DAVID D. HART AND LINDA SILKA

Rebuilding the IVORY TOWER

A Bottom-Up Experiment in Aligning Research With Societal Needs

Academic scientists can transcend publish-or-perish incentives to help produce real-world solutions. Here's how one group did it.

We were trained to do good science: to do our best to develop compelling research questions, to be unbiased about our data, skeptical about our conclusions, and open to criticism from our peers. We were also trained that good science was its own reward; that by pushing back the frontiers of knowledge, we were doing our part to make a better world. But as we progressed along our conventional academic pathways, we experienced a strong sense of cognitive dissonance: despite the production of more and better science, it often fell dramatically short of our hope to solve real-world problems and create a brighter future. Although we met other scientists who felt the same way, none of us knew how to chart a more productive path for doing science that makes a difference. So a group of us at our university set out on an adventure to see what we could do differently. Here's what we learned.

We recognized in the University of Maine (UMaine), our small land-grant university in a state that is large in area but small in population, a potential "model system" to implement and evaluate faculty-led strategies for aligning research with societal needs. Although Maine faces many important challenges that could benefit from strategically aligned research, we focused on the challenges of sustainable economic and community development within the state. Many communities in Maine have strong connections to forestry, fisheries, agriculture, and outdoor recreation sectors that are experiencing rapid and unpredictable economic, social, and environmental changes. Given the multifaceted and interconnected nature of these challenges, we sought to learn whether interdisciplinary research teams could help identify causes and consequences of sustainability problems and develop and evaluate potential solutions. Along the way, we received a $20 million, five-year grant from the National Science Foundation that led to the creation of a permanent home for these efforts in 2014—the Senator George J. Mitchell Center for Sustainability Solutions—whose vision is to "connect knowledge with action to create a brighter environmental, social and economic future in and beyond Maine."

Our alignment strategy would require the development of strong collaborations with diverse stakeholders from the public and private sectors, nongovernmental organizations (NGOs), and civil society, because of their many roles in identifying problems and developing solutions. Fortunately, Maine is characterized by dense social networks where university faculty often have close relationships with important partners. Even when they don't, they frequently know someone who can help build those connections.

Many communities in Maine have strong connections to forestry, fisheries, agriculture, and outdoor recreation sectors that are experiencing rapid and unpredictable economic, social, and environmental changes.

Inspired in part by Justice Lewis Brandeis's concept of states as laboratories of democracy, we used Maine as a laboratory for sustainability, seeking solutions to real-world problems locally and also identifying strategies by which universities anywhere can become more valued partners to society.

Given the varied disciplinary cultures and motivations—both personal and professional—of the faculty we sought to include, it was important to develop a shared vision for the work we wanted to do. During our informal strategic planning process, we invited ideas from all corners about ways to grow our research capacity, engage with stakeholders, and develop solutions to problems they faced. We benefited greatly from our interactions with members of the National Academy of Sciences whose expertise spanned the natural sciences, social sciences, and engineering. One member, Bob Kates, subsequently chaired our advisory board and served as an important mentor for sustainability issues. We also asked for advice from stakeholders representing local and state government, NGOs, and the private sector. For instance, we were fortunate to receive guidance from Angus King after he served for two terms as Maine's governor but before he represented Maine in the US Senate. During a planning meeting with former governor King, we gained confidence about the potential value of our nascent initiative when King became so animated by our core commitment to stakeholders and solutions that he exclaimed, "I just wish you'd been around when I was governor!"

What motivates faculty?

Our desire to develop a faculty-led strategy derived in large part from the hope that this solutions-focused research ethos would become self-sustaining once faculty gained experience with its intellectual and personal rewards. We knew from the outset that sustainability challenges—the epitome of "wicked problems" that cannot be easily defined, let alone solved—often require a collaborative commitment that spans many decades and multiple generations of academic researchers. We sought to understand and connect with the long-term motivations of faculty, individually and collectively.

At an early meeting exploring faculty interest in an initiative of this type, some faculty in the natural sciences, who were among UMaine's most accomplished researchers, expressed concern and frustration about the lack of real-world impact of their research. They shared stories of having conducted detailed biophysical investigations of issues such as wetland loss or impacts of nonpoint-source pollution, and lamented that their research was not being used to solve the problems. They wanted to understand why their past efforts fell short and how we could develop alternative strategies for increasing the chances that their research would inform policies and practices. Social sciences faculty, in contrast, understood the important lessons that fields such as economics, psychology, and political science could provide for changing individual and institutional behaviors, yet we quickly learned that some felt they were left on the sidelines or asked to play only token roles during the development of new research initiatives. So it turned out that social scientists as well as natural scientists had keen interest in a project aimed at bringing together their expertise and forming bonds with individuals and groups outside academia to solve local problems.

