

RESEARCH

Inhabiting the Delta: A Landscape Approach to Transformative Socio-Ecological Restoration

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ABSTRACT

Current legislation and plans for the Sacramento–San Joaquin Delta (Delta) call for large-scale restoration of aquatic and terrestrial habitats, which will require significant changes in waterways, land uses, and cultural patterns. These re-made landscapes will be subject to a variety of new human uses, which Delta planning and adaptive management literature has yet to adequately consider. Failing to account for human uses and evolving place values can lead to diminished performance and public support for Delta restoration efforts.

Our empirical study examined restored and naturalized Delta landscapes using an integrative landscape approach that seeks to reconcile multiple goals and land-use agendas that span ecological, social, economic, and political domains. The research design consisted of six overlapping methods that included a planning, policy, and law review specific to the Delta; surveys and interviews with approximately 100 land managers, scientists, land-owners, law-enforcement personnel, agency

representatives, and Delta residents; nine case studies of restored and naturalized delta landscapes; GIS mapping; and extensive field work.

Findings derived from the synthesis of these methods show that human uses of the Delta's re-wilded landscapes are diverse and pervasive. Given the infrastructural and urbanized context of the region, these environments are subject to multiple and sometimes conflicting uses, perceptions, and place values. Though these myriad uses cannot be fully predicted or controlled (nor should they be), findings showed that more proactive and inclusive planning for human uses can encourage or discourage particular uses while also building constituency, support, and active engagement in ecological restoration efforts. We conclude that reconciling human uses with ecological recovery in the Delta will require a more localized, multi-functional, and creative approach to designing and adaptively managing these emergent landscapes. We recommend that more resources and experimental prototyping be dedicated to such work.

KEY WORDS

Sacramento–San Joaquin Delta, landscape approach, landscape planning, conservation, adaptive management, socio-ecological systems, evolving place, reconciliation ecology, infrastructure, Anthropocene

INTRODUCTION

Current legislation and state plans for the Sacramento–San Joaquin Delta (Delta) call for large-scale ecological restoration, which will require significant changes in land uses and cultural patterns (Figures 1 and 2). Yet these re-wilded landscapes will involve and alter human uses. Our research looks at how human uses can and will continue after restoration, and employs a landscape approach to consider how these uses can be integrated with ecological and adaptive-management goals. This article is based upon a more extensive technical report: *The Human Use of Restored and Naturalized Delta Landscapes* (Milligan and Kraus–Polk 2016). In this article, we focus on the design and application of our research methods for investigating human–environment relationships within dynamic and complex landscapes such as the Delta.

We begin with a brief review of “landscape approaches” in conservation and integrative land-use planning, comparing and contrasting our approach with that of others. We include relevant applications from the Delta and elsewhere. We then describe the research methods we employed in our study and how they led to our findings, followed by our recommendations for more effective planning, designing, and stewarding of these nascent landscapes. Our conclusion reflects on the utility of the research methods as deployed in the study, and where and how they might be further applied in socio-ecological recovery efforts.

Delta Context

The Delta has been radically modified by human agency (Robinson et al. 2014; Wiens et al. 2016; Lund et al. 2007). Nearly all “naturalized” and “restored” landscapes in the Delta are of a feral quality, meaning returned to a wilder state after escape or intentional release from former domestication and agricultural land uses. Domestication in the Delta has been extreme, characterized by the loss and degradation of habitat and the physical processes that maintain them (Robinson et al. 2014). This relatively recent “reclamation” experiment is one of many being played out in delta estuaries around the world (Vörösmarty et al. 2009; Renaud et al. 2013; van

Staveren and van Tatenhove 2016; Tessler et al. 2015) in which human alterations have brought about a “regime shift” to a “new normal” of biogeophysical conditions (Moyle and Bennett 2008; Cloern et al. 2011; Mount et al. 2012).

Thus, the Delta is a novel Anthropocene/Econocene landscape (Florsheim and Dettinger 2007; Norgaard 2013, 2016). The rapid change of Delta ecosystems, combined with the Delta’s role as the tenuous fulcrum of California’s centralized water infrastructure, have led to a broad consensus that a more integrative and coordinated approach to Delta science, planning, and management is needed to address a range of ecological concerns (DSC 2013; DSP 2016; Wiens et al. 2016). These efforts will need to address the cultural and political dimensions of these transformative efforts, particularly for local communities, as mandated by “Delta as an Evolving Place” legislation (Delta Reform Act of 2009 [California Water Code §85054]). To date, Delta research on coupled human–environment coevolution and place values has been extremely limited (Healey et al. 2016; DISB 2017). This limitation is particularly apparent in ecological restoration and conservation efforts.

WHAT IS A LANDSCAPE APPROACH?

Broadly, a landscape approach can be defined as a framework that attempts to integrate multiple competing land uses with the goal of creating more equitable, adaptable, and multi-functional landscapes (Reed et al. 2015). The approach emerged in response to failed single-sector approaches to reconcile divergent conservation and development goals, and looks beyond “project” boundaries to deliver ecological, economic, and social benefits (Cadman et al. 2010; Sayer et al. 2013; Freeman et al. 2015; Reed et al. 2016; Carter et al. 2017). Landscape approaches have developed in parallel with landscape ecology, and adhere to an understanding of landscapes as multi-functional, multi-scalar, and comprising a heterogeneous “mosaic” of inter-dependent land uses, flows, and co-evolving processes (Forman 1995; Forman and Godron 1981; Dramstad et al. 1996; Sayer et al. 2013; Freeman et al. 2015; Reed et al. 2016).

