IMPROVING THE ORGANIZATION OF ENVIRONMENTAL MANAGEMENT

Ecosystem Management, External Interdependencies, and Agency Structures

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During the past 50 years environmental management objectives have changed significantly. There has been an increase in the public's awareness of environmental problems and in the scientific knowledge of complex biological systems. As scientists have grown more aware of the intricate interdependencies within biological systems, it has become clear that managing natural resources as individual components is both inefficient and ineffective. To manage natural resources successfully requires managing whole ecosystems to promote their health and integrity. However, despite this change in direction for environmental management, few of the government agencies charged with this task have been reorganized or given tools to implement ecosystem management.

Many of the government agencies existing today have changed very little from their original structures—structures that were isomorphic to their original missions. Drawing on political and organizational theories, this article identifies the structural choices available to government agencies and why the current structures may be suboptimal. The article then extends current models of organizational design by elaborating the concept of interdependencies. Traditionally, organization theorists have linked structure closely to the interdependencies *within* the organization. This internal focus, however, may not be appropriate to an organization whose primary task is to manage external constituents, technologies, or resources. A theory of external interdependencies is developed and related to the issue of ecosystem management.

The article then illustrates the ideas presented thus far by demonstrating how these principles may be applied to Washington State. The article proposes a restructure of

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Washington's environmental management agencies to enable them to more effectively and efficiently practice ecosystem management. It should be noted that the applicability of the organization theory and external interdependency ideas developed here is not limited to environmental management. It is likely that these ideas are equally applicable to a large variety of government agencies at the national, state, and local levels. However, for the purposes of illustrating the main ideas, the article will be confined to the narrower application of environmental management.

The Evolution of Environmental Management in the United States

The objectives of many environmental agencies have changed from the ones for which the agencies were originally chartered. Environmental management goals have evolved because of increasing knowledge of biological systems and because of increasing awareness of environmental problems. However, although these goals have evolved, the institutions responsible for pursuing these goals have often had difficulty keeping pace.

Consider the evolution of the Environmental Protection Agency. In the 1940s, the federal government began addressing the problems of air and water pollution by creating a network of bureaucratic institutions to administer its antipollution policies. The driving force behind regulation at this time came from state and local government organizations—not environmental groups. These organizations wanted to build political economies attractive to industry, not to zealously protect the environment. Consequently, there was a great deal of consensus between business and government interests. Later, in the 1950s and 1960s, environmental groups began to gain political clout—in part because of the publication of Rachel Carson's (1962) book, *Silent Spring*, which brought the severity of environmental hazards to light and mobilized the public's interest in environmental issues (Booth, 1995). The environmental groups argued for a politically autonomous agency with the ability to set and enforce rigorous standards. With the passing of the Clean Water Act (1977) and Clean Air Act (1970), environmental forces gained concessions, but the preexisting institutions of pollution control became more firmly entrenched. Efforts to increase the enforcement of the Clean Water Act (1977) could not overcome the unwieldy and complex procedures originally built into the act to protect the interests of business. Enforcement of the new standards was made virtually impossible. Environmentalists' attempts to reorganize the air pollution agency were equally unsuccessful. A major overhaul did not occur until 1970 when the competition between President Nixon and "Mr. Environment" Senator Muskie ultimately led to the amendments of the Clean Air Act (1970) and establishment of the Environmental Protection Agency (Moe, 1989).

In passing the Clean Air Act, industry interest groups (such as the National Coal Association) that had previously opposed clean air legislation were shut out of the decision-making process (Booth, 1995). Furthermore, unlike regulatory measures that had been passed prior to 1970, the act included specific standards and regulatory requirements that were intended to shield the regulatory agency from domination or "capture" by the industries being regulated (Ackerman & Hassler, 1981, pp. 1-12; Booth, 1995).

More recent shifts in the environmental debate had comparatively little impact on the basic structures of environmental agencies. One of these shifts was the increasing awareness of species extinction. It led to the establishment of a number of interagency committees charged with preventing species extinction. This was the motivation behind such regulatory efforts as the Interagency Grizzly Bear Committee, the Interagency Agreement on Spotted Owl Management, CITES agreements, and the pivotal Endangered Species Act (1973). These mechanisms were essentially layered on top of the existing agency structures without fundamentally altering the organizational architectures.[1]

This superimposed emphasis on species protection, however, proved to be an inefficient way to deal with the problem. Single species management efforts are an expensive, and often unsuccessful, means for preserving biodiversity. The Endangered Species Act (1973), although one of the most powerful conservation laws in the United States, is a last-resort, crisis-intervention-type mechanism. By the time a species is classified as endangered, its numbers have dropped so perilously low so that recovering the species often requires a massive effort and millions of dollars—and then may still be unsuccessful. Establishing parks as "islands" of species is also not sufficient; the world's parks, refuges, and nature preserves currently amount to about 3% of the Earth's surface area (World Resources Institute, 1989). Even if this number were doubled, there would still be far too little land to protect all current or future endangered species (Salwasser, 1991).

