and Technology Policy Institute. Bartuska pointed out that scientific professional societies, such as the Ecological Society of America (ESA), have established processes to provide "policy-relevant" information before a political narrative has been established around an issue. ESA has people in Washington, DC, "who are paying attention to what's happening in Congress that deal with ecologic and environmental issues" and "a rapid-response team" of member academic and federal scientists to develop white papers "with one of the hallmarks that they can be easily understood…but have the basis of good, solid peer review behind them," Bartuska said. "No group of people is smart enough to guess what the next emerging public misunderstanding will be," Holt argued. He emphasized that education—"helping people to understand" not just what scientists have learned, but also how scientists conduct risk assessment and statistical analysis and "what a public interface is about"—is enabling members of the public to understand issues for themselves. David Rejeski, of the Woodrow Wilson International Center for Scholars, countered that an issue that "will be a trust train wreck" is germline modification. The technology that scientists have developed to "modify and edit the genome easily" is front-page news, he said. Although some US scientists have called for a moratorium[20] on human germline editing and Francis Collins, the director of the National Institutes of Health (NIH), has stated that NIH will not fund human germline-editing research,[21] scientists in China have already conducted such research.[22] "I thought that this was [a research area] that we had decided, morally, religiously, and scientifically, we wouldn't go there," he added. Rejeski asked what the White House, US government agencies, or science institutions like the National Academy of Sciences should do. Handelsman responded that although the US government has laws and policies that restrict research on human germline editing, not all countries do. The decision of whether to conduct this research is an ethical one that "definitely warrants an international debate."

THOUGHTS ON PARTISANSHIP

Jamieson talked about the fact that we all have alternative identities that we can prime or suppress as appropriate. For example, colleagues talk to each other as colleagues, not as mothers and daughters or some other identities. If we give an audience cues that we are

[20]Baltimore, D. *et al*. "A prudent path forward for genomic engineering and germline gene modification." *Science* 348, no. 6230 (April 2015): 36-38.
[21]The NIH Director, "Statement on NIH funding of research using gene-editing technologies in human embryos," *National Institutes of Health* http://www.nih.gov/about/director/04292015_statement_gene_editing_technologies.htm.
[22]Liang, P. *et al*. "CRISPR/Cas9-mediated gene editing in human tripronuclear zygotes." *Protein & Cell* 6, no. 5 (May 2015): 363-373.

partisan and that we are not giving them all the data—people will treat us as partisan and question our motives, she said. As previously noted, Jamieson thinks that a scientist's motive should be to seek and preserve knowledge, not advocate for or engage in persuasive campaigns about public policy.

Jamieson talked about her research that showed it is possible to activate different schemata in an audience, depending on the voices that science uses. She worries that the science community is beginning to talk as though being "partisan" is a hard-wired trait, and that members of the public are not capable of moving into a space in which they become information seekers who weigh the evidence as best they can. However, she said, the partisan switch can be turned off if a speaker does not come across as partisan. A person who receives a diagnosis with cancer, does not consult Rachel Maddow or Rush Limbaugh; the person finds someone who has expertise in medicine and asks, "Doctor, if I was your wife or daughter, what would you ask me to do?" Jamieson said that we ask people to perform a surrogacy function for us. That is why she thinks it's so important to include a value and caring dimension in scientists---because it is intrinsic in all human relationships.

5

Full Court Press: Trusted and Trustworthy Media

"Everybody has an agenda. I don't have a problem with that. It's knowing what the agenda is and being able to control for it."— Scott Hensley

The goals of research scientists and the goals of the media for communicating science may not always align. Workshop participants discussed those differences and strategies that public affairs officers and science journalists can use to develop trustworthy science stories.

UNIVERSITY PRESS OFFICES AND SCIENCE HYPE

Kirk Englehardt of the Georgia Institute of Technology spoke about the role that university press offices can play in communicating science. He explained that universities want the "best students, the best faculty, and the largest grants" and added that there is tremendous pressure to "push out" stories as quickly as possible with the goal of maximizing "eyes on a story". However, when universities value eyes on a story as the optimal outcome, "people start to think that quantity is more important than quality" and there is more room for error and exaggeration, both of which work against trust in science. Explaining how those circumstances evolved, Englehardt said that communication offices share responsibility for boosting a university's external grant revenue and reputation, and these are related to the public's perception of the importance and effects of a university's research program. Communication offices seek to shape that perception among the mass media, funding agencies, and industry. Englehardt said that problems can arise when quality control is absent in the process of shaping perception.

Although university press offices are dedicated to building institutional reputations, Englehardt said that press releases do not always reflect a full understanding of the details of research findings because of the pressure to get material out quickly. Lack of understanding and context can decrease the quality of press releases that are picked up by journalists as part of what Tim Caulfield of the University of Alberta termed "the hype pipeline". Englehardt said that hype often begins with press releases but added that there is "enough blame to go around" concerning the many forces that work to build media coverage of research findings. He touched on the increasing role of social media in promoting research findings and noted

that communication offices need to evolve as scientific discourse moves toward these platforms. James Grunig of the University of Maryland pointed out that as communication vehicles continue to move toward digital and social media and away from traditional print platforms, there will be increased emphasis on the ability of organizations—including universities—to interact effectively through the newer platforms. In this new landscape, Grunig said, "the big story" is not as important as interacting with the public effectively; universities and other institutions will increasingly be expected to move beyond simple dissemination of new findings and assume a more interactive role with the public. Grunig said that the new approaches to communication will be characterized by conversation and exchange of information, ideas, and reactions. Despite the increase in public discussion of science on social media, Englehardt said that university-based scientists remain poorly trained in navigating these platforms because their institutions do not allocate resources for training.

Caulfield noted that many factors fuel the hype pipeline, including researchers' continuing need to publish new findings and secure external research funding, mass-media spin, marketing, vested interests, and the "science bandwagon". He added that social media contribute to hype about scientific issues and that the effect of this hype is related to the asymmetry of negative information, a point that was raised by a number of speakers. Caulfield also discussed the role of "availability cascades" in driving news stories—self-reinforcing processes in which shared beliefs are formed through chain reactions that give a "perception of increasing plausibility through increasing presence in public discourse". Caulfield emphasized that social media enhance the frequency and effect of availability cascades and that the cascades can be reinforced when celebrities, such as Jenny McCarthy[23], take part in or provide leadership of them. According to Caulfield, the cascades "allow misinformation to thrive" in a manner that erodes public trust.

Caulfield said that in some cases, key intermediaries between science and the public—including journalists—may not care about improving the public's trust in science because their incentives are different from those of scientists. Caulfield's noted that journalists are "complicit collaborators" for whom building trust is not a primary objective. However, he also noted that although there is considerable criticism of the mass media for driving hype, his research shows that the media were generally effective in representing information that they were given. There are "errors of omission" in what is quoted by the media, but Caulfield said that the material is generally accurate even if it lacks important context.

