Scientific Societies' Support Systems for Civic Science

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Executive Summary

Scientific societies, associations, and professional organizations have unique opportunities to foster a culture of "civic science" — broad public engagement with issues that arise at the many intersections of science and society. As linchpins of the scientific enterprise, these organizations engage in a variety of activities to this end, including programs focused on science communication, public engagement, informal education, outreach, and advocacy. This report includes descriptions and characterizations of such activities and programs, to present the landscape of civic science efforts currently in place at scientific societies.

While most organizations undertake some civic science actions directly, they also support scientists' communication, outreach, engagement, and advocacy efforts in a number of ways. In some cases, societies create opportunities for their members to engage with non-scientist audiences, while in other cases, programs aim to equip, empower, or reward scientists who undertake these activities more independently.

This landscape assessment gives rise to a number of key insights that will lay the groundwork for future efforts to expand societies' capacity to support effective and sustainable civic science. Right now, the effectiveness and sustainability of civic science activities are often limited by individual organizations' resources and capacities. Silos across the space give rise to redundancies and notable gaps in civic science programs, which contribute to challenges in assessing effectiveness, scaling up those practices that work, and meeting members' demand for civic science support.

At the same time, the report uncovers a number of opportunities unique to scientific societies — practices that might be implemented or scaled up through increased collaboration to better support civic science efforts and contribute to a stronger relationship between scientists and the broader society. This report provides a starting point for the development of a collaborative framework that will allow these organizations to accomplish more than they might do individually. Opportunities for collaboration include reducing duplication of efforts across organizations (e.g., sharing "how-to" content), filling gaps in programming (e.g., facilitating engagement with local policy makers or other communities who are underrepresented in scientists' civic science efforts), and expanding programs and activities that have the greatest potential to shift scientific culture and key institutions like universities (e.g., incentives and other value signals). To increase the efficiency and ultimate impact of this civic science support system, scientific societies are undertaking a collective impact approach. Such an approach will include developing a common agenda and shared measurements, committing to mutually reinforcing activities, increasing coordination and communication across the space, and leveraging a backbone structure to facilitate collaboration.

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Introduction

Strong relationships between scientists and society are essential. Many of the most complex and important problems we face — from climate change to antibiotic resistance to growing economic inequality — require scientists to work with diverse stakeholders to find, discuss, and implement scientific insights and solutions. However, without adequate support, these interactions can be limited in their impact. For example, scientists and their audiences might have different experiences and expertise, they may hold assumptions and perceptions that limit their ability to engage effectively, or they might abide by different norms and practices.

But scientist-society clashes are not inevitable. When these relationships are supported effectively, we see public interest in and support for science, the uptake of scientifically sound practices and policies, and the promise of a diverse and competent scientific workforce for years to come. This is a culture of 'civic science' — one in which "scientists play active roles as citizens, people from all walks of life access science as part of their decision-making processes, and the environment in which people communicate about science is an inclusive space for public problem solving and discovery" (Christopherson, Scheufele, & Smith, 2018).

> *Civic Science* refers to activities at the interfaces of science and society. This includes science communication, public engagement, informal education, outreach, and advocacy.

With this recognition, a group of funders (the Kavli, Rita Allen, Packard and Moore Foundations) began holding discussions in 2017 to better understand the system of people who support scientists' communication and engagement efforts with hopes of finding ways to increase the effectiveness and sustainability of this system. Scientific societies, associations and professional organizations (collectively referred to as "societies" or "scientific societies" in this document) were identified as one key group supporting scientists in engaging and communicating effectively with a wide range of audiences, through programs focused on science communication, outreach, informal education, advocacy, or public engagement.

Because these organizations tend to recognize the importance of civic science, many societies and associations have already developed and implemented a range of programs in this area. Determining ideal strategies for expanding and enhancing societies' collective efforts to contribute to a culture of civic science first requires a comprehensive understanding of this component of the civic science ecosystem. Work by Shupei Yuan, Anthony Dudo, and John Besley (2019) provides an overview of support for public engagement among scientific societies. This work reveals widespread consensus among society staff that scientists should engage with non-scientists and that members want to be supported in doing so. At the same time, their work shows differences in societies' infrastructure (i.e., staff capacity and social

networks) for supporting such programs and variations in the amount and nature of the programs they undertake.

This report builds on the prior research by Yuan, Dudo, and Besley (2019) to map out the ways that societies support civic science. For the purposes of this project, any program or activity that facilitates or encourages connections between science or scientists and non-scientist stakeholders (such as decision makers, journalists, students, or members of the public more broadly) is considered to be a civic science effort. This includes activities that are typically described as public engagement, informal education, outreach, advocacy, science communication, and media relations. Because the civic science umbrella is broad, it is important to note that some related and common activities fall outside the bounds of this project and are therefore not included in this landscape assessment. For example, initiatives related to formal education (e.g., K-12 or undergraduate classroom resources or curricula) or to scientific communications (e.g., resources that support scientists in writing for or presenting to their peers)fall outside the scope of this work.

This report presents a synthesis of information gathered through a review of 29 societies' websites and supplemented by conversations with 27 staff members at a subset of those same societies. The findings are presented in terms of the key questions about societies' existing supports that they address, as follows:

- Scientists' Views of Civic Science: How do scientists think about civic science? What activities do they engage in? What forms of support do they seek for these efforts?
- Common Programs and Activities: What kinds of civic science programs and activities do scientific societies engage in? What does each entail? What programs and activities are most common? This includes:
    - Societies' Direct Civic Science Work: Ways in which society staff directly engage with various audiences
    - Organization Initiatives with Scientist Involvement: Efforts that are organized and executed primarily by society staff with scientists as participants
    - Support for Scientists' Civic Science: Programs or activities that equip, empower, or reward scientists who engage in civic science
- Underlying structures: What resources — staff, volunteers, funds, and expertise — do existing programs and activities require?
- Partnerships: To what extent do societies collaborate with each other or with other kinds of organizations to advance civic science?
- Societies' Goals for Civic Science Programs and Activities: What outcomes are societies' civic science programs and activities intended to achieve? How do organizations' missions and visions relate to civic science?
- Gaps in Programs and Activities: What kinds of civic science activities are rare or absent from societies' portfolios? Which stakeholders are less involved?
- Effectiveness: How do societies define effectiveness for civic science programs and activities? What efforts are understood to be most effective?
- Sustainability: What kinds of programs and activities are most and least sustainable?

Following this landscape review, the report includes case studies, highlighting programs that stand out for their potential for impact. It concludes with recommendations for working towards a

system that facilitates collaboration across societies to increase the collective impact that these organizations have at the many intersections of science and society.

Landscape of Civic Science in Scientific Societies

Scientists' Views of Civic Science

How do scientists think about civic science? What activities do they engage in? What forms of support do they seek for these efforts?

Scientists themselves are key stakeholders in the civic science ecosystem. Not only does a scientific society's survival depend on attracting and retaining members, but without scientists' buy-in, organizations' civic science activities will be limited in their impact and sustainability. Simply put, cultivating a culture of civic science requires scientists to understand, value, and engage in civic science. For this reason, scientists' current thinking and practices are important components of this civic science landscape.

A survey of scientists at American universities conducted in 2013 revealed a variety of personal and professional motivations for public engagement (Dudo & Besley, 2016). Top motives included defending science from misinformation and informing the public about science, but scientists were also interested in improving science literacy, strengthening the perception of science, and communicating for their own enjoyment. This work also revealed that scientists' lowest priorities for participating in public engagement included building trust and establishing resonance with the public.

For the current project, when society staff were asked about how their members view civic science, many people discussed advocacy as a top priority. Specifically, they often learned through member surveys or informal channels that scientists value the fact that societies directly advocate for the discipline. In some cases, members have indicated that they want their society to engage in even more advocacy. This insight from interviews is consistent with recent work by Newman and colleagues (2019), which found that ensuring that policy makers use scientific evidence was the most highly rated goal for science communication efforts, and work by Besley and Nisbet, which revealed that scientists see policy makers as the most important group with whom to engage (Besley & Nisbet, 2011). At the same time, society staff reported a notable gap between the number of members who value their society's advocacy work and those who actually engage in advocacy, with far fewer members seeking out advocacy opportunities, perhaps because they recognize that their society is already advocating for their interests.

Many staff members noted that early career researchers are especially likely to seek out and engage in civic science activities, though it is worth noting that surveys of scientists have revealed that age does not play a significant role in determining scientists' willingness to engage with the public (Besley, Oh, & Nisbet, 2012; Besley, Dudo, Yuan, & Lawrence, 2018). Staff had mixed theories for why early career scientists might be more likely to engage (if they are). For example, some saw this as a response to the recognition that few graduate students and postdocs will eventually go on to obtain a tenure-track faculty position because the US

continues to produce far more PhDs than there are such positions, while others saw this as a cultural or values shift happening over time, independent of career prospects.

