1-1-1997

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From Science to Law to Politics: An Historical View of the Ecosystem Idea and Its Effect on Resource Management

Harry N. Scheiber*

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INTRODUCTION

There is an extraordinary amount of controversy, and not a little confusion, in contemporary debate over "ecosystem management" with regard to virtually all of its aspects—political, scientific, legal, and administrative.1 Indeed, abundant disagreement is manifest not

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I wish to thank my Boalt Hall colleague Professor David Caron and the students in our Spring 1997 seminar on Ocean Law and Policy; Dr. James Sullivan and Ms. Dolores Wesson of the California Sea Grant College Program; and, last, participants in the Marine Ecology Seminar of the Scripps Institution of Oceanography, UC San Diego (La Jolla), and fellow speakers at the Tyler Prize Pavilion inaugural convocation at the University of Southern California, who generously offered valuable comments on many of the ideas expressed in this brief paper as they were presented in my lectures on related themes in those two forums.

The author's research on ocean law and policy has been supported by grants from the California Sea Grant College Program, with funds provided by the Department of Commerce (NOAA) and by the State of California, to the Center for the Study of Law and Society, UC Berkeley. United States Government agencies may duplicate or distribute this Article without restriction.

1. See Richard Haeuber, Setting the Environmental Policy Agenda: The Case of Ecosystem Management, 36 Nat. Resources J. 1, 3 ("Despite significant attention, [ecosystem management] remains a loose collection of agency specific concept papers, pol-

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only over what the specific goals, institutional format, and procedures of ecosystem management (EM) should be in practice but even in discourse over the definition of the term itself. To be sure, some commentators have argued that an acknowledged “core” idea informs most theoretical and administrative formulations of EM that have been put forth by agencies and theorists. This idea posits that resource management should focus upon protecting biodiversity in complex natural systems. A complementary objective is to achieve institutional, attitudinal, and procedural reforms in the law and administration of resource management. These reforms would involve in the decisionmaking processes the entire cast of identifiable “stakeholders” (once known, in less benign rhetoric, as “interest groups”), bureaucratic governmental and/or corporate units, and interested citizen or environmentalist groups.

Other formulations of the basic definition of EM, however, are more concerned with instrumentalism and institutional design. They give what appears to be only a modest nod to the goal of biodiversity preservation, stressing instead what are essentially technocratic, process-oriented goals—especially the enhancement of administrative efficiency and organizational re-design to promote consensus-building. Often this latter approach to EM is linked to “adaptive management.” In practice, adaptive management translates into an elaborate accommodationist and incrementalist tactic for reducing the visibility and consequent political vulnerability of management innovation, and for defusing interest-group assaults on government agency authority by mobilizing a style of continuous reconsiderations and revisions of policies, of political compromises, and of administrative temporizing.
Little wonder, then, that a leading figure among the more optimistic analysts of the EM movement, R. Edward Grumbine, concluded three years ago in a survey and analysis of the literature on EM, that a great variety of "interpretations" of EM existed and that, since "the ecosystem approach [was] relatively new and still unformed, this [was] not surprising."\(^5\) Nor, for that matter, is it so remarkable that when the same author revisited the subject earlier this year he concluded that even after "thousands of hours of discussion, and significant first attempts at implementation," EM was still being "perceived by many as a buzzword"\(^6\)—a new and "slippery" concept that contending interests in resource exploitation and management (and also scholars in natural science, public policy, and law) were busy trying to capture on their own various terms and for their divergent purposes.\(^7\) Meanwhile, analysts of the actual application of EM programs have sometimes concluded that the EM concepts proved in the crucible of actual administration and of politics to be "amorphous [and] unenforceable."\(^8\)

Many of the uncertainties and paradoxes manifest in the current theoretical and policy dialogues have come to the surface in the ongoing debate over the EM approach in general and, more specifically, in the movement to bring ecological concepts into play as a controlling principle of specific new programs in California. Other papers in this symposium address these issues.\(^9\) What is intriguing to an historian such as myself is the way in which both the most optimistic objectives and the intractable perplexities evident in today's debates reflect very dramatically a number of deeply rooted and continuing patterns of relationship between science, on the one hand, and law and policy on the other—complexities that have significantly affected the ways in

\(^{5}\) Grumbine, What is Ecosystem Management?, supra note 3, at 27.


\(^{7}\) Id. at 42.

which the "ecosystem perspective," as it may be termed, has developed over many decades.10

With EM concepts' rise to prominence in the last few years, a few prominent scholars have begun to identify the conceptual origins of ecosystem concepts and consider their application in management, as well as identify the causal connections between changes in the theoretical paradigms in ecological science and how those shifts have affected our thinking about what regulatory law can and should accomplish. Their approaches tend to be at a "macro" level, and seek to define changing paradigms, such as the shift in ecological scientists' conceptualization of ecosystem study from a quest to understand equilibrium conditions to a new concept of dynamic and continuous change.11 I take a very different tack. I will use the history of marine fisheries biology and its application in ocean fisheries management as


exemplary of how ecosystem ideas have developed over nearly a century's time, and how they profoundly influence the terms used in today's discussion of ecological science, law and policy.