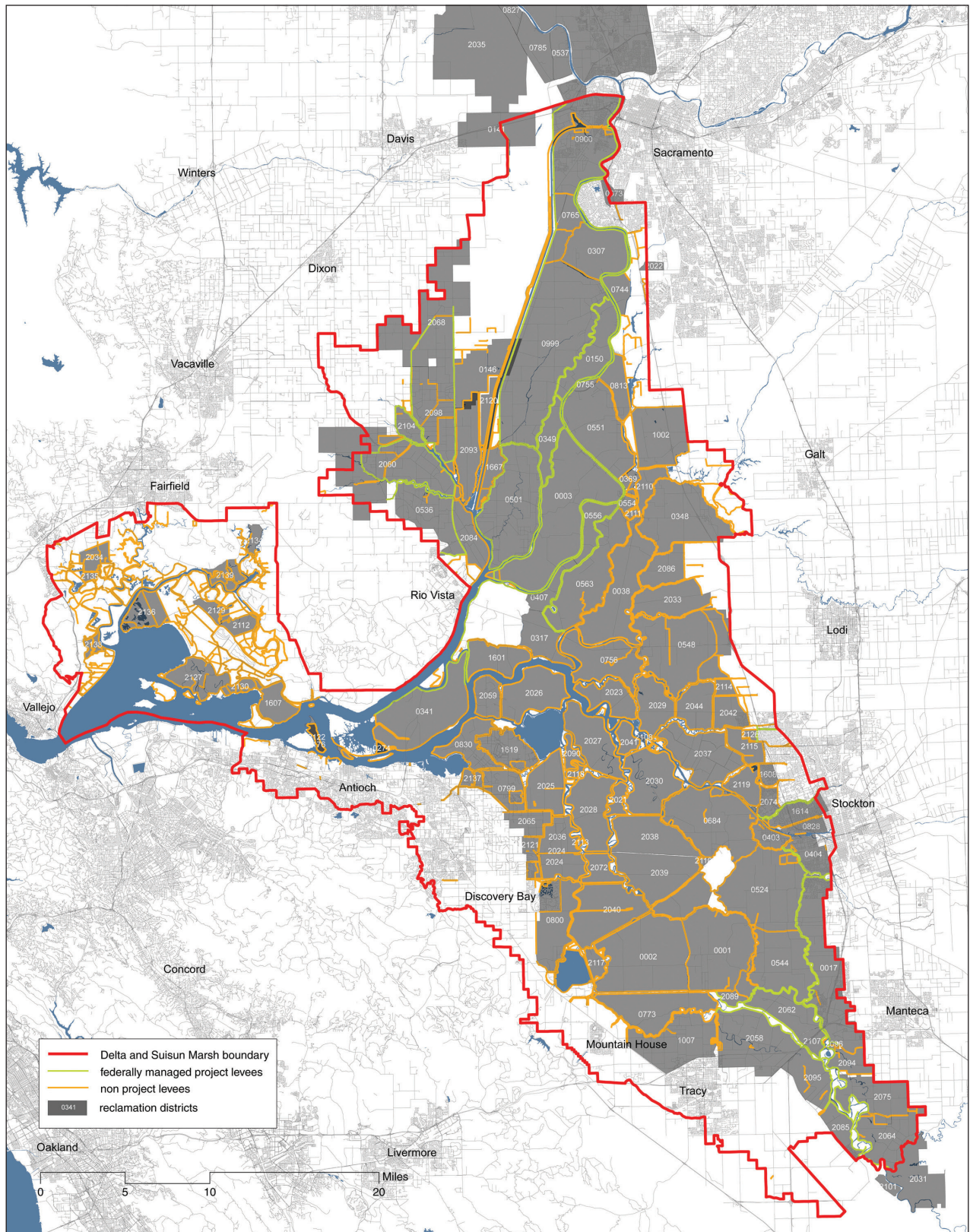


Figure 1 Levees, waterways, and urbanization. This map depicts the distribution and types of levees and reclamation districts within the Delta and Suisun Marsh, and their relationship to waterways, urbanized areas, and roadways. Map: Brett Milligan.

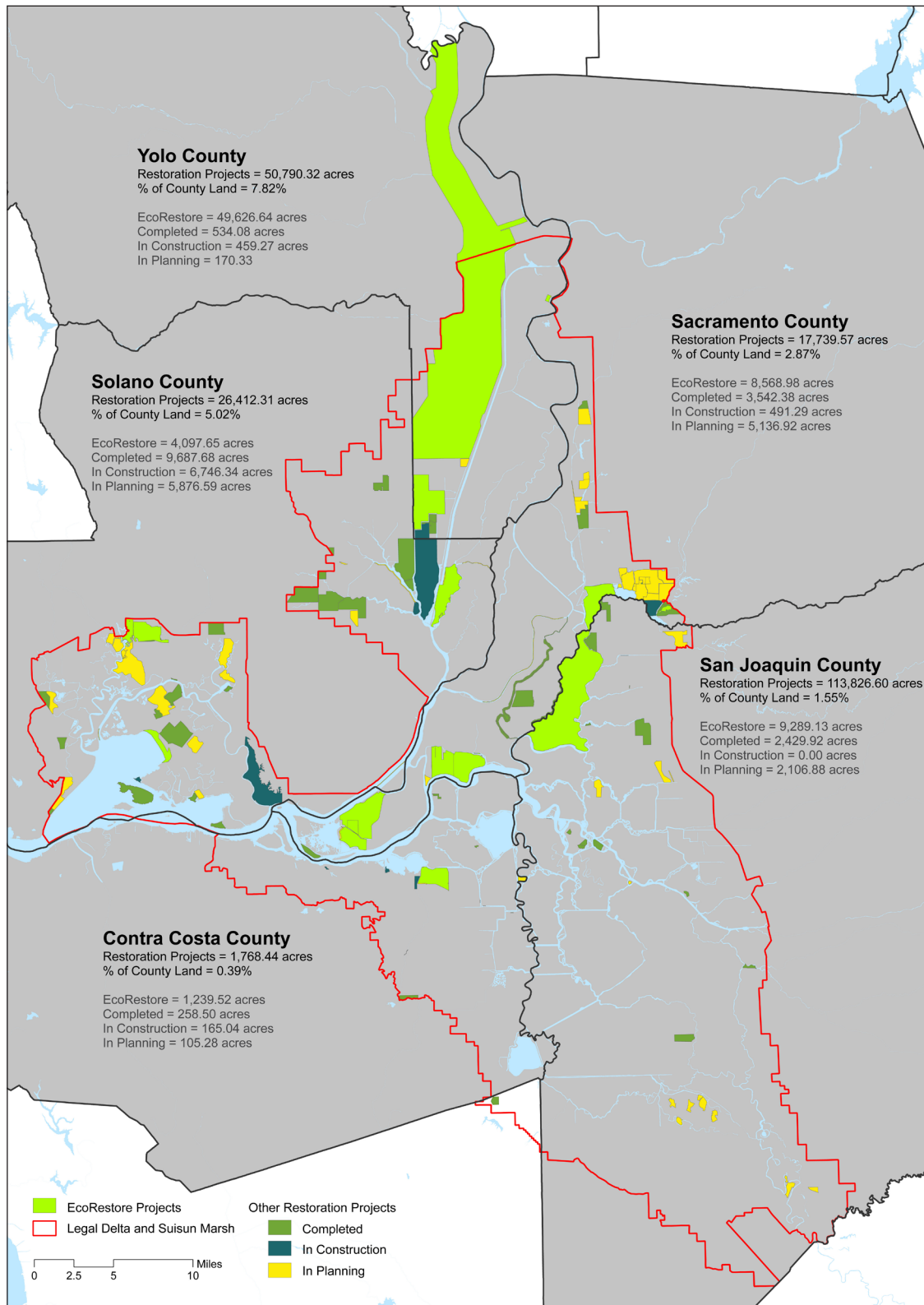


Figure 2 Restored landscapes in the California Delta: current and planned, as of 2016. Map shows proposed EcoRestore projects and all other restoration project that are completed, in progress, or in planning. Total acreages within the Delta are divided up by county. Data from the California Department of Water Resources and EcoAtlas. Map: Brett Milligan and Prashant Hedao.

Demonstrating the expanding application of this approach, the U.S. Bureau of Land Management (BLM) recently adopted a landscape approach to meet their legislatively mandated goal of, “accommodating multiple uses and achieving sustained yield while protecting the scientific, scenic, historic, ecological, environmental, air and atmospheric, water resource, and archeological values of the lands” (Federal Land Policy and Management Act of 1976 [43 USC §1701]). The BLM defines the landscape approach as, “a set of concepts and principles that guide resource management when multiple stakeholders are involved and goals include diverse and sustainable social, environmental, and economic outcomes” (Carter et al. 2017, p. 7). Core principles include “meaningful participation of diverse stakeholders, considering diverse resource values in multifunctional landscapes, acknowledging tradeoffs needed to meet diverse resource objectives, and addressing the complexity of the social and ecological processes involved by embracing interdisciplinarity and considering multiple and broad spatial and temporal perspectives” (Carter et al. 2017, p. 7).

