AN ENVIRONMENTAL PERSPECTIVE ON LARGE ECOSYSTEM RESTORATION PROCESSES AND THE ROLE OF THE MARKET, LITIGATION, AND REGULATION

Daniel F. Luecke*

I. INTRODUCTION

Before discussing the roles of the market, litigation, and regulation in environmental restoration, I present a series of steps that establish the context for that discussion. In this introduction, I offer some definitions of restoration as applied to an ecosystem. Later, I discuss the nature and structure of the restoration process for large systems, describe the goals of different interests in restoration, outline the role of science, and identify some of the flaws that I believe may be inherent in the process. I then discuss markets, litigation, and regulation in the context of the Platte and Colorado Rivers as they relate to the above issues.

The term ecosystem restoration brings to mind a number of possible definitions, such as:

a. The restoration of habitat to pre-disturbance condition; or

b. The re-creation of the historical configuration of a given habitat or region while accommodating human communities; or

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* Rocky Mountain Regional Director and Senior Scientist, Environmental Defense, Boulder, Colorado. Ph.D., Harvard University, 1971; M.A., Harvard University, 1969; M.S., Hydraulics and Hydrology, University of Notre Dame, 1963; B.S., Engineering, University of Notre Dame, 1961. This Article was developed from presentations given at the Strategies in Western Water Law and Policy: Courts, Coercion and Collaboration, University of Colorado Conference (June 1999) and the Environmental Restoration Symposium, James E. Rogers College of Law, The University of Arizona (November 1999). For help in the process of turning these presentations into a paper, I appreciate the invaluable research contribution of Erin Hunter, Environmental Defense legal intern from the University of Colorado Law School, and the editorial assistance of the *Arizona Law Review*.

c. The re-establishment of a balance in ecosystem structure and function to meet the needs of plants, animals, and human communities.[1]

As I employ the term, I use it to mean the third definition, the re-establishment of a balance in structure and function. It is clear that this definition is part scientific—structure and function—and part political—meeting the needs of human communities. It is the combination of the scientific constrained by political reality that, on the one hand makes restoration feasible and, on the other, complicates the science.

II. NATURE AND STRUCTURE OF RESTORATION PROCESS FOR LARGE SYSTEMS (ADAPTIVE MANAGEMENT)

Looking at the watershed scale, the best examples of large ecosystem restoration are the Sacramento-San Joaquin Delta (CalFed process), Columbia River, Everglades, Upper Colorado River, and Platte River. All share the following characteristics:

a. multi-jurisdictional within a given state;

b. multi-party in terms of user interests;

c. multi-agency at both the state and federal levels;

d. multi-state (except the Sacramento-San Joaquin Delta and the Everglades); and

e. transformed by both changes in land use patterns and in basin hydrology.

Ecosystem restoration processes are experimental by their very nature. There is very limited experience in this area, there is no common set of guiding principles, and, for large systems in particular, there are few, if any, successful examples to which one can point. By its very nature, a restoration process must be adaptive, i.e., it must rely on an approach that is incremental and that embodies monitoring, assessment, and evaluation protocols that are sufficient to provide information on the effects of restoration activities. Further, these monitoring and assessment protocols must be linked to the restoration enterprise in a way that allows modifications to, and enhancements of, restoration activities.

1. *See* CALFED BAY DELTA PROGRAM, ECOSYSTEM RESTORATION PROGRAM: STRATEGIC PLAN FOR ECOSYSTEM RESTORATION 4 (revised draft, Feb. 1999) [hereinafter CALFED RESTORATION PROGRAM]; Paul L. Angermeier, *Conceptual Roles of Biological Integrity and Diversity*, *in* WATERSHED RESTORATION: PRINCIPLES AND PRACTICES 49–64 (Jack E. Williams et al. eds., 1997); John S. Richardson & Michael C. Healey, *A Healthy Fraser River? How Will We Know When We Achieve This State?*, 5 J. AQUATIC ECOSYSTEM HEALTH 107–15 (1996).

The large ecosystem restoration process has several key components. Among these components are:

a. Develop a vision of restoration: a description of what the restoration of balance in the structure and function of the ecosystem would look like (this is not necessarily a straightforward task, given that very limited data may be available on structure, let alone function);

b. Define the problem statement: a determination of the geographic boundaries of the ecosystem and definitions of the ecological processes, habitat, species, and interactions (both spatial and intertemporal) affected by the problem;

c. Elaborate goals (and objectives): articulation of clear, tangible, and measurable outcomes that relate to the vision of restoration;

d. Construct conceptual models of restoration: conceptual descriptions of structure and function based on available data, knowledge, and judgement that can lead directly to potential restoration actions (models should highlight key uncertainties and data gaps);