I have chosen to focus upon the history of fisheries oceanography and management, not only because it exemplifies important developments in the history of the ecosystem idea, but also because much of the modern history of the ecosystem approach in resources conservation and management has derived, as I will argue, in a direct line from a series of important developments in fisheries science and policy history of the last hundred years. It is an especially interesting aspect of the story, in the context of the present Symposium, that at some key transitions certain developments in the State of California influenced the course of subsequent change exceptionally strongly.12

Implicit in my claim that the history of ecosystem-oriented scientific research on marine fisheries is key to understanding the development of the EM concept today is the truism that without ecosystem science the pretensions of "management" on an ecosystem basis would be devoid of any substantial meaning.13 The scientific vision, and the methodology of ecological investigation, thus naturally came before applications in law and policy. This vision was advanced intensively in American fisheries oceanography and influenced the conceptualization of marine resources management a full decade and a half

12. I need to say by way of full disclosure that what I contend here is not a standard view that is accepted by all historians of ecological science. It is seldom recognized even in the specialized literature on this subject, and almost entirely overlooked in the legal scholarship that has sought to integrate the history of science and development of resources law, that an "ecosystem vision" (as I will call it) was adopted in a major way by marine fisheries scientists long before that view became more generally—and prominently—adopted in the scientific research directed at terrestrial habitats and land-based species and systems management. My view departs significantly, for example, from the history in McIntosh, supra note 11; and radically from the interpretation of how modern American ecological science and resources management has developed as given in Donald Worster, Nature's Economy: The Roots of Ecology (1977) (giving only marginal attention to marine studies in the development of modern ecological concepts and management applications).

My extended argument for the interpretive view here is available in Modern U.S. Pacific Oceanography and the Legacy of British and Northern European Science, supra note 10. A recent account of federal EM policy in ocean-related resource management mentions in passing that the "conceptual roots" of contemporary EM may be found in several historic policy experiences, including fisheries management. Roger B. Griffis and Katherine W. Kimball, Ecosystem Approaches to Coastal and Ocean Stewardship, 6 Ecological Applications 708, 709 (1996). See also the position stated matter-of-factly in a recent article by two Department of Interior officials, conceding that "ecosystem studies have been conducted for decades, but the momentum for this approach ... has recently been building" and "existing programs are being massaged into an ecosystem paradigm ... ." O. J. Reichman & H. Ronald Pulliam, The Scientific Basis for Ecosystem Management, 6 Ecological Applications 694, 694-95 (1996).

13. See Reichman, supra note 12, at 695 (an explanation of the newly instituted National Biological Service programs in the Department of Interior, based on the premise that "ecosystem management requires ecosystem-oriented science").
before it was commonly recognized as a basis for innovations in American environmental law and policy during the late 1960s and early 1970s. The intellectual history of the science, together with the record of efforts to apply the science in actual management operations, remain important influences upon the formulation of new management programs based on ES principles, however they are defined.

In the following pages, I discuss three important moments in history that shape much of our thinking now. The first goes back nearly a full century in time, and concerns the origins of the modern ecosystem vision in fisheries science. The second involved the post-World War II institution of a unique research program on the California Current ocean region, undertaken by a coalition of state and federal agencies together with the University of California. The third, too, has a specific California focus: the mobilization during 1964 to 1972 of a major interdisciplinary environmental study that provided scientific, legal, and social-scientific guidance for the idea of a unified coastal zone management system. In each of these latter episodes, California scientists and policymakers led in movements that would have a formative influence on national and global trends in environmental law and policy. How the relationships of science, law, and policy were configured in each of these moments is of interest, I think, because they suggest that problematic issues in resource law and management today have significant historical precedents that present cautionary warnings of continuing relevance.

I

EMERGENCE OF AN ECOSYSTEM RESEARCH VISION

The first historical moment began in the 1890s, when a group of extraordinary scientists in northern European fisheries laboratories and universities accomplished a series of path-breaking research investigations on marine fisheries. Breaking away from traditional zoological approaches, which had stressed systematics, these scientists instead sought to understand the habitats of fish species and the relationship of fishery population dynamics to the physical environment.

Until well into the late 19th century, ocean fisheries had been widely regarded by scientists, fishing interests, and politicians as inexhaustible resources. This faith long remained a constant in policy debate and the jurisprudence of international law despite the manifest depletion of whale species by indiscriminate harvest and the commercial crises occasioned by the "disappearances" (as they were called) of some important coastal fisheries in the Northeast Atlantic. Following the introduction of powerful steam-powered trawlers in the late 19th century, the notion of inexhaustibility led to an intensification of concern by government agencies and in scientific laboratories that com-
mercially important species were going to be endangered unless the dynamics of their populations were better understood and new scientific knowledge could be applied to management regimes.14

