The Values of the Delta as an Evolving Place:
Diverse, Elusive, and Understudied

Delta Independent Science Board
April 5 2016 DRAFT

Primary Finding and Recommendation

There is a dearth of -- and a considerable need for – well informed, shared understanding of the values of the Sacramento San Joaquin Delta (Delta) as an evolving place. The Delta is at the center of California's water supply system, water conflicts, and water governance. The California Legislature has declared the Delta to be a place of special significance deserving of State-supported regional planning and governance. Given the Delta's centrality and unique values, we encourage more research, better communication, and greater opportunities for building shared understanding of the values of the Delta as an evolving place.

The Delta is also a powerful example of the difficulties of understanding and managing an environment that has been and continues to be transformed by human activities while environmental change, in turn, affects what people are doing. The Delta Independent Science Board (hereafter, "we" or Delta ISB) recommend the initiation of coupled-natural-social system research to capture the synergy between the knowledge of environmental and social scientists.

Ongoing academic research programs and a stream of new PhDs provide scientific support to other fields we have reviewed. In contrast, we are struck by how few scholars are doing research and preparing the next generation of scholars to contribute to and sustain a broad understanding of Delta values. A new stream of scholars is also essential for initiating and sustaining long-term research on the Delta as a coupled natural-social system. Such an academic foundation is important to building the broader scientific structure supporting a more solid understanding of the unique values of the Delta as an evolving place. We encourage California universities to allocate faculty positions and to encourage existing scholars to undertake work in this area. We also encourage funding programs to help support research related to Delta values and on the interplay of social and natural systems in the Delta.

Purpose of this Review

This review responds to two mandates in the Delta Reform Act of 2009. The first requires that the coequal goals for water and habitat *be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place* (CA Water Code §85054). The second directs the Delta ISB to *provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews* (CA Water Code §85280).

It may at first appear that a review of the scholarly work on Delta values is outside the scope of the Delta ISB. Science and values are typically juxtaposed. But we maintain that successful policy and management decision-making requires consideration of human history, culture, and values. We list the following five reasons for this review:

1) The social sciences, including economics through which values can be expressed in monetary terms, are a part of science.

2) Research in the natural sciences may be neglecting environmental aspects of the Delta's terrestrial, hydrological, and biological environment that are particularly important to the unique values of the Delta as an evolving place.

3) Familiarity with scholars in the social sciences and humanities working on the Delta will help the Delta ISB, Delta Science Program, and scholarly community promote coupled human-natural systems research in the Delta.

4) Delta scientists do research to support informed, rational decision-making for policy and management and their implementation. To that end, research effort should be directed to those areas where the lack of information and uncertainties are greatest.

5) Policy, management, and implementation decisions based on the natural sciences alone can fall short of achieving their goals by failing to include input from the social sciences.

Broad Questions Motivating this Review

The Delta ISB is concerned with whether the science and, more broadly, the scholarship, to support protecting and enhancing the diverse values of the Delta as an evolving place is adequate. Are strong research programs in place? Are the critical questions being asked? Is the understanding of the Delta's diverse values as an evolving place sufficiently accessible to be incorporated in Delta policy and adaptive-management decisions? Are there a sufficient number of new Delta scholars in the social sciences and humanities being produced to sustain research in this area? What might be done to encourage and further improve the quality of scholarly activity in this area?

Extent of the Review Effort

Preliminary inquiries indicated that thee was a paucity of research for us to assess on the values of the Delta as an evolving place. For this reason, our effort has been modest and has taken place largely informally over the past 16 months. Members of the Delta ISB have talked with key staff at the Delta Protection Commission (DPC) and the Delta Conservancy. Prof. Robert Benedetti, professor emeritus at the University of Pacific and co-leader of the Delta Narratives Project was interviewed, and Delta ISB members attended presentations of the Delta Narratives project and participated in its final workshop. Members have listened to and spoken with Delta residents at meetings on the Delta Levees Investment Strategy and on other encounters. We also spoke with Dr. Brett Milligan, assistant professor of landscape architecture in the Department of Human Ecology at UC Davis, who is currently doing interdisciplinary research on the Delta. On the evening of October 14, 2015 the Delta ISB as a whole held a meeting in Knightsen, CA, and heard presentations by Erik Vink and Blake Roberts of the DPC and Prof. Robert Benedetti on the Delta Narratives project. We invited Delta residents to join the Delta ISB for this meeting and express their

thoughts on the presentations and half a dozen enthusiastically did so. A member of the Delta ISB also attended the second meeting of the DPC's "Delta as Place Interagency Working Group".

Major Challenges of Understanding the Values of the Delta as an Evolving Place

Perhaps the most frustrating challenge is to simply grasp what the different groups within the California Legislature thought they had agreed to when they settled on the phrase *be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place*. Keeping the Delta's changing history in the forefront of our consciousness for this review is essential. A quick review of the Delta's changes will help. Philip Garone (2015)[1], writing for the Delta Narratives Project elaborated later, provides an excellent history of the Delta which we have summarized. Garone's dynamic description of the Delta's geological arrival illustrates the fluidity of his larger narrative:

> Geologically, the Delta is a relatively recent creation. Warming temperatures at the beginning of the Holocene Epoch, approximately 11,700 years ago, caused glaciers to melt and sea levels to rise, creating over thousands of years the historical Delta. By 10,000 B.P. (before present) the Pacific Ocean advanced eastward from the edge of the Farallon Islands through the Golden Gate; it soon flooded the valleys that became San Francisco Bay, and by 6,000 B.P. exerted tidal influence through the Delta. The advancing ocean backed the Sacramento and San Joaquin rivers out of their channels, creating a labyrinth of hundreds of miles of sloughs and dozens of low-lying islands. By 4,000 B.P. the Delta resembled its early nineteenth-century visage. (Page 2)

The physical processes of more rapid, yet highly uncertain, rate of sea level rise will surely have significant effects on the Delta in the foreseeable future.

Biological processes through history were also at work. Vegetation in the watersheds above reduced the peaks of floods, affected water penetration into the soil, and moderated the release of spring water that sustained low flows. In the Delta itself, vegetation slowed the water and caught sediment. It is important to realize that biological and geological processes are still interacting. Biological processes will continue to be especially important with species arriving, leaving, or going extinct with climate change.

People, have had some impact on the Delta for thousands of years. Native Americans arrived at least 6000 years ago and the population of those living in or on the immediate periphery of the Delta and dependent on it for food reached at least 10,000 people. They found an abundance of fish and water life, beaver, deer, elk, and muskrat on the islands and adjacent higher ground, and reeds for making baskets, boats, and shelter. Western diseases appear to have decimated their populations before western people made contact. The Spanish, unfortunately, were more interested in conquest than documenting Indigenous cultures. Thus little is known about their belief systems. Judging from what we know of other Native Americans, however, Delta Indians transformed the environment through hunting, gathering and tending the environment, likely with deep respect. Today, Native Americans beyond the Delta continue to harvest resources with respect and with rituals of

[1] http://www.delta.ca.gov/res/docs/DelHAI/Full_Paper_Garone.pdf

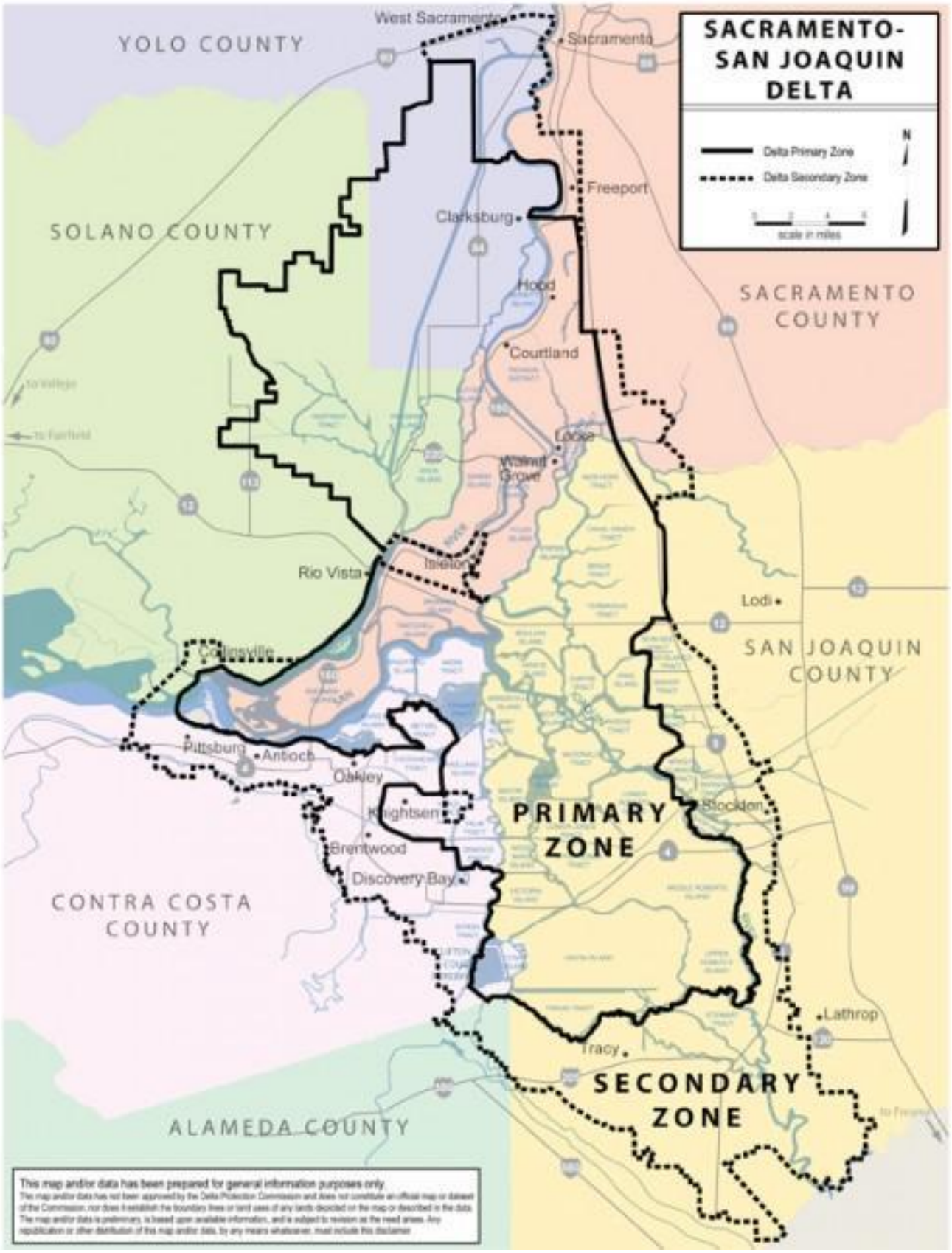
reciprocity—giving thanks and "giving back" in the form of land care, such as planting and weeding sedge beds to grow basket-making materials. Reciprocity, not simply exchange of goods, was likely the basis of Delta Natives relations with each other and the land. Robin Wall Kimmerer argues that it is easier to restore vegetation than to restore the culture of reciprocity.[2] While the Delta of the past cannot be restored, ultimately we need a culture that supports environmental sustainability.