e. Develop and initiate restoration measures (experimentation): based on the conceptual models, development and initiation of targeted research (to resolve critical issues about structure and function), pilot or demonstration projects (to determine the practicality and effectiveness of restoration actions), and/or full-scale implementation measures (in cases where there is reasonable certainty they will achieve a desired restoration objective);

f. Monitor outcomes: data gathering to monitor ecological indicators (e.g., abundance, macro-habitat characteristics, rates of change, nutrient cycling, energy flow, etc.) based on goals and objectives and on the important elements of the conceptual models;

g. Assess and evaluate outcomes: quantitative determination of whether restoration actions have met the stated goals and objectives in the context of the conceptual models; and

h. Based on assessment, restate problem, modify goals, and refine conceptual model: use of the monitoring data and its assessment to modify problem definition, goals and objectives, conceptual models, and restoration actions.[2]

The process is fundamentally iterative. As the above factors suggest, there is a great deal of cycling between the development of conceptual models and the initiation of restoration actions. Also, once monitoring data are gathered and assessed, goals are revised and models respecified.

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2. *See* CALFED RESTORATION PROGRAM, *supra* note 1, at 4.

III. DIFFERENT VIEWS OF GOALS OF ECOSYSTEM RESTORATION PROCESSES

In large ecosystem restoration processes, there is invariably an issue of compliance with federal law, usually either the Clean Water Act[3] or the Endangered Species Act,[4] or both. With the force of a federal statute moving the process, a question arises as to the fundamental motivation of the various interests involved. In my experience, the characteristics of ecosystem restoration tend to reverse the dynamics of traditional environmental advocacy efforts. Instead of working to prevent future activities that degrade environmental quality, restoration seeks to reverse yesterday's damage. This changes the dynamics of the relationships of the various stakeholders to the laws and processes that drive decisionmaking and action. I assert that, among the four major groups that are typically involved, while all may support the vision of restoration, each has its own "undeclared" goal in the process.

a. Federal regulatory agencies seek compliance with the applicable statute and regulations;

b. State resource agency accept compliance, but only to the extent that it does not overburden the state's resource users;

c. Resource users seek certainty with respect to the establishment of goals and objectives (once in place they do not want to see them changed), the development of restoration actions, and costs; and

d. Environmentalists are interested in a vision that is truly balanced (not biased in the interest of resource users), in an adaptive approach that will lead to real restoration of structure and function, and in restoration measures that are not overly constrained by existing resource use patterns.

It remains an open question as to whether these very different perspectives can be accommodated in restoration processes. One reason for optimism, in my opinion, may be the "cushion" created by the way in which

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3. Clean Water Act, 33 U.S.C. §§ 1251–1387 (1994 & Supp. III 1997). *See, e.g.*, DALE PONTIUS, COLORADO RIVER BASIN STUDY: REPORT TO THE WESTERN WATER POLICY REVIEW ADVISORY COMMISSION 19 (1997) (Colorado River); Alfred R. Light, *The Myth of Everglades Settlement*, 11 ST. THOMAS L. REV. 55, 57, 60–67 (1998) (Everglades).

4. Endangered Species Act, 16 U.S.C. §§ 1531–1544 (1994). *See, e.g.*, LEO EISEL & J. DAVID AIKEN, PLATTE RIVER BASIN STUDY: REPORT TO THE WESTERN WATER POLICY REVIEW ADVISORY COMMISSION vii, 7–28 (1997) (Platte River); PONTIUS, *supra* note 3, at 19, 41–42 (Colorado River); Michael C. Blumm, *The Amphibious Salmon: The Evolution of Ecosystem Management in the Columbia River Basin*, 24 ECOLOGY L.Q. 653, 663–66 (1997) (Columbia River); Light, *supra* note 3, at 67–68 (Everglades); Mary C. Wood, *Reclaiming the Natural Rivers: The Endangered Species Act as Applied to Endangered River Ecosystems*, 40 ARIZ. L. REV. 197, 198–203, 225–86 (1998) (Columbia River and Colorado River).

resources like water have been allocated in the past. Table 1 illustrates this point. The upper half of the table shows the portion of water use in each state that goes to the agricultural sector and the portion that goes to all other purposes. As the table makes clear, agriculture uses the lion's share in every state. On the other hand, a comparison of the earnings figures by state (as a percentage of total earnings in each state)[5] for the combined service and manufacturing sectors with earnings in the agricultural sector presents exactly the opposite picture, i.e., agricultural earnings are very low relative to major sectors like manufacturing and services. What this suggests is that a reallocation with fair compensation could occur with very limited economic consequences.[6]