Society staff also frequently reported an increase in members' appetite for advocacy and other forms of civic science in the wake of the 2016 U.S. Presidential election, noting that many scientists and society leaders perceived an alarming increase in society's disregard of evidence. This concern prompted the initiation of several initiatives to bolster support for science among the public and policy makers, including the March for Science (an independent nonprofit organization that many societies partnered with upon inception) and Campaign for Science (a multi-society collaboration that works to advance science advocacy).

At the same time, a number of staff also noted that while scientists' interest in civic science appears high, actual sustained engagement is far less common. They attributed this difference between intentions and action to a number of factors, including the many demands on scientists' time and societies' own struggles to support meaningful long-term engagement.

Common Programs and Activities

What kinds of civic science programs and activities do scientific societies engage in? What does each entail? What programs and activities are most common?

Previous work by Yuan, Dudo, and Besley (2019) articulated three categories of scientific societies' public engagement efforts: (1) societies' own practices, (2) events initiated or organized by societies with scientist members' involvement, and (3) societies' support for individual members' engagement efforts.

Within the broad categories, the tables in the following three sections include descriptions of specific types of programs and activities. They also include the intended audiences and supporting structures that enable a specific activity, such as volunteer committees or staff departments, including the necessary time and expertise. Because these structures vary based on society size, focus, and discipline, the information in the table captures general patterns.

Societies' Direct Civic Science Work

The first group of civic science programs and activities includes efforts by society staff to directly engage with various audiences, such as policy makers, journalists, or students, to advance civic science.

Activity	Description	Audiences	Common Supporting Structures	Examples
Media Relations	Developing content for and engaging with external publications and journalists	Immediate: Journalists; Secondary: Science-interested public	Staff with media, journalism, and/or public relations expertise	Press releases (e.g., Restoring forests means less fuel for wildfire and more storage for carbon, Ecological Society of America); inviting journalists to conferences

Direct Advocacy	Developing content for and engaging with decision makers	Policymakers (typically at the federal level) and their staff; federal agencies that fund research	Staff with policy/advocacy expertise; government relations (and similar) offices; committees of volunteers	Position statements and letters of support on political issues that affect the field and/or members (e.g., Letter of Support for H.R. 3877, Bipartisan Budget Act, Research!America); meetings with decision makers
Society Publications	Regular publications highlighting recent research, geared toward non-scientists	Science-interested public	Staff with field-specific background knowledge and writing expertise	Magazines, newsletters, blogs (e.g., Monitor on Psychology, American Psychological Association, digital and print magazine)
Informal Education Resources	Articles or information about the field in general and key topics	Science-interested public, typically students	Varied	Explainers or activities that introduce people to a field or scientific concepts (e.g., Brainfacts.org, Society for Neuroscience, including a 3D brain, key concepts about brain function, information on diseases and disorders, and more)
Social Media	Use of Twitter, Facebook, Instagram, or other platforms	Science-interested public	Staff or contractor capacity and expertise	Social media used to promote accessible public interest articles about the field and recent research (e.g., @ASAnews, American Sociological Association's Twitter account; @LingSocAm, Linguistic Society of America's Facebook and Twitter accounts) or promote civic science resources for members (e.g., @MeetAScientist, American Association for the Advancement of Science's Center for Public Engagement with Science & Technology; @AGU_SciComm, American Geophysical Union's Sharing Science program)

Most of the societies reviewed engage in direct civic science to some extent, with media relations and advocacy as the most common forms and the areas of this work that staff tend to spend the bulk of their time on. Non-scientist oriented publications and social media are the least common activities in this group, since communications in these forms (e.g., newsletters, magazines, or social media content) tend to be targeted to members and prospective members, rather than broader audiences.

While every society reviewed has some form of social media, typically used to share information with members about the society and the field, some societies also use platforms like Twitter, Facebook, and Instagram to engage with non-scientist audiences by promoting accessible articles and images related to public interests. For example, the Linguistic Society of America consistently posts articles on linguistics from various popular outlets. The society does this by leveraging interns who find relevant linguistics content. When they are unsure of the caliber of the material, they are able to solicit input from a senior member of the society. This practice has resulted in a Twitter following of over 24,000 people, which is especially notable because the society itself has only 4,000 members (typically, societies have 1-2 times the number of followers as members).

In general, societies' direct civic science activities tend to be high-quality, reliable, and strategic, since they are executed by staff members with relevant expertise and experience. This is a major strength of such activities, and likely explains why organizations with particularly limited resources for civic science activities, like smaller societies and those at the earlier stages of developing civic science portfolios, allocate a substantial proportion of the available resources to activities in this category. However, when society staff are solely responsible for these outputs, their capacity limits the impact of the efforts.

Organization Initiatives with Scientist Involvement

Scientific societies also frequently create and oversee various channels or platforms that members can plug into, for example by attending an event or writing a letter or article. In these cases, the organization's staff does most or all of the planning, coordinates logistics, and serves as a resource, while scientists engage as valuable messengers and benefit from opportunities to cultivate skills.

Activity	Description	Audience	Common Supporting Structures	Examples
Contact Members of Congress	Platforms that enable members to electronically contact their elected officials	Members of Congress and their staff	Web infrastructure to send direct emails to Congress; staff capacity to monitor policy landscape and update website content	Web platforms through which users can find their Members of Congress, customize a template note, and email it directly to policymakers (e.g., "Take Action" link to ask elected officials to support legislation that leverages genetics research, American Society of Human Genetics)
Capitol Hill Visit Days	Events that facilitate meetings between scientists and policy makers to discuss specific policy areas or policies	Members of Congress and their staff	Staff with policy/advocacy expertise and experience; often executed with coalitions made of organizations with largely consistent foci	Events for members to meet with policymakers and/or their staff on Capitol Hill (e.g., Rally for Medical Research, an annual advocacy event of meetings in House and Senate in which over 300 scientific organizations take part).

Informal education events	Events designed to introduce members of the public to science concepts through demonstrations, talks, dialogue, etc.	Science-interested public, typically students	Varied	Science fairs and festivals open to the public (e.g., Family Science Days, American Association for the Advancement of Science, which many other societies participate in)
Publication Contributions	Print or online outlets that members can contribute to (often written work)	Science-interested public	Staff with communications expertise and experience	Blogs that are accessible to non-scientist audiences (e.g., STEM + Culture Chronicle, Society for the Advancement of Chicanos/Hispanics & Native Americans in Science)
Scientist Databases	Society-maintained database of members who are willing to speak with non-scientists (most often journalists, but sometimes policy makers)	Direct: Journalists, policy makers, or their staff; Indirect: Science-interested public	Staff capacity to maintain database	Digital database that facilitates finding experts with specific topical expertise (e.g., Find an Anthropologist, American Anthropological Association)
Contests	Invitations to members to submit non-scientific communications; top submissions are rewarded	Science-interested public	Varied	Scientific image contests (e.g., Green Fluorescent Protein Image and Video Contest, American Society for Cell Biology)
Public participation in science	Structures that equip and support members in working with non-scientist stakeholders to discuss, conceptualize, and/or conduct research	Varied	Varied	Support for partnerships between scientists and non-scientists (e.g., Thriving Earth Exchange, American Geophysical Union; the Institute for Civically Engaged Research, American Political Science Association; the Institute on Collaborative Language Research, Linguistic Society of America)

In this group of civic science programs and activities, societies are most likely to have structures that facilitate advocacy, especially web pages that allow users to directly email their elected officials and in-person advocacy events. While some organizations conduct their own advocacy events on Capitol Hill, a number of societies collaborate with each other through existing coalitions to increase their capacity and coordinate their messages.

The informal education subcategory is one for which the extent and level of society involvement varies greatly. One common practice is for a society to participate in events like the USA Science & Engineering Festival, which invite members of the public to interact with scientists

and discover a range of scientific fields. In these cases, society staff tend to organize logistics and members attend the event to interact with visitors.

Another common form of informal education revolves around specific weeks that organizations dedicate to raising awareness about their field (e.g., Brain Awareness Week — Society for Neuroscience, Biophysics Week — Biophysical Society, and National Chemistry Week — American Chemical Society). The society will often organize some portions of the week's programming and will encourage members to organize their own events as well. In these cases, the society frequently provides ideas for events, resources like activity descriptions and marketing materials, and may also help promote affiliated events.

The least common activity in this group is perhaps the clearest form of civic science — public participation in the scientific process. It is likely rare because of the complexities of such work and the large commitment required for researchers to undertake non-traditional research partnerships. Some of the examples in this sub-category from the table above are described in more depth in the case studies section at the end of this report to shed more light on how scientific societies might be able to support more impactful research collaborations between scientists and non-scientists.

Overall, the activities in this broad group usually enable one-off participation on the scientists' part, often setting up a low barrier to entry and requiring a limited commitment for continued engagement. As such, they may make for effective starting points for engaging in civic science, but may also be limited in the extent to which they facilitate a civic science *culture shift,* in which scientists have sustained interactions with diverse audiences.

