American Society of Cell Biology Annual Meeting
Keynote Plenary Address
'Can the Science Paradox be Resolved?'
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Abstract:
Science today permeates our modern world and is directly relevant to decisions that will determine our common future. Yet mistrust of science is pervasive and scientific information is often rejected outright. Can this paradox be resolved? If so, how?

INTRODUCTION

Thanks, Shirley! Good evening everyone!

I have to say how very excited I am about the historic climate agreement reached earlier today in Paris. It's been a long, hard struggle, but now, finally, the world is serious about addressing climate change. Today is a day to celebrate and rededicate ourselves to the hard work ahead. Science played a key role in this transformative agreement, but the entire dialogue and the difficulty with action around climate change reveal a tense, strained, challenging relationship between science and society that is the topic of my remarks tonight.

I know full well this talk is not a typical science talk. But it is consistent with the theme of this year's meeting: integration. My focus is squarely on the integration of science with society. It deals with our relationships and responsibilities to society. I offer a personal perspective, so adjust your expectations accordingly!

Let me begin with a story. In mid-December 2008, just one month after Barack Obama won his historic first election, I was in Australia observing marine life and ecosystems and scouting potential research sites Down Under. I was startled to receive calls from the President-Elect's Transition Team. At one point, John Podesta was on the line saying something like, 'Hi, Jane. The President-Elect would like to nominate you to be his Administrator of NOAA; will you please come to Chicago to talk with him about this job?' After a stunned silence, I blurted out, 'But, John, I'm in Tasmania!' His calm response was short and to the point: 'So?'

I could also have said, 'But, John, I'm an academic. I've spent decades in the university world. I like living in Oregon. I like being able to juggle teaching, research, outreach and advocacy for science and its use.' But I didn't say those things. Instead, after much deliberation and intense discussions with my family, I flew to Chicago in the middle of a snowstorm to meet the impressive guy who would be my new boss for 4 years.

Things happen quickly in that world. The day after my first meeting with him, the President-Elect finalized his 'Science Team' – John Holdren, Steve Chu, Eric Lander, Harold Varmus and me – and took the occasion to articulate his view of science. In announcing the group, he said[1]:

> "…today, more than ever before, science holds the key to our survival as a planet and our security and prosperity as a nation."
>
> "It's time we once again put science at the top of our agenda and worked to restore America's place as the world leader in science and technology."
>
> He went on to say, "…the truth is that promoting science isn't just about providing resources – it's about protecting free and open inquiry. It's about ensuring that facts and evidence are never twisted or obscured by politics or ideology. It's about listening to what our scientists have to say, even when it's inconvenient – especially when it's inconvenient. Because the highest purpose of science is the search for knowledge, truth and a greater understanding of the world around us. That will be my goal as President of the United States – and I could not have a better team to guide me in this work."

Hearing his words, you can appreciate our enthusiasm for signing on.

But what was it really like? Did the reality live up to the promise? For me, it was exciting, but also frustrating; it was exhilarating, depressing, encouraging, and discouraging, but overall quite rewarding – all rolled into a very intense 4 years.

Let me be clear: the President was unfailingly supportive. He clearly believes and implements what he said about science. Moreover, the new science team – colleagues with a common bond and strong previous relationships – functioned as a cohesive unit, working closely across agencies, departments and the White House. (Relationships matter and can cut across bureaucracy.)

But overall, the political climate and the public climate were and are challenging, ranging from supportive to chilling or downright hostile to science – the full spectrum. And, as is often the case, the noisiest voices are often the most strident and the most extreme – and that sets the tone for interactions and public perceptions. Since NOAA is a science agency, we were often in the thick of controversies.

However, despite the craziness – and there was a profusion of it – the NOAA team was able to accomplish most of the very ambitious agenda I brought to NOAA plus other goals that the NOAA team proposed to me. We had a large number of major successes, none of which was easy.