TRUSTWORTHINESS OF SCIENCE NEWS

Ivan Oransky of Retraction Watch and MedPage Today moderated a panel discussion on the challenges faced by Web, print, and radio media in identifying reliable sources and promoting intelligent scientific discussion. Panelists touched on a number of issues raised by other speakers, including exaggerated press releases, communication with university-based investigators, conflict of interest, and the need to get information out quickly. Oransky began the discussion by asking panelists how they identify reliable sources and how they decide who is trustworthy (Box 5-1). Scott Hensley of National Public Radio said that he looks for sources who have expertise in the subject of the story that he is working on and that the

[23] An America model, author, and television host known for anti-vaccine activism.

source also needs to be someone whom he can establish for the audience as having the right qualifications to provide input on the story. Hensley shared frustrating experiences in which he attempted to contact a university-based researcher to follow up on a press release only to find that the contact person was not available to speak about the work. He pointed out the practical challenges that lack of availability creates for journalists who seek to be thorough and accurate in their coverage. Julia Belluz, of Vox, expressed her desire to avoid sources who appear to be biased and those whose consistent positions on a given issue suggest that they lack objectivity. When researching a topic, Belluz said, she uses systematic literature reviews to find sources that have a broad and balanced overview of key issues, and she draws on people who have conducted the reviews to understand what is known and not known about an issue. She said that these "meta researchers [are] hugely helpful and tend to have less of a conflict and agenda." Saying that "everyone has an agenda," Hensley noted that he tries to understand his sources' agendas and to take them into account in his reporting. Liz Szabo of *USA Today* said that because she works for an on-line media organization that demands rapid release of new information, she places a premium on the ability of sources to respond to her inquiries quickly. Szabo emphasized the extreme time sensitivity of the news in which she and many other science journalists must operate. In that setting, Szabo said, she needs her sources to be able to answer her questions "in the equivalent of a tweet" – get to the point quickly in an understandable manner.

Oransky pointed out that Belluz, Hensley, and Szabo are specialist journalists, each with their own expertise in science and medicine. He asked them to discuss the effect that having more generalist reporters cover science news may have on public trust. All the panelists expressed concern about reductions in the number of experienced reporters covering science and medicine. Szabo said that general-assignment reporters have "the hardest job in the newsroom" because "every day is like the first day on the job," they have to rapidly learn

BOX 5-1

Journalists Hensley, Belluz, and Vox described a wide range of characteristics they take into consideration for selecting and determining the trustworthiness of sources for a science news story:

- Expertise
- Credibility
- Objectivity
- Potential conflicts of interest
- Availability to response
- Timeliness of response to a contact or telephone call
- Succinctness
- Clarity
- Quotability

about a new topic. As a result, some of the problems in health and science news stem from articles written by general-assignment reporters. Unlike specialists, generalists do not have the accumulated experience in science journalism to help them to identify good and bad elements of a story, or how to give weight to different opinions about the science. Their lack of depth expertise in science creates a situation, Szabo said, in which these journalists do not "know what to look for" when covering a story and identifying sources. She said that budget cuts, increased Web-based reporting, and other streamlining efforts have reduced the availability of science specialists and increased the number of generalists covering science beats. Although Szabo warned that these changes will mean that more young and unseasoned reporters will have a very challenging job, she emphasized that regardless of background and training, qualified reporters are always taught to "find the other side" and that opposing views need to be represented regardless of whether the reporter is a specialist or a generalist.

"I find it terrifying—the idea of covering the courts in the morning and medicine in the afternoon. I've been full time on medicine for about 4 years, and I'm still learning" Belluz said. She said that the fact that many newspapers no longer have a cadre of experienced science reporters prevents the public from relying on this aspect of "the golden circle" described by Marcia Kean of Feinstein Kean Health care and may drive public audiences to seek information from other, less traditional sources.

The media panelists acknowledged that although intrinsic safeguards exist, journalists make mistakes. Hensley pointed out that in cases where there are substantial failings on the part of the media, there is often more than one level of failure. For example, there may be a failing on the part of a reporter to include a reliable, opposing viewpoint in a given story, and this omission may also be missed during editorial review of the story, he explained. In most cases, institutional safeguards identify and correct such problems, but when there are failures on multiple levels, the problems can result in diminished trust in the media. Hensley echoed Szabo's concerns about "the hollowing out of newsrooms" and about how reduction in the number of experienced science reporters weakens the balance that is designed to optimize reporting. Panelists said that the unfavorable effect of the staffing trends is exacerbated by an increase in the number of inexperienced reporters who work in specialty fields with less of an editorial safety net. Hensley said that "there is much more opportunity for errors in sourcing and errors in judgment on stories that are complex, and I think it is something that we in the profession recognize. But it is difficult to see how we improve it other than one story at a time."

Oransky asked panelists what changes they thought had occurred in the perception of medicine and science as a result of changes in journalism. Referring to her reporting on the recent measles outbreak, Belluz shared the surprise that she felt when she learned about how much information is available to the public that encourages parents to delay or avoid vaccination. She said that was "not the world that [she] inhabits" and added that because these types of issues are so polarizing and because of the media's inevitable effect on public-health messaging, journalists need to be particularly aware of the need for reliable sources. Belluz said that in her reporting she pays particular attention to "balances, harms, and tradeoffs" so that the public can get a full understanding of the complexity of issues. Responding to the

frenzy of media coverage during the Ebola crisis, Szabo said, the country "toggled from apathy to hysteria and back again." In response, she attempted to use her reporting to prevent her newspaper from "going over the cliff into stupid land". During that time, she covered the issue in a manner that was intended to "nudge people toward informed, engaged compassion."

Commenting on the variety of ways in which media consumers can use their time, Hensley said that with each story there is "a battle for attention" and that he and his colleagues are "out there competing for people's attention, whether it is with other news stories, video games, or e-mail or text messages." He explained that "one of the challenges for us is to compete honestly for that attention and to do stories that live up to our standards as a news organization and still engage the audience." He added that the intense competition for the public's attention provides an opportunity for organizations and interests to release information on a variety of platforms that can be incorrectly perceived as legitimate journalism by public audiences. The media panelists and other workshop attendees spoke repeatedly about the challenges to both scientists and the public of navigating a new information age in which experienced journalists, nonscientist celebrities (such as Jenny McCarthy), and the lay public all have access to communication-technology platforms that facilitate the initiation and curation of complex scientific discussion.

6

Strategies to Link Knowledge with Action

"If we really want the public to trust science, we have to create a scientific system that is worthy of trust."—Rose McDermott

"Trust is not a monolithic feature—it operates on many levels…. It can be stewarded, built, protected, and broken." —Molly Jahn,

A framework for how to build, maintain, and if needed, restore the public's trust in science does not yet exist. Workshop participants shared ideas about how the science community, including researchers, research institutions, science communicators, and policy makers, can better engage with members of the public in ways that promote trust in science.

A NEW SOCIAL CONTRACT

Marcia Kean, of Feinstein Kean Healthcare, believes that a new "trust fabric" needs to be built and should not resemble the old social contract. She said that the new fabric will need to be built through "partnership, participation, and peer groups".

ENGAGEMENT

James Grunig of the University of Maryland emphasized that science institutions "fail to engage with the public" on issues that members of the public care about. He said that scientific organizations tend to "just push stories and not engage in true dialogue with people who need information." In public relations, he noted, openness and accessibility are insufficient for building trust alone, science organization must "truly engage."

Kean stressed the need to "get into the dialogue early." She said that unlike the past when scientists did not engage with the public on social media and other non-traditional platforms, scientists will not only need to respond to questions and concerns, they will need to initiate discussions in order to become effective curators of those discussions. Not only do scientists fail to engage on these popular platforms thereby losing opportunities for discussion with the public. "In general, the more radical groups tend to enter issue arenas first, they

dominate the discussion, and then it's very difficult for the [scientific] organization to enter," Grunig said. Scientific organizations that react slowly to those situations end up having a "place in the audience" that prevents them from being effective messengers and diminishes their role as active participants in the contemporary scientific narrative.