Support for Scientists' Civic Science

Finally, other programs and activities are designed primarily to equip and empower members to engage in civic science. In these cases, organizations rarely prescribe exactly how scientists' efforts should look. Instead, scientific societies' resources and expertise are allocated toward providing scientists with resources, skills, incentives, or recognition for civic science initiatives that are driven by the scientists themselves.

Activity	Description	Audience	Common Supporting Structures	Examples
Training Events	In-person events or webinars focused on the development of skills that improve civic science efforts	Varied — can be general or specific (e.g., journalists, policymakers, general public). May or may not be specified	Staff with communications expertise; sometimes requires travel resources. In other cases, these are conceptualized and executed by members, especially at conferences.	Communications workshops (e.g., Sharing Science workshops, American Geophysical Union) and advocacy workshops (e.g., Advocacy Training Seminars, Society for Neuroscience) that society staff lead at universities across the country; workshops at annual meetings(e.g., Science Writing Workshops at the Materials Research

				Society's annual conference); webinars recorded and accessible to members on demand (e.g., Communicating Your Science to Non-Scientists, Biophysical Society)
How-To Resources	Resources with practical recommendations and advice related to civic science activities	Varied — can be general or specific (e.g., journalists, policymakers, general public)	Staff expertise; occasionally created by contractors or volunteer members	Communications guides (e.g., Anthropology & Media: A (Nearly) Pain-free Guide to Working with the Press, American Anthropological Association); advocacy toolkits (e.g., Advocacy Tools, Tips, & Instructions, American Chemical Society)
Information and Ideas	Resources about civic science providing perspectives, inspiration, and/or context on civic science activities; less action-oriented than how-to resources	Varied. May or may not be specified.	Staff expertise (especially for advocacy materials); frequently involves members (individuals and/or committees)	Information about political systems and processes (e.g., Federal Budget FAQs, American Chemical Society), policy updates (e.g., Legislative Tracker, Federal Register Tracker, Policy News, and Federal Budget Tracker, Ecological Society of America), articles about civic science activities (e.g., Why Public Engagement Matters, American Association for the Advancement of Science), or talking points (e.g., Fact Sheets, Research!America)
Fellowships	Structured activities, often including funding, that provide scientists with training and opportunities to engage in civic science	Varied	Can require significant resources for fellow expenses, frequently requires partnerships with relevant organizations	Full-time (e.g., Mass Media and Science & Technology Policy Fellowships, American Association for the Advancement of Science) or extracurricular (e.g., Voices for Science, American Geophysical Union) programs
Grants	Funding for specific civic science efforts for a fixed period of time	Varied, frequently science-interested public or voters	Varied levels of funding; staff capacity to oversee	Funds for specific civic science projects (e.g., Public Engagement Grants, American Society for Cell Biology)
Awards	Recognition, sometimes with prizes, for exceptional civic science work	Varied.	Frequently requires modest financial resources; volunteer committees often review applications or nominations and select recipients with staff oversight	Awards for research with positive impact for society (e.g., Distinguished Contributions to Psychology in the Public Interest, American Psychological Association) or for public engagement, outreach, or

				education (e.g., Dwight Nicholson Medal for Outreach, American Physical Society)

The most common activities in this broad group are those that do not need to be regularly maintained, but can instead be produced once and remain relevant and valuable, such as toolkits or other resources that provide tips and instructions for undertaking civic science activities like meeting with Members of Congress or hosting a public outreach event. Perhaps unsurprisingly, those that require fewer resources (e.g., society staff writing general tips for particular civic science activities) are more common than those that are more time- and resource-intensive (e.g., society staff traveling to a university to deliver a workshop). Many societies capitalize on their annual meetings to provide civic science education and professional development to their members. Sometimes these sessions are led by society staff; other times, they are led by members. In most cases, civic science programming at annual meetings varies from one year to the next.

In this group, the scope of activities varies. For example, “Communications 101” workshops aim to equip scientists with broad skills they can deploy in a variety of contexts for many purposes throughout their careers. Some societies also offer training for more specific civic science efforts, such as in-depth training for specific skill development (e.g., in-person advocacy events) or other kinds of support for specific projects, such as grants for outreach efforts.

It is also important to note that civic science content (e.g., explanations for why engagement is important, examples of effective engagement, or announcements about opportunities to engage) can also appear in channels like newsletters, job boards, or online forums that are not specifically dedicated to this topic and are therefore not included in the table above. Some society staff pointed out that one goal is to embed civic science in all of their programs to some degree. For example, when scientists publish in one of the American Geophysical Union’s journals, they are encouraged to write a “plain-language summary” of the work to increase its accessibility outside specific fields of expertise.

A benefit of the activities in this broad group is that they can require fewer resources — especially staff capacity — than activities in the other categories (though this is not always the case). By equipping scientists to engage in civic science activities, a single staff member may be able to indirectly contribute to far more engagement than they would otherwise be able to do on their own.

However, the return on investment (i.e., ultimate impact) for programs that aim to equip scientists to engage in communications, outreach, or advocacy is not always clear. As many staff members pointed out, the downstream effects of trainings and other supports can appear minimal because applying skills or insights to new activities can require a substantial amount of time and effort for scientists. Society staff are well aware of the many demands on scientists’ time and the relatively low prioritization of civic science activities, particularly due to an academic culture that devalues such work and a dearth of institutional incentives for it. In practice, this means that at present, some society supports like training, resources, or grants may not be as much of a catalyst for effective and sustained engagement as societies might hope.

Underlying Structures

What resources — staff, volunteers, funds, and expertise — do existing programs and activities require?

As the tables above show, different activities tend to be supported by different individuals, teams, or committees. Despite these patterns, there is marked variability in the number of staff supporting organizations' civic science work, their backgrounds, and the scope of these individuals' work. Relevant volunteer member committees take different forms as well — some societies have committees with more specific foci (e.g., the Federation of American Societies for Experimental Biology's Animals in Research and Education subcommittee, under the broader Science Policy Committee) while others are much broader in scope (e.g., American Society of Plant Biology's Science Policy Committee). Similarly, some committees work closely with society staff, while others are less involved in day-to-day activities.

In general, organizations' civic science work is supported by staff members with public relations, journalism, policy, or advocacy expertise, rather than expertise in the discipline the organization represents. In some cases, these staff members have science backgrounds, but they frequently do not. A number of society staff without science degrees discussed the importance of their scientist volunteer committees for ensuring that their organization's communications accurately represent the discipline and research.

A clear theme that emerged from conversations with society staff was that their ability to directly engage in civic science as well as to support scientists in doing so is limited by their staff's bandwidth first and foremost, followed by resource limitations. Many staff suggested that with more funding and colleagues focused on civic science, their organizations would be able to engage in more — and potentially more impactful — communications, outreach, or advocacy.

Partnerships

To what extent do societies collaborate with each other or with other kinds of organizations to advance civic science?

While collaboration between societies on communication, public engagement, or outreach initiatives tends to be rare or one-off, societies frequently engage in long-standing, mutually beneficial collaborations for advocacy, often through formal or informal coalitions. These coalitions allow staff at different societies to work together to coordinate their advocacy messages for greater effectiveness and support each other in a number of other ways. Some staff at smaller societies pointed out the importance of coalitions for smaller organizations in particular, since they can trust the group to advocate on their behalf even when the society staff themselves may not have the capacity to do so.

Why is collaboration more common in the advocacy space than in other civic science areas? Society staff shared a number of theories for why this might be the case. For example, it may be that societies' advocacy goals are frequently consistent with each other's, rather than in competition, which may not be the case for as many goals outside the policy realm. Moreover,

advocacy efforts may have clearer goals, like increasing funding for scientific research, than other civic science efforts do. Clearer goals may make collaboration easier, since people can better understand why and how to collaborate when their intended outcomes are tangible. In addition, advocacy has a longer and more formalized professional history than other civic science components, such as outreach, and collaboration has long been considered a cornerstone of effective policy and advocacy work. Thus, society staff in policy-related roles may have more experience collaborating with other organizations to achieve advocacy goals and a greater expectation for collective work than staff working in other areas.

Another kind of partnership relevant to societies' civic science work takes the form of federations, or societies whose membership is primarily or exclusively made up of other societies, rather than individuals. These organizations include Research!America, the American Institute of Physics, the Federation of Associations in Behavioral & Brain Sciences, the American Geosciences Institute, and the Federation of American Societies for Experimental Biology, all of which include member societies in related fields. One benefit of these higher-level societies is that they can provide centralized resources, coordination, and community for organizations with similar interests and needs. However, this model takes many different forms; in some cases, member societies are in close contact and collaboration with each other, while in other cases societies maintain relative independence.