1. We produced a Scientific Integrity policy that has been labeled 'the platinum standard' of SI policies and continues to guide NOAA's actions. (As an aside, that policy is currently being challenged by Congressman Lamar Smith, Chair of the House Science Committee, who is attacking NOAA over its climate science. My successor, Dr. Kathy Sullivan, is staunchly defending the NOAA scientists who are being accused by Chairman Smith of manipulating climate science for political reasons. Nothing could be farther from the truth. This debacle illustrates the unfortunate attempts to make science a partisan issue when it is not.) Continuing with my list of NOAA's accomplishments:
2. We strengthened science and scientific tracks at NOAA and re-establish the position of Chief Scientist that had disappeared 16 years earlier.
3. We grew NOAA's annual budget from $3.9 B to $5.3B.
4. One of our major successes was using science to turn the corner in ending overfishing and returning fisheries to both sustainability and profitability. That was also one of the most contentious and difficult achievements. I speak from experience when I say 'Change is not for the timid!'
5. We harnessed science to help respond to the DWH oil disaster, including introducing novel, ecosystem-service framing into the assessment of environmental damages from the disaster.
6. We tackled and fixed a seriously dysfunctional weather satellite construction program that is essential for future weather forecasts.
7. We responded to scientific knowledge about the state of the ocean and the need for more holistic management by helping create the nation's first-ever National Ocean Policy that puts stewardship of our ocean and coasts first and foremost.
8. We led the most ambitious and comprehensive National Climate Assessment ever to help Americans understand what's happening, why, what they might expect and what they can do.

9. We produced an exponentially expanding suite of climate services – scientific information, data and products to inform Americans about climate change and their options.
10. And finally, we embraced social media, employed crowd sourcing and citizen science and we strengthened communication approaches to begin to change the narrative around the importance and utility of science.

Looking back, I am astounded that we achieved so much in light of the major catastrophes that came in over the transom and threatened to swamp our ship – ranging from a dysfunctional, hyper-partisan and legislation-light Congress to the economy in a tailspin, ClimateGate and the politicization of climate science, the Deepwater Horizon oil disaster, and the most extreme weather in any 4 years in U.S. history, including Hurricane Sandy.

Throughout these and other experiences, I gained new insights into the world of science, policy, and politics. I had not only a front-row seat but was often center stage in the national tensions around major scientific issues: climate, fisheries, oil spills, endangered species, and more. What have I learned? Based on these experiences, I am gravely concerned about the precarious state of science in this country. Tonight I wish to share some of those concerns and insights with you.

Make no mistake: many politicians and many members of the public share President Obama's view of the central role of science in society, his respect for science, and his desire to ground decisions in good science. Unfortunately, those views are far from universal. Moreover, they are being challenged in ways that threaten the very basis of an informed democracy.

THE PROBLEM: THE SCIENCE-SOCIETY PARADOX

Here, briefly, is the problem as I see it. At a time when scientific information is more relevant for society than ever before, many citizens and their elected leaders distrust science on specific issues, sometimes outright rejecting scientific information and even aggressively orchestrating anti-science witch hunts. To be sure, vested interests organize and lavishly fund many of these anti-science campaigns, but they gain traction because they tap into public perceptions about science and scientists.

To consider this problem in greater depth, we need to break it down into three boxes: (1) views about science in general, (2) attitudes about the science of particular issues,

and (3) opinions about the trustworthiness of scientists. And let me be clear that I will use the term 'science' as shorthand for 'science, technology, engineering and math.'

(1) Views about science in general: Your and my view of science as a worthy pursuit that will likely benefit humanity is embraced by many in the U.S., including many in Congress. Science is broadly seen to have improved human health, provided new engines of economic growth, improved our lives, enhanced national prestige and strengthened national security. Many polls are consistent through time and conclude that science as a whole is trusted and valued[2]. That is good news, indeed.

(2) Attitudes about the science of particular issues: However, generic support for science falls away in arenas where scientific information or its consequences conflict with values or beliefs. We see this, for example in conflicts around climate change, stem cells, antibiotics, vaccines, evolution, the value of social sciences, and gene-editing, etc. In some of these areas, the real choices are societal, not scientific choices; but in others, beliefs and values often trump information.

For example, as Naomi Oreskes and Erik Conway have written[3], some climate deniers (as well as deniers of acid rain, the ozone shield and health consequences of tobacco) believe that the regulations they think would be needed to deal with climate change (or the other problems) are a bigger threat to freedom and democracy than the problem.

In another realm, many who do not believe in evolution value literal interpretations of the Bible and a superior role for humans over an inquiry-based approach.