RESPECTING AND ADDRESSING VALUES

Rose McDermott of Brown University underscored the need to recognize and act on the reality that cultural and religious factors compete with science for a place in the public's value system. To be successful in communicating and building trust, she said scientists must learn to work effectively in this landscape to earn privileges in the public's diverse and complex value systems. Grunig added that although scientists have been trained to be dispassionate observers, to report facts, and to shy away from emotion and anecdote, "logic is not always the best way or the only to address a scientific issue. Emotions are important. Organizations need to react to the emotions." He and other presenters said that scientific organizations need to move beyond merely presenting or correcting facts about given scientific issues; they must acknowledge and act on the reality that peoples' emotions, values, and personal experiences are important elements of these new dialogues.

SCIENCE EDUCATION

Rush Holt of the American Association for the Advancement of Science (AAAS) stressed the importance of identifying and capitalizing on opportunities to teach the public about science, and he emphasized the need to improve the public's education about the concept of risk. With greater understanding in place, Holt said that stakeholders will be better positioned to handle challenging situations in the future. McDermott echoed Holt and highlighted the importance of improving public knowledge of "what science and research are", what clinical trials are, and the nature of information that is gleaned from these sources.

Tim Caulfield of the University of Alberta advised that the commercialization of science must be handled better and said that the unfavorable impact that conflicting research results have on public trust points to the need for more reproducible research. Like several other speakers, Caulfield called for education to help the public to understand the role of uncertainty and how evidence is generated and evaluated. He added that teaching critical thinking to children and analysis to adults needs to be improved because these skills are at the foundation of an informed public. Scientists need to engage actively in discussions on social media as part of larger efforts to recognize and work in new ways with diverse stakeholder communities. With new strategies in place, Caulfield speculated the public would be better equipped to develop logical scientific conclusions on its own.

RESPONSIBLE CONDUCT

"If we really want the public to trust science we have to create a scientific system that is worthy of trust," McDermott stated. She emphasized that that will require scientists to shift their values away from *outcomes* of research and toward the *process* of research—the ethics and quality of study design and research protocols. McDermott pointed out that most institutions reward the speed and sexiness of research. "We don't have a good standard of

ethics across disciplines." She emphasized that science community, government, and journalists should all have a high standard of ethics, and publically acknowledge the people who meet the standards.

LEARNING BY DOING

The workshop included three breakout sessions whose goal was to identify ideas about how the scientific community could restore, maintain, or build trust in synthetic biology, vaccination, and breast cancer screening (Box 6-1). During each breakout session, a facilitator was joined by a case presenter who provided the group with societal context of the topic. The case presenter's role was to help participants to discuss public perceptions of the topic and to promote discussion of potential mechanisms for restoring, maintaining, or building trust. The presenters did that by providing information on what is known about stakeholders in societal discussions and how scientists have engaged in public discussions of the topics. After the sessions, facilitators were responsible for reporting summaries of key points to the entire workshop audience.

The reports from the breakout groups added topic-specific suggestions to many of the ideas that had been offered throughout the workshop. Reporting for the synthetic biology breakout group, Erika Shugart of the American Society of Microbiology said that her group engaged in a lively discussion that started with defining synthetic biology and summarizing what is known about the public's understanding of this field. She said that the group defined the field as "the capacity to engineer biology—applying engineering concepts to biology." She noted that the group first addressed the basic question of whether it should engage in the issue of public trust and decided that it was important to do so. Shugart provided several reasons for the group's decision. Although current regulatory policies may not apply well to

BOX 6-1
Break-out Session Goal and Questions

Tiffany Lohwater, of AAAS, described the formal goal of the breakout sessions, and provided two questions for attendees to guide the discussion.

Session Goal: On the basis of the presentations and discussions of Day 1 and the morning of Day 2, outline the three most effective things that the scientific community can do to foster public trust in the topic.

> **Question 1:** On a scale of 1–10, 1 meaning enjoys poor public trust and 10 meaning enjoys high public trust, where do you think this topic falls?
>
> **Question 2:** What components of trust (from workshop discussions yesterday and this morning) do you think are particularly critical in public engagement to cultivate, maintain, or restore trust?

this novel field, she said, companies are bringing new products to market—a consideration that suggests that the public will soon see the application of this technology. These issues led the group to agree on the importance of starting a public conversation. Shugart added that there have been calls from the scientific community to initiate a more active discussion of this emerging field.

The synthetic biology group reported that there are probably varied degrees of trust about the field and that how the technology is used is probably one of the strongest correlates of public trust. Shugart said that if synthetic biology were applied to food, it might have a lower level of public trust than if it were used for a medically oriented application. As part of the group's efforts to suggest mechanisms for promoting public trust in this technology, it first considered what is known about the public's understanding of the field. This discussion resulted in agreement that such activities as monitoring, surveys, and focus groups around the topic of synthetic biology have been conducted in an episodic manner. However, because the field is generating public attitudes and perceptions that are developing quickly, the group believed that a more structured approach to assessing public knowledge of synthetic biology is needed and that these efforts would help scientists to follow evolving conversations and public attitudes as they develop.

Shugart conveyed the group's belief that because of uncertainty about the field in the scientific community there is tension about whether communication efforts should aim to get the public to "embrace the technology" or the efforts should simply convey information. The group decided that scientists should approach discussions with the public as "honest brokers" and address difficult issues together rather than trying to "sell" the technology. Shugart said that new case studies and scenarios could be developed and used as platforms to engage the public in the discussions. An important aspect of the new communication tools would be inclusion of diverse examples of synthetic-biology applications so that the public can understand the far-reaching applications of the technology. She said that the process by which the discussions occur needs to be considered carefully, and she conveyed the group's belief that the public must be part of them. Shugart's report addressed the question of who in the scientific community would be tapped to communicate about synthetic biology. White men dominate the field today, and the group believed that it was important to learn which people could communicate key messages effectively to different segments of the public. Once they have been identified, they would need to be trained in the skills needed to engage the public fully rather than skills aimed at advocating one point of view over another. Shugart said that those communicators would need to be proficient in explaining scientific uncertainty and the limitations of synthetic biology. She also said that specific efforts should be made to find and enlist the assistance of key intermediaries, such as religious leaders.

Reporting on the childhood-vaccination breakout session, Mary Woolley, of Research!America, said that her group identified a number of ideas that were similar to the ones that Shugart presented. Citing a "landscape of concerns" about the current status of public trust in vaccination, Woolley said that one step that the scientific community can take toward building public trust is to avoid promoting the idea that we are in "a crisis state". She noted that although more than 90% of children are being vaccinated, "pockets of trouble" remain a legitimate cause for concern, and these are reflected in such events as the recent

measles outbreaks. Nevertheless, the group agreed that controversies about vaccination are amplified by people who are "too casual" about referring to a vaccination crisis when, as now, there is none. Woolley reported that the group indicated that enhanced efforts to test messages about vaccinations are needed. It is important that messages are accurate, actionable, and sensible. Wooley pointed out that sometimes scientific words have different meanings to layperson that they have for a scientist. . She cited the example of the Centers for Disease Control and Prevention announcement that measles was "eliminated" in the United States. To most people *eliminated* would meant that the disease "is gone", but in the public health community eliminated means that new cases of the disease are no longer arising. A more effective public message would be to say that the spread of measelse is "under control," she said.

Woolley reported that scientist–communicators should not "stand alone" when talking about scientific issues that are controversial in the public eye. The group believed that it is better and more effective for scientists to form alliances with other groups that can convey trustworthy messages to their own communities. She pointed to Shugart's earlier suggestions about the need to work with religious institutions and other communities as an example of this collaborative strategy. Woolley said that other allies, such as trusted celebrities and political figures, can also serve in this role.

