A Social Science Strategy for the Sacramento-San Joaquin Delta

Draft for Review

Delta Social Science Task Force

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Executive Summary

In the fall of 2018, a six-member independent Social Science Task Force (Task Force) was charged by the Delta Stewardship Council 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 name given to the broad spectrum of partners including public agencies, non-profits, and Tribal governments contributing to the understanding of the Delta system. 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 that considers both people and the environment.

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

The Task Force began its review in December of 2018, meeting twice in person and over a dozen times remotely between January 2018 and December 2019. The Task Force also met 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 (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.

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 for Delta restoration. 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 and restoration success. For example, the social sciences can help in understanding how people interact with the Delta, how the Delta impacts their well-being, and how their actions (including adaptive management) impact the Delta environment – all of which contribute insight into protecting and restoring the Delta.

Our review of the science used to inform Delta decisions shows an imbalance in the consideration, understanding, and use of social versus biophysical sciences, with biophysical sciences almost always given implicit priority. While this may sound dire, we highlight that this is extremely common across natural resource management contexts. But we would be remiss if we did not underscore that social science is not a "luxury good" that can be invested in only when there are additional resources. Rather, it should be an essential part of the overall science portfolio for the Delta science enterprise to achieve the objectives of the Delta Reform Act of 2009. Among the primary goals of this report is to provide a structured set of findings and associated recommendations to help the Delta science enterprise progress towards this general goal.

Based on the review of documents, materials, and presentations summarized above, the Task Force identified three main barriers to the integration of social science in Delta planning, and nine overarching recommendations for addressing these barriers to enable better production and use of social science to inform decision-making. These recommendations do not reflect specific results of social science that the Delta science enterprise can use; conducting social science was not among the charges to the Task Force. Rather, the recommendations are meant to serve as guidelines to direct productive conversations about the best pathways to integrate social science more effectively into the Delta science enterprise. These key findings and recommendations are summarized below.

Finding 1: Research activities are ongoing, but there is no long-term vision for social science integration.

Recommendation 1: Invest in a collaborative process to develop a *conceptual framework* for the Delta that includes social science.

Recommendation 2: Invest in the collaborative development of social and natural *indicators* for the Delta Ecosystem.

Recommendation 3: Develop a *plan for integrating* social science into the delta science enterprise.

Finding 2: There is a lack of social science capacity and investment.

Recommendation 4: Invest in a broad array of *social science studies*.

Recommendation 5: Invest in building an *external network* of social scientists.

Recommendation 6: Invest in *internal social science* capacity.

Finding 3: Social science does not explicitly inform adaptive management structures and processes

Recommendation 7: Apply social science methods to formally *evaluate and define the role adaptive management* can play in the Delta.

Recommendation 8: Continuously *evaluate institutional and cultural barriers* to learning.

Recommendation 9: Evaluate and reduce factors that cause *unnecessary stickiness* in management decisions.

Attention to these findings and recommendations will help the Delta science enterprise achieve its mandated coequal goals of providing more reliable water supply and protecting, restoring and enhancing the Delta ecosystem while protecting and enhancing "the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place." Fundamental to the 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.

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 SSWG 2009).

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.

Questions considered by the Task Force include:

- How can the Delta Science Enterprise increase support for social science research?
- What are priority social science topic areas that need to be supported?
- How can social and natural sciences be better integrated to address complex questions in the Delta?
- How can knowledge generated from social science studies be utilized to support decision-making in the Delta?
- How can social science inform the design of improved and more effective stakeholder processes in the Delta?

[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.

To develop the objectives and questions to be addressed by 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.

The Task Force began its review in December of 2018, meeting in person two times between January 2018 and December 2019 and numerous times virtually. The group reviewed a wide range of material, including the Delta Science Plan (2013 & 2019), Science Action Agenda (2014 & 2017-2021), Delta Independent Science Board's (Delta ISB) Review of Research on the Delta as an Evolving Place, report from the Science Enterprise Workshop, NOAA Science Advisory Board's 2009 report entitled, "Integrating Social Science into NOAA planning, evaluation, and decision-making," and the social science academic literature. The Task Force also met a number of times with the Delta Science Program Staff during its review period.

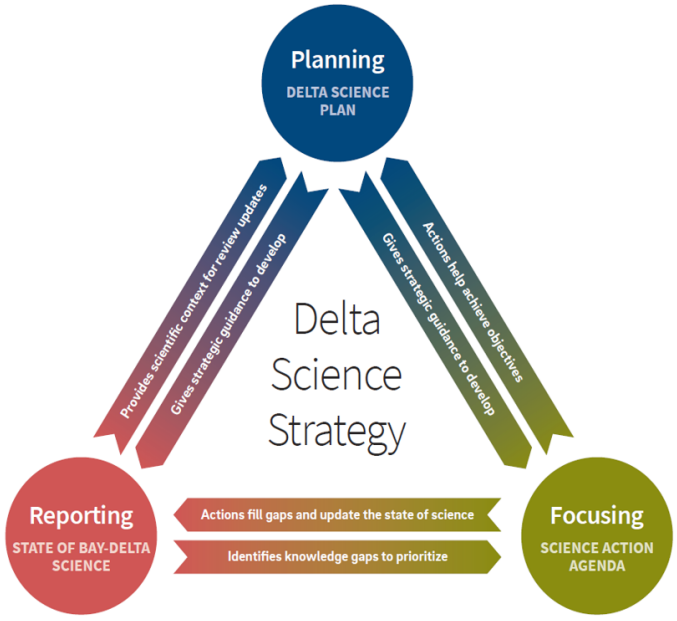
As part of the Task Force charge, the Task Force held two workshops in partnership with the Delta Science Program. The first workshop was held on January 29, 2019 in Sacramento, California. The goal of this workshop was to obtain information from the Delta science community on their major management 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 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 1).



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

Figure 1. Delta Science Strategy (Delta Science Plan 2019)

This document builds from what the Task Force learned in these meetings, applying the individual professional expertise of Task Force members in recommendations for filling identified gaps. Importantly, the Task Force was not asked to conduct social science itself or recommend specific actions based on social science. Rather, the Task Force provides explicit guidance for building a sustainable scientific enterprise that integrates social science. That is, this report does not "do" or report empirical social science itself—rather it provides concrete guidelines for how the Delta science enterprise can promote, guide, and obtain the social science necessary to meet management goals for the Delta.

Why do we need Social Science in the Delta?

