physiology. His pursuit of that program, as he rose to the status of national symbol of science, helps illuminate one of the most far-reaching controversies of the late 19th century, between the natural sciences and the human sciences, epitomized as physics versus history.

In a masterly chapter, Hatfield probes Helmholtz's changing position on this divide. In sharply worded lectures of 1853 and 1862 he had lumped artistic with historical methods and differentiated them from natural science in terms of "artistic induction" versus "logical induction." The former, as an instinctive ordering of facts, yielded insight; the latter produced strict causal relations suitable for deductive explanation. By 1868, however, Helmholtz's view of aesthetics changed along with his view of science. The prominence of "unconscious inference" in the analyzer-synthesizer theory, Hatfield argues, led him to believe that "artistic intuition" has the same aim as unconscious inference and thus also as scientific reasoning, now in its much more inductive form. All three activities sought to abstract the lawlike from phenomena, the invariant forms or ideal types. But in thus assimilating art to science in the search for universal law, Helmholtz only reinforced the boundary he had articulated between natural science and history. Two points are noteworthy: Helmholtz provides a crucial marker for the modern two-cultures dichotomy; and he may be seen as a very early participant in the modernist movement in art, which so prominently abjured context, historical reference, and decoration in favor of abstraction, purity, and essences. Both developments continued for a hundred years. They are now in flux once again, along with analytic reduction as the goal of science. Is this the end of the Helmholtz era, or only an anomaly?

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Environmental Test Case

Everglades. The Ecosystem and Its Restoration. STEVEN M. DAVIS, JOHN C. OGDEN, and WINIFRED A. PARK, Eds. St. Lucie Press, Delray Beach, FL, 1994. xvi, 826 pp., illus., + plates + map. $97.50.

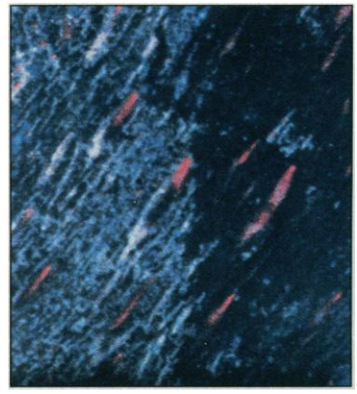
U.S. Secretary of the Interior Bruce Babbitt proposed to take an ecosystem approach to solving environmental problems and declared the Florida Everglades a test case. Though subsequent headlines focused on litigation and permits, the story was really about simultaneously achieving environmental and economic goals with scarce public and private funds. Everglades history suggests that endangered ecosystems threaten sustained economic development. Now a social experiment is under way to test this idea with new policies protecting the regional ecosystems on which the human economy depends. *Everglades* documents part of the scientific basis for such policies. It proposes restoration of ecosystem functions as the first step toward sustaining natural, agricultural, and urban subsystems of the regional landscape.

For a century, state and federal policies were to reclaim (drain) the Everglades for human habitation and agriculture. By 1917, four canals led the way for the U.S. Army Corps of Engineers' Central and Southern Florida Project for Flood Control, based on levees, water storage areas, canals, and large pumps. Flood protection spurred rapid urban and agricultural growth. But evidence accumulated that the diminished function of the Everglades and connected ecosystems threatened the human economy. First, the condition of the Everglades, Florida Bay, and perhaps the fringing coral reef deteriorated as a result of an insufficiency of fresh water, while the dumping of 80 percent of the system's fresh water into Atlantic coast estuaries caused damage of a converse sort. Second, overdrained organic soils have rapidly been depleted by oxidation, presaging farm abandonment or drastic change in farming methods in much of the Everglades Agricultural Area by the year 2000. Third, the urban water supply, stored in the surficial aquifer and Lake Okeechobee, is threatened by overpumping and deteriorating quality.