Like many of her colleagues, Woolley shared her group's support of engaging fully with the public and "avoiding scientific invisibility". She said that the more that scientists can do to become visible in the community before a crisis occurs, the easier it will be for them to act as trustworthy information brokers when a crisis does occur. Also in line with other presenters was Woolley's suggestion that research on factors that influence when and why people trust the scientific community is most useful before a crisis occurs. Woolley concluded her report by emphasizing the importance of context in understanding parents' decisions about vaccination and calling for greater understanding of the social, political, and public context around vaccination as a means of building trust.

Barnett Kramer of the National Cancer Institute reported on the breast cancer screening breakout session. He provided context for his report by saying that the group focused not on the value of breast-cancer screening itself but on issues related to trust in messages related to breast-cancer screening and the scientific methods underpinning the research that generates the messages. Kramer said that his group agreed that there is a need to ensure that "the strength of messages matches the strength of the actual evidence." He explained that if evidence concerning a particular breast-cancer screening-related issue is equivocal, messages related to the issue should reflect the uncertainty. Kramer emphasized the importance of tailored messages of that kind: it is difficult for organizations to back away from health messages that were initially too strong and are later found to be lacking in evidence. One strategy that the group identified to improve public trust related to breast-cancer screening was for the scientific community to work toward improving methods of presenting different levels of evidence to the public. Like the other breakout groups, this group felt that it is important to engage the mass media to a greater extent on these issues than is now the case. He added that because the media's role is to be an honest broker, they need to have the tools to convey messages accurately and respectfully, and more can be done to

facilitate the process. Kramer reiterated earlier observations concerning the need for scientists to understand and respect the public's values and the need for health-care providers to be trained better to explain the tradeoffs of screening to patients in a respectful manner.

During the question and answer period that followed the breakout session reports, Phyllis Pettit Nassi of the Huntsman Cancer Institute said that if scientists do not engage with people who work with communities and bring member of the public to the discussion table, scientists end up talking to themselves. This observation was consistent with much of the workshop's discussion of the importance of improving scientists' ability to communicate effectively with diverse segments of the public.

FINAL THOUGHTS

Jamieson recalled McDermott's explanation that higher oxytocin levels can increase trust: "What is the rhetorical equivalent of increasing oxytocin levels?" Jamieson believes that to ensure the voice of science is a dispassionate voice that focuses on knowledge (but is not cold), scientists "should care about knowing the best they can and carefully specify the limits of what is not known according to scientific norms," she said. Scientists also have to trust that a public audience is capable of understanding the science, she said, "at least as much as they need to engage in the public debate."

Jamieson thinks that too often the public experiences the voice of science as disdainful—a voice that says, "We have a consensus; now accept it." That is an appeal to authority, which she knows from her research does not go over well in the modern world. The modern world reacts poorly to authority, she said, but is responsive to a voice that lets the audience participate in the process of understanding and draw its own conclusions. Scientists should also confront disconfirming evidence to help people learn about science, she said. Scientists who engage rather than only disseminate, Jamieson believes, can become more effective in the public arena.

Appendix A
Workshop Agenda

Tuesday, May 5, 2015

9:00 Welcome & Opening Remarks—Molly Jahn, University of Wisconsin-Madison

9:15 What Surveys Do and Don't Tell Us about Trust in Science—Cary Funk, Pew Research Center

9:45 Defining Trust in Science and the Factors that Erode It—Timothy Caulfield, University of Alberta

10:15 Break for Discussion & Coffee

10:35 Discussion: Trust in the Market Place

Moderator: George Matsumoto, Monterey Bay Aquarium Research Institute

Panelists
Kirk Englehardt, Georgia Institute of Technology
James Grunig, University of Maryland, College Park
Marcia Kean, Feinstein Kean Health Care
Morning Speakers (Tim Caulfield & Cary Funk)

12:00 Break for Lunch

Afternoon Session Moderator: Cynthia Beall, Case Western Reserve University

1:00 Cultural Influences on Trust in Science—Phyllis Petit Nassi, Huntsman Cancer Institute

1:30 Celebrity Scientists and Trust—Declan Fahy, American University

2:00 Biology of Trust and its Influences on Science Politics—Rose McDermott, Brown University

2:30 Discussion: Political Dimensions of Trust in Science

Moderator: David Goldston, Natural Resources Defense Council

Panelists
Ann Bartuska, US Department of Agriculture, Research, Education, and Economics
Jo Handelsman, The White House Office of Science and Technology Policy
Rush Holt, American Association for the Advancement of Science
Rose McDermott, Brown University

3:30 Break for Discussion & Coffee

3:50 Discussion: Trustworthy Sources

Moderator: Ivan Oransky, Retraction Watch

Panelists
Julia Belluz, Vox
Scott Hensley, NPR Shots Blog

Liz Szabo, USA Today

5:00 Adjourn Day 1

Wednesday, May 6, 2015

9:00 Welcome & Opening Remarks—Rick Borchelt, Department of Energy (DOE), Office of Science

9:10 Toward a Common Understanding of Trust in Science—Kathleen Hall Jamieson, University of Pennsylvania, Annenberg School for Communication

9:45 Description and Goals of the Breakout Sessions—Tiffany Lohwater, American Association for the Advancement of Science

10:00–12:00 Breakout Group Discussions

Breakout A: Synthetic Biology
Facilitator: Erika Shugart, American Society for Microbiology
Case Presenter: David Rejeski, Woodrow Wilson International Center for Scholars

Breakout B: Vaccines
Facilitator: Mary Woolley, Research!America
Case Presenter: Diane Griffin, Johns Hopkins Bloomberg School of Public Health

Breakout C: Breast Cancer Screening
Facilitator: Barnett Kramer, National Cancer Institute, NIH
Case Presenter: Phyllis Petit Nassi, Huntsman Cancer Institute

12:00 Break for Lunch

1:00 Synthesis—Approaches to Link Knowledge to Action
Moderator: Cynthia Beall, Case Western Reserve University

Breakout Session Reports

Facilitated Audience Discussion

2:45 Closing Comments—Rick Borchelt, DOE

3:00 Adjourn Workshop

Appendix B
Workshop Registrants

Michele Banks, Artologica
Ann Bartuska, U.S. Department of Agriculture, Research, Education, and Economics
Cynthia M. Beall, Case Western Reserve University
Tim Beardsley, AIBS
Julia Belluz, Vox
Jack Bobo, U.S. Department of State
Rick Borchelt, Department of Energy, Office of Science
Ann Bouchoux, SR Strategy
Jessica Brooks, IDA - STPI
Shane Burgess, The University of Arizona
Russ Campbell, Burroughs Wellcome Fund
Timothy Caulfield, University of Alberta
Ida Chow, Soceity for Developmental Biology
Chris Clarke, George Mason University
Jennifer Cutraro, WGBH
Emily Dilger, American Society for Microbiology
David Ewing Duncan
Kirk Englehardt, Georgia Institute of Technology
Declan Fahy, American University
Cary Funk, Pew Research Center
David Goldston, Natural Resources Defense Council
Diane Griffin, Johns Hopkins Bloomberg School of Public Health
James Grunig, University of Maryland, College Park
Lynne Hall, Huntsman Cancer Institute
Jo Handelsman, The White House Office of Science and Technology Policy
Erin Heath, AAAS
Frank Hedgecock, DuPont Pioneer
Laura Helft, Howard Hughes Medical Institute
Scott Hensley, NPR Shots Blog
Rush Holt, AAAS
Carlin Hsueh, Association of Science-Technology Careers
Audrey Huang, Johns Hopkins Medicine
Marcos Huerta, D.O.E. Office of Science
David W. Inouye, University of Maryland, College Park
Molly Jahn, University of Wisconsin-Madison
Kathleen Hall Jamieson, University of Pennsylvania, Annenberg School for Communication
Marcia Kean, Feinstein Kean Health Care
Heather Killen, Mohave Community College
Se Kim, AAAS
Barnett S. Kramer, National Cancer Institute, National Institutes of Health
Alison Kretser, ILSI North America
Jodi Liberman, APS Physics