At the same time, some societies do collaborate with each other and with other kinds of organizations, typically nonprofits, outside of advocacy coalitions. For example, a number of societies formally sponsored and participated in the March for Science in 2017 and 2018. Similarly, the Society for the Advancement of Chicanos/Hispanics & Native Americans in Science leverages partnerships with organizations like 500 Women Scientists and the Union of Concerned Scientists that allow them to achieve their mission — cultivating leaders in science — more effectively by integrating science communication and advocacy skill development into their leadership curriculum, since these skills are essential for leaders.

Finally, partnerships can take the form of direct funding. A few of the societies reviewed have received external funding to support their civic science programs. For example, the American Society for Cell Biology has provided public engagement grants to members for specific outreach projects with funding from Science Sandbox, an initiative of the Simons Foundation. While external funding often allows a society to allocate more resources to their initiatives, this funding model does not necessarily guarantee sustainability of the programs as funders' priorities or resources change.

Societies' Goals for Civic Science Programs and Activities

What outcomes are societies' civic science programs and activities intended to achieve? How do organizations' missions and visions relate to civic science?

Perhaps not surprisingly, scientific societies' mission and vision statements, as well as their articulated goals and priorities, are centered on advancing the scientific field they represent and helping their scientists succeed in their research. Civic science, in the clearest sense of the concept, is not often central to these organizations' existence — it rarely drives their everyday or strategic decisions.

However, civic science is implicated in the missions, visions, or goals of every society reviewed, even if it is not always a central feature. For some organizations, benefiting humanity is an explicit aspiration articulated in the way the society describes its work and goals. In these cases, the society's stated purpose is to support scientists in using their science *in the service of a better world.* For example, the American Chemical Society's mission is "to advance the broader chemistry enterprise and its practitioners for the benefit of Earth and its people" and the Federation of American Societies For Experimental Biology's mission states that the organization "advance[s] health and well-being by promoting research and education in biological and biomedical sciences."

In describing their aims and activities, many societies also describe specific civic science goals. These tend to fall into at least one of the following categories:

- Cultivating broad support for science generally and/or for their field specifically (e.g., the Linguistic Society of America "aspires to a society which respects, values, and appreciates… the role of science in advancing knowledge.")
- Promoting policies informed by science and conducive to continued scientific progress (e.g., the American Geophysical Union works to "increase the role of the Earth sciences in informing policy and mitigating impacts of natural disasters.")
- Increasing public understanding or awareness of key scientific concepts and advancements (e.g., the Ecological Society of America aims to "raise the public's level of awareness of the importance of ecological science.")
- Attracting future scientists and ensuring they are equipped to advance the field (e.g., a goal of the Biophysical Society is to "continuously improve the mechanisms to engage, support, and retain the next generation of biophysicists."

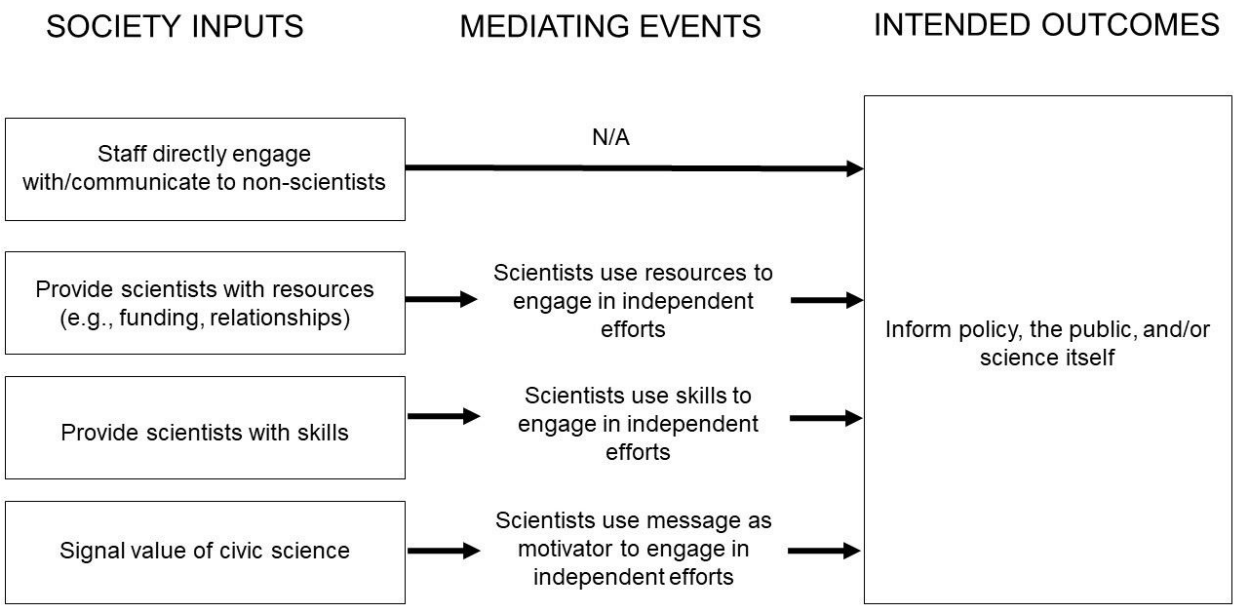
Although nearly every society aims to promote civic science, at least to some extent, the available information on precisely what impact the organization hopes to achieve and how they see themselves doing so varies greatly. Some societies articulate very specific long-term aspirations and short-term goals, while others describe much broader aims, such as ensuring that science benefits society. On the one hand, more specific goals are likely more attainable, as they provide direction and guidance for an organization's activities. On the other hand, broad goals create more opportunities for finding common ground across diverse organizations, as they are likely to share many of the highest level aspirations.

Advocacy is an area in which goals tend to be much more explicitly and specifically defined. Most often, the aim of in-person or electronic advocacy efforts is to maintain or increase levels of funding for scientific research, particularly through robust funding of federal agencies that support science. Other times, organizations advocate for policies that will best support their scientist members, such as permitting ethical uses of animals in research. The clarity of advocacy goals likely results in large part from the fact that policies and funding create much more tangible focus areas for this work; other areas of civic science, such as outreach or informal education, are not as easily connected to such concrete outcomes. Although this difference in outcome clarity may be inherent in the nature of different activities, future efforts might also work to more consistently operationalize goals for civic science efforts beyond advocacy.

Although specific goals for different civic science programs and activities are rarely made explicit in societies' publicly-available materials, general goals are often implicit in the way the efforts are described or in the nature of the programs themselves. The following table characterizes the programs and activities described in the previous sections by the ultimate goals that they are likely designed to achieve. The top row describes the three main overarching goals of potential civic science efforts: for policymakers to understand relevant science and use it to develop sound policies, for members of the public to better understand science, or for the scientific enterprise itself to account for public needs, priorities, and perspectives.

The categories along the left side of the table represent different pathways, or theories of change, for groups of programs and activities. The first group is considered "unmediated" because the broad goals along the top of the table can be achieved as a result of the society's effort. For example, when society staff meet with policy makers or publish position statements, those actions could, in theory, accomplish their goal of informing policy without requiring specific subsequent events or actions.

For each of the other categories along the left side of the table, the society's input cannot directly achieve the goals listed along the top. These programs and activities require scientists to leverage the society's action to engage in some kind of follow-up activity to ultimately make the intended impact. The primary difference between these three groups is in the society's input — whether the society provides resources (e.g., funding), relevant skill development (e.g., communications training), or signaling of the importance of civic science and institutional support. The graphic below depicts these four paths to achieving the three primary intended outcomes of civic science efforts.



Because societies do not tend to publicly state the goals for each of their civic science-related activities and programs, the three primary goals included in the table below are exceptionally broad, and they arise from inferences based on the nature of the described program or activity.

Goals of Societies' Civic Science Programs and Activities

	Goals for Policymakers	Goals for Public Audiences	Societal Input into Science
Unmediated	-Policymaker education -White papers, position statements, letters, testimonies	-Publications disseminating science news -Press releases -Public outreach events	
Mediated, by providing scientists necessary resources (e.g., financial or relationships)	-Congressional Hill Days -Links to contact Members of Congress	-Outreach or engagement grants	-Public participation programs (including resources for partnership formation and project execution)
Mediated, by increasing scientists' skills, experience, or inspiration	-Congressional fellowships -Advocacy trainings, resources, or other resources -Articles about the importance of advocacy or member highlights	-Communication trainings, webinars, and other resources -Communications fellowships -Articles about the importance of outreach or public engagement or member highlights	
Mediated, by signaling the value of civic science	-Advocacy awards	-Communication or outreach awards -Contests for effective portrayal of science for public consumption	

A key takeaway from this table is that while scientific societies on the whole engage in a number of efforts to inform policymakers and members of the public, through both unmediated and a range of more mediated actions, there are very few programs that connect scientists and non-scientists as a means of shaping the way that science is conducted, including what gets studied and how. This is a notable gap particularly because ensuring that science itself is more informed by the public is a crucial component of a culture of civic science (Christopherson, Scheufele, & Smith, 2018) and one of five central goals for science communication articulated by the US National Academies of Sciences, Engineering, and Medicine (2017). Without robust efforts in this area, however, scientific societies will not be able to contribute to a culture shift towards more democratization of the scientific enterprise.