The Spanish made contact in 1776 and through visits over subsequent decades decided the Delta was not a good location for a fort or mission. Westerners began to have a significant impact on the Delta when miners began to pass through in considerable numbers on their way to the goldfields in the central Sierra Nevada foothills beginning in 1850. A shortage of food among the miners led to the beginnings of western agriculture in the Delta, the enhancement of natural levees, and eventually the more serious construction of levees that have been continually improved since. Hydraulic mining in the foothills in the 1880s, following panning and sluicing for gold, set 3.6 million cubic yards of rock, gravel, and sand into motion, most of it carried away to the sea by rivers over the next century. With the initial flush of material, riverbeds rose, towns flooded, levees had to be built higher, and navigation channels had to be dredged, but now there was good material for levee enhancement. The biological destruction through this process of sediment transport was considerable and the mercury used in the mining process still contaminates the Delta.

Agriculture boomed once the railroads connected California to the populations on the East Coast. The Delta, with its easy access to water, prospered early through the export of pear, asparagus, and other crops. Chinese laborers brought to build the western railroads were employed to enhance the levees and some stayed for generations largely working as farm laborers. Though the California legislature in 1912 prohibited East Asians from owning land, the Chinese and Japanese, along with Italians and Portuguese, made important contributions to Delta history and its landscape with important remnants such as the town of Locke remaining. Please read Philip Garone for a more elaborate history of the Delta as an evolving place.

In 1988, the Legislature divided the Delta into primary and secondary zones. Urban and suburban expansion was limited to the secondary zone to protect the historic and agricultural values in the heart of the Delta. The primary zone consists of approximately 500,000 acres of land, levees, and waterways that are considered unique for their agricultural, cultural, recreational, and wildlife values. The primary zone contains many of the legacy communities: Locke, Walnut Grove, Ryde, Courtland, Hood, and Clarksburg in the northern part of the Delta as well as Knightsen in the central Delta. The primary zone is given more importance in this review (see map on the following page) though it is important to keep in mind that some residents of the secondary zone work, recreate, or have a family history in the primary zone. In 1992, the Legislature created the DPC and gave it, among other responsibilities, the authority to design and implement a land use plan for the primary zone. The 2009 Delta Reform Act mandates that the DPC undertake an Economic Sustainability Plan for the Delta and designates the DPC as the lead agency for informing the Delta Stewardship Council (the Council)with respect to the values of the Delta as an evolving place.

[2] Robin Wall Kimmerer is a plant ecologist, Professor and Director, Center for Native Peoples and the Environment, College of Environmental Science and Forestry at SUNY Syracuse.


SACRAMENTO-SAN JOAQUIN DELTA
Delta Primary Zone
Delta Secondary Zone
N
scale in miles
YOLO COUNTY
SOLANO COUNTY
SACRAMENTO COUNTY
SAN JOAQUIN COUNTY
CONTRA COSTA COUNTY
ALAMEDA COUNTY
West Sacramento
Sacramento
Freeport
Clarksburg
Hood
Courtland
Locke
Walnut Grove
Rio Vista
Isleton
Lodi
Collinsville
Pittsburg
Antioch
Oakley
Knightsen
Brentwood
Discovery Bay
Stockton
Lathrop
Tracy
PRIMARY ZONE
SECONDARY ZONE
This map and/or data has been prepared for general information purposes only.

Consider the following more specific major challenges to understanding the values of the Delta as an evolving place:

1) In the primary zone, the values of the Delta are manifest in the economic value of the agricultural land. The primary zone's modest commercial areas; significant recreation associated with fishing and visitation to the Delta's legacy towns, grand homes, and other tourist sites; natural gas production; and other economic activities including levee maintenance provide diversity to the Delta economy. A viable economy can contribute to the *protection and enhancement of the unique cultural, recreational, natural resources, and agricultural values of the Delta as an evolving place.* While significant strengthening of the current economy would help sustain the Delta's unique values, the economy could grow in new ways that might result in a loss of the primary zone's unique qualities. Stimulating the economy in a manner that protects and enhances the Delta's unique, yet evolving, values is a challenge.

2) The second major challenge is to understand the non-economic values. These values are held by current residents, experienced by recreationists, enjoyed by visitors to legacy towns, and are embedded in historic literature and films tied to the Delta. These values are also evolving, a process that is only "good" when the evolutionary processes are moving the Delta in "positive" directions. Of course, determining what is positive to who is also a value judgment. To some extent, some of the non-monetary values are latent, awaiting discovery and communication so that they can be more widely understood and appreciated. Thus the second challenge of protecting and enhancing Delta values is that the non-economic values are vague, diffuse, and hence difficult to grasp. They need to be more formally identified.

3) A major challenge to understanding Delta values is that the Delta does not have a community center, a single place where residents interact, share, and amplify their own sense of the Delta's values. The complexities of the Delta's waterways, the historical settlement pattern, the division of the Delta among five counties, and the shortage of roads connecting islands deprives Delta residents of a social, economic, and cultural center. Nor has there been a political center connecting the various parts of the Delta. The California Department of Transportation has 3 districts in the Delta. Nearly each one of the 57 islands and tracts that make up the Delta has its separate reclamation district. To be sure, Delta residents respond together to what they see as shared externally driven threats. However, they do not have a center in which they interact socially, economically, and political in their daily lives, a place where shared values thrive and are publicly expressed as well as a place where value conflicts might be at least partially resolved in public meetings. This would help Delta residents communicate to the State and federal agencies in unison.

South Delta residents are generally connected to Stockton, west Delta residents interact with multiple communities of eastern Contra Costa County, and north Delta residents head to Sacramento and Elk Grove for supplies, food, and entertainment. In each case, Delta residents are a fraction of the larger metropolitan area's civic life. There is no central Delta-wide school system in which children and their parents interact, no central library to retain books pertinent to the Delta, and no central museum for Delta artifacts. Clearly, values are, or at least can be, better developed, retained, and publicly expressed through a central community, but the Delta, from a social and cultural perspective, is more like a "donut" with an economic, cultural, and political hole in the middle.

The "donut problem" also makes it difficult for federal and state agencies to act with projects that enhance Delta values. The 50+ reclamation districts have many interests in common but do not speak with one voice. The state agricultural, water, transportation, recreation, and fish and wildlife agencies have had no central Delta authority with whom to negotiate and implement their programs. After state agencies make special efforts to get a project underway, there is little to no local capability for the projects to become self-sustaining. Delta communities in the primary zone tend to be too small and seemingly independent to sustain the management capability needed to keep a stream of subsequent improvement projects flowing.

4) Beyond the Delta, the expression of Delta values is even more dispersed and difficult to access and assess. Indeed, a central problem is that only a small fraction of people in California is even aware of the Delta and that it plays a central role in California's water supply system let alone aware of *the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place*. (do we need to document this?)

5) As in other agricultural regions around the globe, there has been a steady departure of farm owners and long-term residents for decades as farm sizes have increased and young adults who have grown up in the Delta seek better opportunities outside farming and beyond the Delta. (Do we need to document and/or modify this?) This process has only been slightly offset by specialty organic, field-to-table, pick-your-own, and boutique farming. Recently, San Joaquin Valley agricultural interests and the Metropolitan Water District of Southern California have purchased Delta farms. These transitions in who resides in the Delta, what sort of work is being undertaken, and who owns the Delta's island raise difficult challenges with respect to both building community and discussing whose values matter in the Delta.

While Delta values are diverse and elusive, there are clearly Delta values that are shared by its dispersed residents. People from beyond the Delta who are introduced to the Delta become fascinated by its history, unusual landscape, recreation options, and role in California's water system. For these reasons among others, the state legislature established the DPC. The DPC exists because the Delta is perceived as being special and because the residents needed an institution through which they could develop and express their values in order to have some control over their collective destiny. The Legislature reaffirmed this role for the DPC in the provisions of the text of the 2009 Delta Reform Act.

Key Actors and Dormant Potential

To help understand the relative deficit of scholars working on protecting and enhancing *the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place,* consider the array of actors working in support of the Delta's natural environment. There are numerous natural scientists with PhDs in our state and federal agencies, and these agencies have funds to contract many more natural scientists to help as needed. There is a strong core of environmental scientists in our universities who are addressing the Delta. There are several NGOs doing excellent Bay and Delta environmental science. And there are many individual environmental consultants and small firms specializing in the Delta's ecology and its restoration. While the DPC has had a small amount of funds to contract academic talent to study Delta values, this is insignificant

compared to the access to scientifically trained talent for the agencies and interest groups working on water reliability or ecosystem restoration.

Universities

Few social scientists and scholars in the humanities have undertaken research on the Delta to back up those defending the Delta's values -- residents, agencies, and NGOs – with verified, retrievable information. One way to see this is to consider the production of PhDs. Appendix A provides a summary of theses (mostly PhD dissertations?) completed since 1990 on the Delta categorized by the chapter of the Delta Plan they support. There is a relatively small number of graduate theses supporting Chapter 5 (on the values of the Delta as an evolving place) and these dissertations are generally only tangentially related to the current issues of Delta values and their potential complementarities and conflicts with water policy and management and with habitat restoration.