In our efforts to develop a systems model that could guide our work, we emerged with two fundamental commitments that have shaped our approach: 1) In addition to the traditional focus on the biophysical components underpinning a problem, a much greater emphasis is needed on the human dimensions, including the complex interactions between society and nature; and 2) productive collaborations must be built between the university and diverse stakeholders to develop a sufficient understanding of sustainability problems and viable strategies for solving them.

One conceptual framework that strongly influenced our thinking came from a team of environmental policy scholars who proposed in an influential 2003 paper titled "Knowledge Systems for Sustainable Development" that three core concepts—salience, credibility, and legitimacy—play key roles in strengthening connections between scientific knowledge and societal actions. These concepts emphasize the importance of addressing questions that have direct relevance to stakeholders, of ensuring the validity of the research results, and of giving stakeholders with different interests a seat at the table in shaping decision-making processes. With an eye on salience and legitimacy, we worked hard to establish productive relationships with people already working to solve the problems, based on open communication, mutual respect, and trust.

In uncharted waters

Because we sensed we were entering uncharted waters for both researchers and research universities, we began by creating low-risk opportunities for teams to develop and practice these approaches. Initially, we used internal funds to provide small grants for short-duration pilot projects. We have now funded more than 50 such projects. Common evaluation criteria in the ever-evolving review process

include a focus on solutions rather than just knowledge production, a commitment to collaborating with stakeholders outside the university, and the development of interdisciplinary teams whose expertise matches some of the key economic, sociocultural, and environmental dimensions of the sustainability problem being examined.

These projects have addressed sustainability challenges that arise in many different contexts, including municipal planning, water resources, forestry, food systems, fisheries, materials management, renewable energy, and climate adaptation. Some of our colleagues felt that stakeholder needs and concerns had a disproportionate influence on our research. For instance, one faculty member vented: "If we wanted to do research that is responsive to stakeholders, we would have become consultants!" But others began to be convinced. In a project focused on the vulnerability of lakes to algal blooms and other water quality problems, the environmental engineer Aria Amirbahman was initially skeptical about the value of incorporating a social science perspective in the work. As he put it, "Social science, and its key role as an essential ingredient in sustainability science, are anything *but* what I was trained in, which is why it was a struggle for me and took some time to be convinced. However, as I slowly learned more about the approach, I began to think that it represented a powerful way to marry the biophysical and social sciences."

Productive collaborations must be built between the university and diverse stakeholders to develop a sufficient understanding of sustainability problems and viable strategies for solving them.

Another early convert was the conservation biologist Aram Calhoun. She had worked for more than two decades to develop biological criteria for conserving vernal pools, seasonal pools of water that provide habitat for distinctive plants and animals, and she became increasingly concerned about threats posed by land use change. She was an early adopter of collaborations with both social scientists and diverse stakeholders (including development interests, state and federal resource agencies, municipal planners, and conservation organizations) that have led to innovative policies embraced by all parties. Similarly, although the fisheries biologist Gayle Zydlewski had no prior experience working with social scientists ("I worked on fish so I *wouldn't* have to deal with people"), she helped lead a collaboration with social scientists and stakeholders to assess the potential for tidal energy development. She now says she not only gained a deeper understanding of the concerns of commercial fishers from the social science research conducted aboard fishing vessels but also benefited from the local knowledge fishers had of the species she was studying. "I'm still studying fish," says Zydlewski, who now leads Maine Sea Grant, "but the work also focuses on how that intersects with what people are doing and what matters to coastal communities."

In anticipation of challenges related to interdisciplinary teamwork and researcher-stakeholder collaboration, we established a parallel effort dubbed "research on the research." In essence, we made a commitment to identifying best practices for interdisciplinarity and stakeholder engagement. We also saw this as an opportunity to develop our research capacity for understanding and improving such practices. Many different kinds of UMaine researchers have participated, including experts in business, higher education, social psychology, communication, and economics. Using a variety of methods, such as ethnographic research, surveys, and experiments, these researchers have simultaneously used our projects as a laboratory for advancing knowledge of organizational innovation practices, and served as internal consultants and coaches to our teams.

