PLEASE DO NOT TAKE

CREATING AND USING KNOWLEDGE FOR SPECIES AND ECOSYSTEM CONSERVATION: SCIENCE, ORGANIZATIONS, AND POLICY

TIM W. CLARK*

Introduction

The loss of global biodiversity is a major problem with profound repercussions for the present and future human generations. Living professional conservationists are the last generation that can prevent the extinction of large numbers of species and the disruption of large scale ecosystem processes. A conservative estimate of species loss is 20+% of the planet's biodiversity within the next decade or two—4,000 to 6,000 species a year from rain forests alone [1]. Losses in the rain forests are about 10,000 times greater than natural "background" extinction rates. In the United States, an estimated 675 plant species may become extinct by the year 2000 [2]. About one-third of all fresh-water fish species are being seriously harmed by environmental degradation, and many species or subspecies are threatened [3]. Species protection under the Endangered Species Act is a long, complex process. Meese [4, p. 51] noted that any delay in listing and consequent protection of species is doubly regrettable because so many qualifying species are already backlogged.

Nearly twice the number of U.S. species now listed are qualified for listing but waiting to be afforded the basic protections of the Endangered Species Act. In all, more than 3,900 species in the United States are considered official candidates. Two hundred to three hundred of these species, many of them plants,

The author is indebted to Ron Brunner, University of Colorado, and Garry Brewer, Yale University for their many ideas; Ron Brunner, Denise Casey, and Rich Reading for their critical reviewing of the manuscript; and the Chicago Zoological Society, the Northern Rockies Conservation Cooperative, and Yale University for their support in the writing of this paper.

*Northern Rockies Conservation Cooperative, Box 2705, Jackson, Wyoming 83001 and School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut 06511.

0031-5982/93/3603-0836$01.00

may already be extinct. The large backlog and the number of possibly extinct "candidate" species indicate a serious breakdown in implementing the Endangered Species Act.

Global warming is expected to increase species extinctions [5]. The agricultural, pharmaceutical, economic, scientific, ecological, educational, and aesthetic loss of these species and ecosystems is incalculable and devastating.

There are several pivotal needs in halting the loss of biodiversity. According to Miller et al. [6, p. 4], among them are the need to: (1) determine "root causes," which requires analyzing policies and institutions to remove obstacles and promote change in structures and approaches that favor biodiversity conservation and use; and (2) support "science," i.e., use modern science to guide the protection, inventory, study, monitoring, and use of biodiversity. The first need requires that conservationists have knowledge of policy processes, the ability to carry out policy analysis, and the inclination and skill to contribute to planning and decision-making processes. Even a little of this kind of knowledge can go a long way toward helping conservation scientists improve policies and programs for better conservation of biodiversity. The second need requires more and better science and its increased use in decision and policy making. Simply meeting this need does not necessarily improve biodiversity conservation. The relationship of science, analysis, and policies in decision and policy making must be understood [7]. Fundamental to these two needs should be an ability for critical self-examination by conservationists of the way they traditionally go about their work. To contribute to planning and decision making, to analyze policies and institutions, and to analyze their own behavior, conservationists need several kinds of information. A few quotations emphasize the value and role of information and knowledge in problem solving in science, organizations, and policy.

Information connects our past to the present and helps us peer toward the future. The data we collect and analyze and the decisions we reach based on them are primary determinants of the kinds of lives we and future generations lead [8, p. 2].

Information is the primary resource, in the sense that without it we lack even the most elementary tools with which to solve present problems and build a better future [9, p. 4].

To the extent that data are underutilized or misused, these resources are wasted and opportunities for better-informed policy decisions are foregone [10, p. 1].

These quotes point out the importance of knowledge, but as Nathan [11, p. 423] observes, "analysis is less important than values and beliefs as a basis for policymaking." If this is true, how can conservation biologists use knowledge most effectively in the decision and policy processes which determine the fate of species and ecosystems, or how can biologists construct better maps, ones that more reliably and effectively contribute to the survival of species? Three kinds of knowledge are essential to conserve species and ecosystems. Conservation biologists are best at bringing scientific knowledge to bear on conservation problems. But in order for science to be used appropriately, an effective program (i.e., a tactical response) must be organized and managed to carry out the needed work; and the program, as well as the science, must be guided by an overall policy (e.g., a strategic response) which correctly recognizes root causes of the problem and offers real solutions. Programs are made of people who are connected by formal and informal roles, reporting relationships, and information flows. They are given authority and resources to meet goals. Programs to conserve species often include bureaucrats, scientists, managers, technicians, and others. Even though government programs are usually organized bureaucratically, many other modes of structuring and operating a program are possible (e.g., [12]). To develop and manage a successful and appropriate conservation program, it is essential to have a "policy orientation" that embraces the complexities and subtleties of the interactions of biological and psychological/sociological/economic/political phenomena that constitute the program and its context [13, 14]. So in addition to scientific knowledge, organization and policy knowledge are required. Only from an integrated, explicit approach using all three kinds of knowledge can conservationists expect to be successful.

At the professional conservation level, clearly, efforts to save species and ecosystems have fallen short of aspirations. Conservationists no longer speak of how to prevent the global extinction crisis, but only how to minimize losses. Conservation successes are partly due to the kinds of knowledge created and acted upon as conservationists seek to understand problems and their solutions. Biology is necessary but not sufficient. Despite some successes on technical problems, and even on some larger-scale applied efforts, there have been many disappointments and failures in conservation on many complex and controversial issues that seem especially resistant to solutions: in ecosystem conservation, clean air, ocean management, the Antarctic, park and preserve management, and endangered species restoration. At the societal level, our collective decisions and actions still tend to have significant unintended and adverse consequences; that is, they are less than fully rational despite the availability of ever-increasing scientific knowledge about the biodiversity crisis, soil degradation, acid rain, the greenhouse effect, and ozone depletion (see [16]). The use of scientific data in analysis and formulation of problems and implementation of solutions often merely reflects and reinforces existing problems and controversies in the political arena rather than solving them. This occurs because science is subordinated to prior political decisions. That is part of the problem too. This is recognized in varying ways and degrees by a growing number of conservation biologists. For example, Hales [15, p. 81] noted that the

> . . . trained, analytical approach of the biologist, or any other disciplinarian, often seems to lead to fragmented problem definitions, and unimaginative solutions, the success of which, over time, is not particularly impressive. Equally important is 'political' wisdom and knowledge, i.e., the ability to make the 'political' system work.

Carr [17, p. 80] argued that good conservation biologists should be

> . . . willing to use their training and analytical skills beyond the confines of biology, reaching out to examine the cultural and sociological factors that bear on the survival of their favorite species.

And Snyder [18, p. 81] said that conservationists must guard against

> . . . too narrow a focus in any one direction; scientific knowledge is just not enough . . . (p. 64), we need a new breed of manager who can employ . . . and understand biology without being trapped by it, economics without being trapped by it, and so on.

But there are many normative, professional, scientific, and bureaucratic barriers working against conservationists acquiring and using the more comprehensive knowledge and perspective called for in this paper. This perspective comprises much more than "bio-politics," a label often heard these days. Schon calls terms like "bio-politics," "politics," or "personalities" used to explain away complex human interactions, especially institutional interactions, "junk categories" [19, p. 44]. He argues that such terms, which really explain nothing, are nothing more than offering up an "explanation," which is not an explanation. It is really just "cutting the practice situation to fit professional knowledge" [19, p. 44; 20, p. 102–104]. Upton Sinclair made this point differently: "It is difficult to get a man to understand something when his salary depends upon his not understanding it."

The type of knowledge and orientation needed is called a "policy orientation," and was described by policy scientist Harold Lasswell [21, 13] several decades ago. The policy sciences help develop this orientation by studying how knowledge is used or not used in decision and policy processes, while simultaneously judging how well these processes themselves are working and trying to upgrade the outcomes of the processes. If conservationists could develop a policy orientation, they could expect to improve their ability to influence decision and policy processes that determine the fate of biodiversity. In turn, this has powerful implications for improving conservation efforts.

The purpose of this paper is to consider the loss of biodiversity as a policy problem from the policy sciences perspective. Conservation biologists are both the objects of, and clients for, policy inquiry in this examination. This paper looks at preventable (corrigible) problems rooted in the problem-solving conception widely used by conservationists. Three questions are examined. First, what is the common problem underlying the failures of the conservation movement to prevent mass extinctions and loss of ecosystems? Second, what accounts for the problem? And third, what can be done about it? Conservation is a policy problem, and not merely a scientific concern, or a breakdown in stewardship values, or any other simple, reductionistic, cause-and-effect relationship. Such explanations can incorrectly tell conservationists that the problem is someone else's, and focus attention away from their own collective behavior, problem-solving style, and modus operandi. Consideration of these questions and answers will inform our individual and collective choices about how we go about trying to conserve species and ecosystems. Hopefully, it will result in improvements.

A Definition of the Problem

Whether it is the Endangered Species Act or the National Forest Management Act, there appear to be recurring patterns in implementing conservation policies and programs. These patterns are evident in program structuring, decision-making processes, and actions based on those decisions—patterns that amount to a definition of a common, underlying problem.

Policies and programs are formulated and implemented by two groups of people. The first group is "formulators," which includes Congress, their staffers, senior agency personnel, interest group lobbyists, and others, who collectively influence, word, or authorize legislation (i.e., the Endangered Species Act) that outlines policy aims (i.e., to prevent the extinction of species and loss of ecosystems). Much analysis can go into the formulation of policies as problems are constructed and solutions prescribed. The second group, "implementators," includes agency program managers, bureaucrats and administrators, team leaders, front-line biologists, technicians, and others whose job it is to carry out the work of meeting specified policy aims. Government agencies must translate the original policy aims through their existing programs, modes of operation, and technical capabilities. In so doing, they make numerous professional and organizational interpretations, which are simultaneously both technical and political decisions (see [22]). Thus, the program's outcomes may diverge significantly from the original policy aims. In fact, a policy is really the sum total of the outcomes of all the activities of all the formulators and implementors, and not merely the original aims as conceived by formulators. Because of this, the role of formulators and implementators are examined in this paper. For simplicity, I shall collectively refer to these people as "analysts" because both groups largely analyze problems and decide how to carry out solutions.

The underlying problem, simply stated, is that most preventable (corrigible) errors made by analysts in the conservation of biodiversity, whether they are involved in formulation (policy analysis in Washington D.C.) or program implementation (resource management in Colorado), stem from the analysts' narrow perspective. Narrowness stems from a host of disciplinary and bureaucratic constraints. Of course, some kinds of errors, such as natural catastrophe, are not preventable; but others are, including some analytical errors. We are concerned with the latter. The fundamental problem comes from analysts who simplify a complex conservation problem to make it tractable, and in so doing misconstrue or overlook some important part of the relevant context (problem setting). Thus, the "solution" is incomplete and faulty. So when a faulty "solution" is implemented through a program, performance and outcomes will be poor, and the species or ecosystem may not be conserved.