We should acknowledge that the much bigger and better populated Mississippi Delta, with the major attraction of New Orleans and that has exported the culture of the blues, also only has a sparse literature on its value as a place. We did a search for "Mississippi Delta as place" and found far more academic work undertaken in the natural sciences and, at least within the first 100 citations to that search, only two with a socio-cultural orientation, but for neither of these does "value" appear significant.[3]

From the perspective of this review, the perfect academic research program would not only address the broad challenge of how water reliability and habitat restoration might *be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place* but also what those values are. Natalie Smith bites off a small but significant piece of this broad topic in her paper for her masters project at The Nicholas School of the Environment at Duke University completed in 2013.[4] She documents that there is a significant qualitative literature on both place branding and how residents value place and change in those place's environments. However, at least judging from her review of the literature, there is a paucity of quantitative studies of place as well as few studies that also look at a place from a larger geographical perspective.

There are many reasons for the discrepancy between the academic support given to the natural and the social sciences - reasons (now outdated) that are deeply embedded in several centuries of academic history. There are two good reasons, however, that this historic discrepancy should not apply to investment in the social sciences and humanities tied to the Delta. First, the Delta is an obvious case of humanity in the Anthropocene. Human influence on the Delta's natural system has been strong for at least a century and a half. The Delta provides an excellent case study of the difficulties of understanding and managing highly transformed environments. Second, the Delta is the first region in

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[3] Cobb, James C. 1992. *The Most Southern Place on Earth: the Mississippi Delta and the Roots of Regional Identity*. Oxford University Press. Woods, Clyde. 1998. *Development Arrested: The Blues and Plantation Power in the Mississippi Delta*. Verso.

[4] *Sense of Place Impacts for Rural Residents in the Sacramento-San Joaquin River Delta* (2013) http://dukespace.lib.duke.edu/dspace/handle/10161/6910

California that the Legislature has declared a place of special significance deserving State-supported regional governance because of its unique values. Strong support for academic research in the social sciences and humanities on the values of the Delta as an evolving place is thus appropriate.

Delta Protection Commission

The DPC is the key actor in promoting research on the understanding of Delta values and for providing mechanisms for sharing values and for protecting and enhancing them through planning. The Delta Protection Act of 1992 created the DPC and declared that *the Delta is a natural resource of statewide, national, and international significance, containing irreplaceable resources, and that it is the policy of the State to recognize, preserve, and protect those resources of the Delta for the use and enjoyment of current and future generations, in a manner that protects and enhances the unique values of the Delta as an evolving place (PRC sections 29701-2). The Commission is a forum for Delta residents to engage in decisions regarding actions to recognize and enhance the unique cultural, recreational, and agricultural resources of the Delta [PRC section 29703.5(a)].* The Delta Reform Act of 2009 reaffirms the role of the DPC and further directs and provides funding for the DPC to prepare an Economic Sustainability Plan every five years. It is important to note, however, that the DPC cannot independently undertake any action that is within the jurisdiction of any other State agency.

The DPC's legislative mandate gives it the opportunity to play a key role in promoting research and providing a forum for coordinating local initiatives tied to the values of the Delta as an evolving place. Commission meetings, held six to eight times per year, provide critical opportunities for residents to participate in the review of land-use plans, to discuss DPC projects and the findings of reports, to be briefed on the activities of diverse agencies involved in the Delta, etc. The DPC meets in different locations in the Delta in order to give residents in each area easier access through the year. The DPC is the lead agency for informing the Council on matters concerning the protection and enhancement of Delta values. The Council has the quasi-judicial authority to enforce the DPC's recommendations to the extent that the Council incorporates them in the Delta Plan.

The following commentary briefly summarizes key activities of the DPC.

1) The DPC's most elaborate single activity has been the preparation of the Delta Economic Sustainability Plan. Prepared by a group of consultants, a draft for review was issued in early October 2011 and the report was completed in January 2012.[5] The Delta Science Program organized an independent panel to review the draft of the Economic Sustainability Plan that was released in December 2011.[6] The timing meant that few of the independent panel's comments affected the final draft. A new Economic Sustainability Plan is getting underway. Appendix B contains the statutory requirements for the plan.

[5] http://www.delta.ca.gov/res/docs/ESP/ESP_P2_FINAL.pdf

[6] http://www.deltacouncil.ca.gov/sites/default/files/documents/files/Review%20of%20Sustainability%20Plan%20Final_0.pdf

2) The DPC completed a feasibility study in 2012 that recommends the formation of a National Heritage Area consisting of all of the primary, most of the secondary Delta and a few additional adjacent areas (see map in Appendix C).[7] Being a National Heritage Area would facilitate national and state recognition of the Delta as an area of special historical value. The study's rationale for the designation centers on these points:

1. *At the heart of California lies America's inland delta.*
2. *Conversion of the Delta from marshland to farmland was one of the largest reclamation projects in the United States.*
3. *Multi-cultural contributions and experiences have shaped the Delta's rural landscape.*
4. *The Delta, California's cornucopia, is amongst the most fertile agricultural regions in the world.*
5. *The Delta lies at the center of California's water resource challenges.*

The Council's Delta Plan supports the creation of a National Heritage Area. In March 2015, California Senators Barbara Boxer and Diane Feinstein and Representative John Garamendi introduced bills for the third time to create the Delta National Heritage Area, seeking up to $1 million annually in Federal funding to obtain matching grant funds from the state and local governments to develop and implement a management plan over the next 10 years with the DPC being the lead agency. We recommend that some of this funding go to support research to further document the Delta's values.

3) To help demonstrate that the Delta is historically special, the DPC funded the Delta Narratives Project. While many modest efforts have been made to describe aspects of the Delta, there has not been a comprehensive effort to tell the Delta's story since John Thompson's dissertation was completed at Stanford University in 1957.[8] The Delta's story deserves recomposing, synthesizing, and telling again through current scientific and popular perspectives.

From 2014 through 2015 the DPC funded a Delta Narratives Project with Prof Steve Boilard of California State University (CSU) Sacramento serving as the Principal Investigator. The project is co-directed by Prof. Robert Benedetti of the University of the Pacific and former DPC Executive Director Margit Aramburu who was also the former Director of the Natural Resources Institute at the University of the Pacific. A team of academic scholars, museum archivists, and librarians came together in support of this project. Scholars from CSU Sacramento and CSU Stanislaus, University of the Pacific, and University of California at Merced have found historical material not easily accessible to the public and prepared Delta "narratives", histories that highlight key information pertinent to the Delta today. Local historical societies, public and private museums, and libraries are

[7] http://www.delta.ca.gov/FeasibilityStudyforaSacramento-SanJoaquinDeltaNHA.htm

[8] Thompson, John. 1957. A Settlement Geography of the Sacramento – San Joaquin Delta, California. PhD dissertation, Geography, Stanford University, available at: https://watershed.ucdavis.edu/pdf/thompson-dissertation%20small.pdf

helping to preserve valuable pieces of the Delta story. The Delta Narratives project has begun to create a way for these pieces to be interrelated, showcasing the Delta region for what the project believes it really is - one of the most historically important regions in the United States.[9] The participants have completed the first phase of the study and the final report lays out an ambitious plan to organize cultural and historical exhibits in the Delta.[10] Financial support for implementing these recommendations, however, has yet to be secured.

4) The DPC has numerous other projects and ongoing activities that engage Delta residents in thinking about and discussing the values of the Delta as an evolving place including:

a) The DPC is charged with developing a land-use and resource management plan for the primary Delta.[11] In conjunction with the plan, the DPC reviews and makes recommendations on proposed developments and land-use changes with respect to how well they fit the plan. The DPC has also produced a "Delta Vision 2030" report.[12] Clearly, these documents also complement the DPC's efforts to have the Delta declared a NHA.
b) To help give the Delta an identity, something that would serve as a logo for the NHA and generally heighten visitors' awareness that they are in a special place, the DPC has partnered with the Delta Conservancy in a "Delta Branding and Marketing Project".
c) The DPC is working on a Delta trail, leadership training and various additional projects involving Delta residents.
d) In addition, the DPC is a forum for discussing levee safety and finance, for advocating action on the control of aquatic vegetation, for discussing and commenting on the BDCP/Water Fix, and for other issues facing Delta residents.
e) The DPC recently initiated a Delta as Place Interagency Working Group. Its charge has yet to be approved by it participants, so this effort is just getting underway. The draft proposes to have members from 6 federal agencies, 13 state agencies, and 8 local agencies with membership open "as needed". The draft of the charge states its purpose and scope:

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[9] Adapted/updated from the websites:
http://www.delta.ca.gov/res/docs/DelHAI/Delta_Narratives_Project_Description.pdf
and http://www.delta.ca.gov/Delta_Narratives.htm

[10] The Delta Narratives project, in the process of identifying and organizing key actors involved in the protection and enhancement of Delta values, assembled an inventory of all of the libraries and museums with material on the Delta that is available at:
http://www.delta.ca.gov/res/docs/DelHAI/Appendix_C_Directory.pdf The project also has brought together an exceptional bibliography available at:
http://www.delta.ca.gov/res/docs/DelHAI/Appendix_D_Bibliography.pdf

[11] http://www.delta.ca.gov/LURMP.htm

[12] http://www.delta.ca.gov/res/docs/Strategic_Plan/Vision_2030_FINALweb.pdf

The purpose of the Delta as Place Interagency Working Group (DAPIWG) is to facilitate implementation of "Delta as Place" (DAP) policies and recommendations identified in the Delta Plan and otherwise advance recognition and enhancement of Delta values. …

The DPC is engaged in a wide variety of activities with Delta residents and speaking with and for Delta residents in various fora. Whether these activities are primarily planning efforts or participating in political processes, the DPC is the key public agency engaging with Delta values. There could, however, be considerably more research support backing their efforts to understand, articulate, protect and enhance the Delta's values. The Delta Narratives Project is strong evidence that professors of history, political science, geography and literature as well as archivists in libraries and museums have a strong interest in providing such supporting knowledge.

