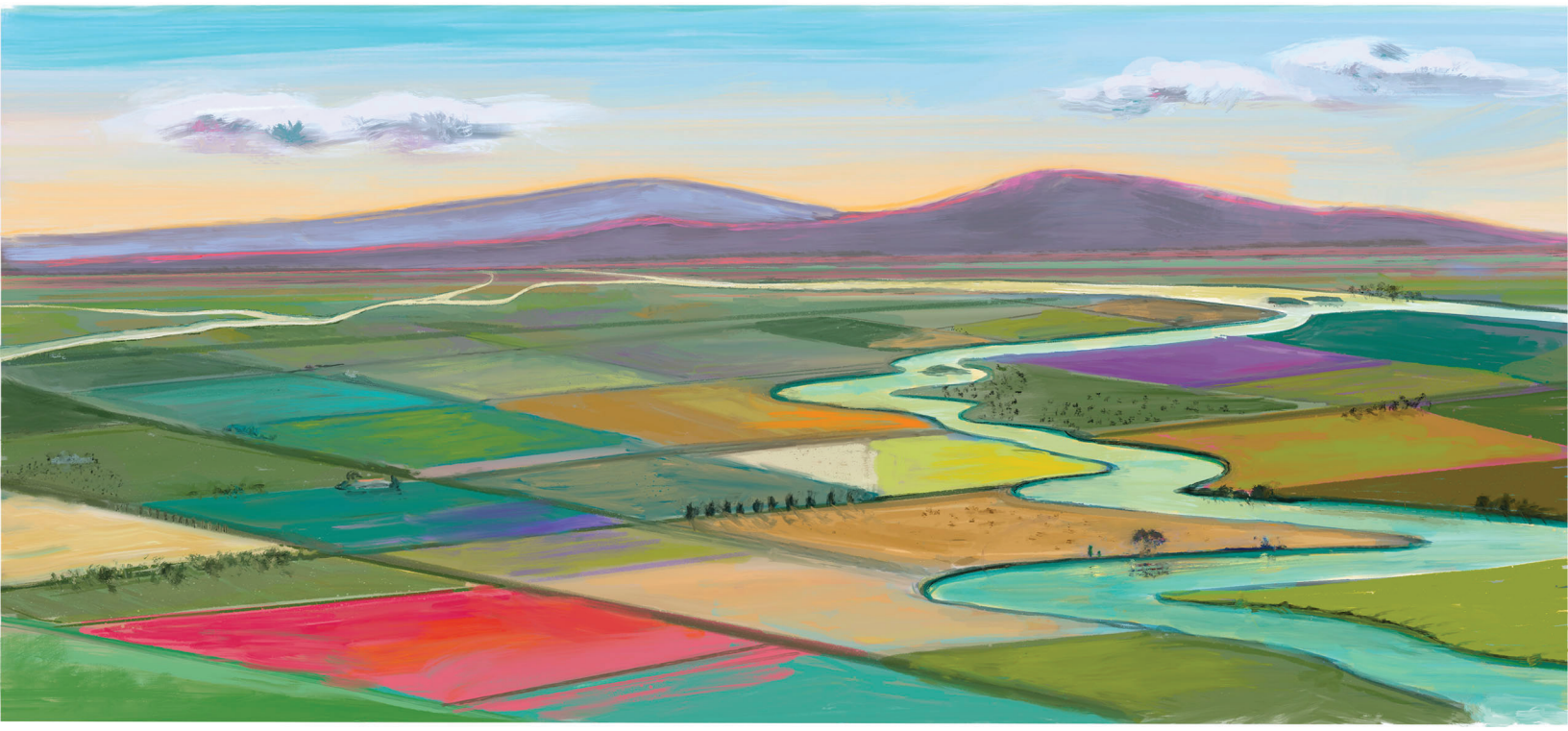

A Social Science Strategy for the Sacramento-San Joaquin Delta

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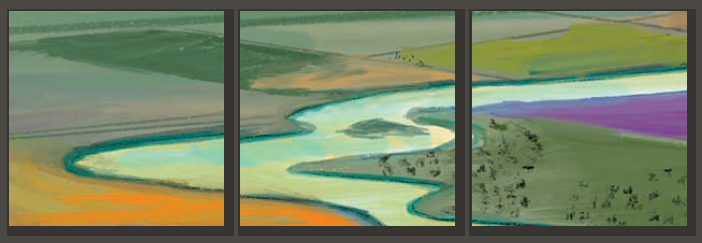

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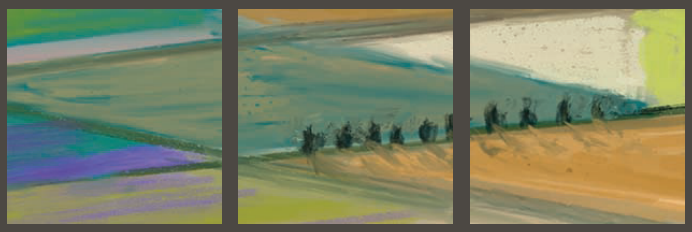


Executive Summary

Task Force Charge

In the fall of 2018, a six-member independent Social Science Task Force (Task Force) was charged by the Delta Stewardship Council's Delta Science Program to develop a strategy for strengthening and integrating social sciences into the science, management, and policy landscape of the Sacramento-San Joaquin Delta (Delta). This document summarizes the findings and recommendations of the Task Force. The intended audience is the Delta science enterprise, the collection of science programs and activities that exist to serve managers and stakeholders in the Delta (Science Enterprise Workshop, 2016). The elements of the enterprise range from in-house programs within individual agencies and academic institutions to large-scale collaborative science programs.

The specific objectives of the proposed strategy are to identify: (1) Opportunities to strengthen the Delta science enterprise; to improve the integration of social sciences into the science, management, and policy institutions that address Delta issues; and to improve social science integration into decision-making about the Delta; and (2) Critical steps and priorities for establishing a social science research program that enhances our understanding of the values of an evolving Delta, and that considers both people and the environment.

The Task Force was not asked to conduct social science or recommend specific actions based on social science. That is, this report does not "do" or report empirical social science—rather it provides a strategy for how the Delta science enterprise can promote, guide, and obtain the social science necessary to meet management goals for the Delta.

What is Social Science and why do we need it in the Delta?

The social sciences encompass dozens of theoretical and applied disciplines and sub-disciplines, such as anthropology, geography, economics, public administration, psychology, and sociology. The disciplines vary in their methods, data types, and analyses. Many social sciences have organized sub-disciplines focused on environmental and natural resource management, such as natural resource economics and environmental psychology. Particularly in contexts where humans deeply impact and are impacted by the state of the natural system, the social sciences can help answer a myriad of questions related to ways in which human and natural systems interact to influence the outcomes (and side effects) of environmental policy and natural resource management. Fundamentally, the integration of social and natural science recognizes that humans are a central part of the system, as is the case in the Delta—and that overlooking this human component often leads to unintended consequences and management ineffectiveness.

An instructive example of the role and impact of social science is found in commercial fisheries, where an old adage states that managers manage fishermen not fish. That perspective has led to substantial gains in the effectiveness, efficiency, and equity of fishery policy over the last 50 years. The development of catch share programs, for example, have replaced the dangerous and wasteful race to fish with a race to create value that has led to both ecological and economic gains over time (see Case Study 1). Social scientists, including anthropologists, political scientists, and economists, were instrumental in the development of these programs and currently in evaluating their performance. More importantly, the focus on managing people not fish has led to a robust and growing body of interdisciplinary research on fishery management.

While protecting and enhancing the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place is a critical component of how managers operate in the Delta, management efforts (e.g., as reflected in legislation and biological opinions for endangered species conservation) typically emphasize the management of habitats, water, and species. Less systematic emphasis is given to understanding and managing the *people and communities of the Delta* to achieve

the coequal goals. The framing of these issues primarily around biophysical rather than social dimensions reflects a paucity of social science input and capacity within the science enterprise.

Given the generally biophysical framing of Delta management, one might ask: why should my agency, project, or program invest in social science research? Such questions are often accompanied by arguments that full-time employee (FTE) caps, limited budgets, and other factors preclude significant new investments in social science. Yet given the imbalance currently devoted to biophysical versus social science, it may be optimal to make strategic tradeoffs between resources devoted to biophysical and social science. Social science input is critical to ensuring that rules and regulations are effective (and understanding why); understanding whether there are unintended consequences of management; improving the efficiency of management interventions; achieving management goals at the lowest costs to the public; and mitigating environmental justice implications, among many other priorities. When social science is overlooked or under-utilized, it implies a lack of attention to management effectiveness, efficiency, equity and social impact. Such a perspective is difficult to defend in a climate in which local, state, and federal agencies are increasingly asked to justify their actions and expenditures in terms of measurable outcomes and benefits to the public.

Task Force Methods

The Task Force engaged the scientific and regulatory community during our deliberations through two workshops, one with the regulator community and one with the academic community. Both workshops initiated a dialogue around social science needs for the Delta. The Task Force also met twice in person and over a dozen times remotely between January 2018 and March 2020 and a number of times with the Delta Science Program staff. The group reviewed a wide range of material, including the Delta Science Plan (2013 & 2019), Science Action Agenda (Interim 2014 & 2017-2021), Delta Independent Science Board's Review of Research on the Delta as an Evolving Place, the Delta Science Enterprise Workshop 2019 report, NOAA Science Advisory Board's 2009 report on "Integrating Social Science into NOAA planning, evaluation,

and decision-making," social science academic literature, and additional publications related to science and management in the Delta. Comments and reviews were solicited on an earlier draft version of this report (December 2019), and this input was considered when composing the final report.

This report is only one product of the Task Force's activities. We view the entire interactive process, including both workshops, as fundamental to generating and supporting conversations about key social science questions for the region and building a network of regional social scientists and champions.

Summary of Findings and Recommendations

Existing Delta Science Strategy documents already recognize the need for social science and many identify initial investments to address that need. The very act of putting together the Task Force, in fact, should be commended as a demonstration of the Delta Science Program's genuine interest in integrating social science. The majority of documents, however, do not clearly define how the different social sciences are relevant to different types of management questions, and how investments in social science can be targeted effectively to achieve the co-equal goals in water supply and restoration.

Based on these reviews and conversations, the Task Force identified three main barriers to the integration of social science in Delta planning, and eight overarching recommendations for addressing these barriers (summarized in Table 1). These recommendations do not need to be implemented in a specific order – incremental and iterative efforts to address any of them when policy windows are open would contribute to broader system change.

Fundamental to these findings and recommendations is an observation that different types of social science are relevant to different questions and problems facing the Delta, and that consideration (and solicitation) of "social science" as a homogeneous and non-differentiated tool will not be sufficient to address the paucity of social science input into Delta management. More broadly, implementing these recommendations requires a recognition that the problems and solutions in the Delta involve people. People include not just those who live and work in the Delta, or people who visit the Delta, but also those involved in the Delta governance. Developing an understanding of all relevant people entails the incorporation of different forms of knowledge, which includes input from different social sciences, as described further in Appendix D.

Table 1. Summary of Findings and Recommendations

Finding 1 There is a lack of social science capacity and investment.	Finding 2 Research activities are ongoing, but there is no long-term vision for social science integration.
Recommendation 1 Invest in a broad array of social science studies. This includes fully integrating social science and scientists in the development of the next Science Action Agenda, RFPs, and in finding diverse mechanisms to fund social science research.	**Recommendation 4** Invest in a collaborative process to develop a conceptual framework for the Delta that includes social science. This includes collaboratively developing a single framework that identifies and demonstrates the interdependence of social and biophysical components of the Delta system. While several agencies have their own such conceptual models, a single Delta-wide model that makes transparent the social and biophysical priorities of Delta science can provide a framework for regional research and strategic planning.
Recommendation 2 Invest in building an external network of social scientists. This includes actions to promote greater representation of social scientists, from different social scientific fields, on advisory boards and panels. It also includes the use of interdisciplinary workshops to involve external social scientists in research prioritization, and to improve the understanding of what the social sciences offer the Delta Science Enterprise.	**Recommendation 5** Secure funding for monitoring and reporting on social indicators. This includes collaborative development of indicators for the social outcomes that represent the science enterprise's overarching goals. Although performance measures have been identified to evaluate the actual implementation of actions, indicators measure the things we care about (or, our overarching goals). These indicators should be continually monitored over time and used to evaluate the effectiveness of strategies and inform strategic decisions. A plan for data collection, synthesis, and reporting these indicators should be funded and institutionalized.
Recommendation 3 Invest in internal social science capacity. This includes hiring senior and junior social scientists across different Delta science enterprise agencies, along with activities to train managers and staff on the integration of social and biophysical sciences to understand the complex Delta system.	**Recommendation 6** Integrate social and biophysical science to improve decision making. This includes creating pathways in which social science can inform decision making throughout the Delta, even though there is no explicit mandate to do so. One approach is to integrate social science with biophysical science to answer broader questions, such as "how can irrigation be managed to guarantee water quality, agricultural practices, and social justice?"

Finding 3
The adaptive management process is not informed by the social sciences.

Recommendation 7

Continuously evaluate institutional, cultural and individual barriers to learning.

This includes involving various social scientists (including economists, psychologists, and/or public administration specialists) in identifying the individual, social, and institutional factors that influence learning and decision making in the Bay Delta.

Recommendation 8

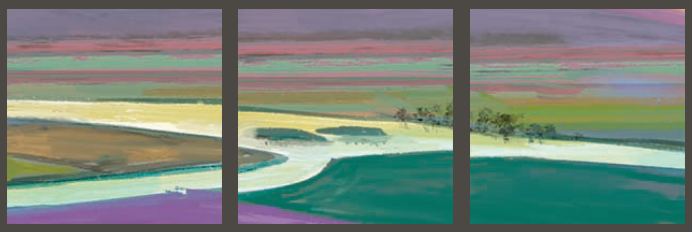
Reduce barriers to integrating new knowledge in future management decisions.

This includes streamlining opportunities for learning about when adaptive management is appropriate. Part of this is recognizing when some barriers are so entrenched as to make adaptive management irrelevant.

Finding 1 *pages 20-37:* R1, R2, R3

Finding 2 *pages 38-51:* R4, R5, R6

Finding 3 *pages 52-59:* R7, R8



Introduction

Genesis of this Report

In the fall of 2018, the independent Social Science Task Force (Task Force) was developed in partnership with the UC Davis Coastal and Marine Sciences Institute and the Delta Science Program of the Delta Stewardship Council (Council). The overarching goal of the Task Force was to work with the Delta Science Program to develop a strategy to strengthen and integrate social sciences into the science, management, and policy landscape of the Sacramento-San Joaquin Delta (Delta) that can be acted upon by the Delta science enterprise.[1] The Task Force was to include experts with a broad mix of social science expertise and to be patterned on successful efforts of the Social Science Review Working Group of the National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board (NOAA Social Science Working Group 2009).

To develop the charge of the Task Force, the Delta Science Program held key interest group meetings in the summer of 2018. The meetings provided input on the charge to the Task Force; relevant documents, materials, and presentations to the Task Force; and opportunities for informational exchanges with the Task Force. The meetings included representatives of local, state, and federal agencies, non-governmental organizations, private consultants, academics, and interested members of the Delta community.

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1 According to the report from the Science Enterprise Workshop (2016), the term 'Delta Science Enterprise' refers to the collection of science programs and activities that exist to serve managers and stakeholders in the Delta. The elements of an enterprise range from in-house programs within individual agencies, academic research, or other organizations to large-scale collaborative science programs funded by governments.

Based on the charge given to the Task Force the specific objectives of this strategy are to identify:

1) **Opportunities** to strengthen the Delta science enterprise, to improve the integration of social sciences into the science, management, and policy institutions that address Delta issues, and to improve social science integration into decision-making about the Delta

2) **Critical steps and priorities** for establishing a social science research program that enhances our understanding of the values of an evolving Delta that considers both people and the environment.

Figure 1 shows the specific questions considered by the Task Force, and where to find responses to each.

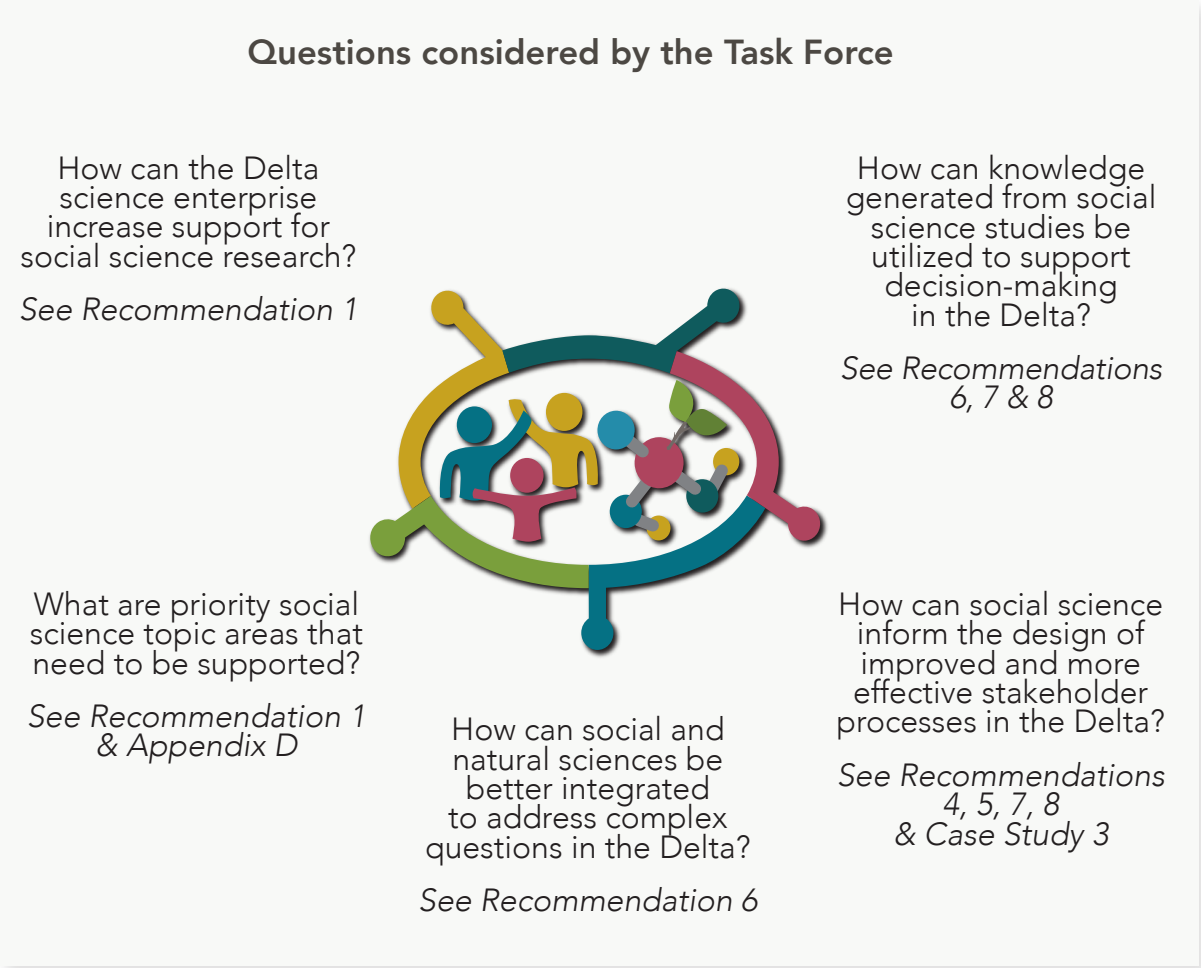

Figure 1. Questions considered by the Task Force and locations where they are specifically addressed in the report.

