Title
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Journal
San Francisco Estuary and Watershed Science, 11(3)

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Publication Date
2013

DOI
https://doi.org/10.15447/sfews.2013v11iss3art9

SF E&W San Francisco Estuary & Watershed Science: A Broad Perspective

The Econocene and the California Delta

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Considering the 50-fold increase and the globalization of economic activity during the 20th century, we are now in the Econocene: an era where our economy has become the major driver of rapid global change. Managing the California Delta will require policies that facilitate looking ahead and continually working with change rather than looking back and trying to secure a static past. Simply making modest adjustments in the current science–policy interface will be insufficient. Impractical changes—that is, those well beyond existing practice—are called for across the public, private, and non-governmental sectors.

Dealing with the variability of nature has been central to human survival, indeed to all species. Being social and smart, people have organized collective strategies to live with nature's capriciousness. Water management, in particular, has long been central to the cultures and structures of many successful societies around the world. With the rise of modern nations in the 19th century, being social and smart took the form of progressive, or scientific, governance of land and water.

Central to science a century and a half ago was the premise that nature varies in knowable ways around an invariable mean. Those concerned with the big questions of geological history and the evolution of life saw dynamics, but hydrologists and ecologists at the time saw stability. For water science, this led to classifications such as a 100-year flood and 10-year drought, as well as management concepts such as reservoir operating rules. For fish and wildlife, the concepts of sustained yield and critical thresholds were developed through an understanding of nature having set properties. Similarly, water rights—indeed our concepts of property in general—are rooted in a known nature that varies around a mean. Importantly, this allowed nature to be divided up, owned, and exchanged. Equally important for this essay, our understanding of responsible environmental management and accountability, whether in the private or

public sectors, is tied to laws and regulations that are premised on a known, or soon to be known, natural world. The role of science has been to articulate the known and push back the unknown wherever it is most important for environmental governance, both public and private.

The mechanical view of nature with statistically definable variation, complemented by increasingly market economic organization facilitated a 3-fold rise in human population and a 50-fold expansion in market activity during the 20th century. This incredible expansion in human activity is transforming the earth. Some scientists are proclaiming that the earth has moved from the Holocene into the Anthropocene, where people are the predominant marker of global change. Given the expansion of economic activity, it would be more appropriate to call it the Econocene to focus our attention on the primary driver of socio-environmental change: the global and increasingly market-based economy.

This expansion has led to numerous unforeseen environmental consequences. Learning from bad experiences, we imposed a series of environmental restraints, modifying private rights and public responsibilities accordingly, throughout the 20th century. As a part of this correction, the politics of conservation and preservation transformed during the late 1960s into a scientifically and legally driven environmental movement based on a new ecological systems understanding of nature. This shift accelerated and compounded the complexity of rooting our understanding of private property and responsible public action in a knowable world. The deterministic scientific worldview behind the idea of property and responsibility did not change, yet we discovered the world changed and evolved, and entirely new phenomena could emerge. While the public as a whole is by no means fully in tune with this systems view—indeed there is a counter rebellion to this shift in understanding—environmental scientists themselves realize that we are now in yet another new phase.

Central to the new phase of understanding is a rejection of the idea that nature varies in knowable ways around a knowable mean. Nature is constantly changing in unforeseeable ways—always has been—though now human activity appears to be accelerating this rate of change and, hence, uncertainty. Second, we can no longer think of a nature that is an "external nature" that is "out there," separate from us, for us to know. The world we live in today is driven by the ways we have known and organized—and by the technologies we have brought to bear on—nature. Our past interventions help explain the world we are in and are a major part of the driving force affecting the dynamics of the world we are trying to stay on top of today. Environmental science is becoming recursive. The California Delta we are trying to understand and the directions in which it is heading are a product of how we understood, governed ourselves, and thereby acted in the past.

While the rapidly expanding market economy has been a central driver of change, it is extremely important to stress that the mistaken incorporation of a predictable and divisible nature into our concept of private property and the market economy does not

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mean collective ownership and central planning are the answer. The problem is deeper than the "socialism *v.* capitalism," "top-down *v.* bottom-up," or right mix of government and market debates of the last century and a half. First, we need to acknowledge that top-down hierarchical social organization has boomed in the age of markets. Corporations are hierarchies, and they are bigger and more important than ever before in human history. It is a fundamental contradiction that modern peoples worship individual choice and markets in an age of corporate bureaucratic organization. Second, and equally important to both governmental and corporate organization, the myth of a predictable and divisible nature proved instrumental to hierarchical structuring, to the very nature of bureaucratic pyramids with many people at the bottom and only a few at the top. It is not a coincidence that California's Natural Resources Agency is divided into departments, boards, and commissions that are distinguished by the particular parts of nature they separately try to oversee and that the departments are further divided yet again. Corporations are similarly structured.