In these examples, all the information in the world won't change someone's belief. Conflicts are not about insufficient or conflicting information, but about values or how values are perceived to relate to the issue[4].

(3) Opinions about the trustworthiness of scientists. Our third category focuses not on the message, but on the messengers (scientists) and their trustworthiness.

Scientists in certain areas are often associated with stereotypes. Ecologists, for example, are often assumed to be environmentalists with an inherent bias and a particular agenda. They are thought of as communicating only messages of doom and gloom, and focusing only on problems, never solutions. Cell biologists are often seen as aloof, speaking in impenetrable language and doing Frankenstein-like research – i.e., playing god, and generally being scary. And all scientists are stereotyped as just

wanting more money for their research, often manufacturing uncertainties to justify the need for more grant money.

These stereotypes reflect beliefs about the trustworthiness of the messengers. Social scientists have contributed significantly to understanding some of these tensions. Here are two relevant results.

1. Researchers Fiske and Dupree have found that to be credible to an audience, someone must be perceived as both capable (having expertise and competence) and warm (being trustworthy and friendly)[5]. I repeat: to be credible, someone must be both capable and warm.

   They found that scientists are generally seen as being "competent but cold" by the American public in relation to other jobs. They are seen as competent, even admired, but not warm, not friendly. Because of this low "warmth" scientists are not always perceived as trustworthy. They are knowledgeable, but not always to be believed. In other words, these researchers conclude that scientists have earned respect but not trust.

2. In complementary findings, Lupia has concluded that to be credible to audiences, scientists must display common interests with the audience as well as relative knowledge expertise[6]. Common interests communicate shared values. Shared values engender trust.

So one take-away from this research is that scientists can better understand how they are perceived by non-scientists and can take action to align perceptions with reality. It is not enough to be competent and knowledgeable; if we want to be trusted, we also need to be and be seen as trustworthy. If our behavior (giving nerdy presentations) is preventing audiences from trusting us, we can modify that behavior and give audiences reasons to trust us not just respect us.

These results may be confusing or surprising to many scientists. Scientists 'trust' scientific findings because the findings have resulted from the scientific process and they have met the standard of peer-review or our own review based on our knowledge. We have the knowledge to judge if something is trustworthy. We judge the process and the message, not the messenger. Non-scientists often place a greater emphasis on the messenger than the message, deciding to believe the message only if the messenger seems trustworthy. We scientists need to understand and respect that difference.

SOLUTIONS TO THIS PARADOX

Why is it important that we understand these conflicts and what might be done to address them? I see two reasons to care: How science and scientists are perceived is important (1) because science needs society, e.g., for opportunities to do create and share new knowledge and be engaged with society, and (2) because society needs science to help find solutions and inform decision to improve human well-being.

To resolve the science-society paradox, scientists must embrace their social contract with society[7]. I believe we have an obligation to do more than just discover new knowledge and share it with other scientists. We also must engage more actively with society in meaningful, 2-way interactions. In short, in exchange for public funding, we have a responsibility to be helpful.

From what I can tell, ASCB has made good inroads in reaching out to policy makers, establishing relationships with decision-makers, producing position papers, and, importantly, offering communication training. I applaud those efforts, but believe they are not at the scale that is needed to accomplish the goals.

Together we must take on the challenge of changing the narratives around both specific issues and perceptions of the trustworthiness of scientists, and do so with humility, transparency and honesty. We know that doing so is possible. Some scientists are fully engaged in changing these narratives. But until scientists across all disciples are more fully involved and until their professional societies, universities and funders enable, support and empower them, progress will not occur.

So, what else can be done? Here are six recommendations:

1. **Invest in understanding the public.** Do not simply focus on educating the public about science, but rather focus on educating ourselves about the public (understanding that there are actually many publics). Communications and engagement are two-way streets. Smart engagement requires respect and understanding. As the late Steve Schneider often told the scientists he was coaching: to be effective, you must 'Know thyself. Know thy stuff. And know thy audience.' Invite your social scientist colleagues who are experts in communications to assist with 'knowing thy audience'.
2. **Train and empower scientists to communicate effectively, then reward them for doing so.**

