

Enhancing Chesapeake Bay Partnership Activities by Integrating Social Science

Final Report

Authors

Lisa Wainger, Daniel Read, and Erika Blair

University of Maryland Center for Environmental Science

Chesapeake Biological Laboratory

Project Managers

Amy Handen, US EPA Region III, Chesapeake Bay Program Office

Kacey Wetzel, Chesapeake Bay Trust

February 7, 2023

Deliverable #7 under contract to Chesapeake Bay Trust, SOW#2

University of Maryland, CES # 07-4-35015



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Enhancing Chesapeake Bay Partnership Activities by Integrating Social Science

1 Executive Summary

This report presents results of an initial investigation into the state of social science integration within the Chesapeake Bay Partnership (CBP). The purpose of the study, which was requested by the Stewardship Working Group, was to identify opportunities where the practice of social science could be enhanced to advance goals and adaptively manage ongoing CBP efforts. This document summarizes recommendations for advancing *social science integration*, or the use of knowledge from multiple social science disciplines to develop or adapt methods, to address the Watershed Agreement goals. Our recommendations cover ideas for prioritizing interdisciplinary research, supporting social science application, and strategically applying social science within and across institutions.

1.1 Objectives and Methods

Some specific objectives within this project were to evaluate the current use of and attitudes toward social science among current CBP partners, increase understanding of social science theories and methods, and advance a dialogue about strategies to enhance social science capacity at CBP. While many partners desired simple and replicable advice for practitioners on how to advance behavior change efforts or for managers seeking to advance specific policies, the effectiveness of doing so is unclear. As a result, our recommendations take the form of steps to build social science capacity that could result in skilled and specific advice for designing and implementing programs and promoting continued learning on how to use social science in adaptive management.

We used a multi-method approach to evaluate the current state, and opportunities for further application, of social science at CBP, with a particular focus on behavioral social science. We combined several distinct literature reviews, a questionnaire to partners, and interviews with social and biophysical scientists (Appendix A). Project advisors Amy Handen (CBPO) and Kacey Wetzel (Chesapeake Bay Trust), and an advisory board consisting of some of the most interested partners across agencies and position types (managers, scientists, practitioners) have helped establish some of the objectives and methods. We supplemented the recommendations that emerged from our investigation with those from groups that have advised programs similar to the CBP on social science integration, to bring in more diverse perspectives.

1.2 Summary of Recommendations

We identified four major themes in our findings that we used to create four major sets of recommendations (Table ES-1) to enhance social science integration. The recommendations are divided into easier and harder approaches.

1.2.1 Build social science literacy and capacity

Our first main finding was that many CBP members, across all levels of the organization, are interested in seeing social science research applied to forward the goals of the Watershed Agreement. However, their understanding of how social science can do so is incomplete. Our questionnaire and interviews revealed that the majority of partnership respondents see social science primarily in terms of promoting public behavior change to advance existing goals. This perspective differed from that of the social science respondents who saw their diverse disciplines as tools to systematically evaluate individual, business, and institutional incentives and behaviors. They noted many opportunities to apply such understanding to adaptively manage the partnership efforts and enhance effectiveness.

To generate the internal knowledge needed to effectively apply social science, we recommend building social science capacity by educating existing personnel and adding social scientists as employees and program advisors. An initial step towards this goal would be to increase communication within the partnership through seminars, web pages and workshops that promote learning about potential social science applications. For example, case studies can be deconstructed to introduce and evaluate different social science theories and methods, ways they can be adapted to CBP contexts, and opportunities or barriers to using them. A more substantial investment would be to hire social scientists and engage external advisors who can develop deep understanding of institutional missions, provide advice to managers, and promote continuous informal learning among interdisciplinary teams.

1.2.2 Enhance the practice of behavioral social science

Our second main finding was that researchers and practitioners can enhance CBP's past investments in behavior change interventions by building more directly on the evidence base and by better measuring the performance of those efforts. Behavioral interventions are approaches used to encourage a beneficial behavior change in a particular community or organization by anticipating and counteracting known decision-making biases (see Section 1.2). These interventions have been designed around specific psychological theories of what motivates change and applying those theories provides a guide of which methods to use. Yet, no simple behavioral recipes have been found to have consistently strong effects across research case studies.

Of the past interventions for the CBP, we did not find strong evidence that interventions were grounded in particular behavioral theories and the majority of studies (59%) did not measure whether their interventions were successful. Also, some interventions that have relatively high success rates in the literature have not been applied through CBP funded work, namely, descriptive norms and defaults (defined in Section 3.2.1). Identifying a specific social science theory of what motivates behavior change can help researchers build on the existing evidence and make sense of their results, positive or negative. Further, the lack of measures of success, prevents shared learning across case studies.

Increasing future effectiveness depends on recognizing every behavioral intervention as an opportunity to build the evidence base of what works in terms of changing behavior and achieving restoration goals. Much can be learned by systematically testing approaches across contexts in which important variables, such as the community's trust in practitioners or the difficulty of the desired behavior change, vary. Also, the audiences for behavioral interventions could be better prioritized by examining the potential magnitude of environmental improvement, should the intervention be successful. The majority of past interventions conducted through CBP have aimed to change homeowners/community members'

behavior around residential stormwater and pet waste. Whereas, impact might be increased by expanding the limited work with policy actors¹ or businesses, if larger effect sizes are anticipated.

1.2.3 Use social science in adaptive management in programs and institutions

Our third main finding was that social science appears to be underused in aspects of adaptive management, where it could be invaluable in improving effectiveness. The potential uses of social science were widely recognized by questionnaire respondents. For example, partnership members described how social science could be used to adaptively manage efforts to understand why certain engagement and institutional practices did not yield desired results by engaging communities from a perspective of receptiveness and empathy (i.e., groundwork). Importantly, some suggested that social science could be used to rectify differences between manager's assumptions about why progress was lacking and the explanations offered by community members. Respondents further described how a lack of resources dedicated to social science hindered their ability to act on ideas.

The absence of resources was one of many institutional issues raised about how the partnership could function more effectively. Insufficient capacity and inappropriate incentives were seen to be hindering progress on some goals, particularly as part of the Strategy Review System (SRS). Many questionnaire and interview respondents felt that the Management Board did not have the capacity or motivation to respond to all the GIT requests, despite GIT teams having a charge to forward diverse goals.

We recommend identifying and investing in social science for high priority and lagging watershed agreement goals. At the programmatic level, co-design processes, in which communities are given opportunities to identify shared goals with environmental managers and meaningfully contribute to the design and implementation of solutions, were seen as key to moving some goals forward, particularly under topics of agricultural management and diversity, equity, and inclusion. At the institutional level, institutional and policy sciences have obvious applications to remove identified barriers to effective partnership functioning, such as concerns with the SRS or lack of attention to goals other than those related to nutrient and sediment runoff. Institutional investigations could reveal reasons for lack of effective response across partners and identify alternative methods of meeting partner needs.

1.2.4 Be strategic in applying social science

Our fourth main finding was that social scientists and managers were concerned that social science was not being applied where it could have the greatest overall impact. They said that resources for social science were spread too thinly across many goals and that some easy-to-address issues were getting repeated attention at the expense of more fundamental, but difficult, problems. They also identified how available resources were inadequate for applying social science in a useful way. A common example was insufficient time and experienced personnel to conduct the kind of intensive place-based work that tends to advance understanding of communities' needs and help to identify potential collaborative solutions.

To remedy these concerns, we recommend creating a detailed strategic plan for social science funding and resource allocation. Developing this strategic document would be an opportunity to engage all

¹ Policy actors are defined as any individual or group that is directly or indirectly, formally or informally, affiliated with the policy process at any stage, from conception to implementation. They include individuals or groups in governments, businesses, NGOs, civic organizations and communities.

partner agencies in finding common goals and complementary capabilities, including identifying social scientists with appropriate expertise. Experience from other government agencies, such as the National Institutes of Health, suggests that a strategic plan is only the beginning of effective interdisciplinary implementation and that organizational structures must be adapted to implement the plan. Finally, the strategic plan must be regularly updated, as partners build experience.

In summary, the findings and recommendations (Table ES-1) suggest that CBP can enhance its social science integration by increasing opportunities to learn about social science, building social science capacity, and enhancing the use of existing science and expertise. We provide some relatively easy steps to address some initial partner concerns with existing programs (shown in blue). The harder to implement recommendations (shown in yellow) might be prioritized during strategic plan development. Many partners' concerns would be resolved by a planning process that sets priorities, allocates internal resources, and develops partnerships and diverse funding sources to increase social science capacity. We further note that many of the recommendations will not be advanced without engaging practical and skilled social scientists who can navigate the sometimes subtle details of project and program design that largely determine the effectiveness of social science development and application.

The conclusion of our many findings is that the partnership is well-positioned to incorporate social science effectively into decision making, if it is willing to make some investments. Partners recognize the need for social science and have useful suggestions for prioritizing new social science investments to meet diverse goals. The partnership also has the potential to broadly advance the application of social science by tracking the performance of its efforts, in order to understand which techniques are most effective and under which circumstances.

Table ES-1. Summary of Findings and Recommendations

MAIN FINDINGS	EASIER RECOMMENDATIONS	HARDER RECOMMENDATIONS
<p>1. Broad support for, but incomplete understanding of, social science (Section 3.1)</p>	<p>Build social science literacy and capacity</p>	
	<ul style="list-style-type: none"> - Share knowledge through webinars, short courses, and workshops 	<ul style="list-style-type: none"> - Build capacity by investing in internal social scientist positions - Develop a community of practice to support internal social scientists
<p>2. Uneven use of behavioral social science evidence and performance tracking (Section 3.2)</p>	<p>Enhance the practice of behavioral social science</p>	
	<ul style="list-style-type: none"> - Continue to fund projects that apply and test theory - Evaluate opportunities to apply promising but unused techniques of descriptive norms and defaults - Expand interventions beyond homeowners to include more business owners and policy actors - Design interventions as experiments 	<ul style="list-style-type: none"> - Develop funding sources with partners for rigorous behavioral intervention or natural experiments that increase the evidence base
<p>3. Underuse of social science knowledge as part of adaptive management (Section 3.3)</p>	<p>Use social science in adaptive management of programs and institutions</p>	
	<ul style="list-style-type: none"> - Conduct social science groundwork to understand why goals are lagging - Co-design and implement solutions to lagging goals with communities - Identify or conduct research to anticipate socio-demographic and behavioral changes that are likely to affect CBP’s future work 	<ul style="list-style-type: none"> - Apply institutional science to identify opportunities to improve partnership function - Adapt institutional rules and processes where barriers have been identified - Apply decision science / social science to identify potential blind spots in how institutions anticipate and prepare for future risks
<p>4. Lack of support and strategic planning for social science application (Section 3.4)</p>	<p>Be strategic in applying social science</p>	
	<ul style="list-style-type: none"> - Develop a strategic plan to enhance the impact of social science - Create an organizational structure to implement the strategic plan 	<ul style="list-style-type: none"> - Develop internal resources for social science research on the partnership (e.g., databases) - Create a process to periodically update and adapt the social science strategic plan

Table of Contents

1	Executive Summary	i
1.1	Objectives and Methods	i
1.2	Summary of Recommendations	i
1.2.1	Build social science literacy and capacity	ii
1.2.2	Enhance the practice of behavioral social science	ii
1.2.3	Use social science in adaptive management in programs and institutions	iii
1.2.4	Be strategic in applying social science	iii
2	Background	1
2.1	Objectives	1
2.2	What are Social and Behavioral Sciences?	2
2.2.1	How does social science advance partnership goals?	3
2.2.2	Some social science theory supporting pro-environmental behavior change	5
3	Methods Summary	8
4	Results and Recommendations	10
4.1	FINDING 1: Broad support for, but incomplete understanding of, social science	10
4.1.1	RECOMMENDATION 1: Build social science literacy and capacity	14
4.2	FINDING 2: Uneven use of behavioral social science evidence and performance tracking	15
4.2.1	Effective interventions are underutilized	15
4.2.2	Narrow audience focus	19
4.2.3	Few efforts to measure success	21
4.2.4	RECOMMENDATION 2: Enhance the practice of behavioral social science	23
4.3	FINDING 3: Underuse of social science knowledge as part of adaptive management	25
4.3.1	Adaptive Management at Programmatic Level: Groundwork and co-design	26
4.3.2	Adaptive Management at the Institutional Level: Incentives and Networks	27
4.3.3	Need for anticipatory adaptive management	29
4.3.4	RECOMMENDATION 3: Use social science in adaptive management in programs and institutions	30
4.4	FINDING 4: Lack of strategic planning for social science integration	32
4.4.1	RECOMMENDATION 4: Be strategic in applying social science	35
5	Conclusions	37
6	Acknowledgements	37

7	References.....	37
A	Appendix A. Detailed Methods Description.....	A-1
B	Appendix B. Literature Review Results.....	B-1
C	Appendix C. Questionnaire Results	C-1
D	Appendix D: Semi-structured interview guide	D-1

Tables

Table 1. Behavioral Intervention Categories and Strategies by G-ITM framework components.....	7
Table 2. Summary of research methods	9
Table 3. Summary of recommendations and rationale for building social science literacy	14
Table 4. Audiences of past behavior change interventions by CBP partners, multi-coded.....	20
Table 5: Summary of recommendations and rationale for enhancing the rigor and diversity of social sciences	23
Table 6. Some co-design details that have been investigated (from Moser 2016)	27
Table 7: Summary of recommendations and rationale for using social science in adaptive management.....	30
Table 8: Summary of recommendations and rationale supporting strategic application of social science.....	35

Figures

Figure 1. Example research questions and methods used by social science disciplines regarding farmers' adoption of management practices.....	3
Figure 2. The G-ITM model as a workflow leading to behavior change	6
Figure 3. Perceived importance of social science to Chesapeake Bay restoration among respondents by CBP role.....	11
Figure 4. Respondent perceptions about the importance of social science to achieving the goals shown, by experience with social science	13
Figure 5. Metrics of success in past CBP Motivation interventions (multi-coded).....	16
Figure 6. Metrics of success by ITM component for past CBP behavioral interventions (single-coded) ...	21
Figure 7. Significant effects by intervention type among reviewed policy actor behavioral experiment (single-coded)	22
Figure 8. Questionnaire results for the question: Indicate the extent to which your experience with social science achieved its intended goal, from Not at all (1) to Completely (5)	23
Figure 9. Degree of spillover benefits to organizations from being a CBP partner by partner type	28
Figure 10. Respondent time availability to engage with CBP by host organization	33
Figure 11. Reasons for not working with social scientists for respondents who had not worked with social science (N = 70).....	33
Figure 12. Respondents capacity to innovate at CBP by role	34

2 Background

“Anything having to do with stewardship, engagement, or education is inherently about social science. But so is wetland restoration, in which a lot of the lack of progress is due to a lack of success with understanding private shoreline owners’ decision-making.” - Interviewee

The Chesapeake Bay Partnership (CBP) is working to address Watershed Agreement (WA) goals that include achieving a Total Maximum Daily Load (TMDL) for nutrients and sediment and advancing diverse ecosystem, education, social, and governance outcomes (chesapeakeprogress.com). Regulations have been used to achieve some of the goals but the majority of goals involve voluntary activities. Committing to and achieving voluntary actions requires substantial engagement among all levels of government, organizations, businesses, and community members.

In recent years, the CBP has increased the use of behavioral social science applications to advance a subset of goals. Those initial efforts, and a lack of progress on some WA goals, have spurred questions about how social science might be integrated more broadly into CBP activities. Within the partnership, the goals of incorporating social science range from expanding efforts to encourage specific public and business actions to altering the CBP partnership structure and processes. Integrating social science to achieve CBP’s diverse social and ecological goals ultimately requires moving the partnership to embrace diverse policy actors and community members in co-developing solutions to unresolved problems.

2.1 Objectives

A strategy for integrating social science, or a social science roadmap, was identified as a need by the Stewardship Goal Implementation Team (GIT) to elevate promising social science tools, relevant to achieving CBP goals. The subset of social science that concerns itself with behavior change theory and application (defined in Section 1.2.1) was of particular interest to the GIT and informed the research direction. However, to address broad partner interests, a range of applied social science was evaluated.

This report proposes an initial strategy for integrating behavioral and other types of social science to adaptively manage CBP efforts. The strategy is made up of a series of recommendations intended to lower barriers to the use of social science tools and promote learning about social science capabilities to address ongoing and future partnership needs. Recommendations are applicable to many CBP activities including public engagement initiatives and internal institutional coordination.

We conducted 4 primary research activities to develop recommendations:

1. Characterize past CBP investments in behavior change implementation to identify opportunities for continued and future research
2. Assess the current state of behavior change science by conducting a literature review on effectiveness of behavioral interventions
3. Conduct a questionnaire and interviews with members of the CBP to characterize diverse social science experiences, motivations, and institutional cultures
4. Evaluate recommendations made by social science teams for similar programs and assess fit for the CBP

2.2 What are Social and Behavioral Sciences?

For the purposes of this report, social science refers to the systematic study of human decision-making, behavior, and relationships. The classical social science disciplines include anthropology, economics, human geography, political science, psychology, and sociology. While these disciplines are diverse in their histories and approaches, in different ways they all “apply scientific methods to analyze, understand, characterize, test hypotheses on, and sometimes predict social phenomena” (Biedenweg et al. 2020:7). In contrast, public engagement, education and communication are methods that may be used in or that apply social science research but, often, are meant to forward a specific goal rather than to advance the systematic study of human behavior.

When applied to conservation, restoration, and environmental management, the social sciences can help to understand and improve policies, practices, and outcomes (Bennett et al. 2017). Many social sciences approach environmental issues with the goal of promoting human well-being through human-environment interactions. Further, social scientists do not see people primarily as drivers of environmental problems but, rather, as part of a complex system of social, cultural, economic and legal conditions that influence peoples’ use, enjoyment, and stewardship of the environment. Social scientists know that environmental stewardship can contribute in many ways to human well-being but also that conflicts arise when tradeoffs are required among alternative uses of the environment. Social scientists apply their perspectives and tools to explore methods for balancing tradeoffs and identifying acceptable solutions among users. Those approaches include examining ways that institutional and political processes can create the appropriate conditions, capacity, or incentives for effective and equitable environmental management.

The diverse social sciences each have distinct questions that they ask about socio-environmental problems, and assumptions that guide those questions (Figure 1; Moon and Blackman 2014). The brief examples in Figure 1 are not comprehensive, but help to demonstrate the diversity of questions that social sciences ask about socio-environmental problems, and how each discipline can complement the others by viewing the same topic from a different perspective. What the figure does not show is that social scientists are increasingly using experimental evidence to draw conclusions about behavioral motivations. However, qualitative studies provide rich details on perspectives and behaviors that are often a first step towards developing experiments and then invaluable in interpreting experimental results.

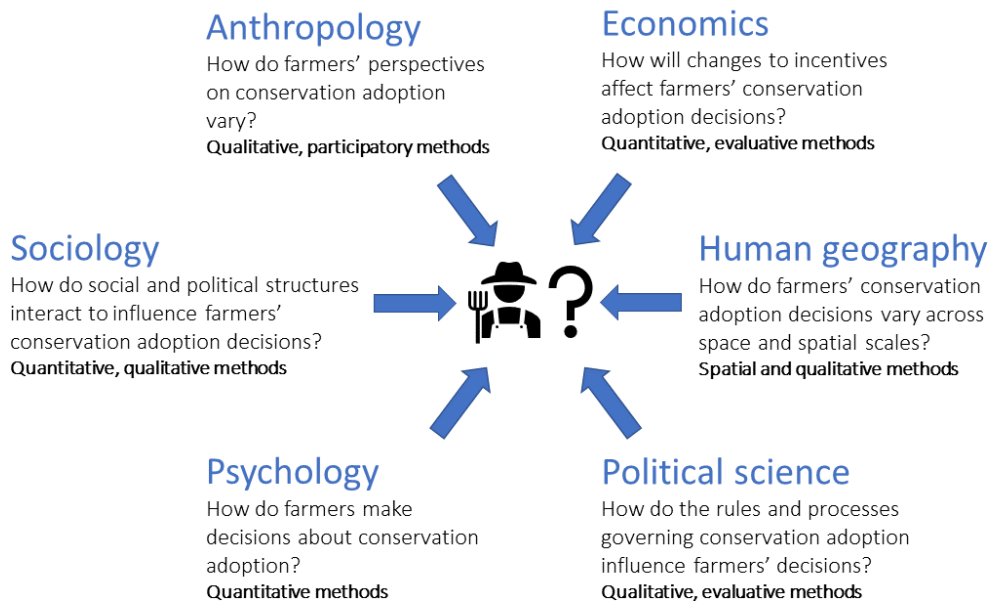


Figure 1. Example research questions and methods used by social science disciplines regarding farmers' adoption of management practices

2.2.1 How does social science advance partnership goals?

“A lot of projects don’t work because they don’t account for human motivations, incentives, or culture.” - Interviewee

Many partnership programs and government agencies have sought to increase the use of social science due to the recognition that progress on goals and missions is often limited by a lack of full use of social science (e.g., Bennett et al. 2019; Biedenweg et al. 2020; NOAA Science Advisory Board 2009). Failure to consider how people will react to programs has been demonstrated to waste resources or lead to low impact. Conversely, well-resourced social science efforts have led to major advancements that programs of any size can leverage to reach their goals. For example, the Director of the National Institutes of Health (NIH) said that the Office of Behavioral and Social Sciences Research (OBSSR) that Congress created in 2003 to work with NIH led to collaborations, “that have advanced not only behavioral and social sciences specifically, but also health research generally, most recently on the Precision Medicine Initiative and the Environmental Influences on Child Health Outcomes initiative” (OBSSR 2016). This office not only receives substantial resources but is strategically positioned to “...facilitate collaboration across the NIH by convening NIH staff and extramural investigators, conducting workshops, developing trans-NIH initiatives, and providing cofunding of meritorious grant applications” (Riley et al. 2020).

Because the social sciences vary so widely, it would be impossible to adequately describe all their potential contributions to CBP goals in this report. A large portion of this report addresses partnership interest in a subset of social science known as behavioral science, in which research is applied to influence behavior. Later in this report, we explore other types of social science that were relevant to

partner recommendations and suggest systemic approaches for integrating many types of social science. The NIH experience suggests that engaging social scientists from diverse disciplines, who can contribute to multi-disciplinary issue exploration, can lead to the design of innovative solutions and transformative research insights.

Behavioral science refers to the systematic study of human judgment and decision-making. It largely developed from engagements between economics and psychology, as experimental work began to show how human decision-making predictably departs from the expectation that people seek to maximize happiness, or how people are *predictably irrational*² (Tversky and Kahneman 1974; Kahneman and Tversky 1979). People are predictably irrational because they exhibit common biases in their thinking and have predictable responses to prompts or nudges that are designed to counter or reinforce those biases. Ongoing behavioral experiments have led to in-depth characterizations of the ways in which emotions, incentives, framings, information, formal and informal rules, and social influences drive human decision-making in different scenarios (Cialdini 2021; Slovic et al. 2007; Thaler and Sunstein 2008).

Behavioral interventions are approaches to influence behavior that have emerged from this research. They work by anticipating and counteracting known decision-making biases. These biases include effects as simple as our tendency to prefer items displayed at eye level over other positions and more subtle effects such as our tendency to underestimate risks that we have not experienced and overestimate ones that we have. Many techniques recognize that people tend to use heuristics, or rules of thumb, when making decisions that can be used to guide decisions.³

Policy-makers and scientists have applied behavioral science to improve outcomes across a wide variety of environmental and public health issues (Carlsson and Johansson-Stenman 2012; Glanz and Bishop 2010). One salient example (Box 1) demonstrates how a scientific understanding of this predictable irrationality can promote pro-environmental behaviors. The case study demonstrates how simply providing information to the public is inadequate for changing behavior. Rather, it shows how using an intervention with a descriptive social norm, in which an individual's behavior is compared to typical or average behavior, motivates change.

² Economists use the term irrational to represent how we all make decisions that do not appear to maximize our happiness or that diverge from our stated goals. However, such behaviors emerge from common psychological and social reasoning and this term does not indicate any type of deranged thinking.

³ Heuristics are mental short cuts that people use to make sense of complex information. Heuristics are only a concern when they lead to decisions that are inconsistent with the decision maker's intent or omit some relevant evidence.

Box 1: Applying behavioral science to reduce household water consumption

Partnering with an Atlanta water utility, behavioral scientists aimed to understand the factors influencing household water use (Ferraro and Miranda 2013). They randomly divided 100,000 customers into one control group and three treatment groups. The control group received no information. Three different letters were sent to each of the remaining treatment groups. The first letter provided tips for water conservation, but the researchers could find no evidence that this reduced water consumption. The second letter provided the same tips along with a personally addressed letter from water regulators encouraging water conservation. The researchers found that this treatment reduced water consumption by 2.5% in the first year, but that residents returned to their previous water consumption levels in later years. The third provided the tip sheet, letter, and a comparison between that household's water consumption with the county median. This treatment reduced water consumption by nearly 5% in the first year, and detectable, but declining, reductions in the next 3 years. Additionally, they found that high water use households were more responsive to this last treatment, and concluded that targeting social norms messages to this group could achieve 88% of the overall reductions for 65% of the cost.

Thus, the researchers demonstrate how water consumption behavior is not necessarily driven by rational cost-benefit decisions, which would have been influenced by the tips conserving water, and only partly by an altruistic sense of doing what is right, as the encouragement to conserve had a small effect. Rather, aligning with what much behavioral theory has shown, water use is influenced by social norms, and the comparison had the greatest effect on high water users because they were furthest from the norm.

2.2.2 Some social science theory supporting pro-environmental behavior change

The idea that many people are motivated to conform to social norms is just one aspect of behavioral science theory. For a broad view of the science and its potential application, we use the G-ITM framework (Groundwork, Information, Technical support, Motivations) to represent major groupings of the types of research and interventions used to promote behavior change (Figure 2). Groundwork is research that applies techniques steeped in receptiveness and empathy to better understand communities and inform the design of a behavioral intervention. The Information category includes actions that provide a basic understanding of potential behavior changes and their benefits to individuals or society. Technical support is a diverse category that includes providing explicit instruction on how to make a behavior change and elements that reduce or remove barriers to change such as financial incentives or regulatory relief (e.g., safe harbor agreements). Motivations are the set of practices that activate internal drivers and goals to direct and energize an individual to engage in a behavior (Ehret et al., 2021).

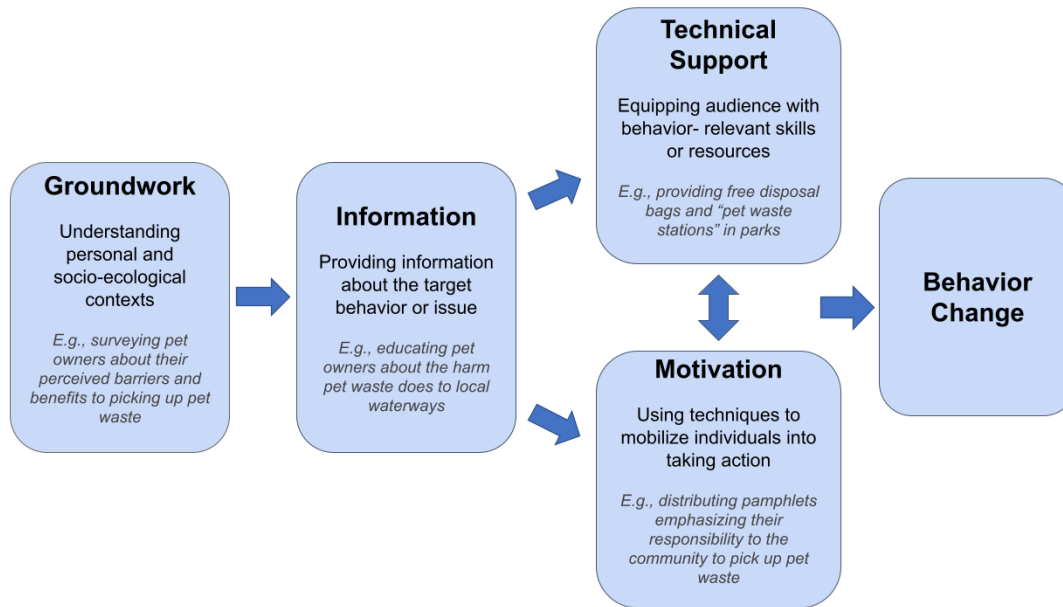


Figure 2. The G-ITM model as a workflow leading to behavior change

Developed from work by Ehret et al. (2021), Fisher and Fisher (1992), Fisher et al. (2014) and Glanz and Bishop 2010.

We created the G-ITM model as a practical model for organizing and differentiating the types of behavioral interventions in use by practitioners and researchers. It is an adaptation of multiple theory-based behavioral frameworks primarily from the Information-Motivation-Behavior Skills (IMB) framework that informs health intervention research (Ehret et al. 2021; Fisher and Fisher 1992; Fisher et al. 2014; Glanz and Bishop 2010). IMB suggests that providing requisite information, motivation, and behavioral skills, or capacity necessary to carry out the behavior, are the three main components of facilitating successful and sustained behavior change. In developing G-ITM, we adapted IMB in two main ways to fit pro-environmental and pro-social behavior change. First, we added Groundwork (G), which aids in developing effective behavioral interventions by establishing a baseline of relevant stakeholders' information, motivation, and behavioral skill levels (Ehret et al. 2021; Glanz and Bishop 2010). Second, we re-named Behavioral Skills to Technical Support so as to encompass both the necessary skills needed to change behavior and the support that removes barriers to change, such as direct technical or financial assistance.

The G-ITM framework embeds a sequence of actions that, when used together, have been shown to increase the effectiveness of voluntary behavioral interventions. The framework starts with Groundwork and ends in Motivation and Technical Support and emphasizes the need for all components when seeking to influence behavior. Groundwork is an essential and foundational step in intervention design and precedes the other components. Information follows Groundwork because individuals need basic information before considering a behavior change, although informational interventions alone have not been consistently effective (Ehret et al. 2021; Kidd et al. 2019). Motivation and Technical support follow Information and build on the prior steps to assist people in changing their behavior. These two components occur at the same stage in the behavior change process because they often influence each

other. In other words, increasing an individual’s technical capacity may increase their motivation to engage in a behavior, and vice versa (Table 2).

Table 1. Behavioral Intervention Categories and Strategies by G-ITM framework components

G-ITM Component	Category	Behavior Change Strategy
Groundwork		Audience segmentation
		Understanding motivations and barriers
		Attitudes and cultural understanding (basic research)
Information		K-12 Education
		Risk communication
		Awareness information
		Behavior-specific information
		Prompts and reminders
Technical Support	Decision support	Guiding decision-making
		How-to skills
	Financial support	Monetary resources
		Regulatory flexibility
	Technical support	Technical assistance
Motivation	Community-level interventions	Identifying and engaging influential messengers
		Public commitments
		Peer diffusion
		Visible social proof
	Individual-level interventions	Descriptive norms
		Injunctive norms
		Defaults
		Priming
		Framing
		Emotional appeals
Non-monetary rewards		

We use this G-ITM framework throughout the report as a way to characterize the application of theory and distinguish intervention types. However, the process of behavior change is not necessarily linear among these steps and can also be iterative. Appendix A.1.1 has more information on the development of the G-ITM framework and how it has organized current understanding and behavioral science including other theories of behavior change such as, Theory of Planned Behavior (Ajzen 1991), Diffusion of Innovations (Rogers 2003), and Dual-process theory (Evans 2011).

