CONGRESS’S USE OF SCIENCE

CONSIDERATIONS FOR SCIENCE ORGANIZATIONS IN PROMOTING THE USE OF EVIDENCE IN POLICYMAKING

A Report from a Workshop Convened at the American Association for the Advancement of Science in Washington, DC on October 13, 2017
About the project: This report is derived from a one-day workshop held at the American Association for the Advancement of Science (AAAS) on October 13, 2017. The discussions presented in this report were supplemented by a literature review and subsequent conversations with participants and additional subject matter experts. The workshop initiated a year-long research project on the use of science in congressional personal offices led by Karen Akerlof, AAAS Visiting Scholar, Research Assistant Professor, George Mason University and Adjunct Faculty, Johns Hopkins University; Maria Carmen Lemos, Professor and Associate Dean for Research at University of Michigan School for Environment and Sustainability; Emily Therese Cloyd, Project Director at AAAS Center for Public Engagement with Science and Technology; and Erin Heath, Associate Director at AAAS Office of Government Relations. The project is funded by the National Oceanic and Atmospheric Administration (NOAA).

Acknowledgements: Thank you to the report’s advisory group for their feedback on early drafts and individual contributions to its content. Thanks also to all of the workshop participants for their generosity in contributing their time, expertise, and insights to the project; to AAAS research team partners Emily Cloyd and Erin Heath for co-leading the workshop; and to AAAS staff members Rebecca Aicher, Chloe McPherson, and Jessica Bates for their assistance.

The author retains full responsibility for the content and all remaining errors. This report does not reflect the official views of either AAAS or NOAA.

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   U.S. regulatory impact analyses .................................................................19
   Bruce A. Desmarais, Pennsylvania State University, and John A. Hird, University of
   Massachusetts Amherst

3. [Box 3] Distinguishing scientific and policy judgments ...................................23
   David Goldston, MIT Washington Office

4. [Box 4] Institutional changes affect how Congress gets its information .............25
   Molly E. Reynolds, Brookings Institution

5. [Box 5] State of the Congress: Staff perspectives on institutional capacity in the House
   and Senate ...................................................................................................28
   Kathy Goldschmidt, Congressional Management Foundation

6. [Box 6] What predicts scientists’ interest in communicating with non-academic
   audiences? ..................................................................................................34
   Ezra Markowitz, University of Massachusetts Amherst

7. [Box 7] Taking a bipartisan approach ..............................................................37
   Suzanne Ffolkes, Research!America

8. [Box 8] Communicating scientific information to Congress through people, events,
   reports, and services ..................................................................................50
   Kei Koizumi, American Association for the Advancement of Science

9. [Appendix F] Citizen-centric advocacy: The untapped power of constituent
    engagement ...............................................................................................73
    Kathy Goldschmidt, Congressional Management Foundation
# Table of Contents

Glossary ............................................................................................................................................. 5  
Executive Summary ................................................................................................................................. 6  
1. **Introduction** ..................................................................................................................................... 10  
   Rationale for the workshop and report.............................................................................................. 11  
   Connecting the dots between information “use,” “usability,” and communication ....................... 12  
   Limits on the rational use of science in policymaking processes...................................................... 15  
2. **The hardest science: The science of “use of science for policy”** ............................................ 17  
   Communication between scientists and policymakers ........................................................................ 21  
   Executive branch .................................................................................................................................. 22  
   Legislative branch ............................................................................................................................... 24  
3. **Institutionalizing evidence-based policymaking** ........................................................................ 29  
4. **Science organizations: Current program approaches and needs** ............................................ 32  
   Factors in congressional successes .................................................................................................... 34  
   Data and research to define impact ..................................................................................................... 36  
5. **Other factors affecting use of science by Congress** .................................................................. 38  
   Informational needs ............................................................................................................................ 38  
   Communication and relationships ....................................................................................................... 39  
   Office and institutional decision-making contexts ............................................................................. 39  
   External forces ..................................................................................................................................... 40  
6. **Strategies to improve the use of science** ..................................................................................... 41  
   Scientific assessments ......................................................................................................................... 41  
   Boundary organizations ....................................................................................................................... 42  
   Co-production of knowledge ................................................................................................................ 43  
7. **Recommendations: Objectives for science-for-policy programs** .............................................. 44  
   Building the capacity of the science community ............................................................................... 44  
   Increasing congressional capacity ...................................................................................................... 46  
   Fostering relationships between the science and policy communities ........................................... 46  
   Tailoring informational content ......................................................................................................... 46  
   Institutionalizing adaptive science and policy learning processes ............................................... 47  
   Implications of the communication context for strategic vs. substantive policy use ..................... 48  
   Testing what works through collaborations on the use of science for policy ................................... 49  
   Conclusion ........................................................................................................................................... 49  
8. **References** ...................................................................................................................................... 52  
   Appendix A: Training and resources for scientists ............................................................................. 58  
   Appendix B: Workshop agenda ........................................................................................................... 67  
   Appendix C: Committee and hearing data, *Vital Statistics*, Brookings Institution ............................ 68  
   Appendix D: Office of Technology Assessment, a short history ...................................................... 69  
   Appendix E: Government support agencies that provide scientific advice to Congress ................... 70
GLOSSARY

Adaptive science and policy learning processes — Iterative feedback between science producers and decision-makers to define the knowledge needed to answer policy questions.

Boundary organization — A group that serves as an intermediary, or broker, between producers and users of science, fostering communication and joint production of information between the two, while allowing them to maintain their identity and unique authority. For example, both COMPASS (www.compassscicomm.org) and the Health Effects Institute (www.healtheffects.org) serve as boundary organizations in the environmental and public health domains, respectively.

Co-production of science — The ways in which actors work together to define and generate knowledge across organizational boundaries.

Evidence-based policymaking — The use in government of systematically gathered information from scientific methods, often describing the development and evaluation of social policies and programs.

Information fit — How users perceive knowledge would meet their needs.

Interaction — The characteristics of the relationships between scientists and decision-makers, including its quality, frequency, and duration.

Interplay — How new knowledge intersects with existing decision routines (negatively and positively).

Policy for science — Government policies that concern research institutions and the practice of science, especially providing funding.

Policymaker — For the purpose of this report, we define policymakers as members of Congress, their staff, and that of committees.

Science for policy — The production and/or use of scientific information to guide policy in areas such as health, the environment, etc.

Scientific assessment — A process by which expert knowledge is evaluated and structured to assist in decision-making for a policy problem.

Strategic vs. substantive use of science — Use of information to advocate for or reconfirm a position which has already been defined (strategic), as opposed to use of information to develop a policy position in the absence of a strong prior commitment (substantive).
EXECUTIVE SUMMARY

A recent survey of U.S. public opinion found bipartisan support for the use of scientific evidence by policymakers (Research!America & Zogby Analytics, 2018). Seven out of 10 Democrats and Republicans say that it is important for public policies to be based on the “best available science.” More than six in 10 say that candidates for Congress should have science advisors. Yet how scientific evidence is used in policy remains unclear in many respects, even though a formidable multidisciplinary academic literature has tried to answer the question over the decades, and many organizations have long experience promoting issue-relevant research findings with policymakers. An October 2017 workshop brought academics and representatives of science organizations together to discuss what we know about the use of science in Congress, and what further strides can be made to ensure that policies are informed by evidence.

This report is designed to provide guidance for scientific organizations seeking to influence policymaking in the U.S. Congress. Drawing on an October 2017 workshop, it strives to synthesize insights from science organizations and academic scholars about the use of science by policymakers in Congress. We first review a multidisciplinary literature on research use and the types of programs available to U.S. scientists who want to improve their ability to participate in policy processes. To ensure that policy decisions are informed by evidence, scientists and science organizations must build the collective capacity of research institutions, Congress, and intermediary organizations to jointly identify and create knowledge that has relevance to societal problems. Optimally, the interactions between these organizations should 1) allow for repeated cycles of problem definition and knowledge production to answer questions relevant to decision-makers and society at large, and 2) establish incentives for scientists and policymakers to do so. These recommendations align with the organizational focus of the evidence-based policy movement that has been gaining momentum in the U.S. and abroad.

Long-term relationships are critical in connecting science to policy
There are three main drivers of knowledge use: fit, or how users perceive knowledge would meet their needs; interplay, or how new knowledge intersects with existing decision routines (negatively and positively); and interaction, or how the collaboration between scientists and decision-makers in producing knowledge increases its use. The message from practitioners and decades of multidisciplinary studies is that long-term relationships (interaction) engender the forms of knowledge exchange that are most likely to result in the use of scientific information for societal decisions, by increasing its perceived fit and ability to be used within policymaker decision routines (interplay). Strategies that formalize these interactions include the evaluation of expert knowledge for policy purposes (scientific assessments), intermediary organizations that serve to clarify and bridge the cultures of the science and policy communities (boundary
organizations), and the joint creation of scientific knowledge by scientists and decision-makers to answer policy-relevant questions (co-production). Notably, these strategies typically occur within and/or between groups, instead of solely at the individual level.

**Identifying useful information—and putting it to use—consumes time and resources**
While building long-term relationships through frequent interactions between scientists and policymakers can be valuable, scholars and science organizations also point to the real-world limits on policymakers’ (and scientists’) willingness and ability to dedicate time and resources to these processes. There are many ways in which science can be used by policymakers, from placing an issue on the policy agenda to pursuing particular policy solutions. Science alone rarely can determine which problems rise to the top of legislative priorities, where it is more likely to play a role is within the internal development and debate of policy alternatives. This latter category can be further broken down into a typology that describes how policymakers and scientists are likely to engage, and for what purpose:

- **When policymakers seek scientific information for the substantive development and/or evaluation of policy options,** the process typically requires them to commit considerable time and resources that are often in short supply. When scientists work with policymakers to identify decision-relevant information, they can lower these barriers to access without serving as an advocate for a specific policy. However, when a wide range of expertise and/or avoidance of perceived bias are required, scientists may be better able to collectively deliver this advice rather than as individuals.

- **The more frequent circumstance is the strategic use of science to promote a policymaker’s established position for political and/or policy purposes.** In these cases, information is most likely to be used: 1) when it comes from an individual or entity that shares the office’s policy objectives; and 2) the content is easily employed in support of the objective, requiring little time from policymakers. Scientists comfortable with advocacy positions are likely to find this type of science use amenable.

**Recommendations for improving the use of science for policy**
As discussed at the workshop, current programs to influence policy through improved science communication with policymakers fall primarily into two categories: 1) building scientists’ capacity through education and training, and 2) facilitating access to policy processes through opportunities to meet with congressional representatives and their staff. These programs seek to close gaps in the capacity of the science community to engage in policy. For example, long-term, trust-building relationships are foundational to use of science for policy, but scientists are less likely to identify building trust as a motivation for conducting outreach compared to other reasons. This misunderstanding by scientists of a core factor in whether policymakers find science useful in decision-making can be addressed through scientist education and training.
The workshop participants offered additional ways scientific organizations could effect change. Improving the use of science for policy entails a multi-pronged approach across the science-policy ecosystem:

- **Building stronger relationships between the science and policy communities through boundary organizations to reduce transaction costs.** Considerable evidence suggests that long-term relationships in which the scientific and policy communities co-produce information lead to greater substantive use of science in informing societal decisions. But the time investments in these relationships are significant. Organizations that work with both communities can reduce the transaction costs for each side. Science organizations that already serve as intermediaries between the science and policy communities—including the state or district universities of members of Congress—may want to consider strengthening or adding to these capacities, and/or promoting the establishment of these entities within the federal research enterprise.

- **Shaping information to fit congressional decision-maker needs.** The easiest way to shape information to fit audience needs—and the one that is typically the focus of scientist training—is the format of the content: concise, no jargon, and easily accessible. But as many have observed, a bigger problem occurs when scientists and policymakers disagree on what information content is useful for decision-making. Aligning information to policymaker needs requires extensive understanding of the office, its issue position, and its likely needs as the issue evolves, even day-by-day.

- **Institutionalizing learning processes between science producers and decision-makers.** Because scientific evidence can rarely dictate policy, the important outcome is not that policies are evidence-based, but that they be evidence-informed. This is more likely if the research and policymaking communities engage in long-term joint learning processes that generate information most relevant to societal decision needs, including through scientific assessments, co-production of knowledge, and boundary organizations. Sustaining these types of time- and resource-consuming efforts requires institutionalized support and incentives within science and policy organizations, and/or boundary organizations.

- **Increasing congressional capacity.** Research from experts from the Brookings Institution and the Congressional Management Foundation finds that declines in personal office, committee, and support agency capacity likely harm Congress’s ability to process information in making policy decisions. Capacity could be improved by increasing personal office staff pay, rebuilding support agency staffs, matching congressional offices

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1 For an example of a university-based center that serves as a boundary organization to facilitate policy impact, see the MIT International Policy Lab at https://policylab.mit.edu/
and committees with science advisors, and providing training for congressional staff on finding and assessing scientific evidence.

- **Testing “what works” in the use of science for policy.** Partnerships between academic scholars and practitioners within science organizations offer opportunities to: 1) refine theories of change with theoretical insights about likely key factors in successful implementation of evidence-informed policy; 2) find ways of measuring organizational impact; and 3) collect and analyze data that can be used for evaluation.

**Conclusion**

Advances in science and technology have rapidly changed the world around us. You need look no further than your smart phone to understand the dramatic ways that society has been altered by the flow of new knowledge into the systems that we rely on every day. The research and policy communities also represent complex systems; ensuring that they work together to create evidence-informed policy requires both individual- and organizational-level change. The time and resources that it takes to maintain relationships supporting the creation of decision-relevant science cannot be borne by individuals alone, unsupported by organizational incentives to do so. Successful efforts to improve science policy will necessarily incorporate broader goals to institutionalize these relationships.
INTRODUCTION

Primary messages:

- Conclusive research on how scientists and science organizations can engage most effectively with policymakers is lacking.
- Science alone rarely defines which issues make the agenda of policymakers and is seldom decisive in policy choices; it “doesn’t tell you what to do.”
- The most common use of science in policy is “strategic,” supporting decisions that have already been made by policymakers for other reasons. “Substantive” use of scientific evidence in evaluating policy options occurs less frequently.
- Ongoing dialogue between those producing science and using it for policy is needed for there to be a good fit between the information and decision context.
- Human decision-making is not an inherently rational process.

At a time when there are increasing calls for the use of evidence in government decision-making, including by Congress (“A fix for the antiscience attitude in Congress [Editorial],” 2017; Commission on Evidence-Based Policymaking, 2017), relatively little is empirically known about how scientific information is used within policymaking processes (National Academies of Sciences, Engineering, and Medicine, 2017; National Research Council, 2012)—even though the gap between the generation and utility of research has been consistently noted (Sarewitz & Pielke Jr., 2007). As a result, the evidence base for how scientists, and science organizations, can more effectively engage with decision-makers to influence policy outcomes is limited (Cairney, 2016). Congress represents one of the most powerful policymaking bodies, but there is even less data on science use by legislatures than by other forms of government, such as executive agencies (Kenny, Rose, Hobbs, Tyler, & Blackstock, 2017).