a. To communicate effectively with lay audiences, scientists need a safe environment in which to learn new skills. Among other things, they need to become bilingual -- to speak the language of lay people as well as the language of science. Learning to translate complex, nuanced, technical findings into understandable but accurate information is often a challenge, but it is possible. Experienced coaches in a safe environment can help scientist become proficient in their new language.
b. Scientists need to do more than just expand linguistic skills and hone their messages. To be deemed trustworthy as well as capable, they also need to communicate in ways that make them believable and credible. And they need to demonstrate respect for their audiences. Using good analogies and metaphors, telling stories, showing emotion, talking about values and shared experiences can all enhance communication efforts.
c. Some training programs already exist, but more are needed. Opportunities and models include: the Leopold Leadership Program for mid-career environmental scientists[8]; COMPASS's communications workshops[9]; the Alan Alda Center for Communicating Science[10]; and the AAAS Leshner Leadership Institute for Public Engagement[11]. But others are needed. ASCB might consider either its own leadership/training program for cell biologists analogous to the Leopold Leadership Program for environmental scientists or a track within another existing effort.
d. *Nota Bene*: Scientific communication training is tougher than normal communication/media training. Most scientists need coaches and peers who can help them translate complex, nuanced scientific knowledge into something that is understandable to lay people, but still accurate. Most media trainers have insufficient understanding of the science to do that. Moreover, finding the right analogies and metaphors is tough, again, because they need to be grounded in a deep understanding of the science. Specialized training, not just generic communications/media training is needed. This is where COMPASS, e.g., excels.
e. Individuals can seek out opportunities for themselves. Societies like ASCB can take on a larger role of expanding opportunities, marshalling resources, and creating the community-wide cultural changes needed for this to be successful. Universities and government agencies also have key roles to play, especially since there should be a high priority placed on training young scientists, not just their elders and on changing the culture and reward structure within academia and agencies.

f. The scientific, governmental and academic communities must recognize that not every scientist can or should be a public communicator, but in my view, all should support those who can and who choose to do so. Public engagement should be a community effort because it benefits us all.

3. **Make science more accessible, open and transparent to the public.** Let lay folks peak behind the curtain, or better yet, help produce knowledge.
    a. Look for opportunities to engage non-scientists, e.g., through citizen science. ASCB members are already pursuing exciting ways to do this – for example, through online citizen-science projects like Worm Watch Lab, Cell Slider, Plankton Portal, Eyewire, Foldit, Fraxinus and Mark2Cure. ASCB might review these and provide guidance to other efforts to improve the overall experience to lay people and utility to science.
4. **Build the infrastructure that supports active communication training and engagement with society.**
    a. Scientists tell us that one of the biggest impediments to doing more public outreach and communication is the lack of time and the lack of appropriate recognition by their peers that doing so is valued. If we want scientists to be out there, we need to recognize and value their efforts. We need to change the academic reward structure, e.g., what 'counts' in promotion and tenure decisions. If doing public outreach simply means doing more in addition to the 'usual' teaching, publishing, getting grants, etc., that is an unfair and unrealistic expectation. The cultural change that has occurred around valuing good teaching provides hope that a cultural change around the importance of communications and engagement with society is feasible. Strong leadership – individual and institutional – will be required for that to happen.
    b. Other infrastructural elements that are needed include: Establish interactions with social scientists and communications experts; Create venues for routine interactions with policy makers and managers whose portfolios are relevant; Initiate partnerships with relevant, science-based NGOs who have deep expertise in public communication or policy; Recognize the need to provide scientific communications training for students as well as faculty.
    c. Acquire the funding needed to do this effectively.
5. **Respond to society's needs and engage in science that helps produce solutions.** Exciting scientific questions can come both from within the scientific community and also from society. Interactions with society can pose new questions that

lead to novel scientific discoveries that may well be helpful to society. 'Use-inspired scientific research' (in the spirit of Donald Stokes[12]) provides exciting options to do fundamental research that is immediately relevant to societal needs.

6. **Unleash and empower your students.** Undergraduate and graduate students are chomping at the bit to be engaged in society. They are tweeting and blogging and dancing their PhDs[13]. Help them succeed, but don't tell them to keep their heads down until they get tenure and then become active.

We need to change the narrative about scientists and science through smarter engagement with the public and with policymakers. And we need to scale up what is already underway. Armed with information about what the public understands and why, scientists can do a better job of communicating and engaging effectively.