The Sacramento-San Joaquin Delta Conservancy

The Delta Reform Act of 2009 also created the Sacramento-San Joaquin Delta Conservancy (commonly known as the Delta Conservancy, or simply Conservancy in this text). The Conservancy was established in the California Natural Resources Agency in 2010. The legislation states:

"The Sacramento-San Joaquin Delta Conservancy can support efforts that advance both environmental protection and the economic well-being of Delta residents in a complementary manner, including all of the following (32301h):

1. Protect and enhance habitat and habitat restoration.
2. Protect and preserve Delta agriculture and working landscapes.
3. Provide increased opportunities for tourism and recreation.
4. Promote Delta legacy communities and economic vitality in the Delta in coordination with the Delta Protection Commission.
5. Increase the resilience of the Delta to the effects of natural disasters such as floods and earthquakes, in coordination with the Delta Protection Commission.
6. Protect and improve water quality.
7. Assist the Delta regional economy through the operation of the conservancy's program.
8. Identify priority projects and initiatives for which funding is needed.
9. Protect, conserve, and restore the region's physical, agricultural, cultural, historical, and living resources.
10. Assist local entities in the implementation of their habitat conservation plans (HCPs) and natural community conservation plans (NCCPs).
11. Facilitate take protection and safe harbor agreements under the federal Endangered Species Act of 1973 (16 U.S.C. Sec. 1531 et seq.) and the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code) for adjacent landowners and local public agencies.
12. Promote environmental education."

The Conservancy has the opportunity to help protect and restore the natural environment of the Delta and Suisun Marsh while helping residents. Yet many of the things in the list above are in the mandates of already established agencies, most of which have well developed expertise to work from their perspective on these areas. For this reason, the Conservancy mostly works with these other agencies, helping with the funding and providing a Delta-centric voice to planning and implementation that helps assure a balance between environmental protection and enhancement and community development and resilience. In this manner, the Conservancy is in the business of restoring and protecting the values of the Delta as an evolving place.

The Conservancy is seeking to protect and enhance agricultural values by strengthening local food markets and supporting the creation of a Delta Farm Ombudsman to help farmers navigate the various State and federal agency hurdles that are disproportionately burdensome to farmers with small acreages.

The Conservancy strives to provide a coordinating framework or forum for Delta habitat restoration activities being undertaken rather independently by multiple agencies. Coordination could help assure that ecological goals are met, and met while protecting Delta values and local interests. It appears to be within the mandate of the Delta Conservancy to provide such a forum, but the multiple agencies have not yet shown much enthusiasm.

California Department of Parks and Recreation

This section needs elaboration. The 2011 Delta Recreation Proposal elaborates the current state of recreation to the extent that available data allow and highlights some identifies key areas in which improvements might be made. The Delta ISB is concerned that in this area as well, the data and research on which to build a plan are weak.[13]

The Delta Stewardship Council and The Delta Plan

The Delta Reform Act of 2009 established the Council and directed it to draft a Delta Plan to assure water reliability and ecological restoration in the context of the Delta as an evolving place. The Council reviews the DPC's Economic Sustainability Plan to assure its consistency with the Delta Plan. *The council shall take into consideration the recommendations of the commission, including the recommendations included in the economic sustainability plan. If the council, in its discretion, determines that a recommendation of the commission is feasible and consistent with the objectives of the Delta Plan and the purposes of this division, the council shall adopt the recommendation* (California Public Resources Code §29773).

Chapter 5 of the Delta Plan discusses Delta values and covers how the Council hopes to participate in the protection and enhancement of Delta values. The chapter also builds on and expands on the material brought together in Delta Vision (2008). The new performance measures for the revised Delta Plan can be found in Appendix D.

The Council is also required by the Delta Reform Act of 2009 to prepare a Delta Levees Investment Strategy . It is currently in the process of preparing the strategy and has

[13] The Delta ISB notes that the 2011 Proposal apparently did not draw on any academic research directly though the other reports it makes reference to may have drawn on research.

found that Delta values are proving a significant, yet elusive, factor in determining investment priorities. The Delta Science Program arranged for an independent panel of scientists to review the Delta Levees Investment Strategy. The strongest and clearest recommendation of that panel was that a common denominator of value, presumably dollars, was sorely needed to reach conclusions logically.[14] This will be very difficult to achieve in practice given the complexities of Delta values and the lack of supporting research.

Summary of Findings and Recommendations

We are impressed with the efforts we have observed to date to understand the values of the Delta as an evolving place. However, based on our discussions and review process, we recommend the following:

We recommend the establishment of an overall Delta research program that has research components that aim to understand and reduce the greatest uncertainties about the Delta. We are concerned about how little research is being undertaken on what Delta values are and how they might be protected and enhanced in the context of the Delta as an evolving place. We sense that more research, through Delta agencies as well as by academic scholars supported by current sources of academic funding, could help clarify what Delta values are, what processes underlie them, and how these can be brought into Delta decision making.

The rest of our points follow from this.

A There need to be on-going research programs based in the social sciences and humanities in multiple universities that are at least somewhat comparable to those in the environmental sciences. A substantial increase in the level of research activity is needed to make up for lost time.

B The Delta Reform Act requires consideration of Delta values in making short and long-term decisions about the Delta. We are aware that decisions concerning Delta as an evolving place cannot be made on the basis of objective, scientifically determined information alone. For example, the question of which levees merit investment depends on existing economic and social values as well as on how Delta residents and the State envision the Delta might best evolve to protect and enhance its diverse values. However, at present decisions must be made on very little research on the processes that protect and enhance Delta values.

C We acknowledge the considerable difficulties of adequately corralling and effectively interpreting economic data for the Economic Sustainability Plan given that the primary Delta is located in five counties and the secondary Delta in six. We also acknowledge the considerable difficulty of implementing a sustainability plan given the number of counties

[14] http://deltacouncil.ca.gov/docs/methodology-and-scientific-basis-support-delta-levee-investment-strategy

involved. Preparation of the next Delta Economic Sustainability Plan provides a key opportunity to reduce the uncertainty surrounding the economy and how it might be sustained and enhanced. Presumably the independent review panel's comments on the first review will affect the design and execution of the second economic sustainability plan due to be released in 2016.

D We recognize funding limitations and encourage more funding for science, especially social science, to support an improved understanding of the values of the Delta as an evolving place. Understanding how the history, culture and economy of the Delta interact with the findings of natural science will advance ongoing efforts to restore the Delta ecosystem and increase water reliability.

E Because there are few Delta social scientists and because few Delta natural scientists design their research in a coupled human-natural systems framework, considerable groundwork is needed to prepare the Delta scientific community to work effectively in this framework. Because that the Delta is among the most humanly transformed rural landscapes in the world, understanding the future requires a coupled systems approach. Working toward this should be a Delta Science Program funding goal as well as a priority of other research funders. One way to start moving in this direction would be to convene a workshop involving natural scientists and the few scholars in the social sciences and humanities who have worked on the Delta to collectively identify natural processes that are especially important for protecting the unique values of the Delta. This workshop should include natural and social scientists working together on similar issues in other systems so that we can develop and understand best practices for application in the Delta.

F The Delta Narratives project has been very successful given the size of its budget. Delta Narratives brought scholars, many of whom were not previously Delta scholars, together to strengthen and communicate interpretations of the Delta's history, provided opportunities for students to be introduced to the Delta, identified sources of information about the Delta including identifying numerous collections in libraries and museums, and successfully rallied the participation of Delta residents. Additional activities along these lines seem warranted to further develop understanding of the unique values of the Delta as an evolving place.

Conclusion

Environmental science needs to be conducted in the social, economic, political, and cultural context. Environmental science that is not cognizant of human values is likely to struggle to be relevant to human affairs. At the same time, environmental science must avoid being governed or directed by human values – that 's the trap of normative science. It is a difficult path to follow, but an essential one. Thus an understanding of the Delta as an evolving place is an essential part of bringing science to bear on the pressing issues in the Delta. Solutions are every bit as much social and cultural as they are environmental.

Acknowledgments

Joanne Vinton provided an early bibliographic search that uncovered key documents including the masters project paper by Natalie Smith. Jahnava Duryea joined several early field trips and helped in the early stages. A variety of other Council and Delta Science Program staff have made suggestions. We, of course, especially appreciate the cooperation of agency personnel, especially Erik Vink and Blake Roberts, and Robert Benedetti and the work of other members of the Delta Narratives Project.

Appendix A

We have tried to find some feasible way to sort the scholarly literature on the Delta in a manner that illustrates the relative amount of output across different types of scholarship. One way that proved relatively easy was to search for PhD dissertations filed such that they appear in ProQuest in which the abstract includes the Sacramento-San Joaquin Delta. The search uncovered both PhD dissertations and Masters theses. We also know of cases of each was not found in the search. For example, the masters project by Natalie Smith was not included.

The determination of which category the dissertation best fits was based solely on the abstract, not a reading of the dissertation. With these caveats, we still find the exercise fruitful. It does give us an idea of the relative proportion of young scholars being prepared to work in the environmental sciences versus the social sciences and humanities.

Delta related PhD Dissertations since 1990 sorted by Delta Plan Chapter

Key: xxx – listed as supporting two chapters, xxx – listed as supporting three chapters

Chapter 3. More Reliable Water

Micko, S.J., 2015, Implementation of Algorithms for the Simulation of Weirs in Three Dimensional Computational Models [Ph.D. thesis]: University of California, Davis, Ann Arbor, 72 p.

Nelson, T.J., 2014, Using the Updated CALVIN Model to develop Optimized Reservoir Operations for the Sacramento Valley [Ph.D. thesis]: University of California, Davis, Ann Arbor, 249 p.

Ragatz, R., 2013, California's Water Futures: How Water Conservation and Varying Delta Exports Affect Water Supply in the Face of Climate Change [Ph.D. thesis]: University of California, Davis, Ann Arbor, 143 p.