Before representatives ever take a vote or other action, an issue has to clear two hurdles: 1) placement on the agenda of at least some congressional members, the president’s administration, and/or the media; and 2) selection of a policy response (Kingdon, 1984). Science can play a role in agenda-setting through media attention to problems it identifies, but studies have found that it usually cannot do so alone, but requires the interest of other stakeholders and politicians (Scheufele, 2014). Development of policy alternatives within the offices of members of Congress is a less visible process than agenda-setting. Staffers on committees and in the personal offices of members of Congress control this largely hidden process. In a four-year study of transportation and health policy, Kingdon found that researchers have more effect on the consideration of policy alternatives than on setting the agenda. Moreover, contextual factors—such as the stage of policymaking—can have a significant impact on scientists’ ability to participate in congressional decision-making (Keller, 2009). Without an understanding of these contexts, scientific
knowledge is likely to remain “on the shelf” (Lemos, Kirchhoff, & Ramprasad, 2012). Indeed, Congress does not necessarily act on scientific information even when it requests it (Feldman, 1989).

While the meaning of science “usability” varies, scientists and policymakers are likely to define it as science contributing to the solution of societal problems (Dilling, 2007), sometimes termed “science for policy” (Brooks, 1964). In this role, science not only serves to inform policy decisions, it can become a strategic instrument of political and policy debate. Indeed, because science is seen as providing “objective facts” and “truth” (Gieryn, 1999), science may often be used rhetorically as substantiation for decisions made for other reasons (Jasanoff, 2005; Suhay, 2017). The simplification of science presents opportunities to achieve policymaker persuasive communication goals (Hilgartner, 1990), and within the diversity of scientific opinion, support for a broad array of positions can always be found (Sarewitz, 2000).

The phrase “science for policy” implies a unidirectional flow of the influence of research on decision-making. Yet, policy also shapes science through federal funding and organizational support for entities such as the National Science Foundation and national laboratories (“policy for science”) (Brooks, 1964). This report primarily focuses on “science for policy,” but many organizations—including those represented at the workshop—focus on both sides of the equation due to the importance of funding for research institutions and implications of these resource allocation decisions to answering important societal questions in domains such as health and the environment.

**Rationale for the workshop and report**

In an effort to increase the use of science by congressional policymakers, many organizations assist scientists in engaging in policy by providing training and opportunities to meet with members of Congress and their staff (see Appendix A). Policy and communication offices in science organizations are steeped in experience from working on the Hill with scientists, policymakers, and issue coalitions. Academics—particularly in the field of political science—have also long been interested in the use of research and technological assessment in legislative decision-making processes (Guston, Jones, & Branscomb, 1997; Hird, 2009; Whiteman, 1985) and defining the conditions in which science is “usable” in policy contexts (Cash et al., 2003; Kirchhoff, Lemos, & Dessai, 2013; Lemos et al., 2012; Posner, McKenzie, & Ricketts, 2016). The goal of the workshop was to identify how researchers and practitioners can work together to address the deficit of knowledge on how policymakers use science, as identified by the two National Academies reports (2012, 2017), and improve its use in congressional decision-making.

Over the course of the day, the participants worked in small groups, listening to short presentations and answering questions across three topic areas: 1) how practitioners currently seek to address the science-policy gap; 2) what opportunities exist for scientists and practitioners
to forge new partnerships; and 3) which factors are understood to be the most important for the communication and use of science in Congress (see agenda, Appendix B). The purpose of this report is to elucidate some of these important barriers and opportunities that may be less frequently addressed within current programs run by science organizations and revisit the goals of use of evidence in policy, drawing on the workshop discussions, a literature review, and subsequent conversations with participants and additional subject matter experts.

Connecting the dots between information “use,” “usability,” and communication

“If you wish to converse with me,” Voltaire reputedly said, “define your terms.” Problematically, what constitutes “use” of research can be extraordinarily broad. Weiss (1979) identified seven meanings of utilization, ranging from a linear “knowledge-driven” model in which basic research informs applied research, development, and application, to a “research as part of the intellectual enterprise” model in which science and policy mutually influence each other, and are influenced by, societal trends. The workshop focused on a simpler typology developed by workshop participant David Whiteman, a University of South Carolina political scientist, relative to decision-making (1985, p. 298):

Substantive – use of information to develop a policy position in the absence of a strong prior commitment;
Elaborative – use of information to extend or refine a position;
Strategic – use of information to advocate for or reconfirm a position which has already been defined.

This report will focus on the two ends of this spectrum—substantive vs. strategic use—because of the similarities of the conditions under which elaborative and substantive use occur. In his analysis of use of information from the Office of Technology Assessment (OTA)² in committees, Whiteman found that 1) strategic use was most common in high-conflict issue areas; 2) substantive and elaborative use occurred predominantly under low-conflict conditions; and 3) that more use of OTA reports in all forms—strategic, elaborative, and substantive—occurred for issues of higher salience, as judged by committee staff. Whiteman also tracked how personal offices used information, finding that only a small percentage were highly active on any issue (Box 1).

That Congress engages in more strategic than substantive use of scientific information, and other forms of policy-relevant analyses, has been observed for decades. Describing the results of interviews conducted in a 1969 study, Kingdon (1989, p. 236) related that a congressman who

² The Office of Technology Assessment was formed in 1972 to provide Congress with scientific and technological advice (Blair, 2013). Twenty-three years later it was defunded under a period of budget-cutting launched under the “Contract with America.” Efforts to bring it back so far have been unsuccessful (see Appendix D for a short history).
In the most in-depth study of congressional use of information to date, Communication in Congress documented significant use of policy analysis by members and staff of Congress (Whiteman, 1995). While not all policy analyses incorporate scientific information per se, they all employ forms of evidence, which can come from research of varying forms, including social science, or the life and physical sciences. Treating each congressional office as an “enterprise” comprised of the elected official and associated personal and committee staff, I explored how enterprises develop the communication networks they need to obtain information and policy analysis from interest groups, executive agencies, congressional support agencies, and policy research organizations. The lessons I learned about policy analysis are generally applicable to the use of research—broadly defined—in Congress.

By determining each enterprise’s level of interest in four specific issues, I made a distinction between those enterprises involved in an issue, occupying a position at the core of the larger issue network, and those enterprises merely attentive to an issue, occupying a position at the periphery of the network. I was then able to contrast the extensive information searches of the few enterprises that choose to become involved in an issue with the much more limited searches of the vast majority of enterprises merely staying attentive to developments.

I was careful to assess the place of policy analysis within the full range of information sources available to enterprises. An important part of my study was to follow enterprises within each issue network as they made use of a set of specific policy analysis projects, which allowed me to examine issues ranging from those which incorporated significant input from the natural sciences (such as compensation for vaccine injuries) to those informed largely by the social sciences (such as physician payment). I was able to establish that enterprises used information from policy analysts and other expert sources much more than previously acknowledged. For the involved enterprises at the core of each network, I found that the level of search activity intensified, and search patterns often became much more elaborate.

Such enterprises at the very core of the issue network were most likely to be aware of relevant policy analysis and to make use of it, often through the personal relationships that developed between staff members and analysts and by the “professional information,” in addition to the policy project-based information, communicated through these channels. Since these core enterprises were the most influential in shaping legislative outcomes, use of analysis by only a few enterprises translated into a potentially large impact on legislative outcomes. This use of analysis rarely conformed to the classic requirements of concrete and substantive use, but following a broader conceptualization permitted the inclusion of use which is more conceptual and strategic. Research use to develop a general intellectual orientation to an issue falls into the first category, while use to justify and support positions that have already been decided would fall into the second.
was asked how he evaluated scientific claims on a controversial issue responded, “We don’t. That’s ridiculous. You have a general position. Once you have that posture, you use the scientists’ testimony as ammunition. The idea that the guy starts with a clean slate and weighs the evidence is absurd.” Researchers and their organizations may view the congressman’s response with some distaste. As Whiteman notes, the strategic political use of their science can be seen as a risk to their reputation. However, in the workshop, the University of South Carolina political scientist observed that strategic use does have its positive features, among them that: “… strategic use reframes to some extent the way that the debate goes.” Or as a National Research Council report (2012) stated, “My science versus your science’ has the merit of putting science in play, and over time opens more space for policy arguments that include science” (p. 38).

Regardless of the form of use, information producers and users may disagree about what makes science usable. Usability is described as “a function of both how science is produced (the push side) and how it is needed (the pull side) in different decision contexts” (Dilling & Lemos, 2011, p. 681). The authors argue that usability is most likely to result when science policies are deliberately designed and implemented to reconcile the supply and demand for scientific information. As University of Michigan political scientist Maria Carmen Lemos remarked at the workshop, policymakers have no difficulty in identifying usable information. “They know what's usable. Why do they know it's usable?” she said. “Because they actually use information all the time. They are not waiting for science to make information. They're making decisions with the best information that they can find.”

Lemos and colleagues (2012) have summarized three main drivers of knowledge use: fit, or how users perceive knowledge would meet their needs; interplay, or how new knowledge intersects with existing decision routines (negatively and positively); and interaction, or how the collaboration between scientists and decision-makers in producing knowledge increases its use. These three dimensions incorporate variables ranging from information quality (timely, accurate, salient) to policymaker individual and organizational characteristics, and the nature of the relationship between scientists and policymakers (duration, one-way vs. two-way communication, iterative). Importantly, the authors found that interaction over time between information users and producers, through repeated two-way communication, could increase the usability of science and its uptake by users. These types of communication can bridge the gap between the science and policy communities. As Lemos commented at the workshop, “… the only examples in the literature that we found that actually took care of fit and interplay in different ways were communication. Dialogue.”

Some preliminary evidence demonstrates that Lemos and colleagues’ model, developed originally for use with a wide range of decision-makers, also has application in the congressional context. The focus on communication, and the need for information to fit relevant issues to
Congress and the institution’s decision routines, were echoed in interviews with staffers conducted by independent evaluators for the Government Accountability Office (GAO) (Fri, Morgan, & Stiles Jr., 2002). The staffers pointed to the following criteria for useful scientific and technological assessments:

1) They are relevant to a problem of active concern to Congress.
2) The results are produced in a timely manner.
3) They are scientifically complete and credible.
4) They are balanced in the framing, analysis, and discussion of issues.
5) They reflect the full range of views held by experts and affected parties and concerned stakeholders so that staff and members can accurately identify and weight the tradeoffs involved in policy choices.
6) They provide analytically informed input supporting the needs of congressional staff and members as they refine and tune legislative products.
7) The assessment team is available for iterative interaction as legislative text changes, or other related projects arise.

**Limits on the rational use of science in policymaking processes**

The statement from GAO’s interview findings (above) that staffers and members of Congress seek to “identify and weight the tradeoffs involved in policy choices” implies that policymakers make decisions according to rational models of human choice. But psychologists have demonstrated that people have cognitive limitations in processing information, calculating probabilities, and understanding risk that “bound” their ability to make rational decisions (Mullainathan & Thaler, 2000). For example, they use cognitive shortcuts to reduce the difficulty of complex problem-solving tasks, which bias their judgments (Tversky & Kahneman, 1974). Recent authors have argued for the need to augment rational models of science usability, taking into account the psychology of decision-makers and the policy context (Cairney, 2016; Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014).

Even within rational models of decision-making, scientific evidence has a necessarily circumscribed role, especially under conditions of informational uncertainty and ambiguity (Kay, 2011). Cairney describes the problems with assuming that evidence can alone be used to make policy decisions as follows (2016, p. 42):

1) Even if the ‘evidence’ exists, it doesn’t tell you what to do.
2) The demand for evidence (by policymakers) doesn’t match the supply (from researchers).
3) Policymakers make choices in a complex policymaking system in which the role of evidence is often unclear.
The wide variety of contexts in which science can be used for policy—and ways in which evidence is used—have made it difficult for social scientists to abstract lessons that can apply across all of them. The next section explores this challenge.
Primary messages:

- Political polarization, willingness to incur costs (time, resources, etc.) in exchange for knowledge, and communication all affect the dynamics of knowledge transfer, making broad generalizations about how to facilitate it difficult.

- When interest groups provide tailored information to congressional offices on an issue of mutual concern, they reduce the time and resources staffers might otherwise have to expend in order to achieve progress in the policy area, increasing the probability of the office’s attention.

- In highly politicized environments, such as Congress, polarization largely governs the formation of issue-related coalitions of individuals and organizations, and the extent and content of informational exchange.

- Learning occurs with difficulty across issue coalitions with different core beliefs, including about science and technology. Coalitions with diverse belief systems are likely to learn from each other only in certain circumstances, such as when they are brought together in a prestigious forum with understood professional norms.

- Some researchers argue that the capacity of Congress for processing information has been diminishing over time as the percentage of staff allocated to state offices has increased, and the number of committee hearings, and numbers of committee and non-partisan support staff, have declined.

- Senior congressional staff report large gaps in the knowledge and skills within the House and Senate needed to support members of Congress, and the time and resources needed for members to adequately consider policy.

As political scientists Bruce Desmarais and John Hird comment in presenting their findings on the use of science in defending regulatory decision-making (see Box 2), there is little generalizable evidence on how policymakers use science, even though knowledge utilization has been a field of study for decades. Indeed, in a recent collaborative exercise, experts identified 40 basic questions that remain unanswered regarding the science-policy relationship (Sutherland et al., 2012).

A number of systematic reviews of the literature on knowledge exchange have demonstrated both the breadth of the literature and its limitations (Cairney, 2016; Contandriopoulos, Lemire, Denis, & Tremblay, 2010; Oliver et al., 2014). In organizational and policymaking contexts, three dimensions have been identified that fundamentally affect how knowledge is transferred: political polarization; willingness to incur costs (time, resources, etc.) in exchange for
Figure 1. The cost of knowledge exchange and the degree of political polarization are believed to influence the type of information use (adapted from Contandriopoulos, D., Lemire, M., Denis, J.-L., & Tremblay, E., 2010)

knowledge; and channels of communication (Contandriopoulos et al., 2010). The combination of each of these dimensions produces different circumstances that make broad generalizations about how to facilitate knowledge transfer difficult, but can be used to make assessments about the likely dynamics of science use in specific contexts (Figure 1). In this figure, the two types of use discussed in this report—substantive and strategic—are placed along dimensions of political polarization and who bears the costs of knowledge exchange. Contandriopoulos and colleagues note that in highly polarized contexts, most use is for political purposes. In less polarized environments where users of information are motivated to contribute time and/or other resources to information, they may 1) engage in direct searches for scientific information that address policy problems or commission studies that answer these questions, or 2) engage in repeated conversations with a wide array of experts in order to jointly address the problem, in a more equitable cost-sharing of the knowledge generation costs.