Michael Lohuis, Monstanto
Tiffany Lohwater, AAAS
Kanoko Maeda, NAS
Kristin Manke, Pacific Northwest National Laboratory
David Manning, Brookhaven National Laboratory
Adrianne Massey, BIO
George I. Matsumoto, Monterey Bay Aquarium Research Institute
Rose McDermott, Brown University
Stephen McFadden, ISRA
Morven McLean, ILSI Research Foundation
Julia Milton, Consortium of Social Science Associations
Keri Moss, American Chemical Society
Delia Murphy, ILSI North America
Phyllis Pettit Nassi, Huntsman Cancer Institute, University of Utah
Anne Nicholas, Society for Neuroscience
Ivan Oransky, Retraction Watch and MedPage Today
Nalini Padmanadbhan, American Society of Human Genetics
Stephen Palacios, Added Value Cheskin
Eleonore Pauwels, Woodrow Wilson International Center for Scholars
Jennifer Pierson, HESI
Kenneth Ramos, Arizona Health Sciences Center
David Rejeski, Woodrow Wilson International Center for Scholars
Keegan Sawyer, NAS
Nathaniel Schaefle, U.S. State Department
Christine Scheller, AAAS
Eugenia Schenecker
Caitlin Schrein, National Science Foundation
Tim Schwab, Food & Water Watch
Erika Shugart, American Society for Microbiology
Debra Speert, FASEB
Arvind Suresh, Genetic Expert News Service
Liz Szabo, USA Today
Grace Troxel, Center for Advancement of Informal Science Education (CAISE)
Harrison Wein, National Institutes of Health
Shari Werb, Smithsonian National Museum of Natural History
Mary Woolley, Research!America

Appendix C
Speaker and Planning Committee Biographies

Ann M. Bartuska is deputy undersecretary for the US Department of Agriculture (USDA) Research, Education, and Economics (REE) (@scienceatusda) mission. She came to REE in September 2010 from the USDA Forest Service, where she was deputy chief for research and development, a position she had held since January 2004. She served as acting USDA deputy undersecretary for natural resources and environment from January to October 2009 and was the executive director of the Invasive Species Initiative of the Nature Conservancy from 2001 to 2004. Earlier, she was the director of the forest and rangelands staff in the Forest Service in Washington, DC. Dr. Bartuska is an ecosystem ecologist and has a BS from Wilkes College, an MS from Ohio University, and a PhD from West Virginia University. She represents USDA on the Committee on Environment, Natural Resources, and Sustainability of the White House National Science and Technology Council. Dr. Bartuska is on the Multidisciplinary Expert Panel of the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), which was chartered by the UN Environment Programme, and is active in the Ecological Society of America, of which she served as vice president for public affairs from 1996 to 1999 and president from 2002 to 2003. She has served as cochair of the Science and Technology for Sustainability Roundtable of the National Academies and on the Board of the Council of Science Society Presidents and is a member of the American Association for the Advancement of Science and the Society for Advancement of Chicanos/Hispanics and Native Americans in Science.

Cynthia Beall is Distinguished University Professor and S. Idell Pyle Professor of Anthropology (@CWRUartsci) at Case Western Reserve University, where she began teaching and research in 1976. She received an MA in 1972 and a PhD in 1976 from Pennsylvania State University, where she trained with Paul Baker. Dr. Beall is a member of the National Academy of Sciences, the American Philosophical Society, and the American Academy of Arts and Sciences. She has served on a number of National Academies committees and is currently a member of the Division Committee of the Division of Behavioral and Social Sciences and Education and cochair of the Roundtable on Public Interfaces of the Life Sciences. She is a founding co-organizer of Science Café Cleveland. Dr. Beall is a physical anthropologist whose research focuses on human adaptation to high-altitude hypoxia, particularly the different patterns of adaptation exhibited by Andean, Tibetan, and East African highlanders. She is working to integrate genomics and human biology to discover how indigenous people living at high altitudes evolve and adapt to the stress of very low oxygen availability. Her efforts include fieldwork in mountainous regions of Bolivia, Ethiopia, Nepal, Mongolia, Peru, and the Tibet Autonomous Region of China, where millions of people live at altitudes of 10,000 ft or more. This avenue of research contributes to the larger question of how evolution and adaptation operate in modern human populations.

Julia Belluz (@juliaoftoronto) is a National Magazine Award-winning journalist who covers medicine and public health for Vox.com. She was a 2013–2014 Knight Science Journalism Fellow at the Massachusetts Institute of Technology. Ms. Belluz's writing has appeared in *Maclean's*, the *British Medical Journal*, the *Globe and Mail*, the *National Post*, *Slate*, *The*

Times (of London), *The Economist*, and other publications. Outside of reporting, she speaks regularly in health-care and journalism conferences all over the world. Ms. Belluz holds a BA from Ryerson University's School of Journalism and an MSc from the London School of Economics. She is based in Washington, DC.

Rick Borchelt (@RickBorchelt) is director of communications and public affairs in the US Department of Energy (DOE) Office of Science. Before going to DOE, he served as the special assistant to the director of the National Institutes of Health National Cancer Institute (NCI) for public affairs and director of NCI's news office, providing strategic guidance and coordination of the institute's communication and public-affairs programs. Mr. Borchelt was communication director for the research, education, and economics mission of the US Department of Agriculture (USDA) and for the USDA Office of the Chief Scientist. Before taking his positions at USDA, he was director of communication for the Pew-funded Genetics and Public Policy Center of Johns Hopkins University, where his work included message development, media relations, and strategic communication. He is a lecturer in science policy and politics in the Hopkins Advanced Academic Programs division. He is a former media-relations director for the National Academy of Sciences; press secretary for the US House of Representatives Committee on Science, Space, and Technology; special assistant for public affairs in the Executive Office of the President during the Clinton administration; director of communication for the DOE Office of Science; and director of communication and public affairs in the Whitehead Institute for Biomedical Research of the Massachusetts Institute of Technology. He also served on the committee that undertook the National Academy of Engineering's study of public communication about engineering. He is an adviser to the National Science Foundation–funded Nanoscale Informal Science Education project. An undergraduate biology major, he has done graduate work in insect systematics and science communication; subjects of particular interest include developing community-based public engagement in science and adapting the Southern narrative tradition to science communication.

Timothy Caulfield (@caulfieldtim) is a Canada Research Chair in Health Law and Policy and a professor in the Faculty of Law and the School of Public Health of the University of Alberta. He has been the research director of the Health Law Institute of the University of Alberta since 1993. He has been involved in various interdisciplinary research endeavors that have led to over 300 articles and book chapters. He is a fellow of the Trudeau Foundation and the principal investigator for several interdisciplinary projects that explore the ethical, legal, and health-policy issues associated with such topics as stem-cell research, genetics, patient safety, the prevention of chronic disease, obesity policy, the commercialization of research, complementary and alternative medicine, and access to health care. Prof. Caulfield has been involved with a number of national and international policy and research-ethics committees, including the Canadian Biotechnology Advisory Committee, Genome Canada's Science Advisory Committee, the Ethics and Public Policy Committee of the International Society for Stem Cell Research, and the Federal Panel on Research Ethics. He is a fellow of the Royal Society of Canada and the Canadian Academy of Health Sciences. He is the author of *The Cure for Everything: Untangling the Twisted Messages about Health, Fitness and Happiness* and *Is Gwyneth Paltrow Wrong About Everything?: When Celebrity Culture and Science Clash*.