IV. THE MARKET, LITIGATION, AND REGULATION IN IMPLEMENTING ENVIRONMENTAL RESTORATION

Few, if any, of the major, large habitat restoration projects are without a history of litigation. This is certainly true for the Upper Colorado River,[7] the Platte River,[8] the Everglades,[9] and the Columbia River.[10] In my opinion, none of these restoration projects would exist were it not for *litigation*. In some projects, litigation remains part and parcel of current efforts at restoration, as it does with the Columbia.[11] In others, litigation has been set aside, at least for the moment, in favor of collaboration in the context of federal regulatory authority.[12] The Upper Colorado and the Platte endangered species recovery programs, though at very different levels of maturation, are both in this phase.[13] However, the possibility of future litigation is an important stimulus to keep projects moving, even if the pace is sometimes undetectable. I will concentrate on the Upper Colorado and Platte

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5. *See* tbl. 1 *infra* Part IV.

6. For a discussion of the economic consequences of water transfers, see generally ROBERT A. YOUNG, ECONOMIC IMPACTS OF TRANSFERRING WATER FROM AGRICULTURE TO ALTERNATIVE USES IN COLORADO (1983).

7. *See* Wood, *supra* note 4, at 238–39.

8. *See* EISEL & AIKEN, *supra* note 4, at 7–39.

9. *See* Light, *supra* note 3, at 56–76.

10. *See* Blumm, *supra* note 4, at 663–66, 670–71; Wood, *supra* note 4, at 237–39.

11. *See* Blumm, *supra* note 4, at 670–71; Wood, *supra* note 4, at 252–84.

12. *See* EISEL & AIKEN, *supra* note 4, at 61–63, 75–79; PONTIUS, *supra* note 3, at 51–53.

13. *See generally* COOPERATIVE AGREEMENT FOR PLATTE RIVER RESEARCH AND OTHER EFFORTS RELATED TO ENDANGERED SPECIES HABITAT ALONG THE CENTRAL PLATTE RIVER, NEBRASKA (1997) [hereinafter COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH] (forming agreement entered into by the states of Colorado, Nebraska, and Wyoming, and the Department of Interior); COOPERATIVE AGREEMENT FOR RECOVERY IMPLEMENTATION PROGRAM FOR ENDANGERED FISH SPECIES IN THE UPPER COLORADO RIVER BASIN (1988) [hereinafter COOPERATIVE AGREEMENT, UPPER COLORADO RIVER] (forming agreement entered into by the states of Colorado, Wyoming, and Utah, and the Departments of Interior and Energy).

processes as vehicles for discussing the use of the market and regulation to achieve the objectives of habitat restoration.

TABLE 1. Water Use by Agriculture and Municipal & Industry Sectors and Percent Earnings for Agriculture and for Manufacturing & Services

	MUNICIPAL & INDUSTRY	AGRICULTURE	SERVICE & MANUFACTURING	AGRICULTURE
	1990 Water Use (percent of total and, in brackets, in millions of gallons/day) [14]		**1990 Percent Earnings**[15]	
Arizona	18 [1181]	82 [5389]	90.6	1.4
California	19 [6789]	81 [28,311]	91	1.8
Colorado	7 [938]	93 [11,762]	89.8	2.2
Idaho	2 [440]	98 [19,260]	81.1	10.4
Montana	3 [248]	97 [9052]	85.5	5.8
Nevada	19 [654]	81 [2826]	86.5	0.6
New Mexico	9 [308]	91 [3032]	87.6	2.6
Utah	17 [756]	83 [3624]	90.9	1.6
Wyoming	9 [723]	91 [7187]	73.9	2.5

The debate on issues of water use sustainability and environmental protection in the Upper Colorado and Platte River basins has extended over at least the last two decades.[16] Though on opposite sides of the Continental Divide, these two river basins are closely linked because of the capacity of water users to transfer water from west of the divide to the east. From an environmental perspective, the goal in both the Colorado and Platte has been aquatic and riverine habitat restoration and protection. The issue is one of allocating water, in a reasonable way, among the irrigated agriculture sector, municipalities, and the natural habitat of each basin using an efficiency criterion paired with instream flow protection. Two of the major components in this work are: (1) whooping

14. *See* University of Colo. Ctr. for the New West, *Tracking Change in the West*, (visited Feb. 8, 2000) <http://www.centerwest.org/tracking_site/h2o_agriculture_full.html>.

15. *See* U.S. Bureau of Census, *County and City Data Book (1994)* (visited Feb. 8, 2000) <http://fisher.lib.Virginia.EDU/ccdb/state94.html>.