Today, most researchers, environmental groups, and government agencies agree that trying to save species "one at a time" is not enough—a more encompassing strategy of conserving biological diversity by protecting genetic resources and sustaining biological communities is required. Species-focused management efforts that concentrate on habitat rehabilitation and enhancement to improve areas for particular species ignore the complex interdependencies between species and may create suboptimal conditions for nontargeted species (Sparks, 1995).

The recognition of these interdependencies led to the rise of ecosystem management. An ecosystem approach to conservation views land as a community of soils, waters, and biota that must retain its compositional, structural, and functional integrity (Franklin, 1988) to maintain biological diversity and desired resource yields. The objective of ecosystem management is the simultaneous sustainability of both the social and natural environments (Pastor, 1995). (For a more extensive discussion of the philosophical and scientific underpinnings of ecosystem management, see Francis, 1993.) Ecosystems may be defined by physical or ecological factors such as watersheds, mountain ranges, or forests. The scale at which they are classified is determined by the purposes of the classifier—at any scale an ecosystem is classified, it remains a part of a larger ecosystem (Salwasser, 1991). Ecosystems most commonly refer to a "distinct and coherent ecological community of organisms and the physical environment with which they interact" (Slocombe, 1993, p. 613). For management by a government agency, it is practical to limit the scale of the ecosystem to a size that does not overload the capacity of the agency to integrate the components within the ecosystem.

Ecosystem management has become widely accepted as the new direction for environmental management. The World Conservation Union has expressed the hope

that "ecosystem management will improve the quality of human life while living within the carrying capacity of ecosystems" (Pastor, 1995, p. 286). The importance of ecosystem management is also gaining increasing attention at the federal government level as a new approach to resource management and environmental regulation. The Clinton administration allotted start-up funding for an ecosystem management effort in the 1995 budget and has already gained the pledged support of agencies such as the U.S. Fish and Wildlife Service (Jackson & Wyner, 1994).

However, to implement a transition from managing single species or components of ecosystems to managing *whole* ecosystems, changes in agency structures are required. Pastor (1995) notes that to effectively manage ecosystems, we need new technical, institutional, and financial tools that recognize ecosystem and societal configurations at many levels. In addition, we need new institutional arrangements and attitudes to implement these tools.[2] Slocombe (1993) adds, "Ecosystem-based management requires not only the greater ecosystem concept, it also requires a new interdisciplinary framework to integrate research, planning, and management to facilitate an appropriate process" (p. 632).

Ecosystem management requires integrating agencies so that all relevant agencies willingly cooperate in carrying out combined programs in research, management, education, and monitoring (Salwasser, 1991). However, most government agencies responsible for managing the environment are currently structured so that each department handles only a part of any ecosystem,[3] such as wildlife population management, air or water quality management, or timber sales management. This leaves the departments in a very poor position to practice ecosystem management because it requires an integrated strategy for the diverse components of the environment. Overlapping jurisdictions, competing interests among different agencies, and differing goals create obstacles in achieving integration and often lead to conflict between agencies rather than cooperation (Slocombe, 1993).

Ecosystem management is really a set of diverse objectives with sometimes conflicting goals that must be balanced. For example, the demands of logging companies requesting permits for cutting must be managed simultaneously with the public's demand for preserved forests and their resident wildlife populations. A less obvious example is seen in the case of fisheries: National and state fisheries hatch fish to maintain fish populations for commercial fishing and sport fishermen, yet critics argue that fishery-hatched species are supplanting more delicate indigenous species, forcing native fish populations down and threatening their survival.

Recognizing the interdependencies between species and the diverse objectives of ecosystem management still leaves us with the question "How should environmental agencies be structured?" Ecosystem management requires redefining the management units to enable them to practice integrated environment and development planning within a coherent region (Slocombe, 1993). We now turn to the structural choices available to environmental agencies.