In response to this new sense of urgency—and with remarkable scientific insight and brilliance of research design—Norwegian, Danish, German and British scientists undertook a broad range of studies that laid much of the conceptual groundwork for modern ecological science.15 Most notable among them, both for his immediate influence on methodology and for his lasting influence on the application of the new ecosystem vision to fisheries management, was Johan Hjort of Norway. Hjort did offshore studies in Canada and Great Britain as well as in the North Sea and North Atlantic waters from the 1910s to the late 1930s. Hjort laid the intellectual foundations of modern fisheries “recruitment” research, as well as advancing the larger ecological approach to fishery habitats and ecosystem relationships.16 Yet there were scientists whose originality in conceptualization of ocean environments also had great influence. Johannes Schmidt, for example, despite having only wooden sailing ships and limited gear at his disposal, produced an extraordinarily complete and highly accurate study of the relationship of the wide-ranging Atlantic deep-sea eel population and its migrations between the species’ chemical and meteorological environment.17 And Fridtjof Nansen’s Fram expedition to the Arctic and sub-Arctic region in 1893 established the importance of including marine physical environment and atmospheric conditions in the analysis of plankton and fishery dynamics.18 Later on, Michael Graham and Alistair Hardy, in England and Scotland, developed an


15. Id. A vitally important institutional innovation that came out of this period of new concern with possible crises of ocean resources in the Atlantic region was the creation of ICES (International Council for the Exploration of the Sea) in 1902; it began as a five-year program seeking to explain fluctuations in the harvest of cod, herring, and the bottom fisheries, but then developed into a permanent multinational collaborative enterprise whose scientific work was supported by the governments of Northern Europe and was used as a source of basic scientific data by fishery management programs throughout the region. See A. E. J. Went, Seventy Years Agrowing: A History of the International Council for the Exploration of the Sea 1902-1972 (1972); Susan Schlee, The Edge of An Unfamiliar World: A History of Oceanography 206-43 (1973) (summary of ICES fisheries research programs before World War II).


17. See essays collected in Exploring the Ocean World (C. P. Idyll ed., 1969) (providing concise analyses of these and other key scientists’ individual contributions from the 1890s to the late 1930s).

18. See id.
ecological vision alongside (and doubtless influenced by) fellow researchers in limnology, who were pursuing a similar line of work with respect to freshwater lakes as ecosystems. Also influential was the pioneering research of Eugenius Warming, in Denmark, on the ecology of plant communities, with direct implications for limnological studies and with a more general impact upon the new fisheries research. Meanwhile, in Scotland there was a strong tradition, in place from almost the beginning of government-sponsored fishery populations research in the late 1880s, of framing research on fish population dynamics in terms of ecosystem relationships within fishery habitats.

World War I severely curtailed deep-sea commercial fishing in the North Atlantic (with the salutary side-effect, ironically, of resting the stocks and permitting a resurgence of the major species' populations). The war also virtually closed down scientific deep-water research, whether in the ecological mode or otherwise. Indeed, governmental financing of oceanographic research in the 1920s was long in recovering from the interruption imposed by the wartime crisis and its fiscal consequences for sponsoring governments. The Great Depression in the 1930s further undermined efforts by fishery oceanographers and biologists to follow up on the leads provided by Hjort and other pioneers. During the interwar period, 1919-1939, however, the history that concerns us here took a curious turn. True, there remained in Northern Europe and Great Britain a persistent interest in fisheries biology in an ecological mode—though it was limited in what it could accomplish because the instrumentation and gear available in that day could go only so far in revealing the secrets of the deep seas. But in the field of practical fisheries management, the science and the policies it generated set out in a very different direction.

Led especially by agency and university fisheries scientists in western Canada, California, and the State of Washington, fishery managers largely abandoned the ecological approach, with all of its limits on applicability, and instead embraced what may be termed the "harvest-yield approach" to research. This approach involved a rudimentary form of input/output analysis: the key datum was Catch per Unit of Effort (CPUE), calculated from days on the water, number and gear capacity of the boats, and labor hours expended, in proportion to the volume of fish harvested. Modified to take specific account of one important biological variable, the year class of the target species, this

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19. See id.
21. This remarkably early start on ecosystem-oriented research (which fell short, in practice, of what the stated research desiderata prescribed) in the Scottish Management efforts is documented in an essay by Margaret Deacon, The Establishment of Marine Stations and Early Commercial Fisheries Research in Scotland, in Ocean Resources: Industries and Rivalries Since 1800 (Harry N. Scheiber ed., 1990).
was a crude but, as it proved in certain fisheries, practicable basis for calculating the broad parameters of what came to be known as Maximum Sustainable Yield (MSY)—the level of harvest beyond which the efficiency of the catch would begin to diminish and the target species population volume would begin to decline because of harm to the breeding stock year classes. A focus on CPUE represented, of course, an entirely different approach than what the emergent ecosystem vision would have directed. The entire approach was species-directed, had an exclusively single-species focus, and was applied as the scientific basis for actual management by providing the MSY target numbers.22