In highly politicized environments, such as those for many issues before Congress, polarization is the key variable in the extent and content of knowledge exchange, and the construction of issue networks. Two political theories are instructive. According to the Advocacy Coalition Framework, actors unified by common core beliefs coordinate within coalitions to influence a policy “subsystem”; scientific and technical information is a part of these core beliefs (Jenkins-Smith, Nohrstedt, Weible, & Sabatier, 2014; Sabatier, 1988). The framework predicts that learning occurs easily within coalitions, but with more difficulty across coalitions with different core beliefs. Certain circumstances, such as when prestigious fora bring coalitions with diverse belief systems together within understood professional norms, can facilitate these forms of knowledge exchange. Science organizations, such as American Geophysical Union, sometimes take on these roles.
Policymakers are thought to utilize scientific expertise, yet there is little systematic evidence concerning if and how they use it. Tracing connections between scientific research and policy outcomes is challenging, and a formidable obstacle is the character of policy arguments themselves (See the National Research Council’s 2012 report, *Using Science as Evidence in Public Policy* for a recent summary). Policy decisions are accompanied by oral arguments and numerous documents produced by multiple parties, yet there are no justificatory documents outlining the policy’s rationale. (This is politically rational.) Thus, tracing the specific science invoked to justify policy outcomes has proven difficult.

In our 2014 paper we utilize data on the regulatory impact analyses (RIAs) that are required by Executive Order to accompany any major new federal regulations (Desmarais & Hird, 2014). RIAs are single, coherent justificatory documents written from the regulator’s perspective, a nearly ideal vehicle to study how research is used in policymaking. Our 2014 paper reports findings from collecting and examining specific citations—both scientific and otherwise—included in 104 RIAs from 2008–2012. RIA citations do not mean that research is driving policy, but at a minimum it indicates that research is being used to justify policy decisions.

We report several findings:

- Non-scientific sources represent the majority of citations by RIAs.
  - Mean number of total citations per RIA is 57.9, with 13.4 of them scientific citations.
  - Citations include think tank reports, internal governmental reports, other regulations, and newspaper articles.
- A broad range of agencies—from the Environmental Protection Agency to Health and Human Services to Transportation—make substantial use of scientific research in justifying new regulations across a wide range of issue areas, though there are no formal requirements to do so.
- Significant variation occurs across disciplines and journals in terms of the frequency of citation in RIAs.
  - Regulators focus most heavily on economics, public health, and related disciplines. (See Box 2 Figure A on the next page.)

*Continued next page*
Box 2, continued

- Regulators disproportionately cite studies published in higher impact journals. This suggests that agencies are seeking more scientifically credible sources to justify their regulations.

Additional research is needed to determine if regulators are utilizing the best possible research in justifying regulatory decisions. In addition, further research is necessary to model the complex interactions involving multiple parties in regulatory policymaking (e.g., regulators, funding agencies, the scientific community, think tanks, congressional committees).

Our initial findings point both to the fact that good science matters in regulatory policymaking during this period and that further research is required to better understand how and why science is invoked.

Box 2, Figure A. Number of citations in each subject area within 104 RIAs from 2008–2012.

*Some material above quotes directly from the 2014 paper.*
Within policy coalitions, information has recognized economic value that facilitates its transfer. This aspect of information sharing is documented by the theory of lobbying as legislative subsidy (Hall & Deardorff, 2006). The model explains the long-observed phenomena that lobbyists work most frequently with the offices of members of Congress with whom they share support for policy goals, at times almost becoming adjunct staff. An office’s involvement in a policy issue costs it scarce time and other resources. Lobbyists can affect the budget line calculation by providing research and expertise that lowers the price tag of the office’s efforts in achieving progress on an issue, potentially influencing which policy areas receive more attention.

**Communication between scientists and policymakers**

Numerous authors concur (Cash et al., 2003; Lemos et al., 2012; Posner et al., 2016) that developing and maintaining open communication between those who generate scientific information and those who use it—including through information brokers such as interest groups—generally increases access, perceived informational value, and usage. As an example, in the field of technological innovation, Sarewitz and Pielke note that “one feature that invariably characterizes successful innovation is ongoing communication between the producers and users of knowledge” (2009, p. 7).

In the policy arena, how scientists provide information to policymakers can increase, or decrease, political polarization by narrowing or broadening the number of policy options before legislators. The role of the scientist in providing advice to decision-makers has been described in a number of typologies (Donner, 2014; Steel, Lach, List, & Shindler, 2001), of which Pielke’s is arguably the most well-known (2007). He posits four ways that scientists may engage with decision-makers:

1) The “pure scientist” does not engage with policy (and according to Pielke rarely exists; most researchers obtain external funding tied to societal policy goals).
2) The “issue advocate” employs their research in alignment with a particular political agenda and policy goals, restricting legislator options.
3) The “science arbiter” uses their expertise to answer purely scientific questions of relevance to decision-makers.
4) The “honest broker” attempts to integrate scientific information into evaluations of policymaker alternatives to broaden the choices available to decision-makers.

Notably, the author states that as scientific issues become more complex and political, individual scientists are less likely to effectively serve in the roles of science arbiter or honest broker of policy alternatives than groups of scientists acting on a committee or in an assessment (p. 17).

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3 In a fifth category, unadvised by Pielke, scientists conceal their political aims within the guise of their providing scientific expertise as “stealth issue advocates.”
Committees are more likely to have the necessary range of expertise and a diversity of sociodemographic and political perspectives that diminish the potential for issue advocacy. Pielke and Klein argue that the proliferation, and professionalization, of scientific expertise across government since 1950 has reduced the importance of individual advisors to policymakers at the top, like the president (Pielke Jr. & Klein, 2009). Workshop participants observed that from their experience, individuals could be highly important and effective with adequate—and potentially sustained—organizational support. Regardless, both individuals and organizations must strive to be clear in differentiating scientific issues from those of policy in order to maintain their credibility and not confuse policy debates when communicating with policymakers, according to a 2009 report from the Bipartisan Policy Center (see Box 4).

**Executive branch**

How scientists provide advice within political contexts has been studied the most extensively within the executive branch. In the 1970s, federal regulatory agencies required new levels of policy-oriented science in response to legislative mandates to protect public health and the environment. A 1993 executive order further required that agencies justify their policy using best attainable information on the need for—and consequences of—proposed regulation (Federal Register, 1993). In their 2014 study, Bruce Desmarais and John Hird found that citations were invoked frequently in regulatory impact analyses (RIAs), even if the majority were non-scientific (Box 2). RIAs provided a unique dataset that allowed the researchers to quantitatively track the use of science in agency discourse. More frequently, researchers studying use of science in the executive branch rely on interviews and case studies of agency decision-making processes.

In one of the most famous examples, Jasanoff’s *The Fifth Branch* (1990) explored how scientific advisory committees at the Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) define good science and negotiate scientific and political conflict. She found that the most valuable experts on committees were those who had not just scientific expertise, but a wide range of knowledge that crossed disciplines, and who understood the policies and practices of the agencies. Indeed, the ability of scientists on the committees to play many roles, “as technical consultants, as educators, as peer reviewers, as policy advocates, as mediators, and even as judges,” (p. 237) is essential if the committees are to be effective, the author concluded.

Powell’s book, *Science at the EPA*, also described the use of science in the executive branch (1999). The author evaluated critical impediments and facilitators through a series of eight case studies. From interviews he found that the two largest categories of factors that serve as barriers are 1) the culture of EPA as a regulatory—not science—agency, including poor communication between policymakers and scientists, and 2) the inadequacy of environmental science for making agency decisions, due to uncertainties and the lack of fit of available scientific tools and analyses. Alternately, the most frequently cited factors that promoted the use of science were: 1)
Box 3

Distinguishing scientific and policy judgments
David Goldston, MIT Washington Office

In 2009, the Bipartisan Policy Center issued a report titled *Improving the Use of Science in Regulatory Policy*. While the report was focused on policymaking in the executive branch, most of its recommendations are just as applicable to congressional action, and to guiding science organizations, and scientists, who want to affect policy (Goldston & Trapani, 2009). Its over-arching point was that **those working to influence or promulgate policy should make as clear a distinction as possible between “questions that involve scientific judgments and questions that involve judgments about economics, ethics and other matters of policy.”**

The report—chaired by a Republican and Democrat, and funded by both right- and left-leaning foundations—noted, “[S]ome disputes over the ‘ politicization’ of science actually arise over differences about policy choices that science can inform, but not determine.” It recommended that when proposing policies, officials be explicit about what the science and policy questions relevant to the policy are, what additional science would make a difference in formulating the policy, and what alternative policy approaches would be consistent with the science. The same advice would apply to policy advocacy by scientists.

When speaking to members of Congress or their staffs, scientists need to be clear about when they are describing scientific findings (and about the level of certainty of those findings) and when they are expressing personal policy preferences (which may be based on that science). Scientists should remember that deciding how to act in the face of uncertainty or deciding how much risk to accept are policy choices.

The distinction between science and policy questions is not always easy to define, but failing even to try can hurt scientists’ credibility, make discussions with public officials more difficult, and lead to distorted debates on issues by obscuring what the true disagreements are. Failing to make that distinction can also needlessly alienate scientists from the policy world by making it seem too often that lawmakers are “rejecting the science” when they are simply drawing different policy conclusions that may still be consistent with scientific information. And politicians are just as eager as scientists to claim, wrongly, that science can settle policy questions.

The focus on the climate debate has made it even easier to lose sight of these important points. The climate debate is unusual both in that there is a clear scientific consensus and that the consensus is rejected by a faction of officials. That is not typical. And it is noteworthy that even on climate, both sides attempt to marshal scientists and scientific claims to make their point. Neither side sees itself as “anti-science.”
demand for science by agency leadership, 2) EPA’s Science Advisory Board, 3) external pressure from Congress and others to articulate scientific evidence used for decisions, 4) adequate resources for research, 5) science-related statutory flexibility and requirements, and 6) communication between scientists and policymakers. The case studies suggested to Powell that as economic and political pressures on agency decisions increased, so did policymaker attention to scientific information (p. 122). But these high stakes also reduced the likelihood that decisions would be made on science, instead of for political or economic reasons.

**Legislative branch**

Research and technical analysis in state legislative contexts has been another area of study of the use of science for policy (Dodson et al., 2013; Dodson, Geary, & Brownson, 2015; Guston et al., 1997; Hird, 2005, 2009). Guston (1997) identified the need to better connect demand and supply for technical analysis in state legislatures, and Hird (2005) found that, indeed, state nonpartisan policy research organizations can help bridge academic research and policymaking. Focusing specifically on health policy, Dodson and colleagues (2013) surveyed state legislators from six states to determine which factors influence their issue prioritization. The policymakers told them that constituent concerns were most likely to affect their decision, followed by scientific evidence of the effectiveness of policy options. Based on these results, the authors concluded that constituents who approach their representatives with scientific information regarding potential health policies are likely to be highly effective. In a follow-on study, they found that state legislators holding leadership positions on health committees preferred data and statistical information, especially health demographics (2015). Stories were also considered helpful, such as personal testimonies and anecdotes.

Some of the most notable analyses of use of information in Congress—such as those of Kingdon (1984) and Whiteman (1995, 1997)—have tracked specific policy issues through interviews and case studies, much as studies on the use of science in regulatory agencies. Kingdon focused on health and transportation policy, arguing that the long-term implications of academic research to policy were likely to be much greater than its immediate impacts. He found that researchers were unlikely to get much attention from policymakers unless their studies were directly related to issues that were already on the agenda. “For the researcher who wants to have an effect in the short run, there is a premium on knowing what is on the minds of people in government,” wrote the political scientist (p. 56). Whiteman’s studies (1997) on the use of research within 92 congressional offices in four policy areas relevant to the 99th Congress, echoed Kingdon’s finding, but observed higher than anticipated rates of short-term use, particularly as background information, but also for briefings, formulating and advocating legislation, and writing speeches on topics of legislative interest.

These studies were conducted during a period between the end of World War II and the early 1990s of congressional interest in building capacity to access and analyze information on rapidly
emerging areas in science and technology. The formation of the Office of Technology Assessment (OTA) is one example of the outcome of this congressional attention—the first additional legislative branch agency in 50 years when it was established in 1972 (Blair, 2013) (see Appendix D for a short history). A handful of organizations—among them the Congressional Research Service (CRS), Government Accountability Office (GAO), Congressional Budget Office (CBO), and the congressionally chartered National Academies (NAS)—also grew during this time in their ability to provide scientific and technological advice (Smith & Stine, 2003) (for information about the role of NAS and these agencies, see Appendix E).

Some scholars have become increasingly concerned that the capacity of Congress to process information has declined since the 1990s because of hyper-partisanship and other institutional changes, leaving the institution even less likely to adhere to rational models of decision-making (Lewallen, Theriault, & Jones, 2016; Mann & Ornstein, 2016). At the workshop, Brookings Institution’s Molly Reynolds and Congressional Management Foundation’s Kathy Goldschmidt pointed to indicators of growing dysfunction. Reynolds (Box 4) detailed staffing statistics showing that members of Congress are increasingly placing their resources in-state to focus on constituent concerns instead of federal policy. Additionally, the non-partisan support staff at CRS, CBO, and GAO that help offices locate and analyze information have seen a downward trend in their

Box 4

Institutional changes affect how Congress gets its information
Molly E. Reynolds, Brookings Institution

In thinking about how to best connect science with the policymaking process in Congress, it is helpful to begin by exploring several macro-level trends in congressional capacity. Using data from Vital Statistics on Congress—a long-running publication of the Brookings Institution—we can see a number of important changes in congressional capacity over time (Reynolds, 2017). Since the early 1980s, in both the House and Senate there has been:

- An increase in the share of the chambers’ staff that is housed in district or state offices rather than in Washington, DC.
  - District- and state-based staff are more likely to handle constituent service functions than policy ones.
  - This suggests that members are choosing to invest more in constituent services than policy expertise.
- Weakening of Congress’s internal policy capacity, as reflected in the decline in committee staff, individuals who also focus largely on policy development. This is especially of concern in the House.
- Declines in the number of non-partisan support staff, which provide unbiased, expert advice to Congress in agencies like the Congressional Research Service, the Congressional Budget Office, and the Government Accountability Office.
- Declines in the number of hearings, suggesting that members may be allocating their time to other activities.

Without in-house expertise, members may be more likely to turn to outside, special-interest groups for information they can use to make decisions.

Continued next page
What are the consequences of these trends?

First, they demonstrate that choices that members make about how to allocate their time and staff are likely influenced by changing incentives in the broader political environment. Policymaking in Congress has become more centralized in the hands of party leaders in both the House and Senate, so rank-and-file members have fewer opportunities to weigh in on the process. They’ve responded by allocating their time and resources away from policymaking activities, such as hiring D.C.-based staff and holding committee hearings. One of the most precipitous drops in legislative branch support staff levels came after the new Republican majority chose, for largely ideological reasons, to abolish the Office of Technology Assessment after retaking control of both chambers after the 1994 elections.

Second, this suggests that considering and leveraging those same political incentives is a necessary pre-condition for boosting congressional capacity generally and encouraging the use of scientific information in Congress specifically.