Commonalities of landscape approaches defined in the literature include an emphasis on contextual and place-specific readings of biogeophysical and socio-political dynamics, which require applications “fitted” to specific geographies and goals (Freeman et al. 2015; Reed et al. 2016). Rather than reducing landscapes to component parts, the approach is synthetic in orientation, attempting to identify complex, relational patterns of emergence and change. This often leads to the use of integrative, mixed-method techniques that include surveys, interviews, focus groups, design workshops, participatory mapping, Geographical Information System (GIS)-based land-use analysis, field sampling/research, and literature review (Moritz et al. 2010; Milder et al. 2012; Sayer et al. 2013; Smith et al. 2013; Ros-Tonen et al. 2014; Mallampalli et al. 2016; Carrie et al. 2017). Other common features include stakeholder inclusion in decision-making, the importance of adaptive management, and supportive regulatory environments (Sayer et al. 2013; Kusters 2015; Reed et al. 2016). Along with associated calls for accountable and transparent governance, some authors also take a political stance to ensure that more powerful actors do not ignore the interests of

the less powerful (including non-humans and future generations) (Kusters 2015; Reed et al. 2017).

Significant differences in landscape approaches concern the spatial and temporal scales at which they operate. Many applications expand the scale of analysis to the “ecoregion,” so as to engage meta-population dynamics related to rates of migration and extinction within and across often fragmented patches of habitat. Similarly, a recognition of globalization means landscape mosaics are affected at the scale of global flows and geopolitics; thus, including trans-national development and extraction pressures, financialization, climate change, “invasive” species, international agricultural markets, urbanization, immigration, and emigration, etc. (Easterling 2014; Adnan 2016). Landscape approaches deal with these larger-scale interconnectivities and intersectionalities in different ways. For example, the landscape approach is being used to guide transnational corporations, like Starbucks and SAB Miller, in landscape investments (Scherr et al. 2017). These investments are intended to support place-based public-private-civic partnerships to address risk and meet corporate commitments related to water quality and supply, climate change, deforestation, and human rights and livelihood (Scherr et al. 2017).

Differences also emerge in how the complex medium of landscape is articulated and synthesized, which leads to differences in which actors and processes are selected and which are left out (Pasiiecznik et al. 2014). Some approaches emphasize human dynamics involved in subsistence, “livelihood,” and cultural activities (Sayer et al. 2013, 2015a); development and extraction pressures (Muller 2014; Carter et al. 2017); and poverty alleviation (Walter and Hamilton 2014; Reed et al. 2016); whereas others, such as many landscape ecology models, focus primarily or entirely on non-human species of concern (Dunn 1996).

Degrees of interdisciplinarity also vary according to how landscape-scale goals are prioritized. The degree of engagement with local communities ranges from non-existent to highly participatory projects, in which community members are directly involved in the planning and implementation of the approach through methods such as participatory mapping (Bourgoin and Castella 2011; Sunderland and Johnson 2013). Also variable is the degree to which

social learning, experimentation, and adaptation are actively cultivated and sought in the process itself (Sayer et al. 2015b). How experience—such as aesthetics, perception, and associated place values—is considered, or not, differs vastly from one approach to another, even though the “perceptual realm” is deemed “decisive for landscape change” (Gobster et al. 2007; Nassauer 2012, p. 222; Wiens et al. 2016).

From our review of the literature, we found that landscape approaches can be diagnostic (exerting agency through new integrative understandings of landscapes), or a design process for implementing deliberate change, or a hybrid of the two. This flexibility appears to fit with the customization of the approach to specified goals. Critics of the landscape approach often focus on its uncoded conceptualization and implementation, though this concern is not shared by all (Reed et al. 2016, p. 2540). There is also a tendency to focus on win-win outcomes when in reality trade-offs and “impractical changes” are more commonly required in reconciling conflicting land uses—a critique with high relevancy in the Delta context (Norgaard 2013; Reed et al. 2017).

Relevant Applications

Over the past decade, published applications of landscape approaches have multiplied, many in the United States. For example, Joan Nassauer has used a landscape approach to better visualize and manage the complex network of Iowa farming landscapes that contribute to the hypoxic dead zone in the Gulf of Mexico (Nassauer et al. 2007; Nassauer 2008). This work demonstrates how integrative planning and stakeholder inclusion can make science more relevant to policy, design, and adaptive management. Likewise, landscape approaches have been applied to large-scale infrastructure projects to assess performance across a holistic range of socio-political, material, technical, and ecological criteria. Davis et al. (2015) have applied such an approach to the recent Panama Canal expansion, showing how the science of logistics provides a limited and flawed accounting of landscape effects.

The U.S. Department of Agriculture (USDA) forest service has adopted a landscape approach to manage

native species, such as greater sage-grouse, and their semi-arid shrubland habitat (Wisdom and Chambers 2009), and the BLM has applied similar techniques to evaluate bighorn sheep habitat (Dunn 1996). Relevant applications in California include the Russian River watershed (NOAA 2014), in which initiatives to rebuild fish stocks were considered alongside flood risk management, the effects of drought, and competing water uses (Chabot et al. 2016).

In the Sacramento–San Joaquin Delta, applications of a landscape approach are surprisingly scant (Wiens et al. 2016). Applying a landscape ecology model to the Delta, Wiens et al. express the need for such an approach to better intervene in the complex “interplay of landscape structure, function and change at multiple scales,” and call for an “integrated landscape perspective... for managing or restoring ecological connectivity, habitat diversity, landscape adaptability, and resilience to change” (2016, p. 1–2).

Wiens et al. acknowledge that the landscape transformations required for restoration will occur within the dynamic cultural and engineered context of the region—the “Delta as Evolving Place.” But in doing so, their treatment of human presence and engineered constructions is largely positioned in terms of external constraints that must be respected but which limit the augmentation of ecological landscape networks. Such limiters include radio towers, levees that cannot be breached, and private lands that need to be worked around or purchased (Wiens et al. 2016). As described above, this approach is common in landscape ecology models, given their focus, where such constraints are significant and consequential to the realization of systemic ecological goals.

However, this framing constructs a duality or separation between the human and non-human—the social and the ecological—which is untenable in the Delta. Human labor and presence will be required to design and create these desired ecological landscapes, using a variety of technologies and machines to do so. Human communities living on or near these lands will need to support their creation for them to be successful. Human presence will be required to monitor and adaptively manage these new lands, and humans will actively inhabit these watery places in a variety of ways, whether those inhabitations are

planned for or not. These realities require a more hybrid approach that envelops human and non-human agents of landscape change.

RESEARCH METHODS

Our study sought to address a lack of research and planning on human use factors in “ecological” restoration of the Delta. Rather than approaching humans as ecological “stressors” or “externalized beneficiaries of the ecosystem’s services” (Ogden 2011, p. 4; Norgaard 2016), we approach humans as co-creators of these landscapes, wherein we have and continue to co-evolve with them (Milligan and Kraus-Polk 2017). Thus, our approach directly engages human experience, agency, and aesthetics as intrinsic to the design and evolution of what restored and naturalized landscapes are and will become.