Another note related to the table above is that social media, an activity that almost every scientific organization engages in through a number of platforms, is absent. This is because societies' social media feeds rarely suggest any clear civic science objective. They are generally member-focused, including scientific content or information about society events and services that are likely to be of interest only to scientists, though many society staff expressed the possibility of using social media to connect with broader audiences. This presents an opportunity for the development of clearer strategies and practices in using social media to achieve civic science goals.

Finally, although it is challenging to connect the broad goals above to anticipated outcomes for evaluating success, the general categories do provide an understanding of the intentions likely underlying current programs and activities. In developing a collective vision, it may be beneficial to determine the extent to which the three categories above represent societies' civic science priorities and further refine them for clarity on specific intended outcomes.

Gaps in Programs and Activities

What kinds of civic science activities are rare or absent from societies' portfolios, and which stakeholders are less involved?

Despite the breadth and volume of societies' existing civic science efforts, there are inevitably areas with few or no relevant programming. Some of the most notable areas with few activities are also perhaps the most quintessential forms of civic science — those that involve public participation in science, including diverse stakeholders not only as the *audience* for communications but as *contributors* as well (Nisbet & Markowitz, 2015). This can take many forms, including policy deliberation, in which members of the public provide input on policies; public dialogue, two-way interactions with the goal of mutual learning; or knowledge co-production, in which scientists and non-scientists collaborate to produce and use research. Societies can support this work by providing a forum for learning and conversation around these participatory approaches, to help scientists understand not only how to do rigorous research involving key stakeholders, but also how to do it in ways that advance diversity, equity, and inclusion. As these activities, by nature, shift the dynamic away from the traditional and typically ineffective deficit model, which emphasizes the dissemination of facts as the central goal of science communication, they might be considered best practices for civic science. For this reason, their rarity among programs offered by scientific societies is particularly notable.

Looking at societies' public-oriented activities in general, there are also few efforts that attempt to reach groups that might not be considered "science-interested" (i.e., those who seek out science content). As prior work has shown, there are rather large disparities among members of the public who tend to encounter science, for example through informal science institutions or online, with younger and more educated people more likely than others to engage in various ways (American Academy of Arts and Sciences, 2019). Societies' existing efforts are likely to reinforce these broader patterns.

Local advocacy is another area that scientific societies have little programming in. Although many organizations might encourage advocacy at local levels, their resources are almost exclusively devoted to federal policy making and federal agencies. This focus is easily explained — given limited resources, it is a strategic decision to target the bodies that provide the greatest financial support for research and make policies relevant to the greatest number of members as possible. However, a number of society staff expressed a desire to support their members' local advocacy efforts, which often have tremendous potential for impact. So far, they have struggled to find ways to do this, given the challenges with tracking local issues and tailoring approaches to individual cases and areas. For now, it is a gap that at least some societies would like to fill, but for which they don't currently have adequate resources to do so.

In addition to these broad areas with limited programming, civic science-related awards are also somewhat rare. Relevant awards are not part of every society's portfolio, and when they do exist, there are often very few of them, which means that only a small fraction of members who engage in civic science efforts are recognized for doing so. This is notable because many society staff and leaders see for awards as potentially impactful indicators that an organization values the work being rewarded, which means that civic science awards may have the potential to help shift scientific culture toward greater acceptance of and prioritization of civic science. Further, impactful awards do not necessarily need to include a financial component; in many cases, recognition along may make for a significant incentive. Given the weight that society recognition can have on an individual's career and the fact that awards do not necessarily require significant funds or staff involvement, this gap presents a potential missed opportunity.

Furthermore, in many cases these awards are reserved for prominent individuals, typically in the later stages of their career, and they are sometimes reserved for non-scientists (e.g., public officials or journalists). While such awards undoubtedly have benefits for organizations and recipients, reserving awards for a select few who are already likely to receive ample recognition further limits the potential of such recognition to support early career scientists and others who might especially benefit from institutional recognition. For these reasons, it may be fruitful for scientific societies to collectively devote more thought and discussion to increasing the availability of civic science awards and ensuring that they support and encourage scientists who might be able to contribute to a culture of civic science.

Effectiveness

How do societies define effectiveness for civic science programs and activities? What efforts are understood to be most effective?

The effectiveness of societies' civic science efforts is challenging to assess. In part, this is because measuring effectiveness requires time and expertise. However, measuring effectiveness is particularly challenging because the specific goals of many programs and activities are not often articulated. However, society staff recognize the importance of understanding how well various programs and activities work. To this end, they currently rely on a few different sources of information to understand the effects of their efforts.

First, a number of activities, particularly those executed directly by society staff, tend to be based on industry standards and widely accepted best practices (e.g., writing press releases about newly published research or issuing formal statements and policy positions). Industry standards are frequently based on quantifiable metrics, so these efforts can often be linked to tangible outcomes. For example, some societies track earned media for publications in their journals, which they generally attribute to the work of communications staff promoting that research. Similarly, advocacy teams can measure how often policymakers reach out to the society for input on policy proposals as an indicator of the society's prominence and credibility on an issue.

It is also commonplace to track metrics for programs and activities that staff members do not do on their own — for example, organizations often track how many members have used a "take action" button on their site to write to their members of Congress, how many media outlets have

picked up a press release, or how many people have viewed public-oriented webpages. However, is significantly more difficult to gauge whether such activities are achieving their maximal impact — to understand whether they are the best approaches for disseminating research to various audiences or whether different strategies could be more impactful.

In the course of this landscape assessment, a number of society staff also shared information about their organization's civic science efforts that their organizations have considered unsuccessful and how such a determination was made. For example, staff from a range of societies expressed that their organization had determined that they are not the ideal messenger for many forms of direct communication with members of the public or journalists. In some cases, they found that they were most impactful when they facilitated connections between these various groups, rather than attempting to share the science themselves. Other efforts were deemed unsuccessful because few scientists participated in them, suggesting that the opportunities themselves were not what scientists desired or scientists did not feel adequately supported to undertake them. For example, one organization found that asking scientists to engage in new civic science collaborations after a training workshop resulted in limited follow-through, most likely because the scientists may not have felt that they had the time, expertise, or direction to take on less guided activities. This experience suggested that if organizations can provide additional direction and resources to facilitate follow-up activities (which many societies struggle to find the capacity to do), they would be more likely to see sustained engagement by their members.

Sustainability

What kinds of programs and activities are most and least sustainable?

By and large, neither societies' direct nor their indirect civic science activities generate revenue. As many staff pointed out, these activities are not intended to make money — societies advocate for and communicate about their field, and equip scientists to do the same, because these activities are essential to the fulfillment of their missions. In some cases, this is enough to ensure sustainability, but when organizations need or decide to reduce their expenses, civic science programs are often cut. Staff at some societies could point to specific examples of activities that their organization chose to scale back on or eliminate entirely because of shifting priorities for resources or changing economic situations. In short, the lack of independent financial support for civic science programs and activities inevitably puts their sustainability at risk.

While obtaining external funding can alleviate financial burdens of civic science programs, such funding is often one-off and term-limited. Thus, for a period of time, a society may have the capacity to support civic science activities that they otherwise would not be able to do, but if (or when) funding is no longer renewed, the organization will likely need to scale back that work. Overall, improving the long-term sustainability of civic science work is a pressing challenge for scientific societies.

Landscape Summary

As the tables included in this section demonstrate, scientific societies engage in a wide variety of civic science activities. These efforts can be directly undertaken by society staff, can involve the organization creating structures that members can participate in, or can serve to equip and empower members to take on their own civic science engagements. Most societies have at least one program in each of these three broad categories, though they do have different priority areas; for example, some organizations have a large staff and can therefore engage in substantially more direct civic science activities, while others have few staff working in this area and make most of their impact through supporting their members' efforts.

No two societies have nearly the same civic science portfolio, and even the execution of common activities (e.g., Capitol Hill Visit Days or communications training workshops at annual meetings) take on distinct forms from one society to the next. Common structures that enable the existence of civic science programs and activities include staff with applied (i.e., communications and/or policy) experience and member committees with specific domain directives. As staff and members tend to have different backgrounds and experiences, some of the most successful civic science efforts arise when these two groups collaborate.

The landscape review also revealed that collaboration across societies is more common in the advocacy space than in other areas of civic science, such as outreach or informal education. Coalitions that connect societies with similar goals and help the organizations coordinate their advocacy actions are considered to be important contributors to favorable policy and funding outcomes. Societies might consider applying an adapted version of this coalition model to facilitate and coordinate their work in other civic science areas.