As a key part of the overall strategy, the Task Force held two workshops in partnership with the Delta Science Program. The first workshop was held on January 29, 2019 in Sacramento, California. The goal of the workshop was to obtain information from the Delta science community on their major management issues and challenges and to introduce the Task Force members to the community. The workshop was well attended, and included presentations by the Council, Delta Independent Science Board (ISB), Delta Protection Commission, Sacramento–San Joaquin Delta Conservancy, Bay Conservation and Development Commission, California Department of Water Resources (Bay-Delta division), Division of Boating and Waterways, California Department of Fish and Wildlife, NOAA Fisheries, Delta Regional Monitoring Program, and the Central Valley Flood Protection Board.

Each presenter was asked to address the following questions:

- What is your agency's mission, with respect to the Delta region?
- What are current Delta-related management issues your agency or organization is addressing?
- What are some high priority science activities (e.g. monitoring, modeling, research, community outreach) in which your agency is engaged in the Delta?
- Are there particular emerging concerns in the Delta environment and/or communities that your agency hopes to address?
- What are some potential challenges (if any) to implementing your management actions or working collaboratively in the Delta?

The second workshop was held on July 23, 2019 at the University of California at Davis and was entitled, "Human Dimensions Research in Delta Environments." This workshop explored the capacity of different social sciences to address pertinent topics identified within the first workshop: invasive species management, water management, and flood risk management. The goal of the second workshop was to demonstrate the value of social science and learn how other entities similar to the Delta science enterprise have incorporated (or not) social science. A secondary goal was to obtain input on the way that *different* social sciences are relevant to different types of questions and challenges facing the Delta science enterprise. The summary for the workshop includes links to videos of the presentations.

The backdrop for the two workshops and this strategy document is the vision of *One Delta, One Science* that "refers to an open Delta science community that works together to build a common body of scientific knowledge. Achieving this vision requires a sustained culture of cooperation and stewardship among decision-makers, scientists, managers, stakeholders, and the interested public" (Delta Science Plan 2019). A key piece of this vision is the science triad of the Delta Science Plan, Science Action Agenda, and State of the Bay-Delta Science (Figure 2).

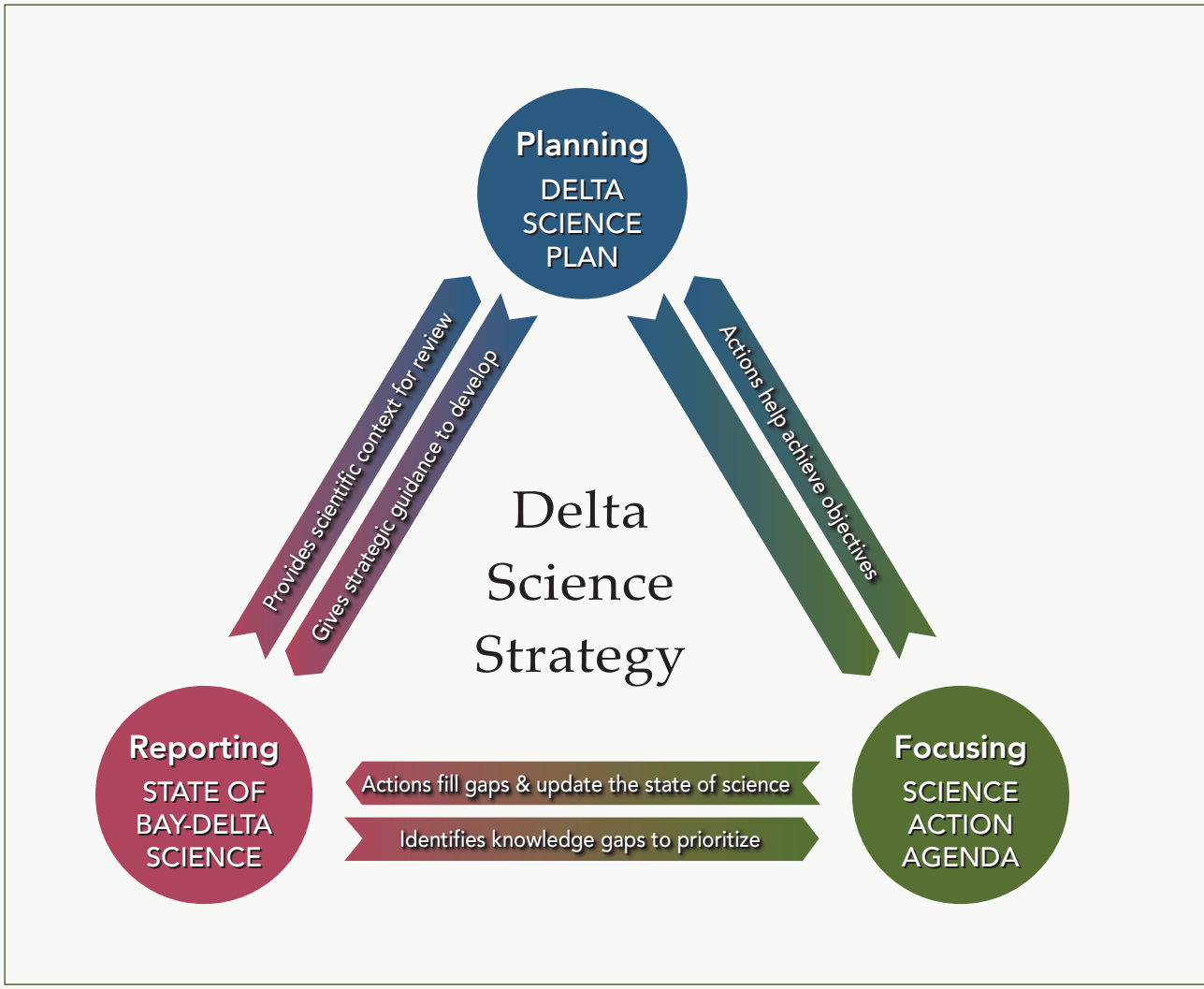

Figure 2. Delta Science Strategy (Delta Science Plan 2019)

This document builds from what the Task Force learned in these workshops, meetings, from formal reviews, and in the public comment period, and the individual professional expertise of Task Force members in recommendations for filling identified gaps. It also draws on reviews of similar social science strategy documents prepared for other organizations and management contexts. This report provides guidelines for how the Delta science enterprise can promote, guide, and obtain the social science necessary to meet management goals for the Delta.

The Delta Science Plan is the overarching document that identifies the tools, organizational structures, mechanisms, and actions needed for a more collaborative and integrated Delta Science community. Objectives and supporting actions lay the foundation for science in the Delta to be credible, relevant, legitimate, produced collaboratively, conducted efficiently, and shared openly.

The State of Bay-Delta Science is a summary of the current scientific knowledge for the Delta. The purpose of the State of Bay-Delta Science is to communicate the state of knowledge to address key management needs, highlight progress made on key research questions, and identify remaining knowledge gaps.

The Science Action Agenda establishes focused science actions to achieve the objectives of the Delta Science Plan and to address key management issues. The science actions are specifically focused on filling gaps and promoting collaborative efforts. The Science Action Agenda serves as the common agenda from which agencies and programs can develop more detailed, shorter-term work plans and provides the basis for topic-specific science implementation plans.

Source: Delta Science Plan 2019

What is Social Science?

One of the primary impediments to the effective use of the social sciences in the Delta is a failure to fully recognize and clearly define how the different social sciences are relevant to different types of management questions. Like the biophysical or natural sciences, the social sciences encompass dozens of theoretical and applied disciplines and sub-disciplines. They vary in their methods, data types, and analyses. Many social sciences have organized sub-disciplines focused on environmental and natural resource issues of the type encountered in the Delta (e.g., environmental and resource economics and environmental psychology). Many practitioners in these sub-disciplines have formal training in biophysical sciences to complement their primary social science expertise and are further trained in the integration of biophysical and social sciences. Disciplinary characteristics and differences are frequently unrecognized in the strategies and documents that guide Delta science. As a result, the definition of "social science" or (alternatively) "human dimensions research" in the Delta is often ambiguous.[2] To more effectively leverage social science research in the Delta, we provide a description of what social sciences are and what they are not.

In relation to the Delta, social science disciplines seek to understand social processes, social phenomena, or individual human attributes that are critical to the effectiveness of management decisions, including but not limited to those on environmental restoration (Sexton et al. 2013, Bennett et al. 2017, Spalding and Biedenweg 2017). As described by the federal NOAA Science Advisory Board (2009, p. 10), social science in the context of environmental management "is the process of describing, explaining and predicting human behavior…." Some disciplines tend to emphasize quantitative data and modeling whereas others make greater use of qualitative methods; most social science disciplines employ both qualitative and quantitative methods.

The social sciences are distinct from the humanities (e.g., philosophy) in that the humanities generally seek to describe, study, critique, or document the human

2 For example, of all projects funded under the 2018 Delta Science Proposal Solicitation Notice, two are categorized as addressing social science topics (i.e., "human dimensions of natural resource management"). However, of those two projects, one appears to be an engineering risk assessment with tangential links to social science or human dimensions research.

experience, whereas the social sciences apply scientific methods to analyze, understand, characterize, test hypotheses on, and sometimes predict social phenomena. Admittedly, the lines often blur between the humanities and social sciences. The conceptual or theoretical foundations that underpin different social science disciplines provide ways to interpret the results that emerge—affording insights that are distinct from those available through a biophysical or humanities lens. Although the humanities can provide useful insights, they should be considered different from rather than as a substitute for social science.

How one implements social science should be distinguished from *what is* social science. Often, non-social scientists might associate community engagement or environmental justice activism with the social sciences. However, both social and natural scientists can engage the community in data collection or apply their findings to understand environmental justice. Hence, the first step to effectively employ social science is to obtain a clear understanding of what social science is, and what it is not.

Each social science discipline has its own fundamental view of how the social world can be described and explained and utilizes a range of methods to this end. Discussing different social sciences as generic and interchangeable is akin to viewing different biophysical sciences (from physical oceanography to population ecology to genomics) as the same. Some social scientific disciplines use what might seem like similar methods, such as interviews and surveys, but the specific design of these data collection instruments are distinguished by the theoretical foundation of the discipline, and the data from these instruments are often analyzed in different ways.[3]

To understand a farmer's adoption of riparian buffers or other best management practices, for example, an economist might implement a survey that asks farmers to choose among various policy options (called a discrete choice experiment), controlling for costs and benefits associated with potential policy designs. The results would help develop a predictive model of behavior, perhaps enabling the estimation of economic

3 For example, a survey can be used to collect different types of data from different groups, and the data can be analyzed in many different ways, to answer different questions. Hence, speaking of "using a survey" to answer a particular social science question is akin to speaking of "using a ship" to answer a marine science question—both speak solely to the tool used for data collection but provide no information on the type of science that is conducted.

values. A social psychologist, on the other hand, might implement a structured survey or laboratory experiment that asks farmers to rate their perceptions of the policy, identify their primary values around farm management, and describe who they trust to share information about riparian habitat management. The result would be a quantification of the extent to which different cognitive and social factors influence their policy perceptions. An anthropologist might interview a group of prominent farmers in the region and spend time with them as they conduct their daily activities, with the intent of describing the belief systems and practices around farming that may support or be in conflict with the new policy. As such, there is no single "social scientist" that can address all management and policy questions; rather, the combined suite of social sciences help us better understand the diverse, complex factors affecting the human system.

Appendix D provides greater detail and more examples of relevant social science disciplines and research questions for the Delta region. However, fundamentally, the key social science questions and research needs must be identified via a collaborative process involving social scientists working in the Delta, managers, stakeholders and others. These cannot and should not be identified solely by an external Task Force.

Why do we need Social Science in the Delta?

Why is social science needed in management contexts such as that found in and around the Delta? A common question fielded by social scientists working in environmental management is whether there are examples of cases in which "social sciences affected management." In fact, the examples are all around us, we just may not recognize that 'science' informed the policy decisions. One example comes from fisheries. An old adage in commercial fishery management is that managers manage fishermen not fish. That perspective has led to substantial gains in the effectiveness, efficiency, and equity of fishery policy over the last 50 years. The development of catch share programs, for example, have replaced the dangerous and wasteful race to fish with a race to create value that has led to both ecological and economic gains over time (see Case Study 1). Social scientists, including anthropologists, political scientists, and economists were instrumental in the development of these programs and currently in evaluating their performance. More importantly, the focus on managing people

Case Study 1

Does Social Science Matter? An Illustration from Fishery Management

There are many examples in which changes in management outcomes engendered through social science are evident. One is the widespread improvements in fisheries made possible through rights-based fishing, *based on economics and other social sciences. Regardless of the availability of biophysical information on fisheries stocks and ecosystems, traditional fishery management has frequently failed to achieve biophysical and socio-economic objectives because it does not account for the behavioral incentives facing fishery participants. The National Research Council Report (1999, p. 26-33), Sharing the Fish: Towards a National Policy on Individual Fishing Quotas, reviews the history of how social science insights and models were used to develop contemporary rights-based management methods worldwide, drawing from pioneering work of economists from the 1950's and later. An extensive literature documents the ecological and socio-economic improvements made possible via these changes. For example, Costello (2008) found that fisheries managed through rights-based approaches collapsed at about half the rate of non-rights-based fisheries. The National Research Council (1999) also documented that the season length of the Alaska Halibut fishery increased from 5 days to 245 days due to rights-based management, while simultaneously reducing mortality from lost and abandoned gear. Examples such as these document how the ability of social sciences to characterize, understand, and predict human behavior can lead to quantifiable improvements in management outcomes.*

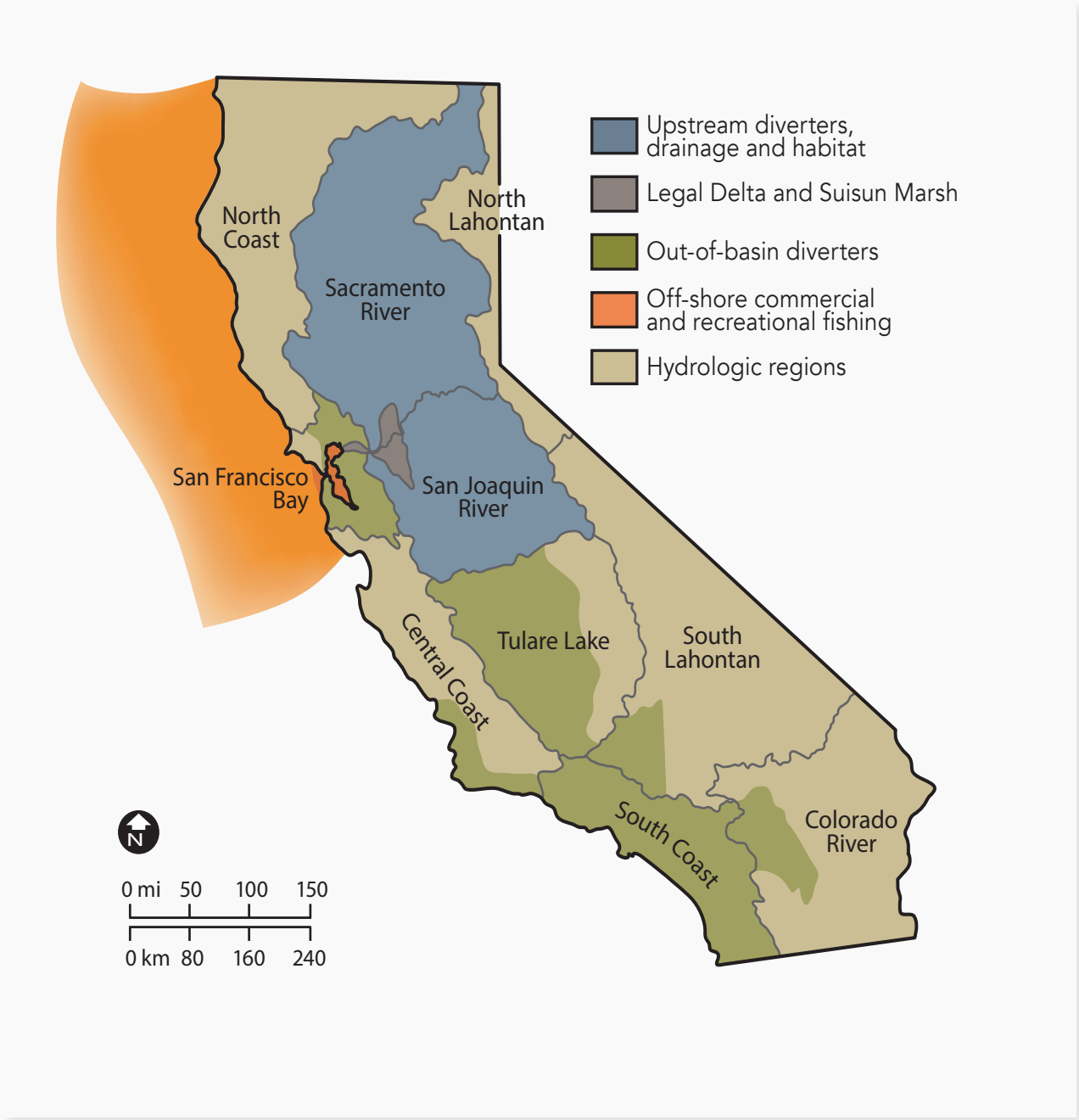

Figure 3. Delta Watershed Map (Hanak et al, 2013).

not fish has led to a robust and growing body of interdisciplinary research on fishery management. The same type of social science insight and information can benefit many areas of management within the Delta.