16. *See* EISEL & AIKEN, *supra* note 4, at 55; PONTIUS, *supra* note 3, at 41–46, 50–54.

crane habitat protection in Nebraska;[17] and (2) native fish protection in the Upper Colorado.[18]

A. Platte River Whooping Crane Habitat

In 1997, Colorado, Wyoming, and Nebraska signed an agreement, formally recognized as the Cooperative Agreement ("CA"), with the Department of Interior to establish a habitat protection program for the Big Bend reach of the Platte River in Nebraska (critical habitat for the whooping crane and other endangered bird species).[19] The agreement contains both water (130 to 150 thousand acre-feet of flow shortage reductions in the Big Bend reach) and land protection objectives and requires participants to put in place the measures to reach these objectives on a precise timeline over the next several years.[20]

Analysis of historic flow regimes in the Central Platte reveals that the river has changed dramatically in the last 100 years.[21] In particular, the spring peak, the flow that determines the geomorphology of the basin (i.e., the geometry of the habitat), has been all but eliminated. The Cooperative Agreement represents the first step in creating flow patterns that reverse this depletion process. The challenge facing the signatories to the agreement is the identification and development of a set of technically, economically, and environmentally feasible options for water management and reallocation that will serve as the foundation for flow based habitat improvements.[22] The Fish and Wildlife Service has established flow targets which it believes must be met to reverse the course of habitat decline.[23] At some times of the year there are surpluses (winter and early summer when current flows are above targets), at others times there are shortages (spring and fall when flows are below the targets). The challenge is to reduce shortages both by managing surplus flows, i.e., re-timing flows, and by

17. *See* COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 1.

18. *See* COOPERATIVE AGREEMENT, UPPER COLORADO RIVER, *supra* note 13, at 1.

19. *See* COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 1 n.1.

20. *See id.* at Attachment 1, 1–14, Attachment III, 1–17.

21. *See* John G. Sidle & Craig A. Faanes, U.S. Fish and Wildlife Service, *Platte River Ecosystem Resources and Management, with Emphasis on Big Bend Reach in Nebraska*, Tbl. 11 (1997) (visited Mar. 22, 2000) <http://www.npwrc.usgs.gov/resource/othrdata/platte2/platte2.htm>.

22. *See* BOYLE ENGINEERING CORPORATION, WATER CONSERVATION/SUPPLY RECONNAISSANCE STUDY: FINAL REPORT 2-1 to 2-7 (1999) (report prepared for Governance Committee of Cooperative Agreement for Platte River Research).

23. *Instream Flow Recommendations for the Central Platte, Nebraska*, Enclosure 1 to Department of the Interior's Amended Comments Under Section 10(j) of the Federal Power Act before the Federal Energy Regulatory Commission on Project No. 1835 (Nebraska Public Power District) and Project No. 1417 (Central Nebraska Public power and Irrigation District) (May 23, 1994).

reallocating water uses from consumption to habitat protection. Achieving this by the use of markets and regulation will be discussed below.

B. Upper Colorado River Endangered Fish Recovery Program

The Upper Colorado Cooperative Agreement—an accord among Colorado, Wyoming, Utah, and the Department of Interior—precedes the Platte agreement by almost a decade.[24] The underlying premise of the Colorado program is that upper basin endangered fish populations can be restored and protected while at the same time allowing development of entitlements under the Colorado River Compact and the Upper Colorado Compact to occur in the upper basin.[25] Here the issue is one of enhancement and protection of instream flows for the benefit of endangered fish while upper basin depletions grow. One possible means of accomplishing this is by allocating, protecting, and delivering surplus water (often found in federal reservoirs in the basin), when available, to important fish habitat. In almost all cases, federal agencies that control these reservoirs have the authority to make releases for purposes of environmental protection.[26]

In the upper basin, both the main stem of the Colorado and its major tributaries are important to the recovery of the river's endangered fish species. Essential habitat can be found on the Yampa, Green, White, and mainstem of the river. The Green and Yampa Rivers serve as the least regulated portion of the upper basin. On the other hand, the main river, while heavily regulated and depleted, is also a very important native fish habitat.

To explain some of the issues associated with the flow management in the upper Colorado, I will use the example of the main river in the state of Colorado. Immediately above the confluence of the Colorado and the Gunnison (near the city of Grand Junction, Colorado) there is a section that is both heavily impacted by development and very important to native fish. This stretch of river is known as the 15 Mile Reach. It is depleted by two of the largest irrigation diversions in the Grand Valley, the most important being the Government Highline Canal. It is also

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24. The Upper Colorado River agreement was signed by all parties in 1988 and the Platte agreement in 1997. *See* COOPERATIVE AGREEMENT, UPPER COLORADO RIVER, *supra* note 13, at 5; COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 1.

25. *See* COOPERATIVE AGREEMENT, UPPER COLORADO RIVER, *supra* note 13, at 2.