Societies' ultimate civic science-related goals provide important context for an understanding of their current work in this area. While outcomes are rarely defined explicitly (again, with advocacy as a frequent exception), organizations' missions, visions, and the nature of their civic science programs imply goals related to connecting science with the broader society, such as informing policy makers, informing members of the public, or informing the practice of science itself, though the latter is substantially less prevalent in societies' civic science portfolios. Since this outcome is an essential component of an ultimate culture of civic science, future efforts should be focused on discovering new ways to authentically and ethically increase public participation in science.

This comprehensive look at societies' activities and programs gives rise to notable gaps in programming. For example, very few programs seek to connect scientists with local policy makers or with members of the public who don't actively seek out science content. Consistent with the rarity of goals that aim to provide meaningful opportunities for the public to contribute to scientific research, activities related to public participation in science are limited.

This assessment also sought to synthesize society staff's current understandings of the effectiveness of their civic science efforts. Effectiveness is hard to measure, and staff are attuned to this challenge. Future efforts should be devoted to defining metrics for success,

articulating how they can be implemented and used to inform ongoing efforts, and sharing them across the societies for increased learning about best practices.

The sustainability of civic science programs and activities presents an additional challenge. Because such efforts are rarely designed to generate revenue and are not often central to an organization's mission, they are often in jeopardy of being cut or scaled back. External funders sometimes provide resources to ensure that particularly impactful projects can be executed, but more widespread and long-term funding sources are needed to support these efforts and, when appropriate, scale them up.

Case Studies

This section includes case studies that demonstrate some of the variability in the practices described in aggregate in the tables above. These case studies are intended to highlight programs with particular potential for impact.

Organization Initiatives with Scientist Involvement

Listen Up and Get Involved! (Acoustical Society of America)

The ASA's Women in Acoustics and Education in Acoustics committees sponsor a free acoustics workshop for kids during the society's Spring and Fall meetings. During the event, ASA members (recruited by the society's Education and Outreach Coordinator) present interactive, hands-on acoustic demonstrations to children between 10 and 17 years old. ASA works closely with local Girl Scout Councils and Girl Guides Provincial Contacts to organize these workshops, so empowering girls is a key part of the program's aims, but any interested child is invited to attend the event.

This program is unique in the outreach space because ASA administers pre- and post-workshop surveys to learn about their audience and to understand the effects of the workshop on children's understanding of and perceptions of science generally and acoustics specifically. The surveys include both open- and closed-ended questions that ask children what they expect to see, what they think acoustics is, and whether they are interested in learning about science and acoustics (before the event), and what they learned (following the event). Using the same questions before and after the event allows ASA to assess whether and how the participants think about science and acoustics differently after attending. For example, both the pre- and post-workshop surveys ask students to rate how much they like doing hands-on experiments and learning about the science of music.

Finally, the surveys assess participants' perceptions of gender in science, by asking students to indicate how much they believe that science is more for men or women and if they think various science-related professions are more for men or women. In this way, the surveys indicate not only whether the demonstrations are effective in helping children learn about acoustics, but also whether they can shift the ways that students think about science and the extent to which women and girls belong and can succeed in the field.

Although the society has articulated multiple specific aims of the workshops and consistently collects information to assess whether the events are achieving those aims, an additional challenge remains — namely, ensuring that the survey results are thoroughly analyzed and used to improve future workshops. Given time constraints and a lack of a clear precedent for how this subsequent step might look, it presents an opportunity for other societies to emulate and build on so that organizations' civic science efforts can be designed with a comprehensive and sound foundation.

Support for Scientists' Civic Science

Civic Engagement Microgrants (Research!America)

Through its Microgrant initiative, Research!America supports student- and postdoc-led science policy initiatives working to convey the importance of scientific discovery and research. In both 2018 and 2019, the organization has solicited proposals for nonpartisan projects designed by the student or postdoc groups that facilitate connections with policy makers and community leaders to elevate the importance of scientific research, innovation, and public health.

In 2018, ten groups received between $1,000 and $5,000 for activities like op-ed writing workshops, roundtable discussions, forums, or science fair-style events with elected and non-elected public officials, community leaders or policy experts, local or state officials and members of the public. In 2019, 15 groups were funded to undertake similar projects.

The Microgrants facilitate dialogue between the student groups and decision makers on issues of importance to their community. In 2019, Research!America launched the Science Meets Science microgrant track, which requires recipients to collaborate with social scientists or communications scholars, in order to align their efforts with insights from these fields. All microgrant recipients also receive opportunities for additional training sessions from experts in science communication, policymaking, and advocacy programs.

In the inaugural year, the Microgrants were supported in part by the Rita Allen Foundation and by individual science societies. In 2019, the grants were supported by Rita Allen and Research!America

Voices for Science (American Geophysical Union)

In 2018, AGU launched Voices for Science to support scientists in engaging in effective and sustained communications with a variety of audiences. For this program, selected scientists opt into either the policy or the media/public communications track. They commit to engaging in at least one relevant activity in their community every month and involving their peers in some of those activities. The one-year program begins by bringing all participants together for an in-person training event and encourages sustained communications throughout the duration of the year through regular group calls to share progress and challenges and through AGU's online community.

The Voices for Science cohorts are diverse groups of scientists from a range of fields. Participants are selected with consideration for the role their national elected officials play in influencing science policy and funding efforts on Capitol Hill.

During the first year, the 30 members of the 2018 cohort took over 700 outreach actions, through which they engaged over 12,500 policymakers, journalists, community members, and other stakeholders directly and over 230,000 people through online engagement.

AGU staff see the network component of each Voices for Science cohort as a key to the program's success. The program catalyzes connections among like-minded scientists at the beginning of the year by holding an in-person training event, and provides platforms for those connections to grow in ways that support more and more effective outreach.

Institute for Civically Engaged Research (American Political Science Association)

In 2019, the American Political Science Association (APSA) launched an annual APSA Institute for Civically Engaged Research (ICER) to equip political scientists to conduct research *with* — and not just *on* — communities of interest.

The program is unique in its integration of various publics in the research process, rather than involvement solely at the end of knowledge production, as typical science communication efforts do. Because political science research often aims to address social challenges, ICER capitalizes on the unique opportunities inherent in the nature of this work to support rigorous and ethical involvement of communities. The week-long in-person institute involves discussion and training on the practical and ethical considerations of collaboration from project conceptualization to implementation to communication of findings.

Although ICER participants uncovered many more questions about how to do rigorous and ethical civically engaged research in the process of learning and discussing the topic, the first year of ICER has provided an exemplar for scientists and organizations looking for ways to deepen public involvement in the research process.

Conclusions & Recommendations

This landscape report reveals a number of strengths and assets that scientific societies can leverage to increase their collective impact through civic science activities. For example, societies can connect scientists with each other and the broader world, foster relationships with the public and private sectors, produce high-quality scientific content, provide meaningful recognition to members who excel in various capacities, and collaborate with each other for successful advocacy. Many scientific societies have been supporting and representing scientists for many years and have therefore built strong reputations within scientific communities and beyond.

External factors also present opportunities for societies to engage in civic science. Advances in technology, particularly online, have provided more outlets for connecting with a variety of audiences. At the same time, political circumstances have motivated more scientists to

communicate with non-scientists. Trust and interest in science remains high among the public, recognition of the value of civic science is on the rise among scientists, and notable institutions like universities respect and take notice of societies' actions and priorities. Together, these factors lay the groundwork for abundant opportunities for impactful civic science.

At the same time, scientific societies also face notable hurdles that need to be diminished or circumvented to better support civic science efforts. Most notably, scientific culture does not encourage or support such engagement and institutional policies, such as tenure and promotion guidelines, do not regularly reward it, so scientists often struggle to engage in effective and sustained ways. Further, effective civic science requires specific skill sets that can run counter to scientific norms and pedagogy (e.g., civic science prioritizes multi-directional engagement whereas academic norms are based on one-directional interactions with large power imbalances), making it crucial for scientists to receive training and support to engage in impactful civic science. Meanwhile, a polarized public makes engaging across ideological differences and moving beyond echo chambers become even more challenging.

In addition, scientific societies' missions are rarely focused on engaging in or supporting civic science. Although it is often a component of a broader strategic plan and an effort that many society leaders believe should be supported, the fact that civic science is not a central or essential component of societies' efforts means that funding for these programs and activities can be limited and tenuous. Without significant external funding for such activities, scientific societies have insufficient resources to support civic science as effectively and sustainably as they otherwise could.

Given that the most important factors for predicting whether scientists will take part in engagement activities are beliefs that the experience will be positive, that the activity can make a difference, and that the scientist has sufficient time, societies might find that their efforts that target these areas have the greatest potential for encouraging and enabling effective and sustainable civic science efforts (Besley, Dudo, Yuan, & Lawrence, 2018).

The following recommendations for increasing societies' capacity for advancing civic science are based on numerous insights from this landscape analysis. For each focus area below, collaboration among organizations is most likely to yield the greatest progress. This is especially true in light of societies' limited staff capacities and resources, all of which can be allocated more efficiently as part of a structured collaborative effort.