The Delta is one of the most productive agricultural regions in the world (Figure 3). At the same time, it hosts fragile and highly altered ecosystems with a number of listed threatened and endangered species and provides water and recreation opportunities to over 26 million people. To ensure the sustainability of the Delta into the future, the California Legislature enacted the Delta Reform Act of 2009. The Act revised the governance institutions of the Delta by establishing the California Delta Stewardship Council and the Delta ISB and established the coequal goals of water supply reliability and ecosystem restoration to be "…achieved in a manner that protects and enhances the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place" (CA Water Code Section 85054). It also sets new guidelines for the use of science in the "development of and implementation of all Delta policies and management – in essence all actions need to be based on science." (Delta Science Plan 2013). Specifically, the mission of the Delta Science Program is to provide the best possible, unbiased scientific information for water and environmental decision-making in the Delta system.

While there are no mandates[4] that directly require social science, the inherent coupled interactions between human and biophysical components of the region require the use of social science to characterize, design strategies for, and evaluate how people interact with the Delta, how the Delta impacts their well-being, and how their actions impact the Delta environment – all of which contribute insight into protecting and enhancing the Delta. Table 2 describes how different social sciences could help understand three of the most pressing issues in the Delta today.

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4 The one caveat is that in response to the Flood Control Act of 1936, economics has been required to complete benefit-cost analyses for water projects. Economists have since contributed to helping account for and enhance sequestration of greenhouse emissions, designing water trading, and evaluating ecological restoration of the Yolo Bypass, among others. To provide the most holistic, relevant science for the Delta system, the social and biophysical sciences should work in tandem. In fact, interaction between natural and social scientists is not rare for the Delta (see Case Study 2); engineers and economists have long interacted in response to the water project requirements described here.

Table 2. Delta topics that social science can help understand (from Human Dimensions Research Workshop, summarized in Appendix C).

Delta topics that social science can help understand

Invasive species management	Flood risk management	Water management and ecosystem restoration
• Public policy analyses can evaluate whether policies and governance processes (such as enforcement, action, and collaboration) at different spatial and temporal scales are effective at mitigating invasive spread	• Psychological studies can measure stakeholder opinions about flood management efforts to inform the development of effective strategies	• Anthropological studies can identify conflicting senses of place that contribute to trust and conflict associated with ecosystem recovery and the best uses of water
• Economic analyses can model economic uncertainty of new invasions	• Recreation studies can measure the number of people using areas prone to flooding and determine the relative risk of different flood management strategies to their personal safety.	• Interactive landscape design efforts can result on restoration projects that more effectively meet both ecological and diverse social goals
• Communication studies can design effective microtargeting to improve messaging around invasive species management	• Economic analyses can model when adaptive investments should be made based on tradeoffs among community values	• Human geography analyses can explore spatial relationships of how water distribution and water quality variation impact the activities of different stakeholder groups and vice versa (how different stakeholder group activities influence water quality).

Fundamentally, the need for integrating social science in Delta management is based on the recognition that humans are a central part of the system—and that overlooking this human component often leads to management failure and unintended consequences. Whereas bringing the best available social science to the table can improve design for success. For example, anthropologists, psychologists and geographers each have unique ways to measure and analyze the ever-changing needs, wants, and values of the communities within the Delta so as to support the Delta as an "evolving place." Anthropologists can identify the best ways to engage

Case Study 2

Multidisciplinary Approaches for Research and Management of Estuarine Systems

The complexity of Delta water supply and water quality dynamics requires transdisciplinary approaches to help inform Delta management (Jahn et al. 2012). In contrast to large body of natural and physical sciences, the social dimensions associated with water supply and ecosystem management remain relatively underdeveloped. Lund et al. (2007, 2010) offered one of the first efforts to bring together ecosystems, infrastructure, and socioeconomic aspects of the California Delta. UC Davis Center for Watershed Sciences and PPIC (a think tank on California policy issues) have convened various groups of academics and consultants with expertise in various fields to cover a wide arrange of elements including flood management, fish and native species, water supply, and water quality. Products of this collaboration (see e.g., report by Hanak et al. 2013) have been highly influential among the Delta's water and environmental technical and policy communities. Furthermore, the processes used to develop the reports involved extensive consultation with the scientists, experts, and managers in agencies, academia, NGOs and other organizations. The inclusive process was an important first step in improving the integration of social science into technical and policy discussions on California water and environmental management issues.

stakeholders in planning processes (see Case Study 3 for more information on this topic). Sociologists and human geographers can identify trends in the demographic and spatial distribution of different ecosystem services (e.g., water rights) and disservices (e.g., poor water quality due to algal blooms), informing planning processes that can be both socially just and ecologically responsive. And organizational and legal scholars can identify barriers to learning so that the mandated adaptive management can proceed as intended (see Finding 3).Although social science is underutilized in the Delta, it has not been overlooked entirely (for additional discussion see Finding 2). At least three Delta Science Strategy documents recognize the need for social science (Delta Science Plan, Science Action Agenda, and the State of Bay-Delta Science). For example, the Delta Science Plan establishes six objectives, among them *maintain, communicate, and advance understanding of the Delta* (objective 6). It additionally calls for use and integration of social sciences, citing the 2017 Delta ISB's review of research recognizing potential gridlocks in advancing science due to lack of understanding human values (Council 2017).

In addition to documents, effective implementation of the frameworks adopted in the Delta require different social sciences at every step. For example, the Delta Conservation Framework developed by California Department of Fish and Wildlife (2017) outlined an integrated process for conservation based on partnerships, common goals, and evaluations of alternatives (Figure 4). Public policy scientists could identify which partners should be included in exchanging information, the type of information that each partner considers important to discuss, how cooperation and learning evolve in the system over time, and the potential socio-economic impacts of alternative scenarios. Psychologists could then evaluate the factors that determine individual engagement in the broader partnership and whether people are satisfied with the process. And finally, a joint study with these social scientists and ecologists could assess the entire Regional Conservation Partnership process, enabling an assessment of whether these steps actually result in a more resilient ecosystem and more satisfied partners. Failure to consider such socio-economic dimensions of conservation has been documented to lead to wasted resources and sub-optimal conservation outcomes (e.g., Ferraro 2003; Newburn et al. 2006; Duran Vinent et al. 2019).

Case Study 3

What has social science found about effective stakeholder engagement?

One of the purposes of governments is to implement the will of the people, but how does a government identify the people's will in a large population that often disagrees about the means and ends? A large body of research in public administration, public policy and sociology has produced insights for how to engage stakeholders in collaborative processes that involve sharing values and establishing goals, co-producing knowledge about the seriousness and importance of problems, and developing strategies for implementation. Some of this research is based on relatively small-scale management of natural resources, as might be found in governing fisheries, endangered species, estuaries, and watersheds (Sabatier et al., 2005; Lubell, 2004; Emerson and Nabatchi, 2012). Factors associated with successful stakeholder engagement have included representative participation, leadership, taking time to develop joint understanding of problems, often through integrating science and local knowledge, designing rules that foster trust, taking time to build trust, and fair rules of negotiations. For example, Heikkila and Gerlak (2005) in their study of four large collaborative resource management situations emphasized the importance of science, leadership, and prior experience. These findings highlight tested structures and processes that can facilitate effective engagement of stakeholders to help identify and define problems that need to be addressed through social science and interpreting how to respond to social science findings.

In summary, all decision-making for the Delta involves *people*, including those who make management decisions and those impacted (directly or indirectly) by such decisions. Understanding the Delta as a system requires an understanding and integration of social science in research and planning processes to help ensure that decision-making has the intended and beneficial consequences - avoiding unintended, unforeseen or negative outcomes.

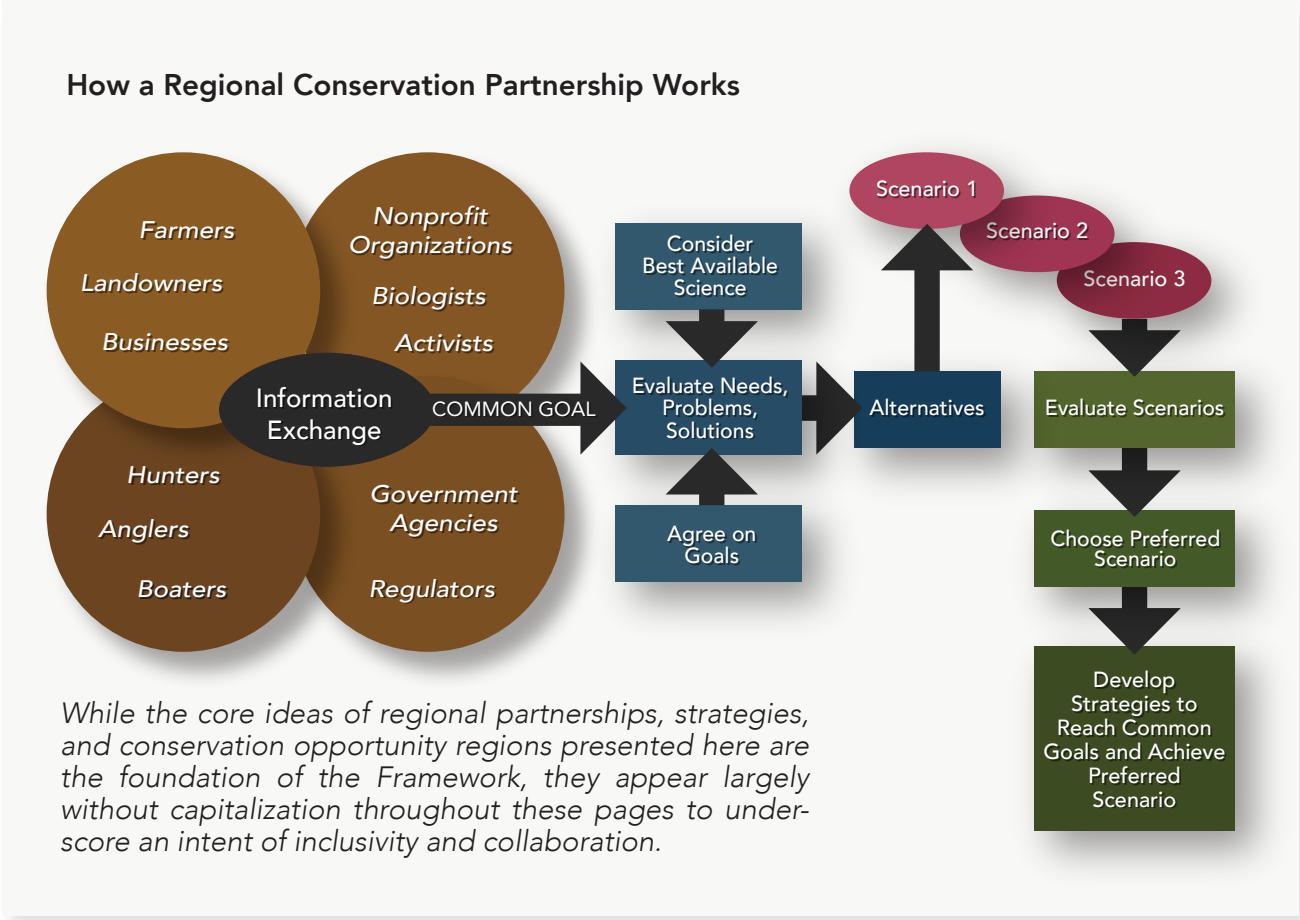
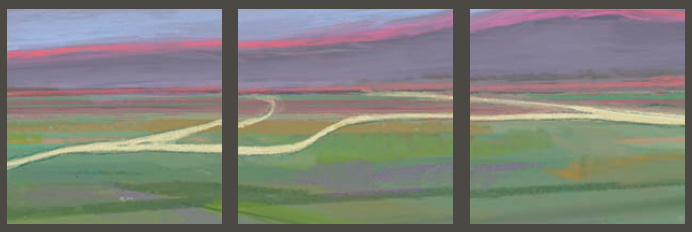


Figure 4. Delta Conservation Framework image showing the steps to building common strategies and goals.



Findings and Recommendations

The recommendations provided by the Task Force are grounded in the fundamental principle that the natural and physical dimensions of the Delta must be understood and managed in combination with the Delta's human dimensions. Thus, improving, enhancing and restoring the Delta necessitates developing knowledge based on systematic and rigorous research about people and their organizations. This does not require a completely new paradigm of decision-making but rather supplementation of existing information sources and means of decision-making that includes social science information.

The Task Force offers three findings and eight recommendations that encourage a vision for (1) supporting a long-term investment in social science capacity, (2) integrating social and biophysical science to address Delta concerns, and (3) using social science to inform adaptive management. While these findings are enumerated, there is no required sequential pathway to success. Rather, each of these can be addressed incrementally and iteratively as social science initiatives mature and evolve throughout the Delta.

Finding 1: Limited Social Science Capacity and Investment

As characterized by the 2018 Delta Science Proposal Solicitation Notice, the "*One Delta, One Science*" vision implies a science community that "works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform water, environmental, and societal decisions." This implies integration and use of *all* science relevant to decisions. However, a review of extant science strategy documents, funding proposals, research results and other evidence suggests that science capacity in the Delta is weighted towards the natural (or biophysical) sciences, with insufficient social science capacity and investment.

While protecting and enhancing the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place is a critical component of how managers operate in the Delta, management efforts (e.g., as reflected in legislation and biological opinions for endangered species conservation) typically emphasize the management of habitats, water, and species. Less emphasis is given to understanding and managing the *people and communities of the Delta* to achieve the coequal goals. The framing of these issues primarily around biophysical rather than social dimensions reflects—from the outset—a lack of sufficient social science input and capacity within the science enterprise.

Given this current framing of Delta management, one might ask: why should my agency, project, or program invest in social science research? Such questions are often accompanied by arguments that FTE caps, limited budgets and other factors preclude significant new investments in social science. Yet given the imbalance between resources (and FTEs) currently devoted to biophysical versus social science, it may be optimal to make strategic tradeoffs between resources devoted to these two different areas.

Social science input is critical to ensuring that rules and regulations are effective (and understanding why); understanding whether there are unintended consequences of management; improving the efficiency of management interventions; achieving management goals at the lowest costs to the public; and mitigating environmental

justice implications, and many other priorities. When social science is overlooked or under-utilized, it implies a lack of attention to these important concerns. Such a perspective is difficult to defend in a climate in which local, state, and federal agencies are increasingly asked to justify their actions and expenditures in terms of measurable outcomes and benefits to the public.

To be clear, excellent and relevant social science has been (and continues to be) conducted in the Delta. However, the resources and planning devoted to social science questions lag behind those devoted to similarly important questions in the biophysical sciences. For the Delta science enterprise to serve the interests of stakeholders and fulfill its mission, it must integrate the social sciences into the full range of its scientific and programmatic activities. This will require a systematic and purposeful increase in social science capacity and investment.

Trajectories of capacity-building priorities tend to be self-perpetuating, and hence require deliberate and sustained corrective actions. For example, the lack of strong social science input when developing science strategies, funding priorities and requests for proposals often lead to outputs that (a) underappreciate the potential contributions of the social sciences, (b) fail to perceive key gaps in understanding social systems, and/or (c) are written using language or conceptual framings that are inconsistent with the ways that social scientists view the issues under consideration. Similarly, advisory boards or review panels (e.g., for research funding proposals) dominated by natural scientists often lack the expertise to make informed decisions regarding social science proposals or initiatives, or to effectively balance the relative benefits of social science versus natural science research when funds are limited. This contributes to the social science community feeling disengaged from the science enterprise, and hence being less likely to participate.

Social science capacity in the Delta refers to (a) the social science expertise applied to Delta problems (i.e., the *researchers* or scientists), and (b) the resulting amount of social science research produced in the Delta (i.e., the *research* or science itself). This capacity can be "internal" to the Delta science enterprise (e.g., dedicated social science staff, dedicated funding for internally managed social science projects), or

Case Study 4

Measuring Values and Tradeoffs Linked to Flood Adaptation Alternatives in Coastal Connecticut

Natural resource management requires tradeoffs—it is never the case that management optimizes all possible benefits to all affected groups. Understanding biophysical outcomes alone is insufficient to understand how those outcomes affect and are valued by people. Social science tools can help characterize the benefits, costs and tradeoffs associated with options for natural resource management. An application of discrete choice experiments (DCEs) by Johnston et al. (2018) illustrates how environmental economics can be used to quantify public values for flood management and evaluate the types of management that would be most supported by affected community residents. They illustrate the approach using a case study application in Waterford and Old Saybrook, Connecticut. A DCE questionnaire asks respondents to choose among a set of hypothetical but realistic policy options, similar to a public referendum with two or more choice options. Each option is described by multiple attributes, including indicators of management outcomes (e.g., effects on natural resources) and the monetary cost to the household. Observed choices (votes) over many sets of options enables analysts to estimate respondents' values and tradeoffs. Results in Waterford and Old Saybrook show that community residents hold relatively high values for the protection of natural assets such as beaches and coastal wetlands. However, typical residents are unlikely *to support large expenditures to protect additional homes from flooding—home protection is typically viewed as a private concern for which public tax dollars should not be spent. Results such as these highlight potential differences between the true values held by the public and the values that might be assumed by decision-makers in the absence of rigorous social science analyses. The results of this study were used in coordination with organizations such as the Nature Conservancy in Connecticut to inform local dialogs regarding the benefits and costs of alternative adaptation strategies in each town.*

"external" (e.g., external advisory boards, research produced by periodic proposal solicitations). This capacity should allow for social science production across various disciplines, fields, and areas of study. The science itself can come from targeted studies (see Case Study 4 for an example), or existing data including articles in academic journals, books, and reports or presentations published through government or non-government organizations.

To be most effective, this capacity must be co-produced by social scientists, stakeholders and managers from the outset. This co-production starts from the beginning of the capacity-building process via joint formulation of research questions and knowledge gaps, to development of internal and external capacity building strategies to obtain the resources necessary to address those questions and gaps, to the development of strategies to link the resulting information to decision-making.

For this reason, the Task Force is not the appropriate body to prioritize specific social scientific research questions to the Delta science enterprise (although it can provide illustrative examples, as in Appendix D). Rather, the Delta enterprise should invest in bringing together those who have the regional knowledge to inform and the capacity to implement priority social science needs. Social science prioritization should be integrated into the workshops that currently develop the Science Action Agenda, for example, rather than as a separate and parallel activity.

Grounded in the above observations, we recommend that social scientific capacity development follow a three-component strategy, reflected in three specific recommendations. The first set of recommendations (Recommendations 1a and 1b) speaks to the systems used to *fund particular research priorities and projects*, for example through the design and implementation of research competitions. The second recommendation speaks to the need to *develop an external network of social science researchers* engaged in Delta science priorities over the long term. The third recommendation speaks to the need to *support social science capacity that is internal to the organizations within the Delta science enterprise.* Although there are necessary overlaps in the topics covered within these three major recommendations, each addresses a distinct priority for improving social science capacity and investment.