Several authors have described problems stemming from analysts' errors. First, Kellert [23, p. 528] demonstrated that nearly all endangered species recovery programs are directed by wildlife biologists. Their understanding of the recovery problem and the recovery solution reflects their training, which emphasizes only biological assessments and solutions. Thus, subtle and complex socioeconomic and cultural attitudes, which may be the fundamental cause of species endangerment in the first place, may be overlooked. Second, Yaffee noted that conservation programs may be hamstrung by scientific and bureaucratic conservatism, faulty decision making, and muddled authority relationships, to mention a few constraints [22]. Wildavsky observed that sometimes failures or barriers are unwittingly built into organizational designs [24]. Parker suggested that the poor performance of one recent program of endangered species recovery was due to the inability of a government to design and manage an effective program [25]. And finally, Littrell noted that bureaucracy itself determines the sort of solutions that seem plausible to bureaucrats (and biologists) in authority and the solutions they allow to be tried [26]. Often, only further bureaucratic solutions to problems are tried. These limited, bounded perspectives cause the common problem. Schon, in his classic book *The Reflective Practitioner: How Professionals Think in Action,* described the limitations of traditional professionalism because of the boundaries or "selective inattention" that specialized training causes—whether that knowledge is biological, bureaucratic, or something else [19]. He described how professionals are often bound up in the formal bureaucratic organization through which most work is done. This has benefits and costs. Numerous analytical errors stemming from single discipline biases or bureaucratic biases should be preventable. The analytical error—what is misconstrued or overlooked—becomes apparent only in retrospect, after resources have been committed and unintended and often adverse results start appearing [11].

Consider the following three illustrations.

1. The 1973 amended Endangered Species Act established a program in the U.S. Fish and Wildlife Service (FWS) to prevent extinctions and ultimately restore species designated as threatened or endangered through the development and implementation of species recovery plans. Concerned about possible program deficiencies, the General Accounting Office (GAO) reviewed the FWS program [27]. Of 493 domestic species formally listed as threatened or endangered, six have officially been declared extinct and five declared recovered in the previous 15 years. Then GAO found that the federal government does not maintain centralized information on the status of the remaining 482 species and whether they are moving toward or away from extinction. However, the best available estimates indicate that about one-third of the species are declining, two-fifths are stable, and one-sixth are improving, and the status of about one-tenth is unknown. The GAO concluded that while some progress has been made over the last 15 years, more remains to be done. Required plans have not been developed and approved for many listed species. Moreover, in the 16 approved species recovery plans which GAO reviewed in depth, nearly half of the tasks listed have not been undertaken, even though the plans were approved over 4 years previously, on average. Further, the FWS has not systematically monitored undertaken tasks. Agency officials attribute these shortcomings to a shortage of funds, but the cause for their limited performance is much more complex, and additional causes are implicated besides those identified by GAO. For example, a former director of the U.S. Fish and Wildlife Service [28, p. 8) wrote:

> In spite of its strength, the [Endangered Species] Act is vulnerable; its armor is not seamless. The Act is vulnerable to political intervention and to decisions based on political expediency rather than what is best for the species. It is not easy to resist the pressure to make special arrangements which provide for advance of projects or programs or individual proposals.

The analytical error in this illustration was that officials have reduced the problem of species restoration to particular methods and a program, which unwittingly has "blind spots" and vulnerabilities. In fact, these programs are constrained by politics. By using the term "program" in describing the analytical error, I mean the bounded decision and policy processes used by the FWS.

2. Conservation efforts in Hawaii illustrate further analytical deficiencies in ESA implementation. According to a Natural Resources De-

fense Council review (NRDC) [29], nearly 40% of Hawaii's known endemic bird species are already extinct, having succumbed to pressures of habitat destruction by human development and the introduction of nonnative animals and plants. Nearly three-quarters of the remaining native bird species are already officially classified as threatened or endangered. Hawaii's two native mammals are also officially designated as endangered. About 40% of the State's native plants are on the official list of endangered species or on another list of potential candidates for such designation.

According to NRDC [29], important among the obstacles to protecting Hawaii's native species are problems at the federal and state agencies charged with protecting endangered species, including unnecessary paperwork requirements (bureaucratic procedures and interests) and inadequate funding. The great length of the list of candidates and the extremely slow rate at which they are formally designated as endangered indicate that the existing process is not serving endangered species well. NRDC found a variety of explanations for the listing backlog ranging from "clear restrictions" due to lack of funding, to less obvious factors such as frequent changes in paperwork requirements. While current funding and staffing levels are clearly inadequate to prevent large numbers of extinctions, policies and decisions at both the national and regional levels within the FWS also appear to be to blame. For example, under the Reagan administration, "excessive political interference" in the FWS program was obvious in preventing the listing of endangered species. The effect of this soon became apparent, and the lack of action on species conservation became an embarrassment to the FWS. In later years of the Reagan administration, the director of FWS set a national goal of listing 50 new species per year. Unfortunately, Hawaii alone has over 500 species needing protection under the ESA. At that rate, many species will be extinct by the time they are listed, let alone protected. NRDC concluded that the minimally increased listing rate suggests that the FWS has not committed itself to species recovery. Excessive, changing paperwork and lengthy, complex internal reviews for each listing proposal have caused extensive delays. Lastly, merely listing a species under ESA does not ensure protection. A recovery plan and program must be formulated and successfully implemented.

The analytical error in this illustration, a common one for governmental programs, was that analysts reduced the species recovery problem to one program (a narrowly bounded set of decision and policy processes), with ever-changing bureaucratic rules and regulations. Thus, available scientific knowledge was not used in a timely way. This has caused delays and further species endangerment. This program precluded a streamlined approach or alternative approaches to the conservation of biodiversity (see [30, 29]). Individual analysts may be powerless in the face of this kind of error.

3. Yaffee studied the FWS's Office of Endangered Species (OES) in Washington, D.C., and how it formulated policy and implemented species restoration programs [22]. He investigated the values that should be accorded plants and animals and the institutions that should be established to prevent their extinction and to restore endangered forms. He found that, even though on the surface the task of conserving biodiversity is a biological one, there remains enormous uncertainty, and therefore latitude, in decision making by agency officials. Focusing on both the technical and institutional dimensions of species conservation, his research included discussions with many people who told him "about what really happens throughout implementation" (p. xi). He noted that while his conclusions are critical of the FWS's OES, they apply to nearly all bureaucratic agencies. In all this, it should be noted that the formulation and implementation of ESA is both a substantive process involving biological issues and a political process incorporating diverse interests. In fact, ESA programs operate through the medium of exchange of power, and the channel of interaction in this marketplace is negotiation. To understand the negotiation process, it is essential first to understand the array of forces that influences the political arena of species conservation. Among these forces is the

> sociology of the network of institutions that participates in its implementation. While policies are written in words on paper, they exist only in the form of the individuals, organizations, and agencies that implement them and the nature of the information, resources, authority, and incentives that flow between these actors [22, p. 9].

Yaffee concluded that how FWS bureaucrats redefine or translate new policies and programs to fit with existing formal and informal operating goals, the existing agenda, and the overall power setting, largely determines if a new policy or program will be successful [22]. By studying the behavior of the OES, Yaffee learned about the "politics of expertise" as used by FWS. By this term, he meant how the FWS uses expert knowledge as a political tool. Yaffee studied a host of forces, both internal and external to the FWS, that shape how ESA is actually implemented [22, p. 104–148]. He concluded that FWS programs were dominated by bureaucratic and scientific conservatism. His results identified the same kinds of ESA implementation problems detailed by the GAO and NRDC reviews, which, however, emphasized factors external to the FWS, such as congressional funding levels, and ignored other factors, including many internal to the FWS, such as scientific and bureaucratic conservatism and fixed standard operating procedure.

Yaffee more recently noted that the ESA calls for interagency cooperation in collective planning in Section 7 of the Act [31]. But he (p. 14) noted that "While the concept of interagency cooperation through consultation was well-defined in wildlife law by the early 1970s [32: 192], it has yielded little substantive effect." On the surface, the record of Section 7 shows that cooperative implementation is possible. In recent years, new informal consulting procedures used by FWS have reduced the number of "jeopardy" decisions by FWS under Section 7 (by which a proposed federal development or action may jeopardize a species listed or candidate, threatened or endangered). But Yaffee asked "Does few jeopardy opinions mean that the conflicts have been worked out, or that the FWS is trying to minimize controversy, potentially at some expense to endangered species protection?" [31, p. 16] He concluded that there is no clear answer. (It is noteworthy that several recent legal challenges to the FWS have ruled against them, indicating that some decisions being made by the FWS are the expense of endangered species.) Yaffee's analysis showed that participants in the consultation process followed their perceived self-interests, and that many of these interests ran counter to the interests of endangered species protection. Political considerations clearly are present in the consultation process.

> Rather than bemoan the fact that politics enters into endangered species decision making, we should recognize the realities of the situation and work to exploit the benefits of political inputs, as sources of information about collective values and how intensely they are held, and minimize the negative effects of such forces on species preservation (p. 17).

He argues that we need to go further than current FWS implementation procedures permit by making the whole process more accessible to nongovernmental groups that can serve as watchdogs to promote adherence with the preservation goal. There have been problems with the ESA consultation process, though the problems have largely been with the implementation of the statute, and not with the law as written. Yaffee concluded that the solution to the endangered species crisis requires improvement in the functioning of human decision-making institutions, such as the FWS.

The analytical error in these illustrations was the reduction of the practical problem of saving species to a program (and set of decision and policy processes) that was highly vulnerable to both external and internal interests more concerned with issues other than species conservation. What works in an ideal model of a government program does not necessarily work in practice. There was an overreliance on traditional bureaucratic structure and incrementalistic policy behavior in implementing ESA. Incrementalism is a form of policy making wherein a bureaucracy moves only a small distance away from the status quo, never really comprehensively solving the actual problem. Evidence suggests that scientifically supportable decisions in favor of species conservation are sometimes traded away for the self-interest of the bureaucracies involved.

In short, these illustrations of endangered species conservation and management are complex. Complexity is typical of many conservation problems and solutions. In such instances, managers

> are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex systems of changing problems that interact with each other. I call such situations *messes*. Problems are abstractions extracted from messes by analysis; they are to messes as atoms are to tables and charts. . . . Managers do not solve problems: they manage messes ([33, p. 674], emphasis in original).