The ecological approach continued to be pursued vigorously in limnology. However, by the 1930s Charles Elton and others were doing pioneering studies of animal ecology and other land-based ecosystem analyses that would exert a powerful influence on modern-day ecological science. Their influence, in fact, was so prominent that most published analyses of the history lying behind the environmental law innovations of the 1970s and today's EM movement have almost entirely failed to recognize the degree to which historic developments in marine fisheries science are equally relevant as part of the historical background.23 Nonetheless, even the scientists who did the research behind harvest-yield analysis and associated management innovations—the most important of which, by far, were those administered by the International Halibut Commission and its research operation, jointly sponsored by Canada and the United States, and including its controls over the halibut fleet on the Pacific Northwest and British Columbia coastal waters in the 1930s—systematically studied the work of Hjort and the other ecosystem pioneers. And while they surely appreciated the transcending importance of studying ecosystem relationships as superior to narrowly focused single-species harvest studies, they did not have the funding, the instrumentation, or the ships to translate the ecological vision into ecological research. Instead, they sustained interest in the more ambitious research methodology, and developed "wish lists" that were ready at hand should an opportunity be offered later, which included money, instrumental capability, or ships.24

22. See supra note 10, and CUSHING, supra note 14.
23. See, e.g., as seen in the otherwise excellent study by Bosselman and Tarlock, supra note 11.
24. See works of my own cited supra note 10, especially CalCOFI's Early Years, at 66-69.
The opportunity to apply the ecosystem vision to research in a major deep-sea program came suddenly. Immediately after World War II, a crisis in the California sardine fishery prompted a group of industry leaders, government fishery scientists, and academic researchers to design an ambitious program for research on the sardine and its environment in the California Current. What they faced, was the possible crash of the Monterey-based sardine industry, made famous by John Steinbeck, that had been one of the world's most intensive commercial fisheries since the early 1930s. They proposed to the University of California and to the state legislature a coordinated attack on the problem that would combine the efforts principally of the U.S. Fish & Wildlife Service, the University of California (and especially its marine station at La Jolla, the Scripps Institution of Oceanography), and the California Fish & Game Division.

Approved by the California Legislature in 1947, the program was financed at the outset by a special state landing tax on sardine and was supplemented by University of California (UC) appropriations. This may have made the program the first intergovernmental effort in modern American history in which state tax funds were granted for some of the operations of a federal agency. The flow of financial support was two-way, however, since Congress authorized the refitting and gift to UC of three small naval ships then being decommissioned. Moreover, the seagoing research of the California program—known as the California Cooperative Ocean Fisheries Investigations, or "CalCOFI"—was coordinated with a federal fisheries research program based in Honolulu, the Pacific Oceanic Fishery Investigations (POFI). This latter operation was also provided with several newly refitted ships and received generous appropriations for laboratory studies as well as work at sea. In addition to the sheer scale of scientific effort and financing that lent special promise to the California program, there was also the opportunity to apply new technologies. For instance, the ships were equipped with new types of bathythermographic gear and sonar technology that had been developed by naval laboratories in wartime programs during 1939-45. With the establishment of these two Pacific Ocean projects, which augmented the Woods Hole research in Atlantic waters, the United States had launched the most ambitious and well financed programs of deep-

sea research to be undertaken by any maritime nation since before
World War I.26

What distinguished the California program above all, however,
was the vision of research goals and methods that its organizers
brought to their work from the outset. This vision was set forth with
great clarity by Roger Revelle, one of the key figures in the project’s
organization (and later to serve with great distinction as director of
the UC Scripps Institution of Oceanography). He envisioned the sar-
dine study in a conceptual framework that embodied the ecosystem
approach inherited from Hjort and the Northern European-British
tradition. Instead of relying upon harvest data and narrowly focused
studies of the sardine population alone, in 1947 Revelle wrote that the
project would represent a holistic approach to the ocean environment
as applied to a large segment of the Eastern Pacific. It would strive to
make "dynamic analyses" of the processes in the sea.27 "In attacking
a problem of such magnitude," Revelle wrote,

all possible scientific tools and methods will have to be employed. It
will be necessary first to describe as completely as possible the existing
oceanographic and biological situations; second to establish empirical
statistical correlations between the various environmental and biologi-
cal factors; and third and most important, to make analyses where pos-
sible of the processes in the sea, that is, the cause and effect
relationships which affect sardine production. . . .

The sardines cannot be treated as isolated organisms living in a vac-
uum. The investigation must be an integrated one in which proper
weight is given not only to the currents and other aspects of the physi-
ical environment but also to the entire organic assemblage including
the plants and animals which form the food chain of the sardines, their
competitors for the food supply, and the predators, including
man. . . .28

This vision animated the CalCOFI research from the outset of opera-
tions. Accordingly, the original, narrower objective of the project—
understanding the sardine population's decline, with the immediate
goal in mind of designing an effective antidote through a regulatory
management regime—became quickly subsumed into a much more

26. On the history of American marine research in the Atlantic region, see Susan
Schlee, The Edge of An Unfamiliar World, supra note 14; and SUSAN SCHLEE, ON ALMOST
ANY WIND: THE SAGA OF THE OCEANOGRAPHIC VESSEL ATLANTIS (1973) (chronicling
studies conducted on George's Bank during 1938-41 that were of seminal importance in
laying the intellectual foundations of marine food-chain studies and which, in this sense,
presaged some of the ecosystem research pursued by the California Current project after
1947 on a much larger scale).