Case Study 5

Balancing Riparian Management and River Recreation on the Cedar River, Washington

In 2010, the King County River and Floodplain Management Section conducted social science to inform their decisions about where to implement levee setbacks, remove large wood from the river, and manage recreational access by seasonal river floaters (Biedenweg et al. 2012). They hired an environmental psychologist to work with them in the design and implementation of a study that would quantify the number of recreationists and density of floater use tracks along the length of the Cedar River, a high-use river passing through the greater Seattle metropolitan area. The psychologist also measured recreationists' perception of large wood as compared to other risk factors inherent to floating the river, characteristics of recreationists that could contribute to their risk of injury (e.g., use of personal flotation devices and visible use of alcohol), and worked with King County staff to identify how floater tracks overlay with existing large wood and levee setbacks. Results from this study informed risk assessments of large wood removal and levee setback project sites, selection of signage locations to warn users of dangerous log jams on the river, and where to focus safety campaigns. In this example, the social science was integrated with ecological science, engineering, and planning to inform a critical watershed management issue. This integration required a concerted commitment by the Capital Projects Manager to fund, support, and synthesize all aspects of science before engaging in a decision process.

Recommendation 1: Invest in a broad array of social science studies.

Nationally, funding for social science has increased at a slower rate than funding for the biophysical sciences (NSF 2018, Table 5.6). Consequently, if the Delta science enterprise aims to integrate social science, they will need to fund or otherwise support it. Steps have already been taken to increase investment in relevant social science—for example via external channels such as the Delta Science Proposal Solicitation Notice and internal emphasis on human dimensions in guidance documents such as the Science Action Agenda for 2017-2021 (Council 2017) and the recent Delta Science Plan (Council 2019). To be effective, these efforts must be structured and implemented in a way that better promotes integrated, high-quality, and relevant social science research in the Delta. Ongoing co-production of these efforts with the social science community is critical for success. For example, despite an emphasis on social science in recent guidance documents, current funding programs are implemented in a way that unintentionally discourages social science applications, dissuades research that effectively integrates natural and social sciences, and diminishes the probability that social science projects will be selected for support.

Updates to program structure and implementation are required to fully realize the vision of the Delta Science Plan for truly integrated social science. As an illustrative example, the 2018 Delta Science Proposal Solicitation Notice included "Human Dimensions of Natural Resource Management" as one of five priority areas in which proposals were sought. The inclusion of this priority is a positive step. However, the structure of the research solicitation reflects a common structure that (a) isolates social science research within a single priority area that is separate from (many) other natural science research priorities, and (b) fails to recognize the potentially important role of social science dimensions in other listed research priorities (e.g., the benefit of integrated research).

Data received from the Council indicated that the review panel for the 2018 proposal solicitation included ten individuals with natural science expertise and only one individual with expertise in human dimensions. The outcome is predictable: social science projects represented only a small minority of submissions and funded projects: 12% (5

of 43) submitted and a similar 12% (2 out of 17) funded proposals listed human dimensions as the primary focus area. Moreover, as noted above, some of the proposals included in this "human dimensions" category do not reflect social science efforts, but instead focus on engineering or other areas. Similar patterns were seen in the 2019 Delta Science Solicitation. As another example, none of the last three Sea Grant Panels tasked with reviewing Delta Science Fellow applications included members with dedicated social science expertise.

Multiple strategies can be applied to address situations such as this, beginning with more thorough engagement of the social science community in research planning to the development of effective mechanisms for internal and external social science funding. These are addressed in sub-recommendations 1a and 1b.

Recommendation 1a: Research funding processes in the Delta should prioritize social science, identify key social science priorities, and engage the social science community.

In order to promote relevant social science research in the Delta, the systems used to fund or otherwise support this research must be adapted to prioritize this type of work, identify specific priorities, and engage the social science community. This must be implemented as a purposeful process "from the ground up." For example, social science expertise and perspective should be engaged from the earliest stages of planning processes used to initiate and fund relevant science. This includes active engagement of social scientists in request for proposal (RFP) development. Representation in these processes (and on review panels) should reflect the relative importance and diversity of social science, with one social scientist not being tasked to represent the "field" just as one natural scientist is not tasked with covering the broad array of natural science proposals. Generic nomenclature (such as 'human dimensions') in RFPs discourages engagement by social scientists who view their work as within a specific discipline or as targeting a particular type of research question (e.g., ecosystem service valuation). This recommendation is distinct from Recommendations 2 and 3 below that address broader issues related to internal and external social science *capacity* in the Delta—this initial recommendation speaks specifically to the design of systems that fund or otherwise support Delta research itself, such as periodic or regular requests for proposals.

It is not always necessary for RFPs to identify *specific* social science disciplines to be effective at engaging the social science community. Many RFPs have engaged social scientists effectively by orienting the solicitation around well-defined research questions that require the integration of particular types of natural and social sciences and written in terms viewed as relevant by social scientists (a result of RFP co-production). An example is the FY16 NOAA Coastal and Ocean Climate Applications (COCA) RFP, which supported "interdisciplinary teams of researchers in the development and transition of climate-related research and information to advance decision-making in coastal communities and coastal and marine ecosystems." One area of focus for this RFP was to "assess costs / benefits / tradeoffs and uncertainties associated with integrating ecosystem services into coastal adaptation efforts." While not explicitly identifying a particular set of social science disciplines, these and other areas of focus were written in such a way as to have meaning for social scientists.

Another example of an effective social science RFP for coastal research is the Northeast Regional Sea Grant Consortium call for research on "Human Dimensions of Coastal and Marine Ecosystems," which was offered for multiple two-year funding cycles including 2012-14 and 2014-16. This Sea Grant RFP was co-produced with involvement of social scientists and managers and was written in terms that elicited significant interest among New England social scientists.[5] A notable aspect is that the entire RFP is oriented around social science. Although the RFP targets research that "links social sciences to natural science research or data" and "addresses the interface between natural and human systems," the stated goal of the solicitation is to "support social science research relevant to regional coastal and ocean management."

A common feature of these and other effective environmental social science RFPs is that they reflect the inclusion of social scientists in key science program decision-making points and associated co-production of RFPs and research initiatives. This representation from the outset engenders language which has meaning to social

5 Another effect of co-production is that the resulting RFPs are written using language that signals the likely involvement of social scientists in proposal evaluation (because they were directly involved in writing the RFP). This encourages proposals from the social science community, given assumptions that social scientists on review panels are likely to favor social science proposals for funding.

scientists and signals that social science is a priority, and hence encourages subsequent engagement of the social science community. Hence, it is not possible to disentangle the research funding process and the underlying social science capacity—a topic addressed in Recommendations 2 and 3.

Recommendation 1b: Integrate multiple modes of funding for internal and external social science research and data collection

One of the many questions we hear is, "how can we fund social science research when we do not have enough funds for our biophysical data needs?" There are many potentially effective ways to invest in social science research, ranging from RFPs targeted at specific research needs, to longer-term cooperative ventures or memoranda of understanding (MOUs) with external organizations such as universities and research labs, to ongoing internal funds devoted to long term data gathering and research. Examples of multi-mode approaches are found in organizations such as US Environmental Protection Agency (EPA) and National Oceanographic and Atmospheric Administration (NOAA), both of which use a variety of internal and external funding mechanisms and resources to obtain social science insight. The appropriate funding mechanism depends on factors such as the type of information required, whether ongoing data collection is needed (instead of one-off research to address a specific question), the extent to which the science enterprise wishes to directly oversee and manage the effort, limitations associated with contracting and FTE creations, etc. Effective integration of social science generally relies on multiple approaches to support internal and external social science research and data collection.

As an illustration, consider the historical use of environmental economics within US EPA. This federal agency integrates multiple funding and support mechanisms to obtain social science research and data necessary to inform regulatory and other activities. The agency maintains an internal National Center for Environmental Economics (NCEE), with dedicated staff and funding to support environmental economics research.[6] The agency also periodically hires contractors (typically consultants) to conduct targeted research necessary to support rulemaking and other activities—for

6 See https://www.epa.gov/environmental-economics/ncee-economic-reports.

example to evaluate the benefits and costs of proposed rules (Griffiths and Wheeler 2005). These contractors will often coordinate directly with NCEE along with other agency offices such as the Office of Water. In addition, the agency supports periodic research through RFPs designed to advance the state-of-the-art in social science, through initiatives such as the Science to Achieve Results (STAR) program.[7] For example, the 2015 RFP on "Water Quality Benefits" supported work to better understand the economic value of water quality. Over the long term, EPA has also maintained strong representation of economists and other social scientists on the agency's Science Advisory Board. Through the integration of different research-support and advisory modes such as these, the agency seeks to obtain the social science information necessary to address immediate needs and to advance the state-of-the-art in ways that promote the agency's mission.

The Puget Sound Partnership provides another example. The agency has supported the participation of external social scientists in workshops that identify and prioritize regional social science needs, such as the most recent Social Science for Salish Sea prioritization effort (Breslow et al. 2019). The inclusion of regional social scientists in this process was crucial for identifying relevant social scientific knowledge gaps, as participating individuals knew the context best, the social scientific resources most likely to be available, and the policy windows that could support research recommendations. These recommendations are intended to be integrated into the science plan, which in turn should inform regional funding priorities for state, federal, and other partners. For example, the Partnership has targeted their existing state and federal budgets to specific social scientific research questions developed during similar social science workshops, contracting social scientists from universities, companies, and NGOs to conduct policy-relevant research on sense of place, for example. Additionally, because many federal science funding programs look highly upon collaborative partnerships that leverage resources and contribute to a larger context, the Partnership has been successful in collaborating with university scientists to fund research conducted by postdoctoral scholars, student researchers, and university-based principal investigators. Over a million dollars have been secured for regionally-relevant social research

7 https://www.epa.gov/research-grants/star.

from the National Science Foundation, the US EPA, and regional awarding bodies who have explicitly stated their funding decision was influenced by the clear relationships between the social scientist and state agency, the leverage of resources (e.g., office space, programmatic administration, etc.), and the clear pathways to integrate results into policy processes.

As a general rule, support for ongoing and regular data collection efforts to meet programmatic needs—where consistency and comparability are required—are often best supported via dedicated funding for internal research operations rather than periodic RFPs. Requiring repeated research proposal submission to fund ongoing social science data collection or monitoring risks gaps in data, if the relevant proposal is not chosen for funding during a particular cycle. In contrast, research RFPs are well suited for supporting "one-shot" research projects that address key questions or develop new research methods, but do not require long-term data collection. This situation is parallel to that found in the biophysical sciences, where different support modes are suited to ongoing monitoring versus periodic research to address emerging questions of concern.

We encourage referring to Appendix D, Major Social Science Fields, to inform initial thinking and framing of social science funding in the Delta, and how future support should be allocated across different scientific fields depending on regional priorities.

Recommendation 2: Invest in building an external network of social scientists.

In addition to the integration of different modes to target and support specific types of social science *research* (i.e., individual research and data collection efforts), there is a general need to enhance the network of social scientists engaged in Delta research—those external to but working in coordination with the Delta science enterprise. This is related to, but distinct from Recommendation 1 above. Where Recommendation 1 speaks to systems used to fund *research or science*, Recommendation 2 targets approaches to engage external *researchers or scientists* over the long term, whether or not these individuals are engaged in specific, funded research projects at any given time. The primary focus on people rather than projects is what sets this second recommendation apart.

Building "people" capacity in this way requires investing in the development of social scientists who might be new to Delta issues, connecting with and possibly integrating existing social scientists working on Delta issues, and maintaining and growing this community over time. These networks can be developed and nurtured through multiple mechanisms—some related to Recommendations 1a and 1b above. For example, inclusion of a larger and more diverse set of social scientists in existing external advisory and review panels, such as the Delta Commission Advisory Board or Delta Conservancy Board, can provide an effective means to engage social scientists in decision-making related to Delta challenges. Other examples include the placement of social scientists on periodic working groups and key steering committees, executive committees, and planning boards.

During 2019, the Council put out a call to fill Delta ISB vacancies, indicating that they would "consider candidates across a wide range of expertise including biology, chemistry, physical sciences, and social sciences." The simple naming of social sciences in the call can be an effective means to solicit interest from the social science community. Even more effective, however, would be a call that explicitly emphasized a desire to engage one or more social scientists on the board in a proactive manner (rather than merely listing social sciences as one possible area of expertise).

Similarly, during the 2016 Delta Science Enterprise Workshop, one of the recommendations was to 'use competitive funding mechanisms to attract the brightest and the best.' While this recommendation refers to all scientists, we highlight that it applies equally to the social sciences. Unfortunately, the mentality that 'if you build it they will come' is simply not an effective approach to increasing social science partners. As a group, social scientists may not look to the Delta for funding given past biases and a lack of perceived respect. Although this is particularly true when considering participation in specific research competitions (see Recommendations 1a and 1b), it also applies to broader engagement with the Delta science enterprise.

As such, the Delta science enterprise will require pro-active efforts to build external social scientific networks. Strategies for this network building can be adapted from those used effectively elsewhere, such as within the Chesapeake Bay Program (where

a social scientist served as Chair of the Scientific and Technical Advisory Committee for multiple years) and the Puget Sound Partnership. The Puget Sound Partnership has a multi-pronged approach to building their external social science network, including: 1) recruiting social scientists to their 11-member Science Panel (much like the Delta's ISB), 2) facilitating a Social Science Advisory Committee as a sub-committee to the Science Panel, 3) using state and federal funding to support external research contracts to conduct regionally-relevant science, and 4) deeply collaborating with external scientists to write grants and support research fellows. The first, the Science Panel, is an appointed group of regionally-distinguished scientists who meet throughout the year to provide scientific feedback to strategic restoration planning. Over ten years, the panel evolved from having one economist and one public policy expert to having two anthropologists, one economist, and one public policy expert. When there was only one social scientist (an economist) on the panel, the scientific community recognized the need for more integration of social science and created the Social Science Advisory Committee made up of two environmental psychologists, four environmental anthropologists, four environmental economists, one human geographer, one public health specialist, and two environmental governance/policy experts (as of 2020). This all-volunteer group, facilitated by a Partnership staff member, meets six times per year to provide social science-specific feedback to Partnership initiatives, allowing for more targeted input whereas the social science members of the broader Science Panel contribute to an interdisciplinary, high level conversation.

Recommendation 3: Invest in internal social science capacity.

The final capacity recommendation relates to the need for dedicated, long-term capacity (people) in social science that is internal to the Delta science enterprise. The science enterprise requires internal social science capacity to help implement and obtain the benefits of the first two recommendations. It will be difficult to secure and maintain an external network without one or more internal staff members who can champion, translate, and continually advocate for social science in the system. It will also be difficult to implement the findings of social science research without someone, or various

someones, who understand the policy context, the social science contributions, and the procedural pathways for integrating science in the planning process.

The Council lacks the capacity to fully engage in conversations with the external social science network, to support and grow this external network of social scientists, and to steer this external social science network to produce knowledge that might be useful to inform their decisions. For example, recent science planning and guidance documents (such as the Delta Science Plan) and research funding solicitations do not reflect sufficient awareness of the human dimensions that are interwoven with many of their currently governed natural resource issues—and for which input from the natural sciences is requested. This lack of awareness of the human dimensions of their current challenges limits how the Council defines the problems faced, identifies and utilizes information (from the social or natural sciences) in developing solutions to solve these problems, and how those solutions are implemented and evaluated. As noted above, this also affects how they write RFPs, and identify, receive, and utilize social science research in decision-making. Dedicated internal social science expertise will help to ameliorate this problem.

As of the revision of this document in March 2020, California Sea Grant and the Council have announced that they will be employing a social scientist to assist with research and outreach on the human dimensions of California water and environmental management and policy issues related to the Sacramento-San Joaquin Delta. This is an excellent step towards building social science capacity. Subsequent work should expand the effort to build permanent capacity across partner agencies, at various levels of management. Specifically, someone at the managerial level with social science capacity could facilitate discussions about biases within the natural and social sciences and enable a cultural shift toward social-ecological considerations in all Delta enterprise efforts.

No one person could embody all the qualities relevant for building internal social science capacity. Rather, intentional hiring can fill out the following skillsets across the science enterprise with experts from different social sciences. What all potential

individuals should have in common, however, is the capacity to think holistically and in a problem-oriented manner relevant to Delta issues. Key skills that these individuals should collectively be able to address include:

i. *Organizing and Understanding Social Sciences*. Given the diversity of social science research, the first basic skill is the ability to organize and recognize this diversity. This includes distinguishing between the different fields, disciplines, and areas of study found in the social sciences, the type of information and knowledge they produce, how these diverse forms of knowledge supplement each other, and how they can be utilized to improve decision-making in the Delta. For example, internal social science capacity can be leveraged to help identify the types of expertise that are required on external advisory boards and review panels.

ii. *Integrating within the Social Sciences*. Like all academic studies, social science research has specializations that provide knowledge about parts but not all of the issue. No single social science can answer all relevant questions. Unfortunately, incentives in academia often do not provide sufficient support for integrating social science to provide a synthesized and more complete understanding of societal issues. Additionally, questions and challenges of governance usually span multiple social science areas, which necessitates integration to better inform decisions. This requires the capacity to not only organize social sciences and see how they connect but also to draw from this information synthesized forms of knowledge, and to understand how this integrated knowledge is relevant to decision-making.

iii. *Integrating between the Social Sciences and Natural Sciences*. Social science research is fundamentally about human behavior. Yet, Delta decision-making involves the interface of human behavior and the natural environment. Similar to integrating knowledge within the social sciences, incentives within academia do not always support the integration of the social sciences and the natural sciences to provide a more complete foundation of knowledge for informing decision making that ultimately deals with the interfaces between human-natural systems. Achieving this goal requires a capacity to develop multi-disciplinary, inter-disciplinary, and trans-disciplinary forms of knowledge. This can be accomplished through a number of different ways including, but not limited to, conjoining social and natural sciences as distinct lenses on the same issue and combining the natural and social science data into integrated models to understand an issue.

iv. *Utilizing Social Science to Inform Decision-Making*. Knowledge produced in the social sciences does not always provide knowledge ready for utilization by decision makers. Even with the best translational abilities, the science enterprise should invest in skills to communicate and translate insights and lessons from the social science into decision-making or formulate rule structures that enable social science information to become part of decision making discussions.

v. *Producing and Evaluating Social Science*. The final skill set relates to external relations of the Council in supporting social scientists in the Delta. Although social science will be produced, to some extent, independent of the Council, the Council can play an indispensable role in steering and influencing the focus and direction of these social scientists. This requires skills in outreach, developing and nurturing networks, writing RFPs and evaluating proposals, and assessing final reports and publications for the potential utility and future research needs.