The research approach we created to pursue these interests shares many characteristics with the landscape approaches described above. Specific to the Delta, we adhere to an understanding that the “mélange of structure, function, and change in landscapes is why the Delta is such a complex and dynamic place, rife with ‘wicked problems’ that challenge management or restoration” (Wiens et al. 2016, p. 5). Thus, we use a multi-scalar approach that emphasizes stake-holder participation, and integrative research methods customized to the specific spatio-temporal geography of the Delta (Graham 2010; Freeman et al. 2015; Reed et al. 2016). Translating these concerns into a research design, our project consisted of six overlapping and mutually informing methods. These included a planning, policy, and law review specific to the Delta; a survey questionnaire; interviews; landscape case studies; GIS mapping; and field work (see [Figure 3](#)). We briefly describe each of these methods below.

Planning, Policy, and Law Review

The planning, policy, and law review served to categorize and distill a complex set of protocols and plans that influence the Delta’s re-wilded landscapes. Planning infrastructure is complex in the region (Luoma et al. 2015; DSC 2016; Clemente et al. 2017), with more than 230 federal, state, and local agencies, institutions, and stake-holders defining,

envisioning, and regulating the Delta (Luoma et al. 2015). Our review covered both current and historic protocols, and was vital to understanding how the Delta is officially defined and managed, and how those definitions and schemata evolve. This research component provided a background that allowed us to analyze all other applied research methods for their adherence to or deviation from these protocols.

Survey Questionnaire

The survey consisted of a standard set of questions that we asked individuals with experience in these landscapes. The survey assessed perceptions of human uses and landscape boundary conditions. The approach here was one of landscape ecology but focused on human habitation, investigating patterns of use and occupation across a mosaic of heterogeneous landscapes. We had 35 survey participants, which, though relatively few, includes most land managers in the region. Overall response rate was likely less than 30%; however, we do not know the exact survey response rate, given that we enrolled agency and organization leads to voluntarily disseminate the survey to their personnel. A diverse array of landscape types were represented in the survey, including federal and state lands, regional parks, mitigation banks, and other private conservation land. Respondents included personnel from state and federal agencies as well as for-profit and non-profit entities. Names of specific agencies and private entities are not disclosed, because participants were assured they would remain anonymous to help ensure responses and unbiased reporting. The survey was conducted between March of 2015 and April of 2016.

Interviews

In addition to the survey, we conducted in-person interviews with land managers, resource enforcement personnel, restoration ecologists, environmental planners, Delta agency staff, and field researchers who work in these environments. These voluntary interviews, nearly 50 in total, varied in length and content. Unlike the survey, interviews allowed for more flexible and in-depth conversations. Many were conducted in the field during tours of landscape case studies (below), and the content of the interview

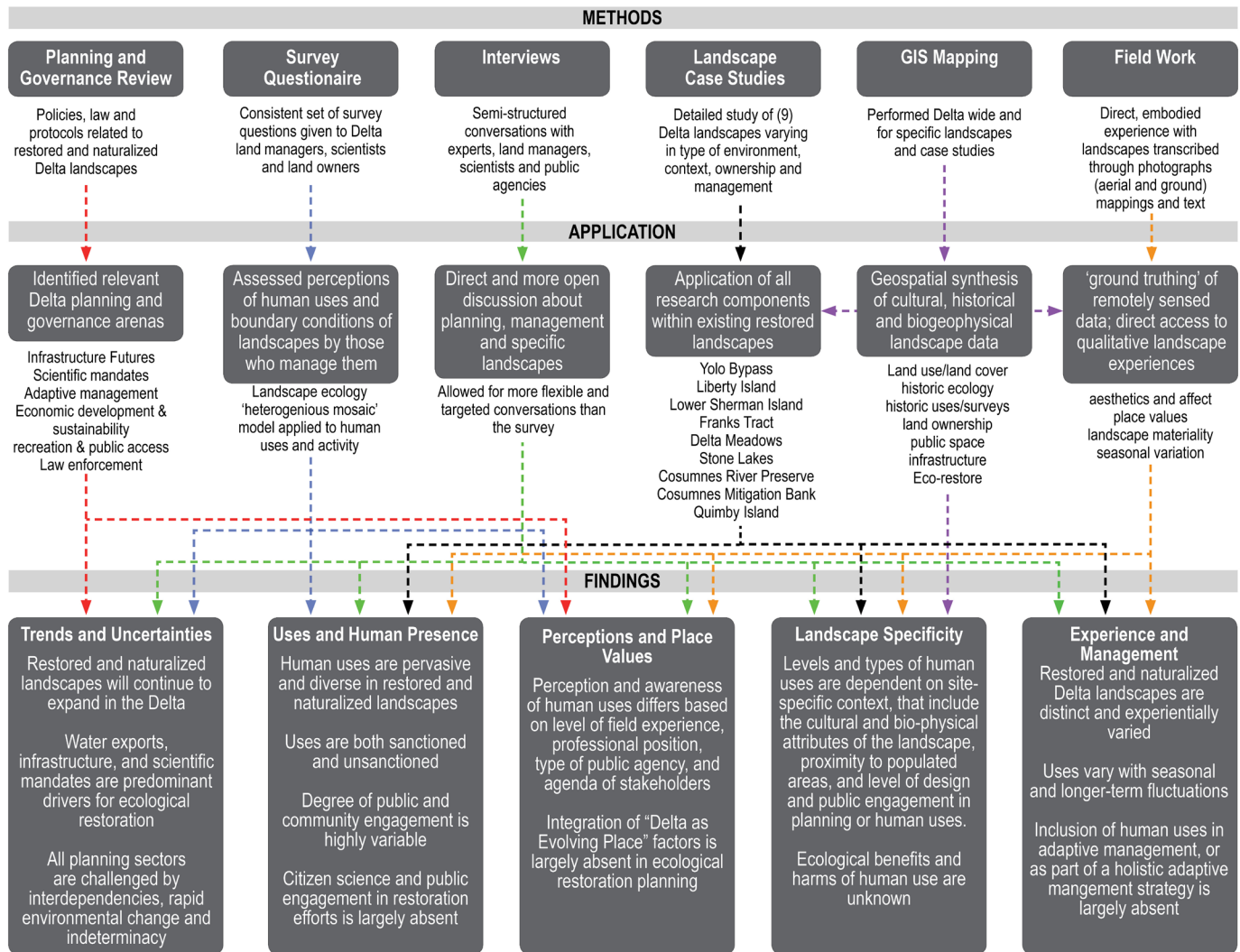


Figure 3 Research methods from *Human Use of Restored and Naturalized Delta Landscapes*. Graphic: Brett Milligan.

studies (below), and the content of the interview could be modified as new information emerged. Later in the study, we also had opportunities to follow up with new questions for interviewees or to clarify previous information. The interviews helped address both questions that emerged in survey results and inconsistencies observed in the planning and governance review. The perspectives gathered from our interviews informed all of our recommendations.