Kirk Englehardt (@kirkenglehardt) is director of research communication and marketing of the Georgia Institute of Technology. The first person to serve in that role, he is responsible for developing the first integrated strategic marketing and communication plan for Georgia Tech's $730 million research enterprise. He provides strategic support for Georgia Tech's research news activities, the university's many research institutes and centers, research leaders, and external partners. That includes focusing on how messages about Georgia Tech's research are reaching and resonating with key internal and external audiences. Before assuming his current role, Mr. Englehardt spent 7 years leading communication activities for the Georgia Tech Research Institute; he led an intensive rebranding effort that sparked great growth, which included doubling the organization's research revenue, now more than $300 million a year. During his 10-year Georgia Tech career, his teams have won more than 65 industry and professional-society awards for communication strategy, measurement, and tactics. Among them are a Bronze Anvil from the Public Relations Society of America, two TAMY marketing awards from the Technology Association of Georgia, and awards from the Georgia Chapter and the Southeast Region of the International Association of Business Communicators for audience research conducted in support of Georgia Tech's research communication strategy.

Declan Fahy (@fahydeclan) is an assistant professor in the School of Communication of American University, in Washington, DC, where his research examines science journalism and science in popular culture. He is the author of *The New Celebrity Scientists: Out of the Lab and Into the Limelight*. His scholarship has been published in *Journalism, Journalism Studies, Nature Chemistry, Science Communication, BMC Medical Ethics, Annals of the American Academy of Political and Social Science*, and other journals.

Cary Funk (@surveyfunk) is associate director of research on science and society at the Pew Research Center. She is a coauthor of *Public and Scientists' Views on Science and Society* and *How Scientists Engage the Public*. She is a survey researcher and has broad expertise in political and social attitudes, including politics and elections, race and ethnicity, and religion and US politics. She has been specializing in public understanding of science topics since 2001. Before joining Pew Research, she directed the Virginia Commonwealth University (VCU) Life Sciences Surveys, national surveys on science and biotechnology. She has served as an outside consultant and adviser on numerous projects related to the science and engineering workforce and public opinion on science. She is now on the Editorial Board of the *Bulletin of Science and Technology and Society*. Dr. Funk began her career at CBS News in New York, where she worked on pre-election surveys and exit polls; in more recent years, she served as an election-night analyst for NBC News. She was on the political-science faculties of Rice University and VCU before joining Pew Research. While an associate professor at VCU, she directed statewide polls on politics and public-policy issues and on K–12 education in addition to the VCU Life Sciences Surveys. She earned a doctorate and a master's in social psychology from the University of California, Los Angeles. Dr. Funk has published numerous academic articles and book chapters in political science, public opinion, and political behavior and is a coauthor of *The Rise of Asian Americans, Asian Americans: A Mosaic of Faiths*, *"Nones" on the Rise,* and *The Shifting Religious Identity of Latinos in the United States*.

David Goldston is director of government affairs at the Natural Resources Defense Council (NRDC; @NRDC). He came to NRDC after working for more than 20 years on environmental policy and science policy on Capitol Hill. From 2001 through 2006, he was the chief of staff of the House of Representatives Committee on Science, Space, and Technology. He has written extensively on science policy, including a monthly column for *Nature*, and has participated in numerous report-writing panels for the National Academies. He has an undergraduate degree from Cornell University in history and completed the course work for a PhD in American history at the University of Pennsylvania.

Diane E. Griffin is University Distinguished Service Professor of Molecular Microbiology and Immunology in the Johns Hopkins Bloomberg School of Public Health (@JohnsHopkinsSPH) and vice president of the US National Academy of Sciences. She earned her BA in biology at Augustana College in Rock Island, IL, and her MD and PhD at Stanford University School of Medicine. Her research interests are in pathogenesis of viral diseases with a focus on measles and alphavirus encephalitis. Her studies address issues related to virulence and the role of immune responses in protection against and clearance of infection. Her work has included evaluation of licensed and experimental vaccines for measles. She is a past president of the American Society for Virology and the American Society for Microbiology. She is the chair of the Viral Diseases Panel of the US–Japan Cooperative Medical Sciences Program. She has received the Rudolf Virchow Medal (2010), the Wallace Sterling Lifetime Alumni Achievement Award from Stanford University (2011), and the Federation of American Societies for Experimental Biology Excellence in Science Award (2015).

James E. Grunig (@jgrunig1) is a professor emeritus in the Department of Communication of the University of Maryland College Park. He holds a PhD in mass communication from the University of Wisconsin. He is the coauthor of five books and editor of a sixth. Dr. Grunig has written more than 250 other publications, such as book chapters, journal articles, and reports. His major research has been in public relations and science communication, including the nature of organization–public relationships (of which trust is a major component). He has won six major awards in public relations and the lifetime award of the Association for Education in Journalism and Mass Communication, the Paul J. Deutschmann Award for Excellence in Research. Dr. Grunig was the founding coeditor of the *Journal of Public Relations Research* and has been awarded honorary doctorates by universities in Peru, Romania, Turkey, and Canada.

Jo Handelsman is the associate director for science in the White House Office of Science and Technology Policy (@whitehouseOSTP). In that position, she helps to advise the president on the implications of science for the nation, on how science can inform US policy, and on federal efforts in support of scientific research. Before joining OSTP, Dr. Handelsman was the Howard Hughes Medical Institute Professor and Frederick Phineas Rose Professor in the Department of Molecular, Cellular and Developmental Biology of Yale University. She previously served on the University of Wisconsin–Madison faculty as a professor in plant pathology from 1985 to 2009 and as professor and chair of the Department of Bacteriology from 2007 to 2009. In 2013, she served as president of the American Society for Microbiology. From 2002 to 2010, Dr. Handelsman was the cofounder and codirector of the Wisconsin Program for Scientific Teaching, the Yale Center for Scientific Teaching, and the National Academies Summer Institute on Undergraduate Education in Biology, programs

focused on teaching principles and practices of evidence-based education to current and future faculty at colleges and universities nationwide. Dr. Handelsman is an expert in communication among bacteria that associate with soil, plants, and insects and was a pioneer in metagenomics, bridging agricultural and medical services. She engages in research on science education and women and minorities in science and in 2011 received the Presidential Award for Excellence in Science Mentoring. Dr. Handelsman also cochaired the President's Council of Advisors on Science and Technology working group that developed the 2012 report *Engage to Excel*, which contained recommendations to the president for strengthening science, technology, engineering, and mathematics education to meet US workforce needs of the next decade. Dr. Handelsman received a BS from Cornell University and a PhD in molecular biology from the University of Wisconsin–Madison.