In such situations, the kind of preventable (corrigible) errors examined in this paper may be fairly common. If this is true, then remedial action might be expected to increase overall performance considerably in species and ecosystem conservation. Several themes emerge. Errors arise when, in an effort to simplify complex problems, only fragments of knowledge are selected on which to formulate or implement policies. The problem (species *X*'s numbers or habitat are dwindling) is reduced in some people's minds to an overly simple technical solution (protect the habitat [34]). Or the problem may be slotted into a "canned program" (list the species, write a recovery plan, do section 7 consultation, use the same bureaucratic machinery used on the previous species case, etc.)—whether successful or not. Other fragments of knowledge may likewise induce the analyst to overlook or misconstrue important aspects of the problem at hand. (For example, why in the summer of 1985 did agency bureaucrats claim for several months until the population had plummeted to near extinction that the decline of wild black-footed ferrets, *Mustela nigripes,* was "emigration"? (see [35, 36]). Technical, scientific sophistication does not prevent errors in the formulation and implementation of policies and programs; if important information is overlooked or misconstrued in the first place, technical sophistication merely compounds the error. Also, in each illustration, there is a significant discrepancy between the analysts' subjective map of the problem, i.e., their analysis or understanding of it, and the problem as it existed in the real world. The discrepancy is manifested when the subjective map is acted upon.

This difference between subjectivity and reality has been long recognized. Plato's *The Republic* recognized this difference in the allegory of the cave. Walter Lippmann's *Public Opinion* examined it in a chapter on "The World Outside and the Pictures in Our Heads," first published in 1922 [37]. Lasswell [21, 13], the key figure in the founding of the policy sciences, incorporated the idea of the discrepancy into the "maximization postulate," which, as we shall see later, is the core postulate of the policy sciences. And Simon [38, 39, 40] reformulated the discrepancy as the theoretical principle of "bounded rationality," which is currently the most influential formulation. Brunner [41] reviews these and other formulations of the idea that are current in traditional disciplines ranging from anthropology to economics and philosophy.

For analysts involved in the conservation of biodiversity, the task is to recognize the difference between "the world outside and the pictures in our heads" by learning how to see more of the relevant context of problems more reliably—a never-ending process of orienting to problems more appropriately by using multiple methods. Conservationists need to attack root causes of the biodiversity crisis by analyzing problems, policies, and institutions more completely and more reliably with the goal of removing obstacles to saving species and ecosystems and promoting improvements on all fronts of this huge task. This requires much more than only biological or scientific knowledge.

Regardless of how readers may understand the problem and its causes, there are obviously several ways to interpret these illustrations. Schon noted that when we first get signals that something is going wrong, often there is no clear, consensual account of the problem [19]. In large organizations (e.g., wildlife management bureaucracies) or policy arenas (e.g., conservation), there are many participants who occupy different positions, have different interests, and relate different and often conflicting stories. It takes a special manager or analyst to make sense of this *Rashomon,* but by inquiring into the situation, the analyst also influences it. Such a person faces a dual problem: (1) how to find out what is wrong, and (2) how to do so in a manner that enhances, rather than diminishes, the ability and scope to fix what is wrong.

Alternative Definitions of the Problem

Obviously, alternative definitions of the common problem are currently in circulation. First, based on the illustrations above, biologists have not made the most of the opportunities available to them to save species. Perhaps the problem is that they have accepted disciplinary blinders and cannot see or cope with resource constraints or political and bureaucratic constraints as well as they might. Second, one explanation for the recurring patterns of failure in saving species and ecosystems is lack of consensus on what constitutes an "acceptable" or "improved" policy or program for the conservation of biodiversity. Some people argue that there is no normative theory suitable for assessing these, that conservationists are doing the best that is possible. A third definition is lack of empirical theory (based on observation or experiment) about biodiversity policies and programs, where "theory" is variously interpreted as causal relationships among variables, as the integration of such relationships, or as a conceptual framework. Without such theory or framework, people ask, how can policy and program behavior be understood in a causal way, much less improved upon? A fourth definition is lack of explicit recognition among public officials [19:326–354, 20:85–120], the public, and the conservation movement about how policies and programs actually work and about how to improve them; this lack constrains public support and investment in the analytical work of analysts and reduces the role and impact of analysts on conservation policy and program decisions.

Despite these claims, it is clear that advances in normative (i.e., establishing norms) and empirical theory are possible and needed to the degree that they contribute to practical inquiry into the structure and functioning of science, organizations, and policy. But from the view of the policy sciences, there is no lack of central theory as a basis for inquiry and improvements in conservation policies and programs. A theory, with core concepts and normative and empirical propositions, has been available for several decades (see [21, 13, 42, 10, 41] for formulations and reviews). What we lack today are university and professional development programs that apply the policy sciences' central theory to specific cases in their full contexts in the world of conservation. As well, some organizational leaders seem to lack knowledge and skills in applying these conceptual tools. This must be remedied if conservationists are to make practical, real-world gains to improve conservation of biodiversity efforts.

Kinds of Knowledge Needed for Conservation

Now consider the second question: What accounts for the common problem as defined above? Briefly, the problem is the "bounded rationality" of conservationists. One's rationality can be too narrowly bounded or constrained because of the assumptions one uses. If one's rationality is narrowly bounded, then one is likely to misunderstand a problem and incorrectly specify its solution. Conservation problems and solutions are defined and influenced by the disciplinary and bureaucratic biases of analysts, among others. Additionally, different kinds of knowledge, based on different underlying epistemological foundations, are needed for successful conservation. Much of this knowledge is never employed in conservation in an explicit, integrated way, thus partly accounting for the limited effectiveness of many policies and programs. At the most basic level, the problem can be attributed to the epistemological assumptions of the analysts—assumptions about what we can know and how we can know it. Schon argued convincingly that:

> universities are not devoted to the production and distribution of fundamental knowledge in general. They are institutions committed for the most part, to a *particular* epistemology, a view of knowledge that fosters selective inattention to practical competence and professional artistry [19:viii] (emphasis in original).

Brunner demonstrated that scientific positivism taught in most university programs exacerbates the common problem—analysts' errors—and that alternative epistemologies can help ameliorate the problems [42, 41]. Positivism is a philosophy of knowledge and knowing (epistemology) that assumes that reality is objective and that it can be understood and reduced to a relatively small set of natural laws. Positivism also assumes that the behavior of nature can be predicted by these objective laws. This philosophy dominates thinking and action in the western world and in modern science. An alternative epistemology, postpositivism, is examined below and its utility for solving conservation problems described.

Three bodies of knowledge are necessary for successful conservation. Scientific knowledge is used to solve theoretical and practical problems of species, populations, communities, and ecosystem conservation. Organization knowledge is used to organize and manage programs that do the work of conservation; it includes a host of individual, group, and organizational issues. Policy knowledge is used to explore problems, to originate policy, to support a program, and to build new policy relevant knowledge. These three types of knowledge rest on different philosophies about knowledge. Scientific knowledge, as it is currently practiced, is based on an epistemology of positivism, as is organizational knowledge, but policy knowledge embraces a postpositivist epistemology. Conservation programs that consider and use these three types of knowledge explicitly and synergistically have the highest chance of success.

Scientific Knowledge

Science is a backbone of the theoretical and of much applied work underway currently in the field of conservation. Several examples illustrate this at several levels of conservation. Research at the species level on the numbat (*Myrmecobius fasciatus*), an insectivorous marsupial specialist in a monotypic family in Western Australia, is ascertaining the species's life history, behavior, activity, physiology, and ecology [43]. Efforts in support of the eastern barred bandicoot (*Perameles gunnii*), an insectivorous marsupial in western Victoria, Australia, are focused on determining the small population's viability, numbers, density, age and sex structure, natality, mortality, immigration, and emigration rates, and habitat relations [44]. Study of the northern Rocky Mountain wolf (*Canis lupus*), a large pack-living carnivore with large spatial requirements, in and surrounding Jasper National Park, Canada, is focused on community interactions—predation (J. Weaver, personal communication). Conservation work on the Greater Yellowstone Ecosystem, a relatively intact northern temperate ecosystem of about 8 million ha, is focused on the entire assemblage of plants and animals and their physical environment (review in [45]). Modern science underlies conservation efforts at these several scales of space, time, and complexity.

Positivistic science uses three methods to create new knowledge: (1) induction, (2) retroduction, and (3) hypothetico-deduction. Romesburg reviewed these methods and their utility in "Wildlife Science: Gaining Reliable Knowledge [46]. Induction is used to determine associations among sets of facts, retroducion is used to establish research hypotheses, and hypothetico-deduction is used to test hypotheses. Romesburg (1981) argues that few hypotheses in wildlife research are tested rigorously; and thus many concepts, such as carrying capacity, correlation and cause and effect, and the reliability of knowledge gained from computer and simulation models, stem from inadequate or misused scientific methods. To gain reliable knowledge, the most rigorous methods possible must be employed to generate new knowledge and test the reliability of existing knowledge.

Simberloff reviewed the contribution of population and community biology to conservation science [47]. While not critiquing the application of science to conservation biology problems per se as Romesburg did for wildlife science, he did review the origin of conservation biology as a discipline and profession, the origin and rise of island biogeographic theory and its applications, the concept of minimum viable populations, and the metapopulation concept, genetics, and various demographic and environmental stochastic models. He summarized "conservation, general rules, and future research" (p. 500) and cautioned that "uncritical propagation of untested rules of refuge design . . . even if ill-founded, will quickly be adopted with occasionally detrimental consequences" (p. 502). He concluded that, if "science advances by testing and refuting hypotheses, conservation science has clearly advanced quite a way" (p. 502–503).

The above discussion focused on biological science, implying that that is all that is needed for conservation. This is incorrect. Equally important are the social sciences. Many conservation problems and solutions lie in the social sciences. Conservation problems nearly always have their roots in social systems, values, beliefs, and attitudes. So, solutions also have their origin there. Knowledge of psychology, sociology, economics, and political science is essential. Conservationists can combine biological and social science understanding simultaneously in preventing or meeting conservation challenges.

Much science is based on a positivistic epistemology. The ideal of positivism is illustrated by the physical sciences' law of motion, "discovered" by Isaac Newton in the 1600s. Scientific laws are understood to be a fixed, underlying objective reality. They reduce the motion of a pendulum, a falling stone, or a solar system to a permanent relationship among a few simple variables; from these relationships, a person can predict the myriad motions of all physical objects. The language, thinking, and institutions of western civilization capture and reflect this "objectified" view of the world, how the world works, and our relationship to it [48]. Conservation science and most of social science operate with this epistemology. But for conservation to be successful, much more than scientific knowledge is required: scientific knowledge is a necessary but not sufficient condition for conservation.