27. Letter from Roger Revelle to John Isaacs, Nov. 29, 1947, on file in Scripps Institu-
tion of Oceanography Directors' Files, SIO Archives, UC San Diego, La Jolla, quoted in
Scheiber, CalCOFI's Early Years, supra note 10, at 68-69.

28. Id.
comprehensive research design. With the extraordinary level of financing and a small oceanographic fleet available to them, the scientists were able to launch sampling cruises that collected monthly samples at stations located 40 to 120 miles apart on a grid that covered more than 600,000 square miles of the California Current offshore of Baja California, and the coasts of California, Oregon, Washington, and British Columbia. The vast region that was studied, the intensity of the research (including readings on physical conditions and biological sampling that included both floral and faunal materials), and the scope of the design for on-shore laboratory analysis, all represented something entirely new in the history of fisheries oceanography. Indeed, it announced the dimensions of what would soon become the paradigmatic style of Big Science, prompting one leader at Scripps to comment on the implications for the future: “The individual scientist, working in seclusion,” he declared, “is apparently a thing of the past.”

When we consider in retrospect the importance of the research that was launched on so massive a scale in 1947-48, a number of points stand out. First, we need to recognize that, setting aside the question of practical fishery management as a short-term project objective, CalCOFI stands as a breakthrough in applying the ecosystem vision to research on ocean resources. Within twelve years or so after CalCOFI’s founding, it could be said plausibly that no ocean region in the world, with the possible exception of the offshore waters of Norway, had been studied so intensively as the California Current. What is more important was the enormous 600,000-square-mile grid system, which provided the basis for correlation of physical, biological, and meteorological data; it was synoptic research, focused on understanding the dynamics of change. Even as early as 1950, the project’s scientific agenda had produced empirical work and new lines of analysis on upwelling in relation to weather conditions and with regard to impact on nutrient supply for the fish; on competition among species for food and on inter-species predation; on disease-producing organisms; on

29. These ecosystem studies were conducted in parallel to the more conventional harvest analyses (CPUE studies) that were under direction of the California state fishery scientists. Even the latter research operation, however, was significantly expanded, with the new funding and personnel made available by CalCOFI, to include some intensive basic science, e.g., on larval distribution in relation to recruitment, age structure of the stocks, and the like. See Marine Research Committee, Report of the Special Technical Committee, MRC Minutes, Dec. 19, 1957, SIO Archives.

30. Letter from Carl Eckart to L. A. Walford, SO Directors Files: Marine Life Research, SIO Archives (June 28, 1948), quoted in Scheiber, CalCOFI’s Early Years, supra note 9, at 72.
larval distribution and reproduction levels; and, not least important, had produced analysis of food chains.\(^3\)

The magnitude of CalCOFI's achievement in pioneering the ecosystem-oriented, holistic approach to a vast ocean environment can hardly be overestimated. It is uncanny to realize that in the history of CalCOFI's studies before 1970, one can identify research that meets most of the proposed criteria for the basic scientific orientation underlying today's "ecosystem management" as set forth in the most widely cited statement of EM theory.\(^3\) Among those components were a focus on sustainability and on the dynamic character of ecosystems, a recognition of the importance of appropriate spatial boundaries, and an awareness of uncertainty and adaptation.\(^3\) For particular relevance to marine eco-management, one may add the central objective of studying multi-species management. This concern was reflected, from its first days, in the California sardine research because of its attention to inter-species competition for food supply.\(^3\) Indeed, the CalCOFI project stands as an exemplary model of "large marine ecosystem research," fully four decades before the concept moved to the center of ecologists' and policymakers' attention.\(^3\) Viewed in the broader perspective of its contributions to environmental science and policy more generally, the ecosystem approach of the California project presaged by more than twenty years what would become the "new environmentalism" of the late 1960s and early 1970s, culminating in the adoption of unprecedented regulatory programs by the Federal Government and, soon after, by many states.\(^3\)

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31. This last topic attracted the interest of a young federal scientist named Rachel Carson who was charged with writing up some of the scientific work for the lay public. Carson's fame and influence, in a later day, would derive from the way she applied food-chain analysis in her book *Silent Spring*.


33. *Id.* at 665-66, 669-70.

34. The necessity for multi-species management as a goal preferable to a research and management focus on single species is a staple in every discussion of fishery management reform and especially EM approaches today; it was also a central concern in the 1996 debate of the Magnuson Act reauthorization. See, e.g., Griffis & Kimball, *supra* note 12, at 709-10. Alison Rieser, *Property Rights and Ecosystem Management in U.S. Fisheries: Contracting for the Commons?*, 24 *Ecology L.Q.* ___ (in this issue).