Scott Hensley (@scotthensley) has been writing and editing posts for *Shots, Health News from NPR* since summer 2009. Before joining NPR, he was the founding editor of *The Wall Street Journal*'s health blog. Mr. Hensley was previously an editor in the paper's New York Health and Science bureau. He initially joined the *Journal* in 2000 and covered health care and the pharmaceutical industry for 7 years. He also wrote "Follow the Money", an on-line column that looked at the health-care industry. His story about Pfizer Inc.'s failed attempt to develop an antiaging pill was part of a series on soaring drug prices that won a New York Press Club award for business coverage in 2003. Previously, he wrote for *Modern Healthcare*, where he was New York bureau chief, and *American Banker*. Mr. Hensley earned a bachelor's degree in natural sciences from Johns Hopkins University and a master's degree from Columbia University's Graduate School of Journalism. He is a member of the Association of Health Care Journalists.

Rush D. Holt became the 18th chief executive officer of the American Association for the Advancement of Science (AAAS; #AAAS) and executive publisher of the *Science* family of journals in February 2015. Over his long career, Dr. Holt has held positions as a teacher, scientist, administrator, and policy-maker. Before coming to AAAS, he served for 16 years as a member of the US House of Representatives, representing New Jersey's 12th Congressional District. His legislative work earned him numerous accolades, including being named one of *Scientific American* magazine's 50 National Visionaries Contributing to a Brighter Technological Future and a Champion of Science by the Science Coalition. He is also a past recipient of two of AAAS's highest honors: the William D. Carey Lectureship Award (2005) and the Philip Hauge Abelson Award (2010). Dr. Holt is a Phi Beta Kappa graduate of Carleton College and holds an MA and a PhD in physics from New York University.

Molly Jahn is a professor in the Laboratory of Genetics and the Department of Agronomy of the University of Wisconsin–Madison (@UWMadAgronomy) and a special adviser to the chancellor and provost for sustainability sciences. She has had a research career in plant genetics, genomics, and plant breeding of vegetable crops focusing on molecular genetics of disease resistance and quality traits. Her research groups at the University of Wisconsin and Cornell University have produced crop varieties that are now grown commercially and for subsistence on six continents under some 60 commercial licenses. She has also worked in developing countries to link crop breeding with improved human nutrition and welfare. Her innovative approaches to intersector partnerships, engagement with emerging institutions, and integrated projects focused on impact and technology transfer have been highlighted in numerous studies and books. She has consulted widely in the private sector and has served as

an adviser for philanthropic interests, venture capital and finance, First Nations, and US and other government agencies in agriculture, food security, and life and environmental sciences. She received a BA with distinction in biology from Swarthmore College and holds graduate degrees from the Massachusetts Institute of Technology and Cornell University.

Kathleen Hall Jamieson is the Elizabeth Ware Packard Professor at the Annenberg School for Communication of the University of Pennsylvania and director of its Annenberg Public Policy Center (@APPCPenn). She is also a fellow of the American Philosophical Society, the American Academy of Arts and Sciences, the American Academy of Political and Social Science, and the International Communication Association and a Distinguished Scholar of the National Communication Association. Five of her 16 books have received political-science or communication awards. And *The Obama Victory: How Media, Money and Message Shaped the 2008 Presidential Election* (written with Kate Kenski and Bruce Hardy) received the 2010 American Publishers Association's PROSE award as best book in government and politics. Dr. Jamieson has earned teaching awards in each of the three universities in which she has taught. In 2013, she keynoted the National Academy of Sciences Sackler Colloquium on the Science of Science Communication.

Marcia A. Kean is chairman for strategic initiatives of Feinstein Kean Healthcare (@FKHealth), a strategy and communication firm dedicated to advancing innovation in the life sciences and health care. Ms. Kean has more than 35 years of biomedical and information technology industry experience, working alongside innovators in the private and public sectors. Her clients have included Big Pharma; startups in biotechnology, device, genomics, informatics, personal-health and clinical-decision support; policy organizations; academic and medical centers; patient-advocacy groups; and government institutes. She has identified and helped to drive adoption of new waves of technology that have transformative impacts on health care. She was a leader in the emergence of the biotechnology industry in the late 1980s and 1990s, paving the way through patient and public education. In 2003, Ms. Kean founded the first molecular-medicine communication practice in the United States, and she was among an early-adopter group seeking to introduce the technologies to the world. She serves as an adviser to an initiative that seeks to shape policy and public education in synthetic biology. She holds a BA from the University of California, Berkeley and an MBA from New York University.

Barnett S. Kramer is the director of the Division of Cancer Prevention of the National Cancer Institute (@theNCI). He was editor-in-chief of the *Journal of the National Cancer Institute* from 1994 to 2012. He serves as chairman of the Physician Data Query (PDQ) Editorial Board on Screening and Prevention and is a member of the PDQ Treatment Editorial Board. Dr. Kramer has served on the Cancer Prevention Committee of the American Society of Clinical Oncology and chaired the committee from 2006 to 2007. He received his medical degree from the University of Maryland Medical School and completed his internship and residency in internal medicine at Barnes Hospital in St. Louis, MO. He completed a medical-oncology fellowship at NCI. He is board-certified in internal medicine and medical oncology and has received a master's degree in public health from the Johns Hopkins University Bloomberg School of Public Health. Dr. Kramer has extensive experience in primary-cancer prevention studies and in clinical screening trials for lung, ovarian, breast, and prostatic cancers. He is an investigator and on the steering committee for two large cancer screening trials sponsored by NCI: the Prostate, Lung, Colorectal, Ovarian (PLCO) Trial and the

National Lung Screening Trial (NLST). He has a strong interest in weighing and reporting the strength of medical evidence and created an annual Medicine in the Media Workshop to help working journalists to develop methods of reporting medical evidence.

Tiffany Lohwater (@tiffanylohwater) is director of meetings and public engagement of the American Association for the Advancement of Science (AAAS). She is responsible for the AAAS annual meeting and the AAAS Center for Public Engagement with Science and Technology. The AAAS annual meeting is the predominant international scientific conference for scientists, engineers, policy-makers, journalists, and others interested in the intersection of science, technology, and society. The AAAS Center for Public Engagement provides a vehicle for boosting public awareness and understanding of the nature of science and the work of scientists while increasing public input into scientific research and policy agendas. Ms. Lohwater's work encourages scientists to take a more personal and active interest in public engagement. She previously worked in research communication and public events for the Johns Hopkins University and the Rensselaer Polytechnic Institute.

George Matsumoto (@george_mage) is a senior educational and research specialist at Monterey Bay Aquarium Research Institute (MBARI). At MBARI, Dr. Matsumoto oversees multiple education and outreach programs, including internship, mentor, distance-education, and seminar programs. He also develops and coordinates collaborations with outside organizations and the MBARI's sister organization, the Monterey Bay Aquarium. Dr. Matsumoto's research interests are in open-ocean and deep-sea communities, the ecology and biogeography of open-ocean and deep-sea organisms, functional morphology, and natural history and behavior. He served on the Digital Library for Earth System Education (DLESE) Steering Committee and the 2000 National Science Foundation Committee of Visitors for Geoscience and currently serves as a national advisory board member for the Center for Microbial Oceanography: Research and Education, the Center for Coastal Margin Observation and Prediction, the Centers for Ocean Sciences Education Excellence, and several regional nonprofit organizations. Dr. Matsumoto is a member of the National Research Council Ocean Studies Board and has served on several other National Academies committees, including Research and Discoveries: The Revolution of Science through Scuba—A Symposium, which he chaired, and the Committee on the Review of the National Oceanic and Atmospheric Administration's Education Program. He received a PhD from the University of California, Los Angeles.