Organization Knowledge

Appropriately organized and managed programs (tactics) are also needed for successful conservation. The programs must be guided by an overall policy (strategy). Both the program and the policy must be supported by reliable science. Without an effective program, guided by appropriate policy, the conservation effort will likely fail or falter. Organization variables—individual, group, and organizational issues—significantly affect a program's performance. There are several kinds of organizations active in conservation—governmental agencies, nonprofit nongovernmental organizations, and private profit organizations. As Clarke and McCool noted: "Whether policies succeed or fail in their objectives is largely dependent upon the nature of the organization(s) mandated to carry out those policies" [49]. Organizations must establish programs to meet policy aims. These programs may be staffed by biological researchers (contracted from universities or from in-house research divisions), resource specialists (e.g., wildlife or range managers), mid-level program managers (e.g., district rangers in the Forest Service), technicians, and others. With a properly designed and managed program, the organization can meet its goal of conservation.

However, programs can also fail. Programs may fail or be unwise on individual, group, and organizational grounds. In wildlife conservation, there have been failures traceable to organizational weakness [35, 50]. We become aware of ineffective organizations and their programs most strongly when public failures reveal their internal weakness [51, 52, 53]. The destruction of the space shuttle *Challenger* in 1986 was a dramatic example of technical failure. Looking below the surface of the technical failure, a host of organizational and program weaknesses were evident—flawed decision-making procedures, excessive pressure on individuals to conform, poor planning, and others. In short, mistakes tend to be revealed in operations. One can debate about the success of certain conservation programs, but a destroyed spacecraft is unequivocal. However, a strong working knowledge of organizations and programs, in theory and in practice, makes it easier to recognize a poorly performing program and to do something about it before disaster strikes. Unfortunately, workers who know only about biology, or are unconcerned about organizational issues in a conservation program, will likely misconstrue or underappreciate the paramount effect organizational variables can have on their work. In turn, they may be unsuccessful in meeting the program's goals and fulfilling their professional aspirations, and incapable of changing a poorly performing program to one appropriate for the conservation aim.

It is important to understand what organizations are. Organizations are

> repositories of cumulatively built-up knowledge: principles and maxims of practice, images of mission and identity, facts about the task environment, techniques of operation, stories of past experience which serve as exemplars for future action [19:242].

When a conservationist acts, he often

> draws on this stock of organizational knowledge adapting it to some present instance. And he also functions as an agent of organizational learning, extending or restructuring, in his present inquiry, the stock of knowledge which will be available for future inquiry [19:242].

Conservationists (analysts) live in organizational systems which may encourage or inhibit reflection and learning. These systems are more-or-less adaptable to new information, more-or-less resistant to new roles. Whether an organization is a good "learning system" or not depends on many complex characteristics [54]. The scope and direction of professional activities are strongly influenced, and may be severely handicapped, by characteristics of the learning system of the organization in which the analysts operate.

We would expect an effective organization—one with an adaptive learning system—to show certain characteristics. First, it would be well matched to its task, its structure being appropriate for its function [55]. Second, it would be properly staffed, led, and buffered from its political environment. Third, it would process information well, and learn rapidly from its own mistakes. And, it would be creative. Because of the complexity and urgency of most conservation efforts, properly managed programs are imperative. Clark et al. [12] and Clark and Westrum [53] gave descriptions of programs likely to be successful in species recovery.

Numerous models of organizational behavior exist in the organization and management literature that are useful to conservationists. Two invaluable holistic models are those of Nadler and Tushman [55] and Kilmann [56]. Organizational arrangements, whether in the service of conservation or other goals, are used to (1) provide a map of tasks, responsibilities, reporting relationships, and groupings, and (2) provide a mechanism for linking and coordinating organizational elements into a coherent whole [57].

As Schon and many others noted [19, p. 326], "Increasingly, the lives of professionals in our society are bound with the lives of the formal bureaucratic organizations through which most work is done." Bureaucracies, because of fixed rules, roles, and regulations, can narrowly bound professional action. Narrow practitioners may miss important opportunities to escape their narrow bounds in confined bureaucracies. In such situations, they can be drawn into a pattern of error which they cannot escape and behavior like a disease which prevents its own cure—in such a case needed organizational change cannot take place, and the impoverished learning system remains unchanged.

Bringing about organizational change once a problem has been diagnosed can be difficult. Several authors have outlined conceptual and practical procedures to do this, but describing these is beyond the scope of this paper. Readers are referred to Katz and Kahn [58], Tichy [59], and Kanter [60] for an introduction. The importance of the organizational dimension to successful conservation is often underappreciated, especially by narrow, technically oriented conservation scientists. Without a well-organized and carefully managed program, it is unlikely a species and ecosystems will be conserved, even if all the needed scientific information is known.

Policy Knowledge

Policy knowledge is most usefully derived from the policy sciences which are a comprehensive framework for complex problem solving, simultaneously requiring both scientific and social science knowledge. Policy knowledge can be used to subsume, organize, and access knowledge from many different areas, including organizational theory. This framework does not give answers, but only supplies a method to get answers. The form and substance (i.e., knowledge of the process and knowledge in the process) of the policy process are objects of inquiry for policy scientists. The process and substance of policy making are interdependent and also interdetermined.

Deriving policy is often misconceived as an attempt to replace political policy decisions with rational, objective policy decisions—based on applied economics, operations research, organizational theory, and, in this case, science and conservation biology [10, 41]. This stereotype is held by scientific positivists about an essentially postpositivistic social process and is a false understanding of the process and how to participate in it.

The policy sciences, originally conceived by Harold Lasswell [13] and his collaborators in the second quarter of this century, recognize limits to rationality and objectivity, clarify the epistemological foundations and implications of those limits, and devise means of improving human inquiry within those limits [42, 10, 41]. They constitute a program of problem-orientation, contextual mapping, and multimethod inquiry, which recommends human dignity as the overriding aim of policy and policy inquiry. Their approach helps users to think—effectively, efficiently, and responsibly—about the problem at hand. Over the lifetime of a professional career, this approach can build considerable knowledge, experience, and specific improvements in a user's practical efforts [21]. But competence in the policy sciences—developing a policy orientation—requires prolonged discipline, study, and persistence.

The policy sciences focus on problems. In order to understand the policy sciences, it is imperative to understand what "problems" and "solutions" are. Problems are constructed from a problem setting or context (see [61]). That is, to identify or understand a problem requires an analyst first to construct a broad, qualitative interpretation of the relevant context. For example, to identify or understand the problem of a given species endangerment, an analyst needs to define the problem and its connection to its larger context, including biological, socioeconomic, and political contexts.

In problem definition, the policy sciences' approach questions traditional views about the presumed rationality and objectivity of decisions and decision makers. Rationality and objectivity are worth aspiring to, but are never achieved. It also relegates quantitative precision and formal rigor to a respected but secondary role in the search for solutions to real problems. Precision and rigor are neither necessary nor sufficient for this task for two reasons. First, if a problem is misunderstood in the first place, precision and rigor merely compound the initial misunderstanding. Second, if a problem is understood well enough, precision and rigor make little difference in finding a satisfactory solution—even though they are sometimes possible and desirable as part of a solution [41].

A policy orientation requires conservationists to know not only about science but also about the conceptual framework of the policy sciences for problem solving. Knowing the social sciences is important too, much as a biologist should know about evolution, taxonomy, physiology, genetics, ecology, and populations. But the key aspect of a policy orientation is having and using the conceptual tools. Part of the needed conceptual apparatus is a model of the policy process.

One useful way to visualize the policy process highlights six phases through which all policies and programs pass over time [14]. Policies and programs seek to solve problems, that is, they constitute "solutions" to problems. Brewer in *Policy Process As A Perspective For Understanding*, noted how helpful it is to conceive of problems as having a "life" and following a predictable "life-cycle" [62]. Problems emerge, as defined and estimated as to their characteristics and potential, face strategic statements (policies) and tactical measures (programs) that are selected to reduce or resolve unwanted consequences, and, over time, problems end, stabilize, or worsen because of corrective policies and programs or because of changes in the problem setting itself [63].

Initiation.—In the earliest phase of the process, a problem is first recognized, and possible means are examined to alleviate, mitigate, or resolve it. Many of these initially suggested "solutions" will be poorly defined, inappropriate, or unfeasible, but efforts are made to appreciate the full extent of the problem, in its complexity, spatial extent, and timing. The acquisition of needed data is initiated. If this phase is successful, it stimulates sufficient creativity to define the problem and possible solutions further.

Estimation.—This phase includes a more thorough and systematic investigation of the problem and thoughtful assessment of options and alternatives. The likely costs and benefits of each option are considered, not only in dollars, but in many other terms. Both positive and negative actions are considered, i.e., the costs of doing something and the costs of doing nothing. As the problem is estimated in more detail, other actors may become involved and influence decisions as well as the problem itself and the range of solutions under consideration.

Selection.—Selection is often seen as the "political" phase because someone with authority, often a politician or high-level bureaucrat, must decide among the "invented" and "estimated" options. He or she must take the analysts' estimations and compare them with his or her assessments of the changing, multiple, conflicting goals of people who have a stake in the problem and of the society at large (which ideally the analyst already took into consideration). This decision can politicize the defined problem and its proposed solution.

Implementation.—This phase is often underappreciated because many people believe that merely passing a law or establishing a policy is equivalent to putting that new law or policy into effect. Nothing could be farther from reality. How policies are implemented by bureaucrats and others—intact or changed—largely determines the meaning of the policies; it is the focus of lively study. It is essential to understand implementation as part of a long and complex process that must be investigated and evaluated in toto.

Evaluation.—This stage reviews the previous stages of formulation and implementation and inquires into the system's performance and individual responsibility. It determines how well problems are dealt with and resolved. It is essential to the following stage.

Termination.—Policies and programs end when they become redundant, outmoded, dysfunctional, or unnecessary. This phase is often not well-defined and may drag on for lengthy periods. However, its importance should not be unappreciated. When, or if, policies and programs receive evaluation as a basis for termination may have little to do with their continued life or death.

This conception of policy as a sequential process allows easy understanding of the life-cycle pattern of programs and policies and allows one to relate problems to the individual and institutional contexts in which they occur. Understanding this process has other benefits for those who use it.

The epistemology of the policy sciences is very different from the positivistic philosophy underlying modern science. It embodies a post-positivistic philosophy which says, in part, that there are no universal, invariant laws covering interactions in the policy process or other complex human enterprises. Instead, meaning is found by understanding the specific context in which the process takes place. This view is described in the following section.