Structural Choices for Environmental Agencies

Current structures of environmental agencies have evolved over time through incremental structural growth. They are the result of political processes and initiatives

that impinge on legislative decisions to create and change environmental agencies. Successful political initiatives tend to be narrow in focus, simplistic by design, uncontroversial, ad hoc, and often favor immediate returns over long-term outcomes. Political processes that shape governmental agencies tend to be subject to limited attention, ambiguities of problems and solutions, political maneuver, coalition formation, and garbage can decision making (March & Olsen, 1989). Whereas business organizations strive to create a structure that is suited to their strategy (maximizing their long-term effectiveness and efficiency) and will reshape their structure as their strategy changes, political organizations rarely have a structure that has a close fit to their current strategy. Political managers often lack the power and the incentive to fight for changes in structure, "their tenure is too short, and control over structure is almost always shared among executive and legislative bodies" (Bower, 1983).

The resulting structures of agencies are characterized by what could be called "historical modularity," that is, they consist of multitudes of different components, each dedicated to purposes prominent at the time of their founding. They reflect a history of repeated games with shifting coalitions, shifting winners, and shifting purposes. Each game generated sufficient political impulse to add a new component with a particular mission but was too weak to attack, to restructure, or to integrate the old, established components. The myopic, precarious character of the underlying political processes prevented fundamental reorganizations of the involved agencies. In this way, a multitude of "single-issue" agencies were created over time. For example, in Washington State, the Department of Fisheries was founded in 1890 (under the name "Fish Commission"—it became the Department of Fisheries in 1921); the Department of Wildlife was founded in 1933; the Department of National Resources was founded in 1957; and the Department of Ecology was founded in 1970. Most of these agencies remain unchanged today. The only exception is a merger of two agencies (the merger of the Departments of Fish and Wildlife in 1994), which, from today's point of view, appears totally obvious but took nearly 60 years of independent existence of both agencies to occur.

The organizational structures generated this way are not necessarily optimal. The evolution process is highly path dependent. The creation and shape of new agencies are highly dependent on the array of existing agencies, that is, the range of issues in their jurisdiction; political forces attempting to weaken, strengthen, or balance the power of old and new agencies (Moe, 1989); political maneuver on the side of actors in the old agencies; issue attention cycles (Downs, 1972); and so forth. Such path-dependent processes of organizational structure generation are unlikely to reach optima of organizational efficiency, interagency coordination, or political responsiveness. Rather, conflicts, redundancies, and inefficiencies abound.

Theories of organization design attempt to identify efficient structures for organizations. Underlying these approaches is the assumption, derived from contingency theory (e.g., Lawrence & Lorsch, 1967; Woodward, 1958), that some structures are better in some environments than in others. Organizations that match their structures to their environmental contingencies experience higher performance.

A number of structural types are discussed by organizational design approaches. Basic types are the functional and the divisional structure. Functional structures result

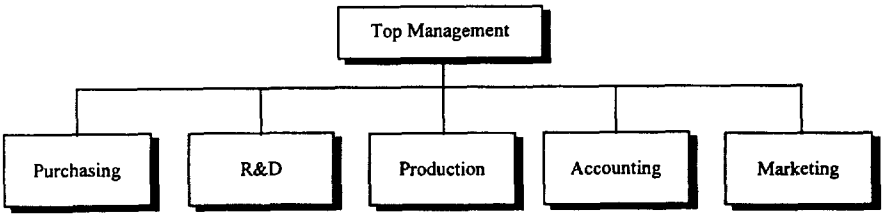

Figure 1. Functional Structure

by dividing the organization's tasks into functional departments managed by professional managers (see Figure 1).

This organization structure has the advantage of economies of scale within functional areas and allows functional experts to specialize within the department (e.g., tax accounting, bad debt accounting, etc.). The different departments (e.g., manufacturing, sales, marketing) are controlled separately through a master plan and operating budget. This type of structure is best suited to small to medium-sized organizations that produce a limited line of related products sharing a common core technology. It is also a cost-effective means of providing standardized products and services on a high-volume basis. However, the structure suffers from extreme rigidity and does not allow easy movement into new markets or products. It fosters specialists rather than generalists. Most coordination is performed at the top of the hierarchy (Miles & Snow, 1978). Responsiveness is low because issues frequently have to travel up to the highest functional levels for adjudication (Fouraker & Stopford, 1968).

Interagency lawsuits are an excellent example of how functional department conflicts can escalate, resulting in large time and money expenses as the agencies resolve their differences in court. For example, in 1993 as the debate over old-growth cutting limits became a national concern, Washington's Department of Wildlife sued Washington's Department of Natural Resources, forcing their conflict to be settled in court and costing the state a great deal of money.