Landscape Case Studies

Nine case studies allowed for a detailed, comparative study of existing restored and naturalized landscapes in the Delta. Through them we could examine how

site-specific conditions influence human uses, as well as how official planning, management, and law-enforcement protocols are implemented, and to what effect. For each of these, we looked closely at how the landscape culturally and ecologically evolved to its current state. We deliberately selected multiple ecosystems and management regimens, including naturalized open water “lakes,” tidal marshes, floodplains, and oak woodlands. Ownership included federal, state, private, and non-profit, including both single-owner and multiple-owner partnerships and memoranda of understanding. We assembled each case study through a review of printed and online resources, participant interviews, extensive field

work, on-site photography (both ground and aerial), and GIS mapping.

GIS Mapping

GIS mapping provided remotely-sensed historical geospatial analysis of landscape and ecological transformations (pre- and post-reclamation), shifting ownership and jurisdictions, land use, management, and infrastructure. We applied GIS mapping to the case studies and Delta-wide spatial analysis.

Field Work

It is difficult to encounter human use as a detached bystander. Field work was essential to “ground truth” the research. Field work consisted of guided tours of landscapes and our own excursions on land and water, which was documented through photographs and text. The direct and embodied experience of the field work fed back into the questions we asked during subsequent interviews, and augmented the GIS-based mapping of our case study sites.

FINDINGS

As illustrated in our research methods diagram (Figure 3), we arrived at our findings through an integrated assessment of all six research methods. Broadly speaking, our data overwhelmingly demonstrated that re-wilded Delta landscapes are expanding and will continue to be strongly affected by human use, presence, and management. In the sections below, we discuss our findings in five categories: trends and uncertainties, uses and human presences, perception and place values, landscape specificity, and experience and management.

Planning and Policy: Trends and Uncertainties

In our planning, policy, and law review, we identified six planning domains of relevance to human use of restored and naturalized Delta landscapes. We arrived at these domains through iterative testing; applying them to the case studies until they consistently addressed the range of applicable factors and concerns we uncovered. Though often crafted in isolation, each of these planning domains are

interwoven and mutually influence one another. Each domain is briefly described below.

Infrastructural Futures

Infrastructure has shaped the form and functioning of the Delta since it was “reclaimed” and will continue to predominantly dictate the socio-ecological conditions of the region. It includes the creation and re-purposing of levees for water conveyance and now habitat restoration, from CALFED, through the BDCP, to WaterFix and EcoRestore. Two general conclusions can be drawn regarding infrastructure: (1) all current plans will increase the acreage of restored and re-wilded landscapes, via the projects themselves or their mitigation; and (2) these plans, and their timelines, are uncertain and likely to be changed and superseded by new propositions.

Scientific Mandates

These cover efforts to meet state and federal regulatory requirements, mitigate for environmental modifications (mainly from infrastructure, above), and adapt to accelerated rates of biogeophysical change, including new species assemblages and corresponding novel ecologies and ecosystem functions (Moyle and Lund 2015). Scientific mandates are the primary impetus that guide ecological restoration. Within them we found emergent trends toward more collaborative and inter-disciplinary approaches, including reconciliation ecology, “the science of inventing, establishing and maintaining new habitats to conserve species diversity in places where people live, work or play” (Rosenzweig 2003, p. 7). Currently, no scientific mandates are informed by social science.

Adaptive Management

This covers the intended adoption of integrative adaptive management in the Delta (DISB 2016; Nagarkar and Raulund-Rasmussen 2016), which is critical to how courses of action are refined and improved within a context of environmental uncertainty. There are uncertainties in how adaptive management theory will be practiced in the Delta, particularly in terms of what phenomena are

monitored and if human uses/agency will be included (Lund and Moyle 2013; DISB 2016, 2017).

Economic Development and Sustainability

This covers plans to bring more visibility and allure to the Delta, and more financial sustainability to Delta communities. These plans include the National Heritage Area (NHA) proposal, the Delta Branding and Marketing Project, and the Delta Protection Commission's (DPC's) *Vision 2020 Strategic Plan and Economic Sustainability Plan* (ESP). These plans assume the continuation of agricultural production as is in the Delta, yet this development pathway is threatened by several factors, including anthropogenic climate change, new conveyance infrastructure, and national and international commodity volatility.

Recreation and Public Access

The Delta Plan "recommends" rather than mandates that agencies provide recreation and public access opportunities in newly restored areas as part of performance measures (DSC 2013). However, based on historic and current precedents, this will likely not consistently occur because of the lack of dedicated funding and regulatory follow-through. Yet plans and efforts by state agencies to increase public access and recreation opportunities do exist, such as the Recreation Proposal for the Sacramento–San Joaquin Delta and Suisun Marsh and the Great California Delta Trail (CDPR 2011; DPC 2017). The DPC's Economic Sustainability Plan specifically recommends increased investment in recreation, which likewise promises economic returns (DPC 2012). Whether such plans will be implemented is uncertain.

Law Enforcement

This covers evolving law/resource enforcement concerns specific to these re-wilded landscapes, and identifies recent trends, such as growth in poaching and illegal marijuana production, the ecological and social effects of which remain uncertain. We found that law-enforcement issues critical to restoration were virtually nonexistent in Delta planning literature. We found the same to be true with resource enforcement, which is specifically concerned

with upholding laws that serve to protect, conserve, and manage unique and limited natural resources held in public trust.

In summary, broad take-aways from the planning and policy review are that: (1) restored and naturalized landscapes will continue to expand in the Delta through both intended and unintended actions; (2) water exports, infrastructure, and scientific mandates are predominant drivers for ecological restoration; (3) all planning sectors are challenged by interdependencies, ongoing rapid environmental change, and socio-political indeterminacy.

Uses and Human Presence

Interviews, survey results, and field work consistently showed that human use activity is pervasive in these landscapes and occurs in a wide variety of forms. In our report, we use the terms "sanctioned" and "unsanctioned" to delineate uses as they relate to management intentions and to avoid value-laden "legal/illegal" terminology. "Sanctioned" use refers to activity that conforms to official usage protocols in place for specific landscapes. In contrast, "unsanctioned" uses are those that diverge from such protocols. Using sanctioned and unsanctioned affords more flexibility in potential adjustments to use designations when they are considered in accordance with an adaptive management approach.

Broad categories of sanctioned uses in the Delta include: restoration work, science and scientific monitoring, land-management practices, infrastructural operations and maintenance, recreation, and resource enforcement. Unsanctioned uses are also endemic to Delta landscapes. Survey results showed illegal hunting/poaching, littering/dumping, vandalism and destruction of property, illegal use of motorized vehicles, and shooting of firearms to be the five most prominent unsanctioned uses; however, the range of such feral activity reported is quite diverse (see [Figure 5](#)). Seventy-nine percent of survey respondents reported unsanctioned landscape use, with the remainder saying use is unknown, or has not been studied or accessed. Where unsanctioned use occurs, it is considered a moderate (45%) to severe problem (30%). Surprisingly, 58% were unsure if unsanctioned uses were benign or beneficial in their effect on the ecology of the



Figure 4 Water infrastructure that was never realized: Ponds #9–13 of the White Slough Wildlife Area. These ponds are the borrow pits from the building of the nearby I-5 embankment. The ponds were dug in this linear fashion to strategically begin excavation of the proposed Delta peripheral canal. When the peripheral canal was voted down in 1982, these lands were retained by the state of California and turned over to the California Department of Fish and Wildlife for management under “interim” status. Today, as part of the White Slough Wildlife Area, they still retain this interim status. Fishing, hunting, wildlife viewing, and a variety of other recreational activities occur within the area. Photo: Brett Milligan.