26. *See* J. David Aiken, *Balancing Endangered Species Protection and Irrigation Water Rights: The Platte River Cooperative Agreement*, 3 GREAT PLAINS NAT. RESOURCES J. 119, 122–26, 148–49 (1999). Examples from case law include *Natural Resources Defense Council v. Houston*, 146 F.3d 118 (9th Cir. 1998), *Barcellos and Wolfsen, Inc. v. Wetlands Water Dist.*, 849 F. Supp. 717 (E.D. Cal. 1993), *United States v. Glenn-Colusa Irrigation Dist.*, 788 F. Supp 1126 (E.D. Cal. 1992), and *Carson-Truckee Water Conservancy Dist. v. Watt*, 549 F. Supp. 704 (D. Nev. 1982).

affected by headwaters diversion that take water under the Continental Divide for irrigation and municipal use in the Platte basin.[27]

As with the Platte, the problem is one of reversing the effects of these depletions and reducing shortages either by moving water from periods of excess to periods where recommendations exceed current flows or by reducing depletions by improving water use efficiencies.

V. ACCOMPLISHING PLATTE AND COLORADO RIVER RESTORATION GOALS

A. Federal Regulation

Both projects operate under the regulatory authority of the Endangered Species Act ("ESA").[28] Both are governed by cooperative agreements ("CAs"), signed by the governors of the watershed states and the Secretary of Interior.[29] Both serve as "reasonable and prudent alternatives" in the ESA Section 7 biological opinion process.[30] Both employ the concept of "sufficient progress," (i.e., movement toward goals specified primarily by the U.S. Fish and Wildlife Service ("FWS") and elaborated in milestones and benchmarks) either in the CA or, in the case of the Upper Colorado, a Recovery Action Plan.[31] The assessment of whether the parties are making "sufficient progress" is in the hands of the

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27. For a description of the diversions and depletions in the Upper Colorado, see Editors of High Country News, *Colorado River As Plumbing*, in WESTERN WATER MADE SIMPLE 153–216 (1987). For a list of existing depletions, see U.S. FISH AND WILDLIFE SERVICE, FINAL PROGRAMMATIC BIOLOGICAL OPINION FOR BUREAU OF RECLAMATION'S DEPLETIONS, OTHER DEPLETIONS, AND FUNDING AND IMPLEMENTATION OF RECOVERY PROGRAM ACTIONS IN THE UPPER COLORADO RIVER ABOVE THE CONFLUENCE WITH THE GUNNISON RIVER app. F (1999).

28. *See* Endangered Species Act, 16 U.S.C. §§ 1531–1544 (1994).

29. *See* COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13; COOPERATIVE AGREEMENT, UPPER COLORADO RIVER, *supra* note 13. The Upper Colorado CA is a very brief document with little detail and no milestones. However, it is accompanied by a Recovery Implementation Program, *see* U.S. FISH AND WILDLIFE SERVICE, RECOVERY IMPLEMENTATION PROGRAM FOR ENDANGERED FISH SPECIES IN THE UPPER COLORADO RIVER BASIN (1987), and, subsequently, a Recovery Action Plan, *see* U.S. FISH AND WILDLIFE SERVICE, RECOVERY ACTION PLAN OF RECOVERY IMPLEMENTATION PROGRAM FOR ENDANGERED FISH SPECIES IN THE UPPER COLORADO RIVER BASIN (revised ed., March 1997) [hereinafter USFWS RECOVERY ACTION PLAN]. The Platte River CA, on the other hand, is very detailed with a host of milestones, planning requirements, and associated responsibilities.

30. ESA § 7, 16 U.S.C. § 1536. For discussion on the Platte, see COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 2, For discussion on the Colorado, see USFWS RECOVERY ACTION PLAN, *supra* note 29, at 1.

31. On the Platte, see COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 1–14 (Attachment I); on the Colorado, *see* USFWS RECOVERY ACTION PLAN, *supra* note 29, at 19–53 (Part Two).

FWS.[32] If the FWS finds that there has not been sufficient progress, it may take a number of intermediate steps that, if not effective in moving the process forward, may lead to the ultimate sanction—a finding that the programs no longer serve as reasonable and prudent alternatives.[33] If this occurs in the case of the Upper Colorado, the FWS has the authority to develop its own reasonable and prudent alternative.[34] In the Platte, the FWS can reopen any biological opinions that have been issued under the CA.[35] In neither process can there be any doubt that the force behind habitat restoration is federal regulatory authority.

B. Role of Markets in the Context of Regulation

The Colorado and Platte River basins are two of the most important ecosystems and economic areas in the Rocky Mountain-High Plains region. The rivers have played essential roles in both defining the character of the region ecologically and in sustaining the economy, but the environmental value of these rivers often has been ignored in the pursuit of narrowly defined economic goals. The challenge, from an environmental perspective, is to correct the resulting imbalance in an equitable and efficient fashion. Markets offer the most reasonable and flexible option because they can create the economic incentives to reallocate water and associated land resources based on willing buyer-seller transactions.