In a divisional structure, general mangers are placed in charge of largely self-contained divisions that are centered around a particular product (known as product structure) or region (known as geographic structure; see Figure 2).

> Each division could be directed to a particular market, could design and produce its own product or service, and could make the operating decisions necessary to coordinate its own functionally structured components. In a sense, each division faced the same set of problems that the larger parent organization had failed to solve, but now the magnitude of these problems was reduced to more manageable proportions. (Miles & Snow, 1978, p. 119)

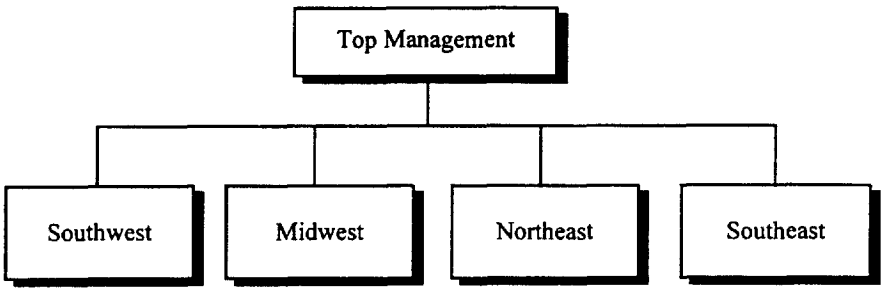

Figure 2. Geographic Structure

Experts from each of the functional areas are now located together in a department with a narrower focus (Daft, 1992; Nadler & Tushman, 1988). They can attend to the needs of a particular area and coordinate their activities to best meet those needs. Response to change is much faster because all the necessary actors are in one location.

Organizational choices between structural types (i.e. functional, divisional structures) were intensely discussed in the organization design literature (e.g., Daft, 1992; Galbraith, 1973; Mintzberg, 1993; Nadler & Tushman, 1988). A main concern of that literature is the formation of organizational structures through grouping of positions and units. Grouping is a fundamental means to coordinate work in organizations (Gulik & Urwik, 1936). By grouping similar tasks together, organizations can reap economies of scale. Grouping also provides the foundation for the organizational hierarchy of authority. It results when organizations establish group leaders and assign these (via "reporting relations") to groups of superiors.

Most researchers in the organization design tradition have emphasized one criterion of grouping: the pattern of interdependence between organizational parts. They have argued that organizations should group highly interdependent tasks together and allocate independent parts to different groups (e.g. Galbraith, 1973; Mintzberg, 1993). Even critical writers on this subject, such as Simon (1973), have subscribed to this "principle."

A main reason for this grouping scheme is the cost of coordination. Grouping highly interdependent units together minimizes coordination costs. Organizations that violate this grouping principle will incur high coordination costs. When organizations allocate highly interdependent units to different groups, coordination has to occur between groups. This involves extensive communication across organizational interfaces and opens up a host of communication problems, such as channels with limited capacity, filters with oblique permeability, and interpretation based on remote criteria. Moreover, in hierarchical organizations, coordination problems have to rise to higher levels of the hierarchy until they arrive at a level that is responsible for all the groups involved. In tall hierarchies such hierarchical referral can entail extensive and slow vertical

communication, as well as considerable overload of top positions in the hierarchy. Organizations can avoid such coordination costs by creating "self-contained structures" (Galbraith, 1973, p. 16) or "functionally integrated small units" (Durant, 1992, p. 359) that group interdependent tasks together.

However, despite its usefulness, the interdependence criterion leaves some uncertainties for designers of organizations and agencies. The principle, by itself, does not define where interdependencies reside, how they emerge, and how they change. Without knowing the location, origin, and dynamics of interdependencies, most efforts to apply the interdependence criterion will be suboptimal and subject to fast obsolescence.

An External Interdependence Approach to Agency Structure

Past work on organizational design and interdependence mainly emphasized intraorganizational and technological sources of interdependence,[4] for example, pooled, sequential, and reciprocal interdependencies resulting from particular organizational technologies (Thompson, 1967); interdependencies resulting from the division of labor (Galbraith, 1973); or scale and process interdependencies (Mintzberg, 1979).

In contrast, we propose that for environmental agencies the main locus of interdependencies is in the external environment. Environmental agencies are charged with a public mandate. Unlike most business organizations, the main task of environmental agencies is not to exploit a given configuration of organizational assets and resources. Rather, their task is to manage public goods, which, by their very nature, are (a) external and (b) subject to intense and highly conflicting demands from multiple constituencies.