3 Methods Summary

We used a mixed methods approach to assess past uses of behavioral social science in CBP, characterize partner attitudes toward and perceptions of diverse types of social science, and to identify institutional barriers and opportunities to further social science integration (Table 3).⁴

⁴ See Appendices for full description of methods, sample summaries, and results.

Table 2. Summary of research methods

PURPOSE	METHOD	SAMPLING STRATEGY	RESULTING SAMPLE
Understand past efforts within CBP to use social science	Case study review	- Searched 4 databases for examples of behavioral interventions designed to advance Bay restoration goals	- 41 case studies
Compare past CBP social science efforts with existing literature on behavioral interventions among the public and policy actors	Academic literature review	- Keyword search and snowball sampling using Google Scholar and Web of Science	- 14 review articles summarizing 1,049 behavioral interventions - 24 behavior change experiments with policy actors
Assess partners' attitudes toward and experience with social science	Online questionnaire	- Sent to CBP partner listservs by multiple messengers	- 151 responses
Investigate partners' perceptions of institutional enablers and constraints to social science	Key informant interviews	- Self-selected from questionnaire - Selected by program partners	- 30 interviews
Compare our findings to social science strategies used in similar partnership programs	Targeted review of gray and published literature	Keyword search and snowball sampling using Google Scholar	- 22 reports and articles

To gather information and evidence, we conducted a case study analysis and three different literature reviews to compare past use of social science in CBP to the current state of the science and recommended practices. In the case study analysis, we characterized 41 cases of past behavior change interventions by CBP partners according to the G-ITM category assessed, the audience they applied to, and the degree of success they achieved. The first literature review synthesized the state of behavioral science as applied to pro-environmental behavior, coding studies by G-ITM component assessed, study

design, major findings, and factors influencing the effectiveness of behavior change interventions. Similarly, the second literature review covered behavioral change interventions conducted with policy actors - those who make, carry out, and influence policy, including policy makers, managers, and key stakeholders – regardless of whether the behavior was pro-environmental, due to the small number of studies. The third literature review examined recommendations that teams of social scientists have provided to programs similar to the CBP for relevance among reports and peer-reviewed articles.

To gather information directly from members of the partnership, we used a questionnaire and interviews to understand attitudes toward and perceptions of social science and experience applying social science. A questionnaire, developed with our advisory board, was sent online in December 2021 by several messengers to multiple CBP listservs (Appendices A.2 and C). We conducted follow-up interviews with those who expressed willingness to do so and recruited additional interviewees to broaden the sample by expertise and position within the partnership. These 30-60-minute interviews allowed for an in-depth exploration of respondents' past uses of social science, the institutional enablers and constraints they faced, and how they thought social science could be better integrated within CBP (Appendices A.3 and D).

In considering which of the advice that has been given to programs similar to CBP is most relevant to the CBP, we recognized that the CBP is more mature in some aspects of social science use than some other estuary and coastal restoration programs. The CBP has made major strides in co-developing management processes with partners when developing the watershed agreement, performance metrics, and the goal team organization. The strategy review system (SRS) established a logical adaptive management framework using principles from decision science. Further, the partnership has funded the application of or research in multiple types of social science (groundwork, behavioral, institutional, economic). Therefore, the current phase of partnership development of social science is best described as adaptive management of efforts to identify additional opportunities, adapt to problems raised about processes, and to address incomplete progress towards goals.

4 Results and Recommendations

Results are organized by the major categories of findings from our investigations into past social science activities and future needs. Recommendations that are responsive to findings are in section 5.

4.1 FINDING 1: Broad support for, but incomplete understanding of, social science

We found high levels of support for social science among the 151 questionnaire respondents and unanimous support among the 30 interview respondents. Questionnaire respondents spanned all goal teams and roles in the partnership. Interviewees also represented diverse goal teams and roles but had relatively less representation from the EPA than the questionnaire and more from state, NGO, academic, and business partners. Interviewees also had high interest in social science and worked in positions across the partnership, although only 6 identified as social scientists.

The questionnaire respondents largely agreed that better integrating social science into CBP would help to achieve the agreement goals, with leadership showing the most consistent support (Figure 3). However, the opinion that social science was key to success was not consistent across types of

respondents. Respondents involved in modeling and technical support showed the most disagreement with social science being key to success, while those involved in public engagement and governance showed the least disagreement. Most respondents agreed that social science could help make achieving Bay agreement goals less burdensome, but nearly a fifth of respondents did not think that a lack of social science was a key reason why many goals have not been met.

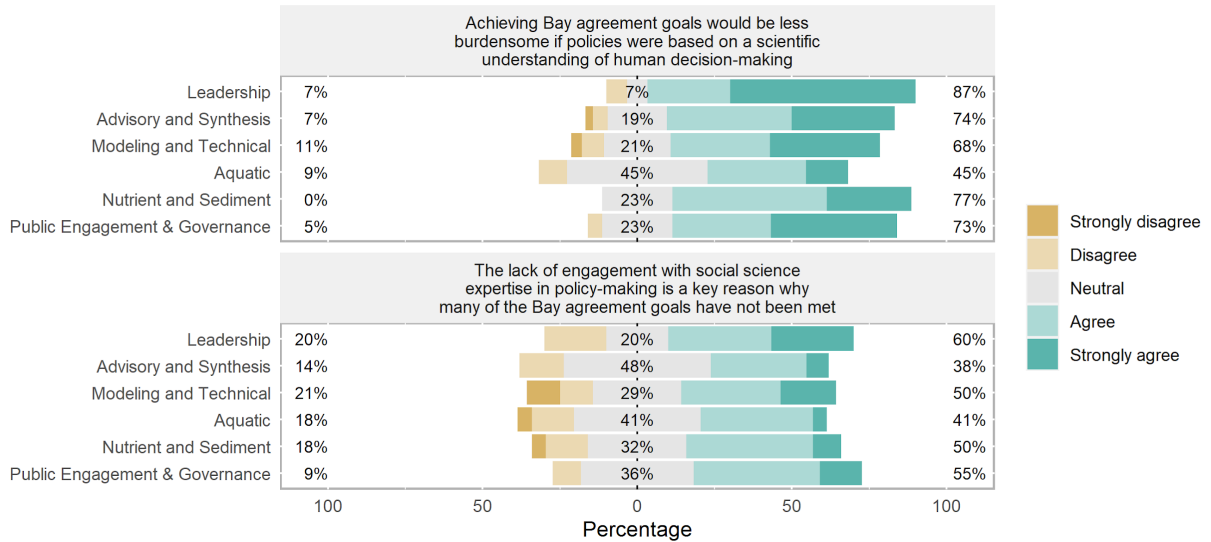


Figure 3. Perceived importance of social science to Chesapeake Bay restoration among respondents by CBP role

Groups were defined as: Leadership (Principals’ Staff Committee or Management Board), Advisory and Synthesis (STAC, Communications WG, STAR), Modeling and Technical (Modeling WG, Climate Resiliency WG, Data Integrity WG, Integrated Monitoring, etc.), Aquatic (GITs 1, 2), Nutrient and Sediment (GITs 3, 4), and Public Engagement and Governance (GITs 5, 6).

Respondents found diverse social science applications to be useful, with some minor differences in priorities for social scientists compared to other partners (Figure 4). Interviews with those who did not identify as social scientists revealed that the two most common goals were to 1) use social science to build support for the Bay goals and 2) promote pro-environmental behavior among the public. Similarly, these were the social science applications most supported by questionnaire respondents who had no social science experience. Conversely, respondents who did have social science experience were more supportive of improving management processes, institutional functions, and mitigating unintended consequences.

“Conceptually, people understand the need for social science, and particularly behavior change around BMPs, but not practically. That is, there is no understanding of what they will get back if they invest in it.” - Interviewee

The 6 interviewees who identified as social scientists highlighted diverse and in-depth applications as beneficial to the partnership. For example, some mentioned that social science is crucial to identifying barriers to private landowners’ adoption of tree planting or other conservation practices and providing insights into approaches for removing barriers. Others described social science integration as a way to build adaptation into CBP through robust program evaluation and network building. They suggested that

such tools would be useful to practitioners and policy-makers in that they would help to build a knowledge base about what works under what conditions, while building trust with relevant communities.

Apart from these uses, questionnaire respondents also discussed other ways in which social science could benefit CBP's work (Appendix C). Several suggested using social science to understand how to better align CBP's work with communities' goals and needs, such as one who wrote, "My observation is that CBP is a top down organization whereas my experience with partnerships that utilize social science are more bottom up. It is tough to force mandates and goals down and engage after the fact, instead of identifying ways to achieve from bottom up." Listening to affected communities when setting goals and strategies is also a key tenet of processes designed to foster collaboration (Norström et al. 2020). Additionally, several respondents mentioned negotiation breakthroughs that they witnessed when social scientists (especially anthropologists) acted as intermediaries that broke down barriers to communication and problem solving when designing natural resource management. Those scientists were able to play these roles because they had developed trusted relationships and understanding of cultural norms and motivations through groundwork.

"In terms of BMP adoption, you need to remove impediments. Social science can identify which impediments are most important." - Interviewee

Despite this broad support for social science, some respondents suggested that the full benefits of social science are not widely understood by CBP partners. For example, one questionnaire respondent wrote "At the moment, I do not think GITs know what needs social science could help, so I think the first step, before ways of achieving the [Bay agreement] goals, is help to identify those needs." Another respondent, who identified as a social scientist, wrote, "Too often, social sciences get relegated to community education and outreach, or public behavior change. We do so much more than that...Also, too often the social sciences are framed as the 'soft sciences,' which delegitimizes us as scientists – part of why I think this continues to be a gap at the CBP."

Questionnaire respondents also described how partnership building and networking are crucial elements to successfully implementing social science, but that they are not well understood by many partners. One respondent who had social science experience reported using it "to improve understanding of local needs and goals, and for defining collaborative opportunities to support multiple stakeholder objectives." However, another respondent, who also conducts such work, described partners' limited understanding of "a) the intricacies of community outreach work... b) the depth of effort and the amount of time that is required to engage communities equitably, c) that it is REAL work that really requires use of science (psychology / sociology / organizational psychology) to do it well..." Similarly, another respondent wrote "Timeframes almost always fall short of what is truly needed to engage stakeholders completely, especially with complex water quality issues that require time and effort to educate the community before initiating plan development." Thus, while there is broad support for social science among CBP partners, their understanding of what social science is and the time and resources necessary to make crucial partnerships work is highly variable.

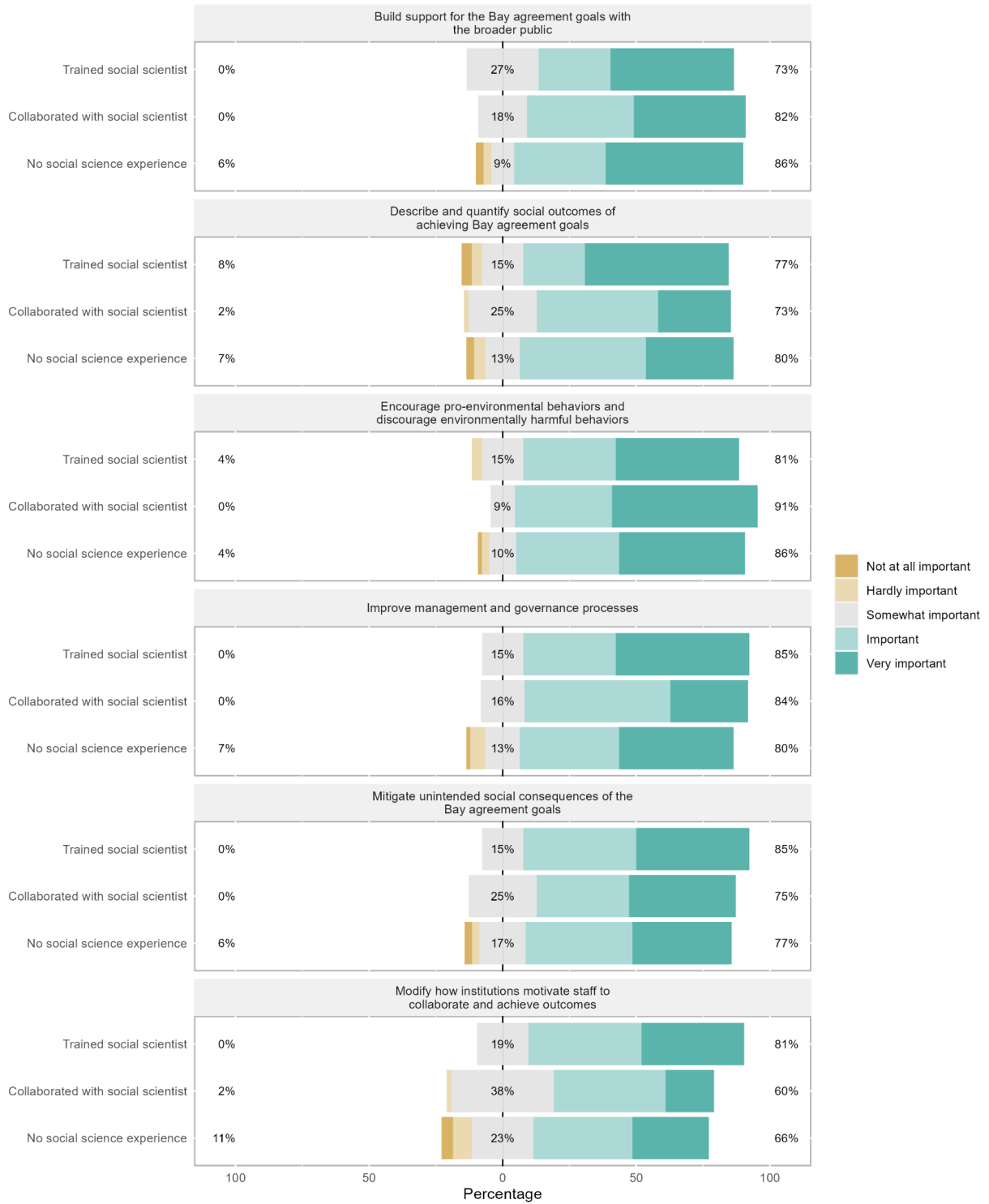


Figure 4. Respondent perceptions about the importance of social science to achieving the goals shown, by experience with social science

4.1.1 RECOMMENDATION 1: Build social science literacy and capacity

Table 3. Summary of recommendations and rationale for building social science literacy

Easier goal: Increase knowledge of diverse social science approaches to raise awareness of the benefits of such investment	
<i>Recommendation</i>	<i>Rationale</i>
- Share knowledge through webinars, short courses, and workshops.	Building understanding of the diversity of social sciences, and how they can have an impact on environmental restoration will be crucial to building further support for their integration. Short courses have worked well in similar programs.
Harder goal: Invest substantially in social science	
<i>Recommendation</i>	<i>Rationale</i>
- Build capacity by investing in internal social scientist positions	Having people with frequent access to decision makers and deep understanding of institutional missions will be invaluable to effectively applying social science and promoting continuous informal learning.
- Develop a community of practice to support internal social scientists	Internal social scientists will need support from a larger community of practice to promote robust application of theory. They will need to consult with social scientists with specialties other than their own to effectively set priorities and stay current on emerging methods and issues.

4.1.1.1 Easier goal: Increase knowledge of diverse social science approaches to raise awareness of the benefits of such investment

Providing in-depth learning opportunities for many partners will further expand their social science literacy enabling them to identify diverse applications of social science to achieve goals. These opportunities could be short-term education workshops, monthly learning webinars, or guided instruction on certain social science theories and methods. Short term education workshops were found to be highly effective at advancing social science integration at NIH (OBSSR 2016). Some materials could be adapted from those that already exist in online communities, including the Conservation Social Science Partnership (consosci.org), the Social Science Working Group of the Society for Conservation Biology (scbsocialscience.org), and the Marine Social Sciences Network (marsocsci.net). These learning opportunities are more likely to resonate with policy actors if the practical applications are made clear.

4.1.1.2 Harder goal: Make substantial investments in social science

We heard that managers did not feel they had sufficient resources to hire social scientists. However, social science integration cannot be effective without substantial capacity, including personnel time. Internal hires within CBPO, or at other agencies where the position is devoted to the partnership goals,

are preferred because they will need access to decision makers who control resources to be effective. Some other programs have created agency positions using Sea Grant fellows or similar arrangements with partners. However, junior career scientists and short-term employees need leadership support in taking on the challenges associated with social science integration. In addition to enhancing the partnerships' social science literacy and capacity, hiring social scientists would also promote continuous formal and informal learning among other program partners.

Internal social scientists are made substantially more effective if they are connected to a broader community or network. The Chesapeake Bay region has numerous colleges, universities, and non-profits with extensive social science capacity. Better networking with these partners would help to support internal social scientists and maximize the diversity of social scientists engaging with the Chesapeake Bay. External partners could be engaged to share knowledge with internal social scientists, provide feedback on specific approaches, and identify collaboration opportunities. Additionally, some regional organizations, such as the Smithsonian Working Land and Seascapes Initiative, have similarly been seeking to better integrate social science into their organization (Bennett 2021). Partnering with such organizations could help to solidify a community of practice around applied social science that is mutually beneficial to many organizations' goals.

“Networking groups together creates a multiplier effect.” - Interviewee

4.2 FINDING 2: Uneven use of behavioral social science evidence and performance tracking

From our review of 34 social science case studies, we found that past application of social science in CBP activities has been narrowly focused on a subset of behavior change interventions to promote pro-environmental behaviors (Appendix B). However, the questionnaire showed a slightly broader application of social science. Among the 54% of questionnaire respondents who reported some experience using social science, the most commonly reported use was to encourage pro-environmental behaviors (46%), followed by improving management and governance processes (26%), which includes improving stakeholder negotiation between community members and government officials, facilitating interactions between practitioners and capacity-builders, and matching better matching outreach and audience.

In comparing funded case studies to existing literature on behavioral interventions with the public and policy actors, we found some strengths and some limitations in how evidence had been used to design successful interventions. The next sections describe those results. Definitions of terms and further explanation can be found in Box 2 and Appendix A, particularly Table A1.

4.2.1 Effective interventions are underutilized

While some of the behavioral interventions that CBP partners have used show strong evidence of effectiveness in the published literature, others do not. Also, few past efforts have been explicitly guided by a specific social science theory (Details in Appendix B.1). The most commonly applied interventions by CBP partners have been using influential messengers, appealing to injunctive norms, and encouraging public commitments (Figure 5, Definitions in Box 2). Descriptive norms and defaults, which have relatively strong evidence of effectiveness, do not appear to have been used by partners.

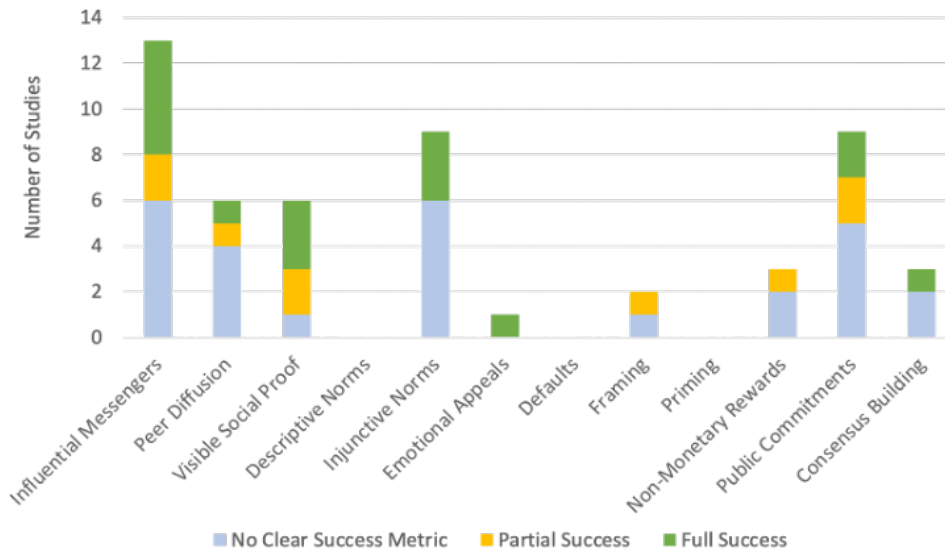


Figure 5. Metrics of success in past CBP Motivation interventions (multi-coded)

Multi-coding means that a single study can appear in multiple bars because they applied more than one intervention type.

While the academic literature does not provide conclusive evidence on which interventions reliably work under what conditions, results from our literature reviews suggest that CBP may benefit from testing some interventions that they have not yet tried. For instance, CBP partners have used public commitments (having individuals publicly state that they will engage in some behavior) and injunctive social norms (labeling some behavior as either morally desirable or undesirable). The scientific literature suggests that both of these intervention can be moderately effective at changing people’s behavior, but that their effectiveness is highly variable depending on the specific audience and behavior of interest (Andor & Fels 2018; Barth et al. 2021; Byerly et al. 2018; Farrow et al. 2017; Osbaldiston & Schott 2012). The literature also suggests that defaults (making the desired behavior the automatic or preselected one) and descriptive social norms (informing individuals about the behavior of their peers) are similarly moderately effective, but that their effectiveness is more consistent across audiences and behaviors (Andor & Fels 2018; Byerly et al. 2018; Farrow et al. 2018; Osbaldiston & Schott 2012; Sunstein & Reisch 2014). However, CBP partners testing these interventions should note that descriptive social norms can decrease pro-environmental behaviors among those who had been outperforming the norm (Andor & Fels 2018; Farrow et al. 2018) and that people can react negatively to injunctive social norms when they threaten personal autonomy (White et al. 2019).

Some of the variability in intervention effectiveness mentioned above can be accounted for by the degree of effort required to undertake the target behavior. For example, lower-engagement interventions (such as defaults and prompts) may be more effective at changing lower-effort behaviors, such as public recycling (Osbaldiston & Schott, 2012). For behaviors that are perceived as more difficult, a higher overall level of intervention effort across ITM categories (see Section 1.2.2) will be needed (Osbaldiston & Schott, 2012). Further, financial incentives may effectively provide additional motivation to overcome cost and risk barriers (Maki et al., 2016).

Box 2: Description of select behavior change interventions (See Appendix A for full list)

Defaults: Presenting a desirable choice as the preselected or automatic options. Example: When online shopping, a box indicating the customer agrees to receive further advertising emails is already checked.

Descriptive social norms: Using standardized wording, verbal or written, to inform an audience that a particular behavior is the norm among their peers. Example: “Most Americans brush their teeth twice a day.”

Emotional appeals: Eliciting emotions associated with a choice or behavior, including through the use of cognitive dissonance.

Framing: Altering how the risks, goals, or other attributes of a choice are presented, usually from positive to negative, or vice versa.

Guided decision-making: Structured assistance in a decision-making process, such as a flowchart, decision tree, or instructions for how to make decisions.

How-to skills: Equipping people, through spoken or written instruction, with knowledge or skills necessary to successfully carry out a behavior themselves.

Identifying and engaging influential messengers: Recruiting significant and trusted individuals to share messages with the surrounding community.

Injunctive social norms: Using standardized wording, verbal or written, to inform an audience that a particular behavior is morally (un)desirable or (dis)approved of by their peers. Example: “Please be a good neighbor and clean up after your dog.”

Monetary resources: Direct provision of financial resources, reduced-priced services, or free items that decrease the financial burden of behavior.

Non-monetary rewards: Prizes awarded for behavior or commitment to behavior, including small monetary rewards without significant financial implications.

Peer diffusion: Informal diffusion of a behavior via word-of-mouth or through other members of the community, regardless of whether they are considered influential.

Priming: Asking, or prompting discussion, about a behavior to promote it, including as it relates to self-concept and identity.

Prompts and reminders: Cues, notifications, or other types of communication that serve to reference or prompt a target behavior.

Public commitments: Making a public (verbal or written) statement or commitment to carry out a future behavior. Example: Yard sign indicating commitment to plant native habitat.

Regulatory flexibility: Reducing existing regulatory requirements in response to target behavior engagement.

Technical assistance: In-person assistance with practical tasks, such as installation, maintenance, or consultation.

Visible social proof: Increasing the observability of a behavior to demonstrate and promote it among peers.

Ultimately, our investigation in CBP partners' past use of behavioral interventions raises two main questions, 1) What will encourage practitioners to use approaches with strong evidence of effectiveness? and 2) How can interventions be designed to promote testing, adaptive management and learning? Designing behavioral interventions around specific theories of behavior change enables practitioners to build on prior research and increase their chance of success. As an example, the project detailed in Box 3 describes how Diffusion of Innovations theory helped practitioners to overcome hesitancy to adopt agricultural conservation practices among a conservative Mennonite community. Their work further demonstrates another advantage of designing behavioral interventions around specific theories, which is being able to compare results of similar interventions applied in different contexts. Their use of Diffusion of Innovations theory broadened the understanding that this technique worked among Plain Sect farmers, an outcome that was not found in the published literature.

Box 3: Using social science to promote agricultural conservation adoption among Plain Sect farmers

Case study: In 2017, the Lancaster Farmland Trust (LFT) saw encouraging success implementing agricultural conservation practices among members of a conservative Mennonite community, who tend to be hesitant to accept government cost-share payments. To do so, LFT applied principles from Diffusion of Innovations (DOI) theory, a long-established framework for understanding the spread of new practices and ideas (Rogers 2003).

Application of theory: One principle of DOI is that all audiences have certain characteristics – including personality traits, socioeconomic factors, existing knowledge, and cultural values – that influence the likelihood that they will adopt new practices. LFT sought to understand these characteristics by hosting 7 focus groups, a stewardship workshop, and a field day, and found that there was strong interest in conservation planning and implementation within the community. A second principle of DOI is that individuals' adoption likelihood is influenced by peer networks, and that early adopters who more readily try new practices can act as opinion leaders to encourage adoption among more reticent individuals. LFT built on this principle by working with two local leaders to share project details and benefits to the community through word-of-mouth and an area-specific dial-in phone service called the "Mennonite Hotline." These outreach methods, in addition to mailings and a flier at a local agricultural store, encouraged people to attend a field day at a dairy farm where contractors were installing conservation practices, which allowed attendees to learn more information about the costs and benefits of the practices. This event played into a third principle of DOI, namely that demonstrating how new practices are advantageous over old practices, but compatible within the existing context, will encourage adoption. After the event, LFT followed up with all farmers in eastern Lancaster County through a mailing encouraging recipients to contact them about the project, and at several community events.

Success: Ultimately, this project resulted in four farms implementing a full suite of conservation practices, 32 practices installed, verified, and maintained, leading to an estimated annual reduction of 7,157 lbs. of nitrogen, 2,752 lbs. of phosphorous, and 11,860 lbs. of sediment, in addition to the design of 1,675 linear feet of stream restoration work.

G-ITM: LFT's success is partly accounted for by the fact that their efforts mapped well onto each of the G-ITM components (Section 1.2.2). Their workshops, focus groups, and field days represent extensive **Groundwork** to *understand motivation, barriers, and assess attitudes and cultural understandings*. Using two influential leaders to spread the word about the project exemplifies the **Motivation** strategy of *Identifying and engaging influential messengers*. The subsequent field day provided **Technical support** in the form of *How-to skills and technical assistance*. And the subsequent mailings and community events used **Information** strategies, including further *awareness information and prompts and reminders*.

4.2.2 Narrow audience focus

CBP partners' past behavior change interventions have largely emphasized homeowners and community members over other audiences (Table 5). Most of these interventions aimed to promote an individual

pro-environmental behavior, such as picking up dog waste or installing conservation landscaping. The least common audience for interventions were policy actors. The policy actor examples largely involved either (1) workshops on how regulators and policy-makers can use behavioral economics in their work, or (2) providing information on community views of oyster restoration of monetary estimates of ecosystem services.

Table 4. Audiences of past behavior change interventions by CBP partners, multi-coded

Decision Maker Type	Number of Studies
Homeowners/Community Members	27
Businesses/Farmers	9
Community Leaders/Outreach Practitioners	6
Policy Actors	5

Our review of behavioral experiments with policy actors suggests that they may be important audiences for further behavioral interventions by CBP partners (Appendix B.3). Many studies found that policy actors were similar to the general public in being predictably irrational (see Footnote 2). The list of documented heuristics (defined in footnote 3) used by policy actors is large but includes anchoring (to prior beliefs), loss aversion, preference for the status-quo, and discounting of future outcomes, all of which can be counteracted, to some degree, with interventions (Box 4). The results further suggest that government officials are influenced by institutional norms (Andersen and Jakobsen, 2017), peer norms (Oberfield, 2010), framing (Andersen and Jakobsen, 2017; Linde and Vis, 2017; Sheffer et al., 2018), and monetary incentives (Kalla and Broockman, 2016).

Box 4: Description of select decision-making heuristics

Anchoring: Relying heavily on the first piece of information given about a topic. Example: After seeing a t-shirt priced at \$1,000, a t-shirt priced at \$100 will seem inexpensive.

Future discounting: Perceiving a desired result in the future as less valuable than one in the present. Example: Taking one cookie immediately, rather than waiting for two cookies at some later time.

Loss aversion: Experiencing losses more severely than equivalent gains. Example: A person dislikes losing \$10 more than they like gaining \$10.

Status quo bias: Preferring to maintain the current state of affairs over changing them. Example: Staying with the same health insurance plan despite the emergence of other options.

“We need to do more than the carrot that just gets them [the public] to break even...Maybe part of it is we need to change our behaviors too as program managers.” - Interviewee

The reviewed studies demonstrate how these widespread decision-making heuristics interact with political, interpersonal, institutional, and informational factors to influence policy actors' decisions. Evidence supports the idea that legislators rely on the accessibility heuristic, a cognitive shortcut where one makes conclusions based on information that is most salient or cognitively accessible, when judging constituent interests (Miler, 2009). As a result, information on constituency opinion was particularly influential in changing politicians voting behavior (Butler and Nickerson, 2011; Nielsen and Baekgaard, 2015). However, the anchoring effect makes them less likely to update their pre-existing beliefs. Several examples demonstrated this heuristic by showing how new climate model estimates did not lead to commensurate policy changes (Bosetti et al., 2017, Knaggård, 2014, Linde and Vis, 2017). Compared to the general public, politicians appeared to be less susceptible to some biases, such as the common ratio effect (underweighting or overweighting equal probabilities) and long-term time discounting (Linde & Vis, 2017).

4.2.3 Few efforts to measure success

Excluding studies that were purely groundwork, the majority of past CBP behavioral interventions (59%) did not include a metric of success, limiting the ability to learn from past efforts (Figure 6). In contrast, all reviewed policy actor experiments included some measure of success, and all, except two framing experiments, found a significant effect of the tested intervention on policy actor behavior (Figure 7). Measuring success is important in behavior change research because a success in one case study does not guarantee the success of the same intervention when transferred to a different population, or even the same population at a different time. The reviews of public behavioral interventions suggested that intervention effectiveness is context-dependent, varying with target behavior, environmental context, behavior domain, and audience knowledge, values, and prior behaviors (Andor & Fels, 2018; Byerly et al., 2018; Ehret et al., 2021; Kolandai-Matchett & Armoudian, 2020; Osbaldiston & Schott, 2012; Wynes et al., 2018). Only by analyzing many studies can the context differences (e.g., types of messengers, socio-demographics of the target audience, regulatory environment) be teased apart.