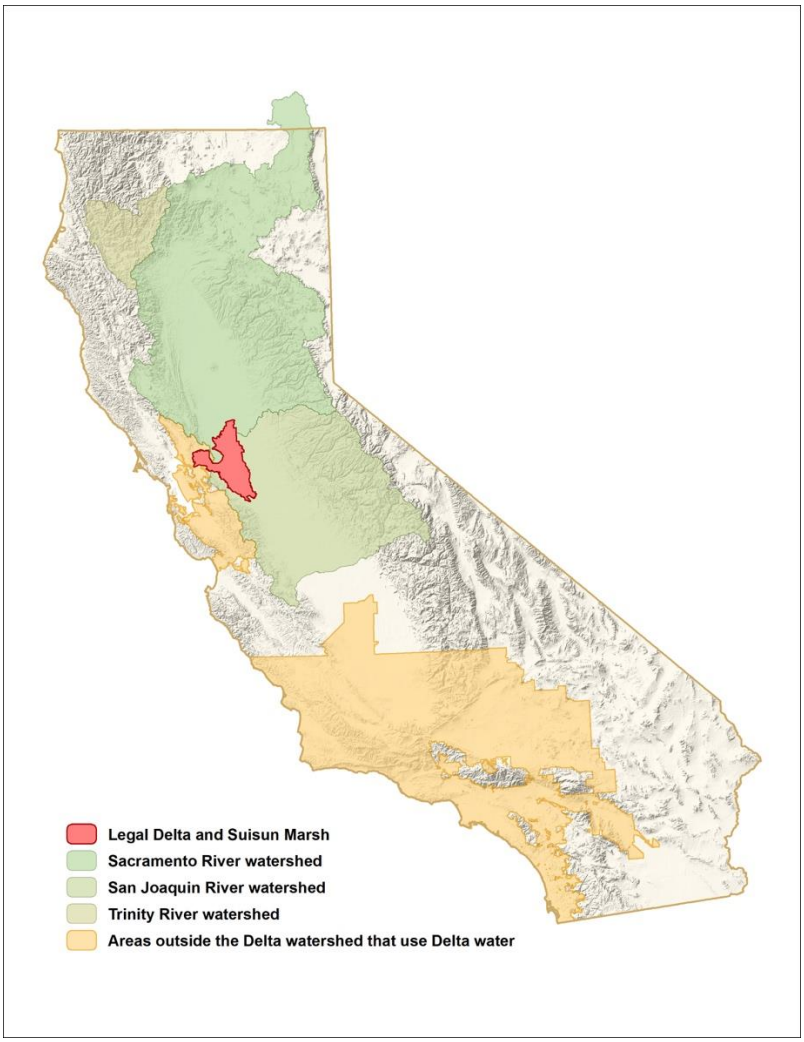


Figure 2. Delta Watershed Map

The Delta (Figure 2) supports one of the most productive agricultural regions in the world, consists of 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 and the Delta ISB and established the co-equal 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.

Social science can provide information relevant to the process of achieving the co-equal goals and satisfy the guidelines for the use of science in the management and restoration of the Delta. For example, the social sciences can help in understanding 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. The Delta as an evolving place implies that there is something unique about the Delta, while emphasizing the ever changing needs, wants, and values of the communities within the Delta.

Social science can also provide knowledge on how to improve the organization and function of the Delta science enterprise. For example, a political scientist might ask how the Delta science enterprise operates as an organization to achieve its mission effectively and efficiently within its the political and economic landscape.

> "Social science is an essential part of the science decision makers need."
>
> Kevin Werner, Science and Research Director for NOAA's Northwest Fisheries Science Center

Three Delta Science Strategy documents recognize the need for social science (Delta Science Plan, Delta Action Agenda, and the Delta Conservation Strategy). 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 Independent Science Board's review of

research recognizing potential gridlocks in advancing science due to lack of understanding human values (Council 2017). A 2018 workshop on the Delta Science Plan offered additional feedback, calling for greater use and integration of social science. While the plan considers social aspects in some of its chapters and performance measures (specifically, those related to the protection of unique cultural values in the Delta, protection of human health, and reduction of risk to people), explicit inclusion of social sciences remains lacking in the plan. For example, one of the appendices in the plan mentions the use of best available science yet the plan offers no criteria for how to include social sciences. Moreover, Delta Science Strategy and planning documents often fail to recognize the unique types of information and data that are provided by different social sciences, and how these unique outputs are relevant to different management questions and challenges. This stands in contrast to parallel plans and strategies regarding biophysical sciences and information, which tend to be more targeted and specific.

The Delta Science Action Agenda also identifies socio-economic dynamics as components of a focused agenda. The 2017-2021 Agenda established 13 Management Needs and Priority Science Actions for which sciences must fill critical knowledge. Three priority action items were directly linked to using social science, including:

1. Consider human behaviors and stakeholder concerns to investigate the most cost-effective methods to improve species habitat on working lands.
2. Develop tools to coordinate and assist adaptive management in the Delta.
3. Understand human responses to policy and management actions to more efficiently integrate the physical and natural sciences with the social sciences

Case Study: Multidisciplinary Approaches for Research and Management of Delta's Estuarine Systems

The Delta complexity in water supply, water quality, ecological, infrastructural, and social dimensions requires interdisciplinary approaches to help comprehend such complexity as well as inform Delta issues (Luoma et al. 2015). Over decades, the natural and physical sciences have offered a better understanding of the Delta's natural and manmade systems along with the interplay with water supply and ecosystems management. Yet, the social dimensions associated with these natural and physical elements remain relatively underdeveloped. Lund et al. (2007, 2008) offered one of the first efforts to bring together ecosystems, infrastructure, and socioeconomic aspects of the California Delta. Later, the UC Davis Center for Watershed Sciences and PPIC (a think tank on California policy issues) convened a group 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 have produced several research reports (Hanak et al. 2013) and peer reviewed publications that specify alternatives and tradeoffs involved in improving native species habitat and populations, providing water for cities and agriculture, and managing flood risks. The reports have been highly influential among the Delta's water and environmental technical and policy communities. Importantly, the drafting of these reports has included processes that involve extensive consultation with the scientists, experts, and managers in agencies, academia, NGOs and other organizations. These policy pieces have been presented in half-a-day public events with invited panelists, press releases, and briefings to agencies and other organizations. This model has been a first step in improving the integration of social science into technical and policy discussions on California water and environmental management issues.

Lastly, the Bay Delta Conservation Plan outlined that the process for conservation is based on partnerships, common goals, and evaluations of alternatives (Figure 3). Effective implementation of such a process requires different social sciences at every step. Social scientists could use the scientific method to identify which partners should be included in exchanging information, the type of information that each partner considers important to discuss, and the potential socio-economic impacts of alternative scenarios. Equally important, social scientists could help design and evaluate 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).

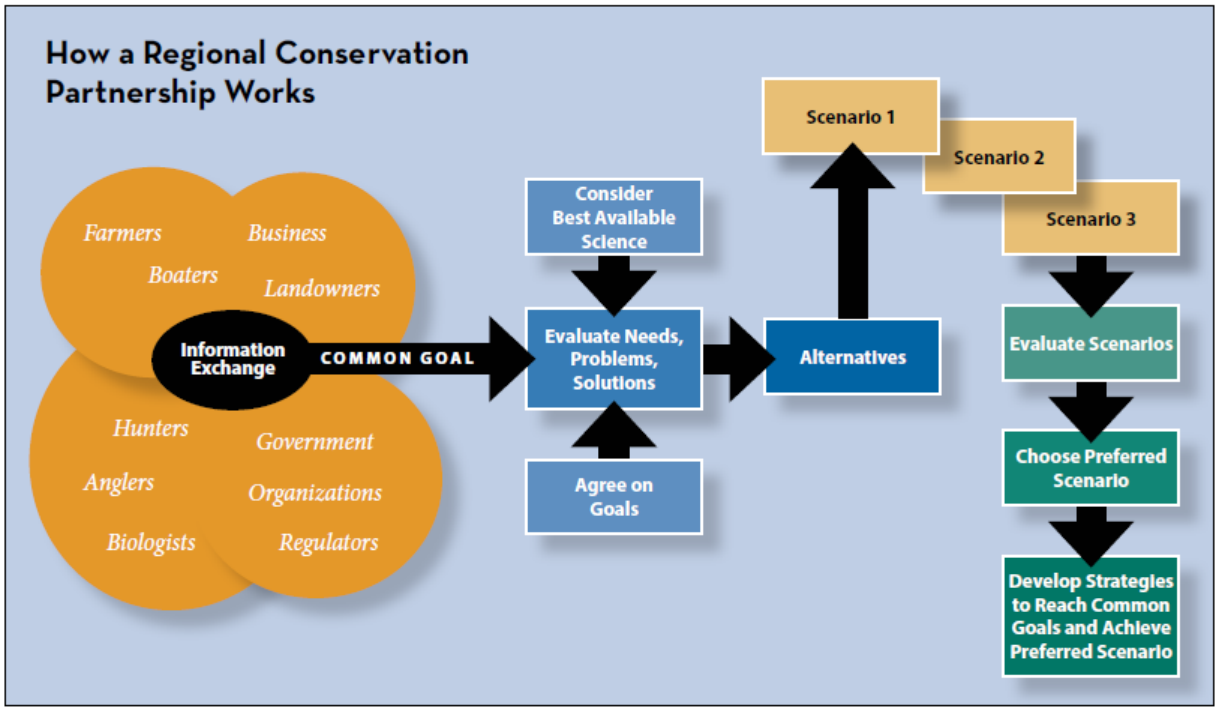


Figure 3. Delta Conservation Framework image showing the steps to building common strategies and goals

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.