Environmental agencies have to pay attention to interdependencies in the natural environments they are charged to manage. If these agencies take ecosystem management seriously, then the structures of environmental agencies should match the patterns of interdependence in ecosystems. This then poses the question: "What are the patterns of interdependence in ecosystems?"

The very concept of an ecosystem is based on the principle that elements within each system are more interdependent than elements of different ecosystems. This does not mean that different ecosystems are independent of each other. Ecosystems interact with each other, are partially nested within each other, and can set parameters for each other, especially in the long term. However, the main interdependencies run within individual ecosystems: The species within an ecosystem interact in complex and multiple ways. For example, they depend on the same resources (competition), provide resources for each other (symbiosis), feed on each other (predator-prey relationships), tolerate each other, and so forth. Slow processes of mutual adaptation of species create highly sensitive and sometimes unique equilibria within these systems.

In contrast, the elements of different ecosystems are comparatively less interdependent. Physical distance is just one reason. Other reasons include (but are not limited to) differences in terrain and soil, climatic differences, and established habitats. These differences result in reduced interaction of species of different systems. Equilibria within systems depend less on influences of other systems than on influences from within the system. Symbiosis, predator-prey relationships, and competition between species of different ecosystems are comparatively limited.

The patterns of interdependence in ecosystems imply that changes in ecosystems require high coordination with other components within the same ecosystem, but comparatively less coordination with components of other ecosystems. For ecosystem management this means, for example, that projects located in different ecosystems require less coordination than those located in the same ecosystem. It also means that different standards can be applied to different systems.

An agency design that minimizes coordination cost would have to take this ecosystem pattern of interdependence into account. Environmental agencies should have a structure that matches this pattern. They should use ecosystems as the main grouping criterion, thereby allowing the main coordination load to accrue within organizational units rather than between. Such an ecosystem-based structure allows environmental management to be tailored to local conditions within ecosystems. Environmental standards and goals can be specified, adjusted, and enforced in tune with local requirements of the ecosystems. Communication between the relevant positions is direct, fast, and much less dependent on characteristics of communication channels and filters. Decisions can much faster be made, without setting precedents for other systems. Expertise with local conditions can be developed and used.

To illustrate these ideas, the article will now discuss an ecosystem-based structure for environmental agencies in the state of Washington.

Environmentally Oriented Government Agencies in Washington State

The main Washington State agencies responsible for managing the environment include the Department of Fish and Wildlife, the Department of Ecology, and the Department of Natural Resources. A brief outline of their responsibilities follows.

Department of Fish and Wildlife. This agency is responsible for the preservation of wildlife and fish for commercial and recreational purposes. This is the agency that issues hunting and fishing licenses, and monitors wildlife population levels. It is also responsible for the state's fisheries and populations of salmon, and has authority over commercial fishing and land use issues that affect streams.

Department of Ecology. This agency is responsible for pollution regulation including water quality, hazardous waste, solid waste, and shoreline management.

Department of Natural Resources. This agency is responsible for the regulation of forest practices, gas and oil conservation, surface mining, and smoke management. It manages federal trust lands, aquatic lands, forest board lands, and heritage conservation lands. In addition, it is responsible for public service delivery such as fire control and environmental education.

In recent years, the problems with attempting to manage separate elements of the environment as individual units have increasingly been the focus of public concern in Washington State. Scientists and environmentalists have been urging a new focus toward ecological health and integrity. This new focus has not been limited to Washington; in fact, in 1990, the Science Advisory Board of the U.S. Environmental Protection Agency (EPA) urged the EPA to place as much emphasis on decreasing ecological risk as on decreasing human health risk (Karr, 1992; Karr, Fausch, Angermeier, Yant, Schlosser, 1986).

The environmental agencies of Washington State were infused with the need to "manage ecosystems," yet they were not given any mechanism by which to accomplish this feat. The agencies are structured like functional departments of the larger Washington State organization. The product that they are to produce for the Washington public is ecosystem health; this requires balancing the needs for preserved habitats to maintain biodiversity and ecological health, with the needs of the commercial and recreational users of Washington's natural resources. Each agency is responsible for a functional component of this goal. Although all of the agencies are being pressed to find ways to protect or manage ecosystems, each of the agencies only has jurisdiction over a small part of any ecosystem. For example, if a project is proposed for an area, its impact on the wildlife must be approved by the Department of Fish and Wildlife, its potential for pollution must be approved by the Department of Ecology, and its impact on trees must be approved by the Department of Natural Resources. There is no mechanism by which to formulate goals or implement strategies for an entire ecosystem. Like any large organization with a functional structure, these agencies suffer from inefficiencies of too broad of a focus, poor coordination between functional activities, and incompatibility of goals.