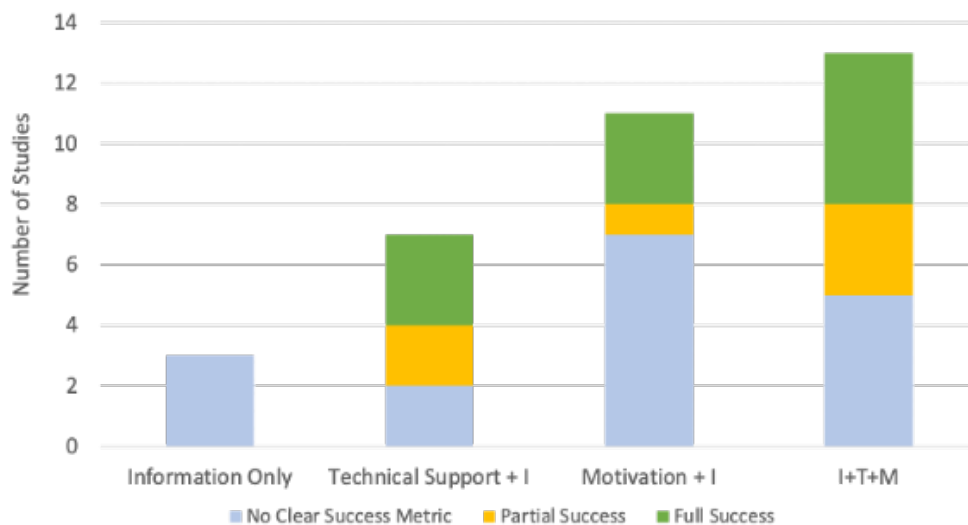


Figure 6. Metrics of success by ITM component for past CBP behavioral interventions (single-coded)

X-axis letters refer to combinations of Information, Technical support, and Motivation interventions.

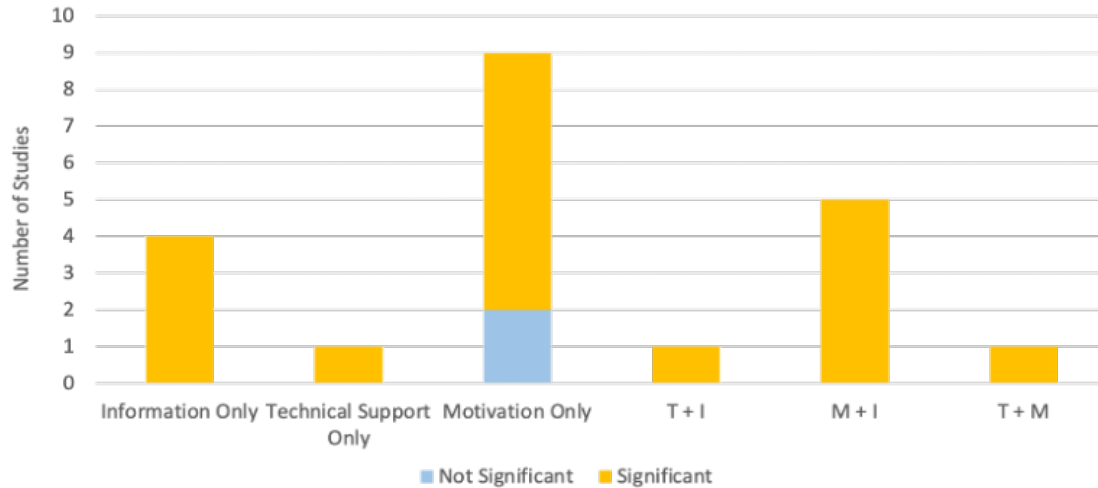


Figure 7. Significant effects by intervention type among reviewed policy actor behavioral experiment (single-coded)

X-axis letters refer to combinations of Information, Technical support, and Motivation interventions.

Of the studies that did include a success metric ($N = 17$), all achieved some level of success and most achieved full success, as defined by the researchers. While interventions combining all three of the ITM components had the most instances of full success overall, interventions using the combination of I and M (without T) had the highest proportion of full success of the studies measuring and reporting success. These results are similar to those found in the review of public interventions. Of the reviews that evaluated interactions between different treatments, most concluded that combining multiple types of interventions tended to increase effectiveness. Anecdotally, questionnaire respondents who reported some past use of social science ($N = 81$) reported moderate success (Figure 8). However, without clear metrics of success, it is unclear what impact these efforts had.

“There’s so much more we need to learn about psychology, social science, political science to figure out how we actually implement the practices that we know we need to.” - Interviewee

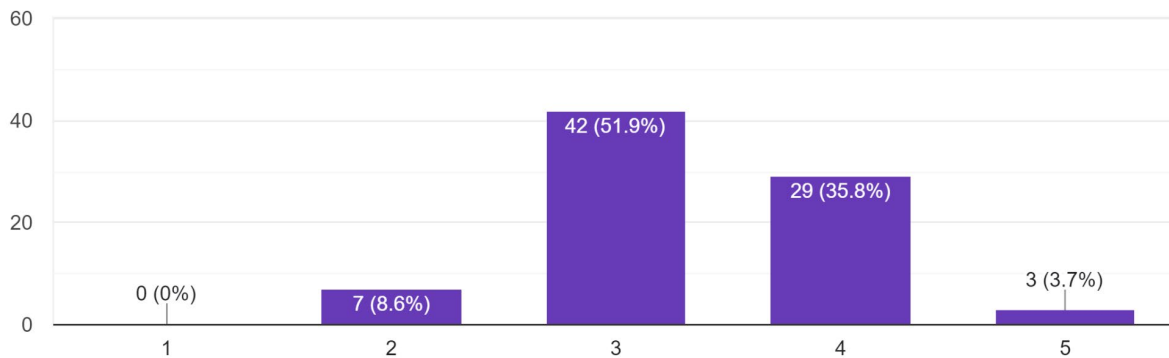


Figure 8. Questionnaire results for the question: Indicate the extent to which your experience with social science achieved its intended goal, from Not at all (1) to Completely (5)

4.2.4 RECOMMENDATION 2: Enhance the practice of behavioral social science

Table 5: Summary of recommendations and rationale for enhancing the rigor and diversity of social sciences

Easier goal: Expand the use of promising social science techniques and promote rigor and impact in application	
<i>Recommendation</i>	<i>Rationale</i>
- Continue to fund projects that apply and test theory	Projects that are well aligned with theory by combining approaches to behavior change have higher probability of success.
- Evaluate opportunities to apply promising but unused techniques of descriptive norms and defaults	Although no social science techniques show consistent and large effects across case studies, descriptive norms and defaults have shown great promise and are not being applied.
- Expand the audience for interventions beyond homeowners to include more business owners and policy actors to increase impact	It is not clear that behavioral approaches are being directed to audiences that will have the largest potential magnitude of effects.
- Design interventions as experiments to improve effectiveness over time	The reasons that behavioral interventions are or are not successful are not well understood. Systematic reporting of projects and measures of success will increase learning and make programs more effective over the long term.
Harder goal: Develop stable funding sources to support work by partners	
<i>Recommendation</i>	<i>Rationale</i>
- Develop funding sources with partners for rigorous behavioral interventions experiments that increase the evidence base	More research is needed to advance understanding of the methods that lead to successful behavioral interventions. Resources will only be sufficient if CBP works with partners to fill knowledge gaps.

4.2.4.1 Easier goal: Expand the use of additional promising social science techniques and promote rigor and impact in application

Our review of past social science efforts by CBP partners revealed that only 19% of such efforts applied any kind of social theory. Projects that are well aligned with theory, including by combining multiple elements of the G-ITM framework, are often found to have higher probability of success in the literature. Further, understanding a behavioral intervention's underlying theory is what allows a practitioner to adapt an established approach to a different context and to improve upon failures or partial successes in the future. Approaches that have had wild success in one setting can completely fail in another setting. Applying theories from multiple social science disciplines can help to explain why this happens and to mitigate the likelihood of failure going forward. Appropriate metrics of success for interventions, based on exploratory groundwork and theory, will deepen understanding over time.

Our review of case studies and social science research evidence revealed that some of the more consistently effective behavioral interventions have not been used by partners. In particular, descriptive social norms, or statements about how most people behave, have relatively high probability of success, but have not been used in the reviewed case studies. An example of a descriptive social norm is, "Last month, you consumed 150 gallons of water per day. The average person in your community consumes 101 gallons per day." The principle behind this intervention is that people have a desire to conform to the group norm, and highlighting how a person deviates from average water consumption will generally encourage them to move towards that norm. Similarly, defaults are not being used, despite having some of the most substantial effects on behavior. Defaults work by making the desired behavior easier to engage in than other behaviors. For example, a study showed that sedentary behavior in the workplace was reduced when variable-height desks were raised to a standing position as an initial default, before being varied over the day (Venema et al. 2018). Employees spent significantly more time standing than sitting, even after the researchers stopped setting the desk heights. The default of a standing setting on the desk makes it easier for people to choose to stand rather than if they had to decide to lower the desk. Defaults can be difficult to implement but descriptive social norms (describing what people are doing) are similar to existing programs that use injunctive social norms (describing what people should be doing) and are only limited by availability of data (e.g., rates of BMP adoption).

While behavioral interventions can create significant change in audience behaviors, the ultimate environmental result of these interventions will depend on the magnitude of impact that an audience's behavior has on the environment. This means that devoting resources to behavioral interventions with individuals or businesses whose behavior has a relatively large effect on the Bay agreement goals could be a cost-effective approach. Often these groups' behavior affects environmental outcomes indirectly, through changing the ways that others directly interact with the environment. For example, Kanter et al. (2020) identify how farmers are just one among many groups influencing nitrogen runoff from agriculture, with others being the fertilizer industry, traders and processors, and retailers. Investing in behavioral interventions among these groups could provide new opportunities to reduce agricultural runoff. Additionally, expanding the audiences for behavioral interventions will also help to build the evidence base about what works across communities and decision types.

“[Social science should be used to] better understand what prevents decision-makers from adopting protective environmental policies and investing more heavily in restoration work.” - Questionnaire respondent

Lastly, designing outreach and social programs as experiments will help to improve effectiveness over time. In particular, behavioral nudges or other interventions rooted in behavioral economics are relatively easy to design as outreach experiments, because a treatment group can be readily compared to a control group. Other intervention types may need to conduct before-and-after surveys or similar approaches. Further, because behavioral interventions can potentially be interpreted as a manipulation, they should be carefully designed in equal partnership with stakeholder representatives to reduce conflict and align with communities’ goals. Although project evaluation takes time and resources, it contributes to an evidence base that can be applied to design future outreach and interventions for increasing effectiveness.

4.2.4.2 Harder goal: Develop stable funding sources to support work by partners

The ability to cost-effectively use behavioral interventions and match intervention types to specific decision contexts will require investment in expanding the evidence base. The CBP should endeavor to work with partners in finding resources to fill knowledge gaps. While some funding opportunities, such as the National Fish and Wildlife’s (NFWF’s) Small Watersheds Grant program, include language that encourages proposals to include social science, such opportunities do not put social science goals at the forefront and tend to limit the resources available for rigorous investigations. A pressing need in behavioral science and relevant to CBP goals is to understand what sustains behavior change over time. While many practitioners have developed methods that they promote as effective, the scientific evidence suggests that the effectiveness of many intervention types varies widely and is often low (Appendix B.2.1). These unanswered questions will only be addressed if research is designed to address them, making the expansion of funding opportunities critical.

4.3 FINDING 3: Underuse of social science knowledge as part of adaptive management

CBP and its partners have long embraced and built upon principles of adaptive management in their environmental work, particularly through the evolving use of the Strategy Review System (SRS). However, our results suggest the need to bolster the partnership’s adaptive management of lagging goals by integrating social science at the local, regional, and full partnership scales. Many interview and questionnaire respondents felt that progress on agreement goals was lagging specifically because programs were not able to adapt to new knowledge or community concerns. To improve adaptive management at this programmatic level, partners suggested conducting groundwork (defined in 3.2.2) to better understand local issues. Partners stressed the need for a deeper engagement than the type conducted in the past that affords the option to change some goals and performance indicators to resonate with affected communities. At the institutional-level, CBP’s adaptive management could benefit from ideas developed for similar organizations, such as evaluating how organizational incentives and processes influence decision-making and innovation and strengthening inter- and intra-organizational networks (Biedenweg et al. 2020; Harguth et al. 2015; Maxwell et al. 2019; Bennett 2021; Bennett et al. 2019; Yaffee and Wondolleck 2000). Acting on these needs will require significant

investment, as the ability of organizations to engage in adaptive management is partly influenced by their willingness to reallocate resources and try new ideas.

4.3.1 Adaptive Management at Programmatic Level: Groundwork and co-design

*“Social science can help to understand why certain practices or recommendations did not yield desired results and distill lessons learned that can be applied as the program seeks to adaptively manage our efforts” -
Questionnaire respondent*

Social scientists with the CBP voiced the need to work more closely with communities at local and regional scales to ensure that CBP’s on-the-ground and in-the-water programs align with their needs. While some efforts to engage with stakeholders and local governments currently exist, the social scientists suggested that partner organizations are not adequately listening and adapting. They recommended that more social scientists, as funded by partner groups, should be doing fieldwork with local stakeholders, and particularly marginalized communities, to understand their needs. As one questionnaire respondent put it, “...better understanding how to engage the disengaged will be critical to success”.

To best adapt CBP program to communities’ priorities, this groundwork would then provide the basis for co-designing new programs with communities. Co-design (also called co-production and transdisciplinary science) is a loosely defined term (Moser 2016). But, in its fullest form, co-design promotes an iterative process of problem solving that balances diverse perspectives, encourages deep listening and learning, and uses social science techniques to address conflict and power imbalances (Norström et al. 2020; Turnhout et al. 2020; Wondolleck and Yaffee 2017). Co-design is often recommended as a way for partnerships similar to CBP to adapt their programs to better fit their varying contexts (e.g. Bennett 2021; Bennett et al. 2019; Yaffee and Wondolleck 2000), largely because it often creates new ways of thinking about problems and requires substantial change by all participants, not only the public.

“If the program is focused on addressing local society needs, you could have a better following and support for CBP goals.” - Questionnaire respondent

While it may sound superficially like any typical stakeholder engagement, research-informed co-design is different from how engagement has typically been conducted within CBP. A specific issue raised by partners was that managers may assume that they know what motivates people and may develop research products based on those assumptions, rather than getting to know the “customer,” as one person phrased it. Many other public engagement processes are similarly designed ad-hoc. But much can be learned from the scientific literature on co-design about how small details in the design of engagement processes can influence outcomes (examples in Table 8), and the extent to which different contexts requires continual adaptation. Further, innovation can emerge when diverse sources of knowledge are allowed to contribute to and negotiate new approaches (Moser 2016). For these reasons, an organization that is somewhat similar to the CBP, the partnership managing the California Delta, now uses co-design to develop their science action agenda that establishes science priorities based on the needs of multiple agencies, groups and constituencies (Delta Science Program 2022).

“I feel like we get talked to a lot, and not necessarily listened to a lot.” - Interviewee, regional-level

Table 6. Some co-design details that have been investigated (from Moser 2016)

Initiation
<ul style="list-style-type: none"> • Project idea initiator • Project idea ownership • Project driver: (anticipated or expressed) need, opportunity
Partner selection criteria
<ul style="list-style-type: none"> • Topical expertise/relevance/stakes • Regional expertise/relevance/stakes • Complementarity • Partners with well-aligned norms, opinions, goals • Partners with opposing norms, opinions, goals
Partner selection processes
<ul style="list-style-type: none"> • Reliance on existing networks • Extension beyond existing networks • Identification and development of new partnerships
Length and frequency of engagement
<ul style="list-style-type: none"> • Frequency range: from once, to several times, to regularly, to ongoing • Length range: from a few hours to several days/meeting • Combination of lengths and frequency
Type of engagement
<ul style="list-style-type: none"> • In-person vs. virtual (phone, skype, email, written input) • Direct exchange vs. platform-supported • Fully facilitated (by professional facilitator from within or outside the core team) vs. hardly facilitated/free flowing
Level of engagement (ladder of engagement)
<ul style="list-style-type: none"> • Inform • involve • consult • empower • Range from one-way input/delivery to two-way or multi-directional dialogic exchange
Current Opinion in Environmental Sustainability

4.3.2 Adaptive Management at the Institutional Level: Incentives and Networks

“There is a log jam at the Management Board level. They have been empowered to do much but can't do everything that the GITs request of them.” - Interviewee

Our findings suggested missed opportunities to embed adaptive management within the institutional dimensions of CBP. An example raised by respondents was that requests to the Management Board for social science needs that emerged during the SRS process were not addressed, even for simple information requests. Also, a common perception was that those who control resources (staff time, funding) were not supporting the full suite of watershed agreement goals, but only the legally required TMDL goals. A lack of strong incentives for goals other than water quality was seen as contributing to a lack of responsiveness and several respondents suggested improved incentives for some goals were needed. Thus, while some found the SRS process useful for motivating action and aligning goals, others saw the process itself in need of adaptive management to ensure that meets all partners’ needs.

“The CBP needs to think more carefully about how to use social sciences to guide its internal work, especially with regards to internal structure change (e.g. funding structures, decision-making structures) and staff behavior changes (e.g. improve how staff carry out collaborations with external stakeholders/communities)” - Questionnaire respondent

In our questionnaire, we asked respondents about institutional characteristics that are thought to promote successful institutional adaptive management. Their responses suggest that CBP exhibits some of these characteristics but that it also has room for improvement. One characteristic that supports adaptive management is when partners have compatible goals and when collaborating benefits those goals (Yaffee and Wondolleck 2000). We largely found evidence that this characteristic exists across different organizations in the partnership. The vast majority of respondents said that their responsibilities at their home organization and the partnership were well aligned, even among those outside of EPA (Appendix Figure C18). Although the majority of respondents said that work with CBP improved their personal and agency capabilities, respondents in the state government category were less likely to fully agree, particularly when evaluating whether work with CBP helped others in their organization (Figure 9).

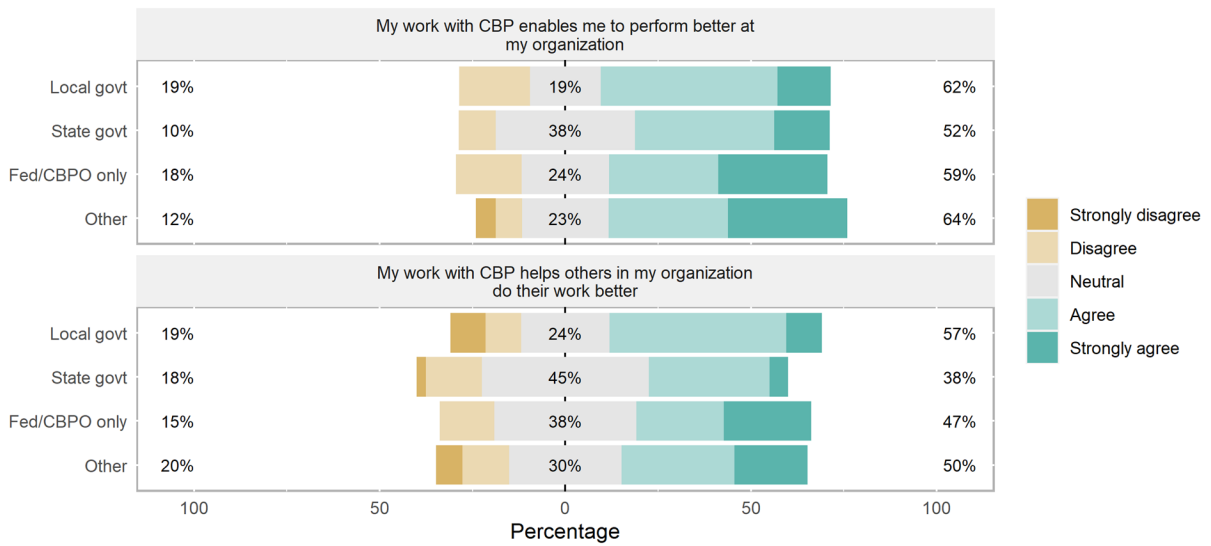


Figure 9. Degree of spillover benefits to organizations from being a CBP partner by partner type

However, respondents shared concerns about ineffective knowledge sharing across the partnership. Effective adaptive management requires mechanisms that allow partners to generate, share, and translate knowledge into new policies (Gerlak et al. 2020). Yet, a common theme among interviewees was the large extent to which the GITs and workgroups are isolated from each other. The interviewees characterized most prior interactions between GITs and workgroups as happening informally through interpersonal relationships or the willingness of chairs to collaborate, rather than as a planned aspect of CBP’s normal functioning. They expressed how they are not encouraged to share their successes or seek assistance outside their workgroups and GITs. One interviewee described how this isolation relates to

social science by describing DEIJ activities that occurred in one workgroup and would have been beneficial to others, but were not shared with relevant partners.

“The Bay Program framework does not allow the people who should be connecting with each other to do so. Most connecting between different groups happens through interpersonal relationships, rather than as a product of the Bay Program organizational structure.” - Interviewee

4.3.3 Need for anticipatory adaptive management

While not a common theme among respondents, the issue of preparing for an uncertain and rapidly changing future was raised during interviews. The need for forward looking science, policy and management is clear as the CBP will soon be entering a new phase following the 2025 deadlines for the TMDL. Some work has been done to identify future science needs (Hood et al. 2021) and prepare for climate change (CBP Climate Resiliency Working Group). However, fully preparing for future change will include considering shifts in human behavior (e.g., growing new crops), changes in ecosystem processes (e.g., shifting food webs) and interactions among changes (Norgaard et al. 2021; Oteros-Rozas et al. 2015; Pinsky et al. 2020). Further, enhancing the ability to test whether policies and plans work well under diverse future events (i.e., stress-testing) can be used to avoid regret if the future turns out to be different from our best forecasts (Fischbach et al. 2015; Marchau et al. 2021; NOAA SAB 2021).

Anticipatory management is informed by making future projections of ecological, social and institutional change and considering interactions among changes. However, respondents suggested that social science has not historically been well used for these purposes. Of particular relevance, psychology and behavioral economics have uncovered many common biases or aspects of human reasoning that can interfere with effective risk management and future planning (Thaler and Sunstein 2008; Kahneman and Tversky 2012) and these biases also contribute to institutional barriers to adaptation (Cinner et al. 2021). As an example, future scenarios, which are commonly used for anticipatory risk management, can be limited by the mental biases of their human creators. Psychological biases, such as the optimism and status quo biases, lead people to think that the future will be similar to and not substantially worse than the present. We found a potential example of that bias when questionnaire respondents identified a lack of systematic application of climate change risks to wetland restoration choices and plant species used in restoration.

4.3.4 RECOMMENDATION 3: Use social science in adaptive management in programs and institutions

Table 7: Summary of recommendations and rationale for using social science in adaptive management

Easier goal: Use social science to adaptively manage programs	
Recommendation	Rationale
- Conduct social science groundwork to understand why progress on certain goals is lagging	Some of the social sciences, especially anthropology, sociology and economics, can provide useful insights about why goals are not progressing by examining cultural values, social characteristics, and incentives
- Co-design and implement solutions to lagging goals with relevant local communities	For high-priority and high-impact management issues, develop capacity for intensive processes of working with communities to co-design solutions
- Identify or conduct research that will allow CBP to anticipate socio-demographic and behavioral changes that are likely to affect its future work	Human behavior has the capacity to exacerbate or ameliorate changes in biophysical conditions and therefore incorporating human behavior can improve future projections and policy analysis.
Harder goal: Use social science to adaptively manage institutions	
Recommendation	Rationale
- Apply institutional science to identify opportunities to improve partnership function, particularly with local and regional stakeholders	Institutional analyses can support adaptation and effective strategic planning by providing relevant data and information about what is and is not working well with structures and processes.
- Adapt institutional rules and processes where barriers have been identified	Some simple changes could be used to promote cooperative, adaptive problem-solving.
- Apply decision science / social science to identify potential blind spots in how institutions anticipate and prepare for future risks	By using data analysis, horizon scanning and other techniques to anticipate extreme events and uncover diverse sources of risk, agencies can design forward-looking policies and become nimbler at responding to crises.

4.3.4.1 Easier goal: Create conditions that support using social science to adaptively manage programs

Social science groundwork often has diffuse benefits but can be an effective component of adaptive management to address lagging goals. Place-based groundwork largely aims first to thoroughly understand the diversity of concerns within and across communities, and second to systematically seek their input on how CBP efforts can align, or potentially misalign, with efforts to address those concerns. Such groundwork is often needed to earn the trust of key stakeholders and to identify a full set of issues

that may be limiting change. Intensive study typically takes the form of working with a relatively small group of individuals over long time periods. As a result, such investigations need to be supported with sufficient resources to conduct quality investigations. The co-design processes explained in Section 3.4.1 are also time consuming and resource intensive. As such, their use must be directed towards high priority goals that can most benefit from this type of intervention. The partnership has followed this recommendation in the past, largely applying co-design to fisheries management issues. Further groundwork and consultation with social scientists and policy-makers can help identify other topics appropriate for co-design.

Relatively small steps to incorporate human behavior can inform risk management and policies to address changing conditions. For example, during the ongoing drought in California, initial appeals to reduce water use appeared to backfire when water use increased soon after the appeals were made. However, a simple behavioral model of water use would have anticipated that baseline water demand would increase with lower rainfall, thereby obscuring the signal of any water reductions made. Accounting for this behavioral shift helped researchers to realize that current policies were partially successful but also required greater enforcement to achieve desired levels of water consumption. More generally, data on how people have responded to past drivers provides evidence of relationships that can be used to project future responses, with or without a policy change. Models that incorporate the variables that represent causal drivers of change, rather than simply projecting past trends into the future, will be better able to anticipate shifts in behavior in response to social, legal and market forces.

4.3.4.2 Harder goal: Apply institutional science to improve partnership function, in partnership with local and regional organizations

The first recommendation to enhance adaptive management would be to apply institutional science analyses to consider whether any adjustments in partnership structure or processes could be beneficial. Institutional science (and related fields of sociology, policy, psychology, management, and economics) can reveal opportunities to improve collaboration and cooperation by changing organizational incentives, inter-organizational and inter-personal relationships, and methods of learning (Gerlak et al. 2020; Heikkila et al. 2020; Wondolleck and Yaffee 2017: Chapter 8; Ehrlichman 2021). Many partners stressed the need for greater institutional flexibility and support for innovation, which would enable pathways for “bottom up” ideas to influence policy. Some recommendations for potential institutional change to promote social science integration have already been made throughout other recommendations. The partnership already follows many of the recommendations that have emerged from the study of how environmental governance institutions learn including, “face-to-face dialog that is open and ongoing; cross-scale linkages [networks across geographic scales]; and investments in institutional rules, norms, and shared strategies for intentional learning.” (Gerlak et al. 2020; Heikkila and Gerlak 2005). What is being proposed here is a thorough approach to reviewing institutional relationships and incentives to reduce frustrations, increase efficiency of interactions, and enhance progress on any partnership goal. Investigations could be designed to provide insights on specific questions such as misalignments between goals and funding, whether there is common understanding of responsibilities for goals, and other applicable insights about governance.

Decision science and futurism are among the social science fields that have developed methods designed to mitigate some of the psychological biases that can limit the ability of scenario planning to incorporate novel insights (Erdman et al. 2015, McGonigal 2022). Horizon scanning is a concept applied

by futurists who have developed mechanisms to identify important signals of change from multiple sources (articles, reports, news articles, social media) and to single out signals that may be relevant to modelers and planners (e.g., McGonigal 2022). In addition, all types of social sciences have qualitative or quantitative insights about potential future behavior change, based on their theories and empirical models of behavioral motivations. By identifying sources of potential future crises or windfalls, such efforts help to prepare agencies to act quickly to unexpected change and could reveal monitoring, analytic, planning and communication needs.

4.4 FINDING 4: Lack of strategic planning for social science integration

Questionnaire and interview respondents reported receiving little support for integrating social science and thought that the support that was given was sometimes lacking a strategic focus. Multiple partners suggested that CBP resources were spread too thinly across many goals and that some easy-to-address issues were getting repeated attention at the expense of more fundamental, but difficult, problems. Some interviewees described how workgroup priorities were largely established based on champions taking up an idea, rather than through systematic evaluation of potential benefits. We also found that environmental policy actors who are not trained in social science often conceive of it as something to be applied in a piecemeal fashion when needed to change the behavior of the public, businesses, or policy-makers. These findings suggest that, thus far, social science has been applied opportunistically, rather than strategically, at CBP.

“The lack of attention to people’s behavior and incentives...is because implementation programs and the TMDL don’t begin with this as a central challenge to managing pollutants.” - Questionnaire respondent

The lack of strategic planning for social science appeared to stem, in part, from the incentive structure of the Bay agreement goals. We interviewed some managers who reported making difficult choices about allocating resources where they were forced to prioritize required biophysical analyses over social science investments. Because program evaluation and monitoring of social indicators were never integrated into required tasks, social scientists reported that their projects were less competitive for limited funding. A related concern was that GIT funding is partly prioritized by estimated progress on outcomes, and the results of social science tend to be too indirect to tie closely to such indicators. One interviewee expressed that securing investments in social science necessitates making clear connections between social science research and eventual pollution reduction, even though the immediate payoffs are diffuse. Others felt like the funding situation creates a Catch-22, in that social science research needs to be funded in order to demonstrate why social science research needs to be funded.

“The biggest obstacle to incorporating more social science into our work is the lack of dedicated resources to conduct this work.” - Questionnaire respondent

The ability to engage in social science activities is potentially limited by insufficient time to go beyond required activities. Federal employees, in particular, had high disagreement that they had enough time to complete tasks for CBP and their main host organization (Figure 10). Similarly, those respondents who had not engaged with social science listed constraints on funding, time, and expertise as top reasons for not doing so, and many mentioned how social science was not a priority for them (Figure 11).