A second point that merits close consideration addresses the issue of how well science served policy. Inherently, ecosystem science is ever-ramifying, that is, continually developing more complex questions. When a research problem becomes more complex with each advance in study, drawing fast or clean conclusions as to the application of new information is an unlikely result. Even the most ardent early theorists of ecosystem science conceded that the dynamic biological relationships with which they were concerned could appear not only intractable, but often inchoate. (In this regard, they anticipated what a later generation of scientists sought to explain through chaos theory.) From the standpoint of political actors with an interest in delaying or killing plans for regulation of a fishery—and that was essentially the posture that the leading California sardine fishermen assumed—it is a joy to be able to refer to the incompleteness of information that ineluctably goes along with a study whose conceptual boundaries are continuously expanding.\footnote{37} From the standpoint of the scientists, especially when the expansion of a project’s scope conceptually translates into annual increments in levels of financial support, there is a strong argument for staying out of the field of political combat over how to apply their findings to actual management practices. Indeed, unlike the situation in most EM projects today, in which scientists are not insulated from tough policy decisions, in CalCOFI’s case the scientists (with the important exception of the California state agency scientists) operated under an explicit charter to confine their role to “advising” and not to get involved in the decisionmaking process.\footnote{38}

In fact, the brilliant work placed in the scientific record by CalCOFI was not matched by its application to sardine management. Weakly regulated almost to the very end, the fishery crashed in the 1952-53 season, when 5,700 tons of sardine were harvested, when only a few years earlier the industry had been taking 200,000 to 400,000 tons and nearly 590,000 tons in the 1938-39 and 1941-42 seasons.\footnote{39}

A final aspect of the CalCOFI project’s history that merits attention, however, is its lasting importance in having produced a data base of oceanic observations over half a century’s time that stands as a

\footnote{37} I come back to this later, in the text infra at note 50.  
\footnote{38} There are differing interpretations of why the scientists behaved as they did. See discussion of these differences in Scheiber, CalCOFI’s Early Years, supra note 10, at 74-75, 81 n.51.  
unique resource available to environmental scientists who are engaged in the study of global climate change today.\textsuperscript{40}

III
INTERDISCIPLINARY ENVIRONMENTAL STUDY AND THE CALIFORNIA COASTAL ZONE CONCEPT

The third moment in the history of ecosystem research is a wonderful illustration of how a significant advance in the conceptualization of an environmental regulatory problem can be achieved when expertise in a variety of disciplines is brought to bear on a common problem. Here again, we have a California focus. California scientists and, in this instance, politicians, were in the forefront of what became a national, and later a truly global, movement in regulatory innovation. It began with a decision by Governor Edmund G. Brown, Sr., in 1964 to convene a statewide meeting on the theme "California and the World Ocean" with the purpose of setting the direction for unified state government policy on ocean and coastal problems.\textsuperscript{41}

Never in California political history has there been more consistent and stalwart adherence to the liberal New Deal, rationalistic mentality, with its great faith in expertise and in bureaucracy, than in Governor Brown's thought and politics. Hence it was entirely predictable that, in the governor's keynote speech to the conference, he said, in effect, that he had brought the best scientific minds in the state into the room, and that they were going to tell the state what to do, and then everyone would go to work to translate the scientists' wisdom immediately into effective policy in the public interest.\textsuperscript{42} His was, in sum, a naive faith that the scientists would have all the answers to determine how policy priorities for the coast and ocean should be defined, which institutional structures would best provide the mechanism for study and for policy recommendations, and what kinds of substantive law and administration should be fashioned.

If the governor's approach was predictable enough, the same cannot be said as to the eminent scientists who were called upon to per-


\textsuperscript{41} Governor Edmund G. Brown, \textit{in CALIFORNIA AND THE WORLD OCEAN: PROCEEDINGS OF THE GOVERNOR'S CONFERENCE, 31 JANUARY-1 FEBRUARY, 1964}, at 5 (1964). One palpable measure of the historic influence of Brown's initiative is the adoption of the same title for a conference just held in San Diego, in 1997, with precisely the same objective.

\textsuperscript{42} Scheiber, \textit{Success and Failure in Science-Policy Interactions, supra} note 10 at 106-7. (The following three paragraphs of the present study will draw closely on material in that article.)
form their roles in this scenario. Interestingly, three of the scientists, all of whom had been leaders in organizing the CalCOFI research, took approaches to the policy issues that expressed strong reservations regarding Brown's faith that scientists and engineers were uniquely qualified to present "clearly defined objectives" that could achieve consensual support and "help avoid those breakdowns" in the political process caused by a lack of sufficient scientific guidance.43 One of these scientists, Milner Schaefer, a major contributor to fishery biodynamics theory and a leading figure in Pacific Ocean research projects, was recruited by Brown for a collaborative study of California ocean and coastal policy. The study, which was discussed at the conference prior to their publication in final form,44 reflected a multidisciplinary and integrative approach to ocean and coastal issues that put aside conventional boundaries between disciplines. It argued that the coastal waters and adjacent land areas should be conceptualized—both for purposes of scientific research and for purposes of management and policy—as a social and ecological system. Together with two other scientists who had pursued the vision of ecosystem research in CalCOFI, Roger Revelle and Wilbert McLeod Chapman, Schaefer insisted that specialists in political science, law, sociology, economics and public administration be brought into the processes of study and policy formulation. They did not chant the mantra, so often heard in forums on environmental policy, then and now, that what is needed is simply more (and more) science. Instead, they took the view that an analysis of the ecosystem, however its boundaries were defined, required an understanding of the institutional forms and social, organizational, and political relationships that expressed and channeled the human role in the dynamics of that system.