The Proposed Restructure

These agencies could be restructured to a geographic structure by creating cross-functional departments that are oriented around ecosystems. The structure first requires delineating the state into significant ecosystems (see Figure 3). Several biologists have suggested the delineation illustrated here (Franklin & Dyrness, 1976), although this is by no means the only option. The number of different areas designated would be determined after carefully evaluating the distinct environments and the resources of the existing agencies.

Each division of the new structure (see Figure 4) would be dedicated to the management of a specific area/ecosystem, and each functional area would be represented in the department. This is similar, in concept, to the relationship of individual state governments to the national government. However, boundaries are drawn around physiographic provinces according to biological characteristics rather than the sociopolitical boundaries that define states. As Deborah Jensen of the Conservation Science Division of the Nature Conservancy points out (Seastedt, 1996), ecological boundaries seldom match up with either land ownership or political boundaries. If ecosystem management is to be the environmental agencies' goal, it seems sensible to make the departments ecosystem centered.[5]

The decentralized nature of expertise and authority in an ecosystem-based structure would allow agencies to respond quicker to emerging problems and avoid confusion over jurisdiction (Daft, 1992). This would also vastly improve the issue of accountability for the agencies. In the past, problems have frequently occurred because it was unclear which agency was accountable for a particular problem. The cutting of old growth in the Pacific Northwest is an excellent example; although the Department of Natural Resource has official authority over tree cutting, the resulting deforestation greatly affected fish and wildlife populations, an issue to be handled by the Department of Fish and Wildlife. An ecosystem-based structure establishes geographic jurisdic-

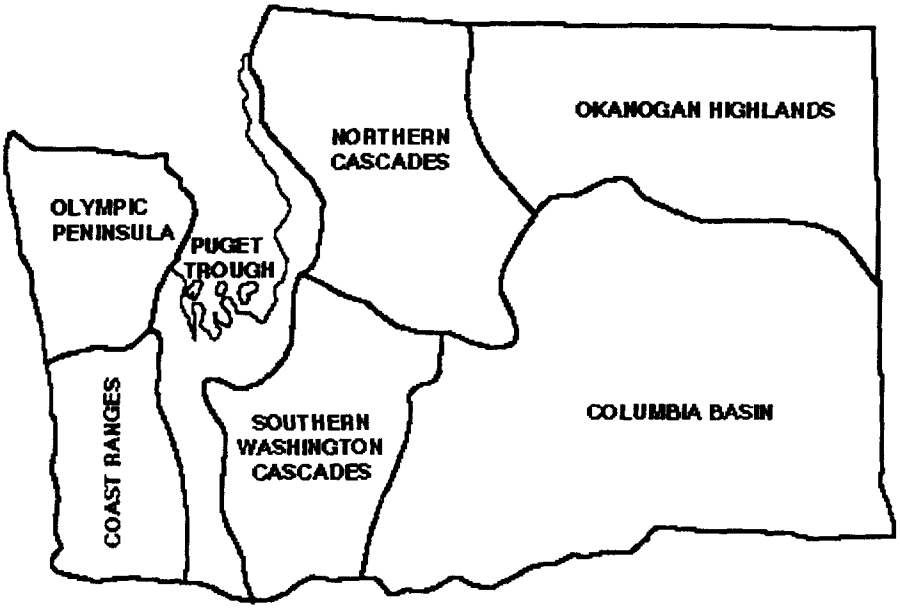

Figure 3. Physiographic Regions of Washington
Source. Adapted from Franklin and Dyrness (1976).

tions with clear geographic boundaries. It delineates accountability in terms of regional areas and therefore regulates which agency has authority over issues that arise.

Another advantage of the ecosystem-based structure is related to interunit coordination. Adjacent geographic units of the new structure have similar goals. The functional units of the old structure have highly dissimilar, conflicting goals. If an issue pertains to more than one geographic area, it will be simpler to coordinate the actions of two geographic divisions with similar goals than to coordinate two functional departments with dissimilar goals.