Yoon, H., 2013, Economic Implications of Fish Conservation through Water Management In the Southern Delta: An Application to the Winter-Run Chinook salmon [Ph.D. thesis]: University of California, Davis, Ann Arbor, 97 p.

Reddy, S., 2012, Comparing Delta Flow and Transport Models: Numerical Results of Flow and Salinity [Ph.D. thesis]: University of California, Davis, Ann Arbor, 476 p.

Faust, K.M., 2010, A system-of-systems approach to participatory water infrastructure decisions [Ph.D. thesis]: Purdue University, Ann Arbor, 158 p.

Kohne, J.R., 2010, Comparing Delta Flow and Transport Models: Theoretical and Numerical Basis [Ph.D. thesis]: University of California, Davis, Ann Arbor, 124 p.

Starratt, S.W., 2004, Late Holocene diatom and geochemical evidence of freshwater flow variation in northern San Francisco Bay, California [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 506 p.

Ateljevich, E.S., 2001, Optimal control of salinity in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 204 p.

Chapter 4. Protect, Restore, and Enhance the Delta Ecosystem

Jacobs, P.J., 2015, Economic Models for Conservation Planning and Policy: Exploring Wetland Conversion and Values in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 75 p.
Micko, S.J., 2015, Implementation of Algorithms for the Simulation of Weirs in Three Dimensional Computational Models [Ph.D. thesis]: University of California, Davis, Ann Arbor, 72 p.
Moftakhari Rostamkhani, H., 2015, A Novel Approach to Flow and Sediment Transport Estimation in Estuaries and Bays [Ph.D. thesis]: Portland State University, Ann Arbor, 182 p.
Durand, J.R., 2014, Restoration and reconciliation of novel ecosystems: Open water habitat in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 177 p.
Lesmeister, S.A., 2014, The Effects of Pesticides and Water Quality on the Survival of the Calanoid Copepods, Eurytemora affinis and Pseudodiaptomus forbesi, of the San Francisco Estuary [Ph.D. thesis]: University of California, Davis, Ann Arbor, 113 p.
Manfree, A.D., 2014, Landscape Change in Suisun Marsh [Ph.D. thesis]: University of California, Davis, Ann Arbor, 136 p.
Barr,Thomas Calhoun, I.,II, 2013, Integrative Control of Curly Leaf Pondweed Propagules Employing Benthic Bottom Barriers: Physical, Chemical and Thermal Approaches [Ph.D. thesis]: University of California, Davis, Ann Arbor, 150 p.
Baumsteiger, J.D., 2013, Diversification, speciation, and phylogeography of freshwater sculpins (Cottus, Cottopsis) in California [Ph.D. thesis]: University of California, Merced, Ann Arbor, 140 p.
Whitaker, M.R.L., 2013, Positive species interactions among plants, microbes, and insects as drivers of ecological community properties [Ph.D. thesis]: University of California, Davis, Ann Arbor, 129 p.
Yoon, H., 2013, Economic Implications of Fish Conservation through Water Management In the Southern Delta: An Application to the Winter-Run Chinook salmon [Ph.D. thesis]: University of California, Davis, Ann Arbor, 97 p.
Henneberry, Y.K.C., 2012, What the Floc: Investigating the interaction of dissolved organic matter with metals in water and the subsequent effects on soil and water quality in a wetland environment [Ph.D. thesis]: University of California, Davis, Ann Arbor, 172 p.
Liu, J., 2012, Malachite Green Adsorption by Activated Carbon from Aquaculture Waste Water [Ph.D. thesis]: University of California, Davis, Ann Arbor, 76 p.
Wagner, R.W., Jr., 2012, Temperature and Tidal Dynamics in a Branching Estuarine System [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 87 p.
Hong, S.P., 2011, Problem solving with geographic networks in the Sacramento-San Joaquin Delta [Ph.D. thesis]: San Jose State University, Ann Arbor, 54 p.
Schaefer, M.M., 2011, Fate and Transport of Three Pharmaceuticals in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 54 p.
Hestir, E.L., 2010, Trends in estuarine water quality and submerged aquatic vegetation invasion [Ph.D. thesis]: University of California, Davis, Ann Arbor, 146 p.
Perry, R.W., 2010, Survival and migration dynamics of juvenile Chinook salmon (Oncorhynchus tshawytscha) in the Sacramento-San Joaquin River Delta [Ph.D. thesis]: University of Washington, Ann Arbor, 238 p.
Grimaldo, L.F., 2009, An examination of factors influencing fish assemblages in the tidal freshwaters of the San Francisco estuary [Ph.D. thesis]: University of California, Davis, Ann Arbor, 166 p.
Lange, M.D., 2009, Suspended sediment transport at a tidal river divergence [Ph.D. thesis]: University of Southern California, Ann Arbor, 239 p.
Garone, P.F., 2006, The fall and rise of the wetlands of California's Great Central Valley: A historical and ecological study of an endangered resource of the Pacific Flyway [Ph.D. thesis]: University of California, Davis, Ann Arbor, 639 p.
Mulitsch, M.J., 2005, Remote sensing of California estuaries: Monitoring climate change and invasive species [Ph.D. thesis]: University of California, Davis, Ann Arbor, 136 p.
Nilsen, E.B., 2004, Studies of carbon cycling, nutrient dynamics and climate change in pelagic and coastal ecosystems using sediment geochemical techniques [Ph.D. thesis]: University of California, Santa Cruz, Ann Arbor, 155 p.
Weber, P.K., 2002, Geochemical markers in the otoliths of chinook salmon in the Sacramento-San Joaquin River system, California [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 123 p.
Ellis, J.T., 2001, Assessing the impacts of an organic restoration structure on boat wakes [Ph.D. thesis]: University of Southern California, Ann Arbor, 120 p.

Anderson, J.D., 2000, Modeling impacts of multiple stresses on aquatic ecosystems: Case study of juvenile chinook salmon in the Sacramento River system [Ph.D. thesis]: University of California, Davis, Ann Arbor, 208 p.
Paulsen, S.C., 1997, A study of the mixing of natural flows using ICP-MS and the elemental composition of waters [Ph.D. thesis]: California Institute of Technology, Ann Arbor, 666 p.

Chapter 5. Values of the Delta as an Evolving Place

Cultural/Historical Value

Parker, C.L., 2012, Documenting the delta: Lessons learned from film [Ph.D. thesis]: San Jose State University, Ann Arbor, 99 p.
Statz, S.E.F., 2012, California's fruit cocktail: A history of industrial food production, the state, and the environment in northern California [Ph.D. thesis]: University of Houston, Ann Arbor, 350 p.
Gambirazzio, G.C., 2009, The parallax view: Race, land and the politics of place-making in Locke, California [Ph.D. thesis]: University of California, Davis, Ann Arbor, 319 p.
Garone, P.F., 2006, The fall and rise of the wetlands of California's Great Central Valley: A historical and ecological study of an endangered resource of the Pacific Flyway [Ph.D. thesis]: University of California, Davis, Ann Arbor, 639 p.
Atherstone, H.E., 1993, Physical environment and human use in the Sacramento-San Joaquin Delta: Historical and present relationships [Ph.D. thesis]: California State University, Stanislaus, Ann Arbor, 171 p.

Delta Recreational Value

White, A., 2009, Not yet glowing: Sacramento Delta anglers and the distant hum of risk [Ph.D. thesis]: University of California, Davis, Ann Arbor, 99 p.
Eurek, J.R., 2002, Modeling recreational boat traffic in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of Southern California, Ann Arbor, 117 p.

Delta Agricultural Value

Kirk, E.R., 2014, Measuring Subsidence in Peatland Soils Using a Nitrogen Budget Approach [Ph.D. thesis]: University of California, Davis, Ann Arbor, 42 p.
Lunning, N.G., 2009, Wind erosion in Sacramento-San Joaquin Delta recorded by phytolith concentrations [Ph.D. thesis]: University of California, Davis, Ann Arbor, 62 p.
McInturff, P.S., 2001, Quantitative epidemiology of ram attrition in commercial sheep flocks [Ph.D. thesis]: University of California, Davis, Ann Arbor, 266 p.
D'Attilio, N.J., 1993, Agriculture in the Sacramento-San Joaquin Delta: A case study of farming revenue versus levee maintenance costs [Ph.D. thesis]: San Jose State University, Ann Arbor, 131 p.
Varela, L.G., 1990, Monitoring and characterization of insecticide resistance in codling moth, tentiform leafminer, and associated parasitoids in apple and pear orchards in California [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 122 p.

Delta in California State History writ large

Mitchell, M.D., 1993, Changes in landscape forms and functions in the Sacramento-San Joaquin Delta, California, 1920-1993 [Ph.D. thesis]: University of Illinois at Urbana-Champaign, Ann Arbor, 342 p.

Pre-Western Contact Delta History

Jorgenson, G.A., 2012, Human Ecology and Social Organization in the Prehistoric California Delta: An Examination of Strontium-87/Strontium-86 Isotope Ratios in the Human Burial Population at CA-CCO-548 [Ph.D. thesis]: University of California, Davis, Ann Arbor, 242 p.

Modzelewski, D.J., 2012, Constructing Native American Identity within the Context of the Native American Graves Protection and Repatriation Act [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 266 p.