Rose McDermott is the David and Mariana Fisher University Professor of International Relations at Brown University's Watson Institute for International Relations (@WatsonInstitute) and a fellow of the American Academy of Arts and Sciences. She received her MA in experimental social psychology and her PhD in political science from Stanford University and has taught at Cornell, the University of California, Santa Barbara, and Harvard University. She has held numerous fellowships at Harvard, including those of the Radcliffe Institute for Advanced Study, the Olin Institute for Strategic Studies, and the Women and Public Policy Program. She was also a fellow of the Stanford Center for Advanced Studies in the Behavioral Sciences. She is the author of three books, a coeditor of two others, and author of over 100 academic articles on such topics as experimentation, emotion and decision-making, and the biologic and genetic bases of political behavior.

Phyllis Pettit Nassi is manager for special populations in the Huntsman Cancer Institute (@hunstmancancer) of the University of Utah and a PhD student who works in educating Alaska Natives about the importance of risk reduction, early detection, participation in clinical trials,and cancer research, and understanding the future, for example, of targeted therapies, pharmacogenomics, and immunotherapy. Ms. Nassi enrolled in the Otoe-Missouri Tribe and is a member of the Cherokee Nation. Raised on the Navajo, Hopi, and Zuni reservations, she works with research teams and national associations that advocate for recognition of the importance of researchers and their staff to understand tribal cultures and how to work with tribal nations.

Ivan Oransky (@ivanoranksy) is cofounder of the MacArthur Foundation–funded Retraction Watch and vice president and global editorial director of *MedPage Today*. He teaches medical journalism at New York University's Science, Health, and Environmental Reporting Program and is vice president of the Association of Health Care Journalists. Dr. Oransky has been executive editor of *Reuters Health*, on-line managing editor of *Scientific American*, and deputy editor of *The Scientist*. He earned his bachelor's degree at Harvard University, where he was executive editor of *The Harvard Crimson*, and earned his MD at the New York University of School of Medicine, where he holds an appointment as clinical assistant professor of medicine.

David Rejeski directs the Science and Technology Innovation Program (STIP) of the Woodrow Wilson International Center for Scholars (@TheWilsonCenter). The mission of STIP is to explore the scientific and technologic frontier, stimulating discovery and bringing new tools to bear on public-policy challenges that emerge as science advances. He is a visiting scholar at the Environmental Law Institute and was a visiting fellow at Yale University's School of Forestry and Environmental Studies and an adjunct affiliated staff member at RAND. In 1994–2000, he worked at the White House Council on Environmental Quality and the Office of Science and Technology Policy (OSTP) on a variety of technology, R&D, and policy initiatives, including the development and implementation of the National Environmental Technology Strategy, the Greening of the White House, and the Education for Sustainability Initiative. Before moving to OSTP, he was head of the Future Studies Unit of the Environmental Protection Agency. He spent 4 years in Hamburg, Germany, working for the Environmental Agency, Department of Public Health, and Department of Urban Renewal and in the late 1970s founded and codirected a nonprofit involved in energy conservation and renewable-energy technologies. He sits on the advisory boards of a number of organizations, including the Board on Global Science and Technology of the National Academies; the expert panel advising the Defense Advanced Research Projects Agency Living Foundries Program; the National Science Foundation (NSF) Advisory Committee on Environmental Research and Education; the NSF-funded Synthetic Biology Engineering Research Center; the external science advisory committee of the Center for Environmental Implications of Nanotechnology; the Committee on Science, Engineering, and Public Policy of the American Association for the Advancement of Science; the Center for Environmental Policy at American University; the National Council of Advisors for the Center for the Study of the Presidency; the *Journal of Industrial Ecology*; and Games for Change. In 2004–2009, he was a member of the Environmental Protection Agency (EPA) Science Advisory Board, and he has served on the EPA Board of Scientific Counselors. He has graduate degrees in public administration and

environmental design from Harvard University and Yale University and a degree in industrial design from the Rhode Island School of Design.

Erika Shugart (@ErikaShugart) is the director of communication and marketing strategy of the American Society for Microbiology and principal of Erika Shugart Consulting, LLC. For the last 16 years, Dr. Shugart has worked in informal science education. In 2003–2013, she oversaw the development of new digital media exhibitions, on-line experiences, and programs as deputy director of the Marian Koshland Science Museum of the National Academy of Sciences. In that role, she managed the creation of several major exhibitions, including Life Lab, Earth Lab: Degrees of Change, Infectious Disease: Evolving Challenges to Human Health, Putting DNA to Work, and a virtual exhibition on safe drinking water. She also conceptualized and managed the museum's on-line presence, including its award-winning Web site. Before joining the museum staff, Dr. Shugart directed the National Academy of Sciences Office on Public Understanding of Science, managing several projects, including the article series *Beyond Discovery*. She began her career at the National Research Council as an intern with the Board on Biology. She also worked at the Office of Policy Analysis of the National Institute of Allergy and Infectious Diseases. She received her PhD in biology from the University of Virginia. In 2010, Dr. Shugart was elected a fellow of the American Association for the Advancement of Science for distinguished contributions and leadership in public understanding and engagement in science. She was a Noyce Leadership Fellow from 2012 to 2013. In 2007, the National Academy of Sciences awarded her an Individual Distinguished Service Award, and she shared Group Distinguished Service Awards in 2004 and 2011.

Liz Szabo (@LizSzabo) is a health and medicine journalist for *USA Today*. Her work has won awards from the Campaign for Public Health Foundation, the American Urological Association, and the American College of Emergency Physicians. Previously, she worked for the *Virginian-Pilot* for 7 years, covering medicine, religion, and local news.

Mary Woolley (@MaryWoolleyRA) is the president of Research!America, the nation's largest not-for-profit, membership-supported grassroots public-education and advocacy alliance committed to giving high priority to research for health. Dr. Woolley is an elected member of the Institute of Medicine and serves on its Governing Council. She is a fellow of the American Association for the Advancement of Science and serves on the National Academies Board on Life Sciences. She is a founding member of the Board of Associates of the Whitehead Institute for Biomedical Research, is a member of the visiting committee of the University of Chicago Medical Center and the National Council for Johns Hopkins Nursing, and serves on the External Advisory Board for Rice University's Professional Science Master's Degree program. Dr. Woolley has also served as president of the Association of Independent Research Institutes, as editor of the *Journal of the Society of Research Administrators*, as a reviewer for the National Institutes of Health and the National Science Foundation, and as a consultant to several research organizations. She has a 30-year publication history on science advocacy and research-related topics. She holds an honorary doctorate from the Northeast Ohio Medical University.

Appendix D
About the Roundtable on Public Interfaces of the Life Sciences

The Roundtable on Public Interfaces of the Life Sciences (PILS) of the National Academies of Sciences, Engineering, and Medicine is a forum that seeks to monitor and improve understanding of the intersections between different life science communities and public audiences on topics that spark public concerns, generate policy debates, or influence market dynamics. The overarching vision of the PILS Roundtable is for life scientists to understand the dynamics of public interfaces, and have access to the knowledge and tools needed to develop proactive, collaborative, science based approaches to public engagement about emerging topics in the life sciences.

The PILS Roundtable is an active and engaged network that brings together Research life scientists, social scientists studying science communication, and professional science communicators. It provides leadership to the life science community through activities that raise awareness among life scientists about the importance of public interfaces; encourage networks among life scientists, communication scientists, informal education experts, and science communicators; and facilitate the development of partnerships and other initiatives among PILS members and their institutions to improve public interfaces for current and emerging life sciences issues.

The PILS Roundtable is led by the Academies Division on Earth and Life Studies in partnership with the Division on Behavioral and Social Sciences and Education.