CONCLUDING REMARKS

I began by sharing some of my journey into the world of government, policy and management. I have often joked that, in collaboration with my colleagues at NOAA, we were able to achieve a number of notable accomplishments in part because my training as a marine biologist was excellent preparation for the rough and tumble world of politics in D.C. because I already knew how to swim with sharks!

My remarks focused on a common challenge and a golden opportunity for the entire scientific community – how to truly serve society more effectively than we are doing now. I've suggested that we work hard to reestablish trust in science and scientists and achieve a better collective understanding of many of the central challenges facing society today. I shared some ideas about how we might do that:

1. **Invest in understanding the public.**
2. **Train and empower scientists to communicate effectively, then reward them for doing so.**
3. **Make science more accessible, open and transparent.**
4. **Build the infrastructure that supports active communication training and engagement with society.**
5. **Respond to society's needs and engage in science that helps produce solutions.**
6. **Unleash and empower your students.**

These are all feasible, but they will take concerted effort, led by individuals who are supported by their colleagues. It's in all of our interests to succeed.

Let me end with another story, this one from the Gulf of Mexico. A number of weeks into the BP Deepwater Horizon disaster, the President asked the Vice President to travel to the Gulf, meet with fishermen, listen to their concerns and share what the government was were doing. The VP's team asked me to accompany him. En route to the Gulf aboard Air Force Two, I briefed VP Joe Biden about fisheries, oil, actions we were taking, etc. Toward the end of my briefing, the VP said something like 'Now, wait a minute. I thought you were a scientist.' Not knowing where his comment was headed, I nervously replied, 'I am.' And the VP then said, 'But… I just understood everything you said!'

'Wow!' I thought, 'What a condemnation of the scientific community! This very distinguished, smart politician has undoubtedly been briefed by scientists hundreds of times and he still thinks he can't understand us.' When we landed, the VP in his warm, personable, Uncle Joe fashion said something like, 'I like you! Come ride with me in my car for our motorcade ride so I can learn more.' So, I say to all of you – shouldn't that scenario be the norm, not the exception?

In conclusion, for the world to achieve the promise offered by the Paris Agreement, to change the narrative around climate science and other major threats or issues facing this country and the world, scientists needs to get out of the ivory tower and be helpful to society in new ways. I invite you to join in this effort. Society will benefit and so will we.

Thanks, enjoy the rest of the conference and please talk with each other about these ideas!

[1]*This address was developed with assistance from Elizabeth Cerny-Chipman.*

REFERENCES

1. Obama, B. President-elect Obama announces key members of Science and Technology team. *Weekly Democratic Radio Address* (2008). <http://change.gov/newsroom/entry/president-elect_obama_announces_key_members_of_science_and_technology_team/%20]>

2. Scheufele, D. A. Communicating science in social settings. *Proc. Natl. Acad. Sci.* **110,** 14040–14047 (2013).
3. Oreskes, N. & Conway, E. M. *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. (Bloomsbury Publishing USA, 2011).
4. Hoffman, A. *How culture shapes the climate change debate*. (Stanford University Press, 2015).
5. Fiske, S. T. & Dupree, C. Gaining trust as well as respect in communicating to motivated audiences about science topics. *Proc. Natl. Acad. Sci.* **111,** 13593–13597 (2014).
6. Lupia, A. Communicating science in politicized environments. *Proc. Natl. Acad. Sci.* **110,** 14048–14054 (2013).
7. Lubchenco, J. Entering the Century of the Environment: A New Social Contract for Science. *Science* **279,** 491–497 (1998).
8. The Leopold Leadership Program. <www.leopoldleadership.standford.edu>
9. COMPASS. <compassonline.org>
10. Alan Alda Center for Communicating Science. <www.centerforcommunicatingscience.org>
11. Leshner Leadership Institute at AAAS Announces First Fellows. *AAAS - The World's Largest General Scientific Society* at <http://www.aaas.org/news/leshner-leadership-institute-aaas-announces-first-fellows>

12. Stokes, D. E. *Pasteur's quadrant: Basic science and technological innovation*. (Brookings Institution Press, 1997).

13. John Bohannon. Announcing the 2015 Dance Your Ph.D. winner. *Science* (2015). doi:10.1126/science.aad7467