Chapter 6. Water Quality

Micko, S.J., 2015, Implementation of Algorithms for the Simulation of Weirs in Three Dimensional Computational Models [Ph.D. thesis]: University of California, Davis, Ann Arbor, 72 p.
Moftakhari Rostamkhani, H., 2015, A Novel Approach to Flow and Sediment Transport Estimation in Estuaries and Bays [Ph.D. thesis]: Portland State University, Ann Arbor, 182 p.
Durand, J.R., 2014, Restoration and reconciliation of novel ecosystems: Open water habitat in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 177 p.
Vasquez, V.R., 2014, Towards Achieving Clean Water Goals: An Evaluation of California's Mandatory Minimum Penalty Enforcement Program [Ph.D. thesis]: University of California, Los Angeles, Ann Arbor, 203 p.
Barr,Thomas Calhoun, I.,II, 2013, Integrative Control of Curly Leaf Pondweed Propagules Employing Benthic Bottom Barriers: Physical, Chemical and Thermal Approaches [Ph.D. thesis]: University of California, Davis, Ann Arbor, 150 p.
Barr,Thomas Calhoun, I.,II, 2013, Integrative Control of Curly Leaf Pondweed Propagules Employing Benthic Bottom Barriers: Physical, Chemical and Thermal Approaches [Ph.D. thesis]: University of California, Davis, Ann Arbor, 150 p.
Henneberry, Y.K.C., 2012, What the Floc: Investigating the interaction of dissolved organic matter with metals in water and the subsequent effects on soil and water quality in a wetland environment [Ph.D. thesis]: University of California, Davis, Ann Arbor, 172 p.
Pereira, M.d.G.C., 2012, The molecular epidemiology and risk factors for Escherichia coli in aquatic systems of Northern California [Ph.D. thesis]: University of California, Davis, Ann Arbor, 59 p.
Wagner, R.W., Jr., 2012, Temperature and Tidal Dynamics in a Branching Estuarine System [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 87 p.
Schaefer, M.M., 2011, Fate and Transport of Three Pharmaceuticals in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 54 p.
Hestir, E.L., 2010, Trends in estuarine water quality and submerged aquatic vegetation invasion [Ph.D. thesis]: University of California, Davis, Ann Arbor, 146 p.
Chen, W., 2009, N-nitrosodimethylamine formation during chlorination of diuron with influence analysis of the Sacramento-San Joaquin Delta water quality for urban uses [Ph.D. thesis]: University of California, Davis, Ann Arbor, 173 p.
Lange, M.D., 2009, Suspended sediment transport at a tidal river divergence [Ph.D. thesis]: University of Southern California, Ann Arbor, 239 p.
Mourad, D., 2009, Investigating the use of coagulation seasonally to reduce DOC and DBP precursor loads from subsided islands in the Sacramento-San Joaquin Delta, CA [Ph.D. thesis]: University of California, Davis, Ann Arbor, 102 p.
White, A., 2009, Not yet glowing: Sacramento Delta anglers and the distant hum of risk [Ph.D. thesis]: University of California, Davis, Ann Arbor, 99 p.
Byington, A.A., 2007, Photo-degradation of methylmercury in the Sacramento-San Joaquin Delta Estuary [Ph.D. thesis]: San Jose State University, Ann Arbor, 64 p.
Baek, S., 2006, The role of atmospheric forcing in determining transport in a shallow tidal lagoon [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 117 p.
Pilon, V.L., 2006, Sources and composition of particulate organic matter in the Sacramento-San Joaquin River Delta, California [Ph.D. thesis]: The College of William and Mary, Ann Arbor, 274 p.
Nilsen, E.B., 2004, Studies of carbon cycling, nutrient dynamics and climate change in pelagic and coastal ecosystems using sediment geochemical techniques [Ph.D. thesis]: University of California, Santa Cruz, Ann Arbor, 155 p.
Li, L., 2002, Effects of activated carbon surface chemistry and pore structure on the adsorption of trace organic contaminants from aqueous solution [Ph.D. thesis]: North Carolina State University, Ann Arbor, 159 p.

Chow, A.T., 2000, Dissolved organic carbon (DOC) and trihalomethane (THM) production of cultivated peat soil from the Sacramento - San Joaquin Delta, California [Ph.D. thesis]: University of California, Davis, Ann Arbor, 207 p.
Monsen, N.E., 2000, A study of sub-tidal transport in Suisun Bay and the Sacramento-San Joaquin Delta, California [Ph.D. thesis]: Stanford University, Ann Arbor, 335 p.
Paulsen, S.C., 1997, A study of the mixing of natural flows using ICP-MS and the elemental composition of waters [Ph.D. thesis]: California Institute of Technology, Ann Arbor, 666 p.
Nichol, G.D., 1996, Estuarine circulation cell of lower Sacramento River [Ph.D. thesis]: University of Nevada, Reno, Ann Arbor, 197 p.

Chapter 7. Reduce Risk to People, Property, and State Interests in the Delta

Shafiee, A., 2016, Cyclic and Post-Cyclic Behavior of Sherman Island Peat [Ph.D. thesis]: University of California, Los Angeles, Ann Arbor, 323 p.
Maendly, R.D., 2014, Flood Risk Analysis in the Lower San Joaquin River System [Ph.D. thesis]: University of California, Davis, Ann Arbor, 197 p.
Reinert, E.T., 2014, Dynamic shake testing of a model levee on peaty organic soil in the sacramento-san joaquin delta [Ph.D. thesis]: University of California, Los Angeles, Ann Arbor, 244 p.
Pappalardo, E.A., 2014, The importance of levee performance in the reduction and evaluation of risk in the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 123 p.
Jones, C.A., 2013, Application of Optimization Modeling to Examine the Benefits of Expanding the Sacramento River Watershed Bypass System [Ph.D. thesis]: University of California, Davis, Ann Arbor, 90 p.
Hamedifar, H., 2012, Risk Assessment and Management for Interconnected and Interactive Critical Flood Defense Systems [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 359 p.
Teel, A.C., 2012, Seismic Tomography of the Sacramento -- San Joaquin River Delta: Joint P-wave/Gravity and Ambient Noise Methods [Ph.D. thesis]: The University of Wisconsin - Madison, Ann Arbor, 105 p.
Hopf, F., 2011, Levee failures in the Sacramento-San Joaquin River Delta: Characteristics and perspectives [Ph.D. thesis]: Texas A&M University, Ann Arbor, 411 p.
Yuhas, T.C., 2011, Escape from the Delta: Preparation and evacuation for catastrophic flooding in California Emergency Management Agency Region IV [Ph.D. thesis]: Naval Postgraduate School, Monterey, California, 83-83
Suddeth, R.J., 2009, Levee decisions and sustainability for the Sacramento-San Joaquin Delta [Ph.D. thesis]: University of California, Davis, Ann Arbor, 43 p.
Athanasopoulos, A.G., 2008, Select topics on the static and dynamic response and performance of earthen levees [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 523 p.
Arulnathan, R., 2000, Dynamic properties and site response of organic soils [Ph.D. thesis]: University of California, Davis, Ann Arbor, 301 p.
Yaari, A., 1999, Modeling wind waves and bank erosion potential on the Sacramento Delta [Ph.D. thesis]: University of Southern California, Ann Arbor, 101 p.
Band, J.W., 1998, Neotectonics of the Sacramento-San Joaquin Delta area, east-central Coast Ranges, California [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 216 p.
D'Attilio, N.J., 1993, Agriculture in the Sacramento-San Joaquin Delta: A case study of farming revenue versus levee maintenance costs [Ph.D. thesis]: San Jose State University, Ann Arbor, 131 p.

Theses on Topics Unrelated to the Delta Plan

Delta Politics and Governance

Lurie, S.D., 2004, Interorganizational dynamics in large-scale integrated resources management networks: Insights from the CALFED Bay-Delta Program [Ph.D. thesis]: University of Michigan, Ann Arbor, 315 p.
Connick, S., 2003, The use of collaborative processes in the making of California water policy: The San Francisco Estuary Project, the CALFED Bay-Delta Program, and the

Sacramento Area Water Forum [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 457 p.
Moody, M.P., 2002, Water for everyone: A cultural analysis of advocacy and the public good in a California water conflict [Ph.D. thesis]: Princeton University, Ann Arbor, 677 p.

Climate Change

Guha, A., 2014, Sources of methane and nitrous oxide in California's Central Valley estimated through direct airborne flux and positive matrix factorization source apportionment of groundbased and regional tall tower measurements [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 197 p.
Morris, J.E., 2014, Biogeochemical Consequences of Converting Corn into Rice Fields: An Analysis of Greenhouse Gas (CH4 and N2O) Emissions in the Sacramento-San Joaquin Delta, California [Ph.D. thesis]: University of California, Davis, Ann Arbor, 89 p.
Poindexter, C.M., 2014, Wetland water flows and interfacial gas exchange [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 110 p.
Hatala, J.A., 2013, Spatiotemporal dynamics of carbon dioxide and methane fluxes from agricultural and restored wetlands in the California Delta [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 137 p.
Assa, Y., 2012, Effect of Agricultural Land use Changes on Greenhouse Gas Emissions and Carbon Dynamics in Drained Peat Soils in the San Joaquin Delta, CA [Ph.D. thesis]: University of California, Davis, Ann Arbor, 78 p.
Mulitsch, M.J., 2005, Remote sensing of California estuaries: Monitoring climate change and invasive species [Ph.D. thesis]: University of California, Davis, Ann Arbor, 136 p.
Nilsen, E.B., 2004, Studies of carbon cycling, nutrient dynamics and climate change in pelagic and coastal ecosystems using sediment geochemical techniques [Ph.D. thesis]: University of California, Santa Cruz, Ann Arbor, 155 p.
Starratt, S.W., 2004, Late Holocene diatom and geochemical evidence of freshwater flow variation in northern San Francisco Bay, California [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 506 p.

Other

Bellinder, A.L., 2012, The California Delta Breeze [Ph.D. thesis]: University of California, Davis, Ann Arbor, 141 p.
Tinka, A.B., 2012, Actuated Mobile Sensing in Distributed, Unstructured Environments [Ph.D. thesis]: University of California, Berkeley, Ann Arbor, 186 p.