In summary, scientific, organization, and policy knowledge are all three essential to comprehensive conservation efforts. They represent very different kinds of knowledge supported by different epistemologies. Having even a little knowledge of these areas can go a very long way in improving conservation performance.

Conceptual Framework of the Policy Sciences

A man is walking through town one night and comes across a fellow frantically searching for something under a streetlight. "Lose something?" the man asks. "My keys! I lost my keys." "Where did you lose them?" "Over there," the fellow exclaims, gesturing toward the dark street. "Then why are you looking for them here?" "Because this is where the light is, you fool!"

To the man who loves his hammer, every problem is a nail.

The generals are always prepared to fight the last war.

Now consider the third question posed at the beginning of this paper: What can be done about the common problem of preventable errors made by analysts (which stem from professional or disciplinary and bureaucratic biases)? Depending on the conservation problem at hand, the task may call for better use of either scientific, organization, or policy knowledge, or all three. In some instances, new knowledge may need to be created to solve the conservation problem. Few people active in conservation appear knowledgeable across science, organizations, and policy. And that is the basic problem. This problem is soluble.

Recall that the task is to see more of the conservation problem–relevant context, and to see it more reliably. Biologists might recommend more science and its application in the way we are all familiar with (see [47]). Organizational theorists and consultants might recommend more effective, efficient, and equitable programs. Policy scientists might recommend acquiring facility in the use of a conceptual framework, adequately designed for the task, as the way to make full use of the opportunities available—a view which not only subsumes but also attempts to comprehend the full context of the situation systematically.

Let's focus on the policy sciences perspective because both scientific and organizational knowledge are easily intuitive, whereas policy science knowledge is less so. We all distill past experience into various forms of knowledge for use in future problem solving—concepts, models, facts, and various other forms [7]. These knowledge fragments in any form are unreliable for problem definition: (1) they reduce the number of factors considered in problem definition to a subset of the factors that may or may not turn out to be important in the real world, (2) they misconstrue interactions among the factors considered and those not considered, and (3) they tend to stereotype relationships among the factors considered on the basis of previous experience.

To avoid these kinds of problems, which are illustrated by the three stories at the beginning of this section, it is necessary to integrate many knowledge fragments within a conceptual framework. A conceptual framework, properly defined,

> identifies those distinctions that have consistently proven to be most important and useful across broad ranges of experience; crystallizes them into basic concepts and organizes them into a logically consistent and cognitively convenient framework for subsequent applications. Both the substances and the form are designed to help the analyst construct a more reliable map of any particular context, as a guide to action in that context.

The framework itself is not a map, but a source of observational cues and questions for constructing many maps [41, p. 13].

The framework does not refer to any particular situation, but to all situations; it is highly abstract and useful in all situations in many ways. Its real value is in helping set aside preconceptions about the problem under consideration and in guarding against devising a new framework for each specific problem, which often is nothing more than a reaffirmation of preconceptions about the problem and the solution.

A full description of the policy sciences framework is well beyond this short paper (see [14]). A brief list of its principal dimensions from Brunner [10]—the maximization postulate, eight basic values, the social process, decision process, and problem-orientation. From a social process perspective, the conservation movement can be characterized as a social movement. It is made up of a group that attempts to explain and justify its behavior in terms of a distinctive viewpoint and to harmonize it with the myth of society at large (see [64]). From a decision process perspective, the conservation movement can be characterized as undergoing specialization; each specialization is coordinated, sometimes loosely, through professional organizations and journals (i.e., Society of Conservation Biology and its journal, Restoration and Management Society and its journal). Each specialization tends to prescribe and revise its research standards in an endless cycle. The positivist research standards of all the specialists' groups are essential to conservation, but additional knowledge, organization, and policy is also essential. From a problem-oriented perspective, it is obvious that individual conservation analysts have latitude to choose among the kinds of knowledge needed and their epistemological requirements for successful conservation. But nearly all stick closely with traditional science and positivism, not because of their proven success but because of the analysts' familiarity with them. Our collective conservation effectiveness suffers for it.

A range of practical tools has been proposed in this paper to combat the professional and bureaucratic narrowness or "bounded rationality" evident in some instances in the conservation of biodiversity (see [65, 66]). Using the full range of knowledge—scientific, organizational, and policy—will help [7, 67]. More specifically, many authors have discussed how organizations can be managed to be more open and flexible; how they can be structured and operated for proactive problem solving; how they can avoid "group-think;" how coordinating roles can maximize information flows and quality, timely decision making; how certain types of decision-making styles and procedures are most useful; how to understand and go about removing organizational and professional blockages to learning and improved performance; how to effect bureaucratic change; how to assemble and run a high-performance team for special problem solving; how to avoid program delays and intelligence failures; how to use decision seminars to maximize problem solving. Many other authors are grappling with these same problems (see references) and have written extensively about solutions.

Conclusions and Summary

All previous sections of this paper provide ideas and a perspective on successful conservation of species and ecosystems. One theme is that successful conservation requires a complementary blend of scientific, organization, and policy knowledge. The blending of these three types of knowledge and their concomitant epistemologies is not easy, but it holds promise of more successful conservation efforts. A second theme is that the policy sciences's conceptual framework for complex problem solving is essential to counter the scientific, professional, and bureaucratic biases and the tool necessary to integrate the three kinds of knowledge. The task for conservationists is clear; they need to learn how to apply this mix of knowledge explicitly, and create new knowledge as needed, applicable to the important job of conservation of biodiversity. In summary, I have offered a perspective on some disappointments and failures of biodiversity conservation by looking at the Endangered Species Act and its program elements, as a policy problem, from a policy sciences perspective.

What is the common problem? As I define it, the disappointing performance, in varying degrees, in the conservation of biodiversity occurs because of preventable (corrigible) errors in the formulation and implementation stages of the policy process, errors which stem directly from the perspective of the analysts involved. Typically, some important aspect of a problem-relevant context is overlooked or misconstrued; and scientific, professional, and bureaucratic biases are implicated as the cause. This is largely a matter of inappropriately defining the particular conservation problem at hand.

What accounts for the common problems? As I diagnose it, the most basic problems are epistemological. Professional or disciplinary, and bureaucratic biases often narrowly bound the rationality of the analyst. But the most obvious surface causes are failure to appreciate and use existing knowledge across several areas—scientific, organizational, and policy—in an explicit, integrated manner. Few analysts are currently capable of doing this. These biases and positivism tend to perpetuate errors of analysts, while the alternative epistemologies provide means of minimizing those errors. The research standards associated with conservation science and management are positivistic, and the alternatives are in flux. This leaves the analysts with some complicated professional choices.

What can be done about the common problem? My recommendation is to acquire facility in all three knowledge areas—scientific, organizational, and policy—and their underlying epistemologies. Even a little knowledge can go a long way in improving conservation performance. Developing facility with the policy sciences' conceptual framework, which is adequately designed for defining the particular problem at hand, is essential. The policy sciences conceptual framework is vital to the important task of biodiversity conservation. Conservation biologists and other people in the conservation movement should gain facility with it. It is a powerful problem-solving tool.

I have also encouraged others, both in and out of the conservation movement, to take the conservation of biodiversity as a policy problem, from whatever perspectives they find convenient and useful. This self-referrential approach—taking themselves as the objects of, and clients for, policy inquiry—can be stimulating and rewarding. In the end, I hope comparisons among the various questions and answers will leave each of us in a better position to make informed choices that realize our various individual and common interests—the successful conservation of biodiversity.

APPENDIX

Diagnosing Problems and Evaluating Organizations

A good introduction to the organizational dimension important in conservation work is the model and diagnostic approach by Gordon [68]. The objective of applying Gordon's diagnostic scheme, in fact the central focus of all organizational analysis, is to improve organizational effectiveness. It can be applied to all organizations "to delineate its events and key interactions, increase understanding of the situation, prescribe corrective action, identify issues related to implementation of the actions, and hypothesize about outcomes" (p. 647). Gordon's approach offers a multifaceted approach to improved effectiveness, that emphasizes behavior in organizations. A four-phased approach is used: description, diagnosis, prescription, and action. This model and approach should be known explicitly to all practicing conservationists.

Description of a program is the essential starting point. Description gives a person direct observation of the situation. On this basis, one can determine if a problem exists. Additional descriptions and interviews of program participants would expand the description by uncovering additional factors that influenced the behavior of the situation. Data collection by more formal methods, including questionnaires and systematic observational studies, are usually not included under description.

Diagnosis, the next phase involves identification of key variables in the situation. This is followed by the application of theories or concepts to explain these factors. Corresponding to each diagnostic perspective are diagnostic questions. These questions aid in pinpointing general problem areas. Further diagnosis should address problem areas uncovered by these questions.

Solutions must be prescribed, once the diagnosis is completed. If the diagnosis, for example, identified problems with communication, role definition, leadership, conflict, and organized structure, these problems must be addressed. Obviously, then communication must be improved, perceptions checked, feedback increased among parties, and defensive climates reduced. Roles must be defined appropriately. Leadership styles must be made to fit the situation and the needs of those supervised. Conflict management must be improved. And the formal organizational chart must be redesigned to clarify relationships.

The final phase is action. In considering action, many questions must be addressed. Among them are: What are the implications of implementing the prescriptions? What are the forces facilitating and hindering needed change? What historical precedents are there for change? Who will bring about the needed change? Who will do follow-up evaluation? Lastly, institutionalization of effective change must occur.

Using Gordon's diagnostic approach in the organization and management of conservation programs should lead to increased functioning. Increasing organizational effectiveness should become a high priority by policy and program managers and technical experts alike. In the three illustrations at the beginning of this paper on Endangered Species Act implementation and its program elements, many opportunities are evident to improve performance. Improved organizational effectiveness is the goal of organizational designers and redesigners and organizational development consultants. Steers (cited in [68, p. 654]) indicates that several classes of factors contribute to organizational effectiveness: (1) employee characteristics, including organizational attachment and job performance; (2) managerial policies and practices; (3) organizational characteristics, consisting of structure and technology; and (4) characteristics of the internal and external environment. To achieve improved effectiveness, a recognition of the complexity of organizations, as well as the individuals and groups that make them up, must be understood.

Two indicators of an effective organization are "quality of working life (QWL)" and "organizational climate (OC)." The QWL includes employees' relationships to working environments. Walton [69] defines QWL as "the degree to which members of a work organization are able to satisfy important personal needs through their experiences in the organization." These include: (1) adequate and fair compensation, (2) a safe and healthy environment, (3) immediate opportunity to use and develop human capacities, (4) future opportunities for continued growth and security, (5) social integration in the work organization, (6) constitutionalism in the work organization, (7) work and the total life space, and (8) the social relevance of work life (p. 655). Several prominent examples show that where programs to improve QWL have been carried out, significantly increased organizational performance resulted (review in [69]).