In particular, I am interested in seeing that the real cost and real value of water and land are reflected in their allocation. Water is invariably under-priced, leading to its misallocation[36] to the detriment of natural systems.

Both the Platte and Colorado Rivers are dewatered by systems based on 19th century concepts of entitlement, pricing, and allocation—concepts that established ownership rights and market value only after water was diverted.[37] All the incentives were designed to encourage water withdrawals. In a semi-arid region like this, where over sixty-five percent of naturally occurring species depend, at least in part, on aquatic and riverine habitat, the resulting environmental problem is that the natural flora and fauna are now rare and at risk.[38] The

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32. On the Platte, see COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 4–8 ; on the Colorado, see USFWS RECOVERY ACTION PLAN, *supra* note 29, at 3 (Part One).

33. On the Platte, see COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 4–8. On the Colorado, see USFWS RECOVERY ACTION PLAN, *supra* note 29, at 4–5 (Part One).

34. *See* USFWS RECOVERY ACTION PLAN, *supra* note 29, at 4–5 (Part One).

35. *See* COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 4–8.

36. For an illustration of this phenomenon, see tbl. 1 *supra* Part IV.

37. *See* Charles F. Wilkinson, *Aldo Leopold and Western Water Law: Thinking Perpendicular to the Prior Appropriation Doctrine*, 24 LAND & WATER L. REV. 1, 1–14 (1989).

38. The 65% figure is intended to be a conservative estimate based on a review of a number of studies on the importance of wetlands and riparian areas in the Southwest

associated economic problem is one of correcting this misallocation without serious disruption to the region's economic interests.

The eventual objective, again from an environmental perspective, is the allocation, use, and protection of water and associated lands in ways that represent their true long-term values, that discourage waste, and that reward cooperative effort. The non-sustainable behavior to be changed is the allocation and use of these resources in a way that accounts only for traditional market effects and that represents ownership patterns that were established in the context of a system that overlooked natural values.

The use of market mechanisms anticipates the fact that abrupt changes in the reallocation of water, while they might have positive environmental consequences, could create economic discontinuities, associated adverse community impacts, and substantial political resistance.[39] In this vein, incentive-based reallocation programs affect gradual change, account for equity interests, and face less political resistance. Introducing and protecting environmental values through markets can, in a very fundamental way, ensure long-term sustainable use of water resources and economic vitality by creating water allocation incentive systems that encourage efficiency, quantify the value of instream uses, and discourage system-scale inefficiencies.

VI. THE ROLE OF SCIENCE

Science plays a fundamental role in: (1) the construction of conceptual models; (2) the development and initiation of restoration measures; (3) the monitoring of outcomes; (4) the assessment and evaluation of outcomes; and (5) the restatement of the problem. From the development of conceptual models through data gathering, monitoring, assessment, and redefinition, science and the

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and Rocky Mountain regions. *See, e.g.*, ENVIRONMENTAL DEFENSE FUND, HOW WET IS A WETLAND? THE IMPACT OF THE PROPOSED REVISIONS TO THE FEDERAL WETLANDS DELINEATION MANUAL 81–87 (1992); J.M. Brode & R.B. Bury, *The Importance of Riparian Systems to Amphibians and Reptiles*, *in* U.S. DEPARTMENT OF AGRICULTURE, PROCEEDINGS OF THE CALIFORNIA RIPARIAN SYSTEMS CONFERENCE 30, 30–36 (1984); Fritz L. Knopf et al., *Conservation of Riparian Ecosystems in the United States*, 100 WILSON BULL. 272 (1988); Special Issue, *Biotic Communities of the American Southwest-United States and Mexico*, 4 DESERT PLANTS 1 (David E. Brown ed., 1982).

39. The concept of using markets to allocate and protect natural and environmental resources has a long history. *See, e.g.*, ORRIS C. HERFINDAHL & ALLEN V. KNESSE, QUALITY OF THE ENVIRONMENT: AN ECONOMIC APPROACH TO SOME PROBLEMS IN USING LAND, AIR, AND WATER (1965); Robert Hahn & Gordon Hesler, *Marketable Permits: Lessons for Theory and Practice*, 16 ECOLOGY L.Q. 361 (1989). A recent report dealing primarily with the allocation of water resources, environmental protection, and the role of markets concludes that "[w]ater markets can be an effective tool for using water more efficiently and improving environmental quality by giving users economic incentives to conserve water and sell it to those who place a higher economic value on it." GENERAL ACCOUNTING OFFICE, WATER TRANSFERS: MORE EFFICIENT WATER USE POSSIBLE, IF PROBLEMS ARE ADDRESSED 3 (1994).

scientific method must be the guides. Without sound, peer-reviewed science, the restoration of a large ecosystem cannot possibly succeed.