**Box 4, Figure A.** Share of House and Senate staff located in the state or district, 1981-2015. Source: *Vital Statistics on Congress.*

**Box 4, Figure B.** Number of legislative branch support staff at CRS, GAO, CBO and OTA, 1981-2015. Source: *Vital Statistics on Congress.*
numbers since 1995, in part due to efforts by Republicans after they gained a majority in the House and Senate in the 104th Congress. Goldschmidt (Box 5) used survey data from senior Washington, DC-based staff to illustrate perceived gaps in staffing capabilities and members’ lack of time and resources to consider policy.

Lewallen and colleagues (2016) see congressional dysfunction as a failure of information processing that reaches beyond hyper-polarization; they present data on committee function as one indicator of the problem. Committees are meant to provide topical expertise and serve as the “legislative workhorses” of Congress. Yet, the number of committee hearings in both the Senate and House has been in steep decline (Appendix C). In studying texts from congressional hearings and testimony over the past 40 years, the authors found that committee hearings have become increasingly focused on problems and policy implementation, instead of solutions, and have become used more for partisan positional statements instead of exploring issues.

The current institutional context described above suggests a highly politicized environment with few resources to engage in knowledge exchange. As we saw in the introduction to this report, these characteristics are correlated with strategic use of scientific information in support of pre-existing political or policy positions (see Figure 1), which was already predominant prior to 1995, according to authors like Kingdon and Whiteman. The variable nature of science use across different contexts may make it prohibitive to draw generalizable lessons, as noted by Contandriopoulos and colleagues (2010): “Collective knowledge exchange and use are phenomena so deeply embedded in organizational, policy, and institutional contexts that externally valid evidence pertaining to the efficacy of specific knowledge exchange strategies is unlikely to be forthcoming” (p. 468). Regardless of these concerns, the field of evidence-based policymaking has taken off on both sides of the Atlantic.
A range of leadership decisions over the past few decades about how Congress operates has weakened the institution (Mann & Ornstein, 2016; Sinclair, 2014, 2017). Much of the communication and decision-making in Congress has been consolidated within party leadership, which in most cases has diminished the voices of rank and file members and the constituents they represent. It may also be a contributing factor in political polarization. Congress is receiving unprecedented amounts of information and outside pressure while the capacity of congressional staffs has declined. With the changes in how Congress is functioning, the trust deficit between citizens and legislators is growing, demonstrated in part by historically low congressional approval ratings. In addition, the U.S. is experiencing unprecedented social, economic, technological, and global change. It remains unclear how Congress will adapt to these interacting factors.

To learn more about staff perspectives on Congress, the Congressional Management Foundation (CMF) asked senior congressional staffers about the importance of 11 key aspects of institutional capacity and their satisfaction with each. We found that senior staffers perceive the largest gaps to be in staff abilities and the capacity of members of Congress to consider policy. The table below presents the findings most relevant to communicating science to Congress, offering both challenges and opportunities for scientists.

<table>
<thead>
<tr>
<th>Survey Questions: “In your opinion, how important are the following for the effective functioning of your chamber?” and “How satisfied are you with your chamber’s performance in the following?”</th>
<th>Very Important</th>
<th>Very Satisfied</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff knowledge, skills and abilities are adequate to support members’ official duties.</td>
<td>83%</td>
<td>15%</td>
<td>68%</td>
</tr>
<tr>
<td>Members have adequate time and resources to understand, consider and deliberate policy and legislation.</td>
<td>67%</td>
<td>6%</td>
<td>61%</td>
</tr>
<tr>
<td>Members and staff have access to high-quality, nonpartisan, policy expertise within the legislative branch.</td>
<td>81%</td>
<td>24%</td>
<td>57%</td>
</tr>
<tr>
<td>The technological infrastructure is adequate to support members’ official duties.</td>
<td>60%</td>
<td>6%</td>
<td>54%</td>
</tr>
</tbody>
</table>

(n=128-130)
INSTITUTIONALIZING EVIDENCE-BASED POLICYMAKING

Primary messages:

- The evidence-based policymaking movement has sought to improve decision-making policy processes at the organizational level.
- While the normative use of the phrase “science-based policy” often refers to the physical and natural sciences, the focus of “evidence-based policy” in recent decades has been on the use of social science in improving policy decisions in areas such as health, education, criminal justice, and welfare.
- The U.S. has seen recent bipartisan support for the institutionalization of evidence-based policymaking (EBPM), but the movement has been most visible in the United Kingdom.
- The rise in government support in the United Kingdom for determining “what works” through evidence-based policymaking may be the result of public declines in trust in the professional judgment of experts, requiring new practices with greater levels of transparency. Institutional loss of trust is a concern in the U.S. as well.

Since World War II, the social contract between the federal government and universities has supported an independent scientific and technological research enterprise in exchange for knowledge and workforce education (Bush, 1945; Guston, 2000). Much of the focus on science policy after the war was on the physical and biological sciences; indeed, the use of the phrase “science-based policy” often refers to them. However, the emphasis of “evidence-based policy” in recent decades has been on the use of social science for improving policy decisions in areas such as health, education, criminal justice, and welfare (Davies, Nutley, & Smith, 2000). Where Vannevar Bush’s Science, the Endless Frontier spoke to the use of science to help government fight disease, protect our national security, and create jobs (1945), evidence-based policy speaks to making data-based decisions that bring higher returns to investments in government programs, better alignment between program outcomes and policy goals, and transparency in decision-making (Haskins & Margolis, 2015). Davies and colleagues (2000) theorize that in the United Kingdom, the rise in government support for determining “what works” resulted from public declines in trust in the professional judgment of experts, requiring new practices with greater levels of transparency. Public trust in institutions remains a concern in the United States as well (Funk & Kennedy, 2017).

In the U.S. during the 1960s, President Lyndon B. Johnson introduced the “Great Society” domestic programs to reduce poverty and racial injustice. Federal funding of social science research increased to address these and other societal problems (Gieryn, 1999). The acceleration
of this spending in the 1970s necessitated a hard look at research use in governance. As a result, some of the largest systematic efforts to evaluate the use of evidence for policy in the United States have centered on social science, though a National Research Council report noted that even the definitions of “relevant to policy” and “socially useful” were unclear (Lynn, 1978). Decades later, a 2012 National Research Council report still found that “To date, there has not been much success in explaining the use of science in public policy” (p. 2). Furthermore it stated, “Despite their considerable value in other respects, studies of knowledge utilization have not advanced understanding of the use of evidence in the policy process much beyond the decades-old [1978] National Research Council report” (p. 51).

Yet during the last decade, enthusiasm for evidence-based policy grew across both the executive and legislative branches. The goal has been to implement social science theories and methods, such as randomized controlled trials and systematic reviews, to evaluate the effectiveness of federal policies and programs, and allocate funding preferentially towards those that demonstrate results (Haskins & Margolis, 2015). These initiatives drew on the availability of large government datasets to conduct assessments (National Research Council, 2012). The efforts were further promoted by the bipartisan U.S. Commission on Evidence-Based Policymaking (2017) led by Rep. Paul Ryan and Sen. Patty Murray, resulting in the establishment of the Evidence-Based Policymaking Initiative at the Bipartisan Policy Center to support the implementation of recommendations from the commission’s 2017 report.

Calls for evidence-based policymaking have been even more visible on the other side of the Atlantic, where the United Kingdom has led a series of initiatives starting in 2010 to figure out “what works” through the establishment of the Office for Budget Responsibility, What Works Centres, departmental evidence audits, an independent commission to assess the impact of international aid spending, and a committee that scrutinizes the quality of evidence in regulatory proposals (Rutter & Gold, 2015). In 2014, the government published the findings of its What Works Centres on crime, health, education, local growth, and early intervention (What Works Network, 2014). Yet, when the Institute for Government, in partnership with two other non-profits, sought to assess—and rank—departmental use of evidence in the UK, they encountered similar problems as had the National Research Council: difficulties defining not only “evidence,” but “policy” and “use” (Rutter & Gold, 2015). As a result, instead of ranking departmental use of evidence, they developed a framework to assess the transparency of evidence in government policy announcements from departments and the Cabinet Office.

Evidence-based policymaking is not without its critics (Head, 2013), some of whom point instead to the need for “evidence-informed” policymaking in recognition that the potential quantity and range of evidence for any decision might be quite large, and that other factors—

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4 In 2015, $1.14 billion was obligated by federal agencies for research in the social sciences (National Center for Science and Engineering Statistics, 2017).
such as politics and stakeholder interests—also play a legitimate role. However, the movement has resulted in interest in institutionalizing evidence-based practices across multiple levels of decision-making, including within legislatures. A three-year study on the use of science in Parliament (Kenny et al., 2017) led to calls to increase the submission of evidence from higher education, to provide parliamentary staff training, and to consider changes in processes, like selection of expert witnesses. Studies of the use of science by policymakers are currently underway in Congress as well (Center for Public Engagement with Science & Technology, 2018).

It is important to note that both in the United States and United Kingdom, the evidence-based policymaking movement has sought to change decision-making processes at the organizational level. By way of comparison, the models of science communication for policy presented in the next section focus on change at the individual level—increasing the ability of scientists to participate in policy processes and connecting them with decision-makers. Organizational- and individual-level change are not mutually exclusive, indeed they are heavily intertwined. But they do represent different foci and associated objectives.
SCIENCE ORGANIZATIONS: CURRENT PROGRAM APPROACHES AND NEEDS

Primary messages:

- Many science policy programs conducted by science organizations can be categorized as either improving scientist capacity or access to policy.
- Scientists’ perceptions of a lack of public scientific knowledge and beliefs about their own abilities and institutional support for public engagement are some of the motivations that lead them to engage with new audiences.
- Science organizations would like better evidence connecting science to policy outcomes and assistance in developing and evaluating program metrics; more research on policymaker goals and preferences would also be helpful.

A wide array of organizations in the United States—including scientist membership societies, universities, and other non-profits—develop and implement programs to increase the capacity of the science community to engage with policymakers. A list of some of the 16 most active organizations and their initiatives are listed in Appendix A. The programs fall roughly into two categories: 1) education and training to improve the understanding of scientists of public policy processes, and their personal skills in interacting with policymakers; and 2) opportunities in which scientists are able to meet—and even work with—decision-makers. Some programs—like many Congressional Visit Days held by scientific societies, and legislative and executive fellowships—combine both types of programs in a closely choreographed series of events. While these categories are not comprehensive—some science organizations also organize congressional briefings and develop position papers (see Box 8, p. 50)—they largely represent the way in which science organizations strive to close the gap between the science and policy communities.

Science organizations address both science for policy (evidence-based decision-making) and policy for science (especially research funding). But they have more concentrated expertise in the latter because of the wide array of policy issues for which scientific information may be relevant, and the importance of maintaining consistent funding streams for the nation’s research infrastructure, including their institutions and/or members. As a result, workshop discussions ranged across both sides of the science policy equation, landing more heavily on government appropriations when it comes to perceptions of the successes of science organizations.

During the workshop, we asked the participants—broken into four groups—to think about the logic model, or theory of change, for one of the programs from their organizations. One group provided a meta-model that aptly captured the program categories described above of training and access as the inputs, and policy change as the outcome (Figure 2). “We believe that having better information, scientific information especially, will lead to better decisions and will lead to...
**Figure 2.** A logic model describes the implementation of programs with scientists in order to affect policy change.

better work,” said University of Michigan’s Maria Carmen Lemos. “People think about money (being the barrier), it’s really time. So how do you decrease the transaction costs? It’s by providing this access, and points of opportunities for engagement, and training people.” Indeed, University of Massachusetts Amherst decision-making scholar Ezra Markowitz concurs that time to participate in non-teaching and non-research activities is indeed one of the strongest factors in the communication and media outreach motivations of scientists (see Box 6).

In reporting for the second workshop group, Congressional Management Foundation’s Kathy Goldschmidt described their discussions of a similar logic model for changing congressional policy decisions. CMF’s Partnership for a More Perfect Union project—while not directed specifically at scientists—employs a wide variety of training and education in conjunction with Capitol Hill visits by civic organizations that bring citizens to meet their representatives. “Our assumption is that if people understand Congress and know how to communicate better that they will be better able to speak to Congress,” she said. “And Congress will therefore be better able to listen to and process the information that they provide.” (See Appendix F for more information from CMF about constituent communication with Congress.)

Two alternative models developed by the workshop participants focused on promoting research funding and science for policy within specific issue areas. These logic models took similar approaches as the first two in building capacity and access—creating toolkits of materials for grass tops groups and “validators” to carry the message to decision-makers—but they also aligned them with a wider set of persuasive communication strategies specific to the issues they were addressing.

- Research!America’s Suzanne Ffolkes described a recent joint campaign to encourage Congress to raise the caps on non-discretionary spending in the FY18 budget: creating issue attention through news media, advertising, social media, action alerts and letters; Capitol Hill meetings; and cultivating congressional champions for research (see a description of the overarching program model in Box 7).

- American Association for the Advancement of Science public engagement expert Emily Cloyd related examples from their group in which the choice of messengers—and their
messages—were very deliberately chosen to address the politicization of climate change in Congress. “We want to make sure that we’re connecting on values like economy and jobs that are affected by climate funding. But also recognizing that there is the baggage of the term climate change … .”

In these two latter logic models, more general educational efforts to improve the civic capacity of scientists and access to governance processes turned toward strategic communication to achieve concrete goals (e.g., funding, appeal to a specific audience).

Factors in congressional successes
It is inherently hard to connect any activity to influence Congress with outcomes on Capitol Hill,

Box 6
What predicts scientists’ interest in communicating with non-academic audiences?
Ezra Markowitz, University of Massachusetts Amherst

A growing body of research reveals a number of key factors that help explain why some scientists are motivated to communicate with non-academic audiences, including policymakers. Across multiple studies (e.g., Besley, Oh & Nisbet, 2013; Dudo & Besley, 2016), research shows that scientists’ willingness to pursue science communication efforts are strongly predicted by:

- Their perceptions of their ability to successfully engage with non-academics, and perceptions of institutional support for their doing so;
- Beliefs about the public’s lack of scientific knowledge;
- Key demographic and personal motivation variables (e.g., career-stage, field of study, perceived personal benefits).

In one study of AAAS members, for example, Nisbet and Markowitz (2015) find that the strongest predictors of scientists’ media and communications behaviors (e.g., reading or writing science-related blogs; talking with reporters) include the belief that media coverage is important for one’s career advancement as well as the amount of time scientists can dedicate to non-research and non-teaching activities. In another recent study, Dudo and Besley (2016) show that U.S. scientists tend to prioritize communication activities perceived to defend science from misinformation and to educate the public about science, while many discount the relative importance of communicating in order to build trust or establish resonance of science with non-specialist audiences. Together, these findings highlight the importance of understanding the diverse and sometimes counter-productive motivations and factors driving scientists’ communication and public engagement efforts, including working with Congress.
given the complexity of the issues, the number of actors, and the long timelines. However, some factors were believed to be related to success, primarily in research funding efforts.

1) **Using scientific consensus reports to solidify the basis for needed legislation**
   
   *Example* National Research Council report: “… the first National Research Council report that said, ‘study ocean acidification, figure this out’—that ultimately was a catalyst for the development of legislation, the FOARAM, [the Federal Ocean Acidification Research and Monitoring Act] in 2009,” said American Geophysical Union’s Lexi Shultz.