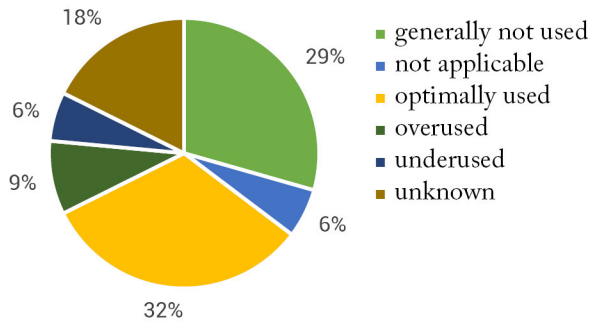
landscape. This was particularly surprising given that most survey participants were land managers and scientists.

Unsanctioned uses are unrecognized within planning and policy discussions, largely because they are not systematically monitored, reported, or discussed, particularly by field researchers who often encounter such phenomena (revealed through interviews and case studies). Also, what is sanctioned and unsanctioned activity is variable, not always clear, and can change. Given these conditions, law enforcement, which is underfunded, under-resourced,

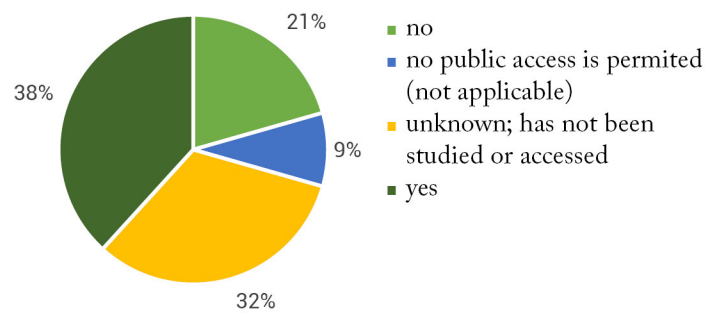
and focused on more populated areas, struggles to control unsanctioned uses.

The distinction between sanctioned and unsanctioned is further complicated by the diversity of legal access regimes (which may or may not be clear to visitors) across these landscape networks and the variable border conditions visitors encounter. Boundary conditions – whether administrative or physical – are critical determinants in conservation (Schonewald–Cox and Bayless 1986). Half of all survey respondents indicated a clear difference in land use, and/or differences in physical appearance between the restored or naturalized landscape and adjacent land.

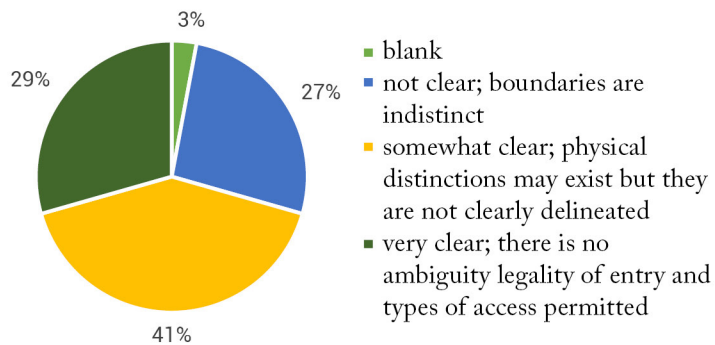
If sanctioned public use is permitted in this landscape, what level of public use currently occurs:



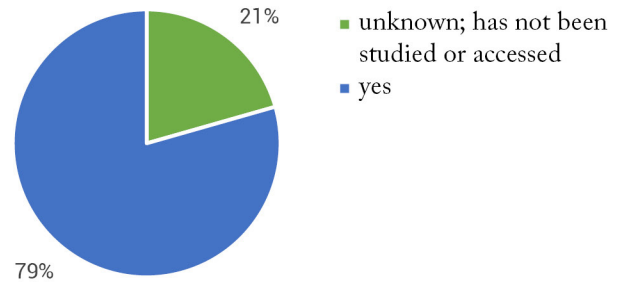
Are any sanctioned public uses beneficial to the ecology and functioning of the landscape?



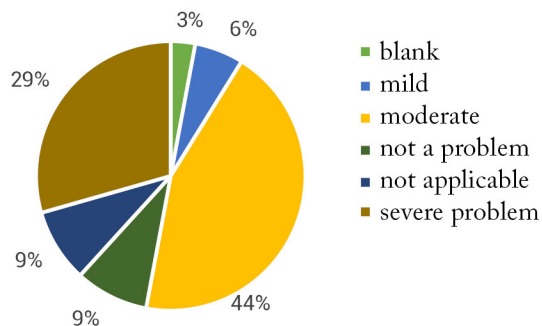
How clearly is the landscape's geographic boundary demarcated (i.e. via signs, fences, gates, etc) to anyone approaching it?



Does unsanctioned human use occur within this landscape?



If unsanctioned human uses occur within this landscape, do they conflict with prescribed uses and restoration objectives for the landscape?



Does unsanctioned use of this landscape affect adjacent properties and landscapes?

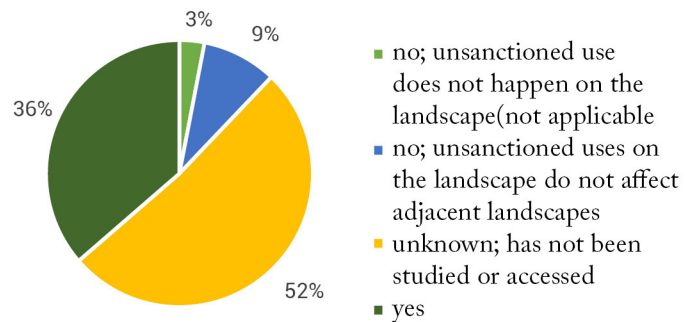


Figure 5 Sample of survey results. See Milligan and Kraus–Polk (2016) for full survey results.

However, only 30% thought these boundaries were “very clear,” approximately 40% thought them “somewhat clear,” and 25% found them not clear and indistinct. Also significant, around 70% replied that there was a variable degree of clarity along the boundary’s edge.

Our mixed methods research revealed a lack of ‘civic ecology’ initiatives in the Delta. More specifically, there is a remarkable absence of citizen science practices being used to engage the public in current science and restoration efforts, which contrasts sharply with the adjacent San Francisco Bay region (Fernandez-Gimenez et al. 2008; Ballard and Belsky 2010). When we interviewed scientists and land managers about the potential for citizen science in the Delta, we heard that it was possible, but with some concerns that it likely required some training and organization to implement.

Perceptions and Place Values

We consistently found that awareness, perceptions, and attitudes toward human uses varied significantly based on professional position and affiliation, level of field/landscape experience, and an individual’s upbringing and values, more generally (Figure 6).



Figure 6 Entrance sign to Liberty Island, summer 2015, expressing different land use perceptions and sense of place. Photo: Brett Milligan.