The original Everglades was a resilient system because it was large enough to tolerate flood and drought. Removing half the system and compartmentalizing the remainder has greatly reduced its resilience. Signs of degradation include an 80- to 90-percent decline in populations of wading birds, loss of peripheral marshes in which wading birds fed, abandonment of wading-bird rookeries in Everglades National Park, reduced hydroperiod with flow pattern changed from attenuated to pulsed, overdrainage and pooling near canals and levees, reversal from muck accretion to subsidence, and reduced flow of fresh water into Florida Bay. Economic sectors now threatened by the Everglades crisis include Everglades agriculture at $750 million a year, ecotourism of the Everglades at $300 million a year, and the downstream Florida Bay fishery at $104 million a year.

"Alligator pond surrounded by sawgrass (gray) and button bush (green). Photo extent ≈3 meters." [From *Everglades*]

"Plant communities of sawgrass marshes (gray), tree islands (green), and wet prairies. Note alligator trails. Photo extent ≈100 meters." [From *Everglades*]



"Satellite image showing plant communities: tree islands (red), sawgrass (gray), and wet prairie (black). Dark side of image is recent fire. Photo extent ≈10 kilometers." [From *Everglades*]

The Everglades case joins a handful of other resource-use crises being addressed by adaptive management, an approach developed in Canada and Europe and now gaining headway in the United States. Adaptive management seeks to formulate public policy in the face of system complexity and scientific shortcomings by stepwise implementation of policy changes accompanied by research, to make simultaneous progress in ecosystem science and application. The idea and previous cases are expounded in C. S. Holling's *Adaptive Environmental Assessment and Management* (Wiley, 1978), Carl Walters's *Adaptive Management of Renewable Resources* (Macmillan, 1986), and Kai Lee's *Compass and Gyroscope* (Island Press, 1993). In *Everglades*, 57 authors describe

the components and processes affecting the natural subsystem of the Everglades, with consideration also of the upstream Everglades Agricultural Area and the downstream Florida Bay. The disparate findings explicate the condition of the ecosystem, building a basis upon which it might be managed intelligently.

This volume is largely restricted to the natural part of the landscape, so much information essential from a management perspective is missing. The urban subsystem is not treated at all. The agricultural subsystem is summarized in one chapter, soon to be elaborated in A. B. Bottcher and F. T. Izuno's *The Everglades Agricultural Area* (University of Florida Press, forthcoming). The water-connected extremities of the Kissimmee River, Lake Okeechobee, Atlantic coastal estuaries, and the fringing reef are not treated here. Key findings on the biogeochemistry of Everglades wetlands are just beginning to be reported at conferences and in journals. A policy-development workshop of economists, political scientists, and legal experts was held in June 1994. Until those deliberations become public, the best treatments of Everglades policy are L. J. Carter's *The Florida Experience* (Johns Hopkins University Press, 1974) and D. John's *Civic Environmentalism* (Congressional Quarterly Press, 1994).

The substance of *Everglades* is the physical environment, limnology, plant, animal, and landscape ecology, and the biology of aquatic, endangered, and introduced species responsive to ecosystem change. Most of the authors argue that large-scale ecosystem restoration requires restoring the driving forces of the ecosystem, especially quantity and quality of freshwater flow, hydroperiod, and fire, rather than particular elements of biodiversity. However, those championing individual endangered species and top consumers or hoping for eradication of aggressively colonizing plants disagree. This signals a split between systems and species ecologists. Two hydrologic models are presented, one simulating the detailed consequences of water-management practices and a simpler one facilitating evaluation of the natural system under alternative policies. Current management has reduced the size of the system by half, broken up the water pooling pattern, pushed water westward, dried the lower part of the system over much of the year, and reduced the abundance of wildlife. Preliminary restoration goals are to increase the amount of water moving through the system and re-establish spatial continuity and seasonality of depth patterns, without damaging the urban and agricultural sectors. Nutrient-removal marshes are recommended in order to return urban and agricultural runoff to oligotrophic quality. Lake Okeechobee water should be delivered to the southern Everglades by flow-ways through the agricultural area, as proposed by the U.S. Army Corps of Engineers in 1955. The costs, effects, and robustness of these and other specific options need to be assessed. A key principle, to which Everglades research and policy does not conform, is that wetland management should relate to the entire catchment, include the effects of remote human land use and activities on the wetland, and account for human communities using or depending on the wetland resources.