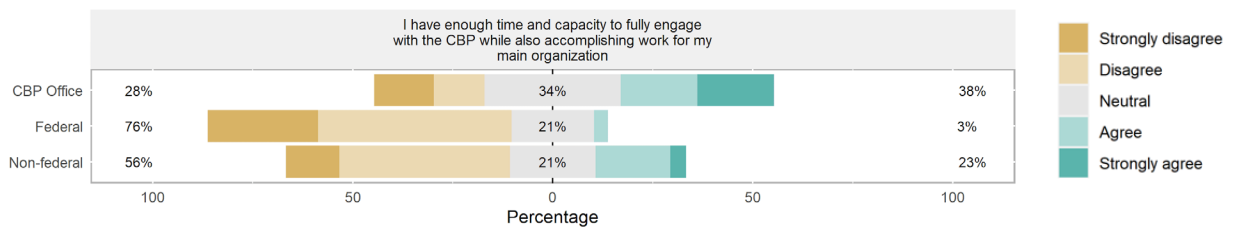


Figure 10. Respondent time availability to engage with CBP by host organization

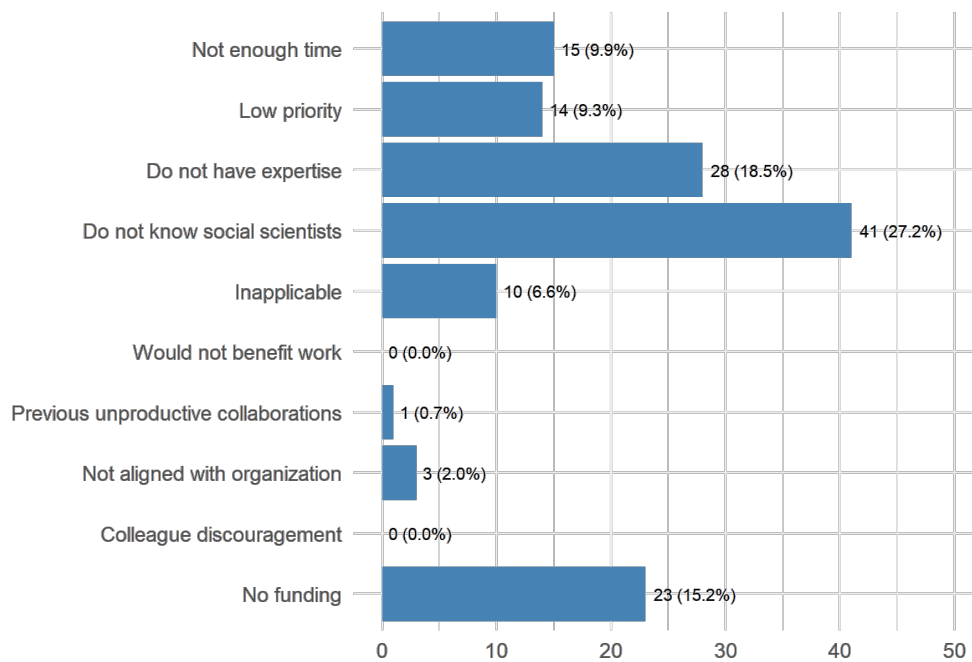


Figure 11. Reasons for not working with social scientists for respondents who had not worked with social science (N = 70)

The interviewees included those who were working to integrate social science in select programs, but many mentioned strong institutional barriers, including lack of support for innovation from CBP. Questionnaire respondents had diverse responses to questions about their ability to innovate and target resources, reflecting heterogeneity across people, partner type, and host organization (Figure 12). In particular, respondents based in local governments reported much less ability to innovate compared with respondents in other organizations, with 43% disagreeing or strongly disagreeing that CBP provides assistance in developing new ideas (Appendix C, Figure C.15). Disagreement was only 22-26% of other respondents. This disparity could indicate that local governments do not see themselves as active participants in setting CBP’s agenda, and that priorities are set by those at higher levels of government.

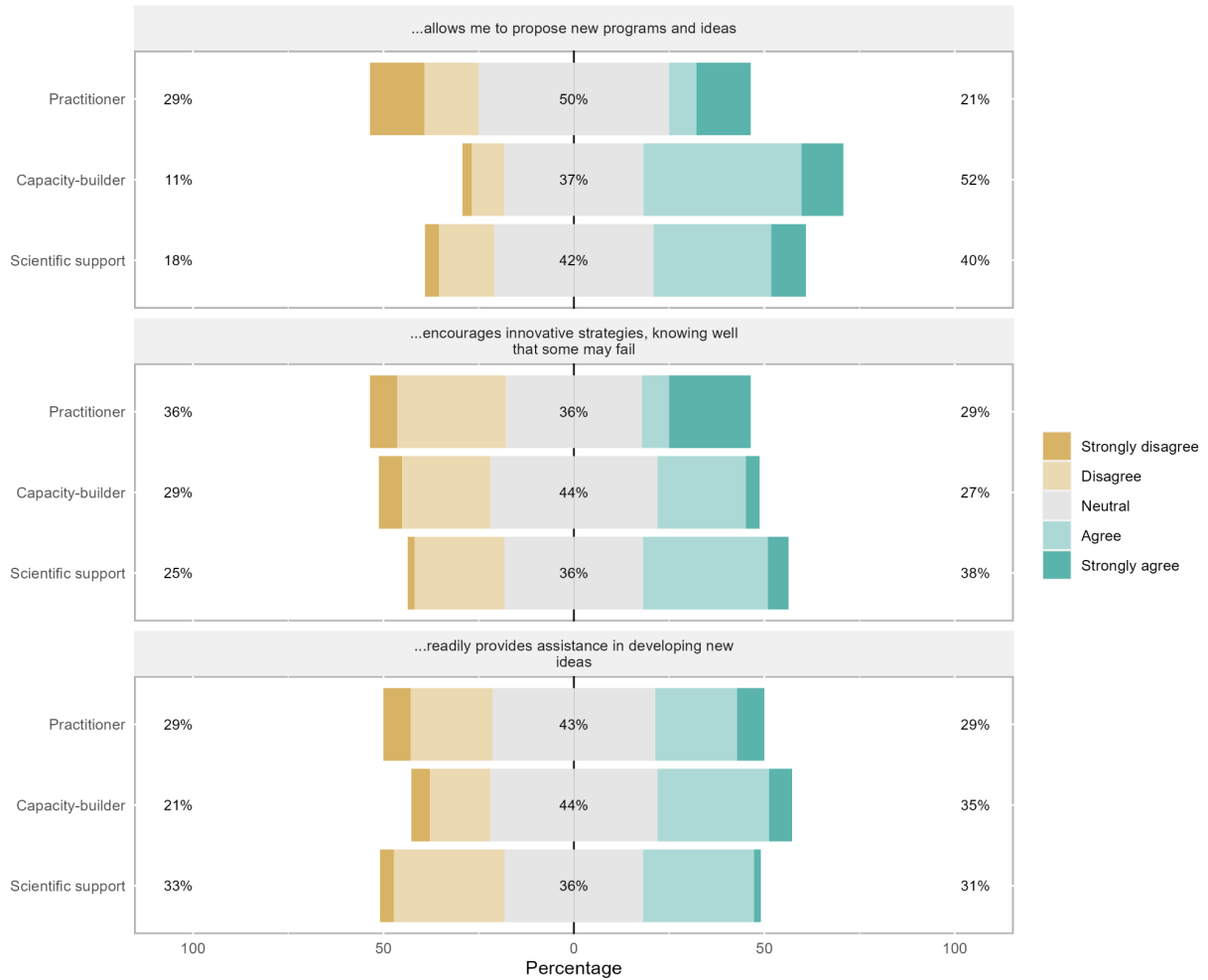


Figure 12. Respondents capacity to innovate at CBP by role

Roles: Practitioner (mainly implements projects on the ground), Capacity-builder (mainly supported practitioners), and Scientific support (mainly produces knowledge) roles. All statements begin with “The Chesapeake Bay Program...”

Across the respondents, there was a general sense that better coordination and strategic planning, both within CBP and between it and outside stakeholders, would further enable social science to contribute to achieving the program’s goals. Within the CBP, they suggested improving coordination at the project planning stage so that multiple groups were not replicating the same efforts in an unplanned manner. Such coordination requires better communication between GITs and workgroups, particularly between the staffers and coordinators who set the agendas for GIT meetings. Between CBP and other stakeholders, interviewees recommended building on existing efforts and stakeholders’ interests to develop projects that will have co-benefits for both community and CBP goals. Some interviewees suggested the need for a communication framework that helps them reach out more equitably across, regional, educational, and linguistic lines. Others mentioned how they do not know where to find social scientists with whom to collaborate, and that a database or a workshop identifying these individuals would be helpful.

4.4.1 RECOMMENDATION 4: Be strategic in applying social science

Table 8: Summary of recommendations and rationale supporting strategic application of social science

Easier goal: Begin developing and implementing strategic planning process	
<i>Recommendation</i>	<i>Rationale</i>
- Develop a detailed strategic plan to enhance the impact of social science research	- A strategic plan is an opportunity to evaluate the most effective role for CBP in advancing social science, including considering distribution of resources to fund high-impact projects, to support other institutions that fund practitioners and social scientists, or support networks with shared goals.
- Create an organizational structure to effectively implement social science strategy, including: <ul style="list-style-type: none"> - Identify people with primary responsibility to collaborate with social scientists - Engage partners with decision making authority in GITs 	- Without appropriate people and programs to implement a strategy, it will not progress. Social science integration will not happen without people who have primary responsibility to respond to social scientists or practitioners, participate in collaborative decision making, or otherwise facilitate coordination.
Harder goal: Develop internal resources and processes to support strategic application of social science	
<i>Recommendation</i>	<i>Rationale</i>
- Develop internal resources for social science research on the partnership (e.g., databases, institutional liaisons)	- Social scientists (internal and external to the partnership) will have increased capacity to evaluate community and institutional concerns, if some basic resources are provided by partners for research.
- Create a process to periodically update and adapt the social science strategic plan	- A process for updating the strategic plan (recommended under short term goals) will be needed to ensure the plan stays relevant and evolves.

4.4.1.1 Easier goal: Begin developing and implementing strategic planning process

Given the many comments that current social science efforts may not be directed where they are most needed or effective, we recommend developing a strategic plan to address these concerns. The goals of strategic planning would be to choose priorities based on the importance of goals and the potential impact of activities at the appropriate scale. Strategic planning often involves examining how to leverage existing institutions and partnerships to enhance capacity and share responsibility for common needs. Strategic planning is commonly done in facilitated workshops and other co-design methods (Section 3.4.1) that evaluate management needs and the most effective role for CBP in meeting those needs through alternative social science investments. Critical to the co-design process will be to include diverse (and practical) social scientists and practitioners since they have the knowledge necessary to understand opportunities and requirements for successful application of social science (see prior recommendation). The external social scientists recommended in 3.1.1. could be used to identify opportunities to apply

and advance social science that may not emerge otherwise, which is consistent with how many governmental programs have standing groups of science advisors to offer useful strategic advice. A key question raised by partners was whether CBP should fund and support individual projects or find ways to support local governments, non-governmental organizations, and networks through new or existing programs. The Chesapeake Funders Network was an example raised by some local practitioners who found their support invaluable. They reported that their willingness to fund strategic planning and ongoing administrative capacity increased their effectiveness in implementing projects because it built skill for making better choices of what to fund and how to better support practitioners.

To make concrete progress on social science application, institutions will need to foster a commitment to acting on strategic plans in multiple ways. We have identified a few institutional barriers, but further work is needed to identify concerns and possible solutions. One of the key issues we heard from partners was that some GITs do not have the appropriate match between expertise and goals. Another major constraint was that the SRS process was not always working as intended when GITs asked for assistance from partners, particularly when responses involved social science investigations or applications. As a result, we recommend that specific people be given responsibility for acting as liaisons between GITs and partners, including, but not limited to, the Management Board. Not only is the Management Board fielding too many requests, members may resist requests that do not represent shared priorities. A common vision of problems, priorities and approaches will need to be established to promote cooperation across partners. One partner suggestion was to involve those with decision making authority on the GITs to promote a shared vision of goals and approaches. Other types of co-design are discussed in the next set of recommendations.

4.4.1.2 Harder goal: Develop internal resources and processes to support strategic social science

Similar to how CBP has developed a system to collect and monitor data on ecological indicators, institutional data and information can be developed to enable social scientists to create insights that can increase efficiency and effectiveness of policies and programs. The type of insights that might be produced are diverse but include identifying the characteristics of institutions and partnerships that are able to scale up and sustain initial successes from place-based test cases. Or, put more simply, move from success stories to successful strategies. Diffusion of innovations within institutions is an active area of study, and aims to use an evidence-based approach to promote ideas that are consistently effective or a good fit to a particular program (Breaugh et al. 2021; Strang and Macy 2001). To generate such insights, social scientists and practitioners will need better cooperation and resources from across the partnership. For example, GIT members engaged in adaptive management reported seeking basic information about program design or key informants from the Management Board, but sometimes received no responses to requests. A long-term vision for improving the ability of institutional and other social sciences to offer insightful studies and relevant advice includes longitudinally tracking institutional structures, relationships, and resources, so that they can be compared to satisfaction with processes and progress on outcomes.

Strategic plans must be periodically revised to be useful and to adapt to new information or changing social and ecological contexts. Establishing a strategic plan as a milestone to be met every few years is one way to promote routine updates of the plan. Additional analyses may be needed to inform the plan such as network analyses or conceptual models that diagram how institutions and communities are

contributing to diverse goals. Both major and minor changes in strategy may need to be considered to adaptively manage, such as altering goals, analytic processes, or partnership structure.

5 Conclusions

We have evaluated the use of social science to achieve specific accessible goals and how it might be applied to inform future adaptive management. The first steps are to increase awareness of the utility of social science to improve program performance and to increase capacity to conduct social science. The CBP is well-positioned to use social science, but progress will continue to be diffuse unless it invests in internal positions, external partnerships and more research.

6 Acknowledgements

We thank, without implicating, our advisory committee members for their helpful input and perspectives on the challenges and opportunities for social science in the Chesapeake Bay Partnership. Members were Suzanne Etgen, Lucinda Power, Katie Brownson, Rachel Felver, Bill Jenkins, Shannon Sprague, Kristin Saunders, Laura Cattel Noll, Kathy Boomer, Greg Allen, Renee Thompson, Britt Slattery, Jess Blackburn, Greg Barranco, and Bo Williams. We are also grateful to those who shared their time in answering the questionnaire and participating in interviews. Finally, we thank our program managers, Amy Handen and Kacey Wetzel for invaluable insights and guidance. We also thank the Stewardship Goal Implementation Team for their interest and support,

7 References

- Ajzen I. 1991. The theory of planned behavior. *Organizational behavior and human decision processes* 50:179–211. Elsevier.
- Andersen SC, Jakobsen M. 2017. Policy positions of bureaucrats at the front lines: Are they susceptible to strategic communication? *Public Administration Review* 77:57–66. Wiley Online Library.
- Andersen SC, Moynihan DP. 2016. Bureaucratic investments in expertise: Evidence from a randomized controlled field trial. *The Journal of Politics* 78:1032–1044. University of Chicago Press Chicago, IL.
- Andor MA, Fels KM. 2018. Behavioral economics and energy conservation—a systematic review of non-price interventions and their causal effects. *Ecological economics* 148:178–210.
- Avellaneda CN. 2013. Mayoral decision-making: Issue salience, decision context, and choice constraint? An experimental study with 120 Latin American mayors. *Journal of Public Administration Research and Theory* 23:631–661. Oxford University Press US.
- Barth M, Masson T, Fritsche I, Fielding K, Smith JR. 2021. Collective responses to global challenges: The social psychology of pro-environmental action. *Journal of environmental psychology* 74:101562.
- Bennett D, Barnwell C, Freedman K, Smutko S, Wittman T, Western J. 2019. Developing a social science research agenda to guide managers in sagebrush ecosystems. University of Wyoming, Laramie, WY: Ruckelshaus Institute of Environment and Natural Resources.

Bennett N. 2021. Integration of Social Science into the Working Land and Seascapes Initiative. Report delivered to the Smithsonian Institution.

Bennett NJ, Roth R, Klain SC, Chan K, Christie P, Clark DA, Cullman G, Curran D, Durbin TJ, Epstein G. 2017. Conservation social science: Understanding and integrating human dimensions to improve conservation. *biological conservation* 205:93–108.

Biedenweg K, Sanchirico JN, Doremus H, Johnston RJ, Medellin-Azuara J, Weible CM. 2020. A Social Science Strategy for the Sacramento-San Joaquin Delta. Report to Delta Stewardship Council.

Biedenweg K, Trimbach D, Delie J, Schwarz B. 2020b. Using cognitive mapping to understand conservation planning. *Conservation Biology* 34:1364–1372.

Bishop ID, Pettit CJ, Sheth F, Sharma S. 2013. Evaluation of data visualisation options for land-use policy and decision making in response to climate change. *Environment and Planning B: Planning and Design* 40:213–233. SAGE Publications Sage UK: London, England.

Bosetti V, Weber E, Berger L, Budescu DV, Liu N, Tavoni M. 2017. COP21 climate negotiators' responses to climate model forecasts. *Nature Climate Change* 7:185–190.

Breaugh J, McBride K, Kleinaltenkamp M, Hammerschmid G. 2021. Beyond Diffusion: A Systematic Literature Review of Innovation Scaling. *Sustainability* 13:13528.

Butler DM, Broockman DE. 2011. Do politicians racially discriminate against constituents? A field experiment on state legislators. *American Journal of Political Science* 55:463–477.

Butler DM, Nickerson DW. 2011. Can learning constituency opinion affect how legislators vote? Results from a field experiment. *Quarterly Journal of Political Science* 6:55–83.

Byerly H, Balmford A, Ferraro PJ, Hammond Wagner C, Palchak E, Polasky S, Ricketts TH, Schwartz AJ, Fisher B. 2018. Nudging pro-environmental behavior: evidence and opportunities. *Frontiers in Ecology and the Environment* 16:159–168.

Carlsson F, Johansson-Stenman O. 2012. Behavioral economics and environmental policy. *Annu. Rev. Resour. Econ.* 4:75–99.

Cialdini RB. 2021. *Influence, New and Expanded: The Psychology of Persuasion*. Harper Business, New York.

Cinner JE et al. 2018. Building adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change* 8:117–123. Nature Publishing Group.

Delta Science Program. 2022. 2022–2026 Science Action Agenda: A Vision for Integrating Delta Science. Delta Stewardship Council. Available from <https://scienceactionagenda.deltacouncil.ca.gov/>.

Ehret PJ, Hodges HE, Kuehl C, Brick C, Mueller S, Anderson SE. 2021. Systematic review of household water conservation interventions using the information–motivation–behavioral skills model. *Environment and Behavior* 53:485–519.

Ehrlichman D. 2021. *Impact Networks: Create Connection, Spark Collaboration, and Catalyze Systemic Change*. Berrett-Koehler Publishers, Oakland, CA.

Erdman D, Sichel B, Yeung L. 2015. Overcoming obstacles to effective scenario planning. McKinsey on Finance 55. Available from https://www.mckinsey.com/~media/McKinsey/dotcom/client_service/Corporate%20Finance/MoF/Issue%2055/MoF55_Overcoming_obstacles_to_effective_scenario_planning.ashx.

Evans JSB. 2011. Dual-process theories of reasoning: Contemporary issues and developmental applications. *Developmental Review* 31:86–102.

Farrow K, Grolleau G, Ibanez L. 2017. Social norms and pro-environmental behavior: A review of the evidence. *Ecological Economics* 140:1–13.

Ferraro PJ, Miranda JJ. 2013. Heterogeneous treatment effects and mechanisms in information-based environmental policies: Evidence from a large-scale field experiment. *Resource and Energy Economics* 35:356–379.

Ferraro PJ, Price MK. 2013. Using nonpecuniary strategies to influence behavior: evidence from a large-scale field experiment. *Review of Economics and Statistics* 95:64–73.

Fischbach, J.R., Lempert, R.J., Molina-Perez, E., Tariq, A.A., Finucane, M.L., Hoss, F., 2015. Managing Water Quality in the Face of Uncertainty: A Robust Decision Making Demonstration for EPA’s National Water Program. RAND Corporation.

Fisher JD, Fisher WA. 1992. Changing AIDS-risk behavior. *Psychological bulletin* 111:455.

Fisher WA, Fisher JD, Shuper PA. 2014. Social psychology and the fight against AIDS: An information–Motivation–Behavioral skills model for the prediction and promotion of health behavior change. Pages 105–193 *Advances in experimental social psychology*.

Flynn BS, Goldstein AO, Solomon LJ, Bauman KE, Gottlieb NH, Cohen JE, Munger MC, Dana GS. 1998. Predictors of state legislators’ intentions to vote for cigarette tax increases. *Preventive medicine* 27:157–165.

Gerlak AK, Heikkila T, Newig J. 2020. Learning in environmental governance: opportunities for translating theory to practice. *Journal of Environmental Policy & Planning* 22:653–666.

Glanz K, Bishop DB. 2010. The role of behavioral science theory in development and implementation of public health interventions. *Annual review of public health* 31:399–418.

Grilli G, Curtis J. 2021. Encouraging pro-environmental behaviours: A review of methods and approaches. *Renewable and Sustainable Energy Reviews* 135:110039.

Grose CR. 2014. Field experimental work on political institutions. *Annual Review of Political Science* 17.

Groves DG, Lempert RJ. 2007. A new analytic method for finding policy-relevant scenarios. *Global Environmental Change* 17:73–85.

Harguth H, Stiles K, Biedenweg K, Redman S, O’Neill S. 2015. Integrated conceptual model for ecosystem recovery: A technical memorandum for the Puget Sound Partnership.

Heikkila T, Gerlak AK. 2005. The formation of large-scale collaborative resource management institutions: Clarifying the roles of stakeholders, science, and institutions. *Policy Studies Journal* 33:583–612.

- Heikkilä T, Weible CM, Gerlak AK. 2020. When does science persuade (or not persuade) in high-conflict policy contexts? *Public Administration* 98:535–550.
- Homar AR, Cvelbar LK. 2021. The effects of framing on environmental decisions: A systematic literature review. *Ecological Economics* 183:106950.
- Hood RR, Shenk GW, Dixon RL, Smith SM, Ball WP, Bash JO, Batiuk R, Boomer K, Brady DC, Cerco C. et al. 2021. The Chesapeake Bay program modeling system: Overview and recommendations for future development. *Ecological Modelling* 456:109635.
- Howlett M, Kemmerling A. 2017. Calibrating climate change policies: The causes and consequences of sustained under-reaction. *Journal of Environmental Policy & Planning* 19:625–637.
- Howlett M. 2014. Why are policy innovations rare and so often negative? Blame avoidance and problem denial in climate change policy-making. *Global Environmental Change* 29:395–403.
- Kahneman D, Tversky A. 1979. Prospect theory: An analysis of decisions under risk. *Econometrica* 47:263–291.
- Kalla JL, Broockman DE. 2016. Campaign contributions facilitate access to congressional officials: A randomized field experiment. *American Journal of Political Science* 60:545–558.
- Kanter DR, Bartolini F, Kugelberg S, Leip A, Oenema O, Uwizeye A. 2020. Nitrogen pollution policy beyond the farm. *Nature Food* 1:27–32.
- Kidd LR, Garrard GE, Bekessy SA, Mills M, Camilleri AR, Fidler F, Fielding KS, Gordon A, Gregg EA, Kusmanoff AM. 2019. Messaging matters: A systematic review of the conservation messaging literature. *Biological Conservation* 236:92–99.
- Knaggård Å. 2014. What do policy-makers do with scientific uncertainty? The incremental character of Swedish climate change policy-making. *Policy Studies* 35:22–39.
- Kolandai-Matchett K, Armoudian M. 2020. Message framing strategies for effective marine conservation communication. *Aquatic Conservation: Marine and Freshwater Ecosystems* 30:2441–2463.
- Linde J, Vis B. 2017. Do politicians take risks like the rest of us? An experimental test of prospect theory under MPs. *Political Psychology* 38:101–117.
- Maki A, Burns RJ, Ha L, Rothman AJ. 2016. Paying people to protect the environment: A meta-analysis of financial incentive interventions to promote proenvironmental behaviors. *Journal of Environmental Psychology* 47:242–255.
- Maor M, Tosun J, Jordan A. 2017. Proportionate and disproportionate policy responses to climate change: Core concepts and empirical applications. *Journal of Environmental Policy & Planning* 19:599–611.
- Marchau VA, Walker WE, Bloemen PJ, Popper SW. 2019. Decision making under deep uncertainty: From theory to practice. Springer Nature.
- Maxwell K, Hubbell B, Eisenhauer E. 2019. Institutional insights on integrating social and environmental science for solutions-driven research. *Environmental Science & Policy* 101:97–105.

- McGonigal J. 2022. *Imaginable: How to See the Future Coming and Feel Ready for Anything—Even Things That Seem Impossible Today*. Spiegel & Grau.
- Miler KC. 2009. The limitations of heuristics for political elites. *Political psychology* 30:863–894.
- Moon K, Blackman D. 2014. A guide to understanding social science research for natural scientists. *Conservation biology* 28:1167–1177.
- Moser SC. 2016. Can science on transformation transform science? Lessons from co-design. *Current Opinion in Environmental Sustainability* 20:106–115.
- Nielsen PA, Baekgaard M. 2015. Performance information, blame avoidance, and politicians' attitudes to spending and reform: Evidence from an experiment. *Journal of Public Administration Research and Theory* 25:545–569.
- Nisar MA, Maroulis S. 2017. Foundations of relating: Theory and evidence on the formation of street-level bureaucrats' workplace networks. *Public Administration Review* 77:829–839.
- NOAA Science Advisory Board. 2009. *Integrating Social Science into NOAA Planning, Evaluation and Decision Making: A Review of Implementation to Date and Recommendations for Improving Effectiveness*. SAB Social Science Working Group.
- Norgaard RB, Wiens JA, Brandt SB, Canuel EA, Collier TK, Dale VH, Fernando HJS, Holzer TL, Luoma SN, Resh VH. 2021. Preparing Scientists, Policy-Makers, and Managers for a Fast-Forward Future. *San Francisco Estuary and Watershed Science* 19. Available from <https://escholarship.org/uc/item/40x3z74k>
- Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, Bednarek AT, Bennett EM, Biggs R, de Bremond A. 2020. Principles for knowledge co-production in sustainability research. *Nature sustainability* 3:182–190.
- Nyhan B, Reifler J. 2015. The effect of fact-checking on elites: A field experiment on US state legislators. *American Journal of Political Science* 59:628–640.
- Oberfield ZW. 2009. Rule following and discretion at government's frontlines: Continuity and change during organization socialization. *Journal of Public Administration Research and Theory* 20:735–755.
- OBSSR. 2016. *The Office of Behavioral and Social Science Research. Healthier Lives through Behavioral and Social Sciences. Strategic Plan 2017-2021*. NIH Publication 16-OD-8026.
- Olsson P, Folke C, Galaz V, Hahn T, Schultz L. 2007. Enhancing the fit through adaptive co-management: creating and maintaining bridging functions for matching scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden. *Ecology and society* 12.
- Osbaldiston R, Schott JP. 2012. Environmental sustainability and behavioral science: Meta-analysis of proenvironmental behavior experiments. *Environment and behavior* 44:257–299.
- Oteros-Rozas E, Martín-López B, Daw TM, Bohensky EL, Butler JR, Hill R, Martin-Ortega J, Quinlan A, Ravera F, Ruiz-Mallén I. 2015. Participatory scenario planning in place-based social-ecological research: insights and experiences from 23 case studies. *Ecology and Society* 20. <https://www-ecologyandsociety.org/vol20/iss4/art32/>

Pinsky M, Rogers L, Morley J, Frölicher T. 2020. Ocean planning for species on the move provides substantial benefits and requires few trade-offs. *Science advances* 6:eabb8428.

Riley WT, Greene-Schloesser D, Blachman-Demner DR, Spittel M. 2020. Twenty-five years of the National Institutes of Health Office of Behavioral and Social Sciences Research. *Translational Behavioral Medicine* 10:1243–1248.

Rode JB, Ditto PH. 2021. Can the partisan divide in climate change attitudes be bridged?: A review of experimental interventions. *The Psychology of Political Polarization*:149–168.

Rogers E. 2003. *Diffusion of Innovations*, 5th edition. Free Press, New York.

Ruvio AA, Shoham A, Vigoda-Gadot E, Schwabsky N. 2014. Organizational innovativeness: Construct development and cross-cultural validation. *Journal of Product Innovation Management* 31:1004–1022.

Sheffer L, Loewen PJ, Soroka S, Walgrave S, Sheafer T. 2018. Nonrepresentative representatives: An experimental study of the decision making of elected politicians. *American Political Science Review* 112:302–321.

Slovic P, Finucane ML, Peters E, MacGregor DG. 2007. The affect heuristic. *European journal of operational research* 177:1333–1352.

Strang D, Macy MW. 2001. In Search of Excellence: Fads, Success Stories, and Adaptive Emulation. *American Journal of Sociology* 107:147–182.

Sunstein CR, Reisch LA. 2014. Automatically green: Behavioral economics and environmental protection. *Harv. Envtl. L. Rev.* 38:127.

Thaler RH, Sunstein CR. 2009. *Nudge: Improving decisions about health, wealth, and happiness*. Penguin.

Turnhout E, Metze T, Wyborn C, Klenk N, Louder E. 2020. The politics of co-production: participation, power, and transformation. *Current Opinion in Environmental Sustainability* 42:15–21.

Tversky A, Kahneman D. 1974. Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *science* 185:1124–1131.

van Der Vegt GS, Essens P, Wahlström M, George G. 2015. Managing risk and resilience. *Academy of Management Journal* 58:971–980.

Venema TA, Kroese FM, De Ridder DT. 2018. I'm still standing: A longitudinal study on the effect of a default nudge. *Psychology & Health* 33:669–681.

Vis B, Van Kersbergen K. 2007. Why and how do political actors pursue risky reforms? *Journal of Theoretical Politics* 19:153–172.

Wainger LA, Helcoski R, Farge KW, Espinola BA, Green GT. 2018. Evidence of a shared value for nature. *Ecological Economics* 154:107–116.

NOAA Science Advisory Board (SAB) and Ecosystem Science and Management Working Group (ESMWG). 2021. Decision Making under Deep Uncertainty: What is it and how might NOAA use it? to the NOAA SAB, Silver Spring, MD. Available from https://sab.noaa.gov/sites/SAB/Documents/Meetings/SAB%20Meetings%202021/ESMWG_DMDU%20Report_Jan2021_Final.pdf.

- White K, Habib R, Hardisty DJ. 2019. How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing* 83:22–49.
- White KM, Smith JR, Terry DJ, Greenslade JH, McKimmie BM. 2009. Social influence in the theory of planned behaviour: The role of descriptive, injunctive, and in-group norms. *British journal of social psychology* 48:135–158.
- Wolske KS, Gillingham KT, Schultz P. 2020. Peer influence on household energy behaviours. *Nature Energy* 5:202–212.
- Wondolleck JM, Yaffee SL. 2017. *Marine ecosystem-based management in practice: different pathways, common lessons*. Island Press.
- Wynes S, Nicholas KA, Zhao J, Donner SD. 2018. Measuring what works: quantifying greenhouse gas emission reductions of behavioural interventions to reduce driving, meat consumption, and household energy use. *Environmental Research Letters* 13:113002.
- Yaffee SL, Wondolleck JM. 2000. Making Collaboration Work: Lessons from a comprehensive assessment of over 200 wide-ranging cases of collaboration in environmental management. *Conservation in Practice* 1:17–24.

Appendices

Table of Contents

A	Appendix A. Detailed Methods Description.....	A-1
A.1	Literature Reviews	A-1
A.1.1	G-ITM framework development and behavioral intervention categories.....	A-1
A.1.2	Methods for Past CBP Behavioral Interventions.....	A-4
A.1.3	Public Pro-Environmental Interventions Review	A-5
A.1.4	Methods for Policy Actor Intervention Studies	A-6
A.2	Questionnaire methods	A-7
A.3	Interview methods.....	A-7
B	Appendix B. Literature Review Results.....	B-1
B.1	Past CBP Behavioral interventions.....	B-1
B.2	Public Intervention Results	B-7
B.2.1	Main findings on public interventions	B-8
B.2.2	Context Variables	B-13
B.3	Policy actor behavioral interventions	B-13
C	Appendix C. Questionnaire Results	C-1
C.1	Your work with the Chesapeake Bay Program.....	C-1
C.2	Contributions of social science to CBP.....	C-3
C.3	Experience with social science	C-6
C.4	Experience with CBP	C-15
C.5	Demographics	C-21
C.6	How should social science be used in CBP.....	C-22
D	Appendix D: Semi-structured interview guide.....	D-1
D.1	Semi-structured interview guide for people who have some experience with social science.	D-1
D.2	Semi-structured interview guide for people who have no experience with social science	D-2

A Appendix A. Detailed Methods Description

A.1 Literature Reviews

The analysis of CBP behavioral intervention projects and literature was organized using the G-ITM structure. Sub-categories, representing more specific intervention types, were developed iteratively under the broad G-ITM groupings, as we reviewed the literature. The broad categories of G-ITM were initially developed using a subset of foundational papers and books on behavioral intervention theory and evidence. We evaluated alternative systems being used to classify behavioral interventions, assessed frequency and consistency of use of terms. As we reviewed the full behavioral intervention literature we grouped concepts and experimental design types into those applying similar theories.