2) **Media outreach**
   
   *Example* Preserving the Fogarty International Center, which advances science for global health at the National Institutes of Health: “In terms of the budget for FY-18, [the administration] wanted to eliminate the Fogarty International Center, and so everyone was up in arms about that. … We worked with our members in raising awareness doing lots of media outreach, social media engagement, and facilitating a webinar describing the work of the Center,” said Research!America’s Suzanne Ffolkes. “Long story short, the committee bills did increase funding for the Center, it was preserved, and so we consider that a success.”

3) **Developing coalitions for outreach and coordination**
   
   *Example* Coalition to maintain National Science Foundation funding: “We were able to preserve the funding for Earth and space sciences, geosciences and social sciences within the National Science Foundation. … There was very strong coalition and partner work and the coalition stayed together,” said American Geophysical Union’s Lexi Shultz.

4) **Retail communication**
   
   *Example* Increasing health funding: “[At the Office of Science and Technology Policy] I was able to help package up an option for increasing health research funding through mandatory funding, or entitlement funding,” said AAAS’ Kei Koizumi. “And actually that grew out of a lot of conversations that I had been having in the community, including actually with Research!America, like fourteen years earlier, on how to have alternative funding paths for health research. And so on, I think my insight was that it took a lot of retail communications, like individual phone calls with congressional staff and committee staff on options for how do we find a mechanism to increase health research funding.”

5) **Other aspects: using distilled key points that connect to values; showcasing bipartisan support for science; and filling a need for expertise or understanding.**
Data and research to define impact

These types of success stories are captivating, but it can be hard to identify the impact of a specific program or organization. While members of the workshop agreed that research demonstrating causation between science knowledge and policy outcomes would be helpful, participants suggested more indirect ways of understanding the relationship would also be useful to their work. National Oceanic and Atmospheric Administration’s David Herring proposed a series of these types of research questions: “What is considered actionable information that [congressional policymakers] would be able to use in their jobs?”; “What are [policymakers’] preferred methods for receiving that information?”; and “What do they perceive as being relevant or salient in their objectives?”

The workshop’s researchers and practitioners related the difficulty not just in trying to connect policy outcomes to science, but in collecting data that allowed them to make long-term conclusions about their programs. Lemos offered the experiences of University of Michigan’s Great Lakes Integrated Sciences + Assessments Center (GLISA) in connecting graduate students to organizations with social science research needs as one example for increasing partnerships between researchers and practitioners, both to improve the types of questions social scientists ask, and data collection and analysis. “The fact that you, the practitioners might have a platform where we can access these kinds of questions would also be very important for us,” she said. “Because it’s hard to find.”

The use of research-defined metrics for the evaluation of programs was hailed as another arena where researchers and practitioners can effectively collaborate to increase the use of science for policy. Social scientists collaborating with American Association for the Advancement of Science have recently published a series of measures to evaluate scientist public engagement (Evia, Peterman, Cloyd, & Besley, 2017; Peterman, Evia, Cloyd, & Besley, 2017). These types of theoretically-based scales could be extended to evaluating engagement with policymakers.
Research!America’s model is to engage and educate Republican, Democratic, and Independent lawmakers on the health, social and economic benefits of public and private sector medical and health research. For example, advocacy for the 21st Century Cures Act involved engaging Republicans and Democrats to help secure strong bipartisan support for the measure and ensure its passage. Most recently, Research!America led two week-long “Raise the Caps” joint advertising, digital, and grassroots campaigns for all science in November 2017 and January 2018. About a dozen scientific organizations joined the initiative, which called on Congress to negotiate a bipartisan budget deal and raise spending caps to provide flexibility to increase federal funding for science in FY18. Metrics for the digital and advocacy activation campaign indicated widespread engagement and awareness of the message inside and outside the Beltway.

Research!America engages by:

- Leveraging the power of patient stories/testimonials;
- Facilitating Capitol Hill briefings with our member organizations highlighting different aspects of the research continuum from discovery to development to delivery for various diseases, i.e. COPD, heart disease, migraine, Alzheimer’s disease, cancer and more;
- Facilitating state-based programs on the health and economic benefits of research and innovation that connect policymakers and leaders from academia, patient groups, industry, and scientific societies;
- Distributing state-based fact sheets on research and public health, infographics, and public opinion survey data on research and related issues targeted to members of Congress and congressional staff; and
- Engaging policymakers online using social media, particularly congressional leaders.

By building relationships and cultivating congressional champions for research on both sides of the aisle, Research!America successfully seeks bipartisan support for legislation aligned with our mission.
OTHER FACTORS AFFECTING USE OF SCIENCE BY CONGRESS

Primary messages:

- Once scientific knowledge is produced, its usability is dependent upon the specific information needs of policymakers, the nature of the relationship between the scientists and decision-makers, and the wider context of policy processes within the decision-making office and institution.
- According to workshop participants, the political ideology of the member is the first, and perhaps most difficult, gate to get through in communicating successfully with them.
- The type of relationships that facilitate the use of scientific information are defined by trust that is generated through frequent, repeated exchanges.

The model that many science organizations pursue to bridge the science-policy gap, described in the previous section (Figure 3), focuses on building capacity among individual scientists and increasing their interactions with decision-makers to improve the use of science in policy. What the model doesn’t explicitly take into account is the decision-maker and their context. The policymaker’s specific informational needs; the nature of communication between scientists and decision-makers; the office and institutional context for policy processes (Boxes 4-5); and external forces at play, like media and competing interest groups, all affect the equation.

Research about knowledge exchange between science producers and users highlights the importance of these factors (Lemos et al., 2012; Lemos, Lo, Kirchhoff, & Haigh, 2014). It is these dynamics—termed fit, interaction, and interplay by Lemos and colleagues, presented earlier in the report—that have been identified as either facilitating, or hindering, the exchange of knowledge. Building scientist capacity and access to policymaking processes are necessary, but not sufficient, conditions to influence policy. The workshop participants detailed some of the constraints across these categories that scientists, and others communicating science to policymakers, face, along with opportunities for change.

Informational needs

For policymakers to use information, they first need to know it exists. “We know that people are so busy,” said American University political scientist Liz Suhay. “And they may not even have relevant pieces of information on their radar screen.” But not all information will be of interest. The ability to raise awareness about research information is correlated with its applicability to issues that are on the political agenda, said workshop participants. Other critical informational characteristics mentioned were the complexity of the information and its degree of uncertainty.
Communication and relationships
The type of relationships that engender use of scientific information are defined by trust, according to NOAA’s David Herring. Relationships that are more likely to build trust are those with frequent, high quality interaction. Herring and others in the group said that transparent processes that are reflective of stakeholder needs can shape the production of science to answer questions of greater relevance to societal decisions, and the perceived integrity of the resulting research. However, participants said that policymakers may have differing views on what constitutes legitimate processes for the generation of scientific information: “How do we reconcile different perspectives of what is and is not legitimate? There may be different perspectives on that. And some research may be dismissed, wrongly perhaps, just based on worldview.”

Participants also suggested there are other ways to increase the likelihood that information will be heard by policymakers. Herring pointed to the example of a celebrity scientist such as a Nobel Prize winner or head of a laboratory as potentially carrying “more weight,” but it also could be “if there’s a clearer recognition or a demonstration … that you’re sharing their [a policymaker’s] agenda, their mission, their values, there’s good alignment there or you're working towards the same purpose.” These comments echo the Advocacy Coalition Framework’s theoretical model of learning occurring most readily within issue groups that share the same core beliefs.

Office and institutional decision-making contexts
Citing evidence presented at the workshop by Brookings Institution’s Molly Reynolds and Congressional Management Foundation’s Kathy Goldschmidt, one breakout group discussed how each congressional office’s structure affects its ability to use scientific research—not only the freedom to search for information, but the capacity to distinguish useful information from non-useful. “We talked about: 1) it matters if your staffs are able to take initiative, if they have the autonomy to use science; 2) if they have the capacity to analyze, to ask the right questions,” said Erin Heath from the American Association for the Advancement of Science’s Office of Government Relations. “It’s not that they don’t have the right facts. It’s that they have too many. And they have to figure out which ones to use and who to trust.”

Workshop participants indicated that the political ideology of the member was the first, and perhaps most difficult, gate to get through in communicating with policymakers as to whether the science was likely to be heard. Other factors included the few—and short—windows of opportunity in which the information was salient, the role of an office’s constituents (Appendix F), and re-election pressures. University of Michigan’s Maria Carmen Lemos pointed out that office staffers have “pragmatic power” in that they get to set the priorities by deciding on who obtains meetings with the office, and how much time they’re getting.

One participant made the case that it is these types of contextual factors that government affairs specialists at scientific organizations are trained to understand and anticipate. “… You need to
understand how an office is likely to receive information of all kinds, not just research information. And then to communicate in a way that hits the sweet spot,” said visiting scholar Kei Koizumi from the American Association for the Advancement of Science. “But there’s an art to it, to determining it, and that’s what a lot of people here in Washington, DC, spend a lot of time trying to understand from that central insight that all offices are not equivalent.”

**External forces**
For most issues that Congress considers, the office and institutional context, interactions, and informational fit are influenced by the wider environment of events and activities, including of media, interest groups, elections, and other branches and levels of government. For example, workshop participants discussed the growing role of corporate and union money in campaign financing since the Supreme Court’s 2010 *Citizens United* decision, gerrymandering, and the power of interest groups to activate constituents and influence members of Congress.

The use of science in policy can be seen as a combination of push from scientists generating data and making it accessible, and pull from policymakers who are interested in using it, straddling a messy middle of whether they agree on what information is useful for societal decision-making. Both sides face individual- and institutional-level constraints. The next section addresses strategies that can be used to overcome them.
STRATEGIES TO IMPROVE THE USE OF SCIENCE

Primary messages:

- Scientific assessments, boundary organizations, and the co-production of knowledge represent complex communication processes that can facilitate the creation of scientific knowledge that is most useful for decision-makers.

- The academic literature on “boundary” organizations is largely unfamiliar to science organizations, few of which self-identify in this category, even though many play this intermediary role. Boundary organizations can both help facilitate the generation of useful scientific information for policymakers, and protect research organizations from political influence.

- Universities could potentially serve as some of the best sites for the “co-production” of knowledge between researchers and decision-makers because of these institutions’ longstanding relationships with their elected officials.

A wide array of strategies can be used to create knowledge in ways that are more useful for decision-makers, including forms of information customization to individuals or groups of policymakers with specific needs. Scientific assessments, boundary organizations that span knowledge systems, and co-production of knowledge represent three strategies often discussed in the literature that are believed to have varying rates of success (Guston, 2001; Kirchhoff et al., 2013). Notably all represent complex communication processes at both individual and organizational levels. Workshop participants discussed each strategy and their relevance to the congressional context.

Scientific assessments

Farrell and Jäger describe scientific assessments as “the entire social process by which expert knowledge related to a policy problem is organized, evaluated, integrated, and presented in documents to inform policy choices or other decision-making” (2006, p. 1). An example of a successful scientific assessment found three areas that contributed to greater impact: 1) level of informational fit to user needs; 2) flexibility in working on interdisciplinary teams and with stakeholders; and 3) resource availability, including funding, support services, and time (Lemos & Morehouse, 2005). However, as members of the workshop and authors observed, assessments rarely have a lot of influence on policy. Farrell and Jäger found that when assessments fail it is primarily for four reasons: 1) lack of scientific credibility; 2) an assumption that questions of interest to the scientific community are the same as those of the policy community; 3) failure to tailor assessments to specific policy communities and provide information in the timeframes needed for policy needs; 4) and inability to achieve political legitimacy through processes in which groups’ interests and concerns are taken account. Political legitimacy can be particularly
difficult to achieve as “an assessment cannot promote knowledge about facts and causal beliefs without simultaneously, if often implicitly, promoting certain values and goals over others” (p. 8).

Referencing the U.S. National Climate Assessment, AAAS’ Emily Cloyd pointed to a variety of factors that can intervene in congressional use of assessments: “There’s a lot of things like identity politics, industry influence, and regional identity that are going into the way that Congress is using or not using scientific assessments.” Assessment designs that are more likely to successfully avoid these roadblocks must be thoughtfully crafted across many dimensions. These include: how assessments are initiated and what their goals are; who will participate and what capacities participants have; how scientists and policymakers will interact; how uncertainty will be handled; how varying opinions will be handled; how the issue will be framed; how geographic and time scales will be selected; how transparent the process will be; and how quality will be assured (Farrell & Jäger, 2006).

**Boundary organizations**

Boundary organizations sit in the space between the science and policy communities, fostering communication and joint production of information between the two, while allowing them to maintain their identity and unique authority (Guston, 1999; Kirchhoff et al., 2013). As Lemos described them in the workshop, “A boundary organization has two roles. One is to bridge and broker while the other is to protect.” By exchanging scientific information with policymakers through these intermediaries, research organizations may maintain their own goals and forms of accountability separate from political influences.

Scientific assessments themselves can serve as a form of boundary organization. At the workshop, Lemos described the boundary organization structure of the Great Lakes Integrated Sciences + Assessments (GLISA). GLISA serves as a boundary organization by adding value to existing climate data from researchers and brokering it to regional managers and planners in areas such as water, forest, and energy resources (Lemos, Kirchhoff, Kalafatis, Scavia, & Rood, 2014). The significant requirements in building long-term relationships—taxing project resources—caused GLISA leaders to build an adaptive framework of “boundary chains” of other organizations that customize the information for their own stakeholders. This strategy reduces the transaction costs of knowledge exchange by building on pre-existing relationships, developing networks of information users.

Many in the workshop said that the idea of boundary organizations—and research on these science-policy structures—were new to them. Erica Goldman of COMPASS—a boundary organization that connects scientists with policymakers (including Congress) and other influencers of the public discourse on the environment—said that the discussion of boundary organizations, and its associated terminology, has been difficult with groups that are not already
aware of the term. Goldman said, “Talking about boundary organization function and why it differs from just any NGO or a specific community—articulating the differences in the value proposition and how it relates specifically to the scientific enterprise—is not that easy.”

**Co-production of knowledge**

While some scholars note that all scientific information is a reflection of the society in which it is produced (Cozzens & Woodhouse, 1995)—hence “co-produced”—beginning in the 1970s Elinor Ostrom began to use the term to denote how actors work together to generate knowledge across organizational boundaries (Bremer & Meisch, 2017). Boundary organizations can serve to facilitate the co-production of this knowledge, but information users and producers can themselves build knowledge through repeated direct interactions that take into account decision-maker needs. In the congressional context, workshop members sought to identify ways that organizations could co-produce knowledge with policymakers outside of the context of boundary organizations like COMPASS. American Geophysical Union’s Lexi Shultz noted that congressional committees were where co-production of knowledge for Congress used to occur, but is no longer as frequent, echoing the findings of Lewallen and colleagues (2016). The legislative support agencies (CRS, GAO, CBO) and the National Academies were identified as potential sites for co-production of information, playing an intermediary role between the science community and policymakers, because they maintain long-term relationships with congressional staff and offices that could lead to new directions for studies, reports, and policies. Workshop participants also suggested focusing on the relationship of congressional offices with universities as sites of co-production of scientific knowledge, citing the close relationships of some members of Congress with research institutions.