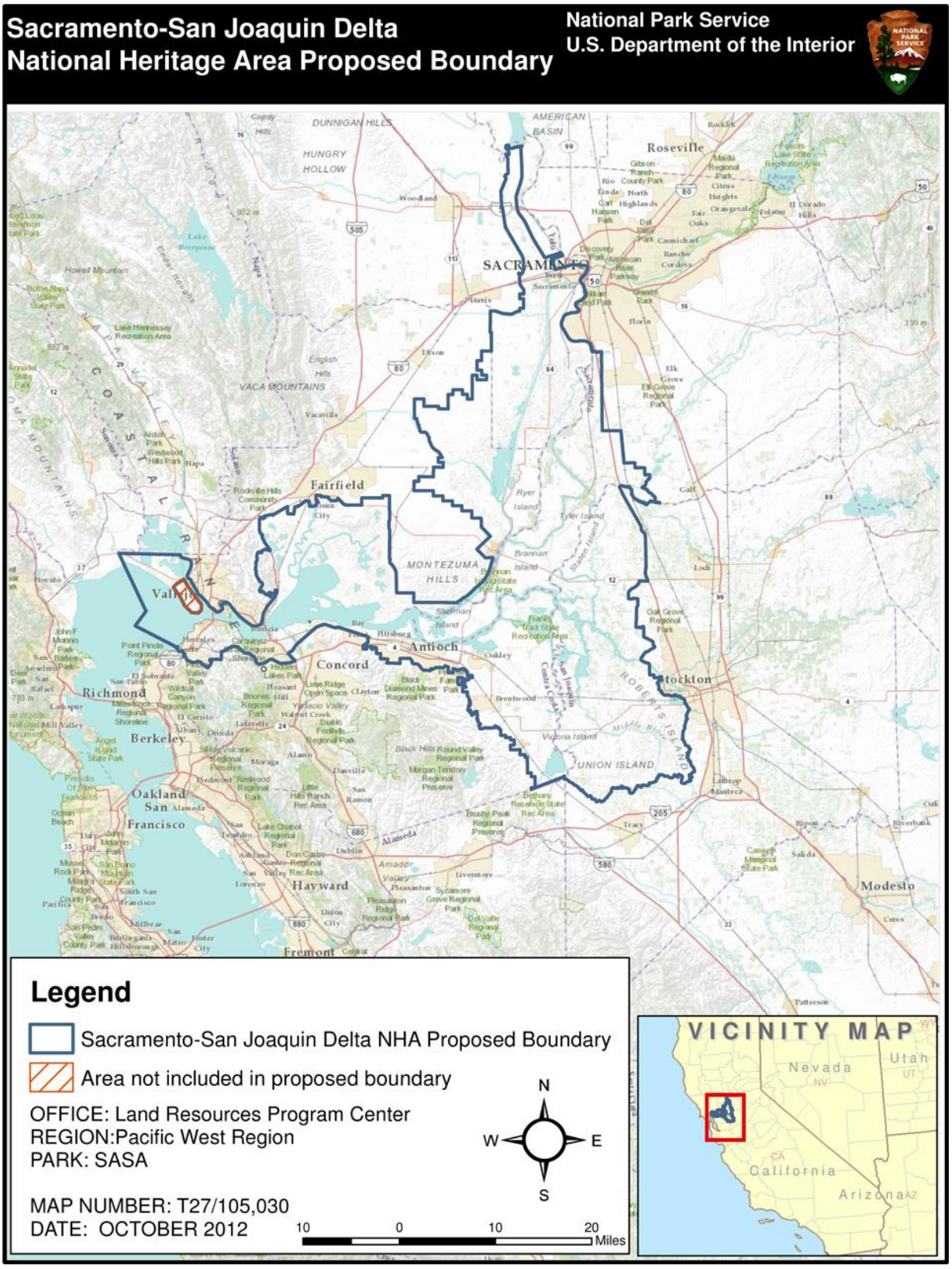
Appendix B

The Delta Reform Act of 2009 mandated what the Economic Sustainability Plan would include. This can make writing the report a little awkward.

SEC. 23. *Section 29759 is added to the Public Resources Code, to read:*

29759. *(a) Not later than July 1, 2011, the commission shall prepare and adopt, by a majority vote of the membership of the commission, an economic sustainability plan. The economic sustainability plan shall include information and recommendations that inform the Delta Stewardship Council's policies regarding the socioeconomic sustainability of the Delta region.*
(b) The economic sustainability plan shall include, but not be limited to, all of the following:
(1) Public safety recommendations, such as flood protection recommendations.
(2) The economic goals, policies, and objectives in local general plans and other local economic efforts, including recommendations on continued socioeconomic sustainability of agriculture and its infrastructure and legacy communities in the Delta.
(3) Comments and recommendations to the Department of Water Resources concerning its periodic update of the flood management plan for the Delta.
(4) Identification of ways to encourage recreational investment along the key river corridors, as appropriate.

Appendix C


Sacramento-San Joaquin Delta
National Heritage Area Proposed Boundary
National Park Service
U.S. Department of the Interior
Legend
Sacramento-San Joaquin Delta NHA Proposed Boundary
Area not included in proposed boundary
OFFICE: Land Resources Program Center
REGION:Pacific West Region
PARK: SASA
MAP NUMBER: T27/105,030
DATE: OCTOBER 2012
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VICINITY MAP
Nevada
Utah
California
Arizona
SACRAMENTO
Roseville
Fairfield
Vallejo
Antioch
Concord
Richmond
Berkeley
Oakland
San Francisco
Hayward
Fremont
Stockton
Modesto
Lodi
Tracy
Livermore
DUNNIGAN HILLS
HUNGRY HOLLOW
VACA MOUNTAINS
MONTEZUMA HILLS
UNION ISLAND

Appendix D

Delta Stewardship Council Performance Measures for the Delta as an Evolving Place

Performance Measure Types

Delta Plan performance measures have been placed into three general classes:

- **Administrative** performance measures describe decisions made by policy makers and managers to finalize plans or approve resources (funds, personnel, projects) for implementation of a program or group of related programs.
- **Output** (also known as "driver") performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions, such as acres of habitat restored or acre-feet of water released, as well as natural phenomena outside of management control (such as a flood, earthquake, or ocean conditions).
- **Outcome** performance measures evaluate responses to management actions or natural outputs.

Core Output/Outcome Performance Measure Criteria

- **Metrics** define the unit(s) of measure and other characteristics for tracking aspects of performance over time.
- **Baselines** are standards or historical reference conditions for comparing with the current condition.
- **Targets** are the desired future conditions or trends.

Chapter 5: Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place

Strategy 5.1: Designate the Delta as a Special Place

Strategy 5.2: Plan to Protect the Delta's Lands and Communities

Strategy 5.3: Maintain Delta Agriculture

Strategy 5.4: Encourage Recreation and Tourism Strategy 5.5: Sustain a Vital Delta Economy

Outcome Performance Measures

- The Department of Water Resources and others increase the extent of their subsidence reversal and carbon sequestration projects to 5,000 acres by January 1, 2017. (Strategy 5.2)

  Metrics:
  - Acres of subsidence reversal and carbon sequestration projects.

  Baseline:
  - Set at zero as of 2008.

Target:

- 5,000 acres by January 1, 2017 (905 acres were converted in 2008-2011 and will be included towards meeting the target).

♦ Prevent further Delta rural farmland loss to urban development in areas designated for agricultural use in Delta Plan regulations. Track conversions of farmland to habitat restoration areas. (Strategy 5.2)

Metrics:

- Acres of farmland lost to urban development.
- Acres of farmland lost to urban development within areas designated for agricultural use in the Delta Plan regulations.
- Acres of farmland converted to habitat restoration.

Baseline:

- Number of acres of Delta rural farmland designated for agriculture in Delta Plan regulations at the time of Delta Plan adoption in May of 2013.

Target:

- Zero acres of farmland lost to urban development within areas designated for agricultural use in the Delta Plan regulations.

♦ Value-added crop processing trends. (Strategy 5.3)

Metrics:

- Revenues (dollars) associated with value-added crop processing.

Baseline:

- Measured as of the date of the Delta Plan's adoption, May 2013.

Target:

- Upward trend as measured by the metric above.

♦ Delta recreation and tourism trends. (Strategy 5.4)

Metrics:

- Acres of accessible state and federal owned land to the public for recreation and tourism.
- Length (linear feet) of shoreline accessible for public recreation.
- Number of fishing licenses bought per year by county.

Baseline:

- Measured as of the date of the Delta Plan's adoption, May 2013.

Target:

- Upward trend as measured by the metrics above.

♦ Delta industrial, agricultural, and recreational economic trends (Strategy 5.5)

Metrics:

- Tonnage of port cargo.
- Agriculture revenue (dollars).
- Recreation spending (dollars).

Baseline:

- Measured as of the date of the Delta Plan's adoption, May 2013.

Target:
- Upward trend as measured by the metrics above.

Output Performance Measures

- Water management, ecosystem restoration, and flood management projects minimize conflicts with adjoining uses by avoiding, minimizing, or mitigating adverse effects. (Strategy 5.2)

  Metrics:
  - Percent of projects that avoid, minimize, or mitigate adverse effects to less than significant levels.

  Baseline:
  - This performance measure was developed during the adoption of the Delta Plan (May 2013) with the primary purpose of measuring consistency with the Delta Plan, setting the baseline at May 2013.

  Target:
  - 100% consistency with the Delta Plan, measured on an annual basis.

- Progress toward preparing and implementing plans for the vitality and preservation of for each Delta legacy community. (Strategy 5.2)

  Metrics:
  - Number of projects initiated to achieve legacy community plan objectives.

  Baseline:
  - Set at zero as of the Delta Plan's adoption date, May 2013.

  Target:
  - Upward trend in the number of completed projects that improve community vitality.

- Track the extent to which recreation facilities are included in new ecosystem restoration projects. (Strategy 5.3)

  Metrics:
  - Percent of new ecosystem restoration projects that include recreational facilities.

  Baseline:
  - Measured as of the date of the Delta Plan's adoption, May 2013.

  Target:
  - Increasing trend in the percentage of new ecosystem restoration projects that include recreation facilities.

Administrative Performance Measures

Strategy 5.1: Designate the Delta as a Special Place

- Delta Protection Commission completes application for designation of the Delta and Suisun Marsh as a National Heritage Area.

- The California Department of Transportation prepares a scenic byway plan and pursues National Scenic Byway status for Route 160 by January 1, 2014.

- Congress designates a National Heritage Area that includes the Delta and Suisun Marsh by January 1, 2014.