These five skill areas imply, among other requirements, that individuals should be sought who have chosen to become "environmental" or "natural resource" social scientists. Many social scientists lack the interdisciplinary interests or training to address environmental issues. For example, an economist focusing on monetary theory or geographer focusing on Marxist political theory are unlikely to possess the skills or interests needed to inform Delta management. Social scientists relevant for the Delta Science Enterprise will likely have dedicated training in natural systems to complement their primary disciplinary expertise, and have experience working and communicating across disciplines on topics such as energy, water, agriculture, conservation, and others. This type of experience and interest is instrumental when seeking to address environmental management challenges that cut across disciplinary perspectives.

There are many pathways to develop and acquire these capacities and skills across the science enterprise. Moreover, all of these skills need not reside within a single individual—they may be present in multiple individuals distributed across different organizations. However, a common mistake is to assume that an existing staff member with natural science training can simply shift to doing social science work (Martin 2019). There are many serious concerns with this that have been observed repeatedly, including frequent misinterpretations of social scientific findings because of the lack of foundational knowledge, invalid studies due to inexperience with the complexities of social scientific methods, and inappropriate use of analytical methods, among others.

Another common mistake is to address the lack of internal social science capacity solely via entry-level short-term positions—such as the California Sea Grant State Fellows Program. Programs such as these are valuable but are not an effective way to meaningfully enhance internal social science capacity. These fellows are often graduate students or post-doctoral scholars in marine, coastal, or watershed resources that have been recruited for 12-month internships within partner agencies. Some of the positions require social science skills to contribute to agency goals, and others seek to build these skills. Although individuals such as these can help to fill gaps in internal capacity, they often lack the institutional authority and longevity to affect the type of institutional changes that are required. Moreover, they lack the level of professional experience to break through the existing barriers to social science integration, and in many cases to understand how social science can and should be integrated. Fellows focused on social science need to have expert internal staff within their agency for effective mentoring. For example, while the Puget Sound Partnership has greatly benefitted from their year-long Sea Grant fellows (e.g., one created the integrated conceptual model described in Finding 2), all fellows worked intensively with an internal staff member knowledgeable about social science, connected to the external social science network, and who was creating a pathway through which the fellow's work would be used to inform procedures in the agency.

Thus, while short-term fellowship positions are mutually beneficial to the student and agency, more effective investment would be in long-term internal capacity that can identify and guide structural changes necessary to promote the effective generation and use of social science to address Delta management challenges. One option would be to establish a permanent, dedicated and relatively high-level social science position in the Council, and/or a permanent standing committee that reports to the Council. Another option is to create an internal social science working group, including both internal members of the Council and externally-based advisory members (external social scientists working or knowledgeable about the Delta region). For example, at the Puget Sound Partnership, there is an internal Human Dimensions Working Group made up of 4-6 internal staff members (2 trained in social science and 2-4 high level managers who integrate all types of science) and four members of the external social science network that are funded to do work in collaboration with the Partnership. These

monthly hour-long meetings ensure that communication is happening throughout the pipeline from social science production to agency actions. Lastly, the Council can consider funding or co-funding a liaison position with the external social science network on the Delta. This might be, for example, a senior social scientist who is well versed of different academic disciplines who partly is connected to the social science community researching the delta but can also serve as an advisor to the Council. A hybrid combination of these four pathways is also possible.

As a final comment, we emphasize that recommendations such as these are often met with a response that "funds are limited," so investments of this type are not feasible without "new" funding sources. Another commonly noted restriction are limits on FTEs within particular agencies. The unstated assumption of responses such as these is that reductions in support for natural sciences or other efforts are infeasible as a means to enable increases in social sciences. The validity of this assumption is far from clear. Given the heavy imbalance in natural versus social science information available to support Delta decisions, it may well be that the benefits of a marginal increase in social science support or FTEs would far outweigh the costs due to a marginal decrease in natural science support. Although new funding for social sciences should be sought as part of a broader strategy, investment in social science capacity should not be constrained to that made possible via new funding.

There are long-term, creative ways to work around funding and FTE restrictions that have been used by various types of agencies. For example, government agencies such as NOAA have developed cooperative ventures wherein the agency supports a position for a specified time using temporary funds (e.g., 3-5 years), under the agreement that another outside entity (such as a university) will subsequently support the position on a permanent basis. Similarly, the Puget Sound Partnership uses a portion of its EPA National Estuary Program support to fund a five-year contract with Oregon State University through which a human geography postdoctoral scholar is hired to sit at the Partnership offices and work with partners to integrate social science in restoration planning. Agreements such as these can be used to develop mid-level and relatively long-term social science capacity even in the presence of binding FTE caps on particular public agencies.

Finding 2: Research activities are ongoing, but there is no long-term vision for social science integration

While many Delta science enterprise documents discuss the need for social science or mention social science activities, there does not appear to be an overarching vision and plan for implementing social science today and in the future. Table 3 presents examples of text in Delta science enterprise documents that mention social science needs and activities. A few observations are noteworthy. First, there is diversity of activities and needs, including studies of ecosystem services of agricultural lands, surveys of recreation, design of investment strategies for habitat conservation, and economic impact analyses. Second, over the years, the desire to integrate natural and social science and to develop decision support tools, especially with respect to adaptive management, has been consistently identified. Further, these documents do not explicitly connect how specific activities, such as studies on ecosystem services or recreation demand, integrate with decision support tools and management decisions more broadly. In summary, Delta science enterprise documents recognize the need for some particular types of social science information but do not situate these needs within a holistic understanding of how social and biophysical sciences may be integrated to address Delta challenges. An overarching vision and plan for implementing social science can help elucidate the linkages necessary to ensure maximal impact and integration of social science supported by the Delta science enterprise.

Related to the lack of a holistic strategy and vision is a tendency to support social science sporadically as a set of "one-off," scattershot individual studies. The Delta ISB concluded in their review of research on Delta as Place that "research on the social and natural processes that sustain the unique values of the Delta as an evolving place is sparse and sporadic. … no established research programs [are] directly aimed at developing an understanding of the processes supporting the Delta as an evolving place." Consistent with Finding 3.1: Inconsistent and fragmented research efforts from the white paper "Funding Science to Meet tomorrow's Challenges," the Task Force finds limited and sporadic funding for social science. Recently, the Delta Science program has pursued efforts to increase the amount of social science through the use of Delta

Science Fellowships and by explicitly calling out social science research needs in the 2018 request for proposals. While these efforts are commendable, they lack a coordinated and sustained investment that falls short in supporting social science research over time and connecting social science to needs of the Delta.

Table 3. Excerpts on social science needs and activities in a sample of Delta Science enterprise documents.

Year	Document & Author Organization	Social Science excerpts from Document
2012	Economic Sustainability Plan for the Sacramento-San Joaquin River Delta *Delta Protection Commission*	*Measures key elements of the Delta economy, develops strategies to enhance the economy, and analyzes the impacts of several important proposals for the Delta Plan on the region's economic sustainability*
2013	Delta Science Plan *Delta Science Program*	*Develops and utilizes science-based adaptive management frameworks for ecosystem restoration efforts and watershed-level management actions….to further the coequal goals*
2013	The Delta Plan *Delta Science Program*	*Survey Delta recreation at regular intervals, such as every 5 years, to inform marketing and planning for recreation and tourism* *Assess opportunities to control or reverse subsidence of farmland*
2014	Interim Science Action Agenda *Delta Science Program*	*Implements ecosystem service studies to understand the economic and ecological benefits of agricultural land.* *Specifies what agricultural practices and operations could be implemented to support restored habitat in the Delta* *Analyses of land and water use by agriculture, including land ownership, cropping patterns, soil types, and other factors to identify the Delta's agricultural regions, their competitive advantages, threats and opportunities (this was also part of the Delta Plan 2013)*

Year	Document & Author Organization	Social Science excerpts from Document
2017	Delta Conservation Framework *CA Dept. of Fish and Wildlife*	*Integrates regular stakeholder communication and socio economic considerations into Delta conservation planning, implementation, science and adaptive management processes* *Develops multi-benefit focused conservation and land management solutions to balance environmental and human needs*
2017	Science Action Agenda *Delta Science Program*	*Invests in assessing the human dimensions of natural resource management decisions* *Investigates the most cost-effective methods to improve species habitat on working lands* *Develops tools to assist adaptive management in the Delta* *Initiates a research program on the Delta as an evolving place that integrates the physical and natural sciences with the social sciences*
2018	Funding Science to meet tomorrows challenges *Delta Science Funding Initiative Workgroup*	*Establishes effective interchange between decision-makers, stakeholders, and scientists* *Promotes decision-support tools* *Develops protocols to evaluate monitoring programs and the value of information generated*
2018	The Science Enterprise Workshop Executive Summary *USGS and Delta Stewardship Council*	*Integrates social science with natural science and engineering to understand the full scope of management issues*
2019	Delta Science Plan *Delta Science Program*	*Strengthens science-management interactions—Improve science governance through more effective interactions between decision-makers, stakeholders, and scientists that support science based management decisions and increased awareness of how people value, use, and depend on natural resources.*

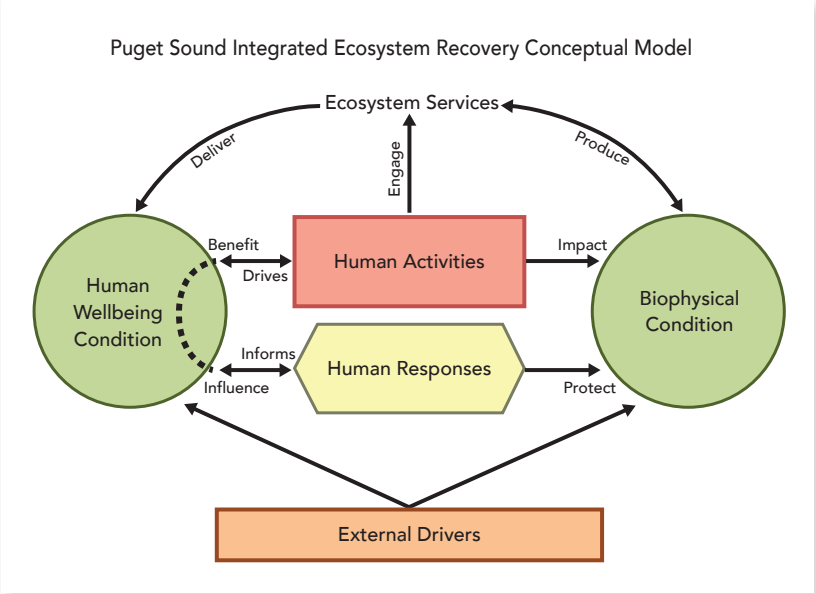
Recommendation 4: Invest in a collaborative process to develop a conceptual framework that includes social science

Social science research has shown that people are more likely to adopt new ways of thinking and to comply with new decisions if they have been a part of a process that defines the system and identifies the relevant strategies (Wondolleck and Yaffee 2000; Schusler et al. 2003). This collaborative learning allows people to exchange ideas in such a way that they can reconcile their different perceptions to reach a more common group perception. This is particularly important in situations where there are a diversity of perspectives, understandings and misunderstandings, such as with the role of social science in ecosystem restoration.

A collaborative learning process to develop a social-ecological conceptual framework that is specific to the Delta will lay the foundation for justifying future investments in social science, communicating the importance of social science, and guiding logical thinking about how to integrate the social science to effectively impact the social-ecological system. While we recognize that there is no shortage of conceptual models in the region, we did not find models that have been regionally adopted and explicitly identify social science and social needs as integral, interactive components of the coupled natural-human Delta system.

A regionally-adopted, integrated conceptual model of the sciences helps create "buy-in" and guidance necessary to effectively integrate social science information into decision-making. While a few staff members could design a conceptual model in a matter of hours, obtaining feedback and having cross-agency discussions about how this overarching model builds from existing, likely agency-specific models, is an important part of the process toward becoming a collective lens and guide for helping make and implement decisions about science priorities. Incentivizing participation in these high-level framing conversations can occur through emphasizing that an integrative framework can be an effective way of responding to the coequal goals mandate, can respond to the diverse needs of the interested and effected public, and can establish a firm foundation for justifying future funding decisions (e.g., for ongoing monitoring and research).

a)



b)

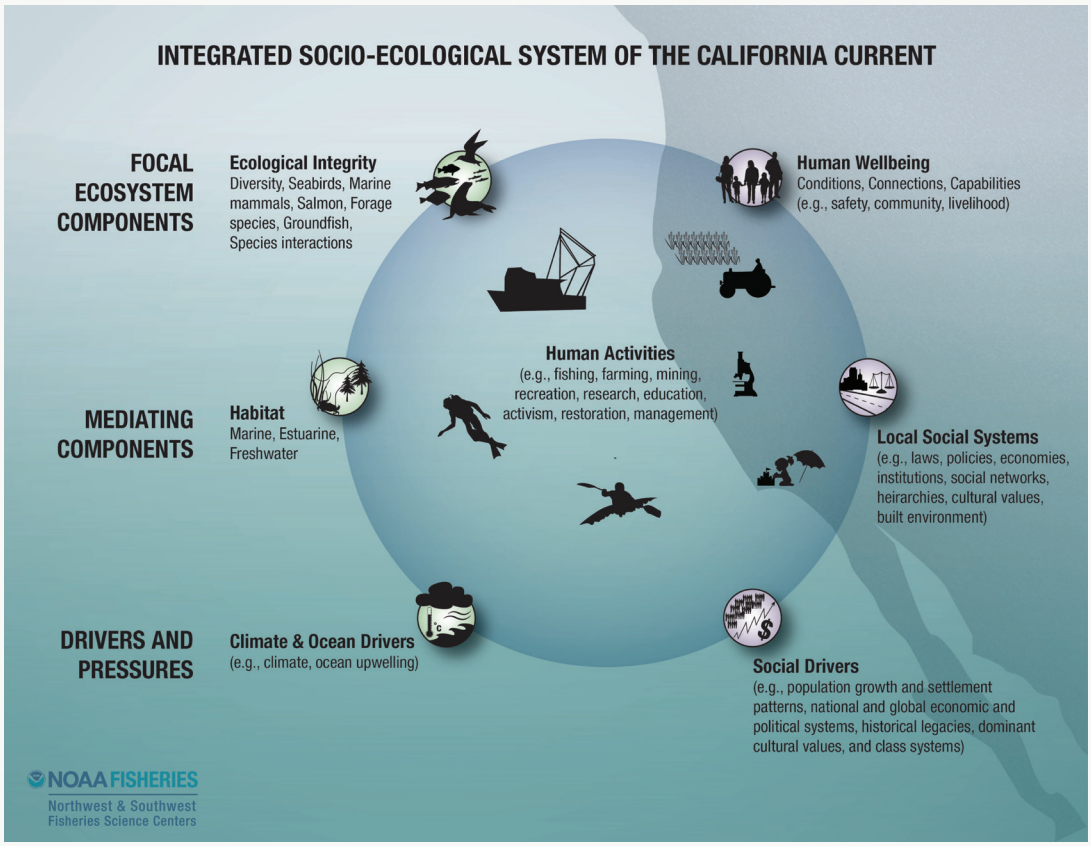


Figure 5. Conceptual models developed for: a) Puget Sound Partnership's Ecosystem Recovery, and b) NOAA's California Current Integrated Ecosystem Assessment.

Two examples of collaboratively developed conceptual frameworks are those from the Puget Sound (Harguth et al. 2015) and the California Current (Breslow et al. 2016) (Figure 5a and b). In the Puget Sound, the state agency (Puget Sound Partnership) tasked one of their internal Sea Grant fellows with leading a collaborative process to develop the "Puget Sound Integrated Ecosystem Conceptual Model" (Figure 5a). The Fellow created an initial draft based on social-ecological system literature that was modified through discussions with internal planners and scientists, then modified again through discussions with the Science Panel (a group of elected science advisors to the agency), then modified further with feedback from regional partners. Although the final version differed from the initial by only a few components, the process of engaging partners highlighted their role as key contributors to the overarching framing of the restoration program and resulted in broad(er) support for the model. The final conceptual model was launched in a short written report and a three-minute animated video hosted on YouTube and is used as the justification introductory slide for all planning and monitoring presentations by Partnership staff. When asked by partners how a specific social science project contributes to the recovery objectives, Partnership staff frequently point to the conceptual model that highlights feedbacks between ecosystem functions, human behaviors, and management strategies.

Recommendation 5: Identify and secure funding for monitoring and reporting on social indicators

Indicators are measurements of the things we care about in the system and allow scientists and managers to compare status and trends over time. Appropriately chosen indicators also allow decision-makers and others to evaluate the effect of interventions or ecosystem changes, as guidelines for strategic planning. They can further support institutionalized objectives that justify continued investment in research.

The Delta Plan Performance measures contain some social indicators, such as limited conversion of farmland, increased recreation and tourism trends, and improved Delta economy that were developed in a multi-year collaborative process with state and federal agencies, stakeholders and scientists. Similarly, the State of the Estuary is updating their indicators to include measures of environmental health that will

consider social equity and a consulting firm developed a monitoring inventory that considers socio-economic factors. While this is an excellent foundation to build from, the Delta science enterprise should confirm that these selected indicators are indeed representative of the primary social objectives in the region, then review how they fit into the larger integrated conceptual model (Recommendation 4) to inform priority restoration strategies.

Importantly, the objectives we refer to here should continually be monitored because they are things we indefinitely care about, unlike some performance measures which, when the goal is met (such as passing a policy), any monitoring of the measure ceases. Additionally, choosing indicators simply because there are data is not entirely helpful; and it may be more management relevant to seek funding and capacity to develop and measure indicators for which there are no existing data yet. The methods by which the science enterprise can support monitoring social indicators can build on Recommendation 1a in this report, which provides ideas for increasing capacity and funding for social science.

For example, The Puget Sound Partnership has developed eleven Vital Signs to represent the statutory goals of a Healthy Human Population and Quality of Life (Figure 6). A proposed suite of Vital Signs was developed using a social scientific process to identify the most representative metrics for the diverse population. The final indicators were selected from this list through a collaborative process with regional boards that identified the best metric for each Vital Sign based on cost effectiveness and ease of communication. Nine of the indicators did not have data sources (Sound Stewardship, Sense of Place, Good Governance, Cultural Wellbeing, Outdoor Activity, and Local Foods) and one needed substantial data cleaning to be relevant at the Puget Sound scale (Economic Vitality).