A bureaucracy, whether public or private, is a hierarchy of wastebaskets. At each level, managers simplify the information they have about the complexity of the system in which they are working as they communicate to the next level up. If information were not filtered and thrown out, the person at the top would need to try to know everything that all the people at the bottom know. The organizational structure of the pyramid, undertaken along preconceived notions of nature's divisibility, strongly influences how the filtering, or synthesis process, is done. When problems arise because they were not identified in prior syntheses, and they are perceived as passing problems, we assemble special task forces of scientists and managers but generally do not change the organizational structure. Sometimes we change the structure, as in the 1970s energy crisis when we assembled diverse energy units from multiple federal agencies into the Department of Energy to integrate energy and strengthen energy planning. Of course, we have subsequently realized that the early links between energy and land, energy and water, and energy and the nuclear fuel cycle have been weakened through this new centralization that intends to emphasize the importance of energy. Hierarchical organization is advantageous only to the extent that systems can really be decoupled. If systems cannot be decoupled so as to facilitate hierarchical organization, a great deal more coordination and communication is a necessary cost.

Over the past century, Californians have struggled to address complex socio-environmental system changes, those in the California Delta being prime examples. We are now being called upon to address greater complexity; in effect the realization that what we had considered to be separable subsystems for our own organizational purposes are, in fact, more tightly coupled than we had thought. Along with this realization, we face more frequent surprises. Furthermore, the solid ground on which natural science has informed governance in the past, that ultimate underlying nature of nature, even if it is only statistical, is now in motion and taking sweeping random turns.

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All parties engaged in environmental governance processes—politically active citizens, private landowners, public resource managers, environmental scientists, and politicians—now must "face forward" to effectively ride the wave of socio-environmental change during the Econocene. What will "facing forward" entail? Since the problems go back a good century and a half, a lot of serious change will be needed. For saying this, of course, smart and knowledgeable people, especially those deeply entrapped in existing science and management practice, will label me as being impractical. And what I am saying is impractical because small changes to current practice will not be sufficient. Big changes are always impractical for those deeply embedded in existing practices that are failing us.

First, and most importantly, whether we are engaged primarily in scientific, political, judicial, or managerial processes, we will all need to change in ways that benefit each other. It is not simply a question of what kind of science is now needed in this new era. We all need to be social and smart together in new ways. Science has to be supported, understood, incorporated into institutions, and acted upon by all. Indeed, acting upon science is the only real test of its usefulness and validity.

Second, we will all have to be more responsive. Both private interests and the common good will change more rapidly. Working together politically will be easier because old battles will become environmentally and economically obsolete sooner. On the other hand, grasping the most significant emerging battles will be more difficult, leading us to cling to the old. As scientists, we will need to spend less time perfecting our understanding of decade-old questions, let alone century-old, and shift monitoring and analysis to incipient issues. Managers will find priorities a moving target. Responsive policymakers will need to keep them moving.

Third, to speed the scientific process and incorporate new knowledge, the lines among science, policy, and management need to blur; policymakers and managers need to participate more in science processes, scientists more in the policy and management processes. Universities, for example, could encourage scientists to take 3-year positions in policy and management and then return to academe. Universities also could welcome government scientists who work in policy and management to 3-year stints in research and teaching.

Fourth, knowledge will not accumulate in a march of progress. Rather, as the socio-environmental system changes, some of what we have known will become obsolete while new questions, now recognizably driven more by socio-environmental system change than by the progress of science, will arise. Surfing in front of the wave of change provides a glorious metaphor; the drudgery of being on a treadmill is equally applicable. The flood of new questions for environmental science in the Econocene is obvious already, but the idea of progress still knocks about in our minds, the language of progress still spills off our tongues and into our texts. In the Econocene, we need to work hard to stay in place.

Fifth, "facing forward" will entail envisioning and implementing preferred *transitory* futures. We will need to drop old battles more quickly and look ahead to what the future holds for our environment and how it fosters our economy and well being. Restoration ecology carries with it the vision of a static past nature that never was realistic and is even less so in the Econocene. We need a rapid philosophical and practical shift toward what I term "futuration" ecology: toward looking ahead to where habitats are headed and then trying to influence their direction toward more desirable outcomes rather than trying to return to the past. Given the great uncertainties ahead, encouraging a diversity of habitats will offer more options for species to find suitable habitats under global change.

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Sixth, we will need to be much more trusting of each other's knowledge and intentions while at the same time less accepting of those who are not working toward the common good. We must learn to understand complex problems together and seek the common good. Looking out excessively for one's own interests was not a virtue among the participants of a wagon train heading west or among farmers settling the frontier. Indeed, individual greed was not likely a virtue in any civilizations heretofore.

The level of the sea may steadily rise, though its rate is in considerable dispute, and there are possibilities of very rapid rise. The frequency of invasive species and severity of devastating droughts and floods will, probably, be more uncertain. The mutable stresses of the rapidly changing global economy and the demand for California's agricultural crops will add to the socio-environmental system's uncertainties. Stakeholders' stakes will move; the public will repurpose. As someone who sees the change we face in rapid evolutionary terms, I cannot be more specific than this. We will surely need to combine the human animals best traits: being smart and social—but just *how* we will need to do this is unclear. I can only hope that we can all be open to discovering, and rediscovering repeatedly, the very difficult situation we have gotten ourselves into, develop more trust among us, and work our way through it smartly, together.