CMF’s Kathy Goldschmidt summarized some of the participant discussion around co-production saying, “We talked about the collective theory of change for boundary expanding and thinking about the co-production function as part of it. … and that the power of articulating a collective impact would be quite powerful right now. So figuring out how to sort of come together as a community to think about how different organizations play different roles and can engage in that role.” She noted concerns in the room, however, about the practical constraints on adopting these models. “One of the strong barriers is that we all have different and individualized incentive structures and needs to fund our organizations. So the barriers around collectively building that capacity are high, but I think that the potential value is also worth looking into.”
RECOMMENDATIONS:
OBJECTIVES FOR SCIENCE-FOR-POLICY PROGRAMS

**Primary messages:**
- **Without institutional support**—whether from the academic community, Congress, and/or intermediary organizations—the types of collaborative relationships that are most optimal in making scientific information usable for policy are unlikely to occur.
- **The success of programs conducted by science organizations depends on the capacity of Congress to process information, and the abilities of congressional staff and scientists—or their intermediaries—to engage in dialogue.**
- **Scientists are less likely to be motivated to conduct public engagement by opportunities to build trust than by the perception that the public lacks scientific knowledge.** Scientist capacity-building would benefit from discussions of trust-building as a critical element in working with policymakers.
- **Partnerships between researchers and practitioners within science organizations offer opportunities to:** 1) refine, and potentially test, organizational theories about how their programs work with theoretically based causal insights; 2) find ways of measuring their impact in working with scientists and policymakers; and 3) collect and analyze data that can be used for program evaluation.

Drawing on the discussion in this report on the social science literature of knowledge exchange at the science and policy interface and the workshop discussions, we present recommendations (Figure 3) for reconceptualizing the objectives of science-for-policy programs. The limitations of science alone to provide the basis for a policy decision—superseding politics, economics, or constituent interests—has led scholars to suggest that policies should be evidence-informed instead of evidence-based (Head, 2013). The new model incorporates the types of programs that already contribute to increasing capacity in the scientific community to participate in policy processes, such as training opportunities, educational materials, and toolkits. But it refines science program—and scientist—objectives from merely contacting decision-makers to building long-term relationships at both the individual and organizational level in ways likely to foster knowledge exchange. The elements of the multi-pronged approach to modify the science policy ecosystem in support of evidence-informed policy are described below.

**Building the capacity of the science community**
Many organizations currently focus on building the capacity of the scientific community to interact with policymakers through communication training and visits with elected officials. Examples of these programs are represented in Appendix A. Interestingly, decision-making scholar Ezra Markowitz notes that scientists are less likely to be motivated to conduct public
engagement by opportunities to build trust compared to other reasons (Box 5), yet the usability literature—and workshop participants—have stressed the importance of long-term, trust-building relationships as critical for knowledge exchange. This suggests a significant mismatch in scientists’ understanding of a core factor in the use of science.

That understanding alone will not be sufficient in increasing the scientific community’s capacity without institutional support within academia for faculty to spend their time investing in policymaking-relevant research and engagement. In the United Kingdom, a study of the use of science in Parliament found that little of the information submitted to Parliament as evidence in policy decisions came from the country’s academic research institutions, compared to government and non-profit organizations (Tyler, 2017). The former director of the Parliamentary Office of Science and Technology called for universities and funders to step up to the plate: “[R]esearch-intensive universities should set up dedicated policy-impact units. These should be staffed by professionals who are adept at navigating academia and policy. They should work across disciplines and universities, and provide a mix of proactive and responsive advice to connect research findings to policy needs.”

**Figure 3.** The goal of evidence-informed policy should not be to change policy per se, but to create the conditions under which science and policy apprise each other in a continuously adaptive learning process.
Increasing congressional capacity
Some of the limitations of congressional capacity include personal staff size, expertise, tenure, and time, and the declining staffing of congressional support organizations. Increased funding for staff within offices of members of Congress, as suggested recently by a think tank (Burgat, Currinder, Kosar, Wallach, & Wallner, 2018), would potentially allow higher salaries to maintain staff longer-term. Additional funding could also increase staff numbers to build expertise and more time into daily schedules for the types of relationship-building with research organizations or their intermediaries that is likely to produce successful use of science for policy.

While some members of Congress would like to rebuild congressional support capacity for scientific and technological assessments, even the return of the Office of Technology Assessment would not provide congressional staff with information on the time scales typically needed—in hours or days, instead of years. Reversing the decline at current government support agencies, and rebuilding the staffing of GAO, CRS, and CBO would be a first step in recouping lost capacity.

While both of the previous recommendations would require Congress to appropriate funding, which makes them less likely, organizations that provide training for congressional staffers—perhaps in collaboration with interested science organizations—could relatively easily, and inexpensively, develop short courses for interns and staffers on use of science in policy. The class would review types of scientific research, how to evaluate them, and what resources the institution can call upon to answer scientific questions. This suggestion was recently made to the UK Parliament to increase the capacity of that institution’s use of evidence (Kenny et al., 2017). The European Commission’s Joint Research Centre has just launched courses with policymakers from executive agencies (personal communication).

Fostering relationships between the science and policy communities
Both academics and policymakers face significant limitations on their time that severely curtail their ability to engage in activities that appear extraneous to their current goals. The evidence cited in this report suggests that long-term relationships in which both the scientific and policy communities co-produce information leads to greater substantive use of science in informing societal decisions, however the time investments in these relationships are significant. Boundary organizations, like COMPASS and others, can reduce the transaction costs for each side. Science organizations that already serve as intermediaries between the science and policy communities may want to consider strengthening or adding to these capacities, and/or promoting the establishment of these entities within the federal research enterprise. NOAA’s Regional Integrated Sciences and Assessments Program—focused on use of climate science for societal

Indeed, some organizations, like the American Association for the Advancement of Science, are in the initial phases of developing these types of rapid-response capabilities for policymakers (Box 8).
benefit—provides a federally funded example of the establishment of boundary organizations based at universities that could be broadened to other science fields and focused on congressional policymakers as well as those at the state and local level.

It is important to recognize, however, that most use of science in Congress is through strategic arguments made to support positions that have already been decided, and that this form of use can also contribute to science in the public discourse and support for science- or evidence-based decision-making. The use of persuasive communication strategies, recognizing the limits of rational decision-making, are key in these circumstances. Organizations aligned on a political issue with the member of Congress are often best suited to deliver this type of focused messaging because of their understanding of the context and audience, and willingness to provide members of Congress with information supporting their position.

Political influence can be achieved not just with authority and rational argument, but also through the friendships that form between people, with the core component of trust (Banfield, 1961). Other means of strengthening the relationships between the science and policy communities for both substantive and strategic use purposes include: 1) matching congressional offices and committees with science advisors; 2) increasing the placement of science fellows in Republican, as well as Democratic, congressional offices; 3) supporting the expression of a wide range of political viewpoints within research institutions, and making that visible in Congress; 4) placing science fellows in state/district congressional offices; and 5) fostering undergraduate and graduate science policy groups for students, such as the MIT Science Policy Initiative.

**Tailoring informational content**
The easiest element of informational fit to deliver—and the one that is typically the focus of scientist training—is the format of the content: concise, no jargon, digitally accessible. For example, the Congressional Budget Office typically develops reports for use by their congressional audiences with 2-3 page executive summaries with sub-headings and bullet points (see more about CBO in Appendix D).

As many have observed, one of the most frequent points at which providing scientific advice fails is when scientists and policymakers disagree on what information content is useful for decision-making (Lemos et al., 2012). Aligning informational fit to policymaker needs requires extensive understanding of the office, its issue position, and its likely needs as the issue evolves, even day-by-day. In order to generate these types of content, scientists and/or intermediaries must develop the types of trust-based relationships described above.

**Institutionalizing adaptive science and policy learning processes**
The work of individuals alone cannot ensure that the research and policymaking communities are engaged in learning processes that produce information useful to societal decision-making needs.
The practices must be institutionalized within organizations that conduct science and produce policy, and/or receive assistance through external group-level strategies, such as boundary organizations, scientific assessments, and co-production as previously discussed.

The Health Effects Institute is one example of a public-private boundary organization—funded by the Environmental Protection Agency and industry—that was initially chartered in 1980 to provide independent research on the health effects of vehicle air pollution in response to the 1977 Clean Air Act requirements (Keating, 2001). It identifies high priority research areas, funds and oversees research, and communicates the results with policymakers. Considered one of the most successful examples of federal governmental boundary organizations, it views Congress as one of its audiences, and provides hearing testimony and briefings.

**Implications of the communication context for strategic vs. substantive policy use**

The communication of science to policymakers is frequently driven by scientists’ perception that “a clear set of facts” exists within the scientific community that is not being used to make decisions about public policy (Lewenstein, 2017). In a recent article, Lewenstein argues that controversies over science are characterized by deep sociohistorical contexts and have a wide range of possible resolutions. These two aspects—unique problem contexts and many potential outcomes—make it difficult to extract meaningful generalizable lessons for resolving science controversies. Similarly, the unique context of each of the 535 offices in Congress and each issue before them make it difficult to propose universally applicable lessons for science organizations and scientists. Limiting the typology of science use in Congress to two primary categories—strategic and substantive—provides a useful framework for organizing lessons about the dynamics of these relationships.

- In cases where policymakers use **scientific information in the evaluation of policy options**, they must be willing to commit substantial time and resources to the endeavor, which are often in short supply. In the most optimal collaborative relationships for knowledge exchange, scientific communities must similarly commit substantial resources to the effort. This points to the importance of institutionalization of adaptive science and policy learning processes across research and policy organizations, and the need for more intermediaries, or boundary organizations, to take on this work and decrease the costs to both communities. Scientists who wish to act in the capacity of Pielke’s “honest brokers” of policy alternatives or “science arbiters” may prefer to work in this sphere of science use. Collective efforts of scientists additionally can offer a broad range of expertise and the ability to protect against perceptions of bias.

- The more likely circumstance for use of science in policy in Congress is through its **strategic use to promote a policymaker’s position for political or policy purposes**. In these cases, information is most likely to be used: 1) when it comes from an individual or
entity that shares the office’s policy objectives; and 2) the content is easily employed for political or policy purposes in support of the objective. While the policymaker is unlikely to expend considerable time or other resources in acquiring the information, the provider is motivated to do so to promote their interests in the policy area. Pielke’s “issue advocates” and organizations that actively promote specific policies are likely best suited to craft these rhetorically persuasive messages, and policymakers are both most likely to learn from them and use them.

For scientists and science organizations that wish to further evidence-informed policy, it may be helpful to become familiar with the types of collective strategies that facilitate knowledge exchange across the policy and science communities, such as boundary organizations, scientific assessments, and co-production. Moreover, they may wish to encourage the institutionalization of science for policy exchanges across their own research institutions, in Congress, and within organizations that facilitate relationships between the two.

Testing what works through collaborations on the use of science for policy
Partnerships on use of science for policy between social science researchers and staff within science organizations offer opportunities to: 1) refine theories of change with theoretical insights about likely key factors in promoting evidence-informed policy; 2) find ways of measuring their impact; and 3) collect and analyze data that can be used for evaluation. These partnerships can be implemented with faculty, but also may be effective at the graduate student level. For researchers, these types of partnerships offer opportunities to test new theories, better understand programmatic contexts, and access data. The success of the National Academies 2017 funding contest for Science of Science Communication research-practitioner partnerships—in which almost 100 proposals were submitted—indicates the enormous opportunity for more of these collaborations when incentivized with even relatively small grants (~$35,000), and could be implemented specifically for programs that work at the science and policy interface.

Conclusion
What we know about the use of science for policy comes from many academic disciplines and from science organizations that work at the interface between the science and policy communities. Science policy can never be encompassed within a single discipline, given that it operates at many levels—stretching between interpersonal relationships, to institutional policy processes and sociocultural belief systems. As many scholars have noted, including those cited in this report, the accumulation of information that can be generalized for practice is not as strong as the quantity of literature would make it appear. However, there are insights about specific contexts for the use of science in policy that may be applied with greater certainty about their expected effectiveness. This report attempts to characterize them for Congress in the hopes that science organizations, and those scientists motivated to pursue research for policy impact, will find them instructive for their work.
Box 8

Communicating scientific information to Congress through people, events, reports, and services

Kei Koizumi, American Association for the Advancement of Science

Providing scientists to serve as congressional staff
Historically, an important way to communicate scientific information to Congress has been through people. A key insight of this workshop report is that scientific information is communicated most effectively to Congress through Washington-based committee or personal congressional staff. From that insight, in the early 1970s science organizations decided an effective scientific communicate route would be to have scientists become congressional staff. The American Association for the Advancement of Science (AAAS) and other science and engineering societies have, for more than forty years, operated science and technology fellowship programs that bring PhD-level scientists and engineers to Washington, DC, to serve for a year in a congressional office (and also in other government branches). There are now approximately 35 such congressional S&T policy fellows each year and, over time, an alumni network of congressional fellows numbering in the thousands. These congressional fellows are trained scientists and engineers working in Congress who can access relevant scientific information to a policy issue through their research skills, connections to the scientific community and literature, and research mindsets but who are also steeped in the congressional policymaking culture. That is, although it is unlikely for a congressional fellow to work in Congress on the exact scientific topic for which he or she trained, he or she can interface between the scientific and congressional communities and communicate ably and exchange information between them.

Building connections between scientists and congressional staff
Science organizations also serve as matchmakers between congressional staff and science experts, drawing on the AAAS membership of scientists. For example, AAAS often connects congressional staff working on a policy issue with scientific experts in that field for short-term informal consultations. Most of these experts have been trained in communicating scientific information to Congress through the many programs that AAAS operates, including the S&T policy fellowships, and Communicating with Congress seminars.

Organizing briefings and meetings
AAAS and other organizations also communicate scientific information to Congress through events, primarily the congressional (or “Hill”) briefing. From the insight that congressional staff are too busy to seek out information proactively or go to a scientific community they are unfamiliar with, Hill briefings bring science to congressional staff where they work. There is an art, not a science, to organizing a Hill briefing, in choosing topics, information to be presented, and speakers. Quite frequently, the briefing is not an end in itself but a vehicle for

Continued next page
communicating a report or for introducing scientific experts to congressional staff for later consultation. And most of the real communication of science at an event takes place not on the podium but in the audience conversations before, during, and after the event.

**Writing and disseminating reports**

AAAS and other organizations also communicate science to Congress through reports. Although policy-relevant scientific reports are primarily the province of the National Academies, other science organizations also issue reports that are intended to communicate science to congressional and other policymakers, or they communicate scientific reports commissioned for other audiences (including the general public) to Congress specifically. One such AAAS report is the What We Know report communicating the latest understanding of climate science to general audiences, including policymakers (whatweknow.aaas.org). For many years, AAAS published a S&T newsletter specifically for Congress attempting to match scientific information to issues relevant to Congress, but AAAS discontinued that “report” for several reasons, including a general decline in the use of newsletters in Congress (and in the public).