After more than a decade of work, what have we learned?

Tap into deep aspirations

Research faculty are motivated by many considerations, including fascination with their subject matter, external recognition, financial reward, and opportunities to teach and mentor students. For many of the faculty with whom we worked, however, there was another, deeper motivation linked to their desire to "make a difference," "make science matter," contribute to something "larger than themselves," and "create a brighter future." For some (especially younger) faculty, this desire was one of the reasons they decided to pursue a career in academia. Early on, many participating faculty found that one overarching way to express this aspiration was to speak about our collective desire to strengthen connections between knowledge and action.

"This work is extremely meaningful for me," Amirbahman, the environmental engineer, says. "In academia, your papers are often read by just a handful of other people in the field. But if through our science we can make a societal change, even if it's incremental—a change in attitude or policy—I think that would be a huge contribution."

After the first year of our planning process, we were surprised to discover how strong this ethos had

become. We entered a statewide competition managed by the University of Maine System to identify the most promising concept for a novel research initiative that would then be eligible to apply for the $20 million, five-year NSF grant that allowed us to create the Mitchell Center. More than 10 teams entered the competition, and colleagues advised us that our proposal, which integrated both theoretical and solutions-oriented approaches to sustainability challenges, would have a greater chance of being selected if we dropped our focus on solutions. When we discussed this advice during a critical meeting of the 15-member interdisciplinary team that led the development of our proposal, the most common response was: "It was never about the money, it was always about 'linking knowledge with action.' "

Create a shared culture

When institutions such as government, business, and NGOs seek to foster a commitment to coordination and collaboration, they attempt to create a shared culture—the development of beliefs and values held in common that are supported by the organization's strategy and structure. The idea of creating a shared culture within a highly decentralized institution such as a university might seem like a Sisyphean quest. Although many universities have a shared commitment to research, teaching, and service, this may not be sufficient to bring people together for sustained collaborations. Academics also tend to share a commitment to excellence, but this doesn't offer any guidance for why and where to deploy such excellence.

Despite an intensive review of the literature, we found no comprehensive and authoritative field guides to this type of work.

At the outset of our work, we recognized the ways in which a set of shared core values could serve as a North Star guiding our work. In August 2008, even before we were awarded our first major grant, a diverse group of faculty developed a statement of core values that remains highly relevant to our efforts. We were inspired by some mission-driven NGOs whose work is fueled by a deep passion to create a better world. But we also knew that universities are very different from NGOs, and that it would be unrealistic to expect all the research participants to share this set of values. Thus, we used them more implicitly than explicitly. We hoped that as more faculty joined our projects, they might organically develop their own understanding and commitment to these values, rather than feeling that they were a prerequisite for participation.

We want to be clear that these values need not be shared by every faculty member at an institution. Some researchers expressed concern that we wanted all faculty to become involved in stakeholder-engaged, solutions-driven, interdisciplinary research. To reassure those with different priorities, we often quoted our colleague Dave Secord, who led an interdisciplinary program at the University of Washington: "We're not trying to change the whole university; we're just trying to create more room within the university for this kind of work."

Learn by doing

For nearly all participating faculty, there were components of the collaborative research program that felt uncertain and risky. Despite an intensive review of the literature, we found no comprehensive and authoritative field guides to this type of work. Indeed, at the first meeting of the science advisory board that oversaw the major grant that funded the effort, one board member suggested that the work would feel a lot like jazz—it would require improvisation.

We decided to embrace this view wholeheartedly. Whether a project was supported by internal seed funding or a major external grant, we framed it as a pilot study because these are intrinsically about learning by doing. Teams were asked to report on their progress annually or more frequently and propose midcourse corrections. Rather than expect teams to achieve high marks in every facet of their work, we tried to create an atmosphere of learning from mistakes as much as from successes. In this, we are inspired by the civil engineer Henry Petroski, who, when writing about the role of failure in the design of bridges and other infrastructure, said that "no one wants to learn from mistakes, but we cannot learn enough from successes to go beyond the state of the art."