The organizational climate is closely linked to the QWL. The OC is the internal environment of the organization and includes communication, reward, leadership, goal-setting process, and other variables. Extensive research on OC shows it is strongly related to overall performance and job satisfaction. A good OC supports group processes such as leadership and minimizes problems such as role stress. A well-managed OC is essential for an effective organization. It is clear that improvements in many conservation programs are possible. Program managers and participants could achieve these improvements if they utilized concepts and analytical tools like those of Gordon [68].

REFERENCES

1. Wilson, E. O. Threats to biodiversity. *Scientific American* 261:108, 112, 114, 116, 1989.
2. BioScience. Extinction countdown for U.S. plants. *BioScience* 39:276, 1989.
3. New York Times News Service. Environmental dangers threaten freshwater fish, 1990.
4. Meese, G. M. Saving endangered species: implementing the Endangered

Species Act. In *Defense of Wildlife: Preserving Communities and Corridors*, edited by G. Mackintosh. Washington, D.C.: Defenders of Wildlife, 1989.
5. Peters, R. L., and Darling, J. D. S. The greenhouse effect and nature reserves. *BioScience* 35:707–717, 1985.
6. Miller, K.; Reid, W.; and McNeely, A. J. A global strategy for conserving biodiversity. *Endangered Species Update* 6(8):1–5, 1989.
7. Brewer, G. D. The policy sciences emerge: to nurture and structure a discipline. *Policy Sciences* 5:239–244, 1974.
8. Brewer, G. D. Creating and using policy research. Unpublished Manuscript. Yale University, 1984.
9. Castle, E. Information: the human resource. Washington, D.C.: Resources for the Future, April 1981.
10. Brunner, R. D. Conceptual tools for policy analysis. Prepared for delivery at the 1987 Annual Meeting of the American Political Science Association, The Palmer House, Chicago, September 3–6. Revised October 1987.
11. Nathan, R. P. The missing link in applied social sciences. *Transaction/Society* 22:72–77, 1985.
12. Clark, T. W.; Crete, R.; and Cada, J. Designing and managing successful endangered species recovery programs. *Environmental Management* 13:159170, 1989.
13. Lasswell, H. D. *A Pre-View of Policy Sciences*. New York: Elsevier, 1971.
14. Brewer, G. D.; and de Leon, P. The foundations of policy analysis. Homewood, Ill.: The Dorsey Press, 1983.
15. Hales, E. Letter to diversity section. *Conservation Biology* 1:81, 86, 1987.
16. Scientific American. Special issue: managing planet earth. Sept. 1989.
17. Carr, A. III. Letter to diversity section. *Conservation Biology* 1:80, 85, 1987.
18. Snyder, N. F. R. California condor recovery program. Raptor conservation in the next 50 years, edited by S. E. Senner, C. M. White, and J. R. Parrish. Raptor Research Repon No. 5:56–71. Hasting, Minn.: Raptor Research Foundation.
19. Schon, D. A. The reflective practitioner: how professionals think in action. Basic Books, 1983.
20. Gruber, J. E. Controlling bureaucracies: dilemmas in democratic governance. Berkeley: University of California Press, 1987.
21. Lasswell, H. D. The emerging conception of the policy sciences. *Policy Sciences* 1:3–14, 1970.
22. Yaffee, S. L. Prohibitive policy: implementing the federal Endangered Species Act. Cambridge, Mass.: MIT Press, 1982.
23. Kellert, S. R. Social and perceptual factors in endangered species management., *J. of Wildlife Management* 49:528–536, 1985.
24. Wildavsky, A. Speaking truth to power: the art and craft of policy analysis. Boston: Little Brown and Co., 1979.
25. Parker, P. Foreword. In *Conservation Biology of the Black-Footed Ferret*, by T. W. Clark. Wildlife Preservation Trust, Special Scientific Report No. 3: 1–175, 1989.
26. Littrell, W. B. Bureaucracy in the eighties. *Applied Behavioral Sciences* 16:263–279, 1980.
27. General Accounting Office. Endangered species: management improvements could enhance recovery programs. U.S. Govt. Printing Office GAO/RCED-89-5:1–100, 1988.
28. Greenwalt, L. A. Reflections on the power and potential of the Endangered Species Act. *Endangered Species Update* 5:7–9, 1988.

29. Natural Resources Defense Council. Extinction in paradise: protecting our Hawaiian species. Hawaii Office, Honolulu, 1989.
30. Scott, J. M.; Csuti, B.; Jackobi, J. D.; and Estes, J. E. Species richness: a geographic approach to protecting future biological diversity. *BioScience* 37:782–788, 1987.
31. Yafee, S. L. Endangered species protection through interagency consultation. *Endangered Species Update* 5:14–19, 1988.
32. Bean, M. *The Evolution of Wildlife Law.* New York: Praeger Publisher, 1983.
33. Hughes, E. Higher education and the professions. In *Content and Context: Essays on College Education*, edited by C. Kaysen. New York: McGraw-Hill, 1973.
34. Smales, I. J.; Craig, S. A.; Williams, G. A.; and Dunn, R. W. The helmeted honeyeater decline, conservation and recent initiative for recovery. In *Proceedings of a Conference on Management and Conservation of Small Populations, Held at Melbourne Zoo, September 26–27, 1989*, edited by T. W. Clark, and J. H. Seebeck. Brookfield, Ill.: Chicago Zoological Society.
35. Weinberg, D. Decline and fall of the black-footed ferret. *Natural History Magazine* 195:62–69, 1986.
36. Carr, A. III. Introduction: the black-footed ferret. *Great Basin Naturalist Memoirs* 8:1–7, 1986.
37. Lippmann, W. *Public Opinion.* New York: Free Press, 1965.
38. Simon, H. A. Rationality and administrative decision making. In *Models of Man.* New York: Wiley, 1957.
39. Simon, H. A. *Reason in Human Affairs.* Stanford, Calif.: Stanford Univ. Press, 1983.
40. Simon, H. A. Human nature in politics: the dialogue of psychology with political science. *American Political Science Review* 79:293–304, 1985.
41. Brunner, R. D. The policy movement as a policy problem. Center for Public Policy Research, University of Colorado, Boulder. Discussion Paper No. 48:1–27, 1989.
42. Brunner, R. D. The policy sciences as science. *Policy Sciences* 15:115–135, 1982.
43. Friend, J. A.; and Kinneal, J. E. Numbat *Mymecobius fasciatus.* In *Complete Book of Australian Mammals*, edited by R. Strahn. Sydney: Angus and Robertson, 1983.
44. Clark, T. W., and Seebeck, J. H., eds. *Conservation and Management of Small Populations. Proceedings of Conference, Melbourne Zoo, September 26–27, 1989.* Brookfield, Ill.: Chicago Zoological Society, 1990.
45. Clark, T. W., and Harvey, A. *Management of the Greater Yellowstone Ecosystem: An Annotated Bibliography.* Northern Rockies Conservation Cooperative, 1988.
46. Romesberg, H. C. Wildlife science: gaining reliable knowledge. *Journal of Wildlife Management* 45:293–313, 1981.
47. Simberloff, D. The contribution of population and community biology to conservation science. *Annual Review Ecology and Systematics* 19:473–511, 1988.
48. Berger, P. L., and Luckman, T. *The Social Construction of Reality: a Treatise in the Sociology of Knowledge.* New York: Penguin Books, 1987.
49. Clarke, J. N., and McCool, D. *Staking Out the Terrain: Power Differentials among Natural Resource Management Agencies.* Albany: State University Press of New York, 1985.

50. Low, R. Captive breeding of threatened neotropical parrots. *Watchbird/CITES* Fall:31–35, 1989.
51. Clark, T. W., and HaNey, A. Implementing Endangered Species Act policy: learning as we go? *Endangered Species Update* 5:35–42.
52. Clark, T. W., and Westrum, R. High performance teams in wildlife conservation: a species reintroduction and recovery example. *Environmental Management* 13:663–670, 1989.
53. Clark, T. W., and Westrum, R. Paradigms and ferrets. *Social Studies of Science* 17:3–33, 1987.
54. Argyris, C., and Schon, D. Organizational learning: a theory of action perspective. New York: Addison-Wesley, 1978.
55. Nadler, D. A., and Tushman, M. L. A model for diagnosing organizational behavior. *Organizational Dynamics*, Autumn:35–51, 1980.
56. Kilmann, R. H. A completely integrated program for creating and maintaining organizational success. *Organizational Dynamics*, Summer:4–19, 1989.
57. Daft, R. L. Organizational theory and design. New York: West Publishing Company, 1985.
58. Katz, D., and Kahn, R. L. *The Social Psychology of Organizations*. New York: Wiley, 1978.
59. Tichy, N. M. *Managing Strategic Change: Technical, Political, and Cultural Dynamics*. New York: Wiley, 1983.
60. Kanter, R. *The change masters*. New York: Simon and Schuster, 1983.
61. Dery, D. *Problem Definition in Policy Analysis*. Lawrence: University of Kansas Press, 1984.
62. Brewer, G. D. The policy process as a perspective for understanding. In *Children, Families and Government*, edited by E. Zigler, S. L. Kagan, and E. Klugman. New York: Cambridge University Press, 1973.
63. Brewer, G. D. Dealing with complex social problems: the potential of the "decision seminar." In *Political Development and Change: A Policy Approach*, edited by G. D. Brewer, and R. D. Brunner. New Jersey: Free Press, 1974.
64. Leopold, A. *A Sand County Almanac*. New York: Ballantine Books, 1949.
65. Jackson, J. A. Biopolitics, management of federal lands and the conservation of the red-cockaded woodpecker. *American Birds* Winter 1986:162–168.
66. Ligon, J. D.; Stacey, P. B.; Conner, R. N.; Bock, C. E.; and Adkisson, C. S. Report of the American Ornithologist's Union Conference for the conservation of the red-cockaded woodpecker. *The Auk* 103:848–855, 1986.
67. Brewer, G. D. Methods for synthesis: policy exercise. In *Sustainable Development of the Biosphere*, edited by N. C. Clark, and R. E. Munn. Massachusetts: Cambridge University Press, 1986.
68. Gordon, J. R. *A Diagnostic Approach to Organizational Behavior*. Boston: Allyn and Bacon, Inc., 1983.
69. Walton, R. E. Quality of working life: what is it? *Sloan Management Review* 15:11–21, 1973.
70. Thomas, J. W. Effectiveness—the hallmark of the natural resource management professional. *Transactions of 51st North American Wildlife and Natural Resources Conference:* 27–38, 1986.