As a result of defining and institutionalizing these social indicators, a portion of the Partnership's dedicated state funding has been allocated to collect these data. Because of the funding allocation, public health specialists, environmental anthropologists, environmental economists, an environmental psychologist, and behavior

Figure 6. Puget Sound Partnership Vital Signs used to monitor ecosystem recovery. Note the extent of healthy human population and quality of life indicators.

change experts have been recruited to collect new data, collate existing data, and contribute to the interpretation of the data for Puget Sound restoration. These efforts have substantively enhanced the external network of social science contributions. The status of these indicators are reported in the biennial State of the Sound and the interactive Vital Sign webpage, two products similar to the online Delta Performance measures and the State of the Delta reports.

Since reporting on the status of these indicators at different spatial scales and across various demographics (Fleming and Biedenweg 2019), local partners expressed an improved ability to communicate their goals to constituents. Additionally, they are now becoming fundamental objectives in local and regional planning processes. For example, one watershed is focusing on protecting and enhancing shellfish as a large strategic initiative. A task force of industrial and recreational shellfish growers, shellfish scientists, government representatives, and Tribal representatives, has defined four overarching objectives as 1) Maintaining cultural practices, 2) Improving shellfish habitat, 3) Increasing native shellfish populations, and 4) Improving access to shellfish beds. (Note, these represent a combination of social and biophysical objectives). All potential management actions must meet at least one of these objectives, and all objectives must be met by the overarching strategic initiative. Because the social indicators are monitored through social scientific processes, the task force will also be able to engage in adaptive management - assessing if the management actions that are implemented indeed affect both social (cultural practices, access) and ecological (habitat, populations) goals.

A common piece of any indicator discussion involves targets. Targets can be either directional (e.g., an increase in X) or numerically specific (e.g., to reach a level of X). Procedures for target-setting are part of the collaborative process and should include decisions regarding whether target identification will take place concurrently with indicator identification, or whether a two-step process will be used. In situations where there is limited data about an optimal status (such as with 'sense of place' perceptions), it is acceptable not to establish targets or to establish only directional targets (e.g., maintain or improve from baseline).

Recommendation 6: Integrate social and biophysical science to improve decision making.

With the definition of an overarching conceptual model that integrates social goals and broad social indicators, Delta science partners can better inform decision frameworks that navigate a clear and sustainable path for integration and investments in social science. Fortunately, there are already some pathways in the Delta that can provide guidance and traction on where to invest in the short-run. First, the coequal goals provide a common vision, specifically to "Protect and enhance the unique cultural, recreational, and agricultural values of the California Delta as an evolving place." Second, the efforts to implement adaptive management and develop decision support tools (such as through structured decision-making (SDM) used by the Bureau of Reclamation with the Delta Science Program) based on the best available (natural *and* social) science provide at least an initial structure to guide efforts and investments.

Fully integrating the coequal goals can build on the concept of a coupled natural-human (CNH) model, where social science, natural science, and engineering research efforts are jointly and simultaneously determined (for examples of coupled systems, see abstracts from NSF's CNH funding program). CNH models can take many forms and have been used in a number of management settings. Many of them operationalize the type of underlying conceptual model discussed in the first recommendation above (Figure 5a and b), but focus at various spatial scales and restoration issues, providing more details of the linkages between identified goals. One CNH modeling approach that could help integrate social science into Delta management is based on developing a causal chain between a management action (e.g., reducing acreage of saltmarsh in a specific location – see Figure 7) and the full suite of ecological, economic, and social impacts resulting from that action. Formulating causal chains could be used as a basis for synthesis research to help understand which areas of the chain are better understood and which areas need further scientific exploration. For example, the conversion of the salt marsh sets in motion a set of ecological and environmental effects (e.g., impacts on aquatic species, reduced water filtration, less storm protection) that in turn impacts socio-economic endpoints such as reduced property values, lost recreation opportunities, etc.

In reference to stated Delta goals, the Delta ISB recommends "an expanded, sustained commitment to research on the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." The 2012 Economic Sustainability Plan by the Delta Protection Commission also recognizes some of these values and the visioning process undertaken by ESSA Technologies, Inc. may be a good effort to build off (Delta ISB 2017). A CNH causal model would identify how these values would be impacted by or impact other social and biophysical components of the Delta.

Once a model is developed for how social and biophysical objectives are integrated, the use of a decision-support tool such as SDM can take the Delta science enterprise's identified social and ecological goals and develop management strategies that directly address all goals, thereby providing a transparent process for integrating social and ecological science into decision-making. According to the US FWS, SDM[8] is:

> *"… a general term for carefully organized analysis of problems in order to reach decisions that are focused clearly on achieving fundamental objectives. Based in decision theory and risk analysis, SDM encompasses a simple set of concepts and helpful steps, rather than a rigidly-prescribed approach for problem solving. Key SDM concepts include making decisions based on clearly articulated fundamental objectives, dealing explicitly with uncertainty, and responding transparently to legal mandates and public preferences or values in decision making; thus, SDM integrates science and policy explicitly. Every decision consists of several primary elements – management objectives, decision options, and predictions of decision outcomes."*

8 US Fish and Wildlife Service Stuctured Decision Making Factsheet

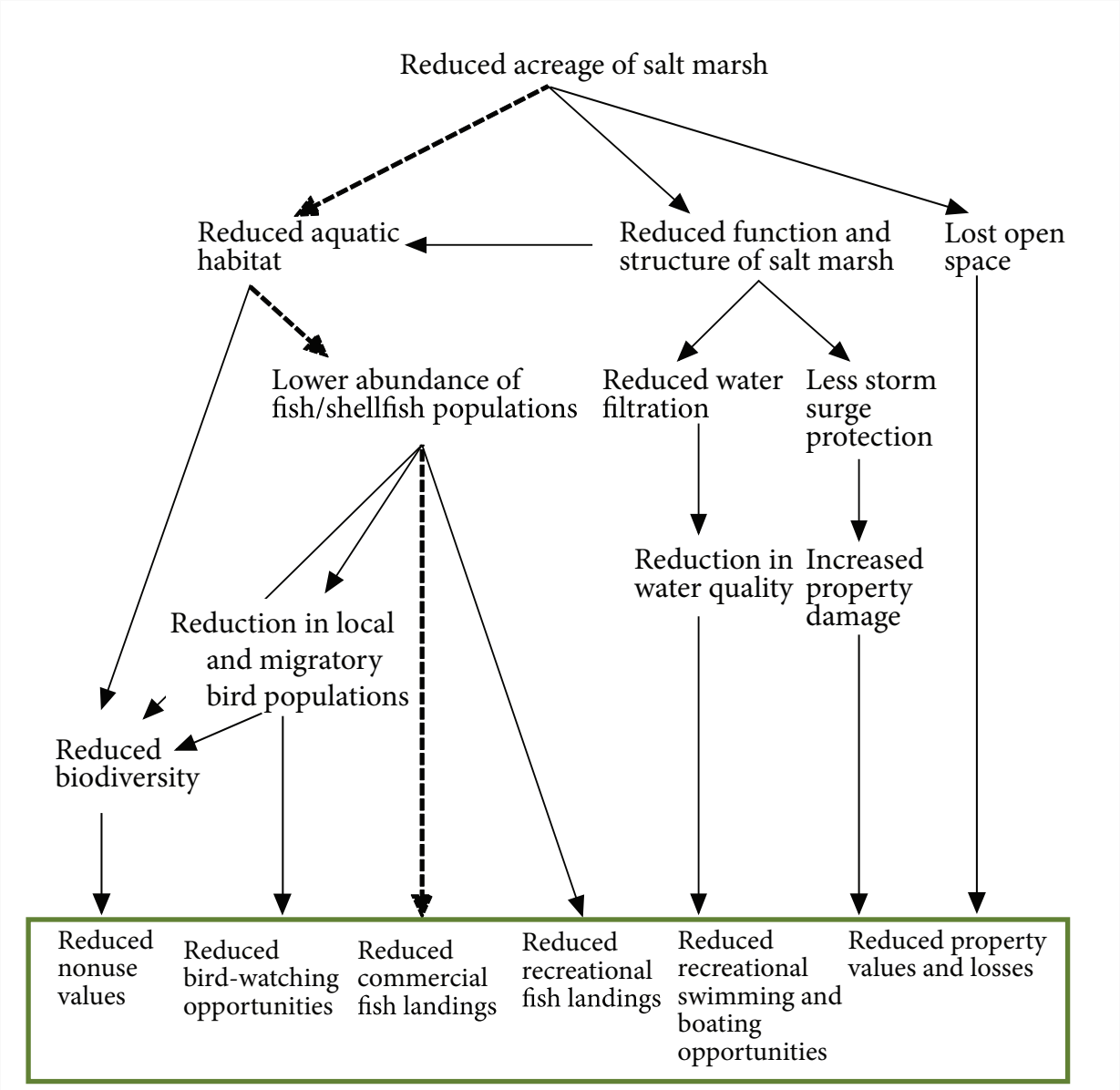


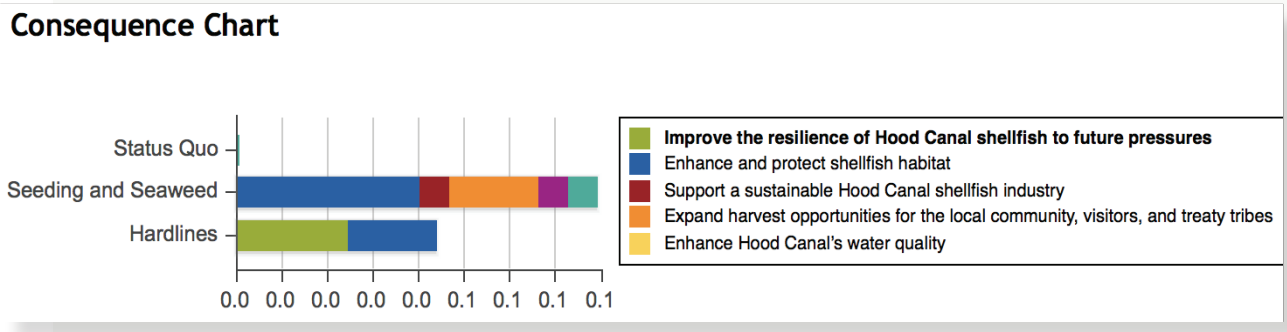
Figure 7. Example of linking biophysical, ecological, and economic endpoints . Source: Holland, D.S. et al 2010. Economic Analysis for Ecosystem Based Management. RFF Press. Page 64.

Developing decision support tools provides a method to prioritize social science research and develop a plan for its integration. In some cases, social science research could contribute to an element in the SDM, for example, identify the risk and uncertainty that a levee project would negatively and positively affect different stakeholders of interest. It would consider work ongoing, for example, in universities, non-governmental organizations, and private consultancies that are not directly under the purview of the Delta science enterprise but that is relevant to it. Additionally, social science can inform the SDM process itself – studying and informing how social and ecological science is or should be integrated for decision making, and the factors impeding such integration. The US EPA, for example, has recently launched a free, web-based decision science application called DASEES (Decision Analysis for a Sustainable Environment, Economy and Society) that has been used by planners to guide integration of social and ecological science for coastal community resilience planning in Florida and water-shed management in Puerto Rico and the Puget Sound Basin (see Case Study 6). The design of this tool was informed by economic, psychological, and decision science findings about how humans make decisions. An environmental psychologist, environ-mental economist, and human geographer in Puget Sound are currently studying the factors that enable the integration of social and ecological science through this and other structured decision-making tools.

Case Study 6

Structured Decision Making for Community Resilience Planning

Residents of Dania Beach, Florida, are concerned about how sea level rise will impact their communities, yet environmental planners were unsure of how to organize the information available to them to set coastal management priorities (Dyson et al. 2019). Staff from the US EPA worked with community members and environmental planners to engage in a transparent decision process using the Web-based application Decision Analysis for as Sustainable Environment, Economy, and Society (DASEES). DASEES provides stepwise prompts to identify the community's social, ecological, and economic goals; the targets for these goals as determined by scientifically understood thresholds; the extent to which proposed coastal management actions would impact each of the goals as determined by scientific studies or expert opinion; and any uncertainties around the information used to populate the software. The output was a consequence table that identified how each proposed management scenario differentially impacted each of the social, ecological and economic goals – thereby enabling an open, data-based conversation about social and ecological impacts of proposed management actions (the consequence table below is provided as an example output from a different project).



Finding 3: Design and evaluation of adaptive management is not informed by the social sciences

The Delta Reform Act requires that the Delta Plan guide implementation of the coequal goals through "a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions." (California Water Code § 85308(f).) The Act defines adaptive management as "a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives." (California Water Code § 85052.) In the absence of social science input and tools, it is unlikely that adaptive management will be effective - or at best will be less effective than it could otherwise be at meeting management objectives.

Social systems research suggests that some of the largest barriers to adaptive management are 1) short-term project cycles (e.g., 5-10 years) that do not allow for sufficient iterations of the action-monitoring-learning cycle, 2) institutional cultures that work against genuinely participatory approaches to learning, experimentation, and innovation, 3) institutional aversion to risk and learning, 4) legal constraints to experimentation, and 5) inadequate protocols to guide adaptive management, among other constraints (Allen and Jacobson 2009; Allan et al. 2008).

As is evident in the list of barriers, adaptive management is fundamentally a social decision-making process and, as such, requires input from the sciences that study those processes. It is easy for those steeped in natural science to see the question of whether adaptive management is helpful in terms mediated strictly by natural science: is there enough information to make confident decisions on whether a standard is being met? If not, could useful information be generated by additional monitoring, data collection, and study of the biophysical system? Public policy, organizational learning, and behavioral sciences enrich this analysis by highlighting the trade-offs inherent in information seeking, providing tools to help understand those trade-offs, and focusing attention on the time frame and context of management decisions. For example, a value of information (VoI) framework is a tool to understand the potential returns from investing in

information acquisition. A key insight of the VoI framework is that the magnitude of the potential returns from new information is determined by the decision-making context that will utilize the information (See Sanchirico et al 2014 for an example of VoI for conservation monitoring programs that contribute to adaptive management).

Organizational learning is a social science that is also critical for translating new information into increased (and shared) knowledge. Learning—and the use of what is learned to improve management decisions—can be aided or impeded by institutional design features. Relevant features include the infrastructure, expertise, training, and time available to key personnel at individual agencies, as well as the existence and strength of networks among institutions (see Case Study 7). All management decisions must also be implemented wherein challenges of adapting administrative and regulatory strategies to constantly shifting contexts can frustrate achieving the desired outcomes. Social science can help evaluate and, hence, learn from administrative and regulatory efforts over time.

The Task Force suggests that the Council, Delta Science Program, and other decision-makers continue the process started by the Delta ISB[9] but expand their effort to include a social science team. Working with public policy analysts, lawyers, and economists to systematically evaluate the extent to which the Delta adaptive management process is effective and what modifications to the institutional structures for learning are needed will go a long way to improving its effectiveness in the Delta. For example, a governance analysis of the institutions in charge of managing the remaining wild Atlantic salmon in New England identified key structural barriers to learning and collaborative management, informing the establishment of a new governance structure to fulfill the adaptive management goals (see Flye et al. 2019). Such changes may focus on decision processes, the distribution of decision-making and implementation power, or funding mechanisms, among many others. Another assessment by a behavioral economist identified key cognitive biases that play out in adaptive management, resulting in recommendations for how to modify governance processes so as to mitigate the impact of such subconscious biases (Iftekhar & Pannell 2015).

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9 Improving Adaptive Management in the Sacramento-San Joaquin Delta by the Delta Independent Science Board in 2016.

To be clear, this finding is NOT about reiterating that adaptive management should be practiced (although this is important), but rather that there is a large body of social scientific research about adaptive management that, if used, could improve the chances for a successful adaptive management process.

Case Study 7

Learning in Water and Ecosystem Governance: Insights from the Everglades

Water and ecosystem governance requires learning. Given how much is spent on advisory bodies, scientific research projects, and information gathering, we should be asking: Are we learning? Who is learning? What are we learning? Learning involves both processes of acquiring information and trial and error experiences and products in changing ideas and beliefs and adopting new strategies, plans, and policies. Learning starts with individuals but can also include groups of individuals, organizations, and communities. For example, water and ecosystem governance in the Everglades is conducted through a large number of federal, state, and local agencies, tribes, and many non-government organizations (Gerlak and Heikkila 2011, 2018). Individuals in these entities interact and engage in various learning processes that involve different information sources (e.g., from debates to internal reports) and focus on trust building, all of which contributed to learning products of greater understanding of the Everglades as well as new projects and awareness of the value and effectiveness of existing programs. While learning can be difficult because people often do not change their beliefs, it can be facilitated by ongoing dialogue, developing trust in the process, and co-producing meaning. As the foundation for sustainable development, learning enables people and organizations to adapt from their experiences toward achieving their goals. Scientists who study learning include organizational learning scholars, public policy analysts, and psychologists.

Recommendation 7: Continuously evaluate institutional, cultural and individual barriers to experimentation and learning.

Pro-active, formal analysis of the prospects for adaptive management can highlight structural and other barriers to experimentation, learning and implementation. For example, the literature on adaptive management adopts the following distinction between passive and active adaptive management. Passive adaptive management is simply the process of learning over time and incorporating new information into management decisions. Most organizations undertake in some form passive adaptive management regardless of whether it is acknowledged formally. Active adaptive management is the adoption of an experimentation ethic where management measures (e.g., restoration, user fees for recreation) are designed and implemented in a way to learn about how the social-ecological system operates and the effectiveness of the different policy instruments. Active adaptive management is often strived for in many organizations but is rarely practiced due to institutional, cultural, and individual barriers. For example, the Delta ISB's Adaptive Management 2016 report found that "Managers are often risk-averse, and consequently are reluctant to take actions that might not work as planned and could be regarded as "failures"." Another common barrier, and one that likely applies in the Delta, is that management occurs within a web of interconnected responsibilities. That kind of complex governance structure can make learning and associated adaptation especially difficult (see Case Study 8).

Figure 8 represents the science governance network for the Delta in 2019, demonstrating the inherent complexity for decision-making within this system. Social science research could help understand how this complex system can improve its functioning. Examples include investigations into what forums, programs, or committees might best serve as a central hub for implementing adaptive management in the Delta, where in the network adaptive management is more likely to follow the passive or active model, or how implementation of adaptive management might serve as the catalyst for strengthening the communication and connectedness of the governance network over time. The Council and an organizational learning scientist could look at whether whether passive or active approaches support the interactions, networking, trust, and accountability needed to promote learning. Furthermore, a social scientific process could investigate the best forums to promote learning across the entire Delta science enterprise over time.