As an example of where a mistake paid off, one collaboration with tribal communities focused on potential barriers limiting the role of basket-making in strengthening the economic and cultural well-being of tribes. This project was co-led by Darren Ranco, a member of the Penobscot Nation and a UMaine anthropologist. Because of his close, long-term relationships with basket-makers, he believed he understood one of their biggest concerns—the limited availability of, and access to, basket-quality brown ash trees. In early planning for this project, he was surprised to learn that they were far more alarmed not by current scarcity of basket-quality trees, but by the threat posed by the anticipated arrival of an invasive forest insect pest, the emerald ash borer, that had destroyed millions of ash trees in other regions. As

the project took this entomological turn, Ranco adjusted course, recruited other experts to join the team, and co-leads the project to the present day.

Committing to learning by doing—which means learning from mistakes, not just successes—poses challenges to a risk-averse culture such as academia. We faced this in our first year when we sought the advice from several members of the National Academy of Sciences. Despite representing different fields and backgrounds, all recommended that untenured faculty members not participate in our initiative. They felt the risks to such junior faculty during the tenure review process would be too high, and warned that participation in a solutions-oriented interdisciplinary project focused on community stakeholders would adversely affect their publication rate, evaluation by disciplinary peers, and other traditional criteria in tenure review processes.

We took their advice seriously, but faced a major dilemma: many junior faculty wanted to join our initiative. Should we tell them to stick to the traditional path of establishing their credibility via disciplinary research and publications—often more basic research—which might require that they put on hold for five to 10 years their desire to do research that addresses real-world problems?

We ultimately decided to support these faculty, while seeking to ensure that they understood the potential risks. We also committed ourselves to share in the responsibility for managing such risks. Among other things, this meant educating members of peer committees, external reviewers, department chairs, deans, and other senior administrators about the importance of this innovative research, as well as about the important contributions made by the faculty member being evaluated. Nonetheless, the internal or external components of the peer-review process sometimes failed to fully value these faculty's work. Fortunately, performance was generally judged to be high for many of the criteria used to evaluate faculty at our land-grant university. Indeed, all junior faculty who have participated in our research initiative have subsequently been promoted with tenure.

Be prepared for conflict

Efforts to build teams of faculty with different expertise, disciplinary cultures, and reward systems often result in some form of conflict. The potential for conflict rises even higher when these teams strive to align their research with the needs and concerns of stakeholders, who themselves may have disparate goals, norms, and preferences.

Although conflict is nearly impossible to eliminate, its frequency and potential damage can be reduced by the establishment of shared norms and proactive practices. Of course, institutions of higher education are no strangers to managing conflict; for example, most universities now have personnel who help resolve conflicts arising between students or between students and faculty. Many of the same approaches are applicable to conflicts that arise in interdisciplinary research and researcher-stakeholder partnerships.

In our experience, however, conflict should be approached differently when aligning research with societal needs. First, research teams should assume they will encounter conflict and should establish a set of shared commitments and practices to address it. In one of our recent projects—a four-year, $6 million NSF grant with over 20 faculty and 40 students from six research institutions—a diverse leadership team that was representative of all the researchers developed a governance document that articulated a collective obligation to treat all team members and community stakeholders with respect and included specific steps for resolving conflicts. All members of the project team agreed to abide by these guidelines.

In addition, because communication—and miscommunication—plays such a central role in both generating and resolving conflicts, we purposely expanded our internal capacity for developing effective communication processes. Many of our projects have included communication faculty with expertise in the theory and practice of conflict resolution as well as faculty with formal training or considerable on-the-job experience in diagnosing and resolving conflicts. Rather than viewing conflict as someone else's problem to solve, we consider conflict resolution a collective responsibility.

In fact, conflict, whether among researchers or between researchers and stakeholders, can be a valuable resource when harnessed effectively. The very differences—in expertise, values, and preferences—that generate conflict can serve as raw material in crafting new ways of understanding and solving societal problems. We have experienced this many times, including during a project focused on threats to coastal shellfisheries from polluted runoff. In the initial problem scoping, clammers, state managers, and shellfish industry leaders told researchers that they were not focusing on the sites that matter the most. On more than one occasion, this perspective was communicated to the research team with a fair degree of frustration. Rather than ignore the need to change sites, the environmental communication researcher Bridie McGreavy and her colleagues made concerted efforts to reach out and explore options. In one case, team members drove several hours to meet with a clammer, explore the site of interest, listen to his concerns, and figure out a plan to link water quality science with the watershed planning efforts in that region. By connecting the local knowledge and values of a range of partners with complementary

expertise of university researchers, the project is going strong six years later, and has become a model for similar shellfishing collaborations along Maine's more than 3,000 miles of coastline.