Everglades research has been embodied in legislative action with astonishing speed. In 1993, Florida became the first state to mandate ecosystem-based management of natural resources. Florida's 1994 Everglades Forever Act establishes the nucleus of an eastern buffer strip of marshland that could conserve and cleanse urban runoff, recharge well fields, provide a groundwater head preventing seepage loss of Everglades water, and supply flow to the southern Everglades. Bolder steps will be needed to achieve these objectives, but the first step is taken. The act also establishes huge nutrient-removal marshes. Farmers are encouraged, with tax incentives, to reduce phosphorus concentration of water received by the marshes. Achieving oligotrophic performance standards in Everglades waters is deferred for 12 years, to provide time for establishment and equilibration of new farming practices, artificial marshes, and hydrological patterns. This new policy is the sort of bridge to the future advocated by *Everglades*, providing steps toward restoration and opportunity to learn. Lost in the translation has been public trust, because the science on which the policy is based is only beginning to appear.

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Non-Linearity and Behavior

Dynamical Systems in Social Psychology. ROBIN R. VALLACHER and ANDRZEJ NOWAK, Eds. Academic Press, San Diego, CA, 1994. xx, 505 pp., illus. $55 or £42.

Ever since its beginning in Wilhelm Wundt's Leipzig laboratory, scientific psychology has struggled with a conflict between the richness and variety of its subject—the human mind and behavior—and the rigor and stern simplicity of "true" scientific research and modeling. Take for instance people's attitudes toward a political candidate or their feelings of love and aggression, topics typical of social psychological research. One's attitude may change in light of new information, but it may also remain the same or eventually change suddenly for no apparent reason. How can such unreliable behavior ever be caught in the form of a serious model, let alone a law of nature?

Roughly speaking, psychologists have taken either of two stances. According to one, psychological phenomena are qualitatively different from those that are studied by the physical sciences and thus require a different form of theoretical inquiry. The other claims that psychological models should be no different from scientific models in general and that the vagaries of the psychological realm are in a sense coincidental, the result of both the complexity of the network of variables that determines human thought and behavior and the problem of finding reliable measures for psychological phenomena.

The latter stance has won out, and this explains why so many psychological theories are in fact disappointing and apparently miss the point that common sense would consider the essence of the psychological, namely the complex, unpredictable, and fluctuating nature of human life.

Vallacher and Nowak's *Dynamical Systems in Social Psychology* presents an attempt at overcoming the ambivalent relationship between theory and phenomena that has haunted psychology for so long. The collection of essays addresses the problems of social psychology in particular, but much of what the authors are saying applies easily to other fields in psychology.

Traditionally, psychology has taken as its examplar an idealized version of scientific models that had their origin in attempts at describing the motions of celestial bodies. With such an examplar, psychology has indeed had a hard time building interesting models and theories. Recent advances in physics and mathematics, however, have opened an entirely new realm of concepts, theories, and phenomena, covered by at first exotic but now widespread notions like chaos, complexity, and nonlinearity. For instance, a simple equation that describes a wide range of natural phenomena—the logistic equation, which now often serves as the main didactic key to the kingdom of non-linearity—displays a number of properties that are similar to what we find in human behavior, such as sudden qualitative changes following no apparent shift in the magnitude of the causes.

Although non-linear dynamics has been around for quite some time, psychologists have only now begun to understand its usefulness and consequences. Probably for the first time in social psychology, Vallacher and Nowak have brought together a number of authors who try to establish a link between the concepts and tools of dynamic systems on the one hand and the