Strategy 5.2: Plan to Protect the Delta's Lands and Communities

- 100% of proposed actions for urban development meet one of the following standards: 1) are located within areas that current city or county general plans as of the date of the Delta Plan's adoption designate for development in cities or their spheres of influence; areas within Contra Costa County's 2006 voter-approved urban limit line, except Bethel Island; areas within the Mountain House General Plan Community Boundary in San Joaquin County; or the unincorporated Delta towns of Clarksburg, Courtland, Hood, Locke, Ryde and Walnut Grove; 2) if located on Bethel Island, are consistent with the Contra Costa County general plan effective as of the date of the Delta Plan's adoption; or 3) if located outside the areas described above, are consistent with the land uses designated in county general plans as of the date of the Delta Plan's adoption and are otherwise consistent with Delta Plan policies.

- Water management facilities, ecosystem restoration, and flood management infrastructure are sited to avoid or reduce conflicts with existing or planned uses when feasible, considering comments from local agencies and the Delta Protection Commission. Plans for ecosystem restoration consider sites on existing public lands, when feasible and consistent with a project's purpose, before privately owned sites are purchased.

- Local governments prepare plans for each community that emphasize its distinctive character, encourage historic preservation, identify opportunities to encourage tourism, serve surrounding lands, or develop other appropriate uses, and reduce flood risks.

- Agencies acquiring land for water management facilities, ecosystem restoration, and flood management infrastructure purchase from willing sellers, when feasible, including consideration of whether lands suitable for proposed projects are available at fair prices.

- The California Department of Transportation, local agencies, and utilities develop plans infrastructure, such as roads and highways, to meet needs of development consistent with sustainable community strategies, local plans, Delta Protection Commission's Land Use and Resource Management Plan, and the Delta Plan.

- As part of the prioritization of State levee investments called for in RR P4, the Delta Stewardship Council consults with the California Department of Transportation as provided in Water Code section 85307(c) to consider the effects of flood hazards and sea level rise on state highways in the Delta.

- The Council, in conjunction with the California Air Resources Board (CARB) and the Delta Conservancy, investigates the opportunity for the development of a carbon market whereby Delta farmers could receive credit for growing native marsh and wetland plants.

- The Department of Water Resources has developed a plan, including funding needs, for increasing the extent of their subsidence reversal and carbon sequestration projects to 5,000 acres by January 1, 2017.

- 100% of State agencies have not renewed or entered into agricultural leases on Delta or Suisun Marsh islands if the actions of the lessee promote or contribute to subsidence on the leased land, unless the lessee participates in subsidence reversal or reduction programs.

Strategy 5.3: Maintain Delta Agriculture

- Local governments and economic development organizations take steps to encourage value-added processing of Delta crops in appropriate locations.

- Local governments and economic development organizations take steps to support growth in agritourism, particularly in and around legacy communities.

- The Department of Fish and Wildlife, the Delta Conservancy, and ecosystem restoration agencies take steps to encourage habitat enhancement and wildlife friendly farming systems on agricultural lands to benefit both the environment and agriculture.

Strategy 5.4: Encourage Recreation and Tourism

- Water management and ecosystem restoration agencies provide recreation opportunities, including visitor-serving business opportunities, at new facilities and habitat areas whenever feasible, and protect existing recreation facilities using California State Parks' *Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh* and Delta Protection Commission's *Economic Sustainability Plan* as guides.

- The Delta Protection Commission and Delta Conservancy take steps to encourage partnerships between other state and local agencies, and local landowners and business people to expand recreation, including boating, promote tourism, and minimize adverse impacts to non-recreational landowners.

- Dedicated funding sources are identified to add of improve recreation facilities in the Delta.

- The Department of Fish and Wildlife, in cooperation with other public agencies, should collaborate with nonprofits, private landowners, and business partners to expand wildlife viewing, angling, and hunting opportunities.

- The Department of Boating and Waterways coordinates with the U.S. Coast Guard and State and local agencies on an updated marine patrol strategy for the region.

- Public agencies owning land increase opportunities, where feasible, for bank fishing, hunting, levee top trails, and environmental education.

- Cities, counties, and other local and state agencies work together to protect and enhance visitor serving businesses by planning for recreation uses and facilities in

the Delta, providing infrastructure to support recreation and tourism, and identifying settings for private visitor- serving development and services.

Strategy 5.5: Sustain a Vital Delta Economy

- The ports of Stockton and West Sacramento encourage maintenance and carefully designed and sited development of port facilities.
- The Energy Commission and Public Utilities Commission cooperate with the Delta Stewardship Council as described in Water Code section 85307(d) and identify actions that should be incorporated in the Delta Plan to address the needs of Delta energy development, storage, and distribution by 2017.

Appendix E
Possible Research Projects

The Delta ISB reviews the adequacy of research done but does not do original research itself. In the process of conducting this review, several possible research projects have been suggested to the Delta ISB as perhaps especially relevant that others might consider undertaking.

Additional sources that the Delta scientists could consider in addressing the challenges of understanding the values of the Delta as an evolving place are listed here. While the Delta itself is not the focus of the efforts discussed in the sources, the information related to socioeconomic and cultural values and cultural landscapes may be applicable.

National Park Service:

http://www.nps.gov/tps/standards/four-treatments/landscape-guidelines/

https://www.ncptt.nps.gov/articles/c2a/guidelines-for-treatment-of-cultural-landscapes/

California Department of Transportation:

http://www.dot.ca.gov/ser/downloads/cultural/languide.pdf

Landscape Conservation Cooperative Network:

https://lccnetwork.org/sites/default/files/Resources/LCC_Network_Conservation_Science_Plan_Version_1.0.pdf

https://lccnetwork.org/projects/Socioeconomics%20or%20Ecosystem%20Services

Another source that could be considered is the potential role traditional ecological knowledge (TEK) and its role in managing the Delta. While there is little research to clarify exactly how Native Americans relied upon the Delta as Place, we can apply the precautionary principle and hypothesize values, erring in the direction of overestimating utility, based on common sense, limited data, and historical wetland-dependent cultures elsewhere. The Delta was greatly dissected by channels, so fishing and boating were likely a part of daily life. All people need food, fiber (for shelter, clothing, baskets, etc.,) and tools (digging, hunting, weapons, food preparation). Native peoples are reported to have been territorial and to have spoken many variations of at least five languages (Stuart 2011). Language units and populations were likely sustained by different parts of the Delta, consistent with burial sites (http://www.calwater.ca.gov/Admin_Record/C-102133.pdf a 1999 CalFed study) (we could include map 7 from West 1994).
The CalFed report says, "There has been some dispute over the exact boundaries and divisions of the Northern Valley Yokuts and Miwoks in the Delta, and delineation of groups is based largely on very limited and problematical historical and linguistic evidence (Bennyhoff 1977:127, Schenck 1926, Kroeber 1925, Wallace 1978)," and "The native population was not evenly distributed. Rather it was clustered in a narrow strip of land boarding the San Joaquin River and its main tributaries (Wallace 1978). Baumhoff (1963:MAP 7) estimated a density of I0+ persons per square mile along the waterways, which is congruent with Schenck's (1926) estimate for the Delta marshlands. Schenck (ibid) estimated that villages averaged about 200 persons each and were located along the main rivers five to ten miles apart. Based on historical records Cook (1955) estimated that

the area contained four or five settlements with a combined population of 1,300 persons. Fr. Ramon Abella in 1811 noted three rancherias (settlements) with a population of 900, or 300 per rancheria (Cook ibid). Considering the 200 or so Indians missionized from the area, Cook (ibid) concluded that the aboriginal population was 1,500 or greater." and

Settlement groups broke up seasonally to exploit other resources, such as acorns, as they became available within a well defined territory for fishing, gathering and hunting. Settlements contained domed-shaped houses and shelters made of brush and tules. Archeological data indicate that human internments were made at Delta settlements and cemeteries. Besides settlements there were fishing stations, hunting camps, and lithic tool manufacturing sites. All lithics had to be imported. and

Fish, fowl, acorns, and tule roots were the primary Northern Valley Yokut subsistence resources. Other resources, such as freshwater bivalves, small mammals, seeds and bulbs, also were important. Elk, deer, and antelope, although reported abundant and easily hunted by the early explorers, probably constituted a marginal subsistence resource (Wallace 1978). Because of the early disruption of Yokut speakers, little ethnographic information is available other than some demographic data recorded by explorers and missionaries, and some linguistic description (Bennyhoff 1977, Schenck 1926, Schulz 1981, Kroeber 1925).

To sustain tribelets, we hypothesize that traditional ecological knowledge (TEK) developed to avoid overharvesting, to weed out unwanted species, and to transplant desired species. TEK potentially supported for additional esthetic and spiritual uses of places and species. Such hypotheses need to be explored by qualified researchers. Other cultures that depend on wetlands (i.e., Marsh Arabs in the Mesopotamian Marshes) can be researched for their TEK, which developed in a region with many parallels with the Delta —virtually all of the native landscapes in a 20,000-km^2 region have been converted to conditions that no longer support the practice of TEK (Alwash 2013).

In order to manage the Delta to honor Native American heritage, it would be useful to have information such as the following anthropological and ecological predictions: tribelet population sizes and associated territory sizes needed to sustain tribelets; the collection of vegetation types that would have provided both plant and animal food, firewood, building materials, supplies for making mats and baskets, medicinal plants, and wood for tools (spears, arrows, bows, etc.), the management regimes that would lead to sustainability.

Management of the Delta as Place could include the experimental reconstruction of a Native American village to serve multiple purposes—working out how native materials might have accomplished multiple uses, honoring Native American culture, providing a central meeting place for Delta stakeholders to engage in adaptive management, ….. [add more??], as well as establishing experimental plots for re-learning while growing early food crops and medicinal plants. The Grand Portage National Monument in northeast Minnesota has elements of this idea (https://www.nps.gov/nr/travel/cultural_diversity/Grand_Portage_National_Monument.html).

Alwash, S. 2013. Eden Again: Hope in the marshes of Iraq. Tablet House Publishing, Fullerton, CA.