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. These disciplinary differences are frequently unrecognized in the strategies and documents that guide Delta

Science—many of which reference "social science" as a broadly defined umbrella category. 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 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…." The social sciences are distinct from the humanities (e.g., philosophy and history) in that the humanities generally seek to describe, study, critique, or document the human experience, whereas the social sciences apply rigorous scientific methods to analyze, understand, test hypotheses on, and sometimes predict social phenomena. In our review, for example, we find that the region's work around 'Delta as Place' has been approached through a humanities focus more than a social scientific one. Although the humanities can provide useful insights, they should be considered as a complement to rather than as a substitute for rigorous social science.

How one implements social science should be distinguished from *what is* social science. Often, non-social scientists might associate community engagement, environmental justice, or citizen science with the social sciences. However, both social and natural scientists can engage the community through citizen science as a data collection tool 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

[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.

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 they are formulated and intended to inform.[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 options in those strategies (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 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 description or explanation of the cognitive and social factors that influence 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 suite of social sciences in combination help us better understand the diverse, complex factors affecting the human system.

Major Social Science Fields

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

[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.

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.

- **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.
- **Sociology** helps to understand how social contexts, interactions, structures and networks influence behavior related to the environment.
- **Political science** can help to characterize the formal and informal institutions and norms (at different scales) that influence the way decisions are made by individuals and organizations in relation to government.
- **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

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. Additionally, 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 (e.g., remote sensing, earth system science).

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

Broad Research Purpose	**Potential Research Questions from Different Disciplines** *(examples from the 2017-2021 Delta Science Action Agenda, Appendix D)*
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?

Broad Research Purpose	Potential Research Questions from Different Disciplines *(examples from the 2017-2021 Delta Science Action Agenda, Appendix D)*
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?

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).

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 nine recommendations that encourage a vision for (1) integrating social science, (2) supporting a long-term investment in social science capacity, (3) developing approaches for integrating social science with other sciences, and (4) integrating social science into decision making for adaptive management. These findings and recommendations operate from the idea that improving the Delta requires sustained support in building and using social science knowledge in conjunction with the physical and natural sciences as well as with the Delta's management and policy decision making.

Finding 1: 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 2 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 analysis. 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 from the white paper "Funding Science to Meet tomorrow's Challenges", which was written with environmental science and the Delta ISB in mind, 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 2. Excerpts on social science needs and activities in a sample of Delta Science Enterprise documents.

Document	Year	Text
Economic Sustainability Plan for the	2012	Measures key elements of the Delta economy, develops strategies to enhance the economy, and analyzes the impacts of several important

Document	Year	Text
Sacramento-San Joaquin River Delta		proposals for the Delta Plan on the region's economic sustainability
Delta Science Plan	2013	Develops and utilizes science-based adaptive management frameworks for ecosystem restoration efforts and watershed-level management actions….to further the coequal goals
The Delta Plan	2013	Surveys of Delta recreation at regular intervals, such as every 5 years, to inform marketing and planning for recreation and tourism Assesse opportunities to control or reverse subsidence of farmland
Interim Science Action Agenda	2014	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)
Delta Conservation Framework	2017	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
Science Action Agenda	2017	Invests in assessing the human dimensions of natural resource management decisions

Document	Year	Text
		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
Funding Science to meet tomorrows challenges	2018	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
The Science Enterprise Workshop Ex. Summary	2018	Integrates social science with natural science and engineering to understand the full scope of management issues
Delta Science Plan	2019	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.

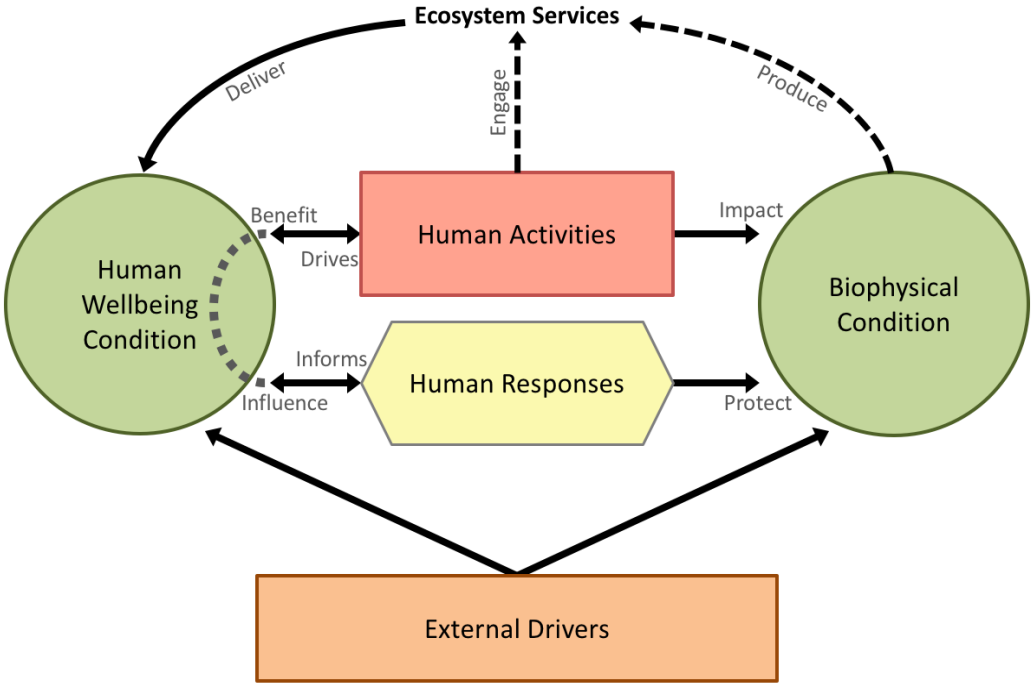
Recommendation 1: Invest in a collaborative process to develop a conceptual framework that includes social science

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 effectively impact the social-ecological system. It also helps create "buy-in" 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 discussions about the model with regional partners over time 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 co-equal 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).

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 4a 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 4a). 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 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 can point to the diagram that highlights feedbacks between ecosystem functions, human behaviors, and management strategies.