Comparing performance among the different geographic divisions of the new structure will be more straightforward than comparing the performance of different functional departments in the current structure. First, in the current functional structure, high performance in one functional area (e.g., endangered species protection) is often gained at the cost of low performance of other functional areas (e.g., logging rights). Because performance of the functional departments depends on political support, performance measures in the current structure are chronically confounded with political success. In the new structure this is unlikely to occur because the territorial subunits cut across individual functions and mandates. Second, in the current structure, performance comparisons are problematic because functional departments are performing very different tasks. In the new structure, the territorial subunits are similar in terms of structure and outputs. Standardized, ecosystem-level performance measures can be established that integrate across diverse functions. These ecosystem-

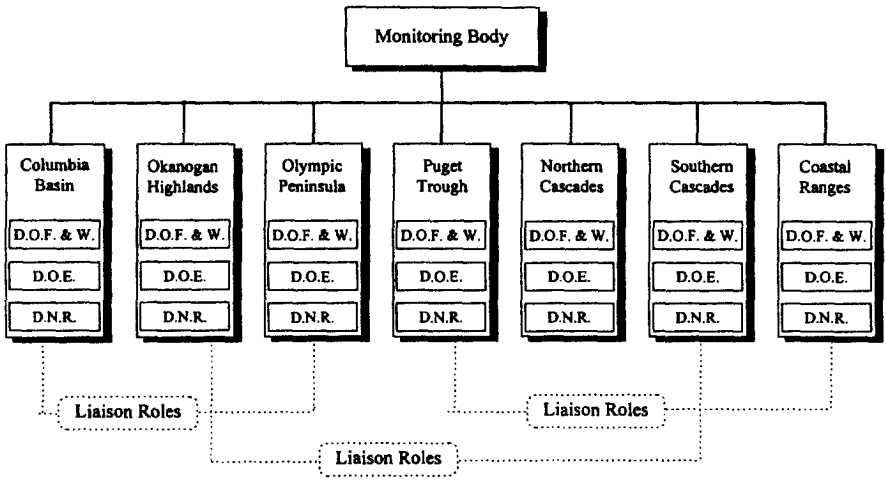

Figure 4. Ecosystem-Based Organization Structure

level measures would evaluate the overall performance of ecosystem management for each territorial unit, allowing more efficient capital allocation (Williamson, 1970, 1985).

The performance of the ecosystem divisions would be evaluated by a statewide monitoring body rather than by local constituents.[6] Centralized performance appraisal will avoid giving local interest groups undue pull over individual divisions. This will help to facilitate unbiased, nonpartisan decision making in the agency. The monitoring body also would be responsible for long-term planning of the agency. As Chandler (1962) has argued for the multidivisional firm, the monitoring body would be staffed with members who are not responsible for short-run operating results and therefore would be given the time and psychological commitment necessary for long-term planning in the interest and well-being of the community of ecosystems as a whole.

To objectively monitor the performance of the departments and make rational budget decisions, it is imperative that members of the monitoring body are not monetarily tied to any of the departments. For example, the monitoring body should not be composed of the senior managers of each of the departments; this would foster favoritism and suboptimize the goals of the state as a whole. In addition, the members of the monitoring body should not be employed by any special interest groups, as this

could also result in less-than-optimal results for the state. By keeping the monitoring body as a separate entity from the ecosystem departments, it reduces the ability of individual departments to engage in opportunistic behavior, and it enables a more accurate assessment of performance (Williamson, 1975).

Because some ecosystems will have greater needs of particular functions than others, the agencies would not be divided up equilaterally; rather, their resources would be distributed in accordance with the needs of the area. For instance, the Puget Trough area might warrant more Department of Fisheries experts than the Okanogan Highlands.

Of course, the self-contained structure is not without cost; it may cause the organization to require duplicated resources. However, the duplication due to specialization may be less costly than the additional slack resources required by a functional structure (Galbraith, 1973). Forming separate ecosystem departments that have the functions of departments of fish and wildlife, natural resources and ecology will undoubtedly require some duplication of equipment or human resources. This can be attenuated by creating circumstances whereby departments can share certain resources such as on-line data storage and retrieval for sharing records and information, thus reducing the duplication of effort among departments. Similarly, an electronic communication system between the departments would allow employees to share experiences and ideas with their functional colleagues in other ecosystem departments so that some economies of scope can be retained.

Because issues are likely to arise occasionally that encompass more than one ecosystem, it may be necessary to assign people in the departments to formal liaison roles responsible for coordination and communication between departments.[7] If a problem demands a higher level of coordination between departments, a task force may be assembled, composed of individuals from each ecosystem area involved, to resolve the issue (Galbraith, 1973).