NOTICE

The attached appendix, figure, and tables were part of the original manuscript of "Creating and Using Knowledge for Species and Ecosystem Conservation: Science, Organizations, and Policy." But lack of space in the journal prevented their publication with the main body of the article. You may find them useful.

Tim W. Clark

APPENDIX II

EPISTEMOLOGY AND THE POLICY SCIENCES

The kinds of knowledge--scientific, organization, and policy--described above are essential to successful conservation of biodiversity. Conservation science alone, although necessary, is insufficient. Sections above noted that the underlying philosophical foundations of science, organization, and policy knowledge are very different. The discussion to this point has only partly answered the question: What accounts for the common problem of preventable conservation failures? Certainly the kind of knowledge available and applied will significantly affect the outcome of the endeavor. But, the most basic answer, as indicated earlier, is that the common problem can be attributed to the epistemological assumptions of the analysts--formulators and implementors, assumptions about what we can know and how we can know it. Much of the following discussion is based on Brunner [42, 11, 41].

Positivism

For most analysts, positivism is science, with several basic assumptions and laws that reduce the behavior of physical things as diverse as planets or genes to invariant relationships among a few simple factors. They are understood to represent a fixed, underlying reality. From these relationships, one can predict the diverse behavior of these physical objects.

Auguste Comte expressed the principle doctrines of positivism (in [19:32]):

> First, there was the conviction that empirical science was not just a form of knowledge but the only source of positive knowledge of the world.

Second, there was the intention to cleanse man's mind of mysticism, superstition, and other forms of pseudo-knowledge.

And finally, there was the program of extending scientific knowledge and technical control to human society, to make technology, as Comte said, "no longer exclusively geometrical, mechanical or chemical, but also and primarily political and moral . "

Positivism began to enter the behavioral sciences in 1940-1950's. It was assumed that if the behavioral equivalents of Newton's physical laws could be discovered, they would provide the foundation for objective and rational decision and policy making. Objectivity would be served because predictions would be outside the analysts viewpoints, and others could use positivistic scientific methods to replicate their conclusions. Rationality would be served because the outcomes of decision and policy options could be predicted with accuracy and precision, independent of the context.

Nearly 50 years' work in the behavioral sciences has proven disappointing: no universal laws about human behavior have yet been discovered independent of the analyst's viewpoint and context, with accuracy and precision [41]. As an example, Brunner [41] examined "rational choice theory," which states that an actor behaves as if he were objectively rational and chooses alternatives that maximize the expected value of outcomes. It assumes that the actor has knowledge of all alternatives and outcomes, and has a consistent utility function for valuing all outcomes. Obviously these assumptions cannot be met.

In reality, to predict behavior the analyst must specify other hypotheses characterizing the actors' views of the choice situation. For example, actors such as "bureaucrats" or "politicians" are sometimes assumed, to maximize a value such as "power" in the face of known outcomes. These other hypotheses are usually kept simple and standardized across actors and time, in keeping with the ideal of reducing complex behavior to the simplest terms.

Testing rational choice theory requires an understanding of the analyst's specifications. If the analyst's specifications approximate the actor's views of the circumstances, the predicted choices can approximate the observed choices. With either outcome, it is the analyst's specifications that are being tested and not the central hypotheses about objective rationality. In summary, the objective rationality hypotheses is untestable in itself; the results of tests rest upon the analyst's specification of a particular context and the results are restricted in scope to that context [42, 11, 41].

Responses to the disappointing application or downright failure of positivism to find "laws" in the behavioral sciences has been diverse. Some practitioners have rejected positivism, seeking alternatives. Some social scientists have retained an orthodox faith with the hope that success is just around the comer. According to Brunner [41:7], others, perhaps the dominant view, maintained the core faith by rejecting "particular tenets and substituting certain heresies," such as nominal standards of success. The revised standards of success are often a "universalized" restatement of the original hypothesis or simply the use of quantitative or formal methods. Research employing "hard" methods appears to be "scientific," giving the impression that it is objective and rational. This bestows advantage by allowing authors to justify their research over the research of others which uses "softer" interpretative forms and methods. Readers and reviewers can then surmise that the harder approach is somehow more substantiative and a better basis for reliable action, even though this may be a false conclusion.

Schon [19:vii], for example, has become convinced that universities are not

> devoted to the production and distribution of fundamental knowledge in general. They are institutions committed, for the most part, to a particular epistemology, a view of knowledge that fosters selective inattention to practical competence and professional artistry. (emphasis in original)

Alternatives to Positivism

Unlike the movement of bodies subject to scientific laws, behavior is dependent on the actor's perspective, it is intentional and selective, rather than determined by universal covering laws [42, 11, 41]. For the policy sciences, this is embodied in the "maximization postulate" [14:16] which:

> holds that living forms are predisposed to complete acts in ways that are perceived to leave the actor better off than if he had completed them differently. The postulate draws attention to the actor's own perception of the alternative act completions open to him in a given situation.

These perceptions may be conscious or unconscious, deliberate or instantaneous, and they may turn out to be in error.

The postulate distinguishes the behavior of living forms from that of inanimate objects. The behavior of inanimate objects is determined by forces in the external environment, according to Newtonian mechanics. So far as we know, a planet in orbit, a falling apple, or a pendulum does not have perceptions of an internal viewpoint that shape its motions.

In contrast, the behavior of living forms depends directly on an internal map of the self in the external environment. This map is subjective because it is a selective and distorted representation of the external environment–the result of genetic predispositions and sensory impressions over time. It allows variations among actors and over time. Consequently, just what the subjective map may be for a particular actor, in a particular situation, at a particular time, is always a matter of empirical inquiry (see [40]).

The maximization postulate is the only postulate in the policy sciences; i.e., its truth is taken as self-evident for purposes of reasoning. All empirical propositions in the policy sciences are based on reasoning (inductive and retroductive) about observed behavior using the maximization postulate, and are subject to clarification and correction when specified in particular cases. The maximization postulate suggests that knowledge about behavior can be improved but that the context of that knowledge is important. We know that every individual's subjective map falls far short of omniscience in many idiosyncratic ways. Trial and error figures into this, but over time and multiple trials the successful responses tend to be fixed as personality traits at the individual level or as social institutions at the societal level. Ideally, relatively unsuccessful responses result in learning and adaptation. Thus the maximization postulate recognizes both the creation and termination of responses at both the individual and societal levels.

Lasswell summed up the point in the principle of contextuality [21:6]: the meaning of anything "depends upon its linkages with the context of which it is part." For human behavior, this means that in fact all contexts are open and that all linkages are ever changeable. Our initial map of a problem and its context and alternatives between the two can result in improved understanding and action. This is because interpretation (the process of mapping the relevant context in such a way that we have a more reliable basis for personal or societal action) can broaden our observations, and inference (inductive and retroductive reasoning) can extend our present understanding. This is also because interpretation focuses our attention on "blind spots," contradictions, and other limitations in our current understanding. Through this process of broadening the attention frame, the previous understanding of a problem and its context tend to become obsolete in the face of the new view. In this process, the inquiry becomes more than just an elaboration of the original preconceptions, and genuine learning takes place.

The policy sciences conceptual tools, introduced previously, provide systematic guidance on what to look for and how to construe it. They offer both observational cues and questions for mapping any problem-relevant context. The answers to those questions result in a map--ideally, a better map of the context (and the problem in it) than otherwise would have happened. Although the real test of the map's accuracy and reliability is the actions that follows.

Lastly, under the maximization postulate, the behavioral distinction between the policy analyst and other people is non-existent. Lasswell [14: 40] summed it this way :

> To some extent we are all blind and no doubt will remain so. But there are degrees of impairment, and so far as decision outcomes are concerned, it is the responsibility of the policy scientist to assist in the reduction of impairment.

From this, it is clear that the policy scientists seeking to improve decision and social process must come to understand themselves as both observer and participant. This position is in marked contrast to a scientific positivist who assumes he is standing outside the system he is studying. The policy scientist is both a part of the system under inquiry and its chief investigator.

Let's return to the common problem: Most preventable errors of analysis in conservation stem from the analyst's perspective. This means that as the analysts simplifies a specific problem, some important part of the context is overlooked altogether or merely misconstrued. Sometimes this is due to the positivistic orientation of the analyst. This positivistic orientation of the analyst may contribute to the underlying problem by: l) constricting the analyst's focus of attention to a small number of factors, 2) implying that the relationship among these factors are fixed, standardized, and otherwise independent of the context, and 3) diverting attention from the analyst's own subjective viewpoint. The errors of analysis and implementation which result are reinforced and perpetuated by the rhetoric of positivism [48].

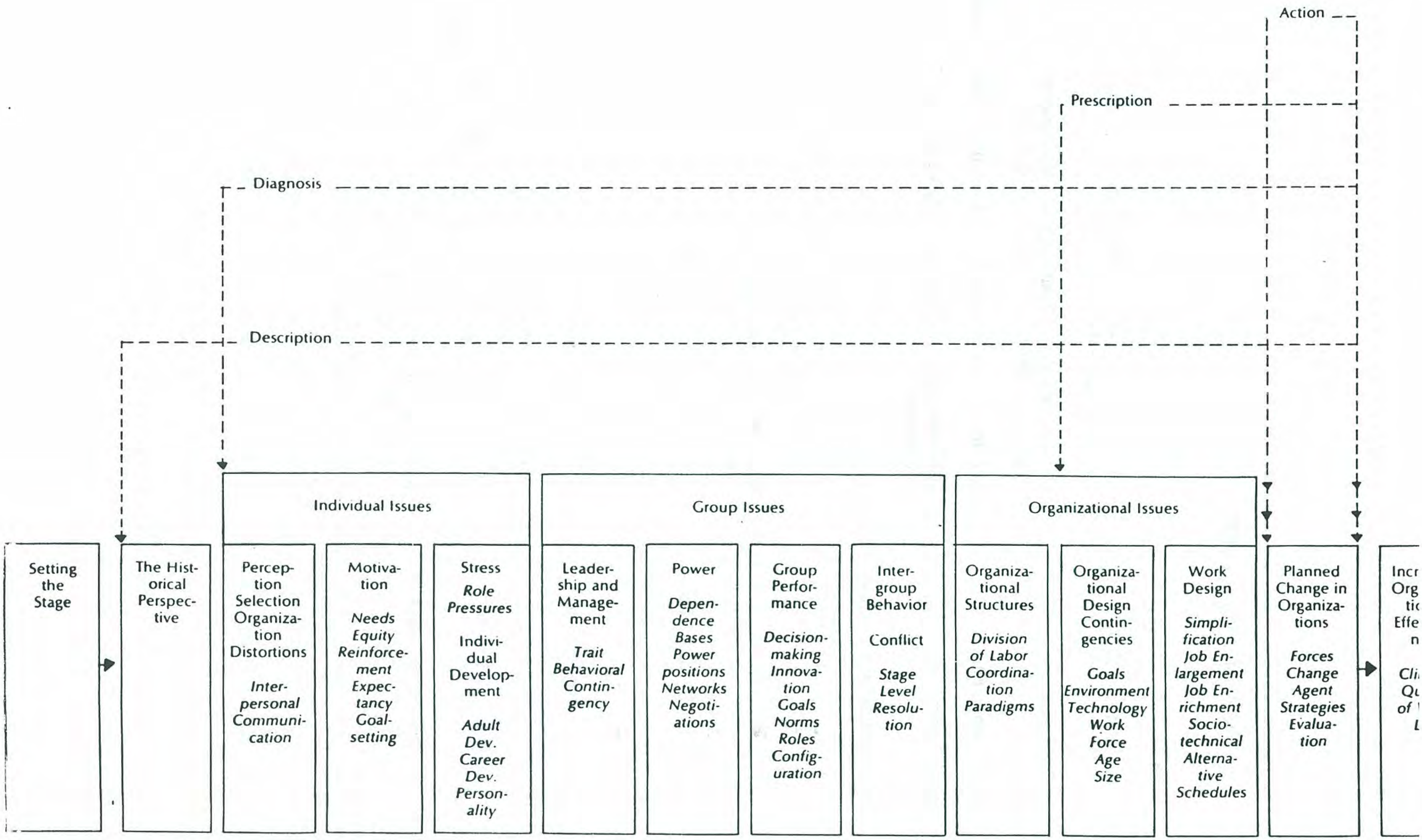
The policy sciences' post-positivistic conceptual framework provides a means of addressing and ameliorating these problems by: l) forcing analysts to broaden their attention beyond their initial understanding of a particular problem, 2) directing their attention to the context-dependent meanings of observations and relationships, and 3) making explicit the role of the analyst's viewpoint, including values, in the construction of any problem context.