Puget Sound Integrated Ecosystem Recovery Conceptual Model



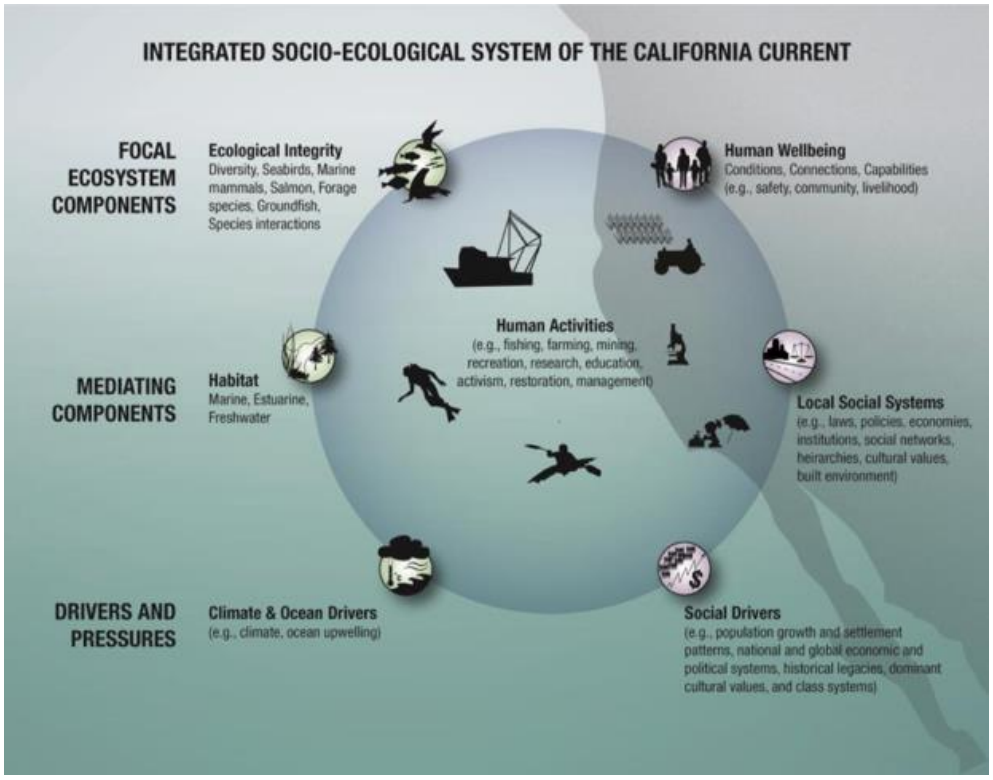


Figure 4. Conceptual models developed for a) Puget Sound Partnership's Ecosystem Recovery and b) NOAA's California Current Integrated Ecosystem Assessment

Recommendation 2: Invest in the collaborative development of 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. Currently, the Delta science enterprise measures several biophysical indicators of ecosystem health, such as water quality. The addition of social indicators would further establish the scientific infrastructure and communicative power for social science integration in Delta recovery.

As with the development of the conceptual model, a collaborative process to developing social indicators is critical. Not only will better, locally relevant indicators be identified, a collaborative process will result in buy-in and understanding of the importance of these indicators. Hence, along with collaborative development of the use of social science in general, the Task Force recommends parallel collaborative development of a set of relevant social science indicators.

Figure 5. Puget Sound Partnership Vital Signs used to Monitor ecosystem recovery. Note the extent of healthy human population and quality of life indicators.

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. A proposed suite of Vital Signs were developed using a social scientific processes to identify the most representative metrics for the diverse population. The final indicators were selected from this list through a collaborative processes with regional boards that identified the best metric for each Vital Sign based on cost effectiveness and ease of communication. As a result of defining and institutionalizing these social indicators, state funding has been dedicated to continual monitoring, new social scientists have been recruited to the restoration enterprise, and local partners have expressed an improved ability to communicate their goals to constituents. These indicators also reflect a consensus over a set of social dimensions that are important to monitor and track as part of management. The status of

these indicators are reported in the biennial State of the Sound and the interactive Vital Sign webpage.

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 should be determined as 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 3: Develop a plan for integrating social science into the Delta Science Enterprise

Social science includes a diverse body of disciplines, implying that there are many paths to increasing the amount, quality, and relevance of social science research. A framework that defines goals, objectives, and indicators used to measure progress towards those goals and objectives is necessary to navigate a clear and sustainable path for integration and investments in social science. Yet there are already some pathways in the Delta that can provide guidance and traction on where to invest in the short-run. First, the co-equal 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 (e.g., utilize a structured decision-making process) based on the best available (natural *and* social) science provide at least an initial structure to guide efforts and investments.

Regarding the co-equal goals, the Delta ISB recommended "an expanded, sustained commitment to research on the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." Some of these research efforts will need to be tailored to the Delta, follow a case study approach, and consist of qualitative and/or quantitative primary data collection. For example, very place-based research on recreational river floaters in King County, Washington was conducted to inform actions that reduce risks from downed trees on a specific river (see text box). Other research efforts, however, could be more synthetic where research from other places is used to gain insights into, for example, recreational demand

and values[4] or agricultural production decisions. A comprehensive plan on how to develop a shared knowledge base about the cultural, recreational and agricultural values would consider how to balance these approaches while providing inputs into structured decision-making processes. It would also consider work ongoing, for example, in universities, non-governmental organizations, and private consultancies that is not directly under the purview of the Delta science enterprise but that is relevant to it.

Case Study: Balancing Riparian Management and River Recreation on the Cedar River, WA

In 2010, the King County River and Floodplain Management Section realized they needed to conduct 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 a social scientist to 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 social scientist 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 PFD's 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 way, the social science was integrated with ecological science, engineering, and planning to inform watershed management. 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.

Once a plan for identifying and collating relevant social science is in place, the use of structured decision making (SDM) can take the Delta science enterprise's identified social and ecological goals and assess the extent to which proposed management strategies are or should take the goals and data relevant to the goals into consideration, thereby providing a transparent process for integrating social and ecological science into

[4] For example, Johnston et al. (2006) provide a synthetic meta-analysis that can be used to predict the value of different types of recreational fishing to anglers, and can be used to provide targeted predictions for places such as the Delta and the species targeted there.

decision-making. According to the US FWS, structured decision-making (SDM)[5] 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."

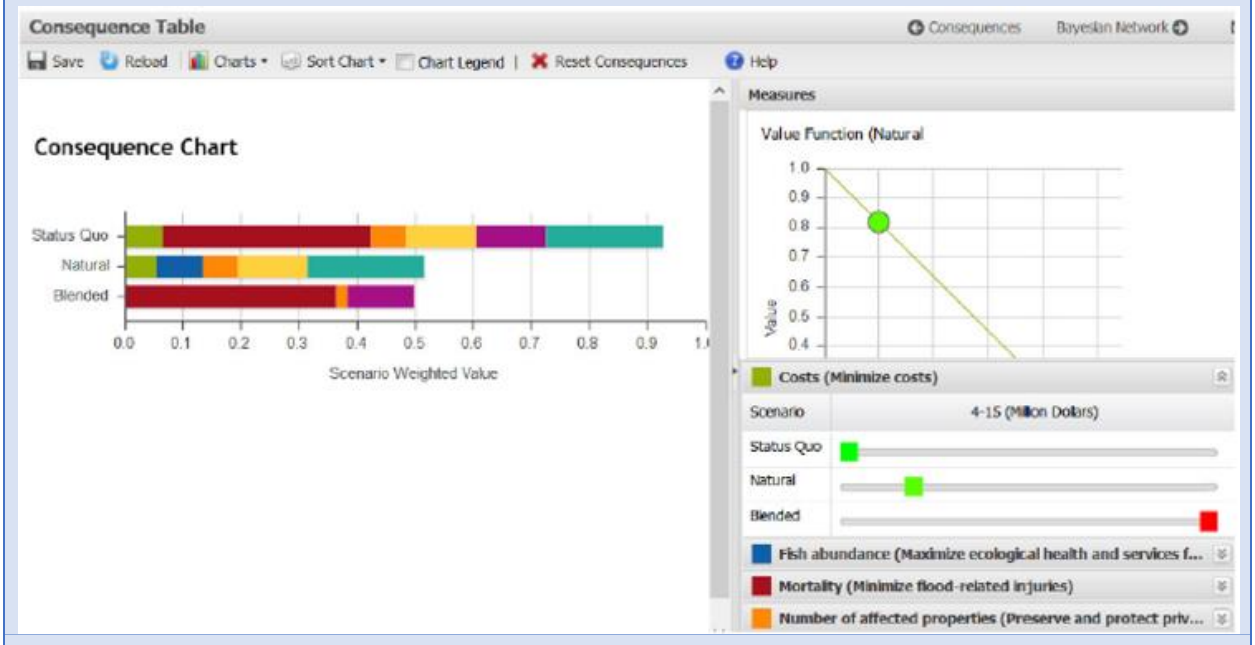
Developing decision support tools for a SDM process provides a method to prioritize social science research and develop a plan for its integration. In some cases, social science research could contribute to an element in the SDM, for example, identify the risk and uncertainty that a levee project would negatively and positively affect different stakeholders of interest. 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 USEPA, 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 watershed management in Puerto Rico and the Puget Sound