However, the role of science in habitat restoration is, if not more complex than the development and testing of hypotheses, at least very different. It is different both because the science is integrative rather than analytic[40] and also because the restoration endeavor has a fundamentally important political component. Regarding the former, Table 2 identifies a host of characteristics, ranging from the underlying philosophy of each to the evaluation goal, that distinguish the integrative from the analytical. From my point of view, one of the most important attributes that distinguishes the integrative approach from the analytic is the application of statistics. The integrative approach is concerned with the minimization of Type II error (the risk of accepting a false hypothesis) while the analytic approach is concerned with minimizing Type I error (the risk of rejecting a true hypothesis). In the effort to minimize Type II error in large ecosystem restoration processes (i.e., implementing a measure that will not lead to restoration) there is always a call for more data and more study, particularly by those who see their interests threatened, before any action is taken.

VII. MAJOR ISSUES IN THE INTERACTION OF SCIENCE AND POLITICS IN LARGE ECOSYSTEMS

A. Restoration Projects

There are a whole host of characteristics at the interface of science and politics common to large ecosystem restoration processes—processes that are invariably multi-party forums.

a. Forums for ecosystem restoration are tailor-made for each process, thus there are rarely, if ever, standard operating rules; a situation that always puts minority representatives (where environmentalists find themselves) at a disadvantage. There are an enormous number of discontinuities, such as lax enforcement of rules of procedure, changing casts of participants, and haphazard attendance at meetings that make progress scattered and unfocused.[41]

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40 *See* tbl. 2 *infra* Part VII (listing characteristics of each).

41. This has certainly been the case for the Recovery Implementation Committee in the Upper Colorado (the committee established pursuant to Sections 2 and 4 of the Endangered Species Act). *See* USFWS RECOVERY IMPLEMENTATION PROGRAM, *supra* note 29, at 3-1. There is not a substantial body of literature on this feature of large scale ecosystem recovery process, but discussion of some of the shortcomings can be found in GAIL BINGHAM, SEEKING SOLUTIONS: EXPLORING THE APPLICABILITY OF ADR FOR RESOLVING WATER ISSUES IN THE WEST 30–38 (1997), DOUGLAS S. KENNY, ARGUING ABOUT CONSENSUS: EXAMINING THE CASE AGAINST WESTERN WATERSHED INITIATIVES AND OTHER COLLABORATIVE GROUPS ACTIVE IN NATURAL RESOURCES MANAGEMENT 9–10 (2000), and Douglas S. Kenney, *Are Community-Based Watershed Groups Really Effective? A Chronicle of Community*, 3 WINTER 34–37 (1999).

b. Scientific uncertainty invariably slows progress. The data to develop conceptual models and establish restoration actions are seldom sufficient to dispel all doubt. This inescapable uncertainty is often used by process participants (usually resource users and state agencies) to call for more data before any action is taken. It is very difficult to overcome this resistance to action.

c. Deadlines always slip with few adverse consequences for those who cause slippage.[42] In large system restoration, some delay is inevitable. Experimentation, particularly in an uncontrolled natural setting, always generates unexpected results. In these situations, there is a reluctance to impose consequences for delay. As a result, sanctions are rarely if ever prescribed or imposed.

d. Process pace is not a common interest of all parties. It is in the interest of some parties (usually environmentalists) to have process move quickly, while, for others (usually resource users), there is an interest in a slow pace. From an environmental perspective (as a minority), this alignment of interests makes it very difficult to force the pace. Minorities seldom can.

e. In large scale ecosystem restoration processes, funds come from several sources including federal agencies, state bureaus, and resource users. State funding implicates state legislatures, arch opponents of ecosystem restoration (especially if endangered species are involved).[43] With funding authority, legislatures often seek oversight, again affecting process schedules.

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42. The Upper Colorado program offers a good example. The State of Colorado had agreed to protect flows for the endangered fish under state water law. It made flow filings in December 1995, *see* Application for Water Rights to Protect the Natural Environment to a Reasonable Degree, Case No. 95CW296 (Dist. Ct., Water Div. 5, Colo. 1995), Application for Water Rights to Protect the Natural Environment to a Reasonable Degree, Case No. 95CW297 (Dist. Ct., Water Div. 5, Colo. 1995), Application for Water Rights to Protect the Natural Environment to a Reasonable Degree, Case No. 95CW156 (Dist. Ct., Water Div. 6, Colo. 1995), and Application for Water Rights to Protect the Natural Environment to a Reasonable Degree, Case No. 95CW155 (Dist. Ct., Water Div. 6, Colo. 1995), but withdrew the filings in 1999, primarily because it lost the support of the environmental community and the FWS after it buckled under the pressure of its water users to weaken the filings. Its failure to protect flows under state law on a timetable to which the state and its water users had agreed had no adverse consequences for the state, but merely forced the FWS to seek another avenue in a programmatic biological opinion. *See* USFWS FINAL PROGRAMMATIC BIOLOGICAL OPINION, *supra* note 27, at 3–5.