These represent a powerful argument against positivistic problem solving. Unfortunately, because the conservation movement is dominated by positivistic conceptions of the conservation problem and expectations of positivistic solutions, post-positivistic inquiry will continue to be penalized. This will change only if the prevailing rhetoric and research standards of positivism in the peer review processes change. This explains why the post-positivistic tendencies described above are concentrated in older, established professionals (e.g., [70]) who are less subject to professional discrimination.

The policy sciences framework offers an invaluable, powerful conceptual tool to problem solve. It can be reasonably expected that if it were widely applied, improved conservation would ensue.

List of Figures

List of Tables



Action
Prescription
Diagnosis
Description
Individual Issues
Group Issues
Organizational Issues
Setting the Stage
The Historical Perspective
Perception
Selection
Organization
Distortions
Interpersonal Communication
Motivation
Needs
Equity
Reinforcement
Expectancy
Goal-setting
Stress
Role Pressures
Individual Development
Adult Dev.
Career Dev.
Personality
Leadership and Management
Trait
Behavioral
Contingency
Power
Dependence
Bases
Power positions
Networks
Negotiations
Group Performance
Decision-making
Innovation
Goals
Norms
Roles
Configuration
Intergroup Behavior
Conflict
Stage
Level
Resolution
Organizational Structures
Division of Labor
Coordination
Paradigms
Organizational Design Contingencies
Goals
Environment
Technology
Work Force
Age
Size
Work Design
Simplification
Job Enlargement
Job Enrichment
Sociotechnical
Alternative Schedules
Planned Change in Organizations
Forces
Change Agent
Strategies
Evaluation

Table 1. Three kinds of knowledge needed in species and ecosystem conservation.

KINDS OF KNOWLEDGE	CONTENT
I. Scientific	
1. Single Species	life history, behavior, morphology, physiology, genetics, taxonomy, general ecology
2. Populations	viability, numbers, density, age and sex structure, natility, mortality, immigration, emigration, genetics
3. Communities	interspecies interactions, predation, competition, parasites
4. Ecosystems	assemenblages of plants and animals and their physcial environment
II. Organizations (Gordon 1983)	
1. Individual Issues	perceptions, interpersonal communication, motivation, stress, individual development
2. Group Issues	leadership and management, power, intergroup behavior, conflict
3. Organizational Issues	organizational structure, organizational design, contingencies, work design, planned change
III. Policy (Brewer 1984)	
1. Program-Supporting	satisfies clearly understood needs of an existing program
2. Policy-Forming	clarifies and informs more general policy needs
3. Problem-Exploring	broader and deeper understanding of problems but not necessarily contributing to existing programs or policies
4. Knowledge-Building	produced primarily for its own sake and without reference to specific problems, programs, or policies

Table 2. Possible benefits from each phase of the policy process (62:153).

Phase in the Policy Process	Possible Benefits
Initiation/Invention	-Creative thinking about a problem -Prototypical design -Crude hypothesis testing -Preliminary investigation of concepts or claims
Estimation	-Scientific examination of likely impacts and outcomes of a set of plausible options -Normative/evaluative examination of likely human impacts of plausible options -Development of outlines of a complex program -Thorough evaluation of concepts or claims -Establishment of a first approximation of performance indicators -Detailed estimation of critical parameters
Selection	-Focusing debate on the actual issues -Allowance for "cleaner," less "hedged," or "compromised" options to be selected -Choice among program designs -Reduction of uncertainty about various options
Implementation	-Development of specific, difficult pieces of a program -Development of a complex program giving due respect to existing institutional and incentive structures -Minimization of implementation costs -Establishment of performance expectations based on estimates of critical parameters for selected option -Reduction in unexpected and unwanted "surprises" from program implementation
Evaluation	-Comparison of estimated performance levels with those actually attined -Reconciliation of expected institutional responses with those actually observed
Termination	-Predetermination of whether the problem is chronic, recurring, or resolvablbe -Generation of information about new problems, some of which may require experimental treatment

Table 3. Principal dimensions of the policy sciences framework (adapted by Brunner 11,41 from Lasswell 14, Chapters 2 and 3).

Postulate	Living forms are predisposed to complete acts in ways that are perceived to leave the actor better off than if he had completed them differently.
Values	**Outcomes and institutions.**
Power	Victory or defeat in fights or elections. Government, law, political parties.
Enlightenment	Scientific discovery, news. Languages, mass media, scientific establishments.
Wealth	Income, ownership transfer. Farms, factories, banks.
Well-being	Medical care, protection. Hospitals, recreational facilities.
Skill	Instruction, demonstration of proficiency. Vocational, professional, art schools.
Affection	Expression of intimacy, friendship, loyalty. Families, friendship circles.
Respect	Honor, discriminatory exclusion. Social classes and castes.
Rectitude	Acceptance in religions or ethical association. Ethical and religious associations.
Social Process	**Components.**
Participants	Individuals, groups, value shapers (official, non-official), value sharers (official, non-official).
Perspectives	Value demands, expectations, identities, myths (doctrines, formulas, mirandas).
Situations	Unorganized (territorial, pluralistic), organized (territorial, pluralistic), value inclusive or exclusive, crisis or intercirsis.
Base values	Positive assets (perspectives, capabilities), negative assets (perspetives, capabilities) by value category.
Strategies	Coercive, persuasive, communicative (diplomacy, propaganda), collaborative (military, economic).
Outcomes	Value (indulgences, deprivations), decisions, choices (by phases of decision process).
Effects	Value (accumulation, enjoyment, distribution), institutions (structure, function, innovation, diffusion, restriction).

Decision Process	**Outcomes**
Intelligence	Gathering, processing, dissemination of information.
Promotion	Adding intensity to the dissemination of value demands.
Prescription	Stabilizing expectations on norms to be severely sanctioned if challenged in various contingencies.
Invocation	Initial characterization of a concrete situation in terms of conformity or nonconformity to prescription.
Application	Final characterization of a concrete situation in terms of conformity or nonconformity to prescription.
Termination	Cancelling a prescription and dealing with claims of those who acted in good faith under it.
Appraisal	Characterizing the aggregate flow of decision according to policy objectives, and identifying both formal and effective responsibility for successes or failures.

Problem Orientation	**Questions and tasks**
Goals	What future states are to be realized as far as possible in social process? Goals clarification.
Trends	To what extent have past and recent events approximated the preferret terminal states? Trend description.
Conditions	What factors have conditioned the direction and magnitude of the trends described? Analysis of conditions.
Projections	If current policies are continued or modified, what would be the probable future of goal realizations or discrepancies? Projection of developments.
Alternatives	What intermediate objectives and strategies will optimalize the realization of referred goals? Invention, evaluation, and selection of alternatives

---

Table 4. The organizational diagnostic checklist (Gordon 68:649-650).

DIAGNOSTIC PERSPECTIVE	DIAGNOSTIC QUESTIONS
Historical	1. Is the work defined effectively?
	2. Do work groups operate effectively?
	3. Do managers perform organizing roles and have an appropriate span of control?
	4. Does the group have effective task and social leadership?
	5. Does management work with correct assumptions about employees?
	6. Is decision-making effective?
	7. Is the interface of technology and individual workers effective?
	8. Does the organization's structure respond to environmental contingencies?
Systems	9. Is there a good fit between inputs and operations?
	10. Are there feedback mechanisms?
	11. Are there good fits between individuals, the task, organizational arrangements, and the informal organization?
Perception and Interpersonal Communication	12. What factors influence the perceptions of organizational members?
	13. What distortions of perception occur?
	14. What encoding and decoding errors occur?
	15. What factors affect the accuracy of communication?
	16. What factors influence any "performance appraisal" occurring?
	17. Is the climate supportive or defensive?
Motivation	18. Do rewards satisfy individuals' needs?
	19. Are rewards applied equitably and consistently after desired behaviors?
	20. Do individuals value rewards they receive?
	21. Are rewards consistently applied in proportion to performance?
	22. Do individuals perceive that their efforts correlate with performance?
	23. Do individuals set goals that are specific, difficult, yet accepted?
	24. Do individuals receive feedback about their goal accomplishment?
Stress and Individual Development	25. Is there evidence of stress in the situation?
	26. Do individuals experience role conflict?
	27. Are roles clear or ambiguous?
	28. Do the socialization processes used fit with the situational requirements?
	29. Do the participants experience problems in adult development or career development?
	30. How do the personality styles of participants fit with the situation? with other people?
Leadership	31. Do the managers have the traits necessary for effective leadership?
	32. Do managers display the behaviors required for effective leadership?
	33. Do leaders encourage the appropriate amount of participation in decision-making?
	34. Does the leadership fit with the nature of the task, leader-member relationships, and position power of the leader?
	35. Is the leadership superfluous to the situation and the followers' needs?