Basin (see Text Box). Social scientists in Puget Sound are additionally studying the factors that enable the integration of social and ecological science through this and other structured decision-making tools.

[5] US Fish and Wildlife Service Stuctured Decision Making Factsheet

Case Study: 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 U.S. Environmental Protection Agency 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 basis of SDM often relies on the concept of a coupled natural-human (CNH) model, where social science, natural science, and engineering research efforts are jointly and simultaneously determined. 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 4a and b), providing more details of the linkages between identified goals. In commercial fisheries management, for example, management strategy evaluation (MSE) is a CNH model utilized in structured decision-making process that illuminates the impacts of different management alternatives in a multi-objective setting. Figure 6 provides a simple graphical illustration of MSE[6]. The key point to highlight is that the MSE is an activity that identifies the coupled natural-human model of the ecosystem, including the governance of the system (including rules) and economic behavior of those being regulated.

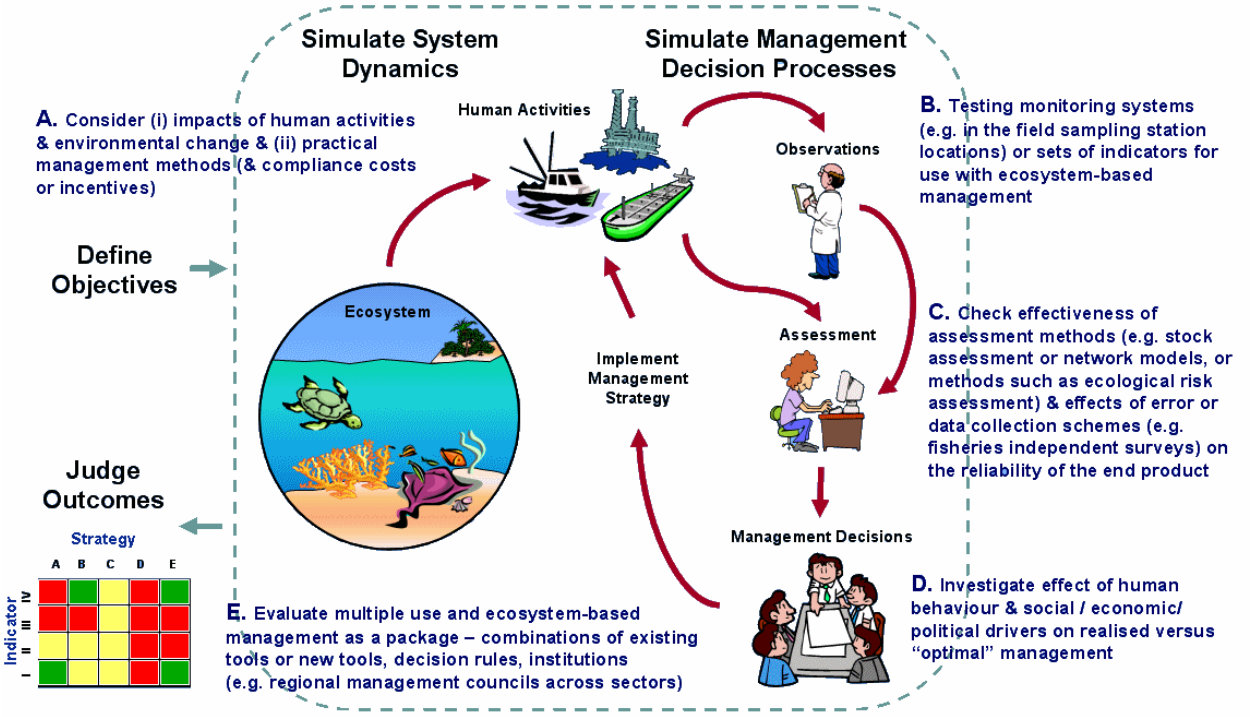


Figure 6. Management Strategy Evaluation for Fishery Management. Source Commonwealth Scientific and Industrial Research Organisation Marine and Atmospheric Research.

Another CNH modeling approach that could help integrate social science into Delta management is based on developing a causal chain between a management action 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. Figure 7 illustrates a causal chain for the management action of converting

[6] Commonwealth Scientific and Industrial Research Organisation Marine and Atmospheric Research

acres of a salt marsh in a particular location. 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 socioeconomic endpoints such as reduced property values, lost recreation opportunities, etc.