In light of the position Schaefer took in the debate of California ocean policy in the mid-1960s, it was no surprise that he played a formative role in the movement for recognition of the coastal zone as a multidimensional unit for study and system-level management. Although a political stalemate frustrated Schaefer's efforts to persuade the politicians to adopt a comprehensive agency framework that would treat the coastal zone and adjacent waters in accord with this idea, he and his colleagues dramatically advanced in public discourse the concept of the coastal area as a social and ecological system whose resources could not effectively be conserved or managed without refashioning the state's agency structure and empowering the regulators

43. *Id.* at 106 (quoting Brown).
44. *Institute of Marine Resources, University of California, California and the Use of the Ocean* 1-2, 1-3 (1965).
in ways that departed radically from earlier practice. This served as the essential political background to the eventual success of a ballot measure in 1972 (Proposition 20) that established the California Coastal Commission and by which California provided national leadership in establishing a model for a systems approach to coastal and marine policy.

In effect, Schaefer and a cohort of colleagues from business, academia, and politics pointed the direction for both science and public policy to embrace an approach to coastal management that reflected an ecosystem methodology analogous to that which had been pioneered in the CalCOFI project for deep-water environments. Schaefer moved over a notch, however, from the position assumed by the scientists in the CalCOFI hierarchy who had ducked the policy issues and sought to let scientific data speak on their own merits to policymakers. Instead, in the coastal zone debate of the 1960s and early 1970s, he and other participants from the scientific establishment specifically sought to fashion a creative kind of working interface between their own disciplines and those of social scientists and experts on public administration. They not only remained alert to the need for "expressing our opinion and judgment at every opportunity," as Wilbert Chapman urged of his fellow advisers to state government, but also, by staying alert to political realities, they sought to keep "sufficiently in tune with state government to be able to communicate with it."

If the principal long-term contributions of CalCOFI were in presaging Large Marine Ecosystem research strategies and advancing the holistic paradigm for environmental studies and policy, the comparable, or at least most notable, long-term achievement of the governor's advisory groups in the 1960s and 1970s was the model they offered for directly involving not only the various academic disciplines, but also the "stakeholders" (as they are called in EM theory today) in the co-

45. Schaefer’s contributions in this regard were pursued through his work as chairman of the Governor’s Advisory Commission on Ocean Resources (GACOR), appointed in 1965. Its history is chronicled in Scheiber, *Success and Failure in Science-Policy Interactions*, supra note 10, at 109-113; the record of a successor commission, the Advisory Commission on Marine and Coastal Resources, is given attention, *id.* at 113-115.


operative conceptualization of resource policy problems and in the dynamics of the policy process itself. The fact that a referendum election was necessary to bring the issue of coastal management in California to closure stands as a cautionary lesson to those who would regard the EM prescriptions for stakeholder involvement as the equivalent of an assurance that consensus will somehow prevail or that the consensus, if achieved, will be either satisfactory to the public or—in the much larger sense—consistent with "the public interest." Consensual agreements among interest groups and/or scientific or other policy advisers do not reflexively produce acceptable law or policy, any more than the mere accumulation of massive quantities of scientific data in and of itself provides adequate guidance for policy.

IV
CONCLUSION: DILEMMAS AND CONUNDRUMS

In the course of this historical foray, we have encountered some striking parallels and precedents to the issues at the center of today's controversies over EM (however defined), and its application in a variety of land-based and marine environments. Having been concerned mainly about the accomplishments of the ecosystem scientists who did pathbreaking marine research early in the century, and the achievements that flowed from California's experience with CalCOFI and with scientific advising on coastal and ocean problems prior to 1972, we might do well now to reflect on some dilemmas and conundrums suggested by a few of the more perplexing aspects of this historical record.

A first one, familiar to all students of resource management, is what may be termed the dilemma of incomplete information. If one waits until there is a "high enough" level of certainty in dealing with the possibility of damage to a resource, as Dr. John Gulland, among others, has persuasively argued, the sustainable limit can be reached and passed—with irreversible consequences, in many instances—long before such certainty is accepted as having been reached. This dilemma, which was notably manifest in the failure of CalCOFI to produce a management plan to curb overfishing and save the sardine, is often at the heart of conflicts between conservation-oriented (or, for

49. See discussion of the "public interest," infra at Part IV.
50. This and the following items in this brief discussion are treated more at length in Scheiber, Success and Failure in Science-Policy Interactions, supra note 10, at 117-21, though I need to thank particularly Robert Friedheim of the University of Southern California and Tyler Prize Laureate Gene Likens, whose insights as expressed in informal comments on my paper to a convocation in 1996 at the University of Southern California are reflected in whatever salutary refinements of my ideas may be evident here.
that matter, preservation-oriented) managers and the various users who are eager to maintain access and high levels of exploitation. In today's debates of law and policy, privatization approaches such as the Individual Transferable Quota (ITQ) concept in fisheries management are advertised as a way of short-cutting and by-passing the dilemma of incomplete information. The self-interest of the users will, through application of property rights mechanisms, assure that the resource will not be squandered.\textsuperscript{52}

