OCTOBER 2013

San Francisco
Estuary & Watershed Science:
A Broad Perspective

Six Lessons Learned in Applying Science to Coastal Ecosystem Restoration

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INTRODUCTION

The commitment of the state and federal leadership for the Bay Delta Conservation Plan (BDCP) stating that ”science will guide how to best restore the ecosystem and how much water can be exported” is welcome, of course. Further, the invitation from the Delta Stewardship Council to the scientific community to indicate what is needed and how the scientific engagement should be structured offers an opportunity to provide that guidance.

However, excellent and internationally recognized science has long been generated on the Bay–Delta ecosystem and programs and structures to develop and apply science in Bay–Delta decision-making have existed for several decades. Is this new commitment to science-guided decision-making merely lip service or does it present an unprecedented opportunity? If so, how can scientific engagement be more effective going forward? And, is the scientific and engineering community really up to it?

Here I offer six lessons learned from 40 years of experience conducting and applying science for the management and restoration of coastal ecosystems in many parts of the United States and internationally. In particular, I have worked many years on the Chesapeake Bay, the Mississippi Delta, the Florida Everglades, and the Baltic Sea. Recently, I was called on by President Obama to serve on the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (Oil Spill Commission 2011). In that effort, I was on the other side of the fence, gaining rare experience for a practicing scientist in sifting though voluminous information to determine what really matters for making decisions and policies, and on a very condensed time-table.

From these experiences I offer this advice to scientists, engineers, and technical managers on how best to take advantage of the opportunity available for science-based decision-making under the BDCP, recognizing that policymaking itself is outside of my expertise and influence. My six lessons are not in any way exhaustive, but merely identify ways to overcome some common pitfalls that limit the effectiveness of science applied to policy.

SIX LESSONS FOR APPLYING SCIENCE TO POLICY

1. Focus diligently on what is known, while working to advance knowledge. Avoid the "little is known" rhetorical trap into which scientists often fall—it only puts science out of the game. By nature of their practice, scientists focus on things that are unknown or imperfectly known, particularly as they relate to their own disciplinary interests, often producing more new questions than answers. Many scientific questions cannot be fully resolved or do not really matter in decision-making. The fact is that we know quite a lot about how the riverine-coastal systems we study work. So, we should not start making laundry lists of research needs until we have done our best to address the questions based on existing knowledge and reasoned inference. Only then can we understand what new and attainable information will truly better inform decisions.

2. Scientists should get out of their skins and understand the larger contexts of both real-world consequences and policy formulation. While workshops and other synthetic processes can help, it is fundamentally the responsibility of all participating scientists to spend time to educate themselves about these larger contexts. In following the scientific findings and debates related to the effects of the BP Deepwater Horizon oil spill, both as a broadly experienced oceanographer and a former Commissioner, I am dismayed by the misconceptions and irrelevance in many of the writings and presentations of my scientific colleagues. Extrapolations from experiments or limited observations betray lack of understanding of the broader biophysical processes at work in the Gulf of Mexico. And, many passionately pursued scientific questions and debates are, as far as I can see, irrelevant to policy or management decisions or improvements.

3. Computational models have become essential to the quantitative integration and application of scientific information, but scientists and decision-makers should have a healthy respect for the limitations in their accuracy and uses. We should remember the aphorism of the pioneering statistician George Box: "All models are wrong, but some are useful." The Chesapeake Bay Program is justifiably proud of its development and application of linked atmospheric, land-use, watershed, and estuarine models to guide efforts to alleviate eutrophication and restore water quality and ecosystem health. But participants in the program become entrained in a singular and deceptively precise model world without remembering that the environment and the society that affects it is the reality—not the model. Actions are delayed while waiting for the models' next version, which, as Box admonished us, will never be right. Critical assumptions go untested and outcomes unverified because of over-reliance on the models (NRC 2011). Instead, the adaptive management that the Chesapeake Bay Program and many other ecosystem restoration programs are attempting to apply requires that models are closely integrated with and reconciled by observations. It also recognizes the uncertainties not represented in deterministic models and provides a basis both for narrowing these uncertainties and for making decisions in the face of them.

4. Too often, high quality and relevant scientific information goes unheeded in decision-making because it is buried in an esoteric paper or, even worse, an un-reviewed technical report. New modes for effective integration and application of science are required that incorporate communication strategies, not just as an afterthought, but as an integral component. For example, my own University of Maryland Center for Environmental Science has attempted to do this by creating an Integration and Application Network (*http://ian.umces.edu/*). These modes must be efficient and timely because expertise is a rare commodity that should not be wasted in endless meetings, but focused sharply and critically. The scientific community must organize for more timely and decisive resolution of controversies that can paralyze decision-making. An example from my own experience concerns the efficacy and unintended consequences of diversions along the lower Mississippi River as a means of sustaining and restoring tidal wetlands. Even then, a position paper on the controversy (Teal et al. 2012) was released nearly 2 years after the workshop airing the conflicting perspectives. Certainly, the Bay–Delta has seen its share of paralyzing controversies that need to be addressed in an objective and timely manner and, to the degree possible, decisively.

5. Scientists must become more adept at understanding and using complex networks through which science influences decision-making. Structures for scientific engagement usually assume a linear model wherein scientists communicate their findings and recommendations to a professional analyst, who communicates with an agency administrator, who communicates with policymakers. Science-based decision making rarely works through such a simplified linear model, but through more complex networks that shape opinions among key influencers, contributing to levels of certainty acceptable to prompt action (Keller 2009). Public awareness as shaped by the news media can play a key role in this regard, and I have had numerous personal experiences in which high-level political leaders only understood or paid attention to the issues after reading about it in newspapers (Boesch 2013). As a result, I have placed emphasis on developing skills and building networks for communication with the news media and even, somewhat timidly, through social media. Boundary organizations, such as COMPASS (Smith et al. 2013), help scientists connect themselves and their science to the wider world and are important in ensuring that science is better understood and used by society.

6. We can no longer treat climate change as a separate issue in ecosystem restoration and resource conservation, one that can be avoided because of controversy or postponed for later consideration. The evidence is clear that climate change is already affecting ecosystems and resources and will have even greater influence over the coming decades. This means coastal scientists have to factor in warming, sea-level rise (NRC 2012), changes in water resources, and other consequences in research, modeling, and assessment. However, this must be done in a measured way to avoid confusion about or postponement of the issues at hand. For example, it is clear that climate change will affect the temperature, depth, and circulation of the Chesapeake Bay—and very likely the amount and timing of runoff—in ways that will change the reductions of nutrient loads that are required to achieve restoration goals (Najjar 2010). However, it is nothing but distracting to attempt to change the load reduction goals set for 2025 now, when the changes expected in that time frame, particularly about runoff, are highly uncertain. Rather, the focus should be on achieving the 2025 goals, given that subsequent adaptation, whether it is to population growth, changes in agriculture, or climate change, will be perpetually required. But this does not mean ignoring climate change adaptation, which can be considered in designing solutions such as improved stormwater management systems. Furthermore, recognizing future requirements for reducing greenhouse gas emissions can lead to a broader array of now more feasible solution sets for watershed and estuarine restoration.

So, colleagues, consider the invitation for a new scientific engagement in the BDCP a real opportunity, yet to exploit it we will have to pick up our game by applying these and other lessons learned from many years of work in the Bay–Delta and around the world.

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