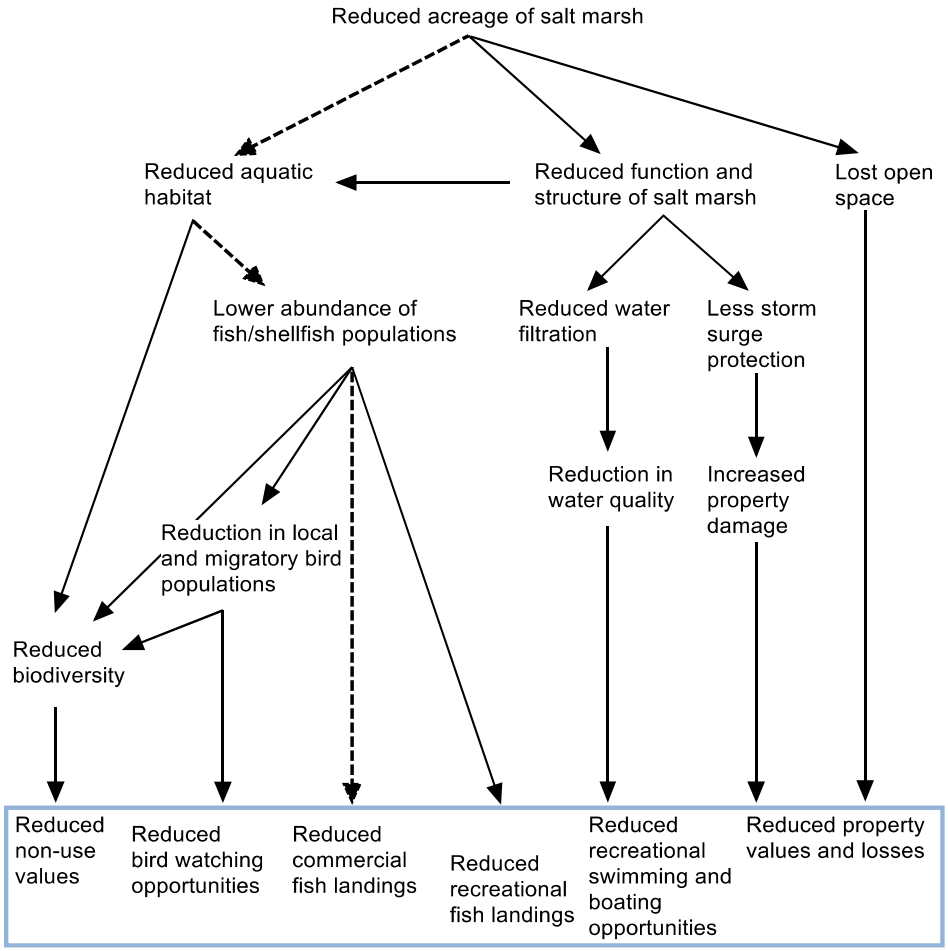


Figure 7. Example of linking biophysical, ecological, and economic endpoints . Source: Holland, D.S. et al 2010. Economic Analysis for Ecosystem Based Management. RFF Press. Page 64.

Finding 2: Lack of 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 heavily towards the natural (or biophysical) sciences, with insufficient social science capacity and investment. For the Delta science enterprise to serve the interests of Delta 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.

A trajectory of decision-making priorities, such as these, 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 two interconnected dimensions. The first dimension of social science capacity reflects (a) the social science expertise applied to Delta problems, and the resulting (b) amount of social science research produced in the Delta. This capacity can be "internal" to the Delta science enterprise (e.g., dedicated social science staff), or "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 science can come from targeted studies, or existing data including articles in academic journals, books, and reports or presentations published through government or non-government organizations.

The second dimension of social science capacity reflects the means by which social science is utilized to inform decision-making. This is influenced by the structures that are in place to (a) ensure that social science research (produced as in the paragraph above) is relevant, and (b) provide mechanisms through which the results of this work can inform decisions. The integration of social sciences into decision-making can be achieved through such mechanisms as program and policy evaluations, the provision of guidance for new approaches to more effectively achieve predetermined

goals, the identification of alternative goals to better meet social objectives or enhance social welfare, and the provision of improved descriptions and explanations of governance systems (which can then point to better ways to navigate and improve them). Developing social science capacity in the Delta that can be useful and utilized by the Delta science enterprise requires investment.

To promote integrated work that is truly relevant for Delta decision-making, efforts to increase social science capacity and investment must address both of these dimensions. To meet this goal, we recommend a three-component strategy:

Recommendation 4: Invest in a broad array of social science studies.

Nationally, funding for social science has increased at a lower 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. For example, despite an emphasis on social science in recent guidance documents, current funding programs are implemented in a way that 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 Dimension 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 this 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 2009 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.

To address this situation, a critical mass of social science expertise and perspective should be engaged from the earliest stages of request for proposal (RFP) development and as part of relevant science advisory panels that inform these RFPs. Social sciences should be integrated with other research priorities in an organic manner, with a broad input from social scientists used to craft the language in these documents. Representation on review panels should also 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. Decisions regarding internal research should be informed by a similar breadth and diversity of expertise across the natural and social sciences.

These efforts must recognize that social science is not homogenous. Whereas natural science needs are often described by science planning and strategy documents in terms of relatively narrow disciplines and areas of expertise (e.g., hydrodynamic modeling), social sciences, in contrast, are often described in course and generic terms (e.g., human dimensions). This generic nomenclature fails to reflect the different types of evaluations conducted by different social sciences, each providing unique insight for Delta management. It discourages engagement by social scientists who view their work as within a specific discipline (e.g, environmental economics), rather than as more general "social science" or "human dimensions." Social science consists of different disciplines, fields, and areas of studies, each with different scopes (types of questions asked), different research methodologies (types of data and means of analysis), different technical languages, different spatial and temporal time scales, and different ways that it can inform decision-making. We encourage referring to the section above, "What are the Social Sciences," to inform initial thinking and framing of social science funding in the Delta. Given the decision-making needs in the Delta are diverse and changing over time, investment in (and recognition of) different forms of social science becomes a necessity to

respond adequately to current needs and to provide a foundation for adapting to future needs.

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

Natural resource management requires tradeoffs—it is never the case that management enhances 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.

Recommendation 5: Invest in building an external network of social scientists.

Building capacity 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—many related to the recommendation 4 above. For example, engagement of a larger and more diverse set of social scientists as part of external advisory and review panels can provide an effective means to engage these individuals in decision-

making related to Delta challenges. In fact, during the 2019 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, as noted above.

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 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 elected group of regionally-distinguished scientists who meet throughout the year to provide scientific feedback to strategic restoration planning. Over ten years, the panel has evolved from having one economist and one public policy expert to now having two anthropologists, one economist, and one public policy expert. When there was only one social scientist on the panel, the scientific community recognized the need for more integration of social science and created what is now called the Social Science Advisory Committee which meets for two hours six times per year to provide social science-specific feedback to Partnership initiatives. This all-volunteer committee, facilitated by a Partnership staff member, allows for more targeted and specific social science input whereas the social science members of the Science Panel contribute to an interdisciplinary, high level conversation.

One of the key tasks of the Partnership is to develop and ensure the implementation of a science plan. They have 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 document (Breslow et al. 2019). The last two mechanisms for building the social science network revolve around funding external science directly and indirectly. Directly, the Partnership has targeted their existing state and

federal budgets to specific social scientific research questions, contracting social scientists from universities, companies, and NGOs to conduct policy-relevant research, such as three studies focused on different methods of exploring sense of place. 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 PIs. Over a million dollars have been secured for regionally-relevant research from the National Science Foundation, the Environmental Protection Agency, and other regional awarding bodies who have explicitly stated their funding decision was influenced by the clear relationships between the 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.

Recommendation 6: Invest in internal social science capacity.

The Delta science enterprise requires internal social science capacity to help implement and obtain the benefits of the first two investment strategies that focus on external social science capacity. It will be difficult to secure and maintain an external network without an internal staff member 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 who understands the policy context, the social science contributions, and the procedural pathways for integrating science in the planning process. Currently, 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 science) 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.

Internal social science capacity should facilitate the development of a certain set of skills that the Council can use to help solve problems and govern Delta complexities. These skills 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 Science.* 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 science, 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 Council 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 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 nature networks, writing RFPs and evaluating proposals, and assessing final reports and publications for the potential utility and future research needs.

There are many pathways to develop and acquire these five capacities and skills within the Council. 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 the lack of knowledge of social scientific literature, inexperience with the many 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 Delta Science Fellows. 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 agency 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. Delta Science 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 in Figure 4a), 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 permanent, dedicated and relatively high-level social science position in the Council, 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. And finally, 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 infeasible without "new" funding sources. The unstated assumption of this response 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 would far outweigh the costs due to a marginal decrease in natural science support. All investments in science capacity require tradeoffs and developing the conceptual model and structured decision-making process for the Delta will help to illuminate them. To make optimal investment decisions, the science enterprise must consider tradeoffs across support for all science. 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.

Finding 3: Social Science does not Explicitly Inform Adaptive Management Structures and Processes

The Delta Reform Act requires that the Delta Plan guide implementation of the co-equal 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.)