Whatever the merits of privatization ideas, there is another, entirely different, approach that has gained impetus because of the lessons learned from failures to impose regulation (as with the sardine) or from failures to make regulatory programs effective (as with the great number of fisheries today depleted or threatened with commercial crashes, in the United States and globally today). This is the precautionary principle, an idea that speaks to the interest of maintaining the integrity of complex ecosystems and their dynamics. In application, however, this concept too has its perplexities, as acknowledged with exceptional candor in a recent UN Food and Agriculture Organization report on fisheries that states:

Ecosystem management is being referred [to] with increasing frequency as the necessary basis for fisheries management. This requirement is precautionary in nature in the sense that it requires that the integrity and essential functions of the ecosystem must be preserved as a prerequisite to fisheries sustainability. \textit{In practice, however, we do not yet know how to manage ecosystems.}\textsuperscript{53}

A second dilemma is evident in avoidance tactics often resorted to by scientists and other experts—not excluding lawyers—who are involved in policy formation for resource use and management, when confronted with the reality that if bureaucratic structures and authority are challenged, or if the interests of private owners or local communities in a market system are threatened, these interests can mount powerful resistance to change. Cooptation, evasion, or simply blunt


resistance are among the strategies that come into play. For the scientist or other specialists, it is a lower-risk (and certainly less aggravating) option to return to the laboratories, research vessels, or libraries and private professional practices than to take on the travails of political combat. The temptation to go around the implementation problem is all the greater when scientists and resource-policy specialists confront the resistance of “iron triangles” where power intimidates the challenger, and when it is easy enough to back off when one can return to one’s core disciplinary or professional pursuits and give them one’s attention relatively free from political distractions and frustrations. In the CalCOFI case, this surely explains why brilliant research did not produce even minimal agreement upon (let alone implementation of) effective management plans. In the case of the Schaefer-led advisory efforts, especially the studies of the coastal-zone question, there was by contrast a willingness to engage directly with the contending forces, and to carry the banner of “science” (though not with any pretensions to scientific “certainty”) into the political hustings, albeit with mixed results.

As was noted earlier in this Article, instances of temporizing, retreat and lack of either conscience or commitment, or perhaps simply sufficient energy to carry through, is evident in the actual workings of EM schemes that are under study today. The question that is most troubling concerns whether EM management has built-in incentives that impel “copping out” tactics and the use of consensus-building procedures and goals as a substitute for the kind of bold management initiatives that, say, the precautionary principle would ideally require. In this inheres, then, one of the anomalies of EM theory and practice. If incentives to deferring decisions are structurally and perhaps prescriptively inherent to the methodology, still those incentives operate in an uncertain relationship to the requirement—present in most EM plans, and an element of nearly all theoretical statements of EM—that the precautionary principle be applied.

The perils of loss of momentum or commitment are compounded, moreover, by the organizational and attitudinal rigidity that characteristically sets in and affects even the most intellectually lively and innovative scientific organizations and groups after the passage of only a few years beyond their founding. When resource management agencies have been in existence for many decades, and rigidification has had more than ample time to work its effects, then the entire conundrum is made even worse. Even during the initial years of the

54. See, Houck, supra note 2.
55. I am indebted on this point to a formal paper by the ecologist Gene Likens and also informal discussion with him at the Tyler Prize Pavilion Convocation at the University of Southern California, 1996 (see supra note 50).
CalCOFI investigations, some of the researchers recognized that the differing traditions, orientations, and professional-industry constituency relationships of the federal agency scientists, on the one side, and the state scientists, on the other—with the academics standing in a third, somewhat insulated position—hampered the effort to move beyond collection of data and ecosystem-oriented analyses to actually grapple with how to develop law and policy.  

Finally, a third aspect of science/policy/law relationships suggested by the history we have considered is the peril of losing faith in the validity of the "public interest" concept as an unfortunate result of the discovery that it is risky to place complete faith in the capacity of science to provide answers that are self-evidently "right." The very complexity of ecosystems means that the choice of management options is as much a function of the social values that underlie the policy positions advocated by the various interest groups, by the scientific and other experts, and by the politicians, as it is a function of any single scientific imperative. When atomization of interests occurs in an extreme way, and scientists are deployed in a way that sends the message that they are merely hired guns for special interests, then reasoned inquiry and decision are crowded out. This diminishes faith in even the theoretical possibility that the common interest can be served through the development of rationally justified options based on good data and sound analysis, with a systematic appraisal of the costs and benefits of those options made available for public discussion and to advance public understanding. The threat, in sum, is loss of dedication to the ideal of responsible, as well as responsive, governance and control of natural resources.

56. See Scheiber, CalCOFI's Early Years, supra note 10, at 73-75; McEvoy and Scheiber, Scientists, Entrepreneurs, supra note 39, at 403-5.

57. This is a main theme in the writings of the late James Willard Hurst in, for example, James Willard Hurst, Law and the Social Order in the United States (1977) and James Willard Hurst, Law and the Conditions of Freedom in the Nineteenth Century United States (1956). See also Harry N. Scheiber, Public Economic Policy and the American Legal System: Historical Perspectives, 1980 Wisc. L. Rev. 1159 (1980).