The survey and interviews indicated that public use is often considered peripheral or detrimental to restoration objectives, and pursuant to compatibility with higher-priority objectives (such as endangered species protection or flood control). There are clear reasons why human access to restored landscapes might need to be limited for ecological reasons, just as there are equally clear arguments for why the public has a fundamental right to access them, just as there are strong reasons for why some agricultural lands should not be re-wilded because of how they might affect local communities. Thus, determination of who does and does not have access to re-wilded Delta landscapes is a political question that is enmeshed in a diversity of stake-holder values and life experiences.

As an example, management of human uses on restored landscapes often operates according to thresholds of acceptability (Fischhoff and Lichtenstein 1984). These thresholds are a product of perceived realities and improvised responses to surprising and “weird” things people do, which cannot be fully predicted by laws and codes. These thresholds also play into the reality of scant resources allocated to law enforcement in the Delta, wherein personnel must choose which events to respond to. These informal protocols can result in significant differences in how uses are perceived by different users across landscapes and locales.

From a legal perspective, expanding restoration in the Delta through tidal marsh and floodplain creation will literally generate more fluid boundaries, which will complicate public access and legal protocols. Specifically, ‘re-commoning,’ via the expansion of navigable waters (Figures 7 and 8), will test definitions of state ownership and interpretations of the public trust doctrine. As public monies continue to support restoration efforts, access and recreational enhancements may be expected or demanded as part of a suite of public benefits. Uncertainties around water rights, flow criteria, endangered species protection, and the definition of beneficiaries and benefits will continue to bring legal contention. The desires of certain publics will be manifest through enactment of supportive laws, legal adaptations, and lawsuits; and imminent changes to the federal systems of environmental protection may alter



Early 1900s (reclaimed for farming between 1902 and 1906)



1937 (levee breaches in 1936 and 1938. 1938 breach was never repaired)



1950s (used as Navy bombing target from 1943 and 1952)



1970s (CA State Park established in 1959)



1993 (Urbanization of adjacent Bethel Island)



2014. (Levees (orange) and grid of regulated hunting blind locations)

Figure 7 Evolution of Franks Tract: 1900–2014. Over the last century, Franks Tract has changed from tidal marsh to reclaimed farmland, to open water Navy bombing range (Antioch Bombing Target), to an officially designated California State Park used for boating, fishing, and waterfowl hunting. Each transformation has entailed changing ecosystems, jurisdictions, and law-enforcement protocols that have spanned private, federal, and state entities. Historic Survey data and 1937 ortho imagery from the San Francisco Estuary Institute. Image: Brett Milligan.

ongoing and new, state, and local efforts to protect, restore, and enhance the Delta ecosystem.

These “Delta as Evolving Place” concerns are largely absent in ecological restoration planning and design practice, yet are significant factors on the ground. Clearly, Delta restoration will not occur within a wilderness context, but rather within the urbanized and territorial “wicked problems” context of this unique region. Within our report, we detail how political and socio-ecological place factors play a significant role in the future coevolution of the Delta (Milligan and Kraus-Polk 2016).

Landscape Specificity

Comparison of the nine case studies showed that levels and types of human uses depend on a range of site- and management-specific factors. The most salient of these were the cultural and biophysical attributes of the landscape, proximity to populated areas, and the level of engagement in planning for and accommodating human uses. Interviews, in particular, revealed how community engagement between the restored landscape and adjacent land-owners, towns, and other residents plays a formative role in the characteristics and effects of human presences. Conservation projects that have strong ties to local communities, such as Stone Lakes National Wildlife Refuge, reap benefits from the presence of invested and supportive neighbors (Figure 9). Interview subjects believed that those projects and landscapes that did not have strong ties experienced more management problems.

Similarly, comparing landscapes that have been a product of planned, formal, and institutionalized restoration processes with those that have been products of accidental or unplanned transformations reveal clear differences. We observed that initial planning-use protocols influence the types and quality of human uses that develop and tend to persist. Accidentally naturalized landscapes – such as from a levee breach – evolve differently; human and non-human users tend to spontaneously colonize the transformed landscape. This colonization is often followed by protocols that attempt to guide or reformat these socio-ecologies. (For detailed documentation of these evolutions, see the case



Figure 8 Floating duck-hunting blind covered in eucalyptus branches, Franks Tract, winter 2016. The California State Parks Department manages a duck-hunting program on Franks Tract. Hunters apply for permits to set up hunting blinds at specific coordinates within a grid of evenly spaced locations across the lake. The blinds are custom built by the hunters and must be removed at the end of the hunting season. Photo: Brett Milligan.

studies for Franks Tract, Liberty Island, and Sherman Island in the report appendices).

As discussed under uses, boundary conditions are key factors in conditioning sanctioned and unsanctioned uses. Areas that are easily accessed – such as those adjacent to public roads, highways, or urban areas – tend to attract more unsanctioned use for this reason. However, proximity cannot entirely explain use patterns. Other factors, such as informal patrolling and community monitoring, can mitigate these trends. The interplay of multiple variables like these are unique to each location, emphasizing the importance of in-depth local planning and management.

We unfortunately found very little research, knowledge, or empirical documentation that assessed the ecological effects of human uses on these landscapes – whether beneficial, detrimental, or benign – and concluded that these effects are largely unknown. In particular, disaggregating the effects of unsanctioned activity, such as pesticide runoff from

marijuana cultivation, from “background” water-quality stressors is a challenge.

Experience and Management

The expansive tidal marshes of Liberty Island afford very different experiences than the more developed, world-class bass fishing lake at Franks Tract, or the actively managed ponds of Stone Lakes National Wildlife Refuge where migrating cranes alight. Re-wilded Delta landscapes are distinct from one another, and conditions within them vary according to daily, seasonal, and longer-term fluctuations, such as drought, floods, and sea-level rise. Cultural practices change in response to these fluctuations as well as to new economic and policy conditions. Mirroring the diversity of landscapes is the diversity of human uses and users. As the U.S. Bureau of Reclamation makes clear: “The average visitor [or user] does not exist” (USBR 2011, p. 3).

As described above, many human uses occur in Delta wilds, be they scientific, infrastructural, or recreational. Anthropologist Tim Ingold refers to these “patterns of dwelling activity” as taskscapes (Ingold 1993, p. 153), a fitting term for landscapes of the Delta. The taskscape encompasses the entire range of activities performed within a landscape that guide its ongoing evolution; “the landscape is never complete: neither ‘built’ nor ‘unbuilt,’ it is perpetually under construction. This is why the conventional dichotomy between natural and artificial (or ‘man-made’) components of the landscape is so problematic” (Ingold 1993, p. 162). Over time, these everyday practices affect and are affected by the landscape medium itself, rendering them inseparable. We mention Ingold’s taskscapes to offer a counterpoint to how ecological restoration planning and science is officially approached in the Delta. Based on our review of those materials, dimensions of human experience within these lands are rarely considered as a significant object of concern or potential management opportunity. Collectively, we have learned much about the physical life cycle tribulations of threatened pelagic fish species, yet we know very little about the landscape experiences of the field researchers who monitor them, and even less about other humans who inhabit these environments.