Importantly, it appears that this definition may not be widely agreed upon in the region. In contrast to the above definition that focuses on an iterative learning process, the 2013 Delta Science Plan defines adaptive management as "a strategy for proceeding with management decisions under uncertain conditions rather than delaying action until more information is available or adopting a rigid, prescriptive approach." In our perspective, the latter definition represents a precautionary approach rather than the learning process that is normally the foundation of Adaptive Management. Moreover, this last definition implies flexibility that does not exist within the prescriptive set of binding regulations within the Delta.

The first challenge for Delta managers, therefore, is to identify whether adaptive management itself is fully understood and embraced by the Delta science enterprise and the full suite of relevant stakeholders. Adaptive management can help managers deal with uncertainty if, but only if: 1) knowledge gaps make it difficult to evaluate the relative merits of possible management choices *ex ante*; 2) learning that occurs after initial management choices are made can reduce those knowledge gaps on a management-relevant time scale; and 3) initial management choices can be modified based on things that are learned, and managers have both opportunities and incentives to periodically revise those initial choices. If these three conditions are not met, adaptive management cannot substantively assist managers, but can be a convenient "deflection device," allowing or even encouraging them to put off confronting difficult trade-offs. In the latter case, decisions made under the guise of adaptive management may not in fact enable adaptive management at all—and may lead to worse management outcomes over time due to delays in facing challenging decisions.

Indeed, the institutional structures for Delta management were not designed to effectively facilitate the challenging task of adaptive management, which requires gathering information, learning, and implementing updated

knowledge. This can be attributed, in part, to the lack of social scientific information consulted in the design of these structures. Social science research suggests, for example, that some of the largest barriers to adaptive management are 1) short-term project cycles (e.g., 5-10years) that do not allow for sufficient iterations of the action-monitoring-learning cycle, 2) institutional cultures that work against genuinely participatory approaches to learning 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; Allen 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 management decisions? If not, could useful information be generated by additional monitoring, data collection, and study of the biophysical system? Social science enriches 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 framework is a tool to understand the potential returns from investing in conservation monitoring programs that contribute to adaptive management (Sanchirico et al 2014).

Social science 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 institutional 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 Everglades Case Study). Simply put, 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.

We recognize, however, that institutional change is neither easy nor costless. Hence, the Task Force suggests that the Council, Science Program, and other decision-makers evaluate explicitly whether changes that could improve adaptive management would be beneficial. This process will require capacity and investment in social science specific to adaptive management. That is, this finding extends recommendations under Finding 2 to explicitly highlight the need for social science that informs the underlying

management structures used within the Delta to enable and support adaptive management. A corollary insight from this section is that social science is not only required to inform *what* is done using existing management institutions and structures in the Delta, but also *how* those management institutions and structures are designed, and whether these structures enable adaptive management as envisioned by the Delta Reform Act.

Case Study: 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. Like many social phenomena, learning has been studied from different social science perspectives and even though thought the foci varies between these perspectives the insights overlap. 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 et al. 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. Moreover, underlying processes of learning are power differentials and political conflicts that both inhibit and inspire individuals to learn.

Recommendation 7: Apply social science methods to formally evaluate and define the role adaptive management can play in the Delta.

Adaptive management is a promising, perhaps unavoidable, approach to management of water and ecosystems in the Delta. The Delta Plan must, by law, include an adaptive management strategy. That does not mean, however, that every aspect of the Delta Plan is well suited to adaptive management, or that the management institutions are well suited to adaptive management. An explicit, formal analysis of the prospects for

learning and its expected value for management could help the Council make more effective use of adaptive management, while reassuring stakeholders that resources are being committed where they are most useful. This analysis should not be ad hoc, but should capitalize on rigorous methods from the social science literature developed to analyze adaptive management and decision-making under risk (LaRiviere et al. 2018). Such an analysis should be conducted or reviewed by the Independent Science Board and periodically reexamined.

In assessing the role of adaptive management, it is important to recognize that its implementation is not an end in itself. Adaptive management can improve management outcomes over time in some contexts. But it also carries costs, can complicate oversight of decision-making, and is subject to at least potential misuse for political ends. It requires a balance between short-term management objectives and long-term learning, between devoting resources to management and to monitoring, and between finality and continual negotiations (Doremus 2011).

A deliberate conversation can define adaptive management within to the Delta context, identify the appropriate local issues for adaptive management, and clarify the appropriate institutions to implement the various steps in the adaptive management process. The Puget Sound Partnership, for example, developed an Adaptive Management Framework to "improve the practice of science-based recovery in the Puget Sound Ecosystem." Within this document, the authors define stakeholder roles in the adaptive management process, a regional plan for developing and prioritizing solutions, a plan for tracking and monitoring results, and approaches to capturing and sharing learning with partners.

Recommendation 8: Continuously evaluate institutional and cultural barriers to learning.

Pro-active, formal analysis of the prospects for adaptive management can also highlight structural and other barriers to learning and adaptation. This includes the type of learning and adaptation associated with improved integration of social science information and capacity within the Delta science enterprise, as recommended above. Increased application of social sciences will have limited impact if institutional and cultural barriers preclude the effective learning and use of this information to improve management over time. One 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.

Case Study: 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. Scientists at UC Davis used social science 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.

Figure 8 represents the governance network for the Delta in 2019 (Delta Science Plan 2019 Figure C-1), demonstrating the inherent complexity for decision-making within this system. The Delta Science Program or Delta Plan Interagency Implementation Committee may provide a hub for learning among the variety of institutions involved in Delta management. The Council could look at whether either or both supports the interactions, networking, trust, and accountability needed to promote learning. Furthermore, the Council could investigate what are the best forums to promote learning across the entire Delta Science Enterprise over time.

As one example of improving infrastructure for learning, 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 science information that will become available through implementation of the other recommendations in this report.