Turn the microscope on yourself

When we embarked on this journey, we understood that there was no surefire formula for aligning research with societal needs. Instead, we anticipated that we would need to develop and evaluate the effectiveness of different strategies for different problems and contexts. It is in this sense that we viewed our work as an institutional experiment.

Of course, the concept of experimentation raises the question of how to ensure that experiments yield reliable inferences. For us, this often meant trying to identify the factors that facilitate or hinder efforts to link scientific knowledge with societal actions, or that influence the effectiveness of interdisciplinary collaboration. Our research was tempered by the expectation that these results would be context-dependent, and we sought to understand the limits to their wider application.

As we puzzled over where to find experts who could help us, we discovered they were frequently hiding in plain sight—in another building right across campus. We found faculty with expertise in such diverse fields as management, psychology, and communication who were eager to use our stakeholder-engaged, interdisciplinary research projects as their own laboratory for strengthening the theory and practice of organizational effectiveness. They were able to put their own conceptual frameworks and methods into practice to help us develop a road map for organizational and institutional transformation.

But beware: when you turn the microscope on yourself, what comes into focus includes warts and all. For instance, this approach—which we sometimes referred to as organizational innovation research—is likely to identify strategic or tactical mistakes as well as disgruntled researchers or stakeholders. Because we were deeply committed to improving our practices, however, we believed in the value of examining our flaws.

As one example, our NSF-funded $20 million megaproject, which comprised subprojects focused on climate and energy challenges, forest management, and urbanization, included an organizational innovation research team with expertise in social psychology, organizational behavior, and other disciplines. This team observed wide variations in satisfaction of project faculty—including significant dissatisfaction among some. To investigate the possible causes, the team quantified not only level of satisfaction but also tolerance of ambiguity, a psychological construct characterizing an individual's need for certainty—his or her preference for the familiar over the unfamiliar. The result: faculty with a low tolerance for ambiguity were less satisfied with the project. But rather than concluding that these faculty were poorly suited to the initiative, we made a number of organizational changes, such as providing faculty with more input into more transparent decision-making processes. This helped. Although faculty sometimes joke that they're living in a fishbowl, this kind of research has helped strengthen our teams' capacity for collaboration, which in turn enhances the real-world impact of our work.

Persevere

We expected at the outset of this work to encounter many obstacles, but we underestimated how challenging it would turn out to be. Although we don't know what lies ahead, it is very unlikely that we can count on smooth sailing. In these uncertain seas, a spirit of perseverance is one of our most valuable resources.

This spirit leads us to view our work as a long-term endeavor. After all, most sustainability problems have been a long time in the making, and they will take a long time to solve (or, more realistically for the wicked problems that they are, to effectively manage). In our experience, stakeholders can become perplexed and frustrated when research partnerships dissolve, which often reduces their willingness to engage in future collaborations. So a level of stick-to-itiveness can go a long way toward building strong relationships with stakeholders. Our tidal energy project is in a remote region of Maine, so when researchers first showed up, they were noticed. Some residents expressed doubts about the team's commitment, citing a previous "collaborative" project in which the researchers came and went all too quickly, primarily interested in getting data for their own goals. For our project, however, one resident recently told the social scientist Jessica Jansujwicz how much the community appreciated that the tidal energy collaboration is still going after 10 years.

The spirit of perseverance serves our faculty members too. When partnerships are linked to the deeper passions and motivations of faculty, these researchers often find creative ways to maintain their internal and external collaborations despite scarce funding, changing institutional priorities, and shifting political winds.

Although many of the faculty who helped launch our initiative have retired or moved to other institutions, an even larger and more diverse group of younger faculty has taken their place. Several factors have likely contributed to this positive trajectory. For example, many more academic units at UMaine are recruiting faculty with skills in interdisciplinary research and stakeholder

collaboration. This trend may be due in part to the success of our initial projects in attracting significant funding, recruiting outstanding graduate students, and delivering real-world solutions. There has also been a campus-wide effort to create opportunities for early-career faculty to gain research experience on large interdisciplinary collaborations with stakeholders and to ensure that they receive recognition inside and outside UMaine for their important work.