Case Study 8

Governance of Invasive *Spartina* in the San Francisco Bay

Spartina alterniflora *is an invasive species throughout the San Francisco Bay. In a targeted approach, regional agencies succeeded in decreasing its prevalence to less than 10% its coverage over ten years. Public policy scholars at UC Davis used social network analysis and other methods to understand how these diverse agencies succeeded in managing this complex, uncertain context (Lubell et al. 2016). Through surveys with all agencies involved in* Spartina *management, they were able to characterize the governance network. They found that although many agencies were involved in the eradication effort, there was substantial centrality in the decision-making, likely influencing the success of the process. While not all adaptive management efforts will thrive under a centralized decision-making structure, this social scientific analysis of existing institutions and potential avenues for learning, strategy implementation, and enforcement can inform adaptive management processes that are more likely to succeed.*

In additional to structural analyses, psychologists and behavioral scientists could study the extent to which cognitive biases are influencing decision-maker's willingness to learn or act upon new information. Decision processes are often steeped in subconscious biases that limit people's willingness to fully engage in adaptive management. For example, a change in a decision could be considered a public admission that an earlier decision was in some sense wrong, or at least imperfect. Many decision-makers may consciously or subconsciously regard this as proof of initial failure, with the potential to negatively affect careers and future staffing or budgeting decisions rather than as a learning success. Once a behavioral scientist identifies these or other relevant cognitive barriers, they could recommend considerations for framing the decision process during region-wide meetings and establishing protocols that limit the influence of subconscious beliefs and attitudes on management decisions.

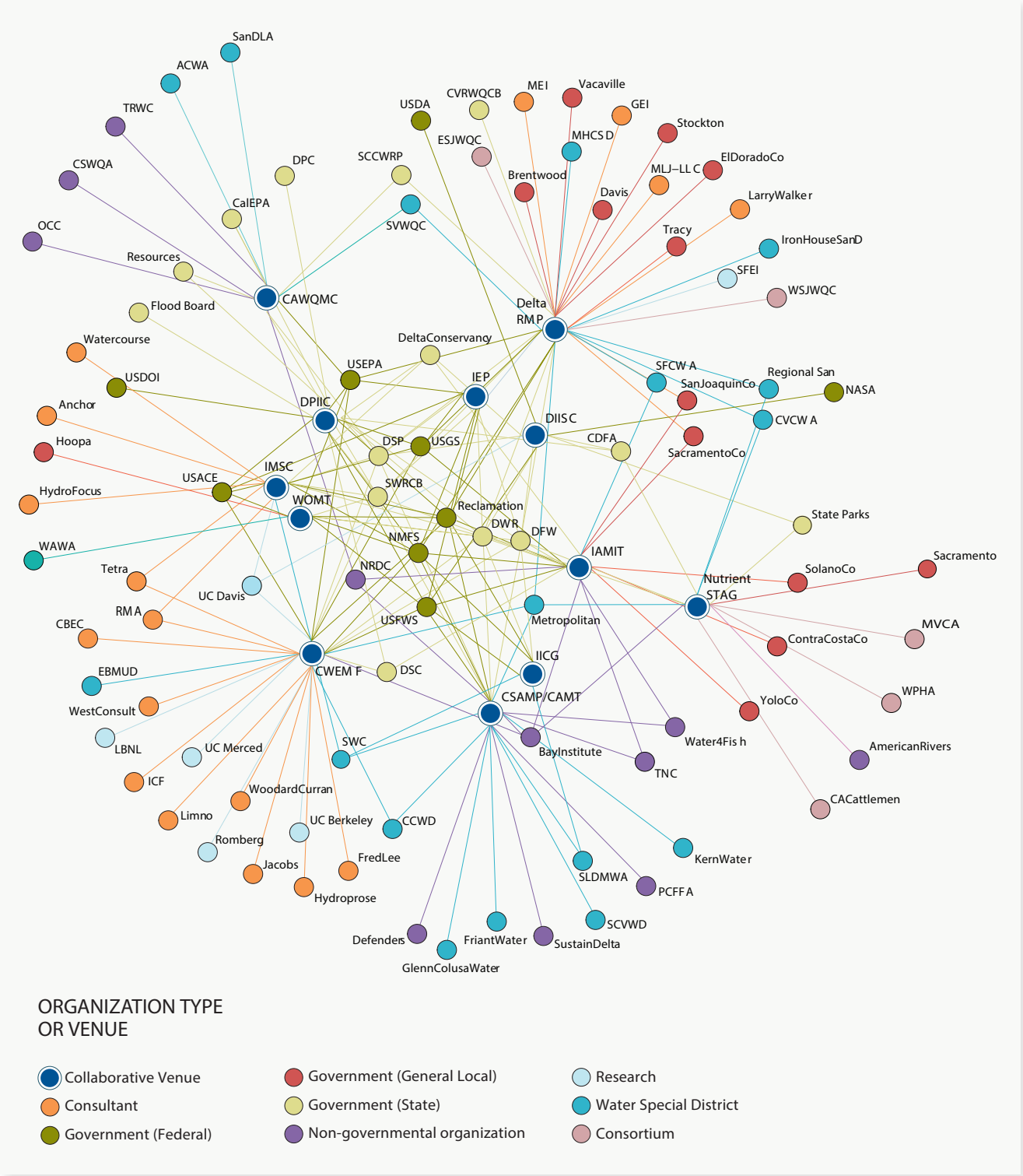


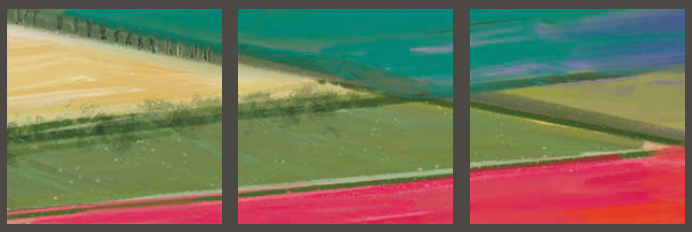
Figure 8. Delta science governance full network, showing the actors involved in implementing the Science Action Agenda (Delta Science Plan 2019, Figure C-1).

Recommendation 8: Reduce barriers to integrating new knowledge in future management decisions.

Regardless of whether information is gleaned in a passive or active way, achieving the coequal goals in a time of rapidly changing social and ecological forces requires that barriers to integrating new knowledge in future management decisions should be reduced. One step in moving in that direction could be a governance analysis to evaluate the extent to which initial management decisions can actually be modified, and the potential impediments to modification. Some management interventions in ecological systems are effectively irreversible at the relevant time scale of policy and politics. Strip mining and the associated filling of streams is one example. Others may be theoretically reversible, but costs and interests stand as strong barriers to change. Proposals to change the major diversion point from the Delta to the Central Valley Project and State Water Project, for example, have been under active consideration for nearly 20 years, but have yet to be formally adopted or rejected. Nearly all management decisions are difficult to reverse to some degree because they benefit entrenched interests or simply because they become accepted as the norm. Careful institutional design can reduce unnecessary irreversibility by highlighting the extent to which change is possible and permissible, and by forcing managers to explicitly and publicly consider change.

Multiple areas of social science investigate how to take into consideration short and long-term consequences when making decisions in adaptive contexts. Real options analysis in environmental economics provides rigorous insight into how one should make irreversible environmental decision under uncertain conditions when new information becomes available over time (Leroux and Whitten 2014). Similarly, in assessing the role of uncertainty on infrastructure investments for flood risk management, economists Sims and Null described the various results of benefit-cost analyses for levee upgrades based on different climate forecasts (Sims and Null 2019). As a result of these calculations, the researchers highlighted that biases associated with accepted levels of risk have differential effects on the long-term social and ecological costs of flood risk management.

Lastly, understanding barriers to learning can lead to improving infrastructure for learning. For example, the ChesapeakeDecisions Web platform was developed to "promote transparency and guide the Chesapeake Bay Program's Strategy Review System." This interactive website is a clearinghouse for documentation associated with strategic planning processes, the status of planning-relevant documents and management decisions, and the portal for collaborative teams to iteratively assess management actions. Efforts such as these emphasize learning and adaptation across the region. We suggest the Delta science enterprise consider institutional structures that meet similar goals while explicitly defining processes to effectively use new social and natural science information that will become available through implementation of the other recommendations in this report.



Summary

The Task Force was created in 2018 to provide guidance for strengthening and integrating the social sciences with ongoing physical and natural scientific research as well as the design and implementation of policies and programs. The social sciences are a branch of the sciences that represent the systematic practice and body of knowledge dealing with describing, explaining, and predicting human behaviors. Similar to the physical or natural sciences, the social sciences are heterogeneous in their scope and methods.

Toward informing decision-making in the Delta, uses of social sciences include, but are not limited to, 1) evaluating and monitoring existing programs and behaviors, 2) predicting impacts of alternatives, 3) describing and comparing how people and organizations interact over time, and 4) helping to clarify the normative implications of different decision making choices. All these opportunities rely on different forms of data (e.g., qualitative and quantitative) and means of analyses that reflect the suite of social sciences.

In reviewing the diversity of documents associated with the Delta science enterprise, the Task Force found many references to the need for social science and several examples of initial steps to fulfill that need. The very act of putting together the Task Force, in fact, should be commended as a demonstration of the Delta Science Program's genuine interest in integrating social science for Delta restoration.

That said, the Task Force identified three (common) findings that encapsulate the challenges preventing further integration of social science within the Delta science enterprise:

1. Insufficient social science capacity and investment
2. A lack of an overarching vision and plan for implementing social science today and in the future.
3. Decision making structures that do not capitalize on social sciences, learning, and adaptive management.

From these findings, the Task Force specified eight recommendations that span temporal and financial investments. Recommendations that could be implemented immediately include: 1) Investing in a broad array of social science studies through the existing joint funding mechanisms, enhancing the proportion of funding dedicated to social science and 2) Investing in internal social science capacity through permanent positions and dedicated fellowships. At the intermediate time scale, the Delta science enterprise can invest in: 3) Developing a conceptual framework that includes social science and is developed based on social science findings on effective stakeholder processes; 4) Monitoring processes for social indicators to compare trends across time and space and evaluate interventions; and 5) Continual building of an external network of social scientists through NGO, university, and public agency partnerships. The effectiveness of these activities will depend on 6) Developing a plan for integrating social science into the Delta science enterprise. Over the long-term, the sustainable and productive integration of social science will depend on 7) Designing decision-making processes to incorporate deliberate measures of learning and 8) Fostering a culture of learning and adaptive management based on social science principles.

Fundamental to these recommendations is an observation that different types of social science are relevant to different questions and problems facing the Delta, and that consideration (and solicitation) of "social science" as a homogeneous and non-differentiated tool will not be sufficient to address the paucity of social science input into Delta management. More broadly, implementing these recommendations requires a recognition that the problems and solutions in the Delta involve people. People include not just those who live and work in the Delta, or people who visit the Delta, but also those involved the Delta governance. Developing an understanding of all relevant people entails the incorporation of different forms of knowledge, which includes input from different social sciences.

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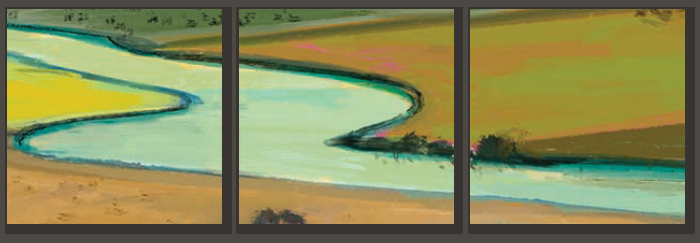

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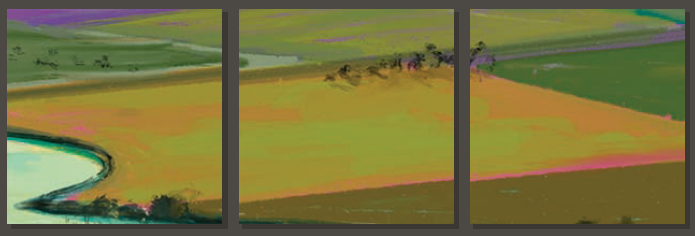
Appendices



Appendix A: Task Force Charge

The Delta Social Science Task Force

Background and Purpose

In the Sacramento-San Joaquin Delta (Delta) region, the importance of social science and of integrating social and natural sciences is widely accepted but examples of this integration are lacking. In response to this disparity and the Delta Independent Science Board's (Delta ISB) review of research on the Delta as an Evolving Place, the Delta Science Program is coordinating a Social Science Task Force (Task Force).

Charge to the Social Science Task Force

The role of the Task Force is to develop a strategy document containing recommendations that can be acted upon by the Delta science enterprise[1] to nurture social science research and strengthen its integration with the natural sciences.

Objectives of the strategy to be developed by the Task Force are to:

1) Identify opportunities to strengthen the Delta science enterprise, to improve the integration of social sciences into the science, management, and policy institutions that address Delta issues, and to improve social science integration into decision-making about the Delta

2) Identify critical steps and priorities for establishing a social science research program that enhances our understanding of the values of an evolving Delta to both people and the environment.

Questions to be considered by the Task Force include:

1) How can the Delta science enterprise increase support for social science research?

    a. How can we marshal additional funding and promote increased budget allocations for social science research in the Delta?

    b. What are the critical steps needed to establish a social science research program in the Delta?

    c. How can we better encourage social scientists to conduct research in the Delta?

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1 The term 'Science Enterprise' refers to the collection of science programs and activities that exist to serve managers and stakeholders in a regional system (Delta Science Plan 2018)

2) What are priority social science topic areas that need to be supported?
    a. What types of data can be used to address complex social science questions?
3) How can social and natural sciences be better integrated to address complex questions in the Delta?
    a. What are human responses to natural resource management actions?
    b. How can social science inform balancing limited resources among humans and wildlife?
    c. What value-based tradeoffs exist among alternative actions?
4) How can knowledge generated from social science studies be utilized to support decision-making in the Delta?
    a. How can social science inform policy decisions that are effective and cognizant of the values of a changing Delta?
    b. How can social science help integrate natural science into decision-making?
5) How can social science inform the design of improved and more effective stakeholder processes in the Delta?

In order to meet the objectives and develop a useful strategy document, Task Force members will work individually and collaboratively to achieve the following tasks:

- Participate in two or more teleconference meetings with the Delta Science Program.
- Participate in a two-day, in-person meeting with key interest groups meeting in or near Sacramento, CA.
- Task Force Chair and/or identified member(s) participate in one or more follow-up meetings with key interest groups organized by the Delta Science Program to present and receive feedback on the Task Force's initial recommendations and the draft strategy report.
- Read and review materials specified in the Charge
- Task Force members jointly author a report that addresses the objectives and questions outlined in the Charge to the Task Force. The report shall provide findings, recommendations, and a strategy for improving social sciences integration in the Delta science enterprise.

Appendix A: Task Force Charge

- Task Force members jointly prepare up to two presentations of the Task Force's final report to councils, committees, or interested groups at the request of the Delta Science Program.
- Chair, Lead Author, and Member roles are explicitly defined in the Task Force Standard Agreement

Committee Composition

The Task Force consists of six to eight social science experts. The Delta Lead Scientist will select members that collectively represent a broad mix of social science expertise based on input from the Task Force Chair, Delta Science Program staff, and others. The Task Force will be patterned on successful efforts of the Social Science Review Working Group of the National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board.

Members of the Task Force represent their scientific disciplines and community. They do not represent or speak on behalf of an agency or professional organization.

Term

The Task Force will carry out its review within an 18-month period. The majority of work is likely to occur between January and December 2019.

Rough timeline for Task Force participation

2018

- December/January 2019: Task Force kickoff meeting with DSP (virtual meeting)

2019

- January: Two-day Meeting (Sacramento and Davis)
    - Day 1: Public meeting and Task Force launch in Sacramento – exchanges between the Task Force and managers/directors, key interest group committee members, and regional experts
    - Day 2: Task Force closed session at UC Davis – initiate report writing

- July: Two-day Meeting
    - Day 1: Task Force participates in a CMSI/DSP symposium at UC Davis
    - Day 2: Task Force closed session at UC Davis – work on strategy report
- December: Draft strategy report
- March: Final strategy report

Materials to Review

Required Reading (explains the current issue with limited social science in the Delta and challenges of social-natural science integration)

- NOAA Social Science Review Working Group Final Report (2009)
- Delta ISB Report – Review of Research on the Delta as an Evolving Place
- Science Enterprise Workshop (Executive Summary)

Supplemental Reading (Delta background and example social science projects)

- Delta Narratives Project
- Documents listed in the Delta ISB review of Delta as an Evolving Place
- Science Enterprise Workshop (Selections from proceedings, pp. 101-107)
- Delta Dialogues
- Science Action Agenda
- Updated Draft Delta Science Plan
- Beginner's Guide to the Delta
- Early reclamation and abandonment of the central Sacramento-San Joaquin Delta
- Defining and Contesting Environmental Justice: Socio-natures and the Politics of Scale in the Delta
- Delta Reclamation District Financing and Budgets
- Delta Regional Opportunity Analysis

Appendix B: Initial Stakeholder Workshop Summary

Delta Social Science Task Force Kickoff Meeting Summary

Meeting date: January 29, 2019
Meeting location: 980 9th St, 2nd Floor Conference Room, Sacramento, CA 95814

Background

The Delta Science Program and the UC Davis Coastal and Marine Sciences Institute have coordinated a Social Science Task Force (Task Force). The Task Force is charged with developing a strategic plan to strengthen and integrate social sciences into the science, management, and policy landscape of the Delta. This effort is in response to recommendations from the Delta Science Enterprise Workshop (2016) and the Delta Independent Science Board's Review of Research on the Delta as an Evolving Place (2017). These recommendations called for increased participation of social scientists in natural resource management actions and integration of social science research with ongoing scientific research in the Delta. This effort will also help fulfill actions supported in the Delta Science Plan and Science Action Agenda, furthering the vision of One Delta, One Science.

Composed of individuals with a diverse set of expertise in the social sciences, the Task Force's key goal will be to develop a set of recommendations to be implemented or utilized by the Delta science community. The purpose of the January 2019 kickoff meeting was for the Delta science community to meet and engage in discussion with the Task Force members. Outcomes of the meeting will inform the strategy report and upcoming Task Force workshop in July 2019.