These ideas, first presented by the authors to the Washington State legislature in 1993, were considered somewhat "radical" and perhaps impossible to implement because of political obstacles. However, the advantages of an ecosystem-based structure for environmental agencies are rapidly gaining acceptance in both scientific and political arenas. Wisconsin has adopted a "modified media model" whereby there are separate media divisions for air and waste management, land and water, but also five field regions and a statewide office. Their mission states that they have adopted decentralized operations for two main reasons: "to bring us closer to local people and local issues, and because we handle a wide range of environmental responsibilities." Florida has taken an even more integrated approach. Florida's Department of Environmental Protection (DEP) was created in 1993 with the merger of the Departments of Natural Resources and Environmental Regulation. Its Environmental Reorganization Act of 1993 required DEP to "protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory and planning programs." Their mission states that they are achieving this legislative mandate by "reorienting its programs along ecosystem rather than political or administrative boundaries. This management concept, known as ecosystem management, integrates diverse programs to achieve priority environmental goals."

Conclusion

There is a great deal of consensus between environmental groups, governmental agencies, and the public that we need to manage for ecosystem health, yet there has been an equal amount of confusion as to how to accomplish this goal. Agencies were given the directive to "manage ecosystems" without being given mechanisms for doing this task. The agencies were originally developed in response to individual problems, and this structure was not critically analyzed for its continued applicability; if agencies are to manage ecosystems rather than individual species (e.g., salmon) or for individual users (e.g., loggers), then they should not be organized around these individual functions. By integrating the functional areas and organizing departments around ecosystems, agencies will be able to finally meet the elusive task of "managing ecosystems." This structure would yield a great number of benefits, including (but not limited to) the following:

- Divisions that are oriented toward managing ecosystems, instead of managing individual species, projects, or interest groups
- Enhanced responsiveness for problems arising between species and within ecosystems, because the necessary/relevant experts from each function are located together and their efforts are coordinated
- A line of responsibility and jurisdiction that is clear, designating the parties with *responsibility of attending to ecosystem needs*, and designating the parties with the *authority to make decisions* relating to the ecosystems
- Reduced conflict between departments because geographic departments will have almost entirely complementary goals, as opposed to the often mutually exclusive goals of functional departments
- Goals of the geographic departments that are more closely aligned with the goals of the state as a whole

The preceding demonstrates that organization theory and the notion of external interdependencies may be used to reorganize governmental agencies so that they may more effectively practice ecosystem management. However, the ideas easily extend to all kinds of organizations whose main transformation processes occur outside of the organization. For example, they might also apply to the Social Security Administration, the National Marine Fisheries Service, the Department of Energy, railways, and telecommunications, just to name a few. For some of the organizations of this type, the importance of external interdependencies is already reflected in their structures—probably as a result of managerial intuition. Future research should be directed at exploring what types of organizations would benefit by having their structures guided by consideration of external interdependencies.

Notes

1. Moe (1990) notes that government agencies may fail to adopt efficient organizational structures because they are not subjected to the same market forces that drive businesses to adapt to changing objectives and environments. Whereas the economic system "weeds out" those firms that do not adopt efficient structures, the political system does not weed out the inefficient, and political actors may not typically be concerned with efficiency (p. 119). Moe also notes that although organization theory and political science originally developed "in tandem," they have since diverged substantively, and as a consequence, organiza-

tion theory (or other economic models of organization) are rarely applied to public administration (p. 116) despite their obvious usefulness.

2. A growing recognition of this fact can be seen in the recent environmental literature that argues for "multimedia" management of environmental systems rather than management through individual media such as air, land, and water.

3. Of the 27 states we were able to obtain organization structure information on, 25 used a functional structure, usually with separate divisions or departments dedicated to fish and/or wildlife, forestry, water quality, or similar divisions.

4. Although we find some discussion of external interdependencies in the resource dependence literature (e.g., Pfeffer & Salancik, 1978), it is confined to organizational strategies to reduce or avoid resource dependence. The coordination cost implications of external interdependencies have, quite interestingly, not been explored in previous research.

5. California has taken a similar approach in integrating the functional areas; however, it has not broken the agency down into an ecosystem-based structure such as this one; the narrower focus of these physiographic provinces would prevent the agencies from being overloaded with too much information and too many diverse needs to manage.

6. Additional measures to increase impartiality of the monitoring body would focus on the composition of the monitoring body, for example, a large proportion of environmental scientists would help to infuse environmental knowledge into agency decisions and potentially reduce partisan decision making.

7. For example, Pennsylvania, which established its geographic-based Department of Environmental Protection in July 1995, has a deputy for field operations who serves as a liaison between the field operations directors and the central office bureaus.

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