We have launched a seed grant program that allows faculty with minimal experience with interdisciplinary teams to hone their skills, and many of them have developed full-fledged programs and competed successfully for major grants. And as newly hired faculty arrive at UMaine, we strive to learn about their expertise and interests, make them aware of our programs, and explore ways they can participate. Taken together, these efforts are not just increasing our numbers; they are cultivating a new generation of research leaders.

Rising to the challenges

To underscore the importance of sustainability collaborations, the Mitchell Center sponsors an annual awards celebration recognizing outstanding research teams and community partners. The center also organizes and hosts an annual statewide sustainability conference that draws over 400 participants from higher education, government, the private sector, and NGOs. The annual Mitchell Lecture on Sustainability, one of the university's premier events, has included lectures by such leading scientists as Elinor Ostrom, the late Nobel Prize-winning political economist, and marine ecologist Jane Lubchenco, former head of the National Oceanic and Atmospheric Administration. The Mitchell Lecture demonstrates the importance of sustainability research to the university community and connects students and faculty with intellectual leaders and exemplars.

Whether the call comes from outside or inside the academy, there is a growing need for universities to mobilize their unique and diverse capacities to address complex societal challenges. Although the impetus and vision for the necessary institutional change usually comes from senior leaders, we have found that the deep-rooted desire of many faculty to use their expertise to make a difference in the world outside academe is a potent, complementary force for aligning university research with societal needs. Indeed, the potential for lasting impact is much greater if we use both bottom-up and top-down strategies to help universities become more useful partners to society.

After more than a decade of university-wide efforts—including experimenting with different strategies and analyzing their organizational consequences—we have learned valuable lessons from which others can benefit. Above all, we have learned that at a time when universities are under stress from many directions, institutional change that benefits universities and the communities that surround them is both possible and exhilarating. Of course, it's also really hard work, which is why we have emphasized here the crucial contributions of research teams, partners, and funders to our collective progress. And although no single recipe will work in all contexts, it is our hope that the ingredients we've identified may prove useful to other universities in their own quests to help solve society's greatest problems.

***David D. Hart** is the director of the Senator George J. Mitchell Center for Sustainability Solutions and a professor in the School of Biology and Ecology at the University of Maine. **Linda Silka** is a senior fellow in the Mitchell Center and the former director of the Margaret Chase Smith Policy Center at the University of Maine.*

Recommended reading

Rebekah R. Brown, Ana Deletic, and Tony H. F. Wong, "Interdisciplinarity: How to catalyse collaboration," *Nature News* 525, no. 7569 (2015): 315–318.

David W. Cash, William C. Clark, Frank Alcock, Nancy M. Dickson, Noelle Eckley, David H. Guston, Jill Jäger, and Ronald B. Mitchell, "Knowledge systems for sustainable development," *Proceedings of the National Academy of Sciences* 100, no. 14 (2003): 8086–8091.

William C. Clark, Lorrae van Kerkhoff, Louis Lebel, and Gilberto C. Gallopin, "Crafting usable knowledge for sustainable development," *Proceedings of the National Academy of Sciences* 113, no. 17 (2016): 4570–4578.

I. J. Gordon, K. Bawa, G. Bammer, C. Boone, J. Dunne, D. Hart, J. Hellmann, A. Miller, M. New, J. Ometto, S. Pickett, G. Wendorf, A. Agrawal, P. Bertsch, C. D. Campbell, P. Dodd, A Janetos, H. Mallee, and K. Taylor, "Forging future organizational leaders for sustainability science," *Nature Sustainability* 2, no. 8 (2019): 647–649.

"The best research is produced when researchers and communities work together," *Nature* 562, no. 7 (2018): 7.

David D. Hart, Kathleen P. Bell, Laura A. Lindenfeld, Shaleen Jain, Teresa R. Johnson, Darren Ranco, and Brian McGill, "Strengthening the role of universities in addressing sustainability challenges: the Mitchell Center for Sustainability Solutions as an institutional experiment," *Ecology and Society* 20, no. 2 (2015): 4.

Jane Lubchenco, "Delivering on Science's Social Contract," *Michigan Journal of Sustainability* 5, no. 1 (2017): 95–108.

Senator George J. Mitchell Center for Sustainability Solutions website: https://umaine.edu/mitchellcenter/road-to-solutions/