1. **Clarify the goals of societies' civic science efforts and use available research to align strategies and intended outcomes.** While advocacy goals tend to be clearly defined, outreach and public communication goals are often broader and more nebulous. This makes it exceptionally challenging to design programs and activities in such a way that they will support the end goals. However, if societies can clarify their civic science goals and develop or leverage theories of change to clarify how they can achieve those goals, their efforts are likely to achieve greater impact.

   Goals and theories of change should be based on existing social science research that sheds light on the most effective practices, such as placing audience interests and needs first. For example, research suggests that programs focused on teaching scientists communication tactics (e.g., reducing jargon use or incorporating narrative

elements) may inadvertently reinforce deficit model thinking — that providing members of the public with more knowledge will lead to a range of outcomes, like greater trust in science or the adoption of evidence-based practices (Besley, Dudo, & Yuan, 2017). Given this research, common practices, such as “SciComm 101” workshops, might need to be re-evaluated to ensure they are advancing *effective* civic science practices understandings, rather perpetuating conventional wisdom and unproductive practices. Additional research may be leveraged to determine ideal messengers for different civic science activities and goals so that organizations and scientists can engage in ways that they are uniquely well-suited to do successfully.

2. **Reduce redundancies — areas in which staff members at different societies are likely to duplicate efforts rather than building on each other’s work.** This can be accomplished in large part by sharing best practices and lessons learned across organizations, particularly for activities and programs that are common features of many societies’ civic science portfolios. For example, many organizations make how-to resources on science communication or general training workshops available to their members, but most society staff currently start from scratch to develop these materials, which costs them time and results in materials of variable quality. Greater sharing would mitigate this challenge. Creating channels and forums dedicated to fostering a culture of learning across organizations will facilitate the streamlining of core civic science activities so that more organizations can benefit from high-quality materials and practices without duplicating others’ efforts. A concrete starting point might be to develop a single, vetted, and up-to-date repository of civic science resources, including how-tos, case studies, and lists of organizations working on relevant issues that numerous societies can both contribute to and benefit from, rather than creating their own resources and continuously updating them.

3. **Assess the merits and feasibility of filling gaps in societies’ civic science efforts.** This landscape assessment has revealed that some key civic science activities are rare or absent from scientific societies’ portfolios. This finding suggests that the same activities are likely uncommon for scientists to engage in, or, at the least, if scientists are engaging in these areas, they are lacking support from their professional organizations. The following are three such gaps that societies might consider incorporating into their work or supporting through external partnerships

    a. Public participation in science: Ensuring that members of the public can inform science — for example through conversations on how science is conducted and is used in policy making or by participating in the research process themselves — is a hallmark of a culture of civic science. However, the vast majority of societies’ direct efforts and those of their members that they support involve the public as passive receivers of science, rather than active contributors to the enterprise. This imbalance is likely to perpetuate unproductive deficit model conceptualizations of science communication and limit true bidirectional, fruitful relationships between scientists and various non-scientist audiences.

    b. Inclusion of diverse audiences: Most science communication and outreach efforts (including, but not only among scientific societies) are accessed by “science-interested” members of the public. This is because people typically have

to seek out articles, videos, or events that share science, and those who are already engaged in the topic are the most likely to do so. Without intentional efforts to ensure that civic science activities involve diverse audiences, they will continue to reach the same people. New strategies, activities, or partnerships may help bridge this gap so that societies' and scientists' existing efforts can be more inclusive and accessible to diverse audiences.

c. Local advocacy: Because supporting local advocacy brings a number of challenges for scientific societies, their current work is almost exclusively focused on educating and assisting scientists for federal advocacy. In turn, many avenues for impact are taken off the table. Without massively increasing societies' staff sizes, which is not currently a feasible way to fill this gap, societies may be able to collectively develop resources for helping scientists apply lessons from federal advocacy to local advocacy or they may find ways to partner with organizations that specialize in more localized and grassroots efforts in order to connect their members with valuable opportunities and support that they cannot currently offer.

4. **Invest in meaningful incentives to encourage civic science.** Civic science tends to be seen as an "add-on" by many scientists — something that might be nice to do but is not central to career success — since there are few rewards for engaging in this work. Societies have the opportunity to create more incentives to encourage scientists to undertake effective civic science.

   Awards provide perhaps the most straightforward incentive for engaging in civic science. Nearly every society included in this landscape assessment gives awards to members who have excelled in an area of recognized importance. Most commonly, these words are for exceptional research, but in some cases, they are for public service, communication, or other civic science-related work. Societies may increase the number of civic science awards they grant each year, particularly for civic science activities that are less frequently recognized (e.g., grassroots mobilization or public participation in research) and for scientists that are less likely to be recognized (e.g., early career researchers or those from underrepresented groups). Such awards could include financial rewards, but they do not need to include money in order to provide valuable recognition that reinforces scientists' efforts and provides a valuable way of demonstrating their civic science work in professional contexts, such as on their CV.

   Although awards are one of the most obvious incentives societies can provide to encourage civic science work, they are not necessarily the only meaningful incentive — or even the most powerful one. In the future, it may be worthwhile for societies to learn more about what motivates scientists to undertake civic science activities, in order to drive the development of more substantial incentives for this work.

5. **Increase the ways and the extent to which societies signal that they value civic science**. Because societies are respected institutions and are understood to be key to the scientific enterprise, they have a unique potential to influence scientists' mindsets and actions as well as institutional norms and practices. On some level, the existence of programs and activities related to civic science signals that societies consider this work valuable. But there are also more explicit ways of making this stance clear and

advancing norms that may have an even greater potential to effect change, such as:

a. Public communications: Societies regularly publish white papers and articles in their journals and on their websites, many of which make the case for individual-level practices and institution-level policies. Societies can leverage these channels to more explicitly explain why civic science is important, how scientists can engage, and how institutions can and should support this work. For example, such communications might convey the benefits that various civic science activities have for scientists, scientific progress, and society more broadly, they might detail the ways that societies can support this work, and could make a case for why and how civic science efforts should be incorporated into tenure and promotion evaluations. Explicit communications about the value of civic science are likely to be especially helpful to scientists looking to change norms or practices at their institution.

b. Scientific content: Because the bulk of societies' efforts are centered around advancing the field they represent, organizations may find more ways to incorporate civic science into activities that are typically considered to be outside of this realm. For example, some societies have begun encouraging or requiring "plain-language" abstracts to accompany journal submissions or grant applications, which provides not only an opportunity for scientists to practice communicating for a non-scientific audience, but can also send the message that communicating in accessible ways is of comparable importance to communicating for one's peers. The more civic science skills and practices are entwined in efforts that might traditionally be considered purely scientific, the less distinct these different areas will seem, which may help encourage a culture shift towards one that prioritizes scientists engaging with non-scientist audiences.

6. **Find ways to increase diversity, equity, and inclusion in all aspects of civic science.** Quality and impactful civic science requires the inclusion of diverse perspectives, backgrounds, and approaches from the scientists and the members of the public or policymakers with whom they engage. One way societies may do this is by evaluating which scientists' expertise and experiences are most often privileged and advanced by the structure of existing civic science programs and efforts, then making changes to practices or policies to bring about greater diversity and equity. In particular, attention should be paid to elevating the voices of scientists who have fewer resources (e.g., early career researchers or those at community colleges) and who have historically been excluded from participating in science for a wide range of reasons (e.g., women and people of color). Further, societies might consider providing additional support to scientists whose identities (personal or professional) might put them at greater risk of experiencing negative consequences for engaging in civic science, such as those who work on contentious topics or who identify with marginalized groups.

   Diversity, equity, and inclusion are also critical considerations for determining with whom scientists engage with and how those engagements unfold. Societies should explore ways of expanding the audiences for the civic science activities they support, including more groups who have historically been excluded from science, who continue to be marginalized, and who have experienced social and scientific injustices. As societies

encourage and equip scientists to engage with more diverse stakeholders, it is essential that societies are proactive in making sure these interactions will be respectful, ethical, and productive for all involved — simply spreading a message to a broader group of people in insufficient; instead, the broader group needs to be fully included and their value should be recognized. Ensuring that the scientists engaged in civic science have diverse backgrounds and identities, and that they are able to engage positively with various publics, will begin repair trust for populations that have been harmed by science in the past and will create a foundation for mutual respect, support, and collaboration in the future.

Advancing diversity, equity, and inclusion in civic science — whether with regard to the scientists partaking in these activities or the members of the public and policymakers with whom they engage — requires careful consideration of historical injustices, power dynamics, and diverse needs in order to bring about greater equity in participation in and access to science.

7. **Find ways to more efficiently connect people and groups in various parts of the civic science ecosystem**. Scientific societies are already known as effective bridge builders that help scientists communicate with particular audiences, such as federal policy makers, journalists, and each other. Societies may consider ways to expand the number of stakeholders that they connect scientists with, leveraging emerging understandings about the benefits of different messengers for achieving different goals.