Literature review methods were tailored to the two different behavioral intervention types (public and policy actor) to reflect the vastly different number of studies in each category, as described below. Each review selected studies with quantitative or qualitative evidence from intervention experiments, rather than theoretical, narrative and anecdotal work, where the latter two categories include case studies that lack theory-based interventions or behavioral goals.

A.1.1 G-ITM framework development and behavioral intervention categories

Our review of the foundational literature led us to create a two-level classification system of behavioral interventions, with four top level categories and 24 sub-categories (Table 2). At the top level of the classification system are the G-ITM categories. Groundwork was defined as research that is typically used to better understand communities and design interventions. Information categories reflect diverse audiences and means of communication. Technical support is a diverse category that includes providing explicit instruction on how to make a behavior change and elements that reduce or remove barriers to change such as financial incentives or regulatory relief (e.g., safe harbor agreements). Motivations are the set of practices that activate internal drivers and goals to direct and energize an individual to engage in a behavior (Ehret et al., 2021).

The G-ITM framework was intended to encompass the majority of common intervention types that are supported by theory, but it is not exhaustive. Rather, the theoretical literature has been simplified to create categories that would be generally consistent across many theories and some lesser-used theories, particularly ones that do not lead to practical implementation guidance, are omitted. In the applied literature on pro-environmental behavior change that we investigated, we found widespread use of the *Theory of planned behavior (TPB)* (White et al., 2009), *Theory of reasoned action (TRA)* (Fishbein and Ajzen, 2009), *Diffusion of Innovations* (Rogers, 2003), and *Prospect theory* (Kahneman and Tversky, 2013). The TPB is largely an updated version of the theory of reasoned action. TRA posits that attitudes and subjective norms influence behavioral intentions, which in turn influence behavior. TPB adds perceived behavioral control, (i.e., whether people think they can perform an action) as an influence on intentions (White et al., 2009). Diffusion of innovations accounts for factors that influence the rate at which novel ideas, practices, or behaviors spread through a community. Some of these factors include attributes of the innovation, change agents, and potential adopters, such as their decision-making processes and social networks. Prospect theory explores multiple consistent biases

(e.g., loss aversion⁵, overweighting low probabilities) that cause people to make decisions that may be inconsistent with the expected benefits they would gain from a given decision.

Other theories that represent interaction of multiple motivational factors, were also represented in our review but were less frequent in empirical work. A theory that is well-used in the health intervention literature, but less common in the pro-environmental behavior literature is Social Cognitive Theory (SCT). SCT explains human behavior in terms of dynamic relationships among personal, behavioral, and environmental influences and emphasizes the capacity for collective (community) action (McAlister et al., 2008). This theory emphasizes personal agency in recognizing that people plan, have foresight, self-motivate and self-regulate (Bandura, 2001). The collective action component of SCT describes motivation for people to work together in organizations and social systems to achieve benefits for the entire group (White et al., 2009). The *Norm activation theory* and the related *Value-Belief-Norm (VBN)* theory, share elements of TPB, and emphasize a personal moral obligation to act (Stern, 2018).

These theories of behavior and behavior change are represented in the sub-categories of G-ITM (Table 2). Because theories overlap to a large degree and go by multiple names, we have not mapped specific theories to each G-ITM category. However, each category has at least one theory, and usually multiple theories that provide a rationale for why that action should work. For example, multiple theories, including the TPB, have been posited to support how and why social norms influence behavior. Social norms strongly influence behavior and represent “...shared rules of conduct that are partly sustained by approval and disapproval” (Farrow et al., 2017).

The Motivation subcategories of visible social proof, descriptive norms, and injunctive norms in Table 2 represent slightly different (and overlapping) theoretical perspectives on how norms contribute to behavior change. Visible social proof and descriptive norms offer evidence of what people are doing and align with theories that people are more willing to undertake a common activity because of a personal or group identity (TPB) or because they are taking a mental shortcut to analyzing whether a particular action will be personally beneficial (Prospect theory). On the other hand, injunctive norms (statements describing that a behavior is appropriate or moral, using mild to intense rhetoric), when combined with other types of information that provide personal agency, are consistent with VBN and other theories. Several motivation subcategories can be directly tied to Prospect theory, including defaults, priming and framing, as these behavioral nudges are designed to counter particular cognitive biases identified in that theory. They are used to help individuals identify or commit to choices that will increase their benefits.

⁵ Loss aversion means that, in their decision-making, individuals prefer to avoid losses more than they prefer to make gains.

Table 7.1. Behavioral intervention types and definitions

Term	Definition
Audience segmentation	Dividing the target audience into strategic subgroups, based on social, personal, or environmental criteria, to improve specificity of later outreach
Understanding motivations and barriers	Formative research indexing the factors that encourage or discourage someone from engaging in a target behavior
Attitudes and cultural understanding (basic research)	Formative research that indexes general personal-cultural factors surrounding an issue or behavior
K-12 Education	Education initiatives administered through the K-12 school system
Risk communication	The method of communicating statistics or data about risks to health or the environment
Awareness information	Information or messaging designed to raise general awareness about issues (e.g., environmental concerns), but not behaviors
Behavior-specific information	Information or messaging designed to encourage or discourage a specific behavior
Prompts and reminders	Cues, notifications, or other types of communication that serve to reference or prompt a target behavior
Guided decision-making	Structured assistance in a decision-making process, such as a flowchart, decision tree, or instructions for how to make decisions
How-to skills	Equipping people, through spoken or written instruction, with knowledge or skills necessary to successfully carry out a behavior themselves
Monetary resources	Direct provision of financial resources, reduced-priced services, or free items that decrease the financial burden of a behavior
Regulatory flexibility	Reducing existing regulatory requirements in response to target behavior engagement
Technical assistance	In-person assistance with practical tasks, such as installation, maintenance, or consultation
Public commitments	Making a public (verbal or written) statement or commitment to carry out a future behavior
Identifying and engaging influential messengers	Recruiting significant and trusted individuals to share messages with the surrounding community
Peer diffusion	Informal diffusion of a behavior via word-of-mouth or through other members of the community, regardless of whether they are considered influential

Term	Definition
Visible social proof	Increasing the observability of a behavior to demonstrate and promote it among peers
Descriptive norms	Using standardized wording, verbal or written, to inform an audience that a particular behavior is the norm among their peers
Injunctive norms	Using standardized wording, verbal or written, to inform an audience that a particular behavior is morally (undesirable) or (dis)approved of by their peers
Defaults	Presenting a desirable choice as the preselected or automatic option
Priming	Asking, or prompting discussion, about a behavior to promote it, including as it relates to self-concept and identity
Framing	Altering how the risks, goals, or other attributes of a choice are presented, usually from positive to negative, or vice versa
Emotional appeals	Eliciting emotions associated with a choice or behavior, including through the use of cognitive dissonance ⁶
Non-monetary rewards	Prizes awarded for behavior or commitment to behavior, including small monetary rewards without significant financial implications

A.1.2 Methods for Past CBP Behavioral Interventions

We evaluated intervention tests that were primarily conducted by three non-governmental organizations that receive substantial US EPA Chesapeake Bay Program funds including the Chesapeake Bay Trust, National Fish and Wildlife Foundation, and the Alliance for the Chesapeake Bay. We also identified a few relevant case studies that were suggested by social scientists at the Chesapeake Bay Trust. We included case studies in the evaluation if they 1) engaged with at least one identified behavior change strategy (or relevant groundwork) to advance Bay restoration goals, and 2) progressed past the proposal or planning stage into some level of implementation. We retrieved the studies from the databases listed in Table A2. The Chesapeake Bay Trust has funded substantial work in the area of social marketing, which were captured in the Chesapeake Outreach Campaign database.

⁶ An intervention based on cognitive dissonance would make the differences between a person’s thoughts and behavior obvious and salient.

Table 7.2. Databases used in Past Effort Analysis

Source	Number of Entries	Source Numbers
Chesapeake Outreach Campaign database	18	1-17
NFWF grant reports	9	20-28
Alliance for the Chesapeake Bay website	3	29-31
Other - provided by CBT	11	18, 19, 32-38

We categorized the type of study conducted by both of the levels of detail in the G-ITM framework to assess the scope of ongoing work. At the top level (G-ITM), many of the studies employed more than one behavior change or groundwork effort and therefore spanned multiple categories of the G-ITM framework. We coded these studies in two ways. First, we coded the final stage reached in the G-ITM sequence, from Groundwork to Motivation. This allowed us to display the studies broken down into single categories. Second, because G-ITM components do not always proceed linearly, we also coded studies by the combination of G-ITM components used. At the second level, if a study engaged with more than one strategy, we noted all. Coding was based on the definitions and criteria listed in Table A1.

Finally, we characterized the studies by coding their performance, target audience type, scale, and psycho-social theory use. Performance was assessed in multiple ways: Was success measured as an outcome of an intervention?; Did the study identify clear metrics of success?; and If success metrics were measured, did the study display partial or full success? Full success was defined as a study that met or surpassed its predetermined performance criteria. Partial success was defined as partially meeting performance criteria or qualitative evidence of attitude change or strengthened partnerships. We included any measures of success used by the studies which included attitude changes and intentions in addition to behavior changes.

Study scale reflects whether the project progressed beyond a pilot phase into a full scale campaign. Studies were considered full scale if they met or surpassed an initial intended target audience reach, or if they expanded over time, following a pilot phase. Theory use was a measure of having applied a theoretical basis in designing or testing interventions. A study had to explicitly reference psycho-social theory in its report to have a theory linked to the project. More information regarding the classifications of target audience, scale, behavior-change strategies, and psycho-social theories are provided in Tables 4-7.

A.1.3 Public Pro-Environmental Interventions Review

Because the literature on behavioral interventions with the public is large, we relied heavily on existing review papers and books that synthesized the state of the science. We identified relevant review studies

by conducting a keyword search of Google Scholar and through snowballing techniques. The search string combined social science methods terms with environmental outcomes relevant to the CBP. We used the following terms: “pro-environmental”, “behavior”, “review”, “social norm”, “incentive”, “messengers”, “nudge”, “framing”, “prompts”, and “commitments”. Our inclusion criteria were: 1) a review article; 2) reviews that summarized tests of behavioral interventions with hypotheses and performance criteria; 3) reviews that analyzed one or more of our defined behavior change strategies; 4) reviews that assessed interventions aimed at the general public; 5) reviews that assessed interventions targeting pro-environmental behaviors.

These studies were coded to identify major findings and factors shown to contribute to effectiveness of behavior change interventions, including study design and contextual variables. We did not assess evidence regarding Groundwork, because that component is used to collect data that can be used to design interventions, but does not involve administering/testing interventions. We include a subset of educational studies when they appeared in reviews with multiple intervention types but did not target our search to educational interventions because a separate review on that work is being conducted by others.

A.1.4 Methods for Policy Actor Intervention Studies

In comparison to the literature on interventions for the public, the literature on policy actor interventions is modest. We used keyword searches of Google Scholar, Web of Science, and snowballing techniques to identify potential studies. We initially identified papers through the references of Grose et al. (2014), the most comprehensive review we found on the topic of field experimental work on political institutions. We then used a snowballing technique to identify other relevant field experiments and review articles. Finally, we conducted a supplemental search via Google Scholar and Web of Science using the keywords “policy actor”, “politician”, “policy maker”, “legislator”, or “bureaucrat”, and “incentive”, “norm”, “social influence”, “nudge”, or “behavior”.

To be included in the quantitative analysis, articles had to 1) study a target audience of policy actors (including politicians, legislators, and government agency personnel); 2) employ an experimental design; and 3) include an intervention that is captured by one or more of the G-ITM framework components. The third criterion promoted the inclusion of studies that were most transferable to environmental concerns since the framework only includes interventions that have been applied to environmental issues. We excluded studies that asked students to act like policy actors except when combined with or compared to policy actors, because student studies have been shown to be unrepresentative of other audiences. We did not require the study to capture a pro-environmental behavior, due to the sparse number of studies found on policy actor behavior. We used experiments and review articles to provide foundational insights into the cognitive biases and motivations of policy actors compared to the larger public.

We coded the policy actor behavioral experiments based on the G-ITM framework components used, significant results, psycho-social theory referenced, the behavior change strategies, and the number of motivation interventions. We also noted study design characteristics, including subject type and sample size. We coded the behavior change strategies based on our previously established definitions and we separated groundwork into two categories: understanding attitudes/biases (policy actors’ prior opinions, beliefs, or implicit biases), and understanding motivation/barriers (factors that encourage or inhibit actors’ engagement in a particular behavior).

A.2 Questionnaire methods

This section describes the development and administration of the questionnaire. Throughout, it references specific questions asked using parentheses (i.e. Q2 refers to Question 2). The full questionnaire, with results, is provided in Appendix 2.

The main purpose of the questionnaire was to understand variation in CBP partners' attitudes toward, and experience with, social science. To understand variation within the partnership, we asked several questions that would allow us to create subgroups within our sample based on role in CBP, position within the organization, and years experience (Q1-3), other main host organizations (Q22), and several demographic attributes (Q26-29). To understand their attitudes toward social science, we asked respondents to rate their agreement on the importance of social science contributions to achieving the Bay agreement goals (Q5), adapting the list of contributions from Bennett et al. (2017). We then asked respondents to indicate whether they have ever used social science (Q7). Those who had then answered questions about that experience (Q8-16), and those who had not answered questions about why not, and how willing they would be to do so in the future (Q17-19). All respondents then were given questions about organizational innovativeness (Q20, which were adapted from Ruvio et al. (2014), and the alignment between CBP and their main organization, which were based largely on findings from Wondolleck and Yaffee (2017).

With the help of our project managers, we then piloted the questionnaire with 7 CBP partners working at different levels of the organization and with different experiences with social science. After completing the questionnaire, these respondents were invited to a follow-up conversation when we asked them about their responses, what they thought the questions meant, and which questions they had difficulty understanding. Based on their feedback, we added and revised several questions and wording to ensure that the questionnaire was accurately measuring the variables we wanted to examine.

We administered the questionnaire online as a Google Form between November 30, 2021, and January 14, 2022. Our project managers assembled a list of 1,560 eligible respondents, and these respondents received three email prompts to answer the questionnaire from ourselves and our project managers, with the last on January 7, 2022. In total, we received 151 valid responses, for a response rate of about 10%.

A.3 Interview methods

While the questionnaire assessed variation in respondents' attitudes toward, and experience with social science, we also conducted further in-depth, semi-structured interviews via Zoom to better understand institutional enablers and constraints to social science integration. During the interviews, we asked interviewees about their role in CBP, their experience with social science, what role they think social science should play, and what policies or institutional practices support or hinder social science. For those interviewees who had no social science experience, we asked if they had seen other salient examples (see Appendix 3 for full interview guide).

We sampled interviewees in two ways. First, questionnaire respondents had the option of indicating their willingness to participate in a follow-up interview. Second, our project managers identified potential key informants whose perspectives would be valuable for the project. Ultimately, we interviewed 30 people, 20 from the questionnaire and 10 key informants.

The interviews were conducted one-on-one, with interviewees divided roughly equally between the two co-PIs. To ensure that we were conducting the interviews similarly, we conducted the first interview together. All interviews were conducted on Zoom and recorded so we could refer back to them. After the interviews were concluded, we reviewed the recordings and created summary notes. We used both inductive coding to generate themes from these interviews, and deductive coding to summarize them according to institutional factors identified by Olsson et al. (2007) as influencing strategies to fit environmental governance arrangements with their social context.

All questionnaire and interview methods were approved by the University of Maryland, College Park Institutional Review Board (ID: 1807215-3) and we obtained informed consent from all respondents and interviewees.

B Appendix B. Literature Review Results

B.1 Past CBP Behavioral interventions

We analyzed 41 case studies to characterize the Chesapeake Bay Program’s past behavioral intervention efforts (Table B1). A few studies that were Groundwork only were included because they were intended to support a behavioral goal. Those groundwork studies are not included in the results graphics. 10 of the studies (29% of interventions) moved beyond the pilot stage (Table B2). The target audience was most frequently homeowners or community members and least frequently policy actors (Table B3).

Table 7.3. Chesapeake Bay Partnership Behavioral Studies Evaluated

Title	Organization/Author	Date	Funder
SAV Outreach	Chesapeake Bay Trust; Action Research	2021	Chesapeake Bay Trust
Shoreline Management Barriers and Benefits	Chesapeake Bay Trust; Action Research	2020	Chesapeake Bay Trust
Rainwater Harvesting Behavior Change Implementation	Blue Water Baltimore	2015	Chesapeake Bay Trust
Clean Lawn Care for Clean Water: A Collaborative Approach	Anne Arundel Watershed Stewards Academy	2015	Chesapeake Bay Trust
Reducing Sanitary Sewer Overflows through Targeted Outreach Campaigns	Lori A. Lilli Environmental Solutions; Ridge to Reefs	2015	Chesapeake Bay Trust
Implementing a Behavior Change Campaign to Recruit Landowners to Have Riparian Buffers Planted in the Prettyboy Watershed	Prettyboy Watershed Alliance	2015	Chesapeake Bay Trust
Clean Streets and Yards/Dog License Amnesty Program	City of Frederick	2015	Chesapeake Bay Trust
Exploring Applications of Behavioral Economics Research to Environmental Policy- making in the Chesapeake Bay Watershed	Chesapeake Bay Program STAC	2015	Chesapeake Bay Trust
Interfaith Partners for the Chesapeake Anacostia Congregational Partners	Interfaith Partners for the Chesapeake	2014	Chesapeake Bay Trust
Inspiring Millennials to Take Care, Take Control of Their Trash	Alice Ferguson Foundation	2014	Chesapeake Bay Trust
Lands Green, Waters Clean	Izaak Walton League	2013	Chesapeake Bay Trust

Title	Organization/Author	Date	Funder
Leaves are a Pain in the Drain	Anne Arundel Watershed Stewards Academy	2013	Chesapeake Bay Trust
Clear Creeks: Our Water, Our Heritage, Our Pride	Gunpowder Valley Conservancy, Inc.	2013	Chesapeake Bay Trust
Communities with LID Practices as the Social Norm	St. Mary's River Watershed Association	2013	Chesapeake Bay Trust
Lawn Fertilizer Use Behavior Change	Midshore River Conservancy, Inc.	2013	Chesapeake Bay Trust
Get Rooted in Cumberland, One Tree at a Time	City of Cumberland	2012	Chesapeake Bay Trust
Watershed Outreach Professionals' Behavior Change Practices, Challenges, and Needs: Insights and Recommendations for the Chesapeake Bay Trust	University of Michigan's School of Natural Resources	2012	Chesapeake Bay Trust
McElderry Park Broad Implementation of a Communications Campaign	Banner Neighborhoods Community Corporation	2011	Chesapeake Bay Trust
Reducing Stormwater Impact by Reaching Homeowners and Service Providers at Behavior "Choice Points"	University of Maryland Center for Environmental Science	2011	Chesapeake Bay Trust
Regional Litter Prevention Campaign	Alice Ferguson Foundation	2010	Chesapeake Bay Trust
Chesapeake Club - "Save the Crabs - Then Eat 'Em"	Academy for Educational Development	2004	Chesapeake Bay Trust
Chesapeake Bay Residents Survey	Conservation Management Institute of Virginia Tech	2002	Chesapeake Bay Trust
Healthy Streams Farm Stewardship Program	Alliance for the Chesapeake Bay	2020	National Fish and Wildlife Foundation
Mobilizing Communities to Enhance Stream Restoration Projects for Stormwater Treatment (MD)	Gunpowder Valley Conservancy, Inc.	2018	National Fish and Wildlife Foundation
Train the Trainer: Increasing Efficiency of Agricultural Outreach (PA)	National Wildlife Federation	2018	National Fish and Wildlife Foundation

Title	Organization/Author	Date	Funder
Increasing Farmer Adoption of Nutrient Stewardship Practices (DE, MD, PA)	The Mid-Atlantic 4R Nutrient Stewardship Association	2017	National Fish and Wildlife Foundation
Closing the Deal with Rural Landowners: Training Chesapeake Bay Watershed Conservation Practitioners	Water Words that Work, LLC	2017	National Fish and Wildlife Foundation
Anacostia Watershed Regional Messaging Campaign	Skeo Solutions	2017	National Fish and Wildlife Foundation
Beyond the Tipping Point; Transforming an Underserved Community into Resource Stewards through Diffusion Innovation	Lancaster Farmland Trust	2016	National Fish and Wildlife Foundation
Cambridge Residential Stewardship Initiative (CRSI)	The Nanticoke Watershed Alliance	2016	National Fish and Wildlife Foundation
Increased Participation in Stormwater Management Programs- Behavior Change through Social Marketing in Aspen Hill, MD	Rock Creek Conservancy	2016	National Fish and Wildlife Foundation
Getting Nutrient Management Plans Off the Shelf: Expanding Farmer Participation on the NMP Process	University of Virginia	2016	National Fish and Wildlife Foundation
Forests for the Bay Program	Alliance for the Chesapeake Bay	2018	Alliance for the Chesapeake Bay
Project Clean Stream	Irvine Nature Center	2004	Alliance for the Chesapeake Bay
Chesapeake Bay Attitudes Survey	UMD Survey Research Center	1994	Alliance for the Chesapeake Bay
The Economic Benefits of Protecting Healthy Watersheds Fact Sheet	US Environmental Protection Agency	2012	US Environmental Protection Agency
Restoration of the Chesapeake Using a Non-Native Oyster: Ecological and Fishery Considerations	Paolisso et al.	2006	State of Maryland and Commonwealth of Virginia

Table 7.4. Study Scope (Single coded)

Study Type	Number of Studies*
Groundwork	7
Intervention	34
Pilot	20
Full Scale	10
Unreported	4

* 6 of 41 studies did not appear to include groundwork

Table 7.5. Target Audience (Multi-coded)

Decision Maker Type	Number of Studies
Homeowners/Community Members	27
Businesses/Farmers	9
Community Leaders/Outreach Practitioners	6
Policy Actors	5

The most frequently used intervention in past CBP behavioral work was providing behavior-specific information (Table B4). Often this Informational intervention was combined with other interventions. Among Technical support interventions, technical assistance was used less frequently than How-to skills and monetary resources. Motivation interventions were more evenly distributed across specific interventions, though using influential messengers was more often used than others.

Table 7.6. Behavior Change Strategy (Multi-Coded)

Strategy	Number of Studies
Information	
Behavior-Specific Information	33
Prompts and Reminders	10
Other Information Strategies	6
Technical support	
How-to Skills	15
Technical Assistance	7
Monetary Resources	12
Motivation	

Identifying and Engaging Influential Messengers	13
Public Commitments	9
Visible Social Proof	6
Peer Diffusion	7
Injunctive Norms	9
Other Motivation Strategies	9

Importantly, the majority of past intervention studies (59%) did not include a metric of success (Figure B1), making it difficult to learn about what interventions are effective under what circumstances. Of the studies that did include a success metric (n=17), all achieved some level of success and most achieved full success. The lack of success metrics in the majority of studies makes it difficult to assess the effectiveness of combining interventions across different ITM components (groundwork studies were excluded). While interventions combining all three of the ITM components had the most instances of full success overall, interventions using the combination of I and M (without T) had the highest proportion of full success of the studies measuring and reporting success (Figure B2). However, results should be viewed as preliminary, due to the limited number of studies for each combination of ITM categories and limited success metrics.

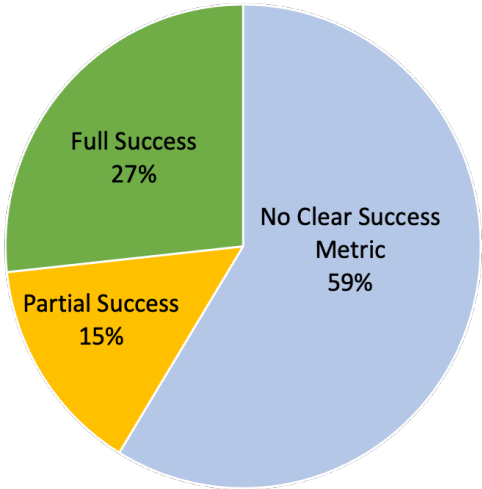


Figure 7.1. Metrics of success in past CBP behavioral interventions, groundwork studies omitted

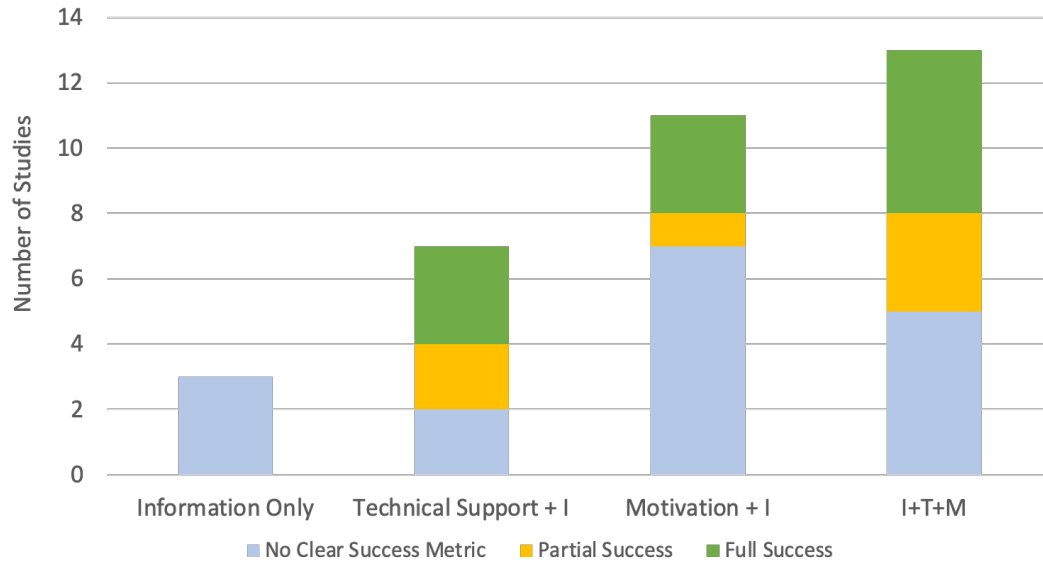


Figure 7.2. Metrics of success in past CBP behavioral interventions by ITM component (single coded)

Past CBP studies used a diverse set of Motivation interventions, which were most commonly influential messengers, injunctive norms and public commitments (Figure B3). Three interventions that were never used were descriptive social norms, defaults, and priming. While metrics of success were not reported for most interventions, nearly all social proof interventions reported metrics of success, with about half reporting full success and half reporting partial success.

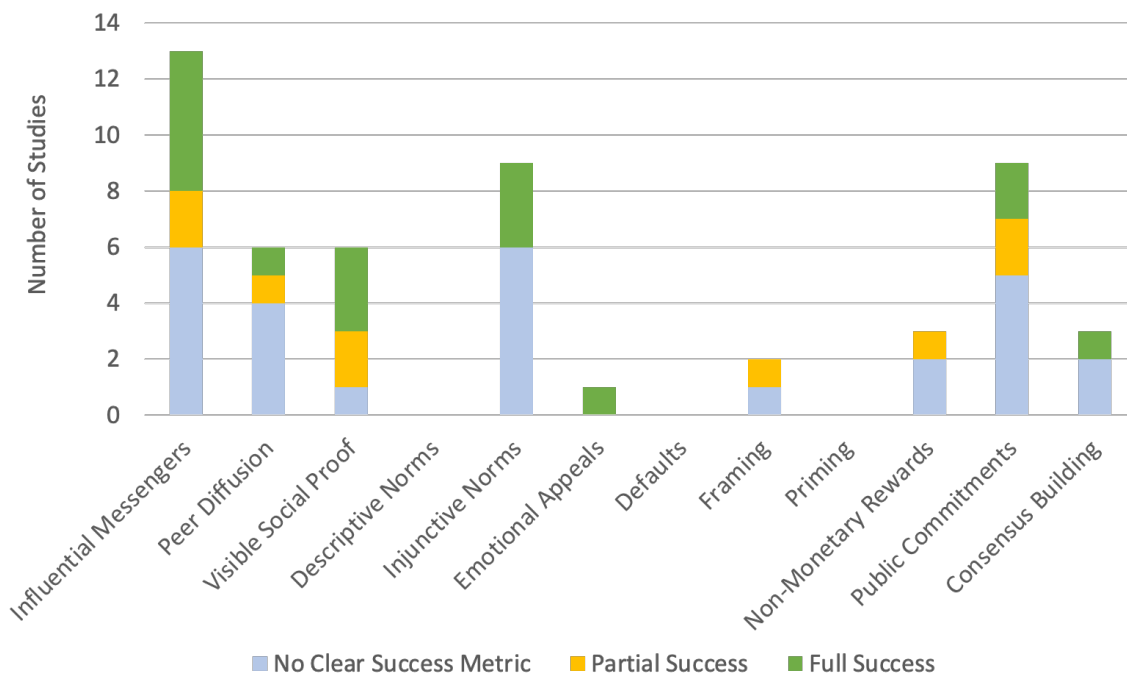


Figure 7.3. Metrics of success in past CBP Motivation interventions, multi-coded, by strategy

We did not find strong evidence that the past studies were grounded in behavioral theory. Few past CBP behavioral interventions identified any psychological or social theory to design their interventions (Table B5). Among the eight studies that cited a theory, the most commonly used theory was social diffusion, which describes the concept that information and behaviors spread best through peer networks and social ties. The other theories referenced were *diffusion of innovations*, which predicts the pace at which new ideas or practices spread through communities, and *cognitive defenses*, which describe how individuals justify their current behavior and avoid change.

Table 7.7. Psycho-Social Theories (Multi-coded)

Theory Referenced	Number of Studies
Social Diffusion	5
Diffusion of Innovations	1
Cognitive Defenses (e.g., repression, rationalization, externalization, cognitive dissonance)	2
No Theory Referenced	34

B.2 Public Intervention Results

We identified 14 primary review articles summarizing 1,049 unique behavioral interventions (Table B6). Three of these articles provided narrative synthesis of the literature and did not explicitly analyze a set of intervention studies. The review articles covered a diverse set of pro-environmental behaviors. All but one review included motivation interventions, with Maki et al. (2016) examining technical support interventions alone. Five examined interventions across all three ITM intervention categories, four examined I and M interventions, and four examined M only interventions. Reviews that looked across categories typically examined interactions and synergies across intervention types.