**Providing timely and relevant scientific information as needed**

And science organizations also communicate science to Congress by offering services. The primary service that AAAS and other science organizations offer Congress for communicating science information is the informal matchmaking service described above. But AAAS and other organizations are also exploring more formal services. AAAS is in the process of establishing a Center for Scientific Evidence in Public Issues (Science EPI Center) that aims to provide policy-relevant, well-communicated, scientifically excellent, rapid-response scientific information and evidence to decision-makers and influencers, including Congress. For Congress, it aims to be a dedicated organizational service that can respond to or anticipate congressional needs for scientific information that is communicated in ways that are tailored to congressional information flows, timeframes, and policy agendas. This organization aims to fill a niche not filled right now by CRS, the Academies, GAO, and other organizations, and might in some ways replace the defunct OTA.

**All of these activities are undertaken with a foundational knowledge base of experience and empirical research.** Through projects like this project, AAAS efforts in developing sound practice in communicating science (https://www.aaas.org/pes/communicating-science-workshops), participation in the broader communication-of-science community in venues such as the National Academies effort, and learning from and sharing experience on communicating science specifically to Congress, AAAS and other societies are continually refining their practices in communicating science to Congress.
REFERENCES

A fix for the antiscience attitude in Congress [Editorial]. (2017, October 1). Scientific American. https://doi.org/10.1038/scientificamerican1017-10
Bremer, S., & Meisch, S. (2017). Co-production in climate change research: reviewing different perspectives. Wiley Interdisciplinary Reviews: Climate Change, 8(6), n/a-n/a.

52


Appendix A | Training and resources for scientists

American Association for the Advancement of Science (AAAS)
The world’s largest multidisciplinary scientific society and a leading publisher of cutting-edge research through its Science family of journals, AAAS seeks to enhance communication among scientists, engineers, and the public; provide a voice for science on societal issues; and promote the responsible use of science in public policy.

- **Science & Technology Policy Fellowships**
  AAAS manages and administers Science & Technology Policy Fellowships in the executive, legislative and judicial branches of the federal government in Washington, DC. The S&T Policy Fellowships provide an opportunity for accomplished scientists and engineers to participate in and contribute to the federal policymaking process while learning firsthand about the intersection of science and policy.
  https://www.aaas.org/page/stpf/become-st-policy-fellow

- **AAAS Catalyzing Advocacy in Science and Engineering (CASE) Program**
  This entry-level program is organized to educate graduate students and upper-level undergraduate students who are interested in learning about the role of science in policymaking, to introduce them to the federal policymaking process, and to empower them with ways to become a voice for basic research throughout their careers. The workshop is designed for students in science, technology, engineering, and math fields, with limited experience and knowledge of science policy and advocacy who want to learn more about science policy.
  https://www.aaas.org/page/about-case

- **Emerging Leaders In Science & Society (ELISS)**
  ELISS is a leadership development program for graduate students from all fields who are eager to collaborate across boundaries for the benefit of society. ELISS is an opportunity for graduate students to apply their expertise to a variety of global challenges at the intersection of science and society. The program is hosted at AAAS’ Center of Science, Policy, and Society Programs with current fellows coming from partner campuses.
  http://elissfellows.org/

- **Communicating Science to Policymakers webinar**
  This session encompasses an overview on the basics of government relations in support of the scientific enterprise, including do’s and don’ts, tips about timing, working individually or with organizations, and how to deal with “pushback.”
  https://www.aaas.org/pes/communicating-science-policy-makers

  Working with Congress is a guide to success in interacting with the government. It will help you determine which route of communication is best suited to your issue, who to speak to and when, what to do to prepare, and how to follow up. Developed by science policy experts in consultation with members of Congress and government staff, Working with Congress distills decades of science policy practice into one slim volume.

- **Communication toolkit**
  From the Center for Public Engagement with Science & Technology, this toolkit from AAAS provides scientists and scientific institutions of all academic disciplines with the resources they need to have meaningful conversations with the public.
  https://www.aaas.org/page/communicating-engage

- **Force for Science toolkit**
  The resources in this toolkit will help you engage, educate and be a force for science. Inspire the next generation of STEM professionals, further understanding among the scientific community and other groups, strengthen collaboration and increase public understanding of science and its impact.
  https://www.forceforscience.org/toolkit

**American Chemical Society (ACS)**
ACS advocates for chemistry, supporting innovation, science education, and environmentally- and socially-responsible public policy.

- **ACS Public Policy Fellowship Programs**
The ACS offers two public policy fellowships. The ACS Congressional Fellowship is a one-year opportunity; two ACS members per year are placed on Capitol Hill as part of the larger, AAAS-administered program. The ACS Science Policy Fellowship is a one-year opportunity that is renewable for a second year. One Science Policy Fellow position is available at a time. The same application is used for both fellowships. Applicants are asked to identify if they are applying for one or both programs.
  https://www.acs.org/content/acs/en/policy/policyfellowships/programs.html

- **Act4Chemistry Legislative Action Network**
  Act4Chemistry—ACS’ legislative network—is a suite of programs and tools that allows members to become involved in advocacy at the state and federal levels. It provides support to individual members, local sections, state committees, and other groups. Individual members can become involved at different levels of commitment and increase their strengths as advocates by joining advocacy groups.
  https://www.acs.org/content/acs/en/policy/memberadvocacy/aboutact4chemistry.html

- **Advocacy tools, tips & instructions**
  Step-by-step guides for actions you can take to advocate for science.
  https://www.acs.org/content/acs/en/policy/memberadvocacy/advocacy-tools.html

**American Geophysical Union (AGU)**
The purpose of the AGU is to promote discovery in Earth and space science for the benefit of humanity. The organization seeks to inform policymakers about the value of science and encourage scientists to get involved in science policy. AGU provides resources to learn more about key policy issues and discover effective ways to engage.
Congressional science fellowship
The Fellowship program—conducted in collaboration with AAAS—enables more effective use of scientific knowledge in government and provides a unique experience to scientists seeking careers involving public use of technical information. The Congressional Science Fellowship program places highly qualified, accomplished scientists, engineers, and other professionals in the offices of either an individual member of Congress or on a committee for a one-year assignment.
https://sciencepolicy.agu.org/Congressional_fellows/

Science policy webinars
A 2017 webinar series, entitled “Back to Basics: Advocating for Yourself and Your Science,” provides tips, tools, and updates on all things science policy.
https://sciencepolicy.agu.org/webinars/

Science policy toolkits
Toolkits include how to have an effective district visit, social media, contacting your member of Congress, and how to stay up to date on science policy issues.
https://sciencepolicy.agu.org/toolkits/

The American Geosciences Institute (AGI)
AGI’s Geoscience Policy and Critical Issues programs support well-informed public policy and decision making by providing information and facilitating dialogue between the geoscience community and decision makers.

Resources for communicating with Congress
Tips on writing and meeting with your member of Congress.
https://www.americangeosciences.org/policy/communicate-with-congress

Geosciences Congressional Visits Days (Geo-CVD)
The American Geosciences Institute (AGI), in collaboration with many other geoscience societies, invites members of the geoscience community from across the nation to come to Washington, DC for the annual Geosciences Congressional Visits Days (Geo-CVD). The Geo-CVD is a great opportunity to gain exposure to the federal legislative process, and provide lawmakers with valuable information to inform policy decisions.
https://www.americangeosciences.org/policy/geo-cvd

The American Meteorological Society (AMS)
The AMS Policy Program promotes understanding and use of science and services relating to weather, water, and climate. AMS seeks to help the nation, and the world, avoid risks and realize opportunities associated with the Earth system.

Summer Policy Colloquium
Each year, the AMS Summer Policy Colloquium brings a select group to Washington, DC for an intense, ten-day immersion in science policy. Graduate students, faculty and professionals in the field of earth and atmospheric sciences and their applications form a
cohort that tackles hands-on exercises, hears from dozens of prominent experts and forges strong professional networking connections. The Summer Policy Colloquium is a career-shaping experience. By arming tomorrow’s leaders with expertise in the policy process, the science community will be more engaged with decision makers, helping ensure that society's policy choices take full advantage of available scientific knowledge.

https://www.ametsoc.org/ams/index.cfm/policy/summer-policy-colloquium/

- **Congressional visits days**
  Congressional visits days are an opportunity for scientists to meet with congressional staff. The goal is to provide information, build relationships, and develop an improved understanding of the congressional landscape.

**American Psychological Association (APA)**
APA is guided by the philosophy that public policy should be based on available scientific knowledge, and that psychological research can contribute to the formulation of sound public policy to address social problems and improve human welfare.

- **Science advocacy toolkit**
  Find simple, effective tools that explain the hot issues: the how-to’s of talking to your representatives, visiting them in your district and, if necessary, on Capitol Hill.
  http://advocacy.apascience.org/

- **APA Congressional Fellowship Program**
  Fellows spend one year working on the staff of a member of Congress or congressional committee. Activities may involve drafting legislation, conducting oversight work, assisting with congressional hearings and events, and preparing briefs and speeches.
  Fellows also attend a two-week orientation program on congressional and executive branch operations, which provides guidance for the congressional placement process, and participate in a yearlong seminar series on science and public policy issues. The American Association for the Advancement of Science (AAAS) administers these professional development activities for the APA fellows and for fellows sponsored by over two dozen other professional societies.
  http://www.apa.org/about/awards/congress-fellow.aspx

**American Society of Agronomy, Crop Science Society of America, Soil Science Society of America (ASA, CSSA, SSSA)**
The societies maintain a science policy office focused on agriculture, STEM education, energy, environment, science and innovation, and science funding.

- **Legislative Action Network**
  https://www.agronomy.org/science-policy/get-involved/lan

- **Advocacy toolkit**
  https://www.agronomy.org/science-policy/get-involved/toolkit
Center for Engagement & Training in Science & Society (CENTSS), Arizona State University
CENTSS is a multidisciplinary research center that aims to change how we as a society think about, learn about, and talk about science and technology. It develops novel approaches to interaction and engagement by integrating multiple disciplines, education levels, experiences, areas of expertise, and modes of communication.
https://ifis.asu.edu/centers/centss

- **Science Outside the Lab**
  The program explores the relationships among science, policy, and societal outcomes in a place where many important decisions about these things are made: Washington, DC. During the two-week workshop, students meet and interact with the people who fund, regulate, shape, critique, publicize and study science, including congressional staffers, funding agency officers, lobbyists, regulators, journalists, academics, and others.
  http://cspo.org/program/science-outside-the-lab/

COMPASS
COMPASS is a non-profit, non-advocacy organization that seeks to see more scientists engage effectively in the public discourse about the environment. Through communication trainings, coaching and real-world connections, COMPASS empowers researchers to build the communication skills, networks, and relationships they need to realize this vision.
https://www.compassscicomm.org/

- **Training**
  Grounded in the latest research on science communication, personalized trainings help identify the relevance of the science for the audiences scientists most want to reach—journalists, policymakers, stakeholders, leaders within institutions, and even other scientists.
  https://www.compassscicomm.org/training

- **Connecting**
  COMPASS identifies and creates new opportunities for scientists to interact with each other and other audiences. As a boundary organization, COMPASS goal is to help scientists foster personal connections that catalyze or contribute to key conversations about the environment. This part of our work is uniquely shaped by timing, salience, appetite, and broader social context. We connect scientists with policymakers (including Congress), the media, and other influencers of the public discourse on the environment.
  https://www.compassscicomm.org/connecting-1

- **Tools and resources**
  Prepping for media coverage on a new paper? Getting ready to meet with a legislator? Wondering how to share insights from science in a way that's meaningful to a non-scientist? Here are a few of go-to resources: the message box workbook, information on meeting policymakers, and tips on working with the media.
  https://www.compassscicomm.org/tools-resources
Ecological Society of America (ESA)
The Ecological Society of America (ESA) is a nonpartisan, nonprofit organization of scientists founded in 1915. The organization seeks to ensure the appropriate use of ecological science in environmental decision making by enhancing communication between the ecological community and policymakers. Media and policy training is provided to members, in addition to bimonthly updates on national policy developments relevant to the ecological community.

- **Policy training**
  ESA policy staff offer training workshops designed to help ecological scientists engage more effectively with policymakers. Featuring hands-on exercises, the workshops include overviews of the workings of Congress, tips on timing and developing a coherent message, and mock congressional meetings. The society's annual meeting often includes workshops featuring speaker discussions on engaging policymakers as well as interactive exercises giving participants a taste for collaborations with stakeholders with multiple perspectives on an environmental issue.
  https://www.esa.org/esa/public-affairs/esa-policy/policy-getting.../policy-training/

Engaging Scientists & Engineers in Policy (ESEP) Coalition
The coalition is an ad hoc alliance of organizations that have joined together to empower scientists and engineers to effectively engage in the policymaking process at all levels of government (federal, state and local). ESEP serves as a resource one-stop-shop, a communication forum, networking opportunity, and as an engagement vehicle for science and technology policy stakeholders.
https://www.aaas.org/esep

- **Science policy webinars**
  http://www.science-engage.org/webinars.html

- **Resources: Toolkits, calendar, Trellis group, key conferences, degrees, communication opportunities, jobs board**
  http://www.science-engage.org/science-policy-resources.html

Federation of American Societies for Experimental Biology (FASEB)
FASEB represents more than 125,000 scientists and engineers through collaborative advocacy with constituent societies. FASEB helps society members to play an active role in advocating for issues relevant to their fields. We provide the advocacy tools and information you need for contacting elected officials and the media.