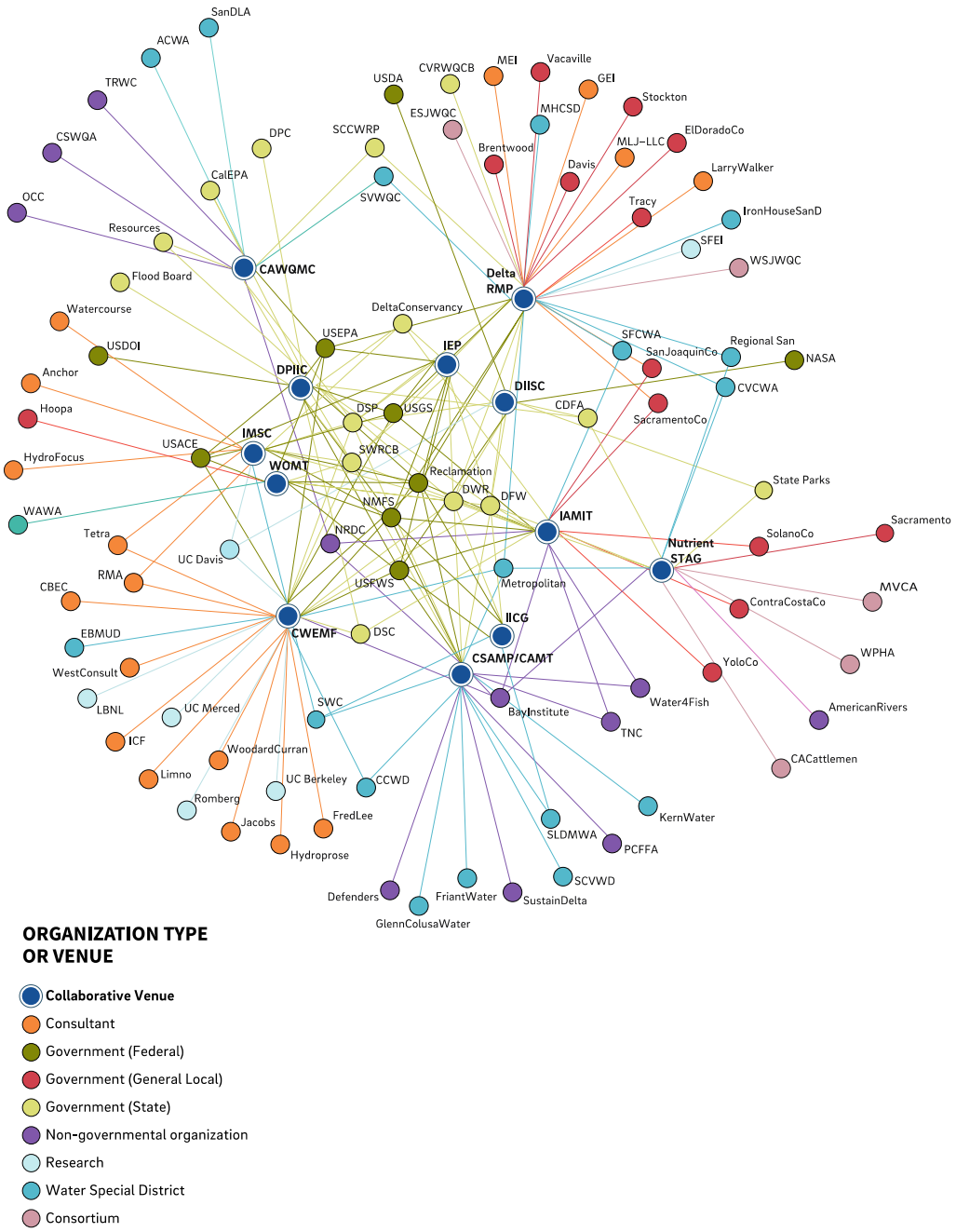


Figure 8. Delta science governance full network, showing the actors involved in implementing the Science Action Agenda.

Recommendation 9: Evaluate and reduce factors that cause unnecessary stickiness in management decisions.

Finally, social science is needed 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 temporal scale. Strip mining and the associated filling of streams is one example. Others may be theoretically reversible, but costs and reliance 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 "sticky" to some degree (that is, difficult to reverse) because they benefit entrenched interests or simply because they become accepted as the norm. Careful institutional design can reduce unnecessary stickiness 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 inform decision-making of exactly this type—when decisions are long-term or irreversible and in which new information becomes available over time.[7] Ad hoc decisions in such cases—or decisions based on natural science input alone—typically lead to sub-optimal outcomes. The input of social science, however, can allow for a more holistic assessment of short and long-term consequences. For example, in assessing the role of uncertainty on infrastructure investments for flood risk management, 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.

Adaptive management efforts should be focused where they are most useful, on the decisions most amenable to modification over time. Decisions which cannot or will not be subsequently modified are not suitable for an adaptive management approach. But many Delta management decisions are made in an iterative way, with periodic reconsideration. Those decisions should be suitable for adaptive management but may still be unnecessarily sticky due to cultural expectations or political entrenchment. Change is necessarily a

[7] As one example, real options analysis in environmental economics provides rigorous insight into how one should make irreversible environmental decisions (such as ecological restoration decisions) under uncertain conditions, when new information becomes available over time (Leroux and Whitten 2014).

public admission that an earlier decision was in some sense wrong, or at least imperfect. Rather than being regarded as proof of initial failure, with the potential to negatively affect careers and future staffing or budgeting decisions, discovery of the need for change must instead be regarded as a learning success.

Summary

To help achieve the coequal goals of providing more reliable water supply and protecting, restoring and enhancing the Delta ecosystem, the Delta Social Science 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 represents the systematic practice and body of knowledge dealing with describing, explaining, and predicting human. 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. A lack of an overarching vision and plan for implementing social science today and in the future.
2. Insufficient social science capacity and investment
3. Decision making structures that do not capitalize on social sciences, learning, and adaptive management.

From these findings, the Task Force specified nine 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) A stakeholder processes to develop 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) formally evaluating and defining the role of adaptive management in Delta restoration and 7) 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: 8) Designing decision-making processes to incorporate deliberate measures of learning; and 9) 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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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?
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?

[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)

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.
- 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.

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)

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.

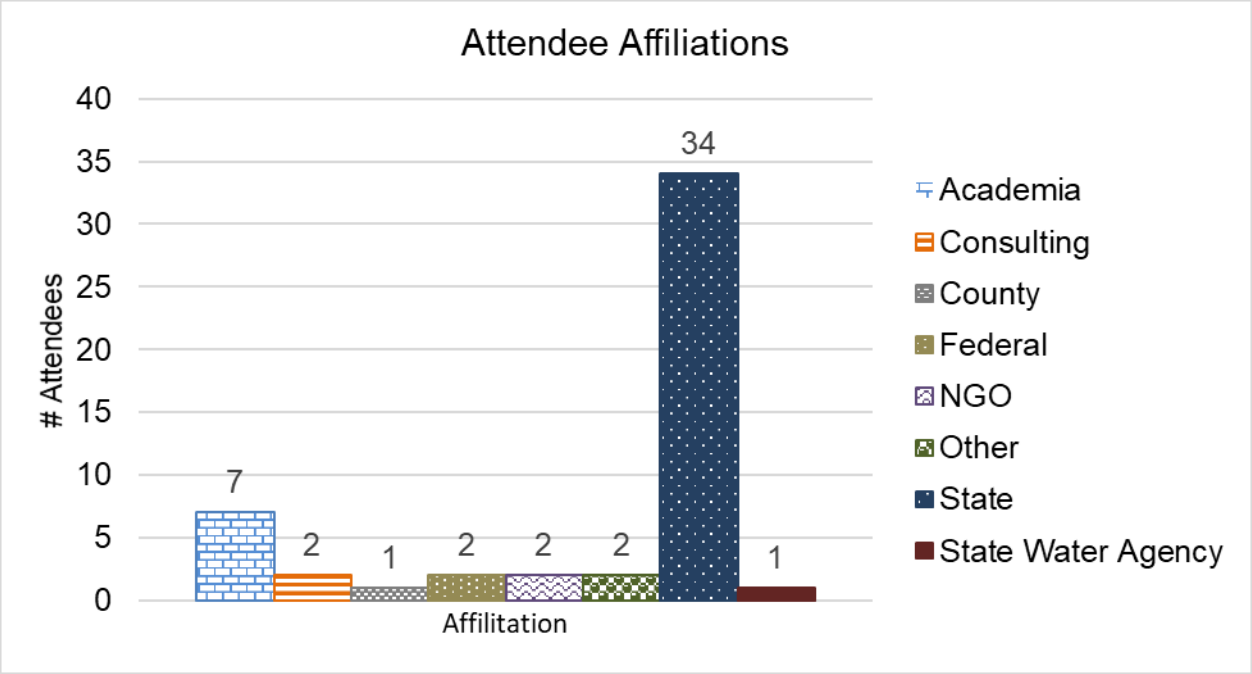

Figure 1. Number of kickoff meeting attendees grouped by generalized affiliation.

Appendix C: Human Dimensions Research in Delta Environments Workshop Summary

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.

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 Delta Science Program and the UC Davis Coastal and Marine Sciences Institute coordinate the Task Force, 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.

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.
- **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.

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