   Creating more and stronger connections throughout the ecosystem will also ensure that that valuable scientific content actually reaches its intended audiences and that scientists and non-scientists are able to engage directly with each other in productive ways. In some cases, this bridge-building may involve connecting scientists with various professional communicators who might have skills and connections that make them ideally suited for sharing various messages.

   How might societies facilitate stronger connections between various stakeholders so that information reaches as many people in a target audience as possible? One way of doing so might involve revising strategies for existing activities. For example:

   a. Social media: Given the widespread use of various social media platforms, societies' efforts in this area may present an untapped potential for sharing science with diverse audiences and for introducing public audiences to the scientists themselves.

   b. Communication contests: Many societies invite members to submit accessible and compelling science content, such as images, to various contests. This content can be leveraged to engage non-scientist audiences by demonstrating scientific progress or simply the beauty of scientific subjects and methods. In some cases, contest submissions are currently shared with various audiences, for example in galleries or museum exhibits, but in other cases, their reach beyond the scientific community is limited. Societies may consider new strategies for sharing their high-quality contest submissions with more audiences to

increase their impact.

c. Conferences: Conferences are a central activity for scientific societies. In many cases, conference programs have started to include civic science sessions, such as talks, panels, or workshops on effective communication or advocacy. While such programming likely provides important networking and learning opportunities for members, in turn equipping them to engage in civic science in the future, societies might explore whether their meetings might also be leveraged to support more impactful civic science efforts. This might take the form of outreach events or in-person advocacy opportunities, for example. While some societies already hold these kinds of events during their conferences, others expressed challenges in doing so effectively, suggesting that the group should work to determine best practices for connecting scientists and non-scientists at these events and scaling up those efforts that work.

The promising news is that a collective impact effort in this space has the potential to capitalize on societies' strengths, assets, and opportunities and mitigate their challenges. Collective impact approaches facilitate strategic and structured collaboration so that partners can make a greater impact on society than they would be able to do independently. For scientific societies, such an approach would involve the following:

1. **Develop a common agenda**: This is the foundation for a collective impact initiative. For the group of scientific societies, a common agenda will orient the group towards a shared understanding of the problems that organizations face in supporting civic science and a consensus about their ultimate goals and strategies for addressing the challenges. The common agenda includes a high-level vision, specific outcomes, strategies to achieve those outcomes, and principles to guide the work. The agenda should be developed collaboratively so that it is informed by diverse perspectives and experiences, with particular emphasis on including representatives from societies that range in size, disciplinary focus, and member backgrounds.

2. **Develop shared measurements**: Common metrics will be essential for ensuring that the collaborative efforts are in fact achieving their intended outcomes. To this end, the group will arrive at indicators for assessing progress and informing activities. The shared measurements will be used continuously so that strategies can be modified as necessary.

3. **Commit to mutually reinforcing activities**: The collaboration will not replace organizations' unique programs or activities but will instead guide the alignment of each society's efforts with the common agenda. This way, organizations can execute activities that help them meet their own goals and missions while continuing to advance overarching civic science priorities and directions.

4. **Engage in continuous communication**: Both in-person and electronic communications will help participants develop relationships that enable collaboration. Continuous communication will also help organizations learn from each other's experiences and coordinate their activities to ensure their actions are supportive of and build on others'.

5. **Leverage a strong backbone**: A “backbone” organization or individual can bolster and sustain the collective impact work by continuously guiding the group’s vision and strategy, supporting aligned activities, facilitating evaluation and adaptation, and mobilizing funding. A backbone should be impartial, working to advance the common agenda and facilitate the inclusion and participation of diverse organizations with varying capacities and assets for collaboration.

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References

American Academy of Arts and Sciences. (2019). Encountering Science in America. Cambridge, MA: American Academy of Arts and Sciences.

Besley, Dudo, & Yuan. (2017). Scientists' views about communication objectives. *Public Understanding of Science, 27*(6), DOI: 10.1177/0963662517728478.

Besley, J.C., Dudo, A., Yuan, S., & Lawrence, F. (2018). Understanding scientists' willingness to engage. *Science Communication, 40*(5), DOI: 10.1177/1075547018786561

Besley, J.C. & Nisbet, M. (2011). How scientists view the public, the media, and the political process. *Public Understanding of Science, 22*(6), DOI: 10.1177/0963662511418743.

Besley, J.C., Oh, S.H., & Nisbet, M. (2012). Predicting scientists' participation in public life. *Public Understanding of Science, 22*(8), DOI: 10.1177/0963662512459315.

Christopherson, E.G., Scheufele, D.A., & Smith, B. (2018). The Civic Science Imperative. *Stanford Social Innovation Review.*

Dudo, A. & Besley, J.C. (2016). Scientists' Prioritization of Communication Objectives for Public Engagement. *PLOS One, 11*(2), 2016: e0148867.

National Academies of Sciences, Engineering, and Medicine. (2017). Communicating Science Effectively: A Research Agenda. Washington, DC: The National Academies Press. https://doi.org/10.17226/23674.

Newman, T., Volpe, C., Lindenfeld, L., Besley, J., Dudo, A., & Leavey, N. (2019). Assessing Scientists' Willingness to Engage in Science Communication.

Nisbet & Markowitz. (2015). Public engagement research and major approaches. Washington, DC: American Association for the Advancement of Science.

Yuan, S., Dudo, A., & Besley, J. (2019): Scientific societies' support for public engagement: an interview study, *International Journal of Science Education, Part B*, DOI: 10.1080/21548455.2019.1576240.

Appendix: Societies' Profiles, Activities, and Priorities: Representative Information

The goal of the landscape assessment table (linked below) is to characterize a number of societies' civic science activities and to tie this information to other information about the organizations (such as their size, their staff infrastructure supporting the activities, and their missions and visions).

The first societies reviewed were those with members on the Society Civic Science steering committee (American Society for Cell Biology, Research!America, American Geophysical Union, and American Association for the Advancement of Science). Subsequent societies were selected as their staff members indicated interest in the initiative (multiple email lists of society staff contact information were merged to send a general interest email to as many potential participants as possible). I concluded after reviewing 29 societies because I had reached "saturation" — the point at which additional data no longer added clarity or variety to the categories included.

I collected all data first by scanning each organization's website. Following this scan, I conducted an informal interview with one or multiple staff members, when possible, to understand the context for the organization's activities and to patch gaps in the information available online.

Because this document is intended to provide a general snapshot of societies' civic science programs to help identify patterns, when information was not readily available online and the interviewee did not address a given aspect, I did not pursue it further. For this reason, there may be minor omissions or imperfect characterizations of societies' programs and activities. I did not have society staff review the information about their organization, as I did not feel such a review process would be a practical or productive use of staff members' time, given the intention that the document would serve as a general sketch of the relevant landscape.

Tab 1: Society Info
Includes information about the organization: the number of members, member demographics, staff size, operating budget, mission, vision, strategic goals, and staff and volunteer that support civic science programs.

Information in this tab can be used to provide context for the information in the subsequent tabs. For example, societies with larger staff sizes and operating budgets might have a greater number of civic science activities and programs or may have larger programs. In particular, information about an organization's staff and volunteer committees involved in their civic science work sheds light on the human infrastructure needed to execute the society's existing efforts.

Tab 2: Activities, Programs
Includes a description of society activities and programs related to civic science.

Categorization of activities:

- I based the highest level categories on distinctions made by Yuan, Dudo, & Besley (2019). *Scientific societies' support for public engagement: an interview study.* These included: a) societies' own practices, b) events initiated or organized by the society with members' involvement, and c) societies' support for individual members' engagement efforts, such as training, grants, or rewards. These categories are articulated in the top line.
- Within each high-level category, I determined more specific categories of activities as I reviewed the first few societies, adding a category when activities arose that did not fit in existing categories and collapsing them when necessary. These categories are articulated in the second line.

A key takeaway from this tab is that societies engage in a wide variety of civic science activities, yet there are also many commonalities between organizations' programs. As a result, there are a number of opportunities for societies to collaborate to streamline efforts and learn from others' experiences.

Tab 3: Missions, Visions, Priorities

Includes publicly-available information about organizations' high-level missions, vision statements, and strategic priorities. This information was categorized by top-level frames (whether they emphasize an end state or an action/activity), and within these frames, what specific goals they articulate. I arrived at meaningful categories after reading the relevant materials for a subset of societies.

A primary takeaway from this tab is that nearly all societies' missions, visions, and/or strategic priorities implicate civic science in some form. Although they vary in the level of specificity and the exact focus of the aim, this commonality will likely be beneficial for establishing a common agenda among societies looking to further their support of civic science.

View the table of representative organization profiles, activities, and priorities at https://docs.google.com/spreadsheets/d/120pR38dHp7fecOFAbUvEwFLbs2hX7HRQFPQUVmiKQIY/edit?usp=sharing.