Table 7.8. Review articles used to analyze pro-environmental interventions with the public

Study	Domain	ITM Component(s)	# Interventions Assessed
Andor and Fels (2018)	Household consumption	IM	44
Barth et al. (2021)	Climate change behavior	M	NA
Byerly et al. (2018)	Land management, meat consumption, transportation choices, waste production, water use, family planning	ITM	160

Ehret et al. (2021)	Water conservation	ITM	100
Farrow et al. (2017)	Energy use, recycling	M	42
Grilli and Curtis (2021)	Energy use, waste disposal, water efficiency, farming, fishing, wildlife conservation	ITM	155
Homar and Cvelbar (2021)	Recycling, water efficiency, transportation	M	61
Kidd et al. (2019)	Biodiversity conservation, natural resource management, climate change	IM	89
Kolandai-Matchett and Armoudian (2020)	Marine conservation	IM	55
Maki et al. (2016)	Recycling, energy conservation, transportation use	T	22
Osbaldiston and Schott (2012)	Recycling, energy, gas, and water conservation	ITM	253
Sunstein and Reisch (2014)	Paper use, green energy, energy efficiency, smart grids	M	NA
White et al. (2019)	General pro-environmental behavior	ITM	NA
Wynes et al. (2018)	Personal vehicles, diet, energy use, air travel	ITM	68
	Total:		1,049
	Average per study (excluding NA):		95

B.2.1 Main findings on public interventions

Many review authors noted the difficulty of drawing firm conclusions from the evidence, given the diversity of approaches and the multi-pronged nature of most interventions that obscured which elements determined results. Nonetheless, several common points emerged about the relative

effectiveness of different interventions. A general and consistent finding was that Information interventions alone are less likely to be effective than when combined with other intervention types. For example, Ehret et al. (2021) examined water conservation interventions and found that information alone was insufficient to generate behavior change, and that interventions combining the three (ITM) components generally had greater effects. Grilli and Curtis (2021) similarly found that providing information and directing people in “what to do” was less effective than motivations, such as commitments and comparative feedback (a descriptive norm).

A finding that emerges somewhat indirectly or qualitatively from studies is that relationship building is often a foundational element of success (Cialdini, 2021; Grilli and Curtis, 2021). The degree to which an individual identifies with a reference group and the level of in-group communication and cohesion is theorized to affect the likelihood of being influenced, and this finding was supported by some of the studies (White et al. 2009). Similarly, someone who is trusted or who is seen as a member of a shared community will tend to be more effective at delivering many types of ITM interventions (Byerly et al. 2018; White et al. 2019; Kolandai-Matchett and Armoudian 2020). Similar to many motivational interventions (social norms, influential messengers, and peer diffusion interventions), relationship building draws on the active and passive mechanisms underlying peer effects. Active and passive mechanisms, like word-of-mouth communication and observational learning, respectively, are more salient when individuals are communicating with or learning from members of their own peer groups (Wolske et al., 2020). A key goal of relationship building is to bridge peer groups so that the strength of these mechanisms increases between intervention designers and audience.

Another interpretation of these results is that the people designing an intervention can conduct groundwork that builds relationships and then apply a mix of ITM components to increase the chances of successful behavior change. Such effort comes at a cost since the amount of time and resources necessary for success tends to be high and “...are more likely to be effective where the sense of belonging to the community is strong.” (Grilli and Curtis 2021).

Under Technical support, the reviews suggested that interventions offering substantial financial support had fairly consistent, medium effect sizes. Importantly, financial support encouraged both immediate and sustained behavior change. Sustained behavior change has not been well studied, but sustaining behavior is a well-known challenge.

Effects sizes of other types of technical support were less consistent, with one review concluded that how-to skills appeared less effective than motivational treatments (Osbaldiston & Schott, 2012). Other examples suggested that technical support interventions can complement motivational interventions. For instance, households with high rates of water consumption are less sensitive to financial incentives, but more sensitive to descriptive social norms nudges (Ferraro and Miranda, 2013; Ferraro and Price, 2013). Further, Technical support interventions, particularly financial incentives and guided decision-making, can help individuals to not only change one-time behaviors, but to develop new, persistent habits (White et al. 2019).

Among Motivation interventions, the reviews found that defaults and descriptive social norms nudges consistently had medium effects on behavior change. Defaults appear to have some of the largest effects compared to other nudges (injunctive norms, education, and disincentives) and, as a result, are only appropriate to use when the choice architect is certain of the net benefits for affected individuals

(Sunstein and Reisch, 2014). However, even defaults can fail when participants have a strong and conflicting pre-determined preference (Sunstein and Reisch, 2014).

Some evidence was strongly supported by individual reviews. In one meta-analysis, making behaviors easy, offering instructions, providing feedback, inducing cognitive dissonance, and eliciting commitments showed the largest effect sizes in isolated studies, but varied by the type of pro-environmental behavior (Osbaldiston & Schott, 2012, Table B7). Andor and Fels (2018) found that product eco-labelling is understudied but the majority of studies they examined presented significant positive effects with promising effect sizes. They also found that individual (self) goal-setting appeared effective when the goals were chosen realistically. However, goal setting/commitments overall had inconclusive effects when evaluated across diverse studies, and the authors noted substantial methodological shortcomings in these studies.

Interventions rarely apply just one behavior change strategy, which makes analyzing the effectiveness of specific treatments difficult, but can also lead to insightful conclusions. Most reviews evaluated confounding treatments by identifying a primary strategy and then analyzing effectiveness as if it were the sole strategy. Other studies evaluated the synergistic effects of treatments. Some reviews did both. Of the reviews that examined synergies, most concluded that combining multiple types of interventions tended to increase effectiveness. Osbaldiston & Schott, (2012) found that combinations of prompts and reminders, public commitments, guided decision-making, how-to skills, and non-monetary rewards were particularly effective. However, a different review suggested that the lack of complementarity of interventions was a concern, “While telling people what to do is ineffective ..., failure to provide the information and resources to help people make their own decisions leads to disempowerment.” (Grilli and Curtis 2021).

Table 7.9. Public Intervention review evidence

G-ITM Component	Category	Behavior Change Strategy	Evidence in the Literature
Information		K-12 Education	<p>Information and education interventions, as a group, appear generally less effective than motivation interventions (Byerly et al., 2018; Grilli & Curtis, 2021).</p> <p>Information interventions are more likely to change behavior when paired with motivation and technical skill interventions (Ehret et al., 2021).</p> <p>Information interventions may be most successful when used with community-based or social norm interventions (Grilli & Curtis, 2021).</p> <p>Prompts and reminder interventions display large effect sizes ($g > 0.60$), but this varies by target behavior (Byerly et al., 2018; Osbaldiston & Schott, 2012).</p>
		Risk communication	
		Awareness information	
		Behavior-specific information	
		Prompts and reminders	
Technical Support	Decision support	Guided decision-making	<p>How-to skills appear less effective than motivational treatments (Osbaldiston & Schott, 2012).</p> <p>Financial support (substantial) consistently shows medium effect sizes ($0.5 > g > 0.4$) with both immediate and sustained behavior change, both alone and when combined with other interventions (Grilli & Curtis, 2021; Maki et al, 2016; Osbaldiston & Schott, 2012).</p>
		How-to skills	
	Financial support	Monetary resources	
		Regulatory flexibility	
Technical support	Technical assistance		
Motivation	Community-level interventions	Identifying and engaging influential messengers	<p>Public commitments display mixed results, sometimes with medium effect sizes ($0.5 > g > 0.4$), which vary by target behavior (Andor &</p>
		Public commitments	

G-ITM Component	Category	Behavior Change Strategy	Evidence in the Literature
		Peer diffusion	Fels, 2018; Byerly et al., 2018; Osbaldiston & Schott, 2012).
		Visible social proof	Peer diffusion tends to be stronger with physically closer peers and more visible behaviors, and weaker across language groups (Wolske et al. 2020)
	Individual-level interventions	Descriptive norms	Social norms have consistent significant effects across target behaviors, $p < .01$ (Barth et al., 2021; Byerly et al., 2018; Farrow et al., 2017).
		Injunctive norms	
		Defaults	Descriptive norms are consistently more effective than injunctive norms (Andor & Fels, 2018; Farrow et al., 2017).
		Priming	Individual-level interventions, in the form of general choice nudges, display a 43-100% success rate across target behaviors across domains (Grilli & Curtis, 2021).
		Framing	Defaults display consistent medium effect sizes ($0.5 > g > 0.4$) across target behaviors (Byerly et al., 2018; Osbaldiston & Schott, 2012; Sunstein & Reisch, 2014).
		Emotional appeals	Loss framing is more effective than gain framing (Homar & Cvelbar, 2021).
		Non-monetary rewards	Cognitive dissonance displays large effect sizes ($g > 0.60$) (Osbaldiston & Schott, 2012) The relative effect of non-monetary vs (small) monetary rewards appears to depend on context. Each has been shown to be ineffective or

G-ITM Component	Category	Behavior Change Strategy	Evidence in the Literature
			more effective than the other across studies (Grilli & Curtis, 2021)

B.2.2 Context Variables

The reviews suggested that behavior change intervention effectiveness is context-dependent, varying with target behavior, environmental context, behavior domain, and audience knowledge, values, and prior behaviors (Andor & Fels, 2018; Byerly et al., 2018; Ehret et al., 2021; Kolandai-Matchett & Armoudian, 2020; Osbaldiston & Schott, 2012; Wynes et al., 2018). Effectiveness of a given intervention seemed to vary with the specific type of behavior. Multiple authors found higher degrees of success for subsets of behavior change when they looked across water consumption, energy use, pet waste, littering, or other categories of pro-environmental behavior (e.g., Byerly et al. 2018, Osbaldiston & Schott, 2012). However, it is not possible with the existing studies to completely disentangle study design and other context factors that may have led to differences in results.

Despite the lack of methodological precision in some studies, it is worth discussing the evidence for some context variables that can inform implementation design choices. A key context variable identified was the degree of effort required to undertake the target behavior. For example, lower-engagement interventions (such as defaults and prompts) may be more effective at changing lower-effort behaviors (such as public recycling) (Osbaldiston & Schott, 2012). For behaviors that are perceived as more difficult to perform/have more barriers, financial or other incentives may be particularly effective at providing additional motivation to overcome barriers (Maki et al., 2016), or a higher overall level of intervention effort across ITM categories will be needed (Osbaldiston & Schott, 2012). Further, the specific type of incentive that is effective may depend on how well a new behavior aligns with existing personal and social beliefs.

Several context variables were found to affect social norm interventions. When individuals are under a cognitive load (e.g., stress, high information load), the influence of descriptive norms may increase, while that of injunctive norms may decrease. This finding may be indicative of descriptive norms functioning as a cognitive shortcut, reducing the effort of decision-making (Farrow et al., 2017). A finding that has been replicated across multiple studies is that descriptive norms (including comparative feedback) can decrease pro-environmental behaviors among those who had been outperforming the norm (Andor & Fels, 2018; Farrow et al., 2017). Further, highlighting descriptive norms may decrease the desired behavior, if a majority of people are not engaged in them (Farrow et al. 2017). In such cases, injunctive norms may be more effective when only a minority of people engage in a desirable activity (Cialdini 2009, cited in Farrow et al. 2017). However, injunctive norms can lead to negative reactions when they threaten personal autonomy (White et al., 2019).

B.3 Policy actor behavioral interventions

We identified 24 studies that used experimental interventions to understand policy actors’ decision-making (Table B8). Many studies grounded their interventions in Prospect Theory to test hypotheses about whether policy actors are less susceptible than the public to systematic cognitive biases, or

generally more purposeful and strategic. A partially competing hypothesis is that the “personality profiles of office seekers and the environment they operate in systematically amplifies certain choice anomalies” (Sheffer et al. 2018). The list of documented “choice anomalies” is large but Sheffer et al. (2018) highlight: loss aversion, preference for the status-quo, and discounting of future outcomes⁷. These studies explored effects of these and other biases in addition to institutional culture on decisions. Some studies tested how information, including uncertainty, was used. A subset of papers examined pro-environmental behaviors related to climate change and land use policy.

Table 7.10. Field experiments on policy actors to examine decision-making influences

Experiments			
Source	Policy Actor	Description	G-ITM Component(s)
Andersen and Jakobsen (2017) (Study 1)	Childcare workers	Effect of professional and nonprofessional norms on policy positions	IM
Andersen and Jakobsen (2017) (Study 2)	Teachers	Effect of professional and nonprofessional norms on policy positions	IM
Andersen and Jakobsen (2017) (Study 3)	School principals	Effect of professional and nonprofessional norms on policy positions	IM
Andersen and Jakobsen (2017) (Study 4)	Teachers	Effect and interactions of different framing and informational cues on policy position	IM
Andersen and Moynihan (2016)	School principals	Effect of freedom to decide where to allocate administrative resources on motivation to acquire expertise	GIT
Avellaneda (2013)	Mayors	Influence of issue salience, stress, and choice constraint on mayors’ willingness to delegate spending authority	G
Bishop et al. (2013)	Policymakers, extension staff, and researchers	Effectiveness of different climate visualization techniques on communicating information	I
Bosetti et al. (2017)	Climate negotiators	Effect of statistical formatting on policymakers’ reaction to scientific uncertainty	I

⁷ Preferring immediate to future payoffs, to a disproportionate degree

Butler and Broockman (2011)	State legislators	Effect of perceived constituent race on legislators' email responsiveness	G
Butler and Nickerson (2011)	State legislators	Effect of constituency opinion on voting action	IM
Flynn et al. (1998)	State legislators	Influence of personal attitudes, subjective social norms, and perceived control on legislators' voting intentions	G
Kalla and Brookman (2016)	Congressional officials	Influence of campaign donations on access to policymakers	T
Linde and Vis (2017) (Study 1)	National parliament members	Political actors' susceptibility to decision-making biases in risk-taking and assessing probability ratios	M
Linde and Vis (2017) (Study 2)	National parliament members	Political actors' susceptibility to decision-making biases during valuation tasks and in response to gains/loss framing	M
Linde and Vis (2017) (Study 3)	National parliament members	Political actors' susceptibility to decision-making biases in risk-taking and response to gains/loss framing	M
Source	Policy Actor	Description	GITM Component(s)
Linde and Vis (2017) (Study 4)	National parliament members	Political actors' susceptibility to decision-making biases when faced with risky political scenarios framed as gains or losses	M
Nielsen and Baekgaard (2015)	City councilors	Effect of school performance information on city councilors' ' spending attitudes	I
Nisar and Maroulis (2017)	Teachers	Effect interpersonal attributes on formation of peer relationships	M
Nyhan and Reifler (2015)	State legislators	Effect of salient monitoring/fact checking on the accuracy of legislators' claims	I
Oberfield (2010)	Police officers and welfare case workers	Effects of organizational and extra-organizational influences on bureaucrats' rule-following identities	TM
Sheffer et al. (2018) (Study 1)	National and regional parliament members	Politicians' immunity to choice anomalies when assessing risk-taking and	M

		losses/gains compared to the general public	
Sheffer et al. (2018) (Study 2)	National and regional parliament members	Politicians' tendencies to commit to failing courses of action when assessing a sunk-cost decision scenario compared to the public	M
Sheffer et al. (2018) (Study 3)	National and regional parliament members	Politicians' susceptibility to future time-discounting preference compared to the general public	M
Sheffer et al. (2018) (Study 4)	National and regional parliament members	Politicians' adherence to the status quo compared to the general public	M
Reviews			
Source	Policy Actors	Topic	
Grose (2014)	Political institutions	Field experimentation on political institutions	
Howlett (2014)	Policy makers influencing climate change policy	Influence of blame avoidance on climate change policy innovation	
Howlett and Kemmerling (2017)	Policy makers influencing climate change policy	Causes and consequences of under-reaction in climate change policymaking	
Knaggård (2014)	Policy makers influencing climate change policy	Role of scientific uncertainty in limiting magnitude of change in climate change policymaking	
Maor et al. (2017)	Policy makers influencing climate change policy	Disproportionate policy responses to climate change as a function of economic considerations; levels of public demand; focusing events; and strategic considerations	
Miler (2009)	Professional legislative staff	Cognitive heuristics in political settings (esp accessibility bias in information)	
Vis and van Kerspergen (2007)	Policy makers	Causes of risky policy reforms despite prevalence of blame avoidance behavior	

Across the ITM categories, Motivation treatments were the most common, with framing being the most common sub-category. The second most common sub-category was behavior-specific information (under Information) and the least common categories were three Technical support interventions, including monetary incentives (Figure B4).

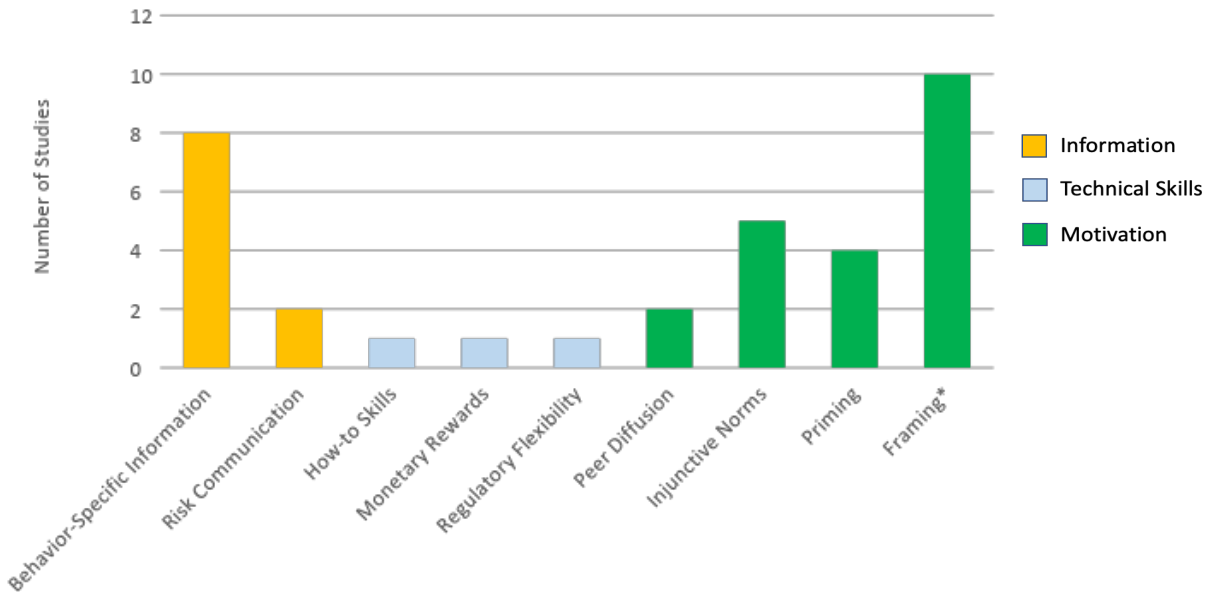


Figure 7.4. Intervention categories among policy actor studies (multi-coded)

All but two framing interventions found significant effects of the intervention. Each study (in Table 10) was counted once but any study could have had multiple intervention types assigned to it

The sample populations for these studies were diverse across policy actor sub-groups, with public service workers (civil service workers that directly interact with the general public) and national government officials being the most common (Table B9). Politicians at all levels of government, educational administrators and staff, social workers, and police encompassed most of the target audiences. The sample sizes tended to be robust, with 80% of studies involving greater than 100 individuals (Table B10), and all studies testing only one or two interventions.

Table 7.11. Study Subjects (Single coded)

Policy Actor Type	Number of Studies
Public Service Workers	5
Mid-level Government Officials	2
Local/Regional Government	2
State Government	4
National Government	5
Mixed Audience	6

Table 7.12. Sample Size (Single coded)

Number of Participants	Number of Studies
Fewer than 100	5
100-499	10
500-999	3
1000-9,999	5
10,000 or greater	1

All studies reported metrics of success and all but two studies (both framing experiments) found significant results (Figure B5). Consistent with other behavioral research, framing was defined in multiple ways. Some framing studies used risk communication interventions to test Prospect theory’s prediction that people tend to overweight small probabilities and underweight large probabilities⁸. They also tested the well-documented findings that people tend to be risk-averse when outcomes are presented as gains and risk-taking when they are presented as losses (Linde and Vis, 2017). Another paper examined attribute framing that changed whether a behavior was consistent with pre-existing beliefs and norms (Andersen and Jakobsen, 2017). Attribute framing was also used to test whether risk preferences were stable under alternative constituent accountability frames (Sheffer et al., 2018).

The framing tests found that policy actors were more likely to make decisions that were consistent with pre-existing beliefs (attribute framing) (Andersen and Jakobsen, 2017). In multiple framing tests for risk, Linde & Vis (2017) found variability of framing effects and concluded that politicians are less vulnerable to the framing of outcomes, if they are more familiar with the type of decision. Accountability framing (change in the likelihood that constituents would be affected and the politician blamed) had inconsistent effects on behavior across countries (Sheffer et al. 2018).

⁸ The typical explanation for this finding is that knowing something is uncertain has a large effect on behavior, but the relative probabilities matter less.

Providing information alone was also shown to influence policy actors' behaviors. Constituency opinion had a significant impact on state legislators' voting behaviors (Butler and Nickerson, 2011), performance information influenced city councilors' spending attitudes (Nielsen and Baekgaard, 2015), and increasing the salience of monitoring increased the accuracy of legislators' claims (Nyhan and Reifler, 2015). Other factors may influence policy actors' desire to acquire information. As one example, providing regulatory flexibility in the form of greater discretion increased principals' likelihood of increasing their effort in tracking student progress (Andersen and Moynihan, 2016). Technical support alone (in the form of monetary incentives) was also found effective. In one example, campaign donors were significantly more likely to secure meetings with senior policymakers than other unspecified constituents (Kalla and Broockman, 2016).

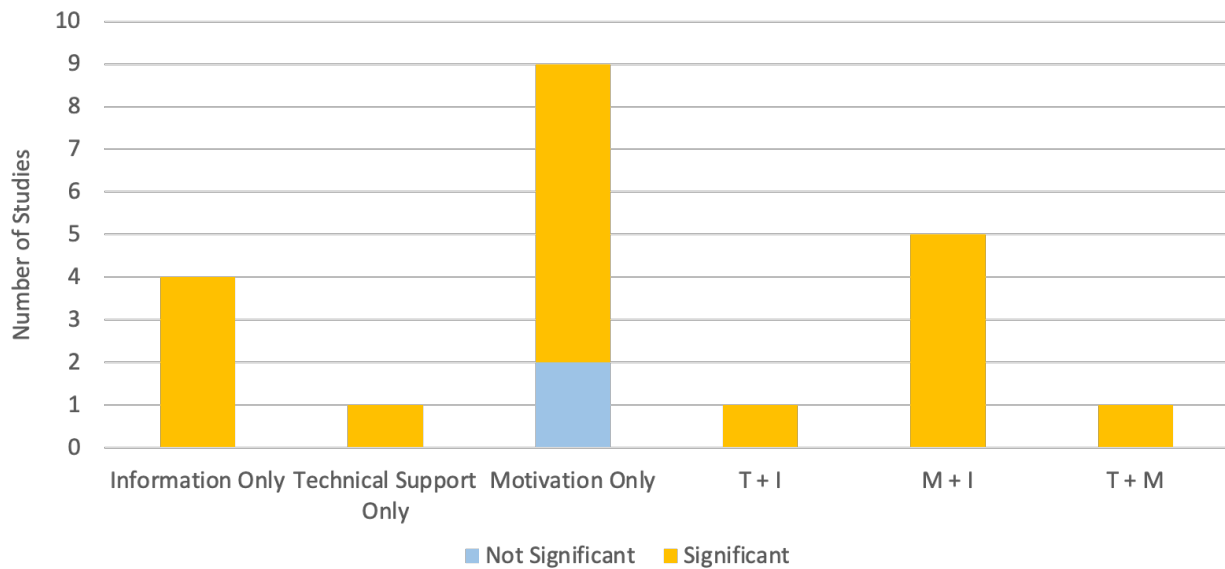


Figure 7.5. Significant effects by intervention type (single-coded). Letters on the X axis refer to combinations of Information, Technical support, and Motivation.

The results of experiments on policy actors demonstrated how the interplay of political, interpersonal, institutional, and informational factors can impact attitudes and decision-making. Government officials are influenced by institutional norms, and they are more likely to agree with policy proposals when they are framed to adhere to pre-existing beliefs about appropriate actions (Andersen and Jakobsen, 2017). However, peer norms also play an important role. Research on the effects of social and institutional influence shows that both co-worker attitudes and institutional training had a significant impact on rule-following tendencies, regardless of individuals' pre-existing rule-following identities (Oberfield, 2010). The findings suggest that social organization, at the institutional and interpersonal level, can override behaviors stemming from personal identity.

The literature also points toward biases that may affect politicians' roles as representatives of their constituencies. Evidence supports the idea that legislators rely on the accessibility heuristic, a cognitive shortcut where one makes conclusions based on information that is most salient or cognitively accessible, when judging constituent interests (Miler, 2009). In the studies, the discrepancies between legislator perceptions and constituent beliefs could be mitigated by increasing civic participation and providing information. For example, when presented with district-specific attitude survey results,

legislators were more likely to vote in accordance with constituent opinion than legislators who did not receive additional information (Butler and Nickerson, 2011). Further, multiple studies suggested that politicians heavily weigh changes to potential votes when making decisions, rather than potential policy outcomes (Butler and Nickerson, 2011; Knaggård, 2014; Linde and Vis, 2017; Sheffer et al., 2018).

Politicians appear to differ from the general population in several ways. A general finding was that politicians' decision-making deviates from expected utility theory (choices that optimize well-being), in ways predicted by Prospect Theory, but it is unclear whether they do so to a larger or smaller degree than the general public (Linde and Vis, 2017; Sheffer et al., 2018). Politicians appeared to be less susceptible to some biases, such as the common ratio effect (underweighting or overweighting equal probabilities) and long-term time discounting (Linde & Vis, 2017), but more susceptible to sunk cost effects, choosing the status quo, and framing effects (Sheffer et al., 2018; Sleesman et al., 2012). Further, the tendency of politicians to escalate commitment to a failed course of action in the face of hypothetical sunk costs was barely affected by the behavioral interventions tested (Sheffer et al., 2018). One study found that policy actors may be more likely to take risks to avoid anticipated losses of their current situation (Vis and van Kersbergen, 2007).

In the context of climate policy, policy makers show stronger anchoring to prior assumptions than student samples. They were less likely to update their pre-existing beliefs when presented with climate model estimates, but more responsive to changes in statistical formatting (Bosetti et al., 2017). Similarly, several studies on the development of Swedish climate change policies showed that, when faced with scientific uncertainty, politicians relied more on pre-existing and politically actionable knowledge than on scientific data (Knaggård, 2014), which is similar to other findings on use of accessibility heuristics (Linde and Vis, 2017). Evidence from risk communication interventions found that side-by-side scenario comparisons and interactive tools were more effective at changing policy actors' beliefs than others (Bishop et al., 2013; Bosetti et al., 2017) and policy actors may be more responsive to displays that are interactive (Bishop et al., 2013).

Although some researchers found that policy makers generally value avoiding the blame of failure more than they value the possibility of receiving credit for a successful political action (Howlett, 2014), the effect was not consistent across countries (Sheffer et al., 2018). This bias may be particularly salient in the context of risky pro-environmental innovations and reforms. For one, climate change displays low immediate visibility in most countries and is often framed as unavoidable, both of which allow governments to justify inaction (Howlett, 2014; Howlett and Kemmerling, 2017). Although not based in experimental evidence, Maor et al. (2017) suggest four conditions that could be influenced to increase political action on climate change: (1) emphasize expected benefits to domestic economy, (2) increase public demand for political action, (3) capitalize on events that focus attention on climate change, and (4) draw on policy actors' desire to demonstrate their political power in national and international policy.

C Appendix C. Questionnaire Results

C.1 Your work with the Chesapeake Bay Program

1. Select the following item that best describes your main role with CBP and answer all further questions with this role in mind:

(151 responses)

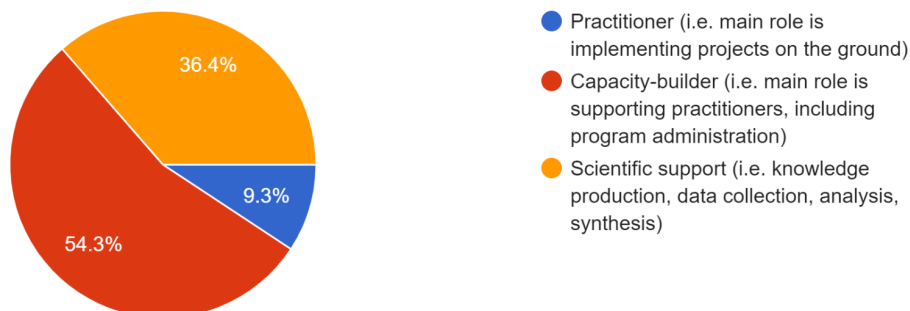


Figure 7.6. Breakdown of self-identified practitioners, capacity-builders, and scientific support among respondents

2. Where within the CBP organizational structure do you mainly work now (you may select more than one, GIT = Goal Implementation Team)

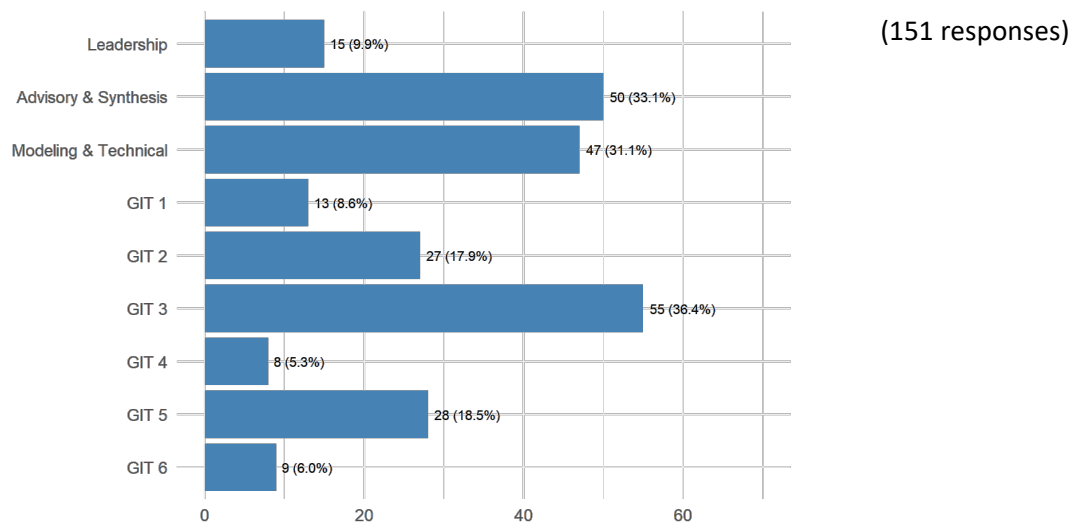


Figure 7.7. Breakdown of where within CBP the respondents work.

Respondents could choose multiple categories. Leadership includes Principals' Staff Committee and Management Board; Advisory & Synthesis includes Communications Workgroup, STAR, and any STACs; and Modeling & Technical includes Criteria Assessment Protocol Workgroup, Climate Resiliency Workgroup, Plastic

Pollution Action Team, Data Integrity Workgroup, Integrated Monitoring Networks Workgroup, Integrated Trends Analysis Team, and Modeling Workgroup.