43. For discussion on sources of funding, see COOPERATIVE AGREEMENT, PLATTE RIVER RESEARCH, *supra* note 13, at 1–4 app. B. For an example of the attitude of state legislatures to endangered species, see Reintroduction of Endangered Species, COLO. REV. STAT. § 33-2-105.5 (1999).

f. Multi-interest processes are subject to hostage-taking, often by parties that share interests. This is a problem in any multi-party process where interests are linked in arenas outside the process. One party may threaten (or take) an action in another forum that makes restoration actions very difficult or impossible.

g. Processes almost always depend on use of (or change in) state law, again implicating state legislatures (hostile forums).

   1. State legislatures may be reluctant or unwilling to make necessary changes to state law.

   2. State institutions are frequently unable or unwilling to carry the burden placed on them by agreements negotiated within the collaborative process.[44]

   3. Legislatures frequently pass laws aimed at one target that are (perhaps unintentionally) antagonistic to implementation of restoration actions.[45]

h. In a multi-party process, the efficacy and weight of one interest (even more so for a minority party) is often imperceptible. Its influence is thin and diffuse. At best, one party can usually do little more than form a coalition (or voting block) to stop an action it does not support. It cannot move the process in a direction it thinks it should go. It may be able to create a stalemate, but not progress. When minority interests with relatively small staffs are faced with this situation, they often see the "opportunity cost" of participation as very high compared with what they are able to achieve.

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44. *See* discussion *supra* note 42.

45. *See* COLO. REV. STAT. § 33-2-105.5.

TABLE 2. The Two Cultures of Biological Ecology – Experimental Biology v. Restoration Biology (adapted from Holling[46])

ATTRIBUTE	ANALYTICAL	INTEGRATIVE
Philosophy	Narrow and targeted Disproof by experiment Parsimony the rule	Broad and exploratory Multiple lines of converging evidence Requisite simplicity in the goal
Perceived organization	Biotic interactions Fixed environment Single scale	Biophysical interactions Self-organization Multiple scales with cross scale interactions
Causation	Single and separable	Multiple and only partially separable
Hypotheses	Single hypotheses and nulls rejection of false hypotheses	Multiple, competing hypotheses Separation among competing hypotheses
Uncertainty	Eliminate uncertainty	Incorporate uncertainty
Statistics	Standard statistics Experimental Concern with Type I error	Non-standard statistics Concern with Type II error
Evaluation goal	Peer assessment to reach ultimate unanimous agreement	Peer assessment, judgement to reach a partial consensus
The danger	Exactly right answer for the wrong question	Exactly right question but useless answer

VIII. THE MARKET, LITIGATION, AND REGULATION IN WHAT ARE INVARIABLY FLAWED ECOSYSTEM RESTORATION PROCESSES

Ecosystem restoration is first and foremost a process of redistribution, i.e., the reallocation of resources from narrowly defined economic activities to environmental purposes. Vested interests with a stake in the former resist this redistribution with great energy.[47] As described above, all of the major restoration efforts have elements of litigation and regulation. In the Upper Colorado and Platte processes, the market element is also present. Whether this component will make success more likely remains an open question. In a comparison of restoration efforts in the Colorado and Columbia Rivers, Mary Wood concludes that the

46. *See* C.S. Holling, *Two Cultures of Ecology*, 2 CONSERVATION ECOLOGY tbl. 1 (1998) (visited Mar. 22, 2000) <www.consecol.org/journal/vol2/iss2/ art4/index.html>.

47. *See, e.g.*, Bennett v. Spear, 520 U.S. 154, 157–61 (1997); Barcellos and Wolfsen, Inc. v. Wetlands Water Dist., 849 F. Supp. 717, 720–21 (E.D. Cal. 1993); Carson-Truckee Water Conservancy Dist. v. Watt, 549 F. Supp. 704, 708 (D. Nev. 1982).

chance of success, i.e., substantially restoring the ecosystem, while slim, is greater in the Columbia than in the Colorado.[48] She bases her conclusion on the role of litigation in the Columbia as opposed to that of the recovery implementation plan in the Colorado which relies on the use of regulation and the market.[49] She may be right in this particular case, but I think that the ultimate redistribution of natural resources from traditional production to protection, however inefficient, can only be accomplished through a market structured by the presence of regulation.

48. *See* Wood, *supra* note 4, at 230–36.
49. *See id.* at 284–86.