- **Advocacy toolkit**
  There are many ways to deliver messages, ranging from privately meeting your legislator to attending a campaign event or town-hall meeting.
Leopold Leadership Program
The Leopold Leadership Program provides outstanding academic researchers with the skills, approaches, and theoretical frameworks for translating their knowledge to action and for catalyzing change to address the world’s most pressing sustainability challenges. http://leopoldleadership.stanford.edu

- **Fellowship**
  In its core training, the program offers two intensive training sessions a year apart to help fellows gain the skills, approaches, and theoretical frameworks for translating their knowledge to action and for catalyzing change to address the world’s most pressing environmental and sustainability challenges. At reunions and through advanced trainings, fellows have the opportunity to reconnect, recharge, learn new approaches, and exchange ideas about integrating science into practice. http://leopoldleadership.stanford.edu/fellowship-information

MIT Science Policy Initiative
The MIT Science Policy Initiative, founded in 2007, is a group of graduate (and some undergraduate) students who work closely with MIT Faculty, the MIT Washington Office, and other science policy advocates to better understand how scientists can play a central role in the framing of science and technology policy legislation and public discourse. We strive to create better scientists and engineers as well as a better society through rigorous research and authentic engagement with public policy. https://mitspi.squarespace.com/

- **Science Policy Bootcamp**
  The Science Policy Bootcamp is a 4-day short course, offered during MIT's Independent Activities Period in January, designed to introduce graduate students and post-doctoral fellows to the “nuts and bolts” of science policymaking. The course provides an opportunity for young scientists and engineers interested in science policy issues to increase their understanding about and practical involvement with science policy. The bootcamp serves to both expose participants to the fundamental structure and dynamics of science policy and inform them of routes into a policy experience or career. https://mitspi.squarespace.com/bootcamp/

- **Executive visit days**
  The MIT Science Policy Initiative coordinates Executive Visit Days (ExVD) each fall. Students meet with executive agencies in Washington, DC to discuss science and technology policy issues, providing an excellent opportunity for networking and learning about career paths in government and think tanks. The program's aim is to underscore the long-term importance of science, engineering, technology, and innovation that support the nation’s economic growth and global competitiveness. https://mitspi.squarespace.com/exvd/
• Congressional visit days
  Once a year, scientists and engineers convene in Washington, DC to discuss science and technology policy issues with their representatives in Congress. The Congressional Visit Days (CVD) program is intended to convey the importance of science and technology funding to our elected officials. Policymakers from federal and non-governmental organizations, such as the Office of Science and Technology Policy, the National Science Foundation, and the National Institute for Standards and Technology teach participants about current organizational goals, funding concerns, and policy priorities.
  https://mitspi.squarespace.com/cvd/

Research!America
Research!America increases public and policymaker awareness of the health and economic benefits of medical research and build a strong base of support for research and innovation.
http://www.researchamerica.org

• Advocacy how-tos
  A quick guide on the do's and don'ts of advocacy.
  http://www.researchamerica.org/advocacy-action/how-be-advocate/advocacy-how-tos

• It's EASY: Engage, Advocate Science Yourself
  This tool is designed especially for those with a science background to learn more about how and why scientists are involved in advocacy for research.

• Porter's Principles
  Every advocate can learn from the Hon. John E. Porter’s tips for setting up a meeting with an elected official and important messages to convey.

Union of Concerned Scientists (UCS)
The Union of Concerned Scientists combines the knowledge and influence of the scientific community with the passion of concerned citizens to build a healthy planet and a safer world.

• UCS Science Network
  The UCS Science Network is an inclusive community of more than 20,000 scientists, engineers, economists, public health specialists, and other experts across the country working to educate the public and inform decisions critical to our health, safety, and environment. Science Network members are using their expertise to make a difference—speaking to the media, delivering testimony, signing on to expert letters to elected officials, conducting research and environmental impact assessments, and serving on federal advisory committees.
  https://www.ucsusa.org/science-network
• **Science network workshop**  
  Webinars on communicating science to policymakers, tips and tricks, and the role of science in policy.  
  https://www.youtube.com/playlist?list=PLTsyt5jvEGIe_82BX6ZjVw4IZUrWwtg

• **Tips and tools**  
  These tips and tools are designed to help beginner and seasoned advocates be more effective when communicating with the media and policymakers.  
  http://www.ucsusa.org/action-center
Appendix B | Workshop agenda

Barriers and Opportunities in Communicating Science to Congress

*Summarizing the State of Research and Practice*

Friday, October 13, 2017; 8:30 am to 4:30 pm
American Association for the Advancement of Science (AAAS)
Abelson Haskins Room (2nd floor)
1200 New York Ave., NW, Washington, DC 20005

This daylong workshop will bring together a select group of researchers and practitioners to synthesize our current understanding of the conditions under which science is most likely to be used by congressional staff. The event has three objectives:

1. To highlight effective models developed by practitioner organizations in communicating with congressional staff;
2. to examine the research literature on the communication and use of science in Congress; and
3. to identify factors in the usability of science by congressional staffers working on science, energy, and environment portfolios.

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<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>8:30 am</td>
<td><strong>Breakfast</strong></td>
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<td>9 am</td>
<td>Welcome and introductions</td>
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<tr>
<td>9:30 am</td>
<td>The context: Current problems in congressional capacity (<em>Kathy Goldschmidt, Congressional Management Foundation; Molly Reynolds, Brookings</em>)</td>
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<tr>
<td>10:00 am</td>
<td>What practitioners know and do: Effective communication of science with policymakers</td>
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<td>11:45 am</td>
<td><strong>Lunch</strong></td>
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<tr>
<td>12:15 pm</td>
<td>Forging better research and practice partnerships</td>
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<tr>
<td>12:45 pm</td>
<td>Usability of science (<em>Maria Carmen Lemos, University of Michigan</em>)</td>
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<tr>
<td>1:15 pm</td>
<td>What researchers know about the communication and use of science in Congress and remaining questions (<strong>Snack break, 2:15 pm</strong>)</td>
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<tr>
<td>3:35 pm</td>
<td>Synthesizing concepts from the day’s discussion</td>
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<tr>
<td>4:20 pm</td>
<td>Next steps, conclusion</td>
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Appendix C | Committee and hearing data, *Vital Statistics*, Brookings

### Committee Staff

![Committee Staff Graph]

*Source: Vital Statistics on Congress, Brookings*

### Hearings

![Hearings Graph]

*Source: Vital Statistics on Congress, Brookings*
Appendix D | Office of Technology Assessment, a short history

According to Margolis and Guston, the origins of the Office of Technology Assessment (OTA) were rooted in four science and technology trends: 1) growth in the U.S. federal budget; 2) increased societal questioning of the benefits of science and technology; 3) heightened legislative activity; and 4) concerns over an imbalance in the relative abilities of the executive and legislative branches to analyze technical issues (Margolis & Guston, 2003). The Technology Assessment Act of 1972, which established the office, stated that “Federal agencies presently responsible directly to the Congress are not designed to provide the Legislative Branch with adequate and timely information, independently developed, relating to the potential impact of technological applications” (The Technology Assessment Act of 1972, 1972). However, some authors point to initial warning signs that there was strong interest from only among a handful of proponents (Smith & Stine, 2003).

The office was uniquely structured to reflect bicameral, bipartisan governance through a Technology Assessment Board of six members each from the House and Senate, evenly divided between parties, and a non-voting director. A Technology Assessment Advisory Council—including 10 experts from the sciences, engineering, or technological fields in addition to the director of the Congressional Research Service and the Comptroller General—provided advice to the Board on OTA activities and assessment findings. But the OTA suffered early on from perceptions that the organization was functionally politically biased toward the Democratic members of the Board, especially Senator Edward Kennedy, who served as its chairman (Norman, 1977). The second director of OTA—a Republican—tried to address partisan concerns in the office’s operations, but also sought to emphasize its congressional function to assess emerging science and technology issues, soliciting public input in deciding upon office priorities, and drawing congressional objections for being too independent (Margolis & Guston, 2003). Even as internal organizational problems moderated in subsequent years, the relationship between OTA and Congress remained problematic up to its demise, in part due to the long turnaround time for reports (~2 years) and its inability to make policy recommendations.

Since then, there have been consistent efforts to re-establish OTA by refunding the office. A 2018 R Street report argued that “in order to build the capacity to successfully meet the next wave of technology policy debates, Congress needs to revive the in-house expertise and in-depth research functions of the Office of Technology Assessment” (Graves & Kosar, 2018, p. 2). Notably, OTA’s founding prompted the establishment of parliamentary technology assessment agencies throughout Europe, starting with France in 1983, and another 15 in subsequent years (Vig, 2003), which have better weathered political attacks than the original OTA in the United States.
Appendix E | Government support agencies that provide scientific advice to Congress

Congressional Research Service
The Legislative Reference Service (LRS)—the 1914 predecessor of the Congressional Research Service (CRS)—was increasingly asked to develop analyses in scientific and technological areas after World War II (Smith & Stine, 2003). By the 1960s, Congress was considering a variety of ways to improve scientific advice to Congress, from creating a Congressional Science Advisory Staff to a congressional Office of Science and Technology. While these bills did not pass, by 1964 the LRS had established a Science Policy Research Division. The Legislative Reorganization Act of 1970, which renamed the agency as the Congressional Research Service, placed new emphasis on policy analysis across all of its topic areas, and broadened its programmatic goals to focus on longer reports and more extensive activities with committee staff and personal offices, in addition to providing background materials on demand to congressional staff. As a result, the organization almost tripled in size from approximately 300 people in 1970 (Smith & Stine, 2003) to close to 900 by the 1980s (Reynolds, 2017), before starting on a general decline in 1995. According to Brookings’ data, by 2015, just 609 remained at the support agency (Reynolds, 2017). CRS currently maintains a division dedicated to “Resources, Science and Industry,” which addresses the “nation’s natural resources and environmental management, scientific advances and technology applications, and industry and infrastructure” (Library of Congress, 2016). The Domestic Social Policy division also addresses health-related research, and studies related to domestic policy and social programs.

Government Accountability Office
In 1921, when the General Accounting Office (GAO) was initially founded, it provided accounting and auditing services for the federal government (Smith & Stine, 2003). But that role changed by the 1970s. The Legislative Reorganization Act of 1970 that created the Congressional Research Service from the Legislative Reference Service also, in combination with a 1974 bill, expanded the reach and resources of the organization to perform program and policy analysis, giving Congress greater ability to oversee executive agencies. In response to these new functions, GAO’s staffing grew to include not just economists and social scientists, but experts in science and engineering. The Center for Technology and Engineering—currently the Center for Science, Technology and Engineering—served as the umbrella organization for this latter group. Thus, as members of Congress looked for ways to re-establish functions previously performed by the Office of Technology Assessment (OTA), they turned to the newly renamed Government Accountability Office (Jones, 2007). In 2001, Congress requested that GAO conduct a technology assessment of biometric use for border control that was to serve as a pilot study of its capabilities (Fri et al., 2002). The study—individually evaluated by Fri and colleagues—led to official congressional designation of GAO’s role in conducting technology assessments with the inclusion of $2.5 million in the 2008 appropriations bill for this purpose (Consolidated Appropriations Act, 2008, 2007), considerably less than the approximately $22 million budget for OTA (Jones, 2007).
The original pilot study has been followed by assessments across a broad range of topics, including climate engineering, nanomanufacturing, 3D printing, nuclear reactor technologies, municipal freshwater scarcity, and data analytics (U.S. Government Accountability Office, nd). Unlike the Congressional Research Service, which will take direct requests from the staffs of individual members of Congress, GAO typically conducts studies requested by committees, or legally mandated in legislation. It also has the ability to initiate activities under the authority of the Comptroller General for issues that do not fit well within committee jurisdictions, and it can make recommendations to Congress. With its new responsibilities for technology assessment, GAO has sought to define what some have argued was never successfully established by OTA (Smith & Stine, 2003)—what is technology assessment, what is it mean to do it well, and how do you measure its outcomes? GAO anticipates releasing a report in 2018 as an attempt to begin a discussion both in the U.S. and internationally of establishing standards for the practice (personal communication).

**Congressional Budget Office**

Since 1975, the Congressional Budget Office (CBO) has provided non-partisan analysis to Congress on budget and economic issues; it does not make policy recommendations (Congressional Budget Office, 2011a). Their economists provide social science expertise to the legislative branch, but their reports may also address other scientific topics. For instance, its budget and economic analyses address energy, natural resources, and environmental programs (Congressional Budget Office, 2011b). The division hires environmental and natural resources economists, who by training have an understanding of the intersections between social and ecological systems, and works closely with outside experts to evaluate the state of the science relevant to the question at hand. Reports from the division have addressed hurricane damage trends, carbon capture and sequestration, oil and natural gas production from shale, and renewable fuels. For example, a 2016 report, requested by the ranking member of the Senate Committee on the Budget, required CBO to consider how sea level rise and the frequency of hurricanes of varying strengths—in addition to coastal settlement—will affect the cost of hurricane damage in coming decades (Congressional Budget Office, 2016). In order to answer the question, CBO needed to make an assessment of the science on the effects of climate change on sea level rise, and hurricane strength and frequency. To do so, it consulted with academics, think tanks, industry, and a federal agency. Since its establishment, CBO has given thought on how to communicate with Congress. Its founding director, Alice Rivlin, was quoted in 1975 as saying:

I feel strongly that our reports should be lucidly written and comprehensible to non-economists. We should break with the ponderous prose of most official economic writing and aim at giving Congressmen themselves something they can actually read and understand. We should assume that the reader is an intelligent, well-informed person without formal training in economics (the average Congressman is a middle-aged lawyer who may or may not have had an economics class 30 years ago in college). We should
not be patronizing or talk down to the audience, but we should avoid jargon and explain all the concepts as we go along. (Congressional Budget Office, 2013)

The National Academies
While the National Academies are not a congressional support agency in the same sense as CRS, GAO, and CBO, they also serve an important role. As a private, non-profit organization congressionally chartered during the Civil War to “investigate, examine, experiment, and report on any subject of science or art” for any department of government (Cochrane, 1978, p. 53), the National Academies have primarily served to advise executive agencies with funding from congressional appropriations. In the 1960s, as science policy issues moved to the forefront of presidential and congressional interest after the 1957 launch of Sputnik, they looked to the Academies for expertise, but there was no existing mechanism to provide it (The National Academies of Sciences, Engineering, and Medicine, nd). What is now called the Committee on Science, Engineering, Medicine, and Public Policy (COSEMPUP) began in 1961 with funding from the National Science Foundation and is currently charted to “to deliberate on initiatives for new studies in the area of science and technology policy, taking especially into account the concerns and requests of the President's Science Advisor, the Director of the NSF, the Chairman of the National Science Board, and the chairmen of key science and technology-related committees of the Congress.” In 1963, the committee performed a series of studies for the House Subcommittee on Science, Research, and Development, funded by Congress (Smith & Stine, 2003). Yet the relationship of Congress to the Academies has remained primarily through the institution’s legislative mandates for studies.
Appendix F | Citizen-centric advocacy: The untapped power of constituent engagement
Kathy Goldschmidt, Congressional Management Foundation

Recently, Congress has seen unprecedented citizen engagement, with phone lines tied up for hours and voicemail boxes full of constituents’ comments. The uptick in communications is ultimately good for democracy, but there are better ways to communicate with Congress than mass form emails and phone calls. The Congressional Management Foundation’s (CMF) report, “Citizen-Centric Advocacy: The Untapped Power of Constituent Engagement”6—based on more than a decade of research with congressional staff—outlines the ongoing feedback loop between Congress and constituents, and details the most effective means of being heard in Washington.

The key findings in the report are that:

1. Direct constituent interactions have more influence on lawmakers’ decisions than other advocacy strategies, including professional lobbying.
2. Congress places a high value on groups and citizens who have built relationships with the legislator and staff.
3. Citizen advocates are more influential and contribute to better public policy when they provide personalized and local information to Congress.
4. Citizens have significant potential to enhance their advocacy skills and influence Congress.

Until they build relationships with members and staff—or become engaged with institutions and organizations who have established relationships—scientists will be viewed by Congress the same way they view any other constituent advocate. Your opinion matters, but may blend in with the thousands of constituent messages received by congressional offices. Amplify your voice by becoming a trusted advisor. It takes more work, but will also have more impact.

For more research and guidance on interacting with Senators, Representatives, and their staff, take a look at CMF’s Communicating with Congress project.7

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7 See http://congressfoundation.org/projects/communicating-with-congress