3. For how many years have you collaborated with the Chesapeake Bay Program Partnership?

(151 responses)

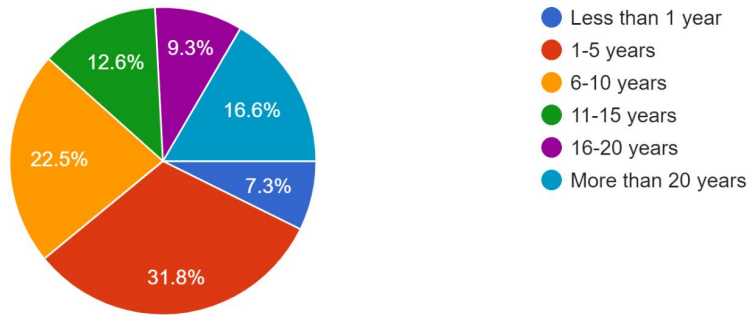


Figure 7.8. Respondents' years working with CBP

C.2 Contributions of social science to CBP

4. Rate how much you agree or disagree with the following statements, from Strongly disagree (1) to Strongly agree (5).

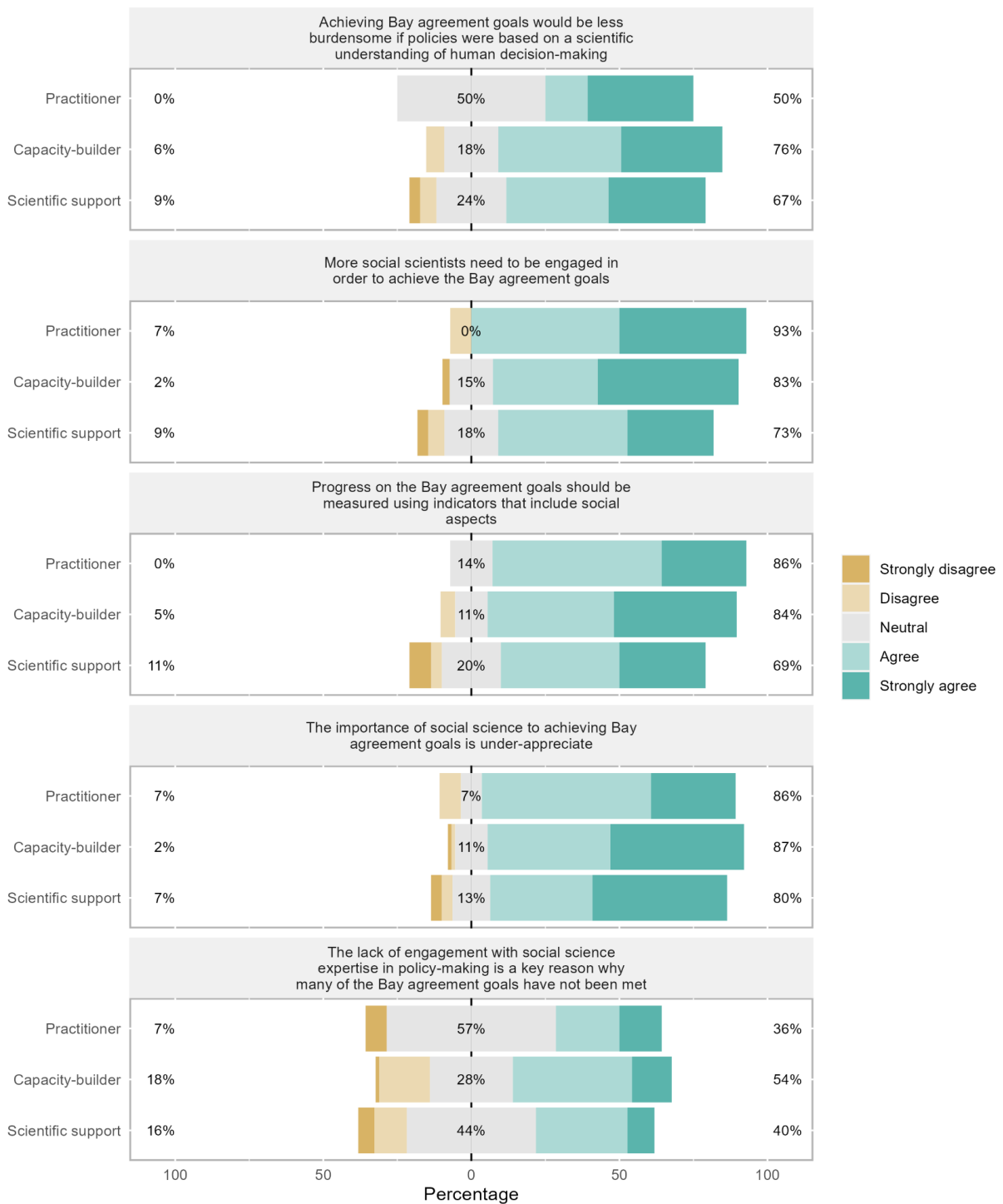


Figure 7.9. Respondents' perceptions about the usefulness of social science to CBP. See Q1 for respondent categories.

5. Rate how important or unimportant you think the following contributions of social science would be to achieving the Bay agreement goals that you are working towards, from Not at all important (1) to Very important (5).

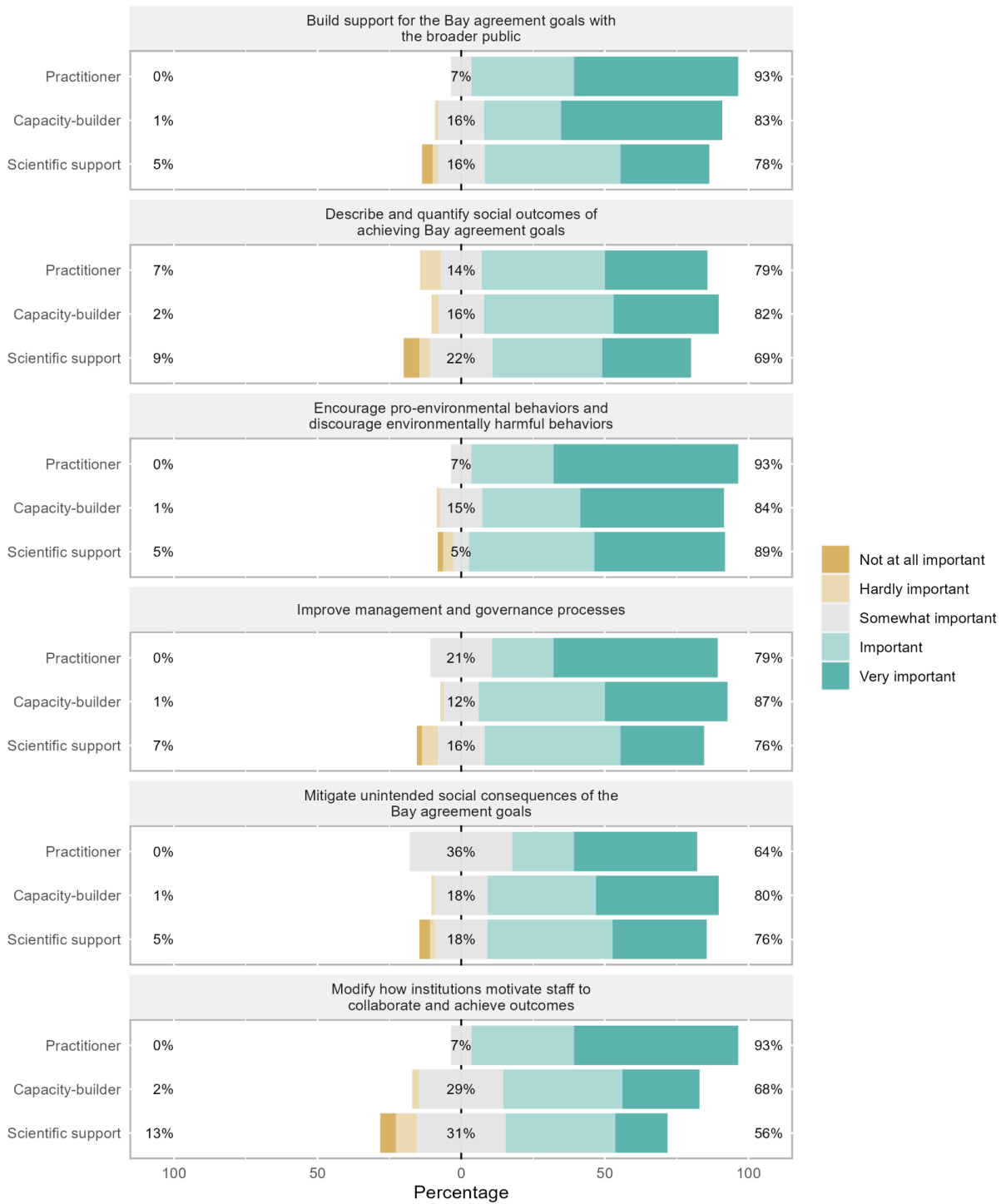


Figure 7.10. Respondents' perceptions about the contributions of social science to CBP. See Q1 for respondent categories.

6. Optional: If there are other ways that you think social science could contribute to achieving the Bay agreement goals, describe them below.

(38 responses, covering 7 common themes)

Theme #1: Improve public communication (8 responses)

- "Inform the work and ensure the max effectiveness of the communications that come from the Communication WG, other WGs, GITs, etc."

Theme #2: Promote pro-environmental behavior change (7 responses)

- "There are missed opportunities to 'nudge' citizens and social groups toward pro-Chesapeake actions. "Won't you join the many neighbors who are contributing their support of the Bay's health with funding and good works"

Theme #3: Align CBP with communities' needs (4 responses)

- "Research whether it is viable to approach Bay restoration in terms of Bay restoration being a co-benefit of people's more pressing wants and needs. E.g., mitigating localized flooding and drainage problems, preserving their rural way of life (land use management opportunities), offering home/yard maintenance services (SWM and engagement opportunities), offering after-school services (education opportunities)."

Theme #4: Improve CBP function (4 responses)

- "The CBP needs to think more carefully about how to use social sciences to guide its internal work, especially with regards to internal structural changes (e.g. funding structures, decision-making structures) and staff behavior changes (e.g. improve how staff carry out collaborations with external stakeholders/communities)."

Theme #5: Estimate ecosystem services stemming from CBP work (2 responses)

- "We should use resource economics to quantify the benefits of the ecosystem services that the CBP provides."

Theme #6: Improve balance between development and environmental impact (2 responses)

- "Making better connections to how economic development is important for prosperity but also detrimental to the environment. Understanding that connection and finding the balance is crucial to progress towards Bay agreement outcomes."

Theme #7: Impact evaluation (2 responses)

- "Helping to understand why certain practices or recommendations did not yield desired results and distilling lessons learned that can be applied as the program seeks to adaptively manage our efforts."

C.3 Experience with social science

Note: Questions 8-16 to be answered by those who are or have collaborated with a trained social scientist, according to Question 7. Questions 17-19 to be answered by those who have not used social science.

7. What is your experience using social science to advance Bay agreement goals?

(151 responses)

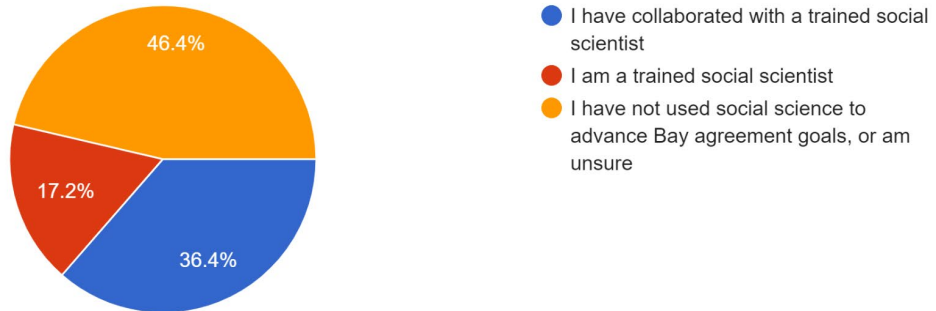


Figure 7.11. Respondents' reported experience with social science.

8. In one or two sentences, briefly describe your experience using social science to achieve Bay agreement goals.

(81 responses, covering 6 common themes)

Theme #1: Promote pro-environmental behaviors (24 responses)

- "I was trained in Social Marketing and use those skills to help groups develop and implement environmental action campaigns based on behavior change principles."

Theme #2: Cost/benefit analysis and ecosystem services quantification (8 responses)

- "Collaborated with natural resource economists on quantifying the economic and ecosystem service benefits of implementing the WIPs."

Theme #3: Improve stakeholder engagement (6 responses)

- "Qualitative and quantitative data collection and analysis to improve understanding of local needs and goals, and for defining collaborative opportunities to support multiple stakeholder objectives."

Theme #4: Integrate social science into program design (4 responses)

- "I have served as a lead evaluator of CBP-associated funded programs/grantmaking, integrating social and environmental data streams to answer evaluative questions and inform CBP management decisions."

Theme #5: Engage policy actors (3 responses)

- "Worked with social science colleagues at UMD to consider how local leaders make decisions and what types of information would better inform decisions that benefit Bay outcomes."

Theme #6: Promote DEI (2 responses)

- "The work I am doing on the diversity workgroup is informed by national projects I am involved with around equity that collaborate with psychologists, anthropologists, evaluators, and higher education experts."

9. Select any of the following CBP outcomes that you have worked to advance through your experience with social science.

(81 responses)

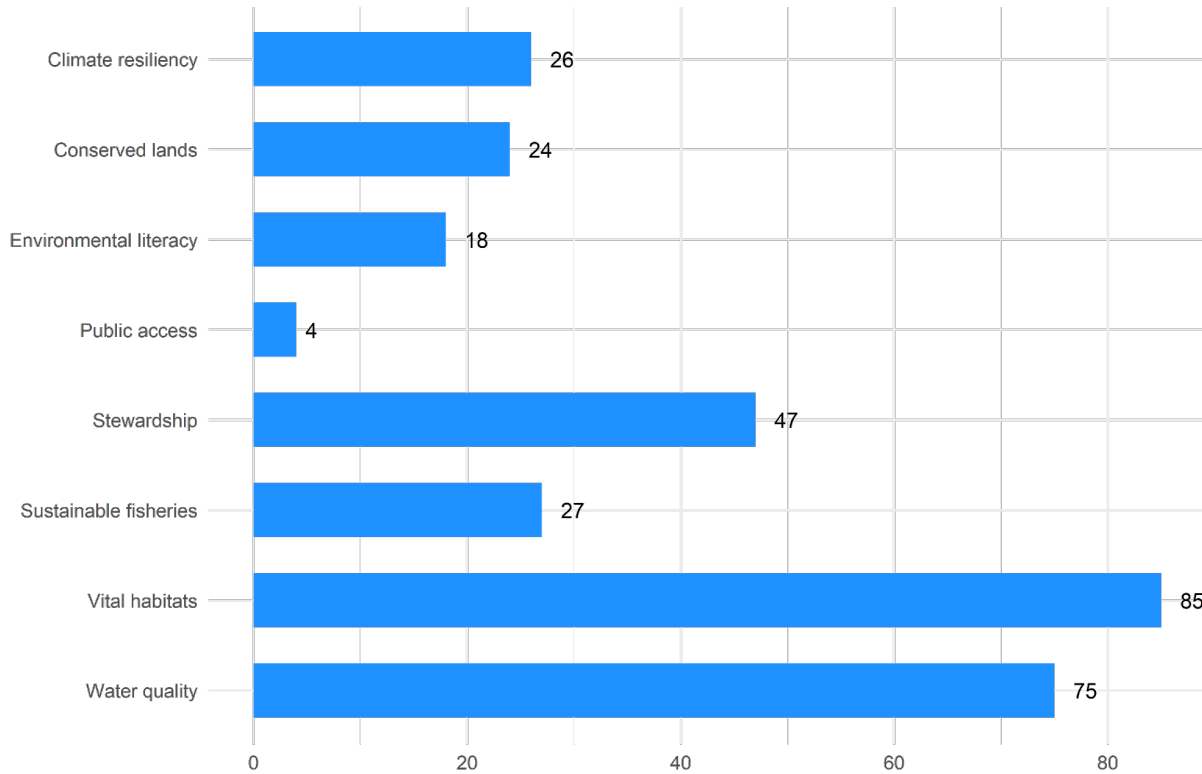


Figure 7.12. Among those who reported some social science experience, the outcomes they have worked to advance using social science.

10. Which of the following best describes the goal of your experience using social science?

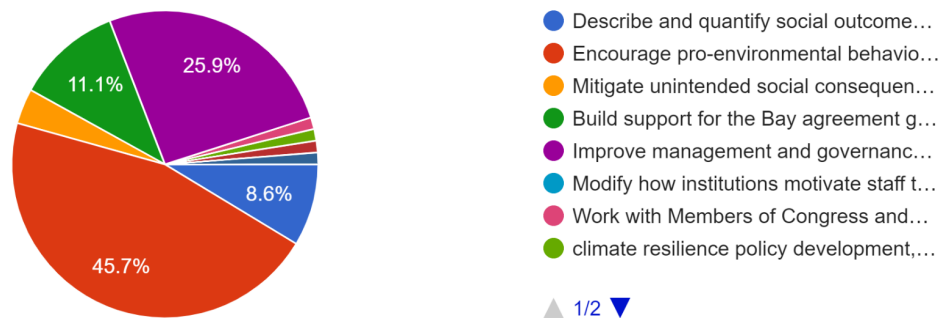


Figure 7.13. Among those who reported some social science experience, their goal in doing so.

11. Regarding your previous answer, indicate which of the following groups were your intended audience:

(81 responses)

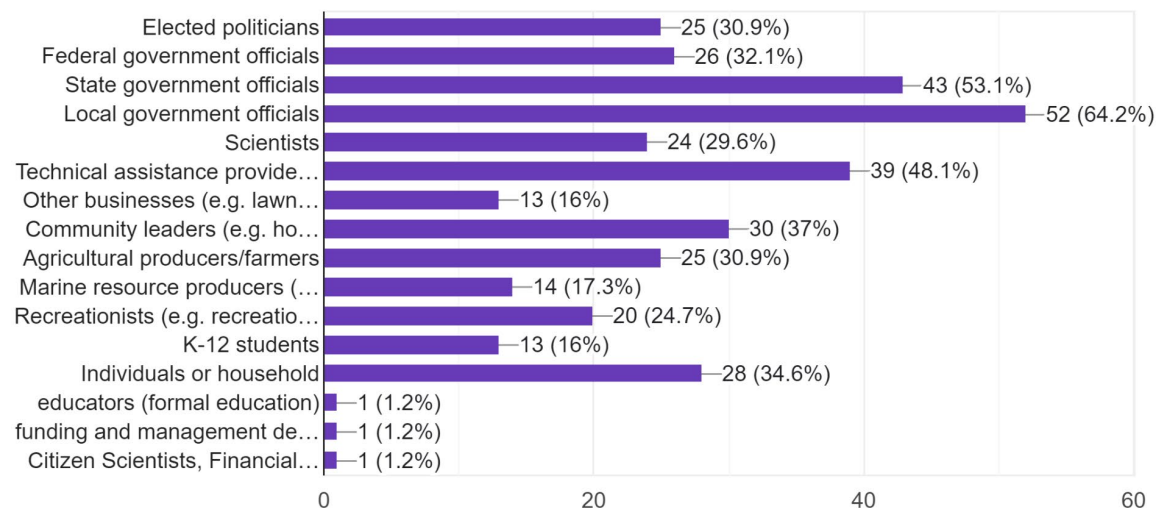


Figure 7.14. Among those who reported some social science experience, the intended audience of those efforts.

12. Briefly describe in more detail how you have used social science in your work with the partnership, for what purpose, and to what degree of success? What went well, and what barriers did you encounter along the way? If you would like to say more about this, please sign up for a 30-minute interview using the link that appears after you submit this questionnaire.

(56 responses, covering 5 success themes and 2 barrier themes)

Success Theme #1: Improved outreach to public (7 responses)

- "The quality and effectiveness of behavior change campaigns improved."

Success Theme #2: Improved outreach to policy actors (3 responses)

- "Our successes have come with coaching local jurisdictions on the fact that it is their long-term financial viability at stake when the discussion comes to managing local water resources (whether that be stormwater, groundwater, etc.) comprehensively."

Success Theme #3: Better understanding of stakeholder priorities (3 responses)

- "We learned from coastal farmers about their decision-making process to deal with wet and salty areas. I believe we were successful at better understanding farmer motivations and providing recommendations for policy and research."

Success Theme #4: Helpful in designing new programs (3 responses)

- "Applied models of organizational change to design and implementation of various parts of the Strategy Review System."

Success Theme #5: Useful to grant process (3 responses)

- “Informed an RFP for a community needs assessment and engagement effort developed through the Diversity workgroup”

Barrier Theme #1: Lack of social science expertise (3 responses)

- “Implementers continue to struggle with how to measure changes in knowledge/attitudes and to connect this work to outcomes.”

Barrier Theme #2: Lack of support for social science (3 responses)

- “The biggest obstacle of incorporating more social science into our work is lack of dedicated resources to conduct this work.”

13. Indicate the extent to which your experience with social science achieved its intended goal, from Not at all (1) to Completely (5)

(81 responses)

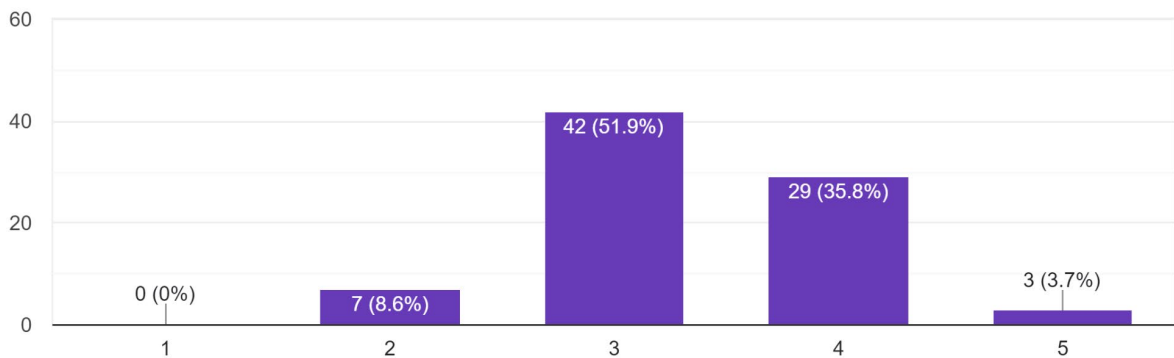


Figure 7.15. Among those who reported some social science experience, the extent to which they perceived they met their goals in doing so.

14. Describe what you think helped and/or hindered the ability of your experience with social science to advance Bay agreement goals.

(64 responses, covering 2 helping themes and 5 hindrance themes)

Helping Theme #1: Supportive colleagues (2 responses)

- "Developing a close working relationship with social scientists...has been a key way for me to gain insights into social science methods and approaches."

Helping Theme #2: Financial support (2 responses)

- "Federal funding and support from the localities in our watershed has been critical to building and sustaining our program."

Hindrance Theme #1: Social science not an institutional priority (9 responses)

- "The lack of attention on people's behavior and incentives isn't because the CBP don't realize it isn't important, but rather it is because implementation programs and tmdl accounting don't begin with this as a central challenge to managing pollutants."

Hindrance Theme #2: Not enough time (5 responses)

- "The CBP does not have enough resources--funding or staff--to carry out every facet associated with social science. Many projects have been developed and materials created, but lack the time and money to pilot, implement and evaluate the project."

Hindrance Theme #3: Lack of expertise (5 responses)

- "I honestly have learned everything that I know about social science (which is still limited) through practice. Some of it I was doing before I know that there was a social science theory to support it. I would definitely say that I have been hindered by my lack of knowledge around social sciences."

Hindrance Theme #4: Stakeholder identification (4 responses)

- "The stakeholders involved were selected based on geographic location. I think that this may have hindered the process since the diversity was not considered."

Hindrance Theme #5: Default to status quo (2 responses)

- "Less attention to keeping it at the center of our efforts in respect to simply defaulting to the way we've always done business --particularly in respect to outreach to producers. People have their favorite "tool" - and are reticent to putting time/energy into doing it differently - despite the evidence of the same outcomes in response to the same types of outreach."

15. Indicate any of the following that you have done in the last five years to advance social science efforts to achieve Bay agreement goals.

(81 responses)

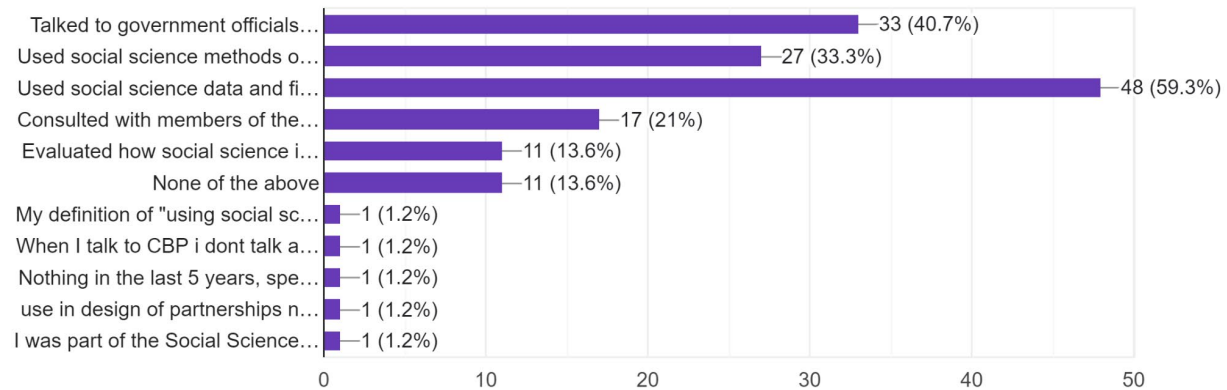


Figure 7.16. Among those who reported some social science experience, their reported efforts to advance social science as a way to meet agreement goals.

16. Use the space below to describe your answer to the previous question in more detail.

(32 responses, covering three common themes)

Theme #1: Engage local governments (3 responses)

- "PA legislators remain concerned about our ability to meet the CB goals without eliminating animal production agriculture and thereby forever changing the character and complexion of the community and Pa's economy. Making the community and societal connections to agriculture to achieve water quality goals helped provide context."

Theme #2: Develop decision-support tools (2 responses)

- "Served on an advisory board for development of an optimization tool to choose water quality protection practices for localities (towns, counties, states) within Chesapeake Bay watershed."

Theme #3: Remove barriers to adoption (2 responses)

- "The VA DCR has/had a website that gave the reasons landowners did not want to take advantage of conservation programs. The reasons were examined and strategies developed to eliminate or moderate the negative reasoning."

17. Which of the following best describes why you have not collaborated with social scientists to achieve Bay agreement goals? (select all that apply):

(70 responses)

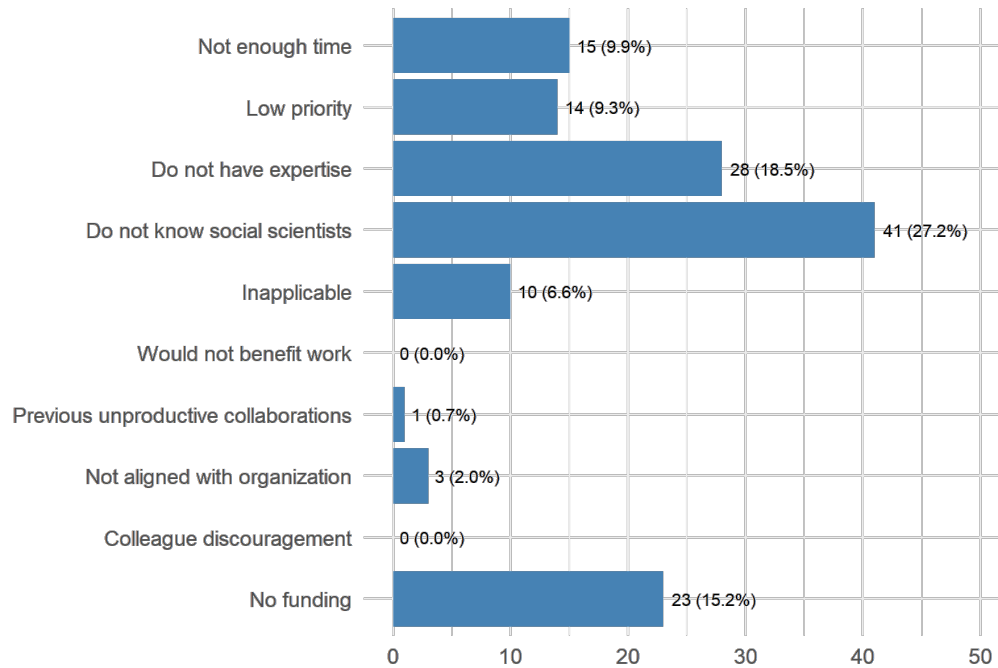


Figure 7.17. Among those who reported no social science experience, their reasons for not doing so.

18. Indicate how willing or unwilling you would be to collaborate with a social scientist on your Bay partnership work, given enough time, support, and an appropriate situation, from Completely unwilling (1) to Completely willing (5)

(70 responses)

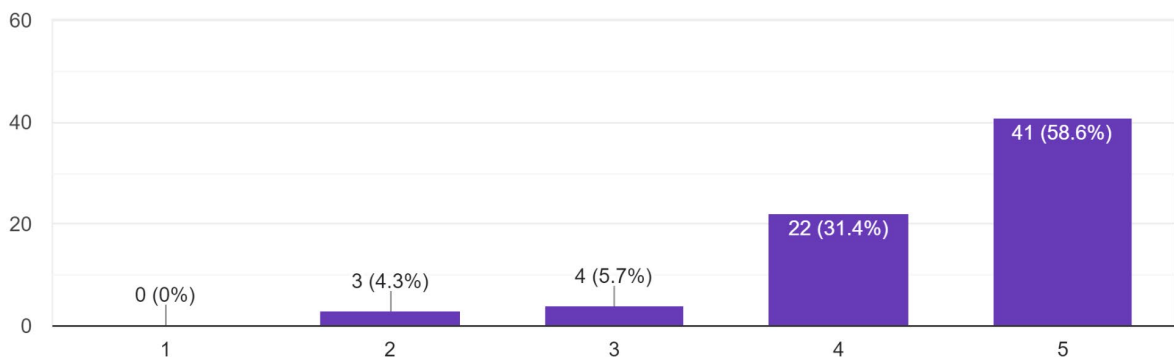


Figure 7.18. Among those who reported no social science experience, their willingness to do so in the future.

19. Optional: Please explain your response to the previous question.

(22 responses, covering 4 common themes)

Theme #1: Don't know who or how (5 responses)

Theme #2: Not enough time (2 responses)

- "Staffing is an issue as our time is already stretched thin."

Theme #3: Skeptical of social science (2 responses)

- "I am suspicious of the government trying to manipulate people and impose ideologies."

Theme #4: Social science would help achieve goals (2 responses)

- "I believe social science is a key [piece] to furthering more widespread improvements across that Bay. It is a large geographic area and different people have different social factors that influence response."

C.4 Experience with CBP

20. Rate how much you agree or disagree with the following statements, from Strongly disagree (1) to Strongly agree (5). The Chesapeake Bay Program...