Meet the Task Force Members

- Jim Sanchirico (chair) – agricultural and natural resource economics
- Rob Johnston – environmental economics
- Kelly Biedenweg – human dimensions of natural resource management
- Josue Medellin-Azuara – engineering, business, economics
- Holly Doremus – environmental law
- Chris Weible – political conflict and public policy

Meeting format

The meeting primarily involved agency presentations (15 minutes; 5 minutes of questions) to the task force members and audience. Presenters included: Erik Vink (Delta Protection Commission), Cory Copeland and Jeff Henderson (Delta Stewardship Council), Campbell Ingram (Sacramento-San Joaquin Delta Conservancy), Evan Sawyer (NOAA Fisheries), Karen Gehrts (Department of Water Resources), Alex Heeren (California Department of Fish and Wildlife), Jeff Caudill (California Department of Parks and Recreation – Division of Boating and Waterways), Janis Cooke (Central Valley Regional Water Quality Control Board), Stephen McCord (Delta Regional Monitoring Program), and Adam Fullerton (Bay Conservation and Development Commission).

Questions provided to presenters

In preparation for the meeting, we requested presenters to address a series of questions:

- What is your agency's mission, with respect to the Delta region?
- What are current Delta-related management issues your agency or organization is addressing?
- What are some high priority science activities (e.g. monitoring, modeling, research, community outreach) in which your agency is engaged in the Delta?
- Are there particular emerging concerns in the Delta environment and/or communities that your agency hopes to address?
- What are some potential challenges (if any) to implementing your management actions or working collaboratively in the Delta?

Dr. Richard Norgaard (Delta Independent Science Board (ISB) member) kicked off the morning with a presentation on the Delta ISB's report on the Delta as an evolving place and his perspective on natural-social science integration opportunities. Following the agency presentations, Dr. Mark Lubell (UC Davis) presented on governance and resources use in the Delta, including a discussion on networks and cooperation.

Presentation and discussion highlights

The various presentations and discussions highlighted multiple common themes regarding ways to engage more social scientists and stakeholders and provide funding for social sciences in the Delta. Below is a summary of some of these topics.

Appendix B: Initial Stakeholder Workshop Summary

Engaging stakeholders

- Agencies find it difficult to get groups to the table, such as industry (unless regulated) and public interest groups. What are the most effective approaches for stakeholder engagement?
- There is a lack of trust between stakeholders and agencies.
- Outreach may be neglected in some projects due to larger priorities and limited resources; policymakers may try to work out details internally.

Social science embedded in missions

- Many are unsure how to track the success of agency missions, particularly for the aspects of those missions that relate to social sciences. How do we know if we are achieving our missions?
- Agencies need to use best available science. Eventually, we could synthesize social science findings and use them in development of policy recommendations, performance metrics, etc.
- It is difficult to identify and summarize the relevant underlying social indicators and dynamics of many projects in the Delta, especially when these considerations are addressed after the initial project planning stage.

Delta as an evolving place

- We often neglect the "Delta as place" piece of the co-equal goals, but there is the need to care for those who work, live, and recreate within the Delta.
- Delta values are relevant to the interpretation of the coequal goals – agriculture, recreation, culture, natural resources – and are within the realm of social sciences.

Complexity

- Delta governance is messy and has a high conflict density. There is mutual recognition that the Delta is a socially challenging work environment.
- The Delta science community needs to improve political knowledge and understand how to navigate complicated political processes.
- There is a lack of legislative directives (e.g., for invasive aquatic vegetation control) that can complicate management actions.

- With such a complex system, it is difficult to prioritize efforts. Priorities are often use-driven (e.g., by recreation) or in response to challenges (i.e., less proactive).

High priority topics

- Invasive (aquatic) species – the spread of aquatic invasive species in the Delta impacts the ecosystem, often requires extensive and costly management, and can negatively affect uses (e.g., recreation).
- Recreation – recreation is highly valued in the Delta and is often a major driver of management actions.
- Agriculture – agriculture is a primary land use and economic source within the Delta region.
- Ecosystem health and restoration – the declining health of the Delta ecosystem is causing concern to many. Agencies have mandates and regulations in place to preserve the ecosystem, protect endangered species, restore habitats, and support fish populations.
- Levees – levees are the foundation on which all the Delta values are built (i.e., no levees, no culture).
- Subsided lowlands – subsidence reversal and management to protect or restore subsided lowlands in the Delta is challenging to address.
- Socioeconomic indicators – we want to improve the precision of usable social indicators, beyond and in addition to tracking economic measures.

Emerging concerns

- Sea level rise (protecting land uses and communities)
- Climate change (widespread implications)
- Degraded ecosystem (water quality and fish decline)
- Water quality (mercury, pesticides, toxicity, nutrients, contaminants of emerging concern)
- Reliance on Delta watershed (reducing reliance)
- Environmental justice (protecting disadvantaged communities)

Appendix B: Initial Stakeholder Workshop Summary

Collaboration and partnerships

- The Delta science community needs to identify partnerships and collaborations outside of Federal and State agencies.
- Currently there is no funding or incentive for NGOs to participate (i.e., no carrot).
- Many additional players (e.g., local government, Delta communities, research agencies) should be involved in the effort to increase social science funding and use.
- The Delta science community should make an effort to reach out to universities and establish relationships with social scientists.

Funding social science

- Existing social science efforts are underfunded. In order to be effective regionally, we need adequate staff and resources.
- It will be useful to investigate the (funding) avenues that allowed for existing social science-related projects and programs to be created in the Delta science community.
- An existing funding challenge is that agencies are constrained by some funding mechanisms (e.g., slow prioritization process within State agencies) and limited by the language in funding mechanisms (e.g., Prop 1 cannot easily fund social science projects).
- We need social science, natural science, and policy champions! Who are they?

Strategy document

- We want a high level strategy document with overarching guidance to be written for agency directors and managers that includes specific examples (e.g., ways to increase social science funding and how to integrate social and natural sciences into the Delta science community).
- The strategy may consider providing small steps to move us in the best possible direction, given limited existing resources.
- There are many levels at which we can support social science. We want to support more social science research, particularly applied research.
- The Climate Change Vulnerability Assessment (Delta Stewardship Council) may be a test model for incorporating social science into a planning study.

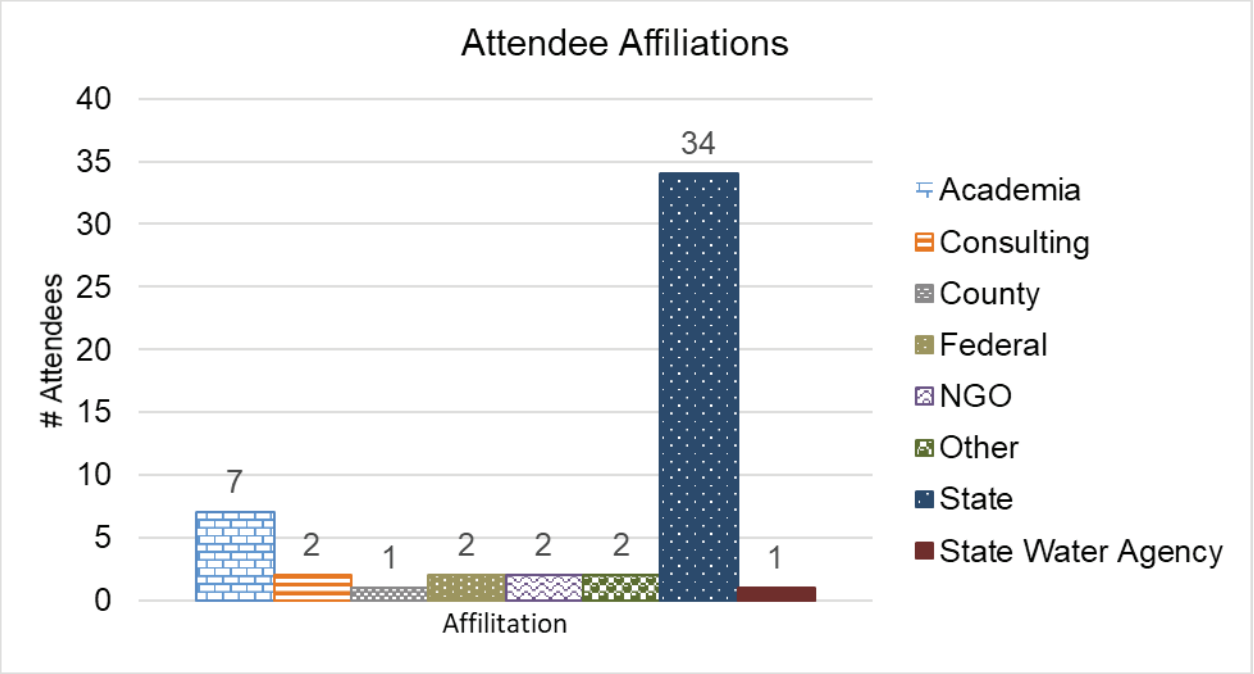

Figure 1. Number of kickoff meeting attendees grouped by generalized affiliation.

Appendix C: Human Dimensions Research in Delta Environments Workshop Summary

DELTA SOCIAL SCIENCE TASK FORCE WORKSHOP SUMMARY

Human Dimensions Research in Delta Environments

Purpose:

The purpose of this workshop was to bring together social scientists from across the country to highlight how they study and address management challenges that are similar to those in the Sacramento-San Joaquin Delta. The workshop showcased a diversity of social science fields, such as economics, anthropology, public policy, social psychology, and landscape design, which are available for addressing complex management challenges. Topics included invasive species management, flood risk and management, water and ecosystems, and social science integration.

Key Takeaways:

- Many environmental and natural resource management challenges are social questions.
- Learning how to best utilize science to inform decision-making is a social science endeavor.
- Social sciences include a diverse set of disciplines, approaches, and tools for researching and managing the Delta as a coupled human and natural system.
- Integration of natural and social science perspectives is key, but social scientists also need to work across social science disciplines.
- We need to build the capacity for social scientists within the Delta science enterprise.

Presentation Highlights:

- Keynote: We can improve how science contributes to better decisions by applying social science approaches and tools, building relationships, being persistent and adaptable, and identifying how scientific information can be applied to decision-making.
- Invasive Species Management: Economic analyses are useful for evaluating responses to invasive species and assessing ecological and economic uncertainty of new invasions; micro-targeting can be a valuable tool for improving conservation messaging and overall communication; and governance plays a major role in the effectiveness of response efforts to new invasive species.
- Flood Risk and Management: Surveys, interviews, and environmental economics tools are all very useful approaches to identify what a community values, where there are tradeoffs, and when adaptation investments should be made. Presenters provided examples of how social science research was used to 1) find innovative solutions to multi-benefit flood risk/set-back levee projects and 2) inform when to invest in levee improvements.

Delta Social Science Task Force

Background

The Task Force was established by the Delta Stewardship Council's Delta Science Program and is a key action recommend in the Delta Science Plan. The Task Force is coordinated by the Delta Science Program and the UC Davis Coastal and Marine Sciences Institute, and it is charged with developing strategic recommendations for engaging and integrating social science in the Delta science enterprise.

Progress

The Task Force was formed in late 2018 with input to the Delta Science Program on its charge and composition from key interest groups. A kickoff meeting was held in January 2019, where Task Force members received input from federal, state and local agencies, and stakeholders about key management issues and challenges relevant to social science issues in the Delta. Outcomes of the kickoff meeting informed the July 2019 workshop themes.

Next Steps

Following the workshop, the Task Force will begin drafting their strategy report. The draft is anticipated by mid-December with time for public review. The final report will be completed in March 2020.

- Water and Ecosystems: Improving management approaches through on-going learning in complex ecosystems is often challenging but necessary; research that engages stakeholders in landscape design can be applied at large and small scales (e.g., Franks Tract Futures); and anthropology and political ecology can help identify important humanistic themes (e.g., related to sense of place, disagreement and trust) that occur in conflict and ecosystem recovery.
- Social Science Integration: Panelists from the Chesapeake Bay, Puget Sound, NOAA Fisheries, and U.S. EPA discussed the importance of connecting at the local level and identifying shared benefits. They also recommended frameworks and performance indicators (i.e., Integrated Ecosystem Assessments, Management Strategy Evaluations, and human well-being indicators) that rely on social science integration.

More Information:

Speaker information and a video recording of the workshop are now available on the UC Davis Coastal and Marine Science Institute webpage at https://marinescience.ucdavis.edu /engagement/past-events/human_ dimensions_research.

For more information regarding the Delta Social Science Task Force, please visit the Delta Stewardship Council webpage at https://deltacouncil.ca.gov/ or contact Rachael.Klopfenstein@deltacouncil.ca.gov.

Appendix D: Major Social Science Fields Relevant to the Delta

Many books and articles describe the different social sciences that can inform environmental restoration, and it is beyond the scope of this report to provide a comprehensive and detailed review of all possible types of social science. Instead, this report provides a broad understanding of the major types of social science that might be applied to address key questions in the Delta. Bennett et al. (2017) group social sciences into seven "classic social sciences" (sociology, anthropology, political science, geography, economics, history and psychology) and four "applied social sciences" (law, education, communication and development). Not all publications categorize social sciences equivalently, and some areas of study such as history and law are not always considered social sciences (rather, some consider them humanities). Nonetheless, most categorizations are similar, and we recommend this article as a foundational resource for understanding the suite of social sciences relevant to the Delta.

A few among the key social scientific disciplines are presented below and in Table 1. These examples are not exhaustive; there are more disciplines than are listed, and each discipline could be simultaneously used to understand different components of a question from its own worldview. Hence, this list should be considered as illustrative rather than comprehensive. It is provided solely to convey that different types of social science are relevant to different types of questions.

- Anthropology can describe cultural beliefs and practices that are critical to people's sense of place and identity, in turn affecting how different cultural groups react to policy and biophysical changes in the ecosystem
- Communications studies generally apply what we know from other social sciences to evaluate the best ways to inform and engage stakeholders
- Economics can help us understand both micro- and macro-economic factors associated with how people make decisions and tradeoffs when faced with scarce resources, the role and effect of market structures, and what this behavior implies for social welfare and efficiency (benefits and costs).
- Psychology helps us understand the thought processes that form people's perceptions about issues related to the environment and how humans interact with it, and why people engage in certain types of behaviors.

- Public administration can help analyze how public organizations make decisions and interact with other types of actors in environmental management.
- Sociology helps to understand how social contexts, interactions, structures and networks influence behavior related to the environment.

Just as there are many different types of social science, there are other disciplines that are not considered social science. For example, engineering is not a social science—even though it sometimes provides outputs (such as monetary cost estimates) that might seem similar to those provided by some social science disciplines. There are also a number of more recently developed social sciences such as decision science that combine methods and insights from multiple classic social sciences such as economics and psychology with discipline-specific methods. Interdisciplinary disciplines such as geography encompass methods that are considered to be social science (e.g., human geography) with other methods that are not social science in themselves (e.g., remote sensing, earth system science).

In addition to disciplinary areas of study, there are various environmental *topics or focal areas* of study that leverage inter- or transdisciplinary methods. For example, ecosystem services research integrates methods and data from biophysical, social and health sciences. Another example is interdisciplinary research on climate change adaptation. Although these are important areas of study, they are not widely considered to be social sciences. Rather, research in these crosscutting areas borrows, integrates and adapts approaches from existing social sciences to study topics of interest.

Diverse analytic objectives

Within each discipline, multiple analytical methods can be applied depending on the objective of the science. From a broad perspective, however, virtually all social science analysis can be categorized as (1) Explanatory or Predictive—seeking to explain or predict human responses; (2) Normative—seeking to evaluate or determine what is "best"; or (3) Descriptive—seeking to describe, understand, or characterize human-related phenomena. Some social sciences involve all three categories to various extents and ways; and other social sciences emphasize one or two of these categories. Table 1 provides a few illustrative examples of how these analytical

Appendix D: Major Social Science Fields Relevant to the Delta

Table 1. Examples of social scientific research questions specific to the Delta from different disciplines for different analytical purposes.

Examples taken from the 2017-2021 Delta Science Action Agenda, Appendix D.

Broad Research Purpose	Potential Research Questions from Different Disciplines
Explanatory or Predictive Science *Seeks to predict behaviors as they respond to exogenous and endogenous factors using hypotheses and designed sampling procedures*	*Psychology: What values, attitudes, and prior experiences influence farmers' adoption of a riparian buffer strategy?* *Political Science: What factors explain how information is used in decision-making processes?* *Communications: What format is most useful to communicate scientific lessons from past drought management actions to inform future management?*
Normative Science *Seeks to evaluate programs from a normative (or value judgement) perspective, and identify options that are better or best.*	*Archeology: How do we interpret artifacts as cultural indicators of environmentally sustainable societies?* *Decision Science: What is the most optimal way to convene community modelers to develop decision-support tools to address management questions?* *Economics: What are the benefits and costs of alternative environmental restoration strategies?*
Descriptive Science *Seeks to describe or characterize the systems associated with environmental decisions and behaviors.*	*Human Geography: How are people in the Delta affected by and adapting to climate change?* *Anthropology: What are the cultural beliefs and practices that influence how communities use and establish their sense of place from the Delta environment?* *Sociology: How can we collaborate among various agencies to negotiate sharing of data and improve data accessibility?*

purposes across the social sciences might apply to the Delta. We use examples from the 2017-2021 Delta Science Action Agenda Appendix D to illustrate how different social science fields can address already identified regional questions. We do so for communicative purposes, yet do not recommend these as priority or even important questions necessarily. Rather, identification and prioritization of social science should be done by the Delta science enterprise as part of implementing the proposed social science strategy.

Table 1 illustrates that one type of analysis is rarely sufficient to answer social scientific questions relevant to the Delta. For example, decision-makers considering alternative policy interventions to address water flow restrictions might want to (1) predict how different groups in the Delta might react to each policy, (2) evaluate which policies might be preferred across a variety of different criteria and (3) understand how each policy might influence different groups within the Delta. Hence, requests for ambiguously defined "social science" input are typically insufficient to ensure that the relevant information is obtained, and relevant questions are answered.

Types of Social Science Data

Social scientists rely on a broad array of data types—both qualitative and quantitative—to draw conclusions. These include data derived from direct and purposeful interventions such as surveys, focus groups, interviews and/or field experiments; data from direct but passive observations of behavior; data from organized markets (e.g., housing sales and price data); and secondary data from published or other sources such as policy documents, data provided by government agencies, or Twitter feeds. No one data type is best for all purposes. In all environmental management, we seek the Best Available Science to inform policy and practice. The standards for determining the Best Available Social Science are fundamentally the same as those for the biophysical sciences; they all should employ the most rigorous method to test the most likely theory to explain the topic of interest (Charnley et al. 2017). Sometimes, in both the biophysical and social sciences, this means that qualitative data are more appropriate than quantitative data (or vice versa). Ongoing efforts in the Delta recognize the need to include socioeconomic data as part of the Monitoring Enterprise Review (Nelitz et al. 2019) to support decision making.