Our ecological knowledge of the Delta is highly abstracted from direct landscape experience. Such abstraction has its value. Ecological data sensed by others is interpreted and translated into documents, so they can be broadly accessed by planners, scientists, and decision-makers who, in turn, can act upon that information, fostering a feedback loop of adaptive learning. The issue, as we see it, is that there is currently no such empirical feedback loop for embodied human action and experiences within these landscapes, because it is not yet an object of concern within the scientific and planning community. Specifically, the inclusion of human uses in adaptive management, or as part of an “integrated adaptive management” strategy, is largely absent.

In our fieldwork and interviews, we encountered several isolated yet promising models of integrative adaptive management. These included the California Department of Fish and Wildlife’s Natural Resource Volunteer Program (NRVP), active in the Yolo Bypass Wildlife Area and CalTIP (Californians Turn In Poachers and Polluters); UC Davis’ scientific bird monitoring coupled with recreational hunting (also in the Yolo Bypass); UC Davis’ volunteer-based fish monitoring in Suisun Marsh; the U.S. Coast Guard auxiliary; and the Delta Conservancy’s volunteer waterway clean-up. Part of what made many of these efforts effective is that they enroll public citizens or academic organizations to assist in monitoring and management efforts by offering them access to places they want to be, or activities they wish to engage in. This creates a win-win situation.

DISCUSSION / RECOMMENDATIONS

Our study was undertaken with a transformative agenda to address gaps in Delta science, planning, and design that relate to human use of restoration areas. Thus, the integrative approach we deployed in the study was largely diagnostic, seeking to empirically demonstrate the complexity and magnitude of coupled human–environment relationships within re-wilded Delta landscapes. Having shown how our results supported our initial hypothesis—the peopled nature of these landscapes—our recommendations point toward a more integrative socio-ecological approach to Delta restoration.



Figure 9 Native plant hedgerow being installed at Stone Lakes National Wildlife Refuge by the Sacramento Tree Foundation, winter 2015. In addition to providing habitat, the hedgerow is intended to be a buffer and natural fence that will discourage trespassing onto adjacent, privately held farmland. Photo: Brett Milligan.

Our overarching recommendation is to apply more integrative approaches to restoration that treat humans and human agency as integral to the ecology of these environments. We already see a move in this direction with the emergence of more inclusive forms of restoration planning in the region. A current example is the Cache Slough Complex restoration planning effort, in which state agencies, Solano County representatives, local land-owners, and other community stake-holders are involved and in conversation with one another at the initial stages of planning. These integrative approaches will present challenges and require trial and error to refine. However, we think they will prove worthwhile since they embrace the real social, technical, and institutional complexities of the Delta, rather than disregarding such realities in the planning stage, only to crash into them upon implementation.

The Cache Slough experience also demonstrates the need for more localized planning that can address

unique landscape conditions. It is common to speak of the Delta as a whole, yet it is neither biophysically nor socio-culturally homogenous. Restoration planning needs to be customized to the cultural and biophysical specificities of the restoration site and its surrounding context.

The Delta's novel ecology is surprisingly absent in regional marketing and visitor information, as if we do not want people to know the extent of its anthropogenic alteration. This omission is a lost opportunity for conservation efforts. Calling attention to the Delta's dynamic and novel ecologies offers another dimension of Delta experiences and "sense of place" that might improve scientific efforts, and build constituency for improving the health and resiliency of the larger estuary.

There is considerable opportunity to experiment with more creative, inclusive methods to perform landscape monitoring and management that give

value to the experiences and embodied knowledge entailed in such work, particularly since “[t]he social relations through which monitoring takes place may be as important to successful adaptive management as the protocols employed or the data obtained” (Sayre et al. 2012). Civic ecology, community-based environmental monitoring, and community-based watershed stewardship programs have shown promise in increasing citizen trust in government, improving the biophysical environment, and fostering participants’ ecological understanding, while aiding scientific efforts and offering productive and desirable work–play experiences for the public (Shandas and Messer 2008; Theobald et al. 2015; McKinley et al. 2015, 2017). As an example, the creation of a Delta Research Station may be an opportunity for additional public engagement with the Interagency Ecological Program, which conducts extensive monitoring throughout the Delta (IEP 2014).

Creative alternatives also exist for resource and law enforcement. In our interviews, participants repeatedly brought up the “positive bystander effect,” whereby having “eyes on the landscape” can reduce unwanted and unsanctioned activity while encouraging desired activity. The EcoRestore initiative, which will create 30,000 acres of critical habitat restoration in the Delta by 2020, presents many opportunities to prototype and empirically test many of these integrative management techniques.

The Delta Independent Science Board (DISB) has spearheaded a movement toward more participatory planning and design for human uses and place values (DISB 2016). In their comments to the recent 2017–2020 Delta Science Program Science Action Agenda, the DISB specifically advocate for a holistic evaluation of human responses to management actions as well as ongoing consideration of human concerns and behaviors when policy is developed and updated (DISB 2017). We concur with their call for integrative adaptive management, which accounts for shifting uses, cultural preferences, and socio-politics that will occur with biogeophysical transformations. We suggest that unsanctioned use be planned for in ways similar to newer approaches toward novel and reconciled ecologies, accommodating those “guest” species that “play nice” (or taste good) (Orion 2015; Pearce 2015). A critical component of managing

unsanctioned uses is making conscious and well-considered decisions about whether an activity should be considered unsanctioned, based upon empirical and local data (Cabrera 2016).

CONCLUSIONS

The landscape approach we designed and applied in this study was tailored to both the attributes of the Delta and our research question: how do humans inhabit and co-create restored and naturalized Delta landscapes? Specific research method choices, such as our distillation of Delta planning, policy, and science literature, was based on the prominent yet shifting agency that these works and protocols exhibit in the region. This customized or “fitted” approach adheres to current scholarship on landscape approaches, which emphasize the need for adaptability of methods to address geographic, place-specific conditions combined with specific issues of concern. Our empirical interpretation of the Delta is clearly one among many. It is a reading attuned to specific landscapes in the Delta and how people inhabit and affect them. This targeted specificity (rather than assumed universality) should form the basis for its evaluation and its potential adaptation for application to similar environments, such as other urbanized deltas undergoing intentional processes of ecological recovery and land transformation.

Landscape approaches also strive to engage complex realities and diverse stake-holder and participant perspectives that characterize landscapes generally. In our view, the six interrelated research methods we deployed—the planning and policy review, surveys, interviews, case studies, GIS mapping, and field work—gave us access to an understanding of the Delta’s re-wilded landscapes that we would not have achieved through pursuing any of these in isolation, and produced an assembling and understanding of the landscape medium that was far more than a sum of its parts. It was in our reading across these methods—identifying the correlations, gaps, and contradictions among them, and then asking new questions based on those findings—that a consolidated interpretation of what was occurring in these landscapes has emerged.

The work presented in this paper has been largely diagnostic as a landscape approach, confirming

that Delta wilds are characterized by pervasive and diverse human uses. It identified social and cultural phenomena that have yet to be adequately accounted for in the making and management of these evolving landscapes. This is but the first stage of the landscape approach. Going forward, we hope the findings and recommendations presented here can move into active planning and design efforts for transformative socio-ecological restoration in the Delta.

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