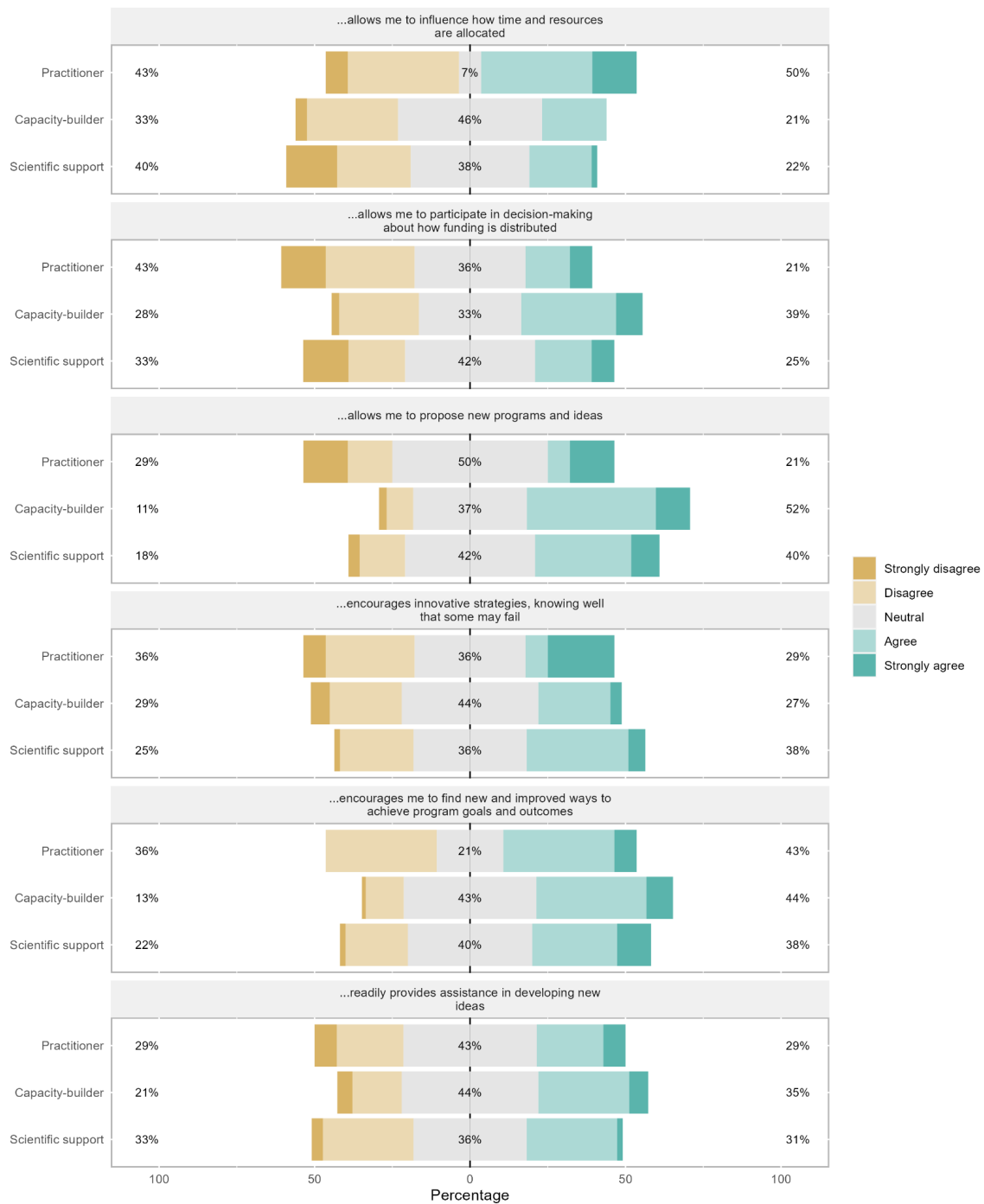


Figure 7.19. Respondents' perceptions of CBP support for innovation.

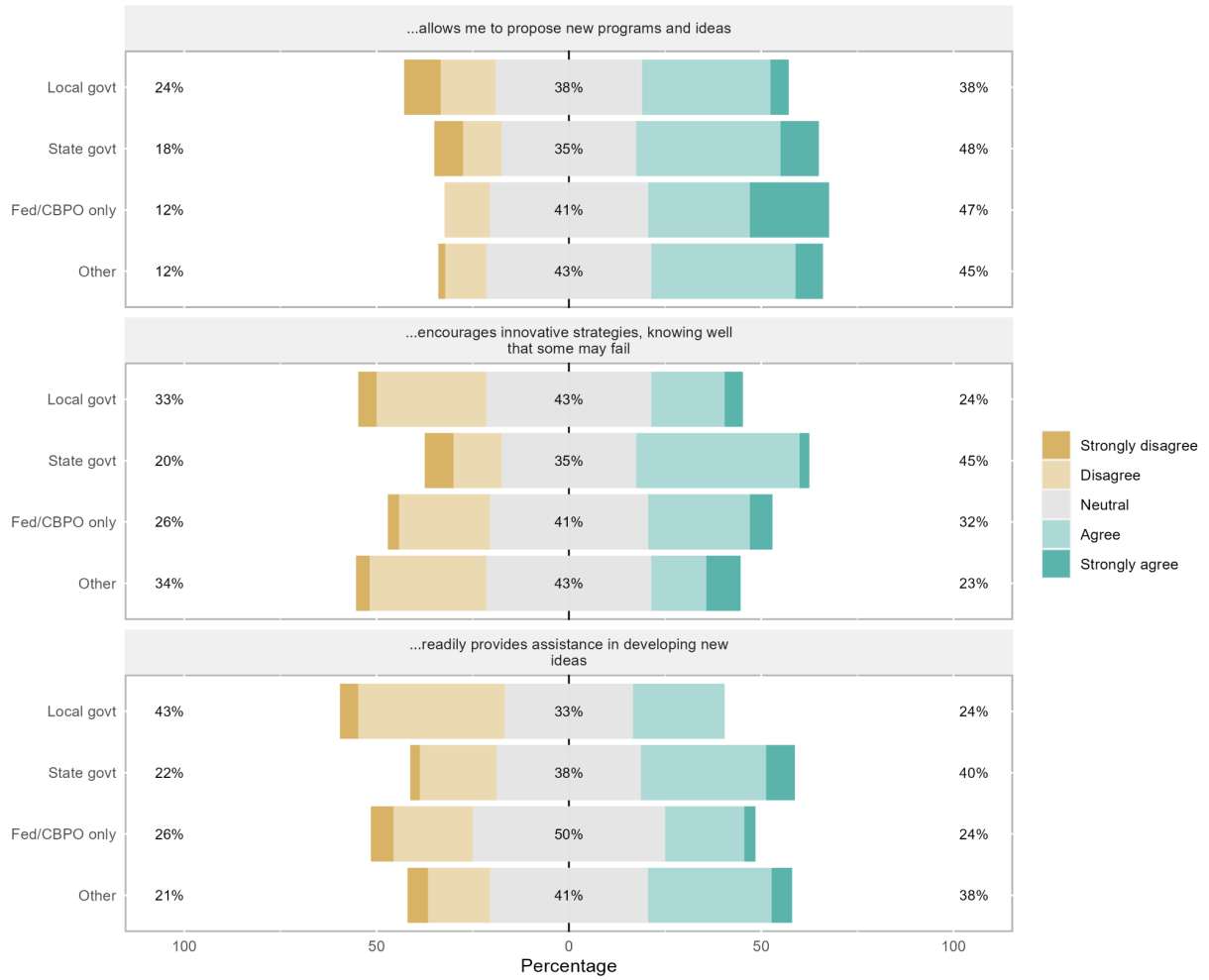


Figure 7.20. Responses to the same question, but summarized by host organization, rather than reported role in CBP

21. Rate how much you agree or disagree with the following statements, from Strongly disagree (1) to Strongly agree (5).

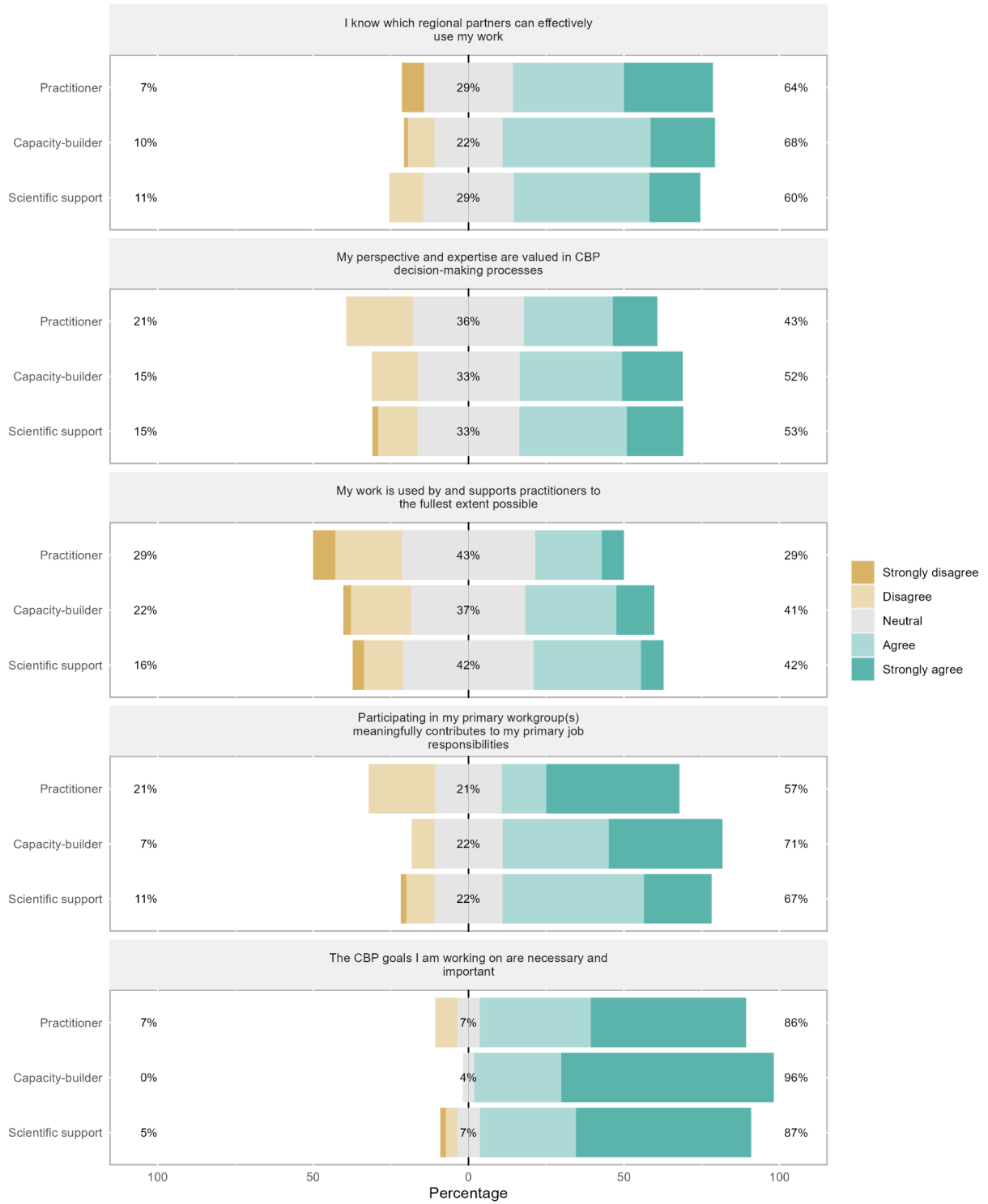


Figure 7.21. Respondents' perceptions of the importance of their work at CBP.

22. Indicate all the organizations for which you have work responsibilities.

(151 responses)

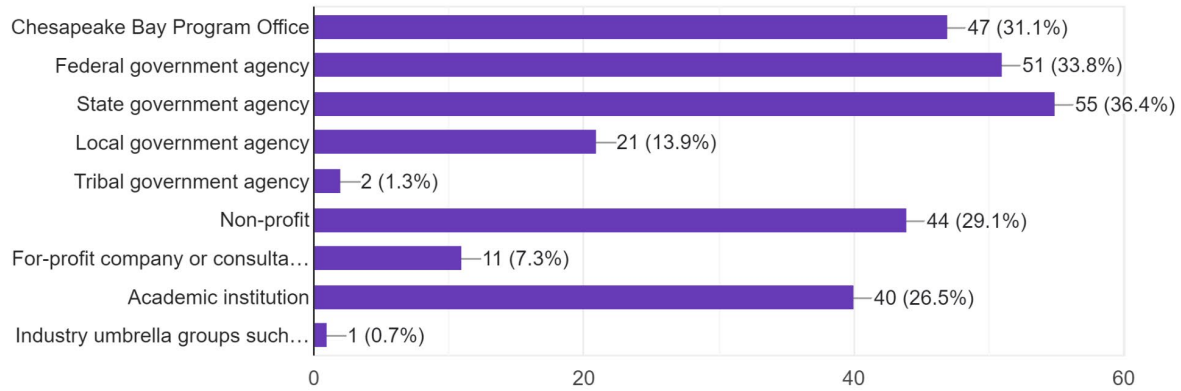


Figure 7.22. Organizations to which respondents report. Respondents could choose more than one.

23. Regarding your answer to Question 22, rate how much you agree with the following statements, from Strongly disagree (1) to Strongly agree (5).

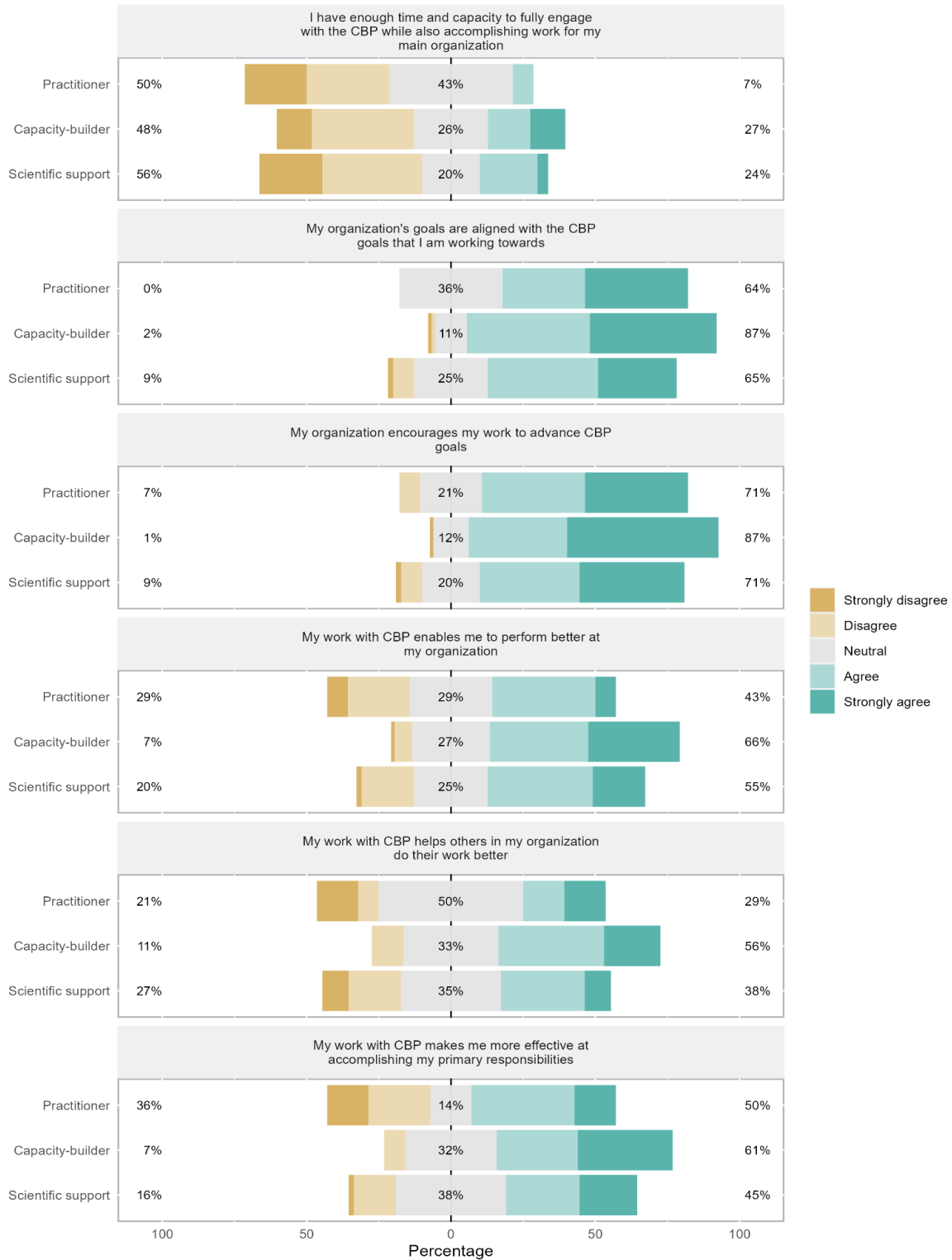


Figure 7.23. Respondents' reported alignment between CBP and their other goals.

24. Indicate how often you adjust work with your organization (as specified in question 22) based on your work with the CBP workgroups, from Never (1) to Continuously (5).

(151 responses)

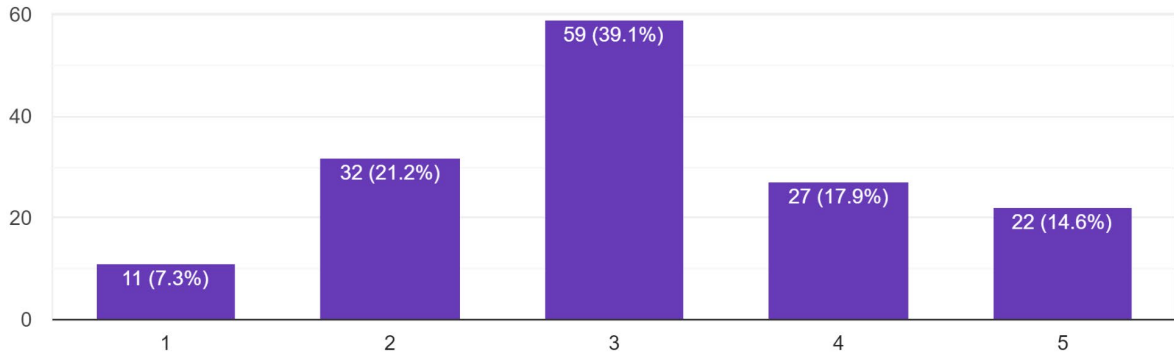


Figure 7.24. Respondents' reported frequency of adjusting other work based on CBP work.

25. Indicate how often you adjust your CBP work based on your other work with your organization, from Never (1) to Continuously (5)

(151 responses)

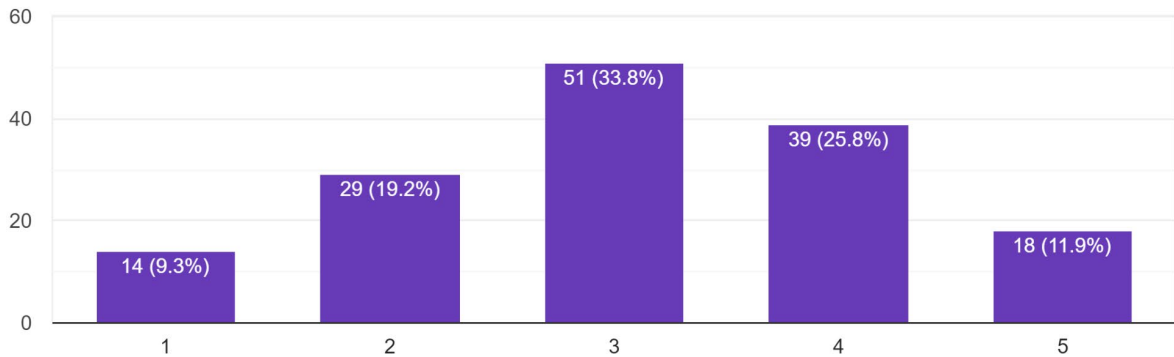


Figure 7.25. Respondents' reported frequency of adjusting CBP work based on other work.

C.5 Demographics

26. What is your highest level of education?

(151 responses)

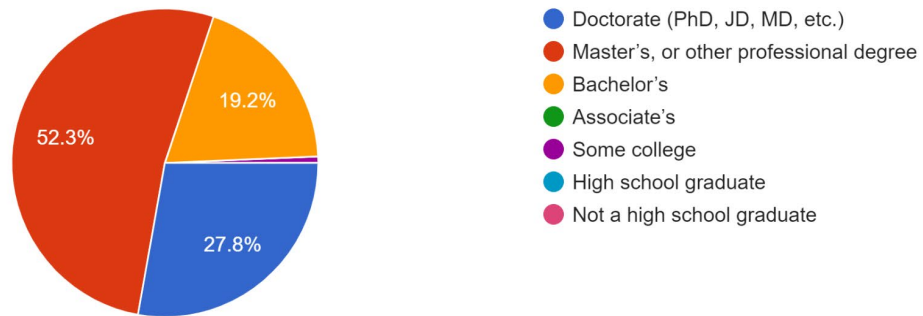


Figure 7.26. Respondents' reported level of education.

27. What is your gender?

(151 responses)

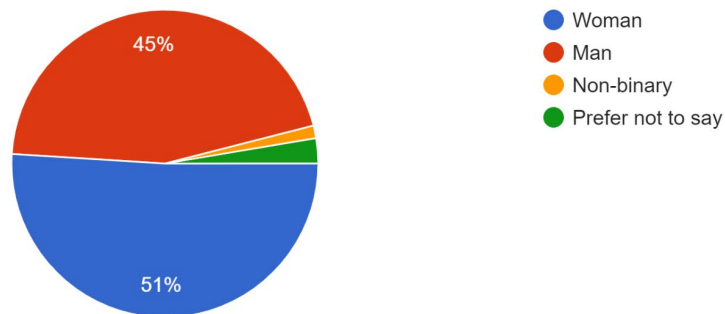


Figure 7.27. Respondents' reported gender.

28. What is your race (Select all that apply)?

(151 responses)

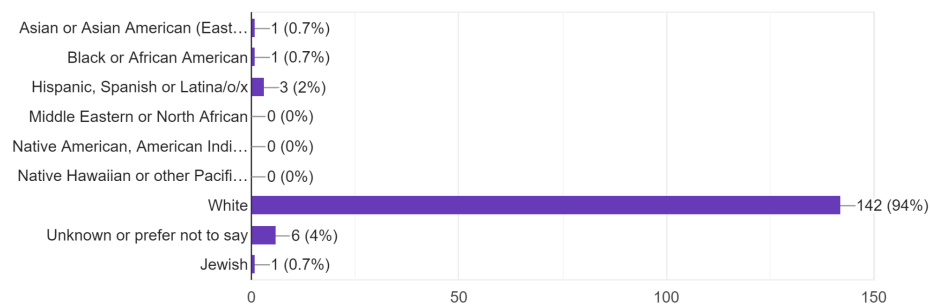


Figure 7.28. Respondents' report race. Respondents could choose more than one category.

29. What is your age?

151 responses

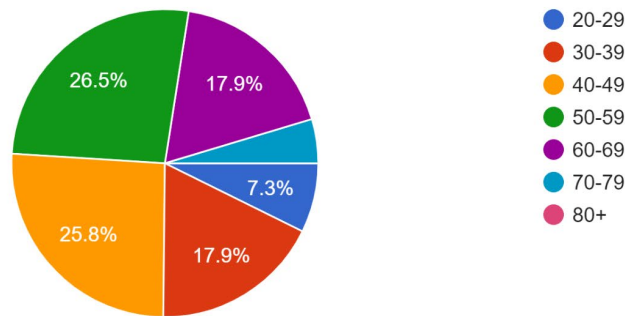


Figure 7.29. Respondents' reported age.

C.6 How should social science be used in CBP

30. Use the space below to describe how you think social science should be used by the Chesapeake Bay Program. Note that after you submit this questionnaire, you will be given the option to sign-up for a 30-minute interview.

(91 responses, covering 9 themes about social science priorities for CBP and 2 themes about concerns facing social science integration)

Priorities Theme #1: Align Bay restoration with stakeholder goals at multiple levels (19 responses)

- "Broad stakeholder engagement (education and solicitation of input) should be integral at multiple levels of policy and implementation, from high-level policy development to local management practice implementation."
- "Work with people's agendas in the CBP staff's mind and you will get further with your goals. CBP should put themselves in other people's shoes to realize how to bring people to the table of the CBP goals. Social Science information should be a guidance tool for a CBP focus group to use to understand the problems the public faces, then implement the CBP goals that benefit society. If the program is focused with local society needs addressed, you could have a better following and support for CBP goals."

Priorities Theme #2: Behavior change (17 responses)

- "I suggest an emphasis on the use of economics and social marketing for the purposes of better describing the value of natural resources and for reducing or eliminating actions that are causing challenges to meeting CBP goals."

Priorities Theme #3: Promote DEI (6 responses)

- "Social science will be useful in advancing DEI goals, which are becoming a huge priority for CBP. Natural/physical scientists and practitioners may or may not be well-equipped to work with target DEI groups and social scientists may be able to help mediate interactions to avoid problems."

Priorities Theme #4: Social science should encourage environmental awareness and stewardship among a wider group (6 responses)

- "I think social science should be used to help educate the public, stakeholders, government and other interested parties as a way to get them to care about the Bay."

Priorities Theme #5: Inform goals and strategic planning (6 responses)

- "I believe social science should be used as a factor considered with targeting and used when measuring how progress to established goals and milestones are measured."

Priorities Theme #6: More interdisciplinary science is needed (4 responses)

- "Social scientists should have discussions with environmental scientists to develop hypotheses linking environmental effects to what social scientists measure. Anthropogenic stressors are the sources of environmental impacts. If social scientists have a variety of metrics that reflect human behavior at different spatial and temporal scales linkages between behavior and environmental impacts (positive or negative) could be made."

Priorities Theme #7: Adaptively manage existing programs (2 responses)

- "Social science is critical to a "voluntary" or aspirational program. Early adopters are not adequately rewarded and holdouts never punished. It turns into a game that spins on its head giving mixed messages of success and pending calamity. There are many competing interests and not enough common benefits with the almighty dollar (or other trades) not being properly used to smooth out the give and take of a "commons" problem."

Priorities Theme #8: Engagement with policy actors (2 responses)

- "Better understand what prevents decision-makers from adopting protective environmental policies and investing more heavily in restoration work."

Priorities Theme #9: Better support partners (2 responses)

- "If we have to prioritize, probably need to focus on implementation to achieve water quality and other goals/outcomes that are far behind, while also better communicating the local/environmental/community benefits associated with that implementation. The partners (state/local govt and nonprofits) are the ones who are on the ground doing implementation and stakeholder engagement and the CBP needs to figure out how we can best serve as a more active and engaged resource that our partners enjoy leveraging as more than a data source."

Concerns Theme #1: Top-down structure with distinct siloes limits social science (3 responses)

- "My observation is that CBP is a top down organization whereas my experience with partnerships that utilize social science are more bottom up. It is tough to force mandates and goals down and engage after the fact instead of identifying ways to achieve from bottom up."
- "It would be great if social science could provide insights on institutional and governance structures or incentives that could motivate more action on the part of the Management Board. Sometimes I'm not really clear what their role is except telling us they don't have the capacity to provide the support we are asking for. I would also like to see greater involvement from social

scientists as we seek to implement the newly-approved DEIJ implementation plan and engage communities more meaningfully in our work.”

Concerns Theme #2: Need for clear guidance on using social science (3 responses)

- “I am regulated by the state and therefore work much more closely with them. Their goals are my goals. I unfortunately need to be a generalist and cannot dive into the details as the CBP does. However, clear and easy to use guidance is always helpful. This is especially true for social science. This needs to be easy, ready to use guidance.”

D Appendix D: Semi-structured interview guide

D.1 Semi-structured interview guide for people who have some experience with social science

- Ask permission to record the interview
- Outline interview: what questions you'll ask, hope to inform recommendations
- Questions
 - What they do now and how they work with CBP
 - What role social science should play in CBP
 - Their experience with social science, how it started, how it was received by policy actors
 - What policies enabled or constrained social science

This interview is being recorded to help ensure accurate notes. The recording will be deleted as soon as we are satisfied that we have captured the conversation. Is that ok with you?

[Tell the interviewee that some questions may seem repetitive, because we can't identify their response on the survey]

1. How did you become involved in Chesapeake Bay restoration efforts and what are your current roles and responsibilities now?
 - a. Can do this briefly if we know the respondent
 - b. Or "What do you see as your role in CB restoration?"
2. What role do you think social science should play in efforts to restore the Chesapeake Bay, and what needs to be done to make that happen?
 - a. Probe for
 - i. Describe/quantify outcomes
 - ii. Mitigate unintended consequences
 - iii. New ways to motivate staff
 - iv. Build public support
 - v. Promote pro-environmental behaviors
 - vi. Improve management and governance processes
 - b. What elements of social science make it useful/unuseful in policy-making?
 - i. Probe for evidence of co-design
3. Can you say more about how you have used social science, and/or collaborated with social scientists, to fulfill your current work responsibilities?
 - a. How did the project get started and then designed? Did the project unfold as initially planned?
 - i. Probe for evidence of co-design: how was the problem identified, how were the methods/intervention chosen, how were the results shared?
 - b. What were the outcomes of the project and how was it received by policy actors?
 - i. Probe for evidence of hurting stalemate: when the status quo hurt all individuals and brought them to the table
 - ii. Probe for what level of policy actor or government official they communicated with

4. What policies or other colleagues' priorities supported or hindered your use of social science and/or collaborations with social scientists? Do you have nothing to report? [*Probe for actions that enabled activity by others*]

D.2 Semi-structured interview guide for people who have no experience with social science

- Ask permission to record the interview
- Outline interview: what questions you'll ask, hope to inform recommendations
- Questions
 - What they do now and how they work with CBP
 - What role social science should play in CBP
 - Any experience using social science
 - Examples they've seen of social science, what made them successful or not
 -

This interview is being recorded to help ensure accurate notes. The recording will be deleted as soon as we are satisfied that we have captured the conversation. Is that ok with you?

[Tell the interviewee that some questions may seem repetitive, because we can't identify their response on the survey]

1. How did you become involved in Chesapeake Bay restoration efforts and what are your current roles and responsibilities now?
 - a. Can do this briefly if we know the respondent
2. What role do you think social science should play in efforts to restore the Chesapeake Bay, and what needs to be done to make that happen?
 - a. Probe for
 - i. Describe/quantify outcomes
 - ii. Mitigate unintended consequences
 - iii. New ways to motivate staff
 - iv. Build public support
 - v. Promote pro-environmental behaviors
 - vi. Improve management and governance processes
 - b. What elements of social science make it useful/unuseful in policy-making?
 - i. Probe for evidence of co-design
3. What, if any, experience do you have working with social scientists or using social science knowledge?
4. How have you seen others use social science in relation to Chesapeake Bay restoration, and how successful do you think those efforts were? Or do you have nothing to report?
 - a. What policies or partners' priorities made it successful/unsuccessful?
 - b. Probe for evidence of co-design
 - c